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Appendix E

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, Franklin et al. 2004, USDA 2004). 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 pair 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 overall objective of this module is to monitor the response of CSOs to full implementation of the landscape management strategy developed in the Herger- Feinstein Quincy Library Group (HFQLG) Act as called for in the Record of Decision for the Final Supplemental Environmental Impact Statement (USDA 2004). The CSO module is designed to provide information on treatment effects at the individual territory and population level scales, as described below under the specific questions.

From an experimental design perspective, establishing strong inferences regarding cause-effect relationships requires a rigorous experimental-control design with treatment and control experimental units under which the investigator attempts to control for extraneous variables and isolate treatment effects. Conducting rigorous experimental work at the landscape and home-range scale in nature is particularly challenging due to inherent variation at multiple spatial scales, lack of replication, particularly at the landscape scale, and prohibitive cost. A rigorous experimental approach also requires a working collaborative relationship between researchers and managers and the political will to prioritize treatment implementation in time and space to meet experimental design needs. In this project, treatments will be implemented in time and space by the USDA Forest Service as dictated by multiple management objectives surrounding full implementation of the HFQLG Act, and not prioritized to meet research objectives. This type of treatment application limits the strength of the resulting inferences that can be drawn regarding cause and effect relationships. Therefore, our research approach is designed to maximize the types of information that can be gained under an experimental context where the spatial and temporal application of treatments is not under control of the investigators.

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 a subset of treatment units (TU) and (2) develop a habitat suitability model to assess how habitat suitability and owl numbers are projected to change 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 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. All CSO encountered will be captured and marked with a unique color band to allow subsequent identification of individual CSOs (Franklin et al. 1996). Mark-recapture techniques and reverse-time models will be used to estimate population trends, survival, and recruitment based on uniquely banded CSOs and to estimate trends in occupancy based on the polygon surveys across the study area, within TUs and to compare these parameters between treated and untreated CSO territories (Nichols 1992, Pradel 1996, Nichols et al. 2000).

Habitat models will be developed using resource selection functions to predict CSO habitat suitability and population numbers (Manly et al 2002) across the study area and TUs, and to project changes in habitat suitability resulting from treatments (Zabel et al. 2003). 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. Our specific objectives for 2003 were to complete the survey polygon and survey point networks in the 11 Treatment Units (TU), conduct surveys in 5 TUs (2,3,4,5,7), color-band all territorial CSOs, assist the Plumas NF with the design of contract surveys for TUS 8-10, and systematically collect pellets around known roost/nest locations. Our primary objective was to develop an accurate understanding of CSO distribution and abundance in the surveyed TUs to provide the required baseline information for habitat modeling and monitoring the effects of HFQLG implementation.

Results and Accomplishments - 2003

A team of 3 field project leaders managed the field effort in 2003 along with a seasonal field crew of 16 technicians. A network of survey polygons and survey points was completed across all 11 original TUs in 2003. 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 3730 survey points have been established, ranging from 166-518 per TU (Table 1).

CSO surveys were conducted on US Forests Service lands within TUs 2-5 and 7-10 during 2003. Surveys in TUs 2,3,4,5, and 7 were conducted by field crews from the Sierra Nevada Research Center, Pacific Southwest Research Station, Davis CA. Private contractors conducted surveys in TUs 8-10. All surveys adhered to the Region 5 Spotted Owl Survey Protocol (1991). Extensive broadcast surveys were conducted three (PSW) or six (Contractors) 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. A 3-visit protocol was used in TUs previously surveyed in 2002, while a 6-visit protocol was used for the initial survey year in TUs 8-10 in 2003. 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 9,499 extensive point surveys were conducted in 2003, resulting in 603 owl detections and confirmation of 70 territorial CSO pairs, singles, or unknown status pairs (Table 2, Figures 1-10). 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 1-2 pairs of owls may be located in a few of the TUs. Surveys to be conducted in 2004 will be used to specifically evaluate pair status and location of nests or main roosts at these additional sites. We think this is especially true for TUs 8-10 where only 1 year of contractor survey information is available. A second year of surveys is required to have a confident assessment of the distribution and abundance of CSOs in these TUs. We color-banded 28 CSOs and collected approximately 500 pellets from roost/nest locations during 2003.

Discussion

Our efforts in 2003 focused on building on the initial baseline surveys conducted in 2002 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 70 territorial CSO sites in 2003, plus 9 pairs confirmed in TU-1 during 2002, and suspect there may be an additional 1-2 sites in a few TUs 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 TUs 7-10, since 2003 surveys were the first year these TUs have been inventoried. Survey results to date 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 on private lands within sample TUs will be conducted in 2004 to determine if gaps in some areas are actually occupied by CSOs on private lands.

Objectives - 2004

Priority objectives for 2004 are to continue CSO surveys in a subset of the original TUs and attempt to complete color-banding of all territorial CSOs within the survey areas. Efforts are under way to analyze and identify all prey items in the pellets that were collected in 2003 to assess CSO diets in the study area. Pellets will be systematically collected again in 2004 to address annual variation in diet. Evaluation of available radio-telemetry technological options is being conducted and initial field applications of radio-telemetry may be conducted in 2004. First generation predictive habitat models are being developed using the CSO data from 2003 and the vegetation map completed in 2003. Monitoring for West Nile Virus will be initiated in 2004 in conjunction with the Wildlife Genetic Laboratory at UC Davis. Collaborative efforts are being developed between the Lassen demographic study and the Plumas-Lassen Administrative Study to coordinate research efforts and efficiency.

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Table 1. Summary of the number of survey points per Treatment Unit, and the number of extensive surveys conducted and number of California spotted owl detected on extensive surveys during 2002 and 2003.

Treatment Unit	Number of Call Stations	Number of 2002 Extensive Surveys	Number of 2002 Owl Detections	Number of 2003 Extensive Surveys	Number of 2003 Owl Detections
1	518	2992	46	-[a]	-
2	339	1706	151	961	113
3	370	2027	58	1024	73
4	451	2783	97	1122	91
5	426	1803	119	1262	62
6	479	-	-	-	-
7	190	-	-	572	50
8	256	-	-	1471	42
9	276	-	-	1530	50
10	259	-	-	1557	122
11	166	-	-	-	-
Totals	**3730**	**11,311**	**471**	**9,499**	**603**

-[a] = indicates no surveys were conducted in the TU during that year.

Table 2. Summary of number of California spotted owl pairs, territorial singles and unknown pairs located by Treatment Unit during 2002 and 2003 in the PLAS study area.

Treatment Unit	Number of 2002 CSO Pairs		Number of 2003 CSO Pairs	Number of 2003 CSO Unknown Pairs	Number of 2003 Territorial Singles	2003 Total
1	9		-[a]	-	-	-
2	8		12	1	0	13
3	8		8	1	0	9
4	8		7	0	2	9
5	8		8	1	2	11
7	-		6	0	0	6
8	-		5	0	2	7
9	-		5	0	0	5
10	-		8	1	1	10
Total	**41**		**59**	**4**	**7**	**70**

-[a] = indicates no surveys were conducted in the TU during that year.

Figure 1. Summary of California spotted owl distribution by social status based on surveys during 2002 and 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

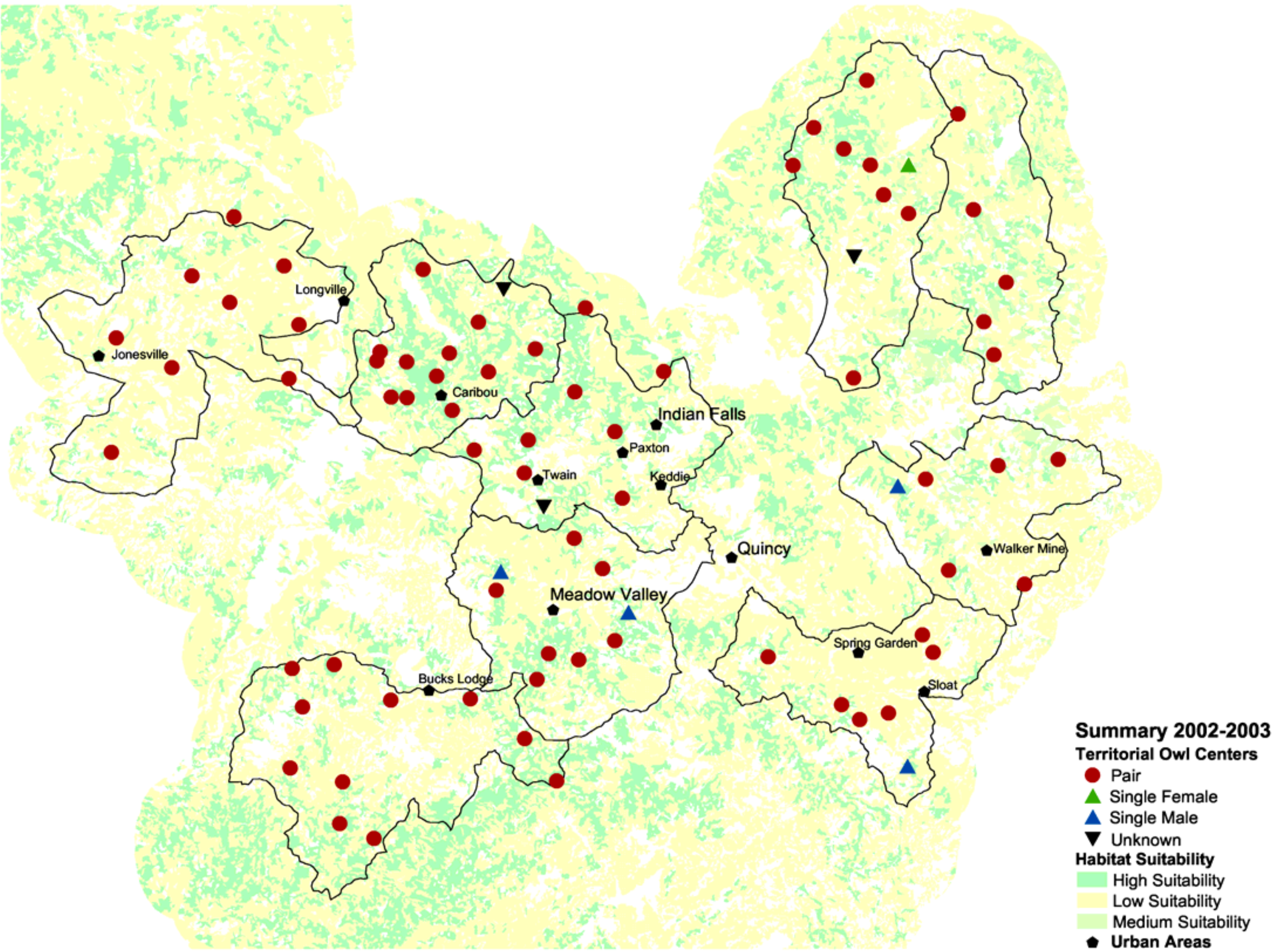

Figure 2. Distribution of California spotted owls detected on surveys conducted during 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

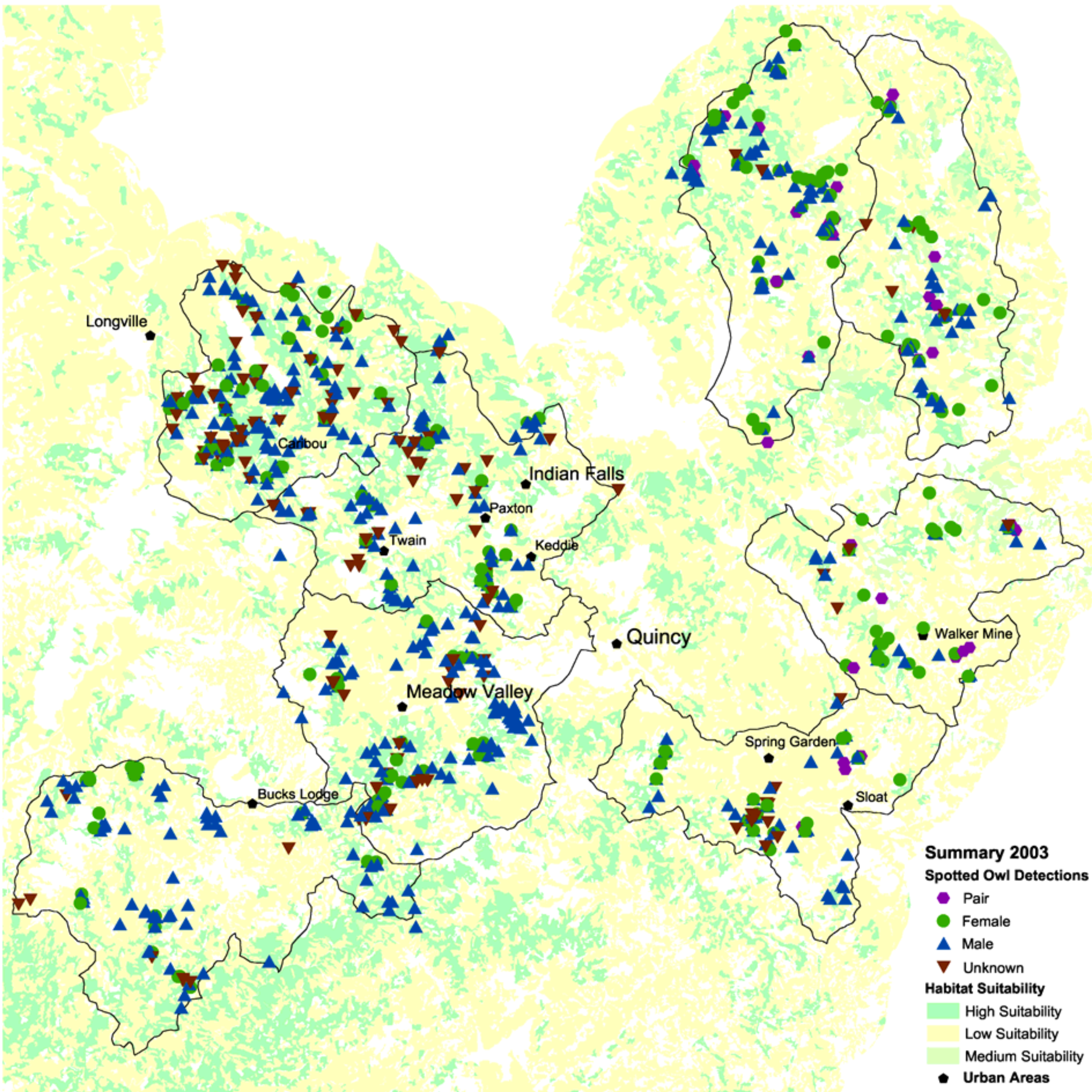

Figure 3. Distribution of California spotted owls detected in Treatment Unit 2 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

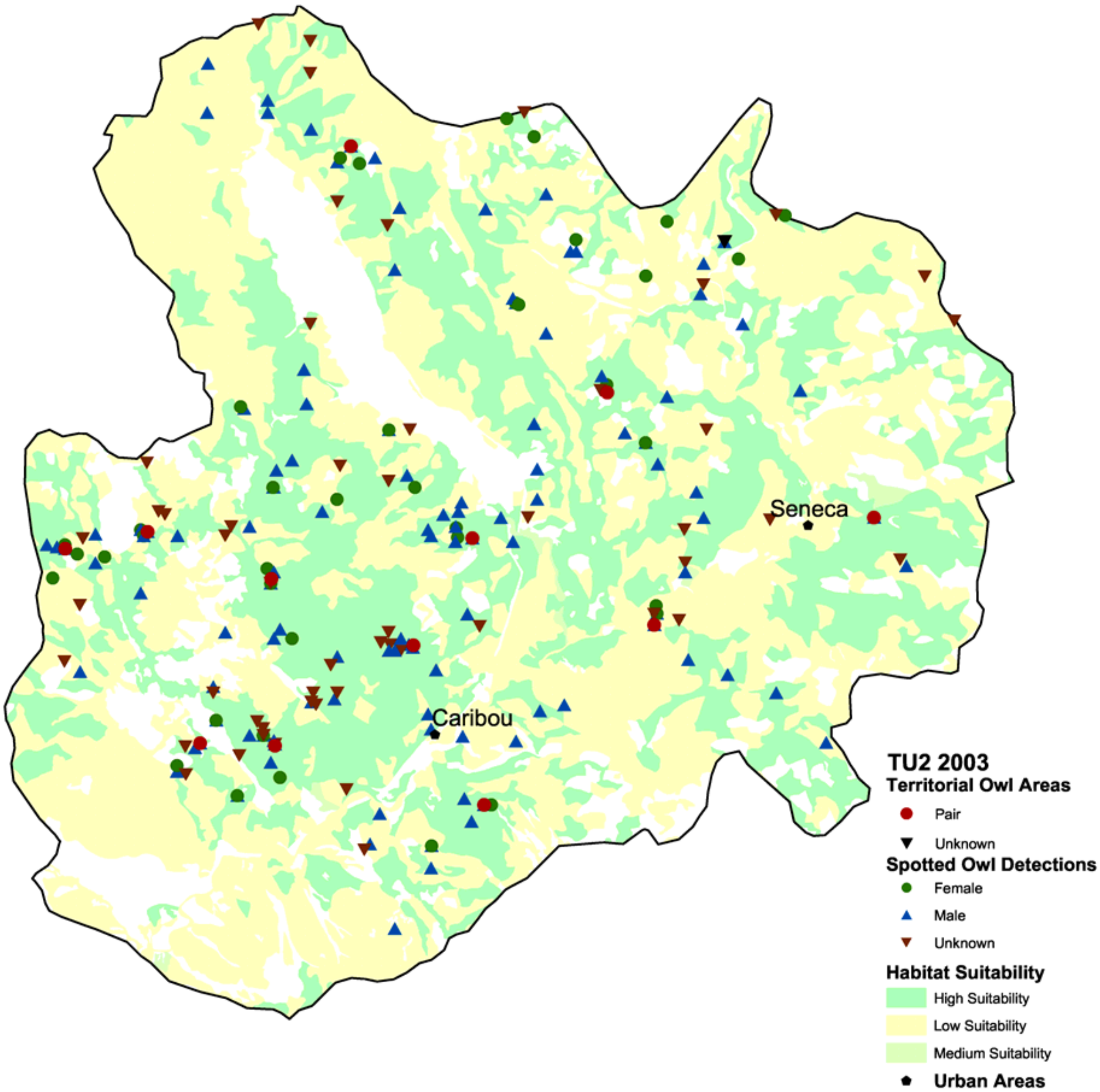

Figure 4. Distribution of California spotted owls detected in Treatment Unit 3 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

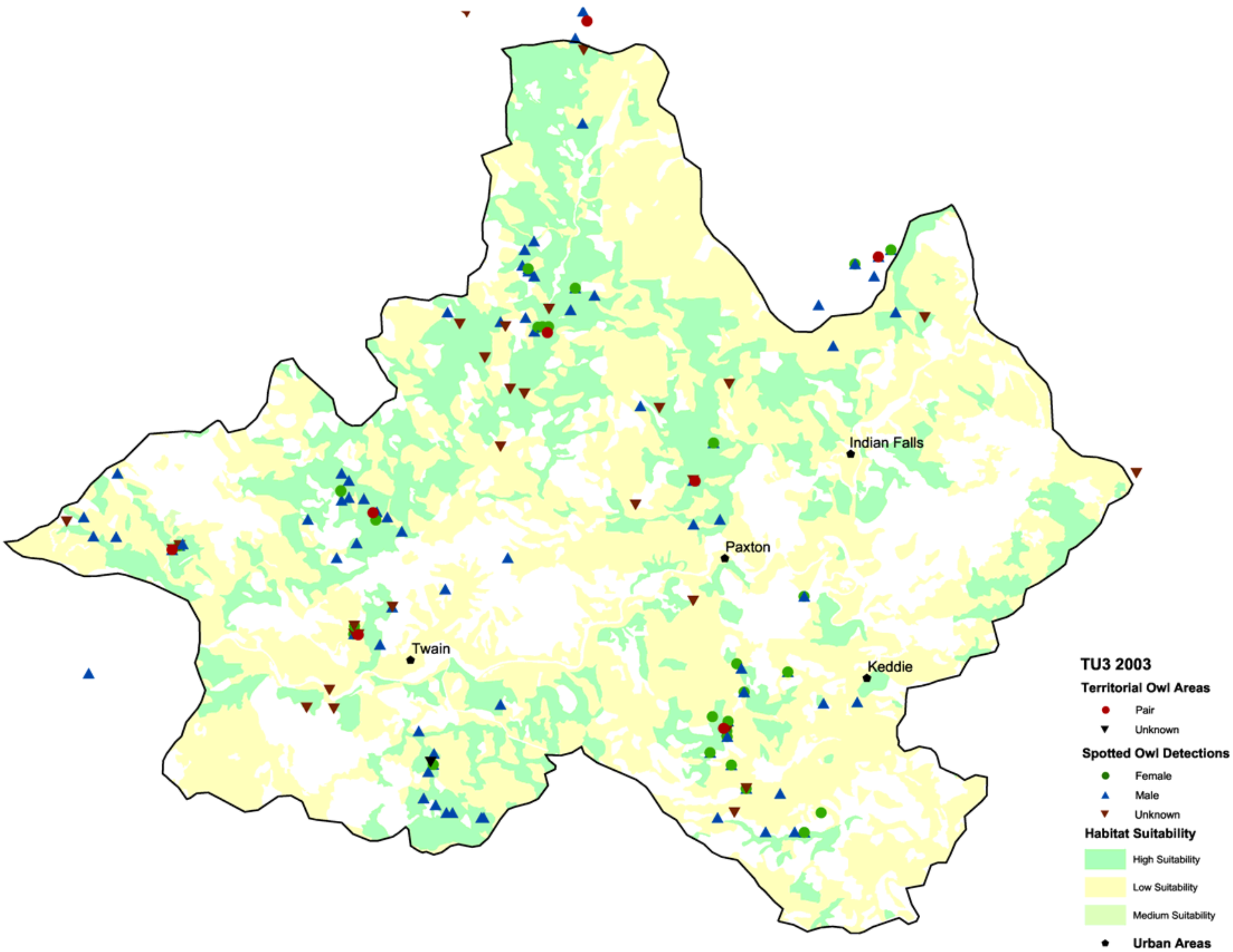

Figure 5. Distribution of California spotted owls detected in Treatment Unit 4 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

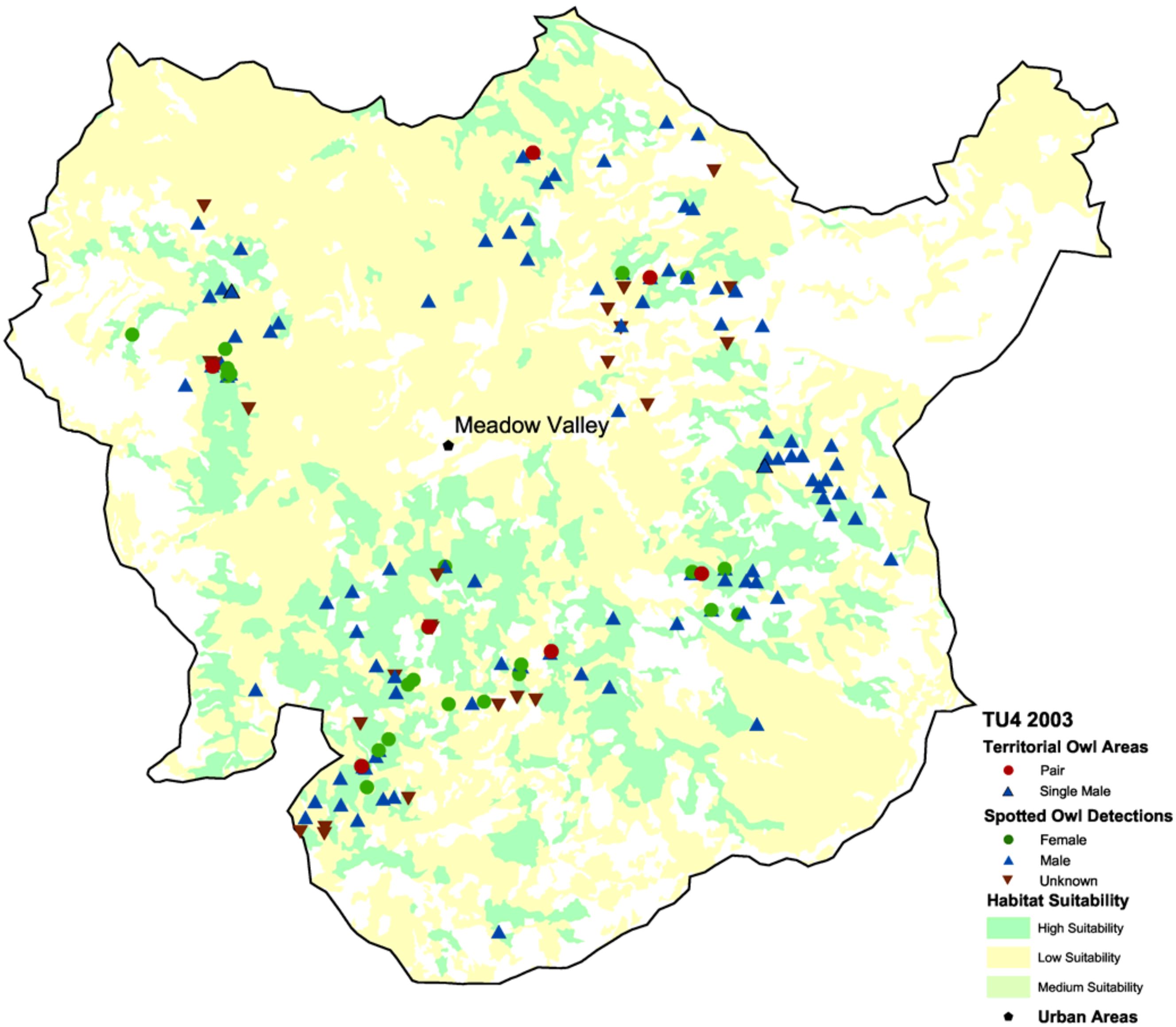

Figure 6. Distribution of California spotted owls detected in Treatment Unit 5 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

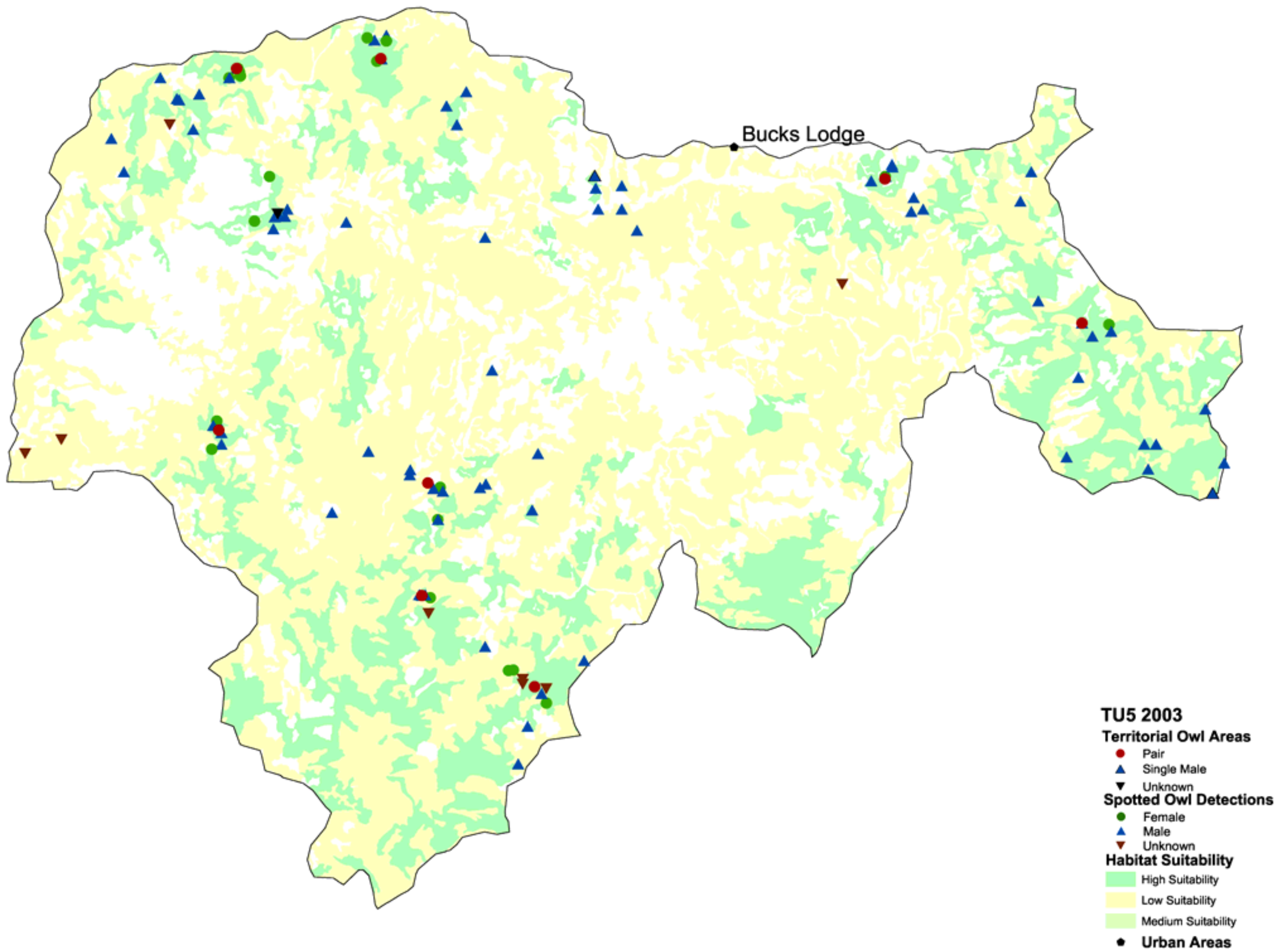

Figure 7. Distribution of California spotted owls detected in Treatment Unit 7 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

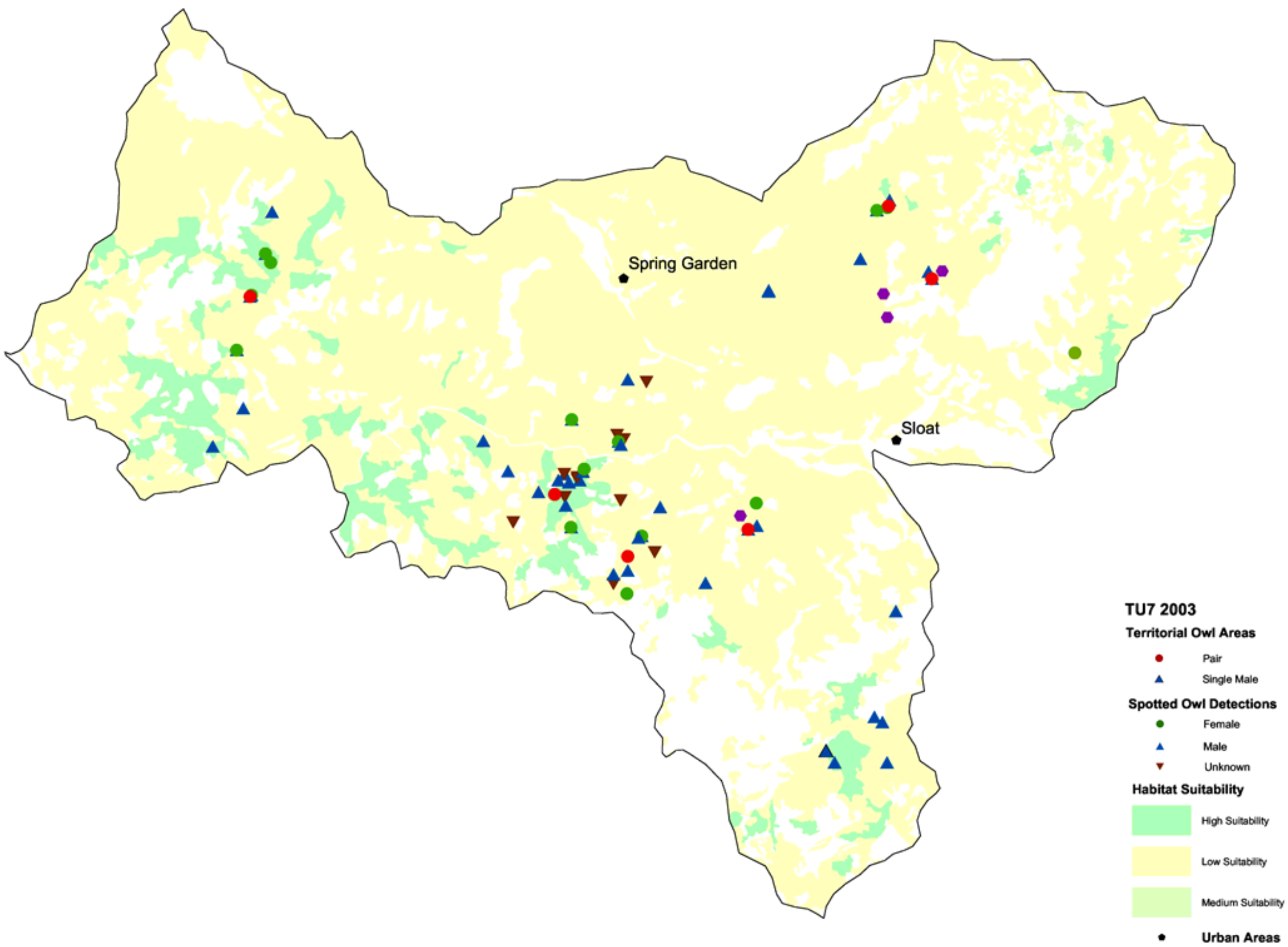

Figure 8. Distribution of California spotted owls detected in Treatment Unit 8 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

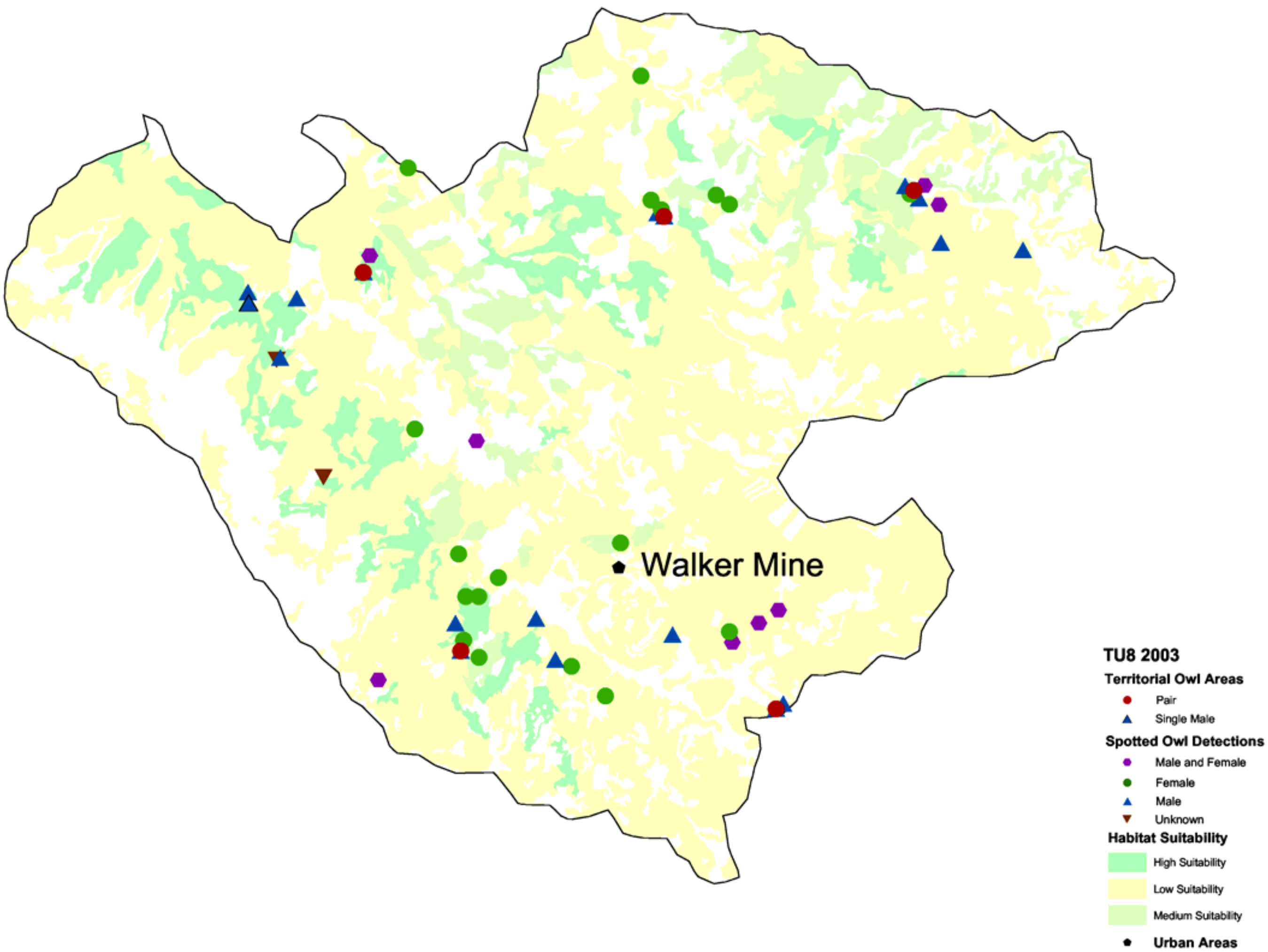

Figure 9. Distribution of California spotted owls detected in Treatment Unit 9 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.

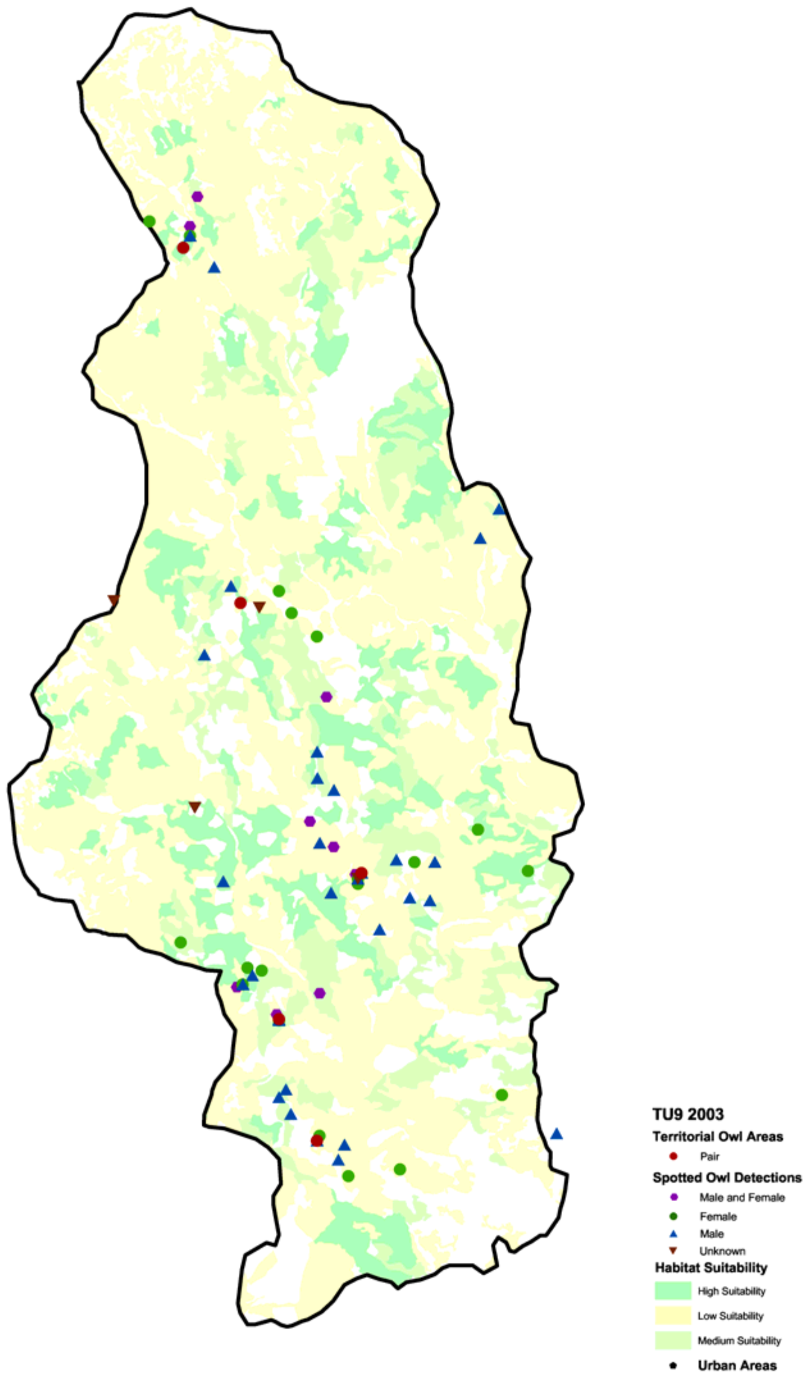

Figure 10. Distribution of California spotted owls detected in Treatment Unit 10 during surveys conducted in 2003 with reproductive habitat suitability as defined in the California Wildlife Habitat Relationship Database in the Plumas-Lassen Administrative study area.