Plumas/Lassen Administrative Study
2002 Annual Report
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Introduction

The Pacific Southwest Region and the Pacific Southwest Research Station have agreed to jointly develop and fund an administrative study to fill management information needs concerning the relationship between management-caused changes in vegetation and their effects on spotted owl habitat and population dynamics. The original impetus for this study is in the Record of Decision (ROD), dated January 12, 2001, for the Sierra Nevada Forest Plan Amendment (SNFPA), Final Environmental Impact Statement (FEIS). In this document the Regional Forester presented his decision to amend the Pacific Southwest Regional Guide, the Intermountain Regional Guide and land and resource management plans (LRMPs) for national forests in the Sierra Nevada and Modoc Plateau. Among the elements of this decision was a commitment to develop in collaboration with PSW, a Study that would examine the relationship between management-caused changes in vegetation and their effects on spotted owl habitat and population dynamics. The Regional Forester specifically stated in the ROD:

> "Under the procedures of the adaptive management strategy in this decision, the Forest Service will cooperate with the Pacific Southwest Research Station to design and implement an administrative study to examine the relationship between management-caused changes in vegetation and their effects on spotted owl habitat and population dynamics. I would expect group selection provisions of the HFQLG pilot project as well as other treatments to be used in carrying out this study. The administrative study is intended to investigate the response of the California spotted owl and its habitat, particularly populations of prey species features of their habitats, to various silvicultural treatments."

Purpose of the Study

The fundamental intent of this study is to examine responses of key forest elements to several approaches to fuels management and sustainable silviculture in the Sierra Nevada. The study attempts to investigate these relationships at the landscape scale, over significantly larger spatial scales (aggregations of watersheds averaging about 50,000 acres) and longer time scales (20 + years) than has been done before. It would assess forest responses to the combined effects of both management treatments and natural forest processes. A landscape-scale design provides a comprehensive view of how forest elements, including rare species, cope with a constantly changing environment.

This study is interdisciplinary, examining at least five groups of response variables (spotted owls, small mammals, terrestrial birds, vegetation, and fuels conditions) through collaboration between researchers of the USDA Forest Service Pacific Southwest Research Station (PSW) and cooperators from the University of California, Berkeley and Davis, and the Point Reyes Bird Observatory. The study addresses the most significant uncertainties that confound management decisions in the Sierra Nevada today. How do old-forest-dependent species respond to vegetation management over space and time? Do fuels management approaches effectively address fuels loadings without negatively affecting species viability? These issues are at the heart of the controversy over the Sierra

Nevada Forest Plan Amendment (SNFPA) and are highlighted in the Adaptive Management Strategy that is part of SNFPA.

Objectives of Study

The need for the proposed research project is to resolve persistent questions about the effects of vegetation-management actions upon wildland fire behavior, silvicultural goals, landscape dynamics, and old-forest-dependent species viability. The objectives of the proposed research project is to gather needed scientific data to resolve these key ecological and forest-management questions so as to inform future management decisions.

Accordingly, the proposed research program is designed to address four principal issues:

•***Wildland Fire Behavior and Protection.*** Are specific combinations of defensible fuel profile zones (DFPZs) and subsequent area fuel treatments effective in reducing the extent and severity of wildland fires? (These two types of actions are defined in the subsequent Proposed Action section.) What are practical considerations and costs of constructing, maintaining, and using alternative combinations of fuel treatments? Are hypothesized fire-management gains from these fuel-treatment combinations (in the form of reduced property and resource losses, increased resource benefits from wildland fires, and increased suppression efficiencies) commensurate with the costs and potential adverse ecological impacts of the treatments? Are realized fire management benefits consistent with hypothesized results in reducing fire risk and altering fire behavior?

•***Silvicultural Goals.*** Is small group-selection silviculture effective in promoting regeneration of shade-intolerant tree species; establishing desirable forest age, species, and size distributions at landscape scales; and providing sustainable levels of timber harvest? What are the practical considerations, limitations, and costs of implementing a group-selection silvicultural system over short- and long-term time frames? ("Group selection", an uneven-aged silvicultural system, is described in detail in the Herger-Feinstein Quincy Library Group [HFQLG] Final Environmental Impact Statement [EIS].

•***Landscape Dynamics.*** How do combinations of DFPZs, area fuel treatments, group selection, riparian protection standards, and species-specific protection measures affect landscape dynamics such as forest structure, composition, and succession at multiple scales of space and time?

•***Species Viability.*** How will old-forest-dependent species, particularly the California spotted owl and its prey, respond to changes in vegetation composition, structure, and distribution induced by different forest management regimes? How is change manifested at the individual and population levels of biological organization?

We have developed individual research modules that address the major issues. Results to date are discussed in detail under Response Variable Modules below and the specific study strategies are described in Appendices D, E, F, G, and H of the overall Study Strategy for this project. These five research modules include:

- Forest structure.
- Fuels, fire behavior, and fire effects.
- Spotted owl responses.
- Small mammal distribution, abundance, and habitat relationships.
- Landbird distribution, abundance, and habitat relationships.

Study Plan and Treatments

This study comprises is a significant component of the SNFPA Adaptive Management Strategy, and as such, it is intended to address key questions and uncertainties. Adaptive resource management is management by experiment. In this vein, we propose subjecting portions of the Sierra Nevada's westside coniferous forest ecosystem to several alternative management actions and test a set of predictive models that represent competing hypotheses about how the system will respond. This approach acknowledges that the relationship between the chosen management action and the mechanism that affects the system is far from precise. We know there will be sources of variation in the measured response variables that will be unexplained by the models. Nevertheless, we will learn about ecosystem functioning by monitoring responses within each treatment regime and evaluating alternative ecosystem models to determine which ones provide the best fit to the observed responses.

Experimental Design Issues

We believe it is important to establish a research framework that addresses forest management at the scale at which it is normally executed. Two crucial questions are addressed best at the landscape scale; owl population and fire behavior response. The natural landscape is a spatial-temporal mosaic of a variety of ecological characteristics, with each landscape element responding to different stressors over differing spatial and temporal scales. Experimental and analytical approaches at a landscape scale are complicated by the large land areas involved. Working with treatment units of large size (i.e. an average of 50,000 acres) creates difficulties in identifying spatial replicates and controlling potentially extraneous variables. Furthermore, it is difficult to identify homogenous landscape units at the outset of the experiment. Intrinsic landscape variability and land-use histories (over 100 years) confound the identification and delineation of suitable sampling units. Moreover, even in the absence of any treatment it is impossible that existing landscape characteristics would have identical trajectories throughout the duration of the research project.

While some response variables need to be studied at the landscape level, other response variables will need to be examined using smaller geographic domains, which will enable use of more standard experimental designs. The study is therefore designed using nested hierarchical spatial domains for the response variables, addressing different response variables over the appropriate spatial domain suited to each variable. This will enable simultaneous investigations of a range of important response variables.

Watersheds, which serve as Forest Service management units, have been chosen as useful geographic units for study. Such topographic definition is relevant to daily, seasonal, and annual movements of animals. By identifying a group of adjoining watersheds, a landscape unit is defined that is relevant to larger scale ecosystem processes, including population processes of larger, wide-ranging animals, such as California spotted owls. The following criteria were used to identify logical watershed units within the study area in which various options for vegetation management could be applied. These are called treatment units.

- Each treatment unit includes a group of entire CalWater Planning Watersheds (i.e. watersheds are not split).
- Each treatment unit is large enough to contain 10-20 pairs of California spotted owls. This number is considered the minimum number necessary to assess effects of treatments at the population-treatment unit scale.
- Each treatment unit contains relatively high amounts of land available for forest management.

Based on application of these criteria, 11 treatment units were identified within the study area. These units range in size from 45,000 to 79,000 acres, averaging 55,700 acres. Two of the treatment units are located on the LNF, and 9 are located on the PNF. The total area in the treatment units is 613,000 acres, of which 493,000 (80%) are administered by the National Forests. The qualifying treatment area comprises 54% of the study area.

Three vegetation treatment regimes have been formulated for application to the treatment units. All regimes focus upon reducing wildland fire hazard, but each regime focuses upon different aspects of vegetation management. The regimes are intended to be distinctly different from each other such that monitoring and effects analysis is likely to address the four research questions posed above.

The overall study strategy is captured in a document that describes the overarching framework for the study as well as the objectives for the individual modules. This strategy was originally drafted in April of 2001. The first round of review was informal and led to a second draft in September of 2001 when a scientific peer review was conducted. Six scientists were asked to review the document and their comments were solicited. Simultaneously additional input was sought from interested parties. This led to a third draft in March of 2002 which incorporated comments received to date. With this third draft the Plumas and Lassen National Forest staffs began the development of a purpose and need statement and subsequently a Notice of Intent to pursue an EIS for the proposed treatments. The study strategy is now being revised for a fourth time to reflect the proposed action and additional comments and thoughts regarding the overall study design.

Treatment Definitions and Regimes

Each treatment regime involves 2 or 3 treatments types:

•***DFPZs***

•***Area fuel treatment***s

•***Group selection***

Three regimes, with at least 3 replications, are the most that will fit upon the available land base. The three selected treatment regimes, referred to as Treatment Regime A, B, and C in this document, are summarized in general terms in Table 1 and described in detail below. All treatment regimes would reduce wildland fire hazards. Treatment Regime A would result in the least amount of direct human-induced change and emulates, for the most part, the vegetation-management standards called for in the SNFPA. Treatment Regimes B and C would result in increasingly higher levels of human-induced change but would still allow for persistence of existing forest-stage development, create and maintain a sustainable small patch mosaic forest structure, and contribute forest products.

Response Variable Modules; Progress in 2002

Fuels and Fire Module

2002 Annual Report: Landscape Fuel Treatment Effectiveness in the Plumas and Lassen National Forests

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Objectives

The goal of this component in the project is to determine how landscape level fuels and silvicultural treatments affect potential fire behavior and effects. Past management activities including fire suppression, harvesting, and livestock grazing have changed the structure of many coniferous forest in the western United States, particularly those that once experienced frequent, low-moderate intensity fires (Biswell 1961, Hartesveldt and Harvey 1967, Parsons and DeBendeetti 1979). Changes in climate over the 20th century could have also influenced present ecosystem structure. Restoration of these ecosystems is the goal of the project but there currently is limited information on the effects of such treatments, especially at the landscape scale.

Data collection methods

Information will be collected at 2 scales, first within the nested vegetation plots (0.1 to 1 ha) and second, using remote sensing at the scale of the watersheds (17,800-32,000 ha). Ground data collection is being coordinated entirely with the vegetation module sampling crew to maximize efficiency in sampling and analysis.

Ground based sampling of ladder, surface, and ground fuels

Surface and ground fuels will be sampled in each of the vegetation field plots using the line intercept method (Brown 1974) augmented with information collected from Sierra

Nevada conifers (van Wagtendonk et. al 1996; 1998). At each plot center, two randomly placed azimuths will be used to sample surface fuels. Each azimuth will have a 10 meter fuel transects installed and 1 and 10 hour fuels will be sampled from 0-2 meters, 100 hour from 0-3 meters, and 1000 hour fuels data from 0-10 meters. Duff and litter depth (cm) will be measured at 3 and 10 meters along each transect.

Ladder fuel height will be estimated ocularly to the nearest 0.25 meters at each plot. Average fuel height will also be estimated ocularly at each plot to the nearest 0.25m. In addition, an expert-based set of criteria will be used to assign an overall ladder-fuel hazard rating to each site.

Data will be collected to quantify course woody debris (CWD) as a supplement to fuel load data. Fuel load data will give excellent estimates of loads (metric tons/ha) but will not give good information on the size distribution and condition of such materials. At each fuel sampling point, a strip-plot (4 meters by 20 meters) will be established with one of the respective woody fuel transect lines serving as the strip-plot centerline.

Within each strip-plot only logs or parts of logs that are at least 1m in length and have a large end diameter 15cm or greater will be measured and counted. The species (if possible) and decay class of each log will be recorded. The following decay classes will be used to rate the CWD (Thomas 1979):

Decay Class 1 Bark is intact; twigs are present; wood texture is sound; log is still round; original wood color.
Decay Class 2 Bark is intact; twigs are absent; wood texture is sound or becoming soft; log is still round; original wood color.
Decay Class 3 Bark is falling off; twigs are absent; wood texture is hard; log is still round; original color of wood is faded.
Decay Class 4 Bark is absent; twigs are absent; texture of wood is soft, blocky pieces; shape of log is oval; wood has faded to light yellow or gray.
Decay Class 5 Bark is absent; twigs are absent; wood texture is soft and powdery; shape of log is oval; wood has faded to light yellow or gray.

Remote sensing

Two different remote sensing methods are possible. First, high-resolution IKONOS imagery of several treatments will be collected to provide information on continuous forest pattern, structure, cover and variability using methods developed by Menning (dissertation, 2003) including spectral entropy canopy diversity analysis (SpECDA). These data and analyses have the benefit of being linked to analyses of vegetation and wildlife habitat conducted by other researchers in the project.

Second, an approach similar to that developed by van Wagtendonk (2001) in Yosemite National Park is being considered to provide information on fuel development. Two thematic mapper (TM) scenes could be used to help differentiate the forest types. One

TM scene could be obtained in June and another over the same area in October. The two scenes would be used to differentiate the vegetation types including forests, deciduous hardwoods, montane chaparral, wet meadows, and dry meadows. The spatial resolution of all data would be 30 m X 30 m. Bands 3 and 4 will be used from the TM data and Normalized Difference Vegetation Index (NDVI) would be computed. The result of this procedure would be a high quality forest ecosystem map that will include rock, meadows (dry and wet), bare ground, montane chaparral, riparian areas over 30 m in width, and the 3 most common forest types (ponderosa pine, mixed conifer, white fir).

If pursued, this second technique would be performed before and after restoration treatments for all treatment units. The vegetation map under development for the project will be used in the fuels classification. It will not have the spatial resolution (approximately 5 ha) required to develop a GIS fuels layer but will have excellent information on the dominant vegetation in each polygon.

Analytical methods

Calculation of Fuel Loads

Ground and surface fuel loads will be calculated by using equations developed for Sierra Nevada forests (Menning dissertation 2003, van Wagtendonk et al. 1996; van Wagtendonk et al. 1998). Coefficients required to calculate all surface and ground fuel loads will be arithmetically weighted by the basal area fraction (percent of total basal area by species) that will be collected in the vegetation portion of this study. This methodology will produce accurate estimates of fuel loads (Stephens 2001). Many fuel inventories done in the Sierra Nevada have assumed that the fuel particles being inventoried had similar properties to those found in the northern Rocky Mountains (Brown 1974). Van Wagtendonk's comprehensive work in quantifying Sierra Nevada fuel properties, both surface and ground, allow custom fuel load equation to be developed for this project.

Fuel models

Plot based fuel measurements will be used to create a set of custom fuel models (Burgan and Rothermel 1984) for this area. Fuel model development will also include a stochastic element to more closely model actual field conditions that include a large amount of spatial heterogeneity. Stochastic fuel models will be produced for each strata (forest type, aspect, seral stage, etc.). The vegetation component of this study will measure crown cover and average tree height at each plot. Crown bulk density estimates will come from previous work by Stephens (1998). Topography information will be generated from a digital elevation map (DEM) for all areas. All information will be produced at the 30m X 30m scale.

Potential fire behavior

Potential fire behavior will be estimated using a similar technique done by Stephens (1998) but at much larger spatial scales. The effectiveness of the different restoration treatments will be assessed with computer models such as FARSITE (Finney 1996) and FLAMMAP. FARSITE is a deterministic, spatial, and temporal fire behavior model that uses fuels, slope, aspect, elevation, canopy cover, tree height, height-to-live crown base, crown density, and weather as inputs. FLAMMAP is similar to FARSITE but does not use a user-determined ignition but burns the entire landscape using one set of weather data. These models will be used to quantify the potential fire behavior of the different treatment approaches.

A historic fire risk map will be produced to estimate the probability of ignitions in the treated areas when FARSITE is used. The risk map will be used to generate an actual ignition point in each FARSITE simulation. The duration of each simulation would be 4 days approximating the duration of many large-scale wildfires in the Sierra Nevada. Weather information at the 90th percentile condition will be used and this data will be collected from local weather stations. Fire simulations would be constrained and unconstrained by suppression activities. Constrained simulations will use typical fire suppression tactics and resources. Outputs from the fire simulation include GIS files of fire line intensity (kW/m), heat per unit area (kW/square meter), rate of spread (m/s)**,** area burned (ha), emissions (tons) and if spotting and crowning occurred. Scorch height (m) would be calculated from fireline intensity, air temperature, and wind speed. This information was used to compare the effectiveness of the different landscape level restoration treatments.

Fire effects

Fire effects will be modeled using the GIS outputs from the FARSITE and FLAMMAP simulations coupled to quantitative models that estimate tree mortality (Stephens and Finney 2001). The percent tree cover removed and amount of bare mineral soil exposed by the simulated fires will be estimated for each 30 X 30 meter pixel. This will require generating GIS based fire effects models from published studies. This will enable the estimation of fire effects at the landscape scale.
Response variables

Large wildfires in the Sierra Nevada are commonly high severity events that kill the majority of the small and medium sized trees within their perimeters. This tree mortality will significantly reduce canopy cover. Many wildlife species such as California spotted owls prefer diverse forest structure for foraging and breading. Research indicates that owls prefer to nest in areas with canopy cover in excess of 65 percent. Reduction of canopy cover below 55 percent may reduce the nesting habitat quality for the owl. Consequently, one response variable will be the percentage of the landscape where canopy cover was reduced from over 65 percent to below 55 percent after simulated wildfires. A spatial constraint (minimum of 50 ha) will be used in this analysis since small patches of habitat are probably not be used by this species. Spotted owl foraging habitat has a more diverse desired structure. Telemetry studies have indicated that owls prefer foraging habitat with patches of forest with at least 50 percent canopy cover. Some areas of lower cover can also be included in the foraging habitat but this should probably only comprise a maximum of 20 percent of the area. Foraging habitats are much larger than nesting habitats with a minimum size of approximately 500 ha. A second response variable will be the percent of the landscape after simulated fires that surrounded a nesting habitat where percent cover was reduced from over 50 percent to below 45 percent in 75 percent of an area (minimum of 500 ha). The GIS based fire mortality models will allow for such spatially explicit estimates.

The change in suppression efficiency from the different treatments will also be a response variable. All treatments employ defensible fuel profile zones and 2 treatments use the group selection silvicultural system. Addition of these landscape elements may affect the ability of a wildfire suppression crew to successfully extinguish a fire during initial attack. FARSITE will be used with realistic suppression elements (15 person hand crews, aircraft, bulldozers, etc.) to determine if these landscape level fuel treatments will increase suppression efficiency when compared to the untreated condition. The response variable will be the percentage of wildfires contained below 5 ha in size in one burning period (24 hours) before and after landscape fuel treatments.

It is common for wildfires to be propagated by spotting and this can exponentially increases the size of the fire during the early periods (1-24 hours). The ability of a treatment to reduce the number of spot fires is an important fire behavior characteristic. The number of spot fires will be estimated before and after treatments to determine if treatments reduce fire spread from spotting. The response variable will be the percentage change in spot fire initiation before and after landscape level fuel treatments.

Field Season Progress 2002

No data were collected in 2002. Data collection will begin in summer, 2003, with the vegetation sampling crew. Remote sensing image acquisition will also begin in the summer of 2003.

Collaboration, Integration of Five Modules

All data collection beginning in 2003 and beyond will be coordinated entirely with the vegetation module. This will increase efficiency in sampling and improve our ability to statistically link fuel attributes to the surrounding vegetation as measured by the vegetation crew. In addition, because the vegetation plots overlap many of the sampling sites of other modules, this collaborative approach allows us to provide fuel load and fire risk information to researcher from other modules who need to understand how these factors vary at their sites. In Autumn 2002, we conducted a field trip with representatives of the vegetation crew to work on joint sampling methodologies.

We are using remote sensing to collect data covering several of the treatment units. Landscape-level analyses conducted using this imagery will provide data on continuous landscape characteristics such as fuel production, canopy cover, and forest structural diversity. We have initiated discussions with researchers from the other modules about correlating our findings with their assessments of population and habitat suitability. We anticipate these collaborations may enhance all modules’ abilities to extend analyses to the landscape scale.

Coordination with Interested Parties

We plan to work closely with Mark Finney, a fire-modeling expert in Missoula, Montana on fire behavior assessments. In addition, we anticipate close coordination with fire management offices at the Forest Service districts.

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Vegetation Module

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Objectives

The vegetation module of the Plumas-Lassen Administrative study has three principal objectives. First is to assess how management treatments affect forest structure and species composition at stand and landscape scales in the ponderosa pine, mixed-conifer and red-fir forests of the northern Sierra Nevada/southern Cascades region. Second is to generate vegetation and fuels data for other modules of the administrative study that can be linked to focal species or processes. Third is to investigate the ecology and silvics of mixed-conifer tree species.

The vegetation plot is a basic tool that will be deployed to meet many of the above objectives. Each plot consists of a circle with two concentric rings: the circle has a radius of 12.6 m and an area of 0.05 ha, the inner ring has an outer radius of 17.8 and a 0.1 ha area, and the outer ring has 56.4 m outer diameter and 1 ha area. The most intensive sampling will occur in the center circle, where all live trees ≥ 10 cm diameter at breast height (DBH) will have the following measurements taken: species identification, DBH, height, height to base of the live crown, crown radius, crown shape, and distance to nearest neighboring tree. Dead trees ≥ 10 cm DBH will have DBH, height, and decay class recorded. In the inner ring, the same sets of measurements (for live and dead trees) will be taken on all trees with DBH ≥ 50 cm. In the outer ring, all live trees of DBH ≥ 80 cm will have species and DBH recorded; dead trees of DBH ≥ 80 cm will have DBH, height, and decay class recorded. Two randomly oriented 50 m long transects, used to assess shrub and tree cover and fuel loading, will begin in the middle of the center circle and proceed at right angles to each other. Four circular plots of 2.5 m radius will be used to assess herbaceous cover (by species) and tree regeneration in the seedling and sapling size classes. Surface-soil samples will be taken in each plot and archived.

Vegetation plots will be located across the entire terrain of the Administrative Study, both in areas that are scheduled for management treatment and areas that have no planned treatments. Plot locations in untreated areas are to be selected from among a system of transects already established by workers in the songbird module, with several plots to be established on each transect. An additional series of plots will be installed in trapping grids established by small-mammal researchers. In treated areas, plots will be established and permanently marked prior to installation of shaded fuel-break and area treatments; these plots will be measured again within two years. Plots in areas scheduled for group-selection harvest will only have herb and shrub layers assessed prior to treatment. An additional series of vegetation plots will be established in exemplary late-successional stands to be located from vegetation maps and discussion with National Forest personnel. These stands will serve as reference conditions for managed stands.

The above system of vegetation plots and targeted sampling locations will generate data that are of direct use to researchers in the fire and fuels, owl, small mammal, and calling-bird modules. Vegetation module researchers will also use these plot data to answer two questions. First, how does the mixed-conifer plant community vary across the study site, and what are the physical factors that determine local community composition? Logistic regression will be used to formulate models of occurrence of individual tree species with respect to the continuous variables of soil pH, microclimate, slope, and aspect. Temperature maximums and minimums, and total precipitation will be calculated using PRISM models (http://www.ocs.orst.edu/prism/prism_new.html). Second, does application of fuels treatments make stand structure more similar to old growth? This question will be addressed both by analyzing the short-term change in stand structure from fuels treatments, and the longer-term changes as treated stands develop over time. Multivariate statistical techniques will be used to compress a suite of stand-structure and composition measures such as stem density, basal area of shade-intolerant trees, and shrub cover into an index of old-growth character that can be readily compared among stands.

The assessment of landscape integrity and heterogeneity will be done with a simulation approach. An existing map of the study area that was recently generated by interpretation of aerial photos will be used as a base: it classifies the landscape in patches defined by tree size class and canopy cover. The spatial metrics of connectivity, contagion, mean patch size, and patch diversity will be calculated for each treatment unit. Empirical research on stand structure, described in the previous paragraph, will allow estimation of how patch classification will change after fuels treatments. A new map of the treatment units will be generated incorporating the modeled changes in patch classification due to fuels treatments and spatial metrics will be recalculated. This procedure will provide an indication of how the integrity of forest cover and structure will change across the landscape once fuels treatments are applied.

Local (i.e., stand-level) spatial arrangement of vegetation elements is thought to be a key factor that influences 1) suitability of stands as wildlife habitat and 2) propagation of ecosystem processes such as fire. Researchers from vegetation, owl, and fire modules will collaborate closely to explore this theme. Working in stands that have been identified as foraging zones for the California spotted owl, we will apply nearest-neighbor and tree-height-diversity analyses to ask whether vegetation that combines a clumped distribution with a diverse height structure presents a risk for conveying flame from the forest floor to the canopy. These analyses will be carried out before and after fuels treatments in order to determine how fuels treatments affect horizontal and vertical vegetation structure, and how these changes are correlated with owl persistence in foraging zones after fuels treatments.

As part of their objective to investigate the ecology and silvics of mixed-conifer tree species, vegetation researchers will combine experimental and observational approaches to understand how biotic factors affect stand development. Researchers will take advantage of the large trees (referred to by foresters as leave-trees) that will be retained in group-selection openings: prior to cutting, the distance to, direction, DBH, and species identity of all trees within 25 m of the leave-tree will be measured. Three years after the group-selection harvest, cores will be extracted from the leave-trees with an increment borer and a release index will be developed by comparing growth rate during the three years prior to and after the harvest. Release will be related to the identity, size, and distance of neighboring trees using a series of nested equations based on the concepts of the crowding index and maximum likelihood estimation. The entire procedure will address the question of which species compete most intensely with one another. Data on local co-occurrence of tree species from the landscape vegetation plots, analyzed using the ecological concept of community assembly rules, will provide a complementary perspective on this question.

Vegetation researchers will also investigate the regeneration requirements of the most shade-intolerant of the mixed-conifer trees: ponderosa, jeffrey, and sugar pine. While installing vegetation plots field workers will assess resource availability and growth and survival rates of saplings of these species by taking a fisheye lens photograph of the canopy immediately above each sapling, a soil sample at the base of the saplings, and a measurement of the past season's extension growth of the leader. Mathematical models relating extension growth to canopy openness and soil texture will be formulated, and details of local stand structure will be derived from the vegetation plots. A similar procedure (with the exception of the growth measurement) will be followed for dead saplings that do not appear to have been killed by fire; probability of survival with respect to canopy openness and soil texture can thus be estimated.

Accomplishments

The groundwork was laid for the 2003 field season. A post-doctoral research ecologist, Seth Bigelow, was hired and began work at the end of August. Dr Bigelow is a specialist in plant-soil relationships with an interest in ecological forestry. He received training in

Botany and Ecology at the University of Florida and has completed a four-year postdoctoral appointment at the Institute of Ecosystem Studies in New York.

In Fall 2002 module personnel made individual trips to the Mt. Hough, Almanor, Beckwourth, and Feather River ranger districts to build relationships with district personnel responsible for planning and implementation of management treatments. Input from management personnel was sought on knowledge gaps, silvicultural practices, and location of old-growth stands. Several trips to the field were made to evaluate methods – one such trip was made with Kurt Menning, the post-doctoral researcher for the Fire and Fuels module. Module members attended four day-long meetings for coordination with other modules, and attended the demonstration / discussion of experimental treatments in early September organized by the Mt. Hough ranger district. Module personnel also attended a three-day symposium on Science and Management in the Sierra Nevada.

Small Mammal Module

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Introduction:

Small mammals provide critical food sources for many carnivores, including the American marten, California spotted owl, and Northern goshawk. As a result, changes in small mammal abundances could have affects on many species throughout the forest. Understanding the demographics, habitat requirements, and natural fluctuations of small mammals is critical to the management of Sierra Nevada forests. Alterations in habitat structure can directly affect small mammals by increasing habitat quality allowing greater small mammal density, higher reproduction, and increased survival. In addition, changes in the spatial distribution of habitat characteristics can lead to differences in small mammal distribution patterns (e.g. more clumping).

Determining which components of the habitat are important in structuring the dynamics of small mammal populations requires close monitoring of several independent populations through multiple years combined with measuring habitat characteristics. In addition, the requirements of key prey species (woodrats and flying squirrels) must be understood in detail. In particular, daily activity and habitat use of key prey species within specific habitat types is necessary to understand the link between small mammal and predator populations.

In addition to understanding small mammal population dynamics and habitat relationships, we will investigate the phylogenetic relationship between the chipmunk species living in the study site. Several of the chipmunk species are virtually identical in appearance and can only be identified by differences in their baculum. As a result, we will look for molecular techniques to identify species using a small of ear tissue. This will allow proper identification of the species without killing individuals being studied.

Finally, chipmunks represent a primary prey species for diurnal predators, such as the Northern goshawk. Alterations in habitat structure may affect the quality of small mammals by altering their ability to build fat layers in anticipation for hibernation. We will look at changes in the fat content of chipmunks throughout the year and relate that to habitat structure. The results of this aspect of the study would provide a possible link between habitat structure and population dynamics.

Objectives:

Research objectives for the small mammal unit are to evaluate small mammal responses to different forest management practices. Specifically we will investigate:

1. spatial and temporal patterns of small mammal populations inhabiting a variety of habitat types.
2. habitat associations of small mammal populations.
3. spatial and temporal activity patterns and habitat use for two species of concern (woodrats and flying squirrels).
4. phylogenetic relationship of chipmunks in the study area.
5. differences in the development of fat layers in chipmunks inhabiting different habitats.

Methods:

Small mammal populations will be sampled monthly using established trap grids. Two different grids will be set to overlap each other with a 10 x 10 grid containing a single Sherman live-trap at 10m intervals inside a 6 x 6 grid containing 2 Tomahawk live-traps at 30m intervals. Tomahawk and Sherman traps will be opened in the late afternoon and checked the following morning. All Sherman traps will be closed during the day to prevent deaths from heat exposure. All Tomahawk traps will continue to be opened and checked throughout the day to capture diurnal species. All traps will be baited with peanut butter coated oats and sunflower seeds. Trapping grids will be established using a system of 3 tree sizes (size class 2, 3, and 4) and 2 understory (open and brushy) Categories. Grids will be established, in triplicate, in each of the combinations of categories, for example, 3 grids in size class-small, understory-open. In addition, 3 grids will be established in meadow, or grassland habitats.

All individuals captured will be weighed, sexed, given ear tags for identification, and have their reproductive condition noted. All animals will be released at the site of capture. Population demographics will be modeled by species using program MARK or another appropriate computer program. Monthly survival and population densities will be modeled for each species on each site. These parameters can then be used to identify habitat variables that are linked to population parameters using multivariate analyses. To supplement species habitat relationships, individual woodrats and flying squirrels will be captured and fitted with radio-collars. These individuals will be followed throughout the year to identify activity patterns and specific patterns of habitat use. Locations obtained from radio-tracking will be entered into a GIS database of habitat types and will be associated with a number of vegetation characteristics.

Habitat characteristics will be measured at every point of the trap grids. Characteristics that will be measured include nearest tree species and size, canopy cover, shrub cover, amount of course woody debris, and amount of bare ground. Characteristics will be measured using a 5m radius circle centered on each trap station. Habitat characteristics will be measured during late spring when trees and shrubs are at their full bloom, and the majority of annuals are also flowering.

We will collect a sample of chipmunks from areas throughout the study site and bring them back to U. C. Davis for use in the phylogenetic study. Individuals collected will have standard morphological measures taken and a portion of the ear will be taken for use in molecular analyses. All individuals will be preserved in the museum at U. C. Davis. Species will be identified using the unique shape of the baculum. Molecular techniques will be used to determine methods for describing species using non-lethal molecular techniques.

We will follow the development of fat layers in chipmunks throughout the year in a number of different habitat types using non-lethal techniques. We will use a portable device (TOBEC machine) to measure the proportion of fat found in the entire body of chipmunks. The development of fat in chipmunks will be related to differences in habitat quality and structure, and will be compared through time between sites at varying elevations.

Field Season Progress (2002):

The 2002 season began in September with the hiring of a postdoctoral fellow and 4 technicians. Work began in the study site on 1 September and continued through November 2002. During this period, 12 trap grids were established and preliminary trapping was initiated. Mark-recapture was used to provide a preliminary estimate of the numbers and diversity of small mammal residing on each grid. In addition, preliminary habitat characteristics were measured on each of the grids. Each night that a grid was trapped represented 172 trapnights accounting for the 100 Sherman and 72 Tomahawk traps. The twelve sites, with the number of days trapped in parentheses, are called Barrel (6), Bear Holler (6), Beesting (5), Buck (5), Cedar (5), Greenbottom (9), Gulch (5), Lassen (16), Loop (16), Soloman's Meadow (9), Steep (9), and Trippin' Falls (9). The sites at Lassen and Loop were established first and were used to identify potential problems with the live-trapping techniques and grid design before additional sites were established. From these sites we discovered that trap death was unreasonably high for chipmunks during the daytime. As a result modifications were made to the trapping protocol to prevent unnecessary deaths. These modifications included closing Sherman traps during the daytime, checking traps multiple times during the day, and providing artificial cover for shade. A summary of the elevation and number of individuals trapped on each grid, are provided in Table 1.

Habitat characteristics were also measured at major grid points on all grids. At each Tomahawk trap station (n = 36) a 5-m radius plot was used to measure several habitat characteristics. We measured the percent cover of tree canopy, shrubs, dead branches (< 10 cm), small logs (10-50 cm), large logs (> 50 cm), rocks, forbs, and trees and snags. The distance to the nearest tree and shrub were measured as well as the circumference of the tree, shrub height and shrub width. A summary of the habitat characteristics for each grid can be found in Table 2. These characteristics will be used to determine how varied each of the sites are and where we need to focus site selection next season. In addition, we will begin to investigate relationships between small mammal distributions and habitat characteristics.

Terrestrial Birds Module

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BACKGROUND and INTRODUCTION

Coniferous forest is one of the most important habitat types for birds in California (CalPIF 2002). In the Sierra Nevada, a century of intensive resource extraction and forest management has led to major changes in the amount and quality of coniferous forest habitat. Problems that the forests have faced include loss of habitat to intensive logging operations; lack of replacement of old-growth stands due to harvest rotations of insufficient length in time; changes in forest structure due to fire suppression; elimination of snags and dead trees; and fragmentation (SNEP 1996, CalPIF 2002). Bird and other wildlife populations have subsequently been altered by such changes; declines and extirpations have been observed in a number of species, some of which are now afforded special status at the federal or state level.

The Record of Decision for the Sierra Nevada Forest Plan Amendment (SNFPAA) directs the Forest Service to maintain and restore old forest conditions that provide crucial habitat for a number of plant and animal species. Certain taxa are emphasized in this strategy because of their dependence on old forest habitat attributes. Simultaneously, the Forest Service is taking steps to reduce risks of catastrophic fire by removing vegetation and reducing fuel loads in overstocked forests. Achieving all of these potentially competing goals as well as meeting other demands placed on Sierra Nevada forests is a challenging task.

The SNFPAA Record of Decision called for an administrative study to test the effects of various forest management techniques, intended to reduce fuels and re-introduce natural fire regimes, on California Spotted Owl populations and other components of old forests. In investigating this issue, valuable feedback can be gained by determining how the full compliment of the avian community will respond to different forest management regimes, particularly at the landscape scale. If forest management practices encourage old forest development and forests across landscapes trend towards larger trees and higher canopy cover, how will birds other than the Spotted Owl respond to these conditions?

Here we report on the progress of the landbird study module, one of an integrated series of studies intended to evaluate land management strategies designed to reduce wildland fire hazard, promote forest health and provide economic benefits within the area covered by the Herger-Feinstein Quincy Library Group Forest Recovery Act Pilot Project (HFQLG Pilot Project).

OBJECTIVES

Long-term objectives

1. We intend to monitor the distribution and abundance of birds across the landscape in response to changes in forest structure and composition as determined by vegetation growth/succession and by human-induced treatments. Forests in the northern Sierra Nevada grow rapidly (Powell et al. 1992) and growth rates (characterized, for example, by changes in tree size class and canopy cover) will presumably impact habitat conditions. Treatments, such as forest thinning for fuels management or group selection for timber harvesting, will also impact habitat conditions on the site of treatments and surrounding areas in some way. When analyzed over time and across the spatial extent of landscapes (and in relation to treatment schedules) what is the response of bird communities? Will forest structure and composition resulting from a combination of continuous vegetative growth and specific management regimes create conditions capable of sustaining stable avian communities? This study is distinguished by its geographic domain or scale. We are principally interested in measuring response of variables over large geographic areas and over relatively long time periods. The reason for this is rooted in the rate and extent of treatments combined with the rate and extent of vegetation growth. This landscape-scale study endeavors to incorporate spatial and temporal factors that might influence the response variables.

2. In addition to assessing responses of landbirds to forest management and succession integrated over time (10 to 20 years) and space (all treatment units) we plan to simultaneously address the short-term, localized responses of landbirds to specific forest treatments. What are the site-specific changes in bird community composition and abundance in response to treatments and how does this change over time following treatments? This two-scale approach allows us to understand both the effects of specific management practices and the integrated effects of treatments and vegetation succession.

3. Finally, we also intend to build predictive models that can associate habitat conditions with expected avian species abundance. These habitat relationships models will enable us to predict how habitat changes measured in response to vegetation growth and management will influence the overall distribution and abundance of bird species across a landscape. In a modeling context, treatments

will be assessed in terms of how effective they are at moving stand and landscape vegetation structure and composition toward a desired condition.

Objectives for 2002 – Pilot year

1. To initiate data collection to the greatest extent possible with at least 50% of the landscape-scale sample size and at as many Defensible Fuel Profile Zone (DFPZ) sites as possible; see below for details.

2. To evaluate our study design and site selection methodology and adapt them to the on-the-ground realities of the study site.

METHODS

General sampling method
We are using standardized five-minute variable circular plot (VCP) point count censuses (Ralph et al. 1993) to sample the avian community in the study area. In this method, points are clustered in transects but data is only collected from fixed stations along the transect, making the point, not the transect, the sampling unit. All birds detected at each station during the five-minute survey are recorded according to their initial distance from the observer. These detections are placed within one of six categories: within 10 meters, 10-20 meters, 20-30 meters, 30-50 meters, 50-100 meters, and greater than 100 meters. The method of initial detection (song, visual, or call) for each individual is also recorded. Counts begin around local sunrise and are completed within four hours. Each transect is visited twice during the peak of the breeding season.

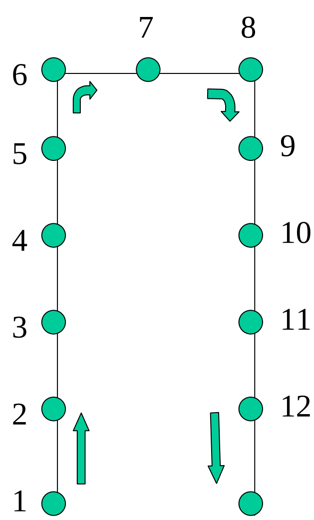
Point count data allow us to measure secondary population parameters such as relative abundance of individual bird species, species richness, and species diversity. This method is useful for making comparisons of bird communities across time, locations, habitats, and land-use treatments. Using a variable radius point count should enable us to provide more precise estimates of density and detectability of individual birds (Rosenstock et al. 2002).

Landscape-scale sampling design
The larger scale or landscape level sampling is primarily intended to meet objective 1 (see long-term objectives above). Forest structure is probably the most important variable of forest condition with respect to habitat selection by terrestrial birds. Thus, to ensure coverage of the array of forest structural types within the study area, we are stratifying the forested areas into ten classes. These classes, when combined, create a three by three matrix of forest structural conditions; three classes of tree size (size class 2 = 6’ to 12’ crown diameter, 3 = 12’ to 24’ crown diameter, and 4 = >24’ crown diameter) and three classes of canopy cover (<40% canopy cover, 40-60% canopy cover, and > 60% canopy cover). These, along with a tenth class for shrub habitat creates ten classifications that are then used to stratify random starting points for each transect using a random point generator program (ESRI 1999). Due to accessibility issues, starting

points are constrained to areas further than 100 meters but no more than 200 meters from roads for accessibility purposes. Ten random starting points are generated per stratum even though only one point is used. In the event that the first point of ten is not manageable in the field due to topography, bodies of water, proximity to treated areas, etc., the next point in the list is used, until a satisfactory location is found for that particular stratum. Once points are deemed suitable, a random bearing is then generated by spinning a compass. The transect is then established by placing 5 additional points going out along this bearing at 250 meter intervals, turning 90 degrees from original bearing, going 250 meters to point 7, and then point 8, then returning 180 degrees from original bearing back towards the starting point, until 12 points are established (Figure 1). If non-forested habitats are encountered, stations are placed 250 meters ahead, in successive 250-meter increments, until forested habitats are again encountered.

Stand-scale sampling design
In addition to the landscape level monitoring, we are monitoring a sample of treated stands before and after treatment. We are using a modified BACI (Before/After Control/Impact) experimental design with replicated control and "impact" sites. Controls for each treatment site will be a subsample of the landscape points described above that have similar pre-treatment conditions to the treated sites, that are located within the same treatment unit. Eight to twelve point count stations will be established in each treatment site.

Figure 1. Layout of point count stations along landscape-scale transects.



Specific forest stands in each treatment unit will be subject to one of three treatment types: DFPZ thinning, group selection, and area thinning. All treatment units will contain DFPZ's and 8 of the 11 will include group selection sites. Within each treatment unit, two replicates of each type of treatment (i.e., either a DFPZ or a group selection site) will be randomly selected for before and after sampling. At this time we are not going to be sampling area treatment sites. Because the treatments will be implemented gradually over time, our initial efforts have focused on the treatment units scheduled first for treatment activities.

Vegetation sampling methods
Ultimately, vegetation will be described in detail at each point count station every 3 years during the study. Intensive vegetation sampling was not conducted in 2002, because we are in the process of designing a coordinated sampling approach together with the other study modules.

Statistical Analyses
We analyzed point count data in order to create preliminary by-point community indices for each transect. Community indices were created using a restricted list of species that excluded those that do not breed in the study area or are not accurately surveyed using the point count method such as raptors, waterfowl, and shorebirds. (For a complete list of the species used in this analysis see Appendix 3). It is important to bear in mind that this data should be considered a preliminary result. It would be inappropriate to use one year of data to rank the importance or quality of any individual site over another. With future years of data collection and more complex analysis techniques we will be better able to assess the importance of particular sites as well as habitat types and features for songbird populations in the study area.

We present the mean by point (average per point per visit by transect) for the following three indices. This method allows for using the point as the individual sampling unit and therefore makes possible the stratification of points for analysis based on attributes other than the transect and comparison of uneven sample sizes.

Species Richness
Species richness is defined as the mean number of species detected within 50 meters of each point per visit.

Diversity
Species diversity is defined as the mean number of species detected within 50 m (species richness) weighted by the mean number of individuals of each species. A high diversity score indicates high ecological (species) diversity, or a more equal representation of the species. Species diversity was measured using a modification of the Shannon-Wiener index (Krebs 1989). We used a transformation of the usual Shannon-Weiner index (symbolized H'), which reflects species richness and equal distribution of the species. This transformed index, introduced by MacArthur (1965), is N_1, where $N_1 = 2^{H'}$. The advantage of N_1 over the original Shannon-Wiener metric (H') is that N_1 is measured in terms of species instead of bits of information, and thus is more easily interpretable (Nur et al. 1999).

Abundance

The index of abundance is the mean number of individuals detected per station per visit. This number is obtained by dividing the total number of detections within 50 meters by the number of stations and the number of visits.

2002 PROGRESS and RESULTS

In 2002, we established and surveyed 75 point count transects in the study area. Of the 75 transects, 55 are landscape level transects, five in each of the eleven treatment units, and 20 are DFPZ transects (Appendix 1 and 2). The DFPZ transects were established in treatment units 1, 4, and 6, the three units that were furthest along in the planning and implementation of DFPZ's as of the start of the 2002 field season. Eight DFPZ transects were established in treatment unit 4 and six each were established in treatment units 1 and 6. Following re-consideration of study design and available resources following the 2002 field season, we plan on decreasing the number of DFPZ transects per treatment unit in future years (see methods section above).

A total of 89 species were detected during point count surveys within the study area in 2002 (Appendix 3). We determined breeding bird diversity, richness, and abundance among all sites surveyed in 2002 (Table 1). Abundance ranged from a 2.08 on the A13 transect to 7.67 on the 114 transect. Richness ranged from a low of 2.04 on the 122 transect to 8.91 on the D401 transect. Diversity ranged from a low of 2.35 on the 213 transect to a high of 8.16 on the D401 transect. It should be noted that any given point along a transect does not necessarily have the same size and canopy cover class as the random starting point for which the transect is named. While this is preliminary data there is considerable variation between transects in these indices, more than in our data from the nearby Almanor Ranger District of the Lassen National Forest over the past five years (Burnett and Geupel 2001). This may be due at least in part to the vastness of the area from which we are sampling.

Table 1. Mean Abundance, Species Richness, and Diversity for all point count transects surveyed in the Plumas/Lassen area study in 2002.

Transect	Mean Abundance	Mean Species Richness	Mean Ecological Diversity
113	4.25	6.08	5.72
114	7.67	8.33	7.33
122	3.29	2.04	3.80
123	4.33	2.83	5.17
124	5.21	6.92	6.12
213	2.56	2.45	2.35
214	3.96	5.58	5.14
222	4.46	6.17	5.64
223	6.04	8.58	7.77
224	4.54	6.08	5.64
313	3.71	5.25	4.81
314	4.08	3.75	3.70
322	4.67	6.67	6.09

Transect	Mean Abundance	Mean Species Richness	Mean Ecological Diversity
323	5.33	7.92	7.28
324	4.54	6.83	6.45
413	5.83	8.25	7.56
414	6.92	8.75	8.03
422	4.33	6.08	5.64
423	4.54	6.75	6.38
424	5.71	8.08	7.34
513	5.42	7.17	6.54
514	2.50	4.33	4.19
522	5.50	7.67	6.89
523	3.54	5.33	5.04
524	4.42	6.42	5.95
613	5.96	7.00	6.43
614	3.50	3.33	3.28
622	4.25	6.50	6.16
623	4.88	7.42	6.94
624	4.67	7.42	7.01
713	2.63	3.83	3.62
714	3.79	5.58	5.17
722	2.38	3.67	3.55
723	3.58	5.33	4.93
724	4.76	4.17	4.05
813	5.13	8.00	7.45
814	4.13	5.42	5.04
822	4.58	5.83	5.13
823	4.50	3.92	3.83
824	3.42	5.25	4.94
913	5.25	7.42	6.88
914	5.29	6.75	6.12
922	3.18	4.55	4.21
923	5.00	4.50	4.37
924	2.16	3.95	3.83
1013	2.08	3.50	3.35
1014	2.92	4.42	4.11
1022	4.38	6.17	5.66
1023	3.28	3.00	2.94
1024	4.38	6.50	6.01
1113	2.38	3.50	3.27
1114	4.33	5.58	5.14
1122	5.46	7.83	7.34
1123	3.83	5.75	5.38
1124	4.44	3.82	3.70
D101	3.63	4.00	3.66
D102	5.21	5.75	5.06
D107	4.25	6.17	5.81

Transect	Mean Abundance	Mean Species Richness	Mean Ecological Diversity
D108	4.67	6.42	5.89
D109	6.13	8.67	7.96
D110	7.63	8.83	7.72
D401	6.88	8.91	8.16
D402	4.71	6.75	6.24
D403	3.70	5.42	5.09
D404	5.00	7.17	6.73
D405	4.54	6.58	6.05
D406	4.46	6.42	5.98
D407	4.50	7.00	6.52
D408	5.13	7.75	7.12
D602	4.33	6.17	5.77
D603	3.83	5.5	5.11
D604	3.92	6.00	5.59
D605	4.79	6.17	5.75
D606	5.46	7.25	6.59
D607	4.08	2.82	2.66

Assessing Site Selection Design

One of the major objectives for 2002 was to evaluate our sampling methods. Using GIS vegetation information along with GPS locations for all landscape level points established in 2002 we were able to determine the forest cover type and structural class for each point (Table 2). We then stratified the available area, defined as USFS land with a slope <30%, within the study area (Table 3). By comparing these two tables we were able to determine if our site selection methodology did an adequate job of sampling the study area based on the relative abundance of certain structural categories as well as cover types (dominant tree species). Based on this analysis we have determined that our sampling method employed in 2002 is an effective way of creating samples based on the relative abundance of those stratum in the study area. We did however expect our methodology to result in a slight bias in favor of the size and cover class combinations that are less common, and biased against those that are more common, since we are selecting one starting point from each category regardless of relative representation. For example, class 1,3 is the most common structure class in the study area (by area), 46%, but only 40% of our points fall in this category, while the 1,4 category is much less common representing approximately 8% of the study area and 15% of our points fall in this category. We deemed this bias necessary in order to achieve large enough sample sizes in the uncommon stratums.

Table 2. Estimate of the distribution of landscape point count locations based on size and cover class from USFS GIS vegetation layers.

	Cover class, Size Class							
Forest Cover Type	**1,2**	**1,3**	**1,4**	**2,2**	**2,3**	**2,4**	**Total**	**Proportion of Total**
Doug Fir - Mixed Conifer	1	5	3	2	11	10	32	0.08
Black Oak	0	0	1	1	1	0	3	0.01

True Mixed Conifer	0	3	0	0	0	1	4	0.01
Pnd.Pine - Mixed Conifer	6	39	23	2	13	12	95	0.24
Pnd. Pine	1	3	1	1	0	0	6	0.02
Red fir	0	1	0	0	0	0	1	0.003
True Fir	1	26	0	9	18	0	54	0.14
White fir - Mixed Conifer	2	83	33	15	29	40	202	0.51
TOTAL	11	160	61	30	72	63	397	
Proportion of total	0.03	0.40	0.15	0.08	0.18	0.16		

Table 3. Classification of available habitat (hectares of USFS land with slope <30%) within the Plumas-Lassen Study area from USFS GIS vegetation layers.

	Cover Class, Size Class							
Forest Cover Type	**1,2**	**1,3**	**1,4**	**2,2**	**2,3**	**2,4**	**Total**	**Proportion of Total**
Black Oak	587	683	39	472	819	168	2768	0.024
Doug Fir - Mixed Conifer	878	4786	878	763	7306	4838	19449	0.085
Lodgepole Pine	21	151	0	1	0	0	173	0.001
True Mixed conifer	16	255	137	0	239	960	1607	0.008
Ponderosa Pine	1210	1353	128	80	0	0	2771	0.013
Pnd. Pine-Mixed Conifer	2099	14533	3821	445	3197	4011	28106	0.138
Red Fir	138	915	14	397	1541	24	3029	0.017
True fir	1423	9976	578	1950	5055	93	19075	0.110
White Fir – Mixed conifer	1396	19809	3303	524	8241	3720	36993	0.241
Other (non-conifer)	262	691	27	134	194	19	1327	0.011
TOTAL	8030	53152	8925	4766	26592	13833	115298	
Proportion of total	0.070	0.461	0.077	0.041	0.231	0.120		

Per point estimates of abundance were made for all species detected within 50 meters at each point. Abundance results calculated from 2002 point count data (Table 4) will be used to perform an analysis of data power before the onset of the next field season. Power analysis is a helpful tool to determine if our study design will result in sample sizes adequate enough to detect changes in the abundance of species over time. For example, it is already fairly clear that our sampling method will not adequately survey Black-backed Woodpecker or Wrentit populations in the study area, sample sizes for these species are simply too small to be able to detect significant changes in species numbers over time.

Table 4. Mean abundance and standard deviation of species detected within 50 meters of all point count stations (n=900) in the PLAS.

Species	**Mean**	**Standard Deviation (±)**
Audubon's Warbler	0.508	0.51
Mountain Chickadee	0.496	0.59
Golden-crowned Kinglet	0.404	0.48
Hermit Warbler	0.381	0.49
Oregon Junco	0.364	0.49

Species	Mean	Standard Deviation (+)
Red-breasted Nuthatch	0.236	0.38
Dusky Flycatcher	0.239	0.41
Western Tanager	0.231	0.4
Brown Creeper	0.166	0.32
Fox Sparrow	0.168	0.45
Nashville Warbler	0.155	0.34
Hammond's Flycatcher	0.096	0.24
Cassin's Vireo	0.093	0.25
Stellar's Jay	0.084	0.30
American Robin	0.079	0.23
MacGillivray's Warbler	0.080	0.24
Warbling Vireo	0.053	0.19
Pine Siskin	0.043	0.23
Spotted Towhee	0.042	0.16
Hairy Woodpecker	0.036	0.14
White-headed Woodpecker	0.033	0.15
Hermit Thrush	0.032	0.13
Evening Grosbeak	0.028	0.16
Chipping Sparrow	0.026	0.13
Red-breasted Sapsucker	0.023	0.13
Black-throated Gray Warbler	0.022	0.13
Green-tailed Towhee	0.023	0.13
Townsend's Solitaire	0.018	0.12
Cassin's Finch	0.018	0.10
Black-headed Grosbeak	0.022	0.13
Western Wood-Pewee	0.014	0.10
Brown-headed Cowbird	0.014	0.09
Olive-sided Flycatcher	0.014	0.10
Red-shafted Flicker	0.012	0.09
Wilson's Warbler	0.011	0.10
Calliope Hummingbird	0.008	0.06
Yellow Warbler	0.007	0.07
Mountain Quail	0.006	0.07
Anna's Hummingbird	0.006	0.07
Lazuli Bunting	0.005	0.06
Pileated Woodpecker	0.006	0.06
Pacific-slope Flycatcher	0.004	0.06
White-breasted Nuthatch	0.003	0.04
Clark's Nutcracker	0.002	0.03
Hutton's Vireo	0.003	0.05
Winter Wren	0.002	0.03
Western Scrub Jay	0.002	0.04
Wrentit	0.002	0.03
Black-backed Woodpecker	0.002	0.04

COLLABORATION WITH OTHER MODULES

We have held numerous meetings and field visits with the other modules in this project in order to maximize efficiencies across the entire project. We have agreed to collect data from common locations with the small mammal, fire, and vegetation modules. We are currently working with each module to maximize our field crews with potential to share personnel at some level in coming years.

CONTACT WITH INTERESTED PARTIES

PRBO has been conducting songbird monitoring in the Lassen region for the past six years. We have established contact and in many cases working relationships with many of the local interested parties. We currently collaborate with the Almanor Ranger District of the Lassen National Forest, Lassen Volcanic National Park, The Nature Conservancy, Audubon Society, as well as several other local interest groups. We believe strongly in the importance of building partnerships and collaborations in maximizing the effectiveness of our work.

CONCLUSIONS

The 2002 pilot year was a very important part of finalizing study plans, determining sample sizes, and redefining objectives. Before the onset of the 2003 field season, we will evaluate the location of our transects in light of new information gained from power analysis, and the placement and implementation of DFPZ's, group selection treatments, and area treatments, in order to determine the number of transects that need to be added in treatment sites as well as untreated areas (landscape level). Evaluation of 2002 results has led to our preliminary plan to add approximately 55 additional landscape transects for a total of 110 transects, 10 in each treatment unit. DFPZ, group, and area treatment transects will be added in units that have finalized the site selection of these treatments in order to make sure we have sufficient samples from treated and untreated sites. In addition, data collected in 2002 have helped us determine the optimal window under which counts can be conducted within the study area in order to maximize data collection during a limited time frame. With several more years of data we will be able to create a complete breeding species list for each Treatment Unit and the study area as a whole as well as to develop habitat associations for many of the key songbird species in the study area.

PERSONNEL

This project was coordinated by PRBO staff biologist Ryan Burnett. Field work was supervised by Greg Levandoski and Ryan Burnett. Field work in 2002 was conducted by Ryan Burnett, Glen Davis, Greg Levandoski, Mike Palladini, Adena Rissman, and

Michael Wickens. PRBO staff biologists Diana Stralberg and Lazarus Pomara organized GIS resources, created maps, random starting points, and generated tables presented in this report. Computer programs used to manage and summarize data were created by PRBO staff biologists Grant Ballard, Dan Barton, and Mike Lynes. The study was carried out under the guidance of PRBO Terrestrial Program Director Geoffrey R. Geupel, PRBO Science Coordinator Mary K. Chase, and Peter Stine of the PSW Sierra Nevada Research Center.

ACKNOWLEDGEMENTS

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Appendix 1. Landscape Transects established and counted in the Plumas-Lassen Study Area in 2002 (Transect names are based on classification of the random starting point. The first digit in transect number refers to treatment unit, second digit refers to size class, third digit refers to closure class).

Treatment Unit	Transect	First Visit	Second Visit
1	113	5/29/2002	6/26/2002
1	114	5/28/2002	6/26/2002
1	122	6/6/2002	6/26/2002
1	123	5/28/2002	6/26/2002
1	124	5/29/2002	6/26/2002
2	213	6/10/2002	NA
2	214	6/10/2002	6/25/2002
2	222	6/10/2002	6/29/2002
2	223	6/23/2002	6/29/2002
2	224	6/10/2002	6/29/2002
3	313	6/15/2002	6/28/2002
3	314	6/25/2002	NA
3	322	6/15/2002	6/28/2002
3	323	6/16/2002	6/28/2002
3	324	6/15/2002	6/28/2002
4	413	5/27/2002	6/24/2002
4	414	5/23/2002	6/24/2002
4	422	5/23/2002	6/24/2002
4	423	5/27/2002	6/25/2002
4	424	5/23/2002	6/24/2002
5	513	6/11/2002	6/28/2002
5	514	6/13/2002	6/27/2002
5	522	6/13/2002	6/27/2002
5	523	6/15/2002	6/27/2002
5	524	6/12/2002	6/27/2002
6	613	6/2/2002	6/30/2002
6	614	6/13/2002	NA
6	622	6/2/2002	6/30/2002
6	623	6/1/2002	7/11/2002
6	624	6/1/2002	6/30/2002
7	713	6/12/2002	7/8/2002
7	714	6/12/2002	7/1/2002
7	722	6/16/2002	7/1/2002
7	723	6/13/2002	7/1/2002
7	724	6/12/2002	NA
8	813	6/22/2002	7/6/2002
8	814	6/22/2002	7/6/2002
8	822	6/22/2002	7/6/2002
8	823	6/23/2002	NA
8	824	6/22/2002	7/6/2002
9	913	6/21/2002	7/4/2002
9	914	6/20/2002	7/4/2002

Treatment Unit	Transect	First Visit	Second Visit
9	922	6/21/2002	7/4/2002
9	923	6/21/2002	NA
9	924	6/21/2002	7/4/2002
10	1013	6/20/2002	7/3/2002
10	1014	6/21/2002	7/3/2002
10	1022	6/20/2002	7/3/2002
10	1023	6/20/2002	NA
10	1024	6/20/2002	7/5/2002
11	1113	6/18/2002	7/2/2002
11	1114	6/18/2002	7/2/2002
11	1122	6/18/2002	7/2/2002
11	1123	6/18/2002	7/9/2002
11	1124	6/18/2002	NA

Appendix 2. Defensible Fuel Profile Zone transects established in the Plumas-Lassen Study Area and dates counted in 2002.

Treatment Unit	Transect	First Visit	Second Visit
1	D101	6/16/2002	7/10/2002
1	D102	5/29/2002	7/9/2002
1	D107	5/28/2002	7/9/2002
1	D108	5/28/2002	7/9/2002
1	D109	5/29/2002	7/10/2002
1	D110	5/29/2002	7/9/2002
4	D401	5/22/2002	7/8/2002
4	D402	5/21/2002	7/7/2002
4	D403	5/21/2002	7/7/2002
4	D404	5/21/2002	7/8/2002
4	D405	5/22/2002	7/7/2002
4	D406	5/21/2002	7/7/2002
4	D407	5/23/2002	7/2/2002
4	D408	5/22/2002	7/8/2002
6	D602	6/1/2002	7/10/2002
6	D603	6/2/2002	7/10/2002
6	D604	5/25/2002	7/11/2002
6	D605	5/25/2002	7/11/2002
6	D606	5/25/2002	7/11/2002
6	D607	6/2/2002	NA

Appendix 3. List of all species detected on point count surveys (common, AOU code, scientific name) in the PLAS in 2002. (Species in bold are those included in point count analysis).

Common Name	AOU Code	Scientific Name
American Crow	AMCR	*Corvus brachyrhynchos*
American Dipper	AMDI	*Cinclus mexicanus*
American Kestrel	AMKE	*Falco sparverius*
American Robin	**AMRO**	***Turdus migratorius***
Anna's Hummingbird	**ANHU**	***Calypte anna***
Audubon's Warbler	**AUWA**	***Dendroica coronata audobonii***
Band-tailed Pigeon	BTPI	*Columba fasciata*
Belted Kingfisher	BEKI	*Ceryle alcyon*
Bewicks Wren	**BEWR**	***Thryomanes bewickii***
Black-backed Woodpecker	**BBWO**	***Picoides arcticus***
Black-headed Grosbeak	**BHGR**	***Pheucticus melanocephalus***
Black Phoebe	**BLPH**	***Sayornis nigricans***
Black-throated Gray Warbler	**BTYW**	***Dendroica nigrescens***
Blue-gray Gnatcatcher	**BGGN**	***Polioptila caerulea***
Blue Grouse	BGSE	*Dendragapus obscurus*
Brewer’s Sparrow	**BRSP**	***Spizella breweri***
Brown-headed Cowbird	**BHCO**	***Molothrus ater***
Brown Creeper	**BRCR**	***Certhia Americana***
Calliope Hummingbird	CAHU	*Stellula calliope*
Canada Goose	CAGO	*Branta canadensis*
Cassin's Finch	**CAFI**	***Carpodacus cassinii***
Cassin's Vireo	**CAVI**	***Vireo casinii***

Chipping Sparrow	**CHSP**	***Spizella passerina***
Clark's Nutcracker	**CLNU**	***Nucifraga columbiana***
Common Nighthawk	CONI	*Chordeiles minor*
Common Raven	CORA	*Corvus corax*
Dusky Flycatcher	**DUFL**	***Empidonax oberholseri***
Evening Grosbeak	**EVGR**	***Coccothraustes vespertinus***
Fox Sparrow	**FOSP**	***Passerella iliaca***
Golden-crowned Kinglet	**GCKI**	***Regulus satrapa***
Gray Flycatcher	**GRFL**	***Empidonax wrightii***
Gray Jay	**GRAJ**	***Perisoreus canadensis***
Green-tailed Towhee	**GTTO**	***Pipilo chlorurus***
Hammond's Flycatcher	**HAFL**	***Empidonax hammondii***
Hairy Woodpecker	**HAWO**	***Picoides villosus***
Hermit Thrush	**HETH**	***Catharus guttatus***
Hermit Warbler	**HEWA**	***Dendroica occidentalis***
House Wren	HOWR	*Troglodytes aedon*
Huttons Vireo	**HUVI**	***Vireo huttoni***
Lazuli Bunting	**LAZB**	***Passerina amoena***
Lesser Goldfinch	**LEGO**	***Carduelis psaltria***
MacGillivray's Warbler	**MGWA**	***Oporornis tolmiei***
Mountain Chickadee	**MOCH**	***Poecile gambeli***
Mountain Quail	**MOQU**	***Oreotyx pictus***
Mourning Dove	**MODO**	***Zenaida macroura***
Nashville Warbler	**NAWA**	***Vermivora ruficapilla***
Northern Goshawk	NOGO	*Accipiter gentilis*
Northern Pygmy-Owl	NPOW	*Glaucidium gnoma*
Orange-crowned Warbler	OCWA	*Vermivora celata*
Oregon Junco	**ORJU**	***Junco hyemalis***
Olive-sided Flycatcher	**OSFL**	***Contopus cooperi***
Osprey	OSPR	*Pandion haliaetus*
Pine Siskin	**PISI**	***Carduelis pinus***
Pileated Woodpecker	**PIWO**	***Dryocopus pileatus***
Pacific-slope Flycatcher	**PSFL**	***Empidonax difficilis***
Purple Finch	**PUFI**	***Carpodacus purpureus***
Red-breasted Nuthatch	**RBNU**	***Sitta canadensis***
Red-breasted Sapsucker	**RBSA**	***Sphyrapicus ruber***
Rock Wren	**ROWR**	***Salpinctes obloletus***
Rufous Hummingbird	RUHU	*Selasphorus rufus*
Red Crossbill	**RECR**	***Loxia curvirostra***
Red-tailed Hawk	RTHA	*Buteo jamaicensis*
Red-shafted Flicker	**RSFL**	***Colaptes auratus***
Sage Thrasher	**SATH**	***Oreoscoptes montanus***
Sharp-shinned Hawk	SSHA	*Accipiter striatus*
Song Sparrow	**SOSP**	***Melospiza melodia***
Spotted Owl	SPOW	*Strix occidentalis*
Spotted Towhee	**SPTO**	***Pipilo maculatus***

Stellar's Jay	**STJA**	***Cyanocitta stelleri***
Swainson's Thrush	**SWTH**	***Catharus ustulatus***
Townsend's Solitaire	**TOSO**	***Myadestes townsendi***
Tree Swallow	TRES	*Tachycineta bicolor*
Turkey Vulture	TUVU	*Cathartes aura*
Violet-green Swallow	VGSW	*Tachycineta thalassina*
Warbling Vireo	**WAVI**	***Vireo gilvus***
White-breasted Nuthatch	**WBNU**	***Sitta carolinensis***
White-headed Woodpecker	**WHWO**	***Picoides albolarvatus***
Williamson's Sapsucker	**WISA**	***Sphyrapicus thyroideus***
Western Scrub-Jay	**WESJ**	***Aphelocoma californica***
Western Tanager	**WETA**	***Piranga ludoviciana***
Western Wood-Pewee	**WEWP**	***Contopus sordidulus***
Wilson's Warbler	**WIWA**	***Wilsonia pusilla***
Winter Wren	**WIWR**	***Troglodytes troglodytes***
Wrentit	**WREN**	***Chamea fasciata***
Yellow Warbler	**YWAR**	***Dendroica petechia***

California Spotted Owl Module

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Introduction

Knowledge regarding the effects of fuels and vegetation management on California spotted owls (***Strix occidentalis occidentalis***)(CSOs) and their habitat is a primary information need for addressing conservation and management objectives in Sierra Nevada forests (Verner et al. 1992). Current fuels management concepts propose treatments at the landscape spatial scale, such as DFPZs and SPLATs, designed to modify fire behavior and facilitate suppression efforts. Resulting changes in vegetation structure and composition from treatments may affect CSOs and their habitat at multiple spatial and temporal scales. The goal of this module is to assess the effects of fuels and vegetation treatments on CSOs and important resources, such as vegetation and prey, that affect CSO distribution, abundance and population dynamics.

Habitat is operationally defined as the physical space occupied by an animal and the biotic and abiotic factors (e.g., resources) in that space (Morrison and Hall 2002). Habitat quality refers specifically to the ability of an area to provide conditions appropriate for individual and population persistence (Morrison and Hall 2002). Habitat selection is a hierarchical process by which an individual animal selects habitat to use at multiple scales. These scales range from the geographic range of a species, to use of an individual home range within the range, to use of vegetation patches within a home range, to use of specific resources (e.g., prey species, nest cavities) within vegetation patches (Johnson 1980). The multiple-scale nature of habitat selection indicates that the criteria for selection may be different at each scale, and that inferences garnered at each scale can have ramifications for understanding habitat relationships and subsequent development of management direction (Manly et al. 2002). Additionally, for species regulated by territorial behavior, including raptor species such as CSOs, population-level constraints can influence the density and distribution of individuals or breeding pairs, through territorial behavior and competition for space and resources. At the landscape-scale, raptor populations regulated by territorial behavior that are near carrying capacity exhibit a more-or-less regular distribution of territorial breeding pairs, with individual pair locations influenced by local habitat conditions, and landscape breeding density influenced by landscape distribution of habitat (Newton 1979).

The implications of habitat selection at the individual animal scale and of territorial regulation at the population level dictate that research seeking to understand landscape treatment effects should address habitat use and quality at the individual scale, as well as, population density and habitat relationships at the landscape-scale, to fully assess the effects of landscape fuels and vegetation management strategies. Current management direction is proposing landscape-scale treatment regimes to address fire and fuels issues, timber harvest, and vegetation restoration. It is necessary that research address management effects on CSOs at the appropriate scales at which management is being conducted. Proposed landscape treatments may have effects at either, or both, the individual territory or owl site scale as expressed through change in occupancy, diet, use of vegetation patches, survival or reproduction, or at the population level as expressed through change in the density or spatial distribution of territorial breeding pairs at the landscape-scale. The individual site scale and population level perspectives are complementary in that the population level provides context for interpreting change at the site scale. Most importantly, both perspectives are required by managers concerned with managing for high habitat quality sites, as well as, well-distributed, viable populations across landscapes while implementing management strategies to deal with large-scale fire and fuels issues.

Study Objectives

The CSO module is designed to provide information on treatment effects at the individual site and population level scales. The following objectives and questions will be addressed:

1) How do landscape-scale treatment regimes affect CSO density and habitat suitability at the landscape-scale?

2) How do fuels treatments and group selection harvest affect CSO occupancy, diet, reproduction, survival, and habitat fitness potential at the nest site, core area and home range scales?

3) How do fuels treatments and group selection affect diet, habitat use and home-range size and configuration?

Question 1: How do landscape-scale treatment regimes affect CSO density and habitat suitability at the landscape-scale?

Landscape vegetation patterns are a primary determinant of the density and distribution of spotted owls. Treatment regimes, along with natural disturbances, historical context and local conditions, are expected to result in differing landscape vegetation patterns across treatment units over time. Differences in vegetation patterns are expected to result in differences in the distribution, abundance, and quality of owl habitat at the landscape and home-range spatial scales. This question addresses owl population responses at the landscape scale and how owl density, distribution, population dynamics and habitat suitability are affected by the cumulative treatments and natural disturbances, and resultant landscape vegetation patterns. The general approach will have 2 major components: (1) monitor the number and location of territorial owl pairs and territorial singles over time within each treatment unit (TU) and (2) develop a habitat suitability model to assess how habitat suitability changes as a result of treatments. The approach will be adaptive and based on an iterative process of habitat model development, predictions of treatment effects on owl density and habitat suitability, monitoring of treatment effects and model predictions, revision of habitat model as necessary, followed by the next iteration of the process. The goal is to assess treatment effects on CSO populations and their habitat within a habitat modeling framework designed to improve understanding of wildlife habitat relationships and provide land managers with a tool to predict the effects of management actions on CSOs and their habitat.

CSO density will be estimated annually in each TU using extensive broadcast calling and intensive status surveys to determine owl CSO occupancy and social status. The target population is the territorial pairs and single individual CSOs within each TU. Each TU is mapped with polygons that conform to natural sub-watershed boundaries and are approximately the size of the core area of an individual owl pair. This size was used because it is large enough to potentially contain only one pair of owls. The sampling frame consists of the collection of polygons, with polygons functioning as the primary sample units (PSUs). Annual surveys will be conducted in each PSU with a combination of intensive status surveys and a maximum of 4 extensive broadcast call surveys. Survey effort will be explicitly documented and used to develop a function to account for probability of detection in the estimation of CSO occupancy and density over time. Mark-recapture techniques and reverse-time models will also be explored to estimate population growth rates, survival, and recruitment based on uniquely banded CSOs and to estimate trends in occupancy based on the polygon surveys within TUs and to compare these parameters across treatment regimes (Nichols 1992, Pradel 1996, Nichols et al. 2000). Our apriori expectation is that 12-20 owl pairs may occur in each treatment unit based on the size of the treatment units and currently available information on CSO density and distribution in the study area.

Habitat models will be developed using resource selection functions to predict CSO habitat suitability and population numbers (Manly et al 2002) across TUs and to project changes in habitat suitability resulting from treatments. Logistic regression will be used to compare CSO territory locations to available habitat at multiple scales to develop a statistical function for assessing habitat suitability. A priori models will be identified and an information theoretic approach will be used to identify the best models (Burnham and Anderson 1998). An iterative process of model development, field-testing of predictions, and model refinement will be used in adaptive framework to improve knowledge of CSO habitat relationships and project potential management effects.

Question 2: California spotted owl diet, survival, reproduction, and habitat fitness potential at nest-site, core area, and home-range scales.

Habitat patterns at within home-range scales affect owl occurrence and demographic responses. The objectives at the home-range scale are: (1) determine owl habitat-use patterns and habitat selection; and (2) determine if there are differences in habitat quality or habitat fitness potential (i.e., owl survival and reproduction) associated with variation in habitat patterns. Each of the above questions will be assessed hierarchically at the nest-site, core area, and home-range scales within each owl home-range, as stronger associations between owl occurrence, demographic responses and habitat occur at the nest-site and core areas spatial scales within home ranges (Lehmkuhl and Raphael 1993, North et al. 2000, Franklin et al. 2000).

Extensive broadcast surveys and status surveys will be used to locate all owl pairs within treatment units as described above under Question 1. Reproductive status will be determined each year at each territory and all owls will be banded with unique color-bands (Franklin et al 1996). Pellets and prey remains will be systematically collected at nest-sites and roosts to determine diets. Habitat at nest-sites (plot data) will be measured following a modified FIA protocol. Habitat at the core area and home-range scales will be assessed using aerial PI vegetation information. Habitat-use and selection patterns will be ascertained by comparing habitat at owl sites versus random or unoccupied sites using logistic regression models, classification and regression tree models, and an information-theoretic approach to model selection (Burnham and Anderson 1998). Habitat fitness potential, or habitat quality, will be assessed by relating survival and reproduction to habitat patterns and additional explanatory variables, such as weather, prey abundance, and seed production, using both a components-of-variation and model selection approach (e.g., Franklin et al. 2000) and a Bayesian belief network approach (D.C. Lee, pers. comm.). Annual variation in diet will be determined and related to habitat patterns at core area and home-range scales.

Question 3: Acute responses of California spotted owls to treatment effects within core areas and home-ranges.

In addition to the chronic responses addressed in Questions 1 and 2 above, owls may also exhibit short-term, acute behavioral responses to treatments. Acute responses may range from no effect, to shifts in use of prey species or space within home ranges to territory abandonment, or to reproductive failure or death during periods or seasons of treatment implementation. Changes over longer time periods following treatments may range from no effect to shifts in habitat use patterns and prey selection within home ranges to changes in habitat quality (survival and reproduction), which at the most extreme can result in home ranges that are no longer suitable for occupancy

The objectives of this question are to determine behavioral responses and home range configuration, habitat use, and prey use patterns of a subset of owl pairs to treatments within core areas of home ranges. Radio-telemetry will be used on an estimated total of approximately 30-40 pairs of owls across treatment units to determine how the above variables change before, during, and after treatments within core areas and home ranges. Plot-scale habitat information will be collected at foraging locations using the modified FIA protocol to provide fine-scale habitat use information. The specific pairs to be included in the study will be determined pending completion of: (1) initial CSO surveys conducted over the first years of the study under Question 1 that will provide an assessment of current owl distribution and abundance across the treatment units: (2) completion of the aerial PI vegetation coverage for the study area; and (3) finalization of treatment locations within treatment units. Each of these pieces of information is needed to determine current vegetation patterns within existing owl home ranges and how each home range will be treated. This information is required to identify suitable owl territories appropriate for inclusion in the telemetry study. Therefore, this module of the overall study plan will not be implemented until the second or third year of the study after a stronger informational base is available for specifying the details of the sampling design. The design of this module of the study will require extensive cooperation between managers and researchers in the design and timing of treatment implementation to meet basic study design objectives.

Specific Objectives 2003

Current information is lacking on the distribution and abundance of California spotted owls (CSOs) within the Plumas-Lassen Administrative Study (PLAS) area, with the majority of existing CSO records recorded during 1990-1992. Understanding the current distribution and abundance of CSOs is required to determine their status, establish baseline information, provide data for developing first-generation habitat models, and for refining the spatial allocation of treatments. Updated information on CSO distribution is also required to assess the current existing PAC network. Treatments will avoid Protected Activity Centers (PACs). Current information on existing vegetation conditions is necessary for developing first-generation habitat suitability models. Our specific objectives for 2002 were to establish survey polygon and survey point networks in the 11 Treatment Units (TU) and conduct initial owl inventory surveys in 5 of the 11 TUs, and contribute to the completion of a current vegetation map for the entire study area.

Results and Accomplishments - 2002

A team of 3 field project leaders was recruited in 2002 along with a seasonal field crew of 9 technicians. A network of survey polygons and survey points was established in TUs 1-5 in April–May 2002 and in TUs 6-11 during September-November 2002. Each network is designed to provide 100% survey coverage of a TU. The distribution of survey points was tailored to the local topography within each TU such that points were located at prominent locations, such as ridge points, to provide efficient coverage of the TU. Points were established along roads as a first option to minimize travel time and maximize survey efficiency. Off-road, hike-in points were established as necessary to provide survey coverage of road-less areas. Point locations were recorded with a GPS and entered into a GIS, and points are field marked with flagging and a uniquely numbered metal tag. A total of 3755 survey points have been established, ranging from 166-518 per TU (Table 1).

CSO surveys were conducted on US Forests Service lands within TUs 1-5 during 2002. Surveys in TU 2 and 5 were conducted by field crews from the Sierra Nevada Research Center, Pacific Southwest Research Station, Davis CA. Private contractors conducted surveys in TUs 1 (Steven Holmes Forestry), 3 (Merlin Biological), and 4 (Platy-Hill Resources). All surveys adhered to the Region 5 Spotted Owl Survey Protocol (1991). Extensive broadcast surveys were conducted six times at each survey point across the breeding period (April-August), unless owls were detected and follow-up status surveys determined territorial, pair and reproductive status. Extensive surveys were terminated in the vicinity of documented pairs to minimize disturbance. Individual surveys were 10-min in duration and consisted of alternately playing spotted owl calls and listening for the first 8 minutes and then listening for the final 2 minutes. Extensive surveys were conducted using CD players and broadcast callers to minimize potential variation in calling ability across a large number of observers. We used the spotted owl calls and call sequence recommended on the PNW survey-training tapes (Eric Forsman, PNW, pers. comm.).

A total of 11,311 extensive point surveys were conducted in 2002, resulting in 471 owl detections and confirmation of 41 pairs of owls (Table 1, Figures 1-x). Based on clusters of detections of male and female owls and locations of historic sites recorded in the California Department of Fish and Game database, we suspect an additional 1-5 pairs of owls may be located in each TU. Surveys did not begin until mid- to late-April in 2002 due to delayed project approval finalized at the end on January 2002 and subsequent start-up time constraints. Therefore not all surveys could be completed by June to conclusively determine reproductive and pair status to protocol at locations of all owls detected during extensive surveys. Surveys to be conducted in 2003 will be used to evaluate pair status and location of nests or main roosts at these additional sites.

Discussion

Our efforts in 2002 focused on updating baseline information on CSO distribution and abundance in a subset of the TUs. Existing information is 10-12 years old for most of study area outside of the region that overlaps with the Lassen demographic study in TUs 1 and 11. We documented 41 confirmed pairs and suspect there may be an additional 1-5 pairs per TU based on clusters of male and female detections. An additional year of survey work is required to develop a more accurate estimate of the baseline number and distribution of territorial pairs that occur in each TU. Comparison of our first year survey results with existing information in the CDFG database indicated that some of the original locations continued to be occupied by CSOs whereas there have also been changes in the spatial distribution of CSO nest sites and core areas compared to the previous existing information. These results emphasize the importance of collecting current baseline information for assessing current status, providing accurate data for management and conservation planning, and generating the base data required to develop empirical habitat relationship models.

Our a priori expectation is that territorial pairs of CSOs should be distributed in a somewhat regular distribution across each TU, assuming suitable habitat is available and well distributed. This population distributional pattern is characteristic of territorial raptor species that breed as solitary pairs with populations regulated by territorial behavior (Newton 1979). Although are results are preliminary based on only one year of survey work, our results suggest that CSOs are distributed in a pattern that is consistent with our a priori expectation. Confirmed pairs and clusters of detections (possible, unconfirmed pairs) appear to be regularly distributed over most of the TUs where suitable habitat is present. Surveys are needed on private lands within TUs to determine if apparent gaps in some areas are actually occupied by CSOs on private lands. A notable exception to the more or less continuous distributional pattern we observed was reported from the northwest portion of TU-4 where a of cluster male and female detections suggested presence of a single territory in an area where records for 5 pairs and 2 territorial singles are listed in the CDFG database. Apparently there have not been significant changes in the vegetation in this area between 1990-2002 (Gary Rotta, Plumas National Forest, pers. comm.). This is a priority survey area for PSW survey crews in 2003 to either confirm or refute the 2002 survey results suggesting a gap in CSO distribution. Our short-term survey results also need to be viewed in the context of longer-term population trends. Results from long-term demographic studies that include TU-1 indicate that owl populations have declined over the previous decade (Blakesley et al. 2001), although the magnitude of the decline and role of potentially interactive causative factors are uncertain.

Objectives - 2003

Priority objectives for 2003 are to conduct initial CSO surveys in TUs 6-11 and continue annual surveys in TUs 1-5 to document the distribution and abundance of CSOs across TUs and to locate nest sites or main roost sites to provide information for constructing habitat models. Color-banding of territorial CSOs will be initiated in 2003. The updated photo-interpreted vegetation cover will be available in 2003 and initial habitat models will be generated.

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Table 1. Summary of the number of survey points established, individual surveys conducted, number of California spotted owl detections and confirmed pairs during 2002, along with the historic number of territorial pairs recorded in the 2001 California Department of Fish and Game spotted owl database.

Treatment Unit	**Number of Call Stations**	**Number of Surveys**	**Number of Owl Detections**	**Number of Confirmed Pairs**	**Number of CDFG Historic Pairs**
1	518	2992	46	9	12
2	358	1706	151	8	12
3	344	2027	58	8	9
4	323	2783	97	8	11
5	321	1803	119	8	9
6	479	-[a]	-	-	18
7	387	-	-	-	14
8	324	-	-	-	11
9	276	-	-	-	12
10	259	-	-	-	8
11	166	-	-	-	11
Totals	**3755**	**11,311**	**471**	**41**	**127**

-[a] = indicates no work was conducted on this aspect of the study in the TU during 2002.

Figure 1. Distribution of California spotted owl pairs reported in the California Department of Fish and Game 2000 database and confirmed pairs based on 2002 surveys in the Plumas-Lassen Administrative study area.

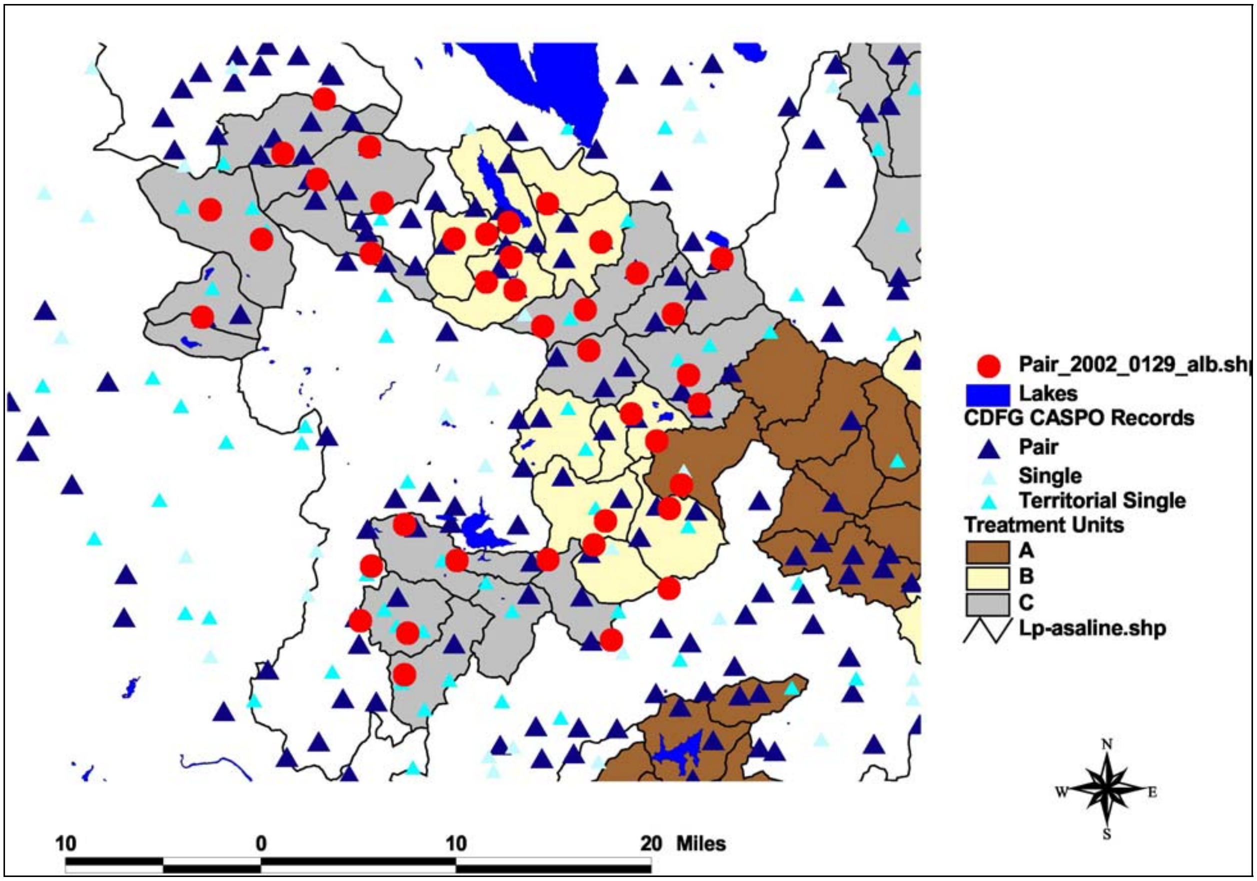


Figure 2. Distribution of California spotted owl pairs reported in the California Department of Fish and Game 2000 database and confirmed pairs and all owl detections in Treatment Unit 1 based on 2002 surveys in the Plumas-Lassen Administrative study area.

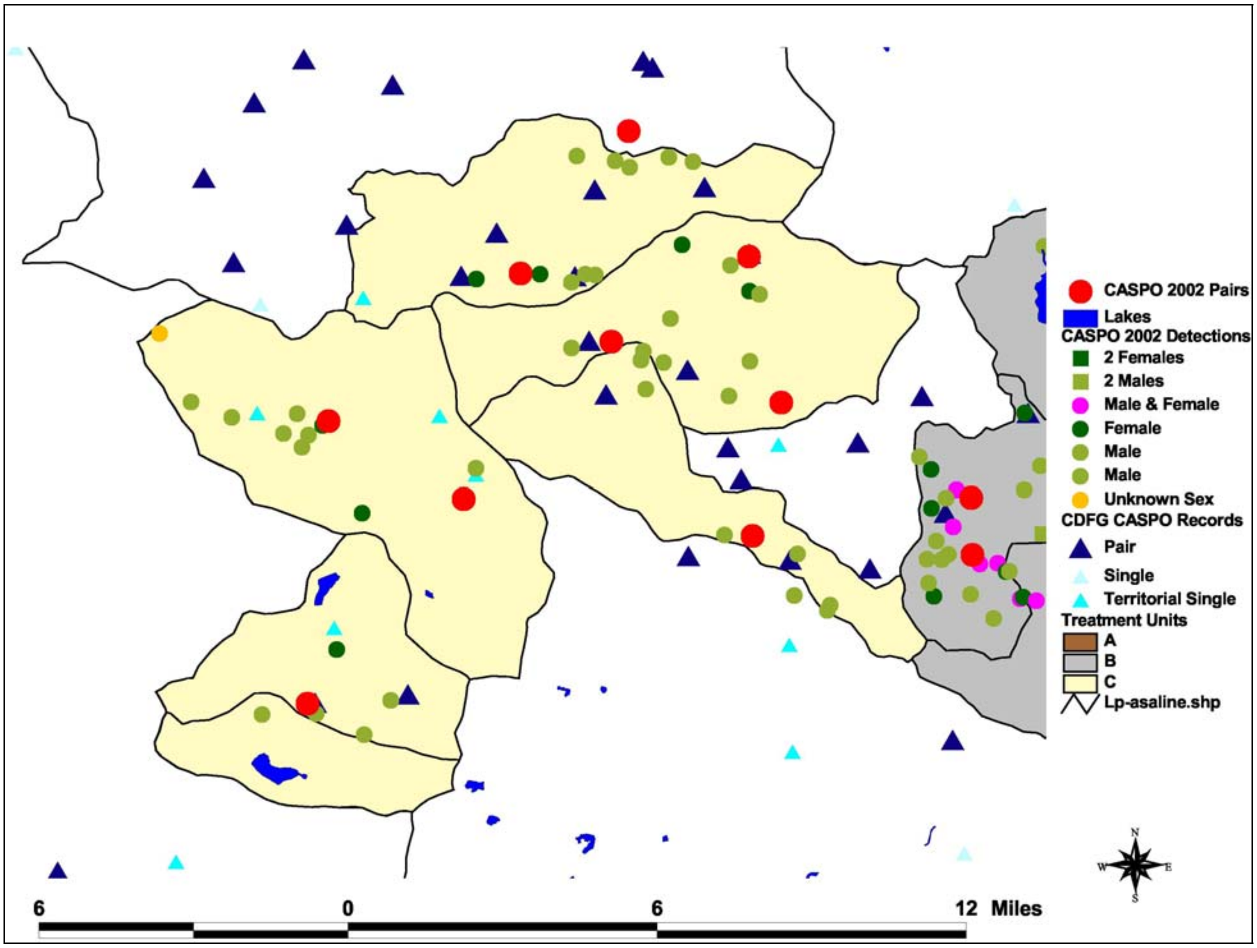


Figure 3. Distribution of California spotted owl pairs reported in the California Department of Fish and Game 2000 database and confirmed pairs and all owl detections in Treatment Unit 2 based on 2002 surveys in the Plumas-Lassen Administrative study area.

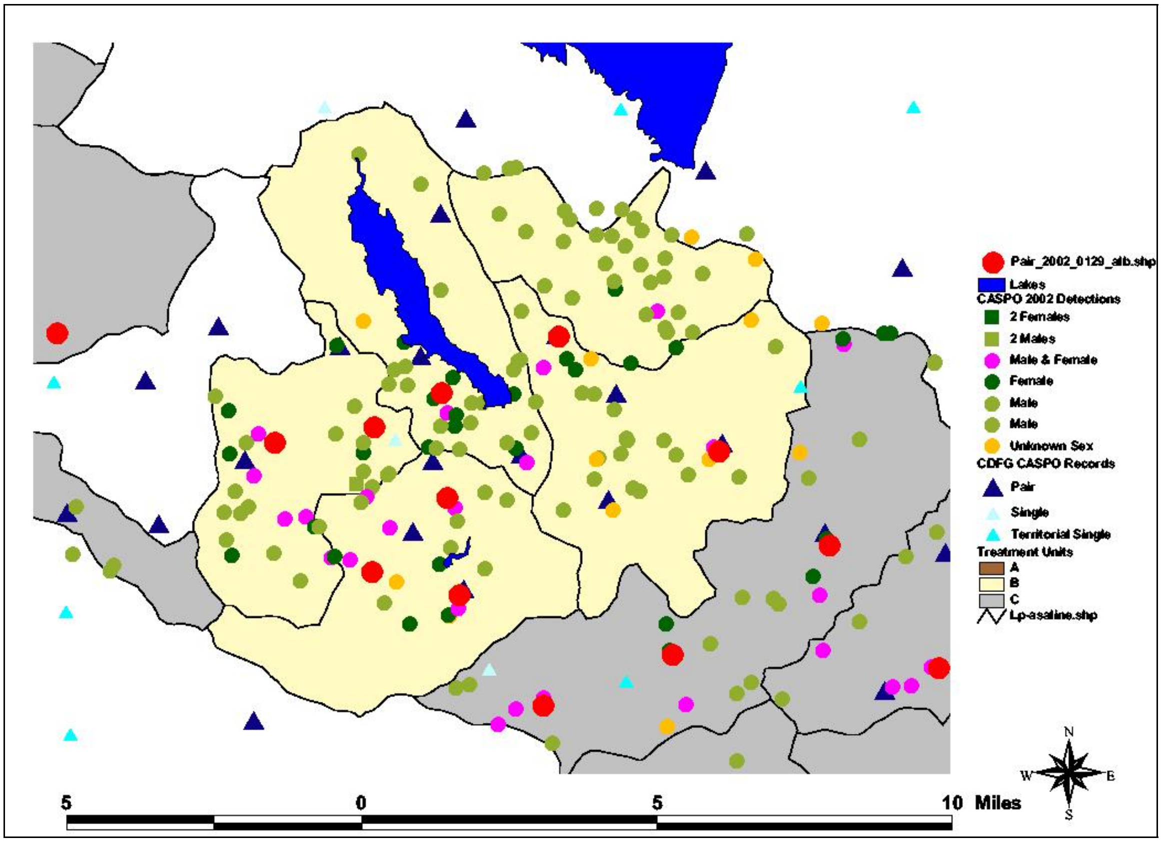


Figure 4. Distribution of California spotted owl pairs reported in the California Department of Fish and Game 2000 database and confirmed pairs and all owl detections in Treatment Unit 3 based on 2002 surveys in the Plumas-Lassen Administrative study area.

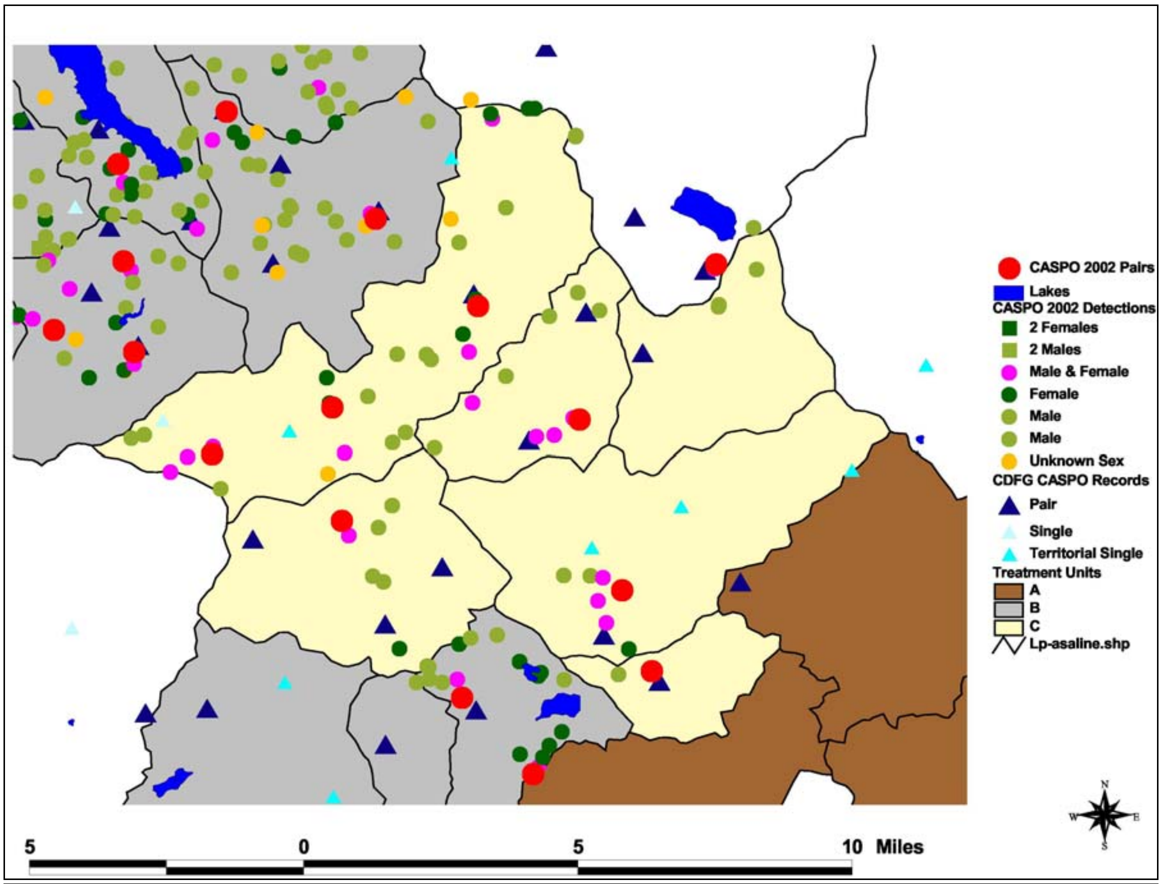


Figure 5. Distribution of California spotted owl pairs reported in the California Department of Fish and Game 2000 database and confirmed pairs and all owl detections in Treatment Unit 4 based on 2002 surveys in the Plumas-Lassen Administrative study area.

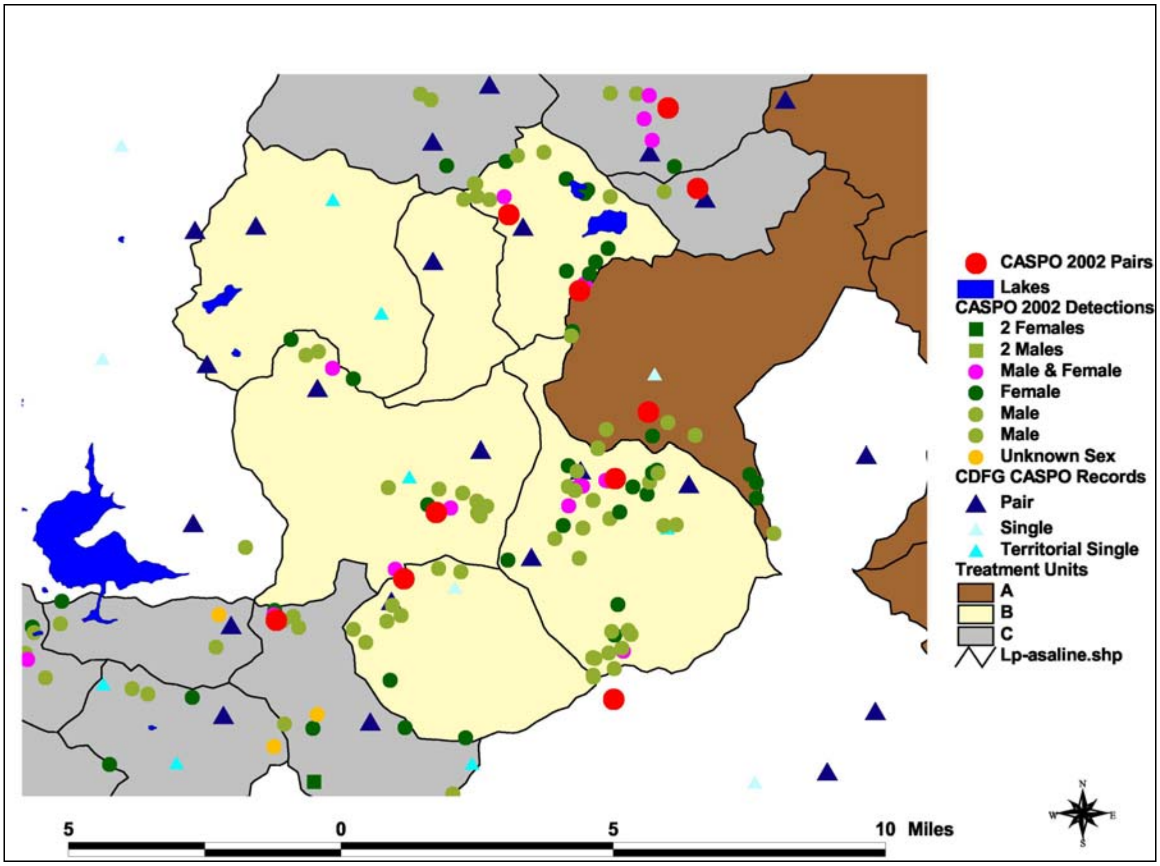
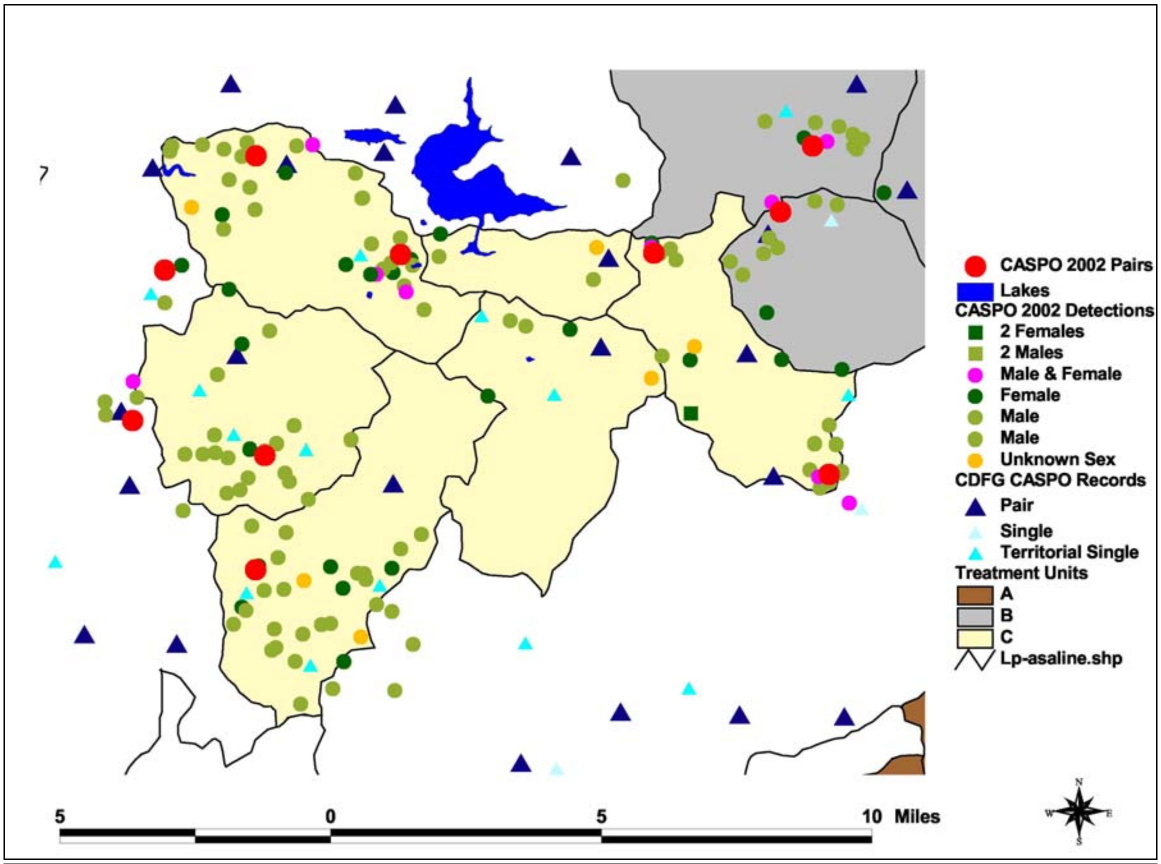


Figure 6. Distribution of California spotted owl pairs reported in the California Department of Fish and Game 2000 database and confirmed pairs and all owl detections in Treatment Unit 5 based on 2002 surveys in the Plumas-Lassen Administrative study area.



Coordination with National Forest System Staff

This project requires constant and careful collaboration with National Forest System (NFS) staff. There are many reasons this is required, including:

- Research is oriented towards management questions
- Vegetation treatments are planned in conjunction with research staff
- Treatments are executed by NFS
- Research work is done on Ranger Districts
- Safety of employees in the field is a shared concern

This project represents a program of unprecedented geographic magnitude and thus coordination is especially important. Success is dependent on effective cooperation and understanding of the respective roles of the parties. Thus many people involved in this project have worked hard to accomplish this coordination.

Intra-Agency Agreement

The Pacific Southwest Region (REGION) and the Pacific Southwest Research Station (PSW) have developed an Intra-Agency Agreement to jointly develop and fund the study. This agreement was signed by the Regional Forester and the Station Director in April of 2002. This agreement lays the foundation for the close cooperation and collaboration between Region 5 (including the Lassen and Plumas National Forest staffs) and PSW (in particular the scientists and support staff of the Sierra Nevada Research Unit). The agreement establishes a commitment for up to twenty years to complete the objectives of this study.

QLG Steering Committee

Although the Plumas Lassen Study is not directly related to the HFQLG Pilot Project, the QLG Steering Committee has been an effective forum in which to coordinate with key individuals from the Plumas and Lassen National Forests. In particular the Forest Supervisors meet with PSW Research personnel regularly to stay in touch with study design and implementation issues. Other key personnel, including the HFQLG Pilot Project coordinator and his staff are consulted regularly regarding study issues.

Plumas Lassen Study Team

The Plumas Lassen Study Team is comprised of Principal Investigators for all five research modules, research support staff, and project coordinators from the Plumas and/or Lassen Natioanl Forests. The Study Coordinator provides liaison to National Forest managers and staff, coordinates National Forest activities related to Regional responsibilities, participates in annual reviews and provide for participation by other relevant National Forest staff in these reviews, and facilitates review of study design leading to concurrence from NFS decision-makers. We have had approximately 20 meetings since the inception of the project and coordination has been excellent.

District Rangers/Plumas Lassen Study Team

All parties agreed that perhaps the most crucial coordination required for this project was the coordination in the field. This study involves extensive field work and deployment of field personnel who will be moving about the Ranger Districts from March through November each year. As many as 40 permanent, term, temporary, and university/collaborator staff will be in the field almost every day during much of this time period. Furthermore, the assistance of District staff; biologists, fuels specialists, etc. and the support of the District Rangers is vital to the ultimate success of the study.

In furtherance of the objective of close coordination with District staff we have initiated periodic meetings between Study scientists and their staff with District Rangers and their staff. All four participating District Rangers have participated as well as selected staff, depending on the topic. We have had five meetings over the last 12 months and covered a range of topics including:

- Research objectives/specific study strategies for each of the five modules
- Safety policy and procedures
- Communication strategy
- Logistics of working in the field on the Districts
- Housing for field crews
- EIS development and placement of treatments

These meetings have been very valuable and productive and we plan to continue them on an as needed basis.