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Dusky-footed Woodrat Monitoring
In
Point Reyes National Seashore
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Photo: B. Moose Peterson

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ABSTRACT

In response to U.S. Fish and Wildlife Service (USFWS) concerns about the impacts of fuel reduction activities on Dusky-footed Woodrat (*Neotoma fuscipes*) and Northern Spotted Owl (*Strix occidentalis caurina*) populations, we studied woodrat house densities in a variety of habitats and along roadsides and measured the relative importance of woodrats as prey of Northern Spotted Owls. Through pellet analysis, we confirmed this importance and found woodrats made up 76% and 82% of prey biomass consumed in 1997 and 2002 respectively. In general, densities of woodrat houses found here are among the highest reported in similar habitats. Woodrat house densities in 50m plots were highest in California bay (*Umbellularia californica*) and red alder (*Alnus rubra*) habitats and lowest in grassland habitat where no houses were found. Average roadside density was higher than plot density and marking woodrat houses along roads so treatment crews could avoid them is important. We recommend that efforts continue to minimize the impacts to Dusky-footed Woodrats and subsequently, Northern Spotted Owls.

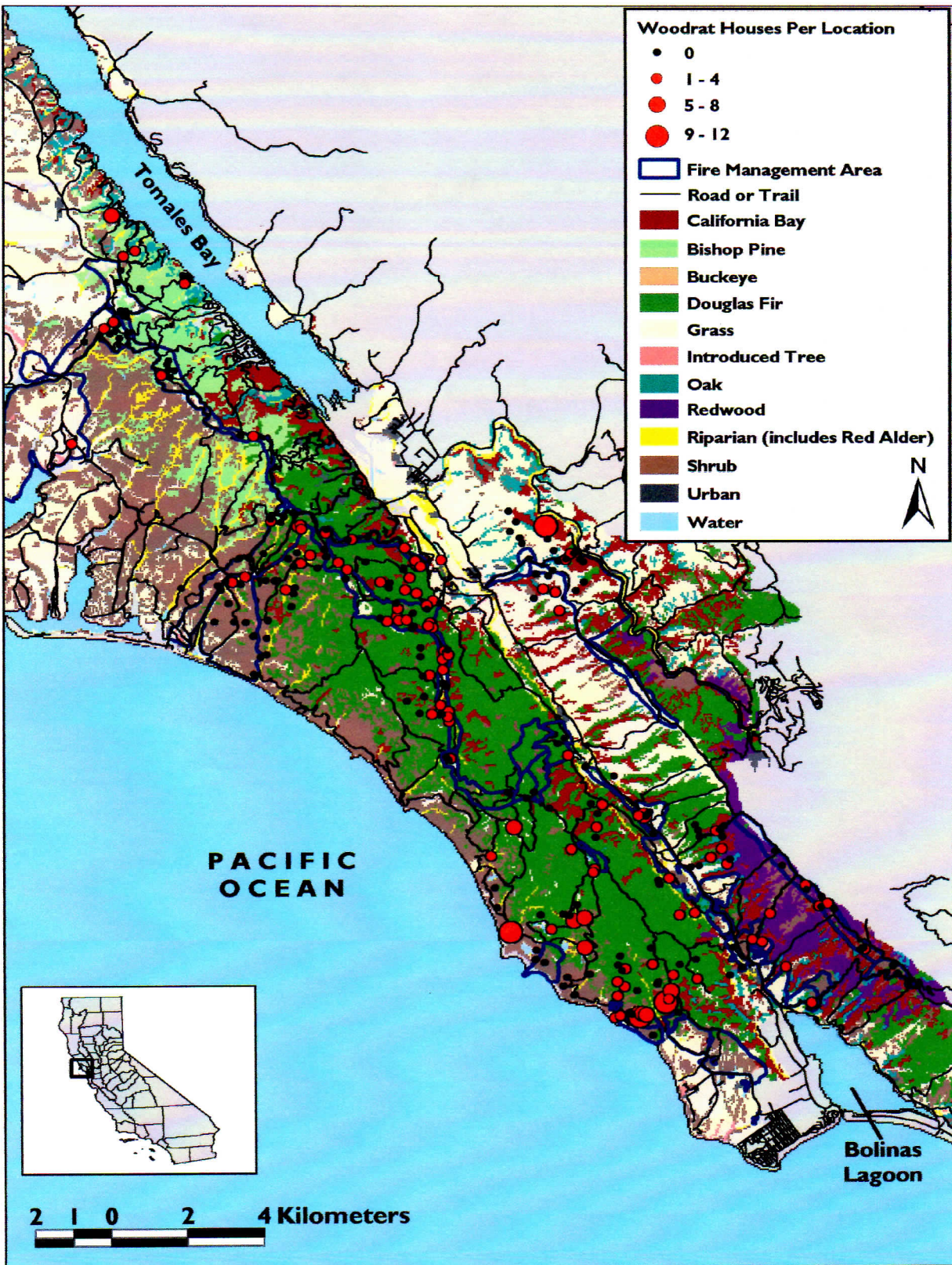


Figure 1. Surveyed plots with relative densities.

INTRODUCTION

In 2001, Wildland Urban Interface (WUI) fire prevention activities were planned for the Point Reyes National Seashore (PRNS) and Golden Gate National Recreation Area (GGNRA) in Marin County, California. There are a minimum of 38 documented Northern Spotted Owl territories located within 2 km of the planned fire treatment areas (Fehring et al. 2003). The USFWS expressed concern that fuel reduction activities may impact Dusky-footed Woodrats and subsequently Northern Spotted Owls who are thought to primarily eat woodrats. The Northern Spotted Owl was listed as threatened by USFWS in 1990 and all potential impacts to their populations must be addressed when federal agencies such as the National Park Service (NPS) are planning or funding management activities.

This study is designed to address potential impacts of fire prevention treatments such as mowing, burning, and other fuel reduction activities on local woodrat populations. All field work was conducted prior to treatment activities. The three main aspects to this study are:

- 1) Calculate woodrat densities using 50m point centered house counts (plots) in forested habitats such as bishop pine (*Pinus muricata*), California bay (*Umbellularia californica*), coast redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), as well as grassland and scrub habitat which includes California hazelnut (*Corylus californica*), coffeeberry (*Rhamnus californica*), coyote brush (*Baccharis pilularis*), and red elderberry (*Sambucus callicarpa*);
- 2) In areas where mowing and other thinning treatments were planned, survey roadsides for woodrat houses and mark houses so treatment crews could leave them intact. Calculate woodrat densities along surveyed roadsides;
- 3) Collect Northern Spotted Owl pellets and analyze to determine the relative importance of woodrats as an owl prey item.

Prior woodrat studies in Marin County have found woodrat densities as high as 92.9 active houses per hectare and an average of 36.0 active houses per hectare (Willy 1992). A 1996 analysis of local Northern Spotted Owl diets indicated that woodrats made up 63-92% of total prey biomass depending on habitat type (Chow and Allen 1997). Other owl diet studies conducted in California have found that woodrats make up over 70% of prey biomass (Ward et al. 1998). These studies further support the need to survey for, and minimize the impacts to, local woodrat populations.

WOODRAT ECOLOGY

Dusky-footed Woodrats are common within their range along the Pacific coast from the Columbia River in Oregon to Baja California (Ingles 1965). They are found in a wide variety of habitats although they prefer dense shrubby and high cover habitats (Cranford 1977). Woodrats mainly eat hard-leaved sclerophyllous vegetation although their diet varies widely and takes advantage of seasonal resources. Hazelnut and twinberry crops as well as large quantities of California bay flowers are utilized (Cranford 1977). Woodrats are nocturnal and are the preferred prey of small and

medium mammals as well as birds of prey (Ingles 1965). Woodrats build large, often conspicuous stick nests both on the ground and in trees. These "houses" are the focal point of their home range and are often used by several generations, persisting for a decade or more (Sakai and Noon 1997, Hammes et al. 2002). Woodrat populations are limited by suitably dense habitat for food and predation protection, materials for house construction, and dispersal ability (Carey 1999).

METHODS

House Count Plots

Determining relative woodrat abundance using house counts has been established as a more cost-effective method than live trapping. Although some studies have shown little correlation between the number of houses and the number of rats trapped (Cranford 1977, Fargo and Laudenslayer 1999), others have found the number of occupied houses to be strongly correlated with the number of woodrats trapped (Willy 1992, Vreeland and Tietje 1999). Reported occupancy rates (woodrats/woodrat house) range from 0.49 to 0.72 depending on season (Willy 1992), to over 1.0 (Sakai and Noon 1993), to 2.2 to 3.1 woodrats per house depending on house sampling method (Vreeland and Tietje 1999). According to a U.C. Berkeley graduate student who has recently trapped woodrats in PRNS, assuming winter occupancy of one woodrat/house is reasonable (pers. comm. Sarah Cunningham) and data presented here will assume this 1:1 occupancy. Studies have expressed concern about whether all nests can be located visually (Fargo and Laudenslayer 1999). We paid special attention to locating these "atypical" nests (concealed in tree cavities, covered by rocks or below ground) and are confident that few houses were overlooked.

We used AlaskaPak (NPS 2002) extension for ArcView 3.2a (ESRI 2000) to select 150 random points located within PRNS and GGNRA fire management treatment areas as delineated by NPS staff (Figure 1). In order to avoid the bias intrinsic in the locations of these fire management treatment areas (along roads, trails, ridgelines), as well as to capture more habitat types, we selected an additional 150 random points. Points were downloaded onto a Garmin 12 Global Positioning System (GPS) for use in the field.

Points were located on the ground with the GPS unit, marked with a flag, and labeled with the point number. Slope and aspect were measured using a compass and clinometer. Canopy cover was measured using a convex spherical densiometer, trees within an 11.3m radius were counted and tallied according to size class (8-23cm dbh, 23-38, over 38, and dead snags). Litter depth was measured at 10 locations within the 50m plot. Ocular estimates were made to quantify the percent absolute cover and average height of each major life form. Relative cover was estimated for each dominant plant species and actual habitat alliance and association were determined to verify plot habitat type as classified by the vegetation map (Sawyer and Keeler-Wolf 1995).

We searched the 50m radius plot circle in a spiral pattern radiating out from the plot center, covering the entire plot, looking for any evidence of woodrat houses. Special

attention was paid to locating houses in trees, rock outcroppings, and hollow logs. All houses were assessed for external evidence of activity and classified as active or inactive (Willy 1992). Evidence of activity included presence of fresh vegetation cuttings, fresh scat, tail rattling, and clear entrances. Distance from the plot center and bearing to the nest were also measured.

Road surveys

In 2002, prior to fuel removal treatments along roadsides, surveys were conducted to locate, mark, and document all woodrat houses in the treatment areas. Surveyed areas were along paved roads in developed rural areas neighboring PRNS lands. Twelve roads were surveyed on foot, with each side of the road searched in a 7m belt transect. NPS personnel determined length of roads using Arcview 3.2A. All house locations were documented with a Garmin 12 GPS unit. Distance from the road was visually estimated and signs of activity were documented using methods similar to those used in the plots. Habitat alliance and association information was also documented (Sawyer and Keeler-Wolf 1995). All houses were clearly flagged to alert treatment crews of their locations.

Pellet Analysis

In 2002, Northern Spotted Owl pellets were collected opportunistically during the course of a reproduction study being conducted throughout Marin County. We did not attempt to achieve a minimum number of pellets per owl, we merely collected a sample of pellets egested during the breeding season. Pellets collected in 1997 were also analyzed in order to compare prey consumption from two different years. The 1997 pellets were not limited to the breeding season and reflect prey items captured all year.

Pellets were dissected dry, and bone fragments were saved while the fur and other items were discarded. The most useful bones for identification are those of the skull, especially if there are teeth present as teeth can be diagnostic to a genus (Gilbert 1990). This is difficult with other bones because there is much overlap in size between genera, however, these bones are helpful in determining the number of individuals consumed. There are very few bird bones that are not crushed during digestion. Even birds with a full skull (one sample found) are very difficult to identify to species. These were all combined into a "bird" category. Prey weights were taken from a variety of sources (Table 1) and the rat-like and mouse-like weights were averaged from the weights of their group members. Bird weights were based on identified species according to banding data (unpublished data PRBO Conservation Science).

Table 1. Mammal nomenclature and weights.

Common Name	Scientific Name	Weight (g), Source
Deer Mouse	<i>Peromyscus maniculatus</i>	22, Forsman et al. 1984
Calif. Meadow Vole	<i>Microtus californicus</i>	39, Forsman et al. 1984
Mouse-like	Mouse/Vole	31, estimated here
Dusky-footed Woodrat	<i>Neotoma fuscipes</i>	269, Forsman et al. 1984
Norway Rat/Black Rat	<i>Rattus norvegicus</i> / <i>Rattus rattus</i>	227, Storer and Usinger 1963
Brush Rabbit	<i>Sylvilagus bachmani</i>	300, Ward et al. 1998
Rat-like	Woodrat/Black/Norway/Rabbit	265, estimated here
Botta's Pocket Gopher	<i>Thomomys bottae</i>	55, Ward et al. 1998
Bird	various	70, PRBO banding data
House Mouse	<i>Mus musculus</i>	16, Storer and Usinger 1963
Insect	various	1, Ward et al. 1998

RESULTS AND DISCUSSION

House Count Plots

We surveyed 270 plots and found a total of 201 houses (Figure 1). Seventy-six percent of these houses were determined to be active. Although we did not estimate forest age for each plot, the surveyed forest habitat would generally be considered mature second growth, which approaches structural similarity to old-growth habitat. Logging did occur in the study area but it has not been logged in the past 50 years (Evens 1988).

Examining density of active woodrat houses, we found the average across habitats to be 0.95 active houses/ha. The highest density was in California bay habitat (1.19/ha) (Figure 2). Douglas fir and red alder habitat also had densities of at least one active house per hectare. Coast redwood and scrub habitats each showed densities of over 0.5 houses per hectare. Bishop pine habitat had the lowest woodrat house density of any forested habitat type and no woodrat houses were found in grassland habitat.

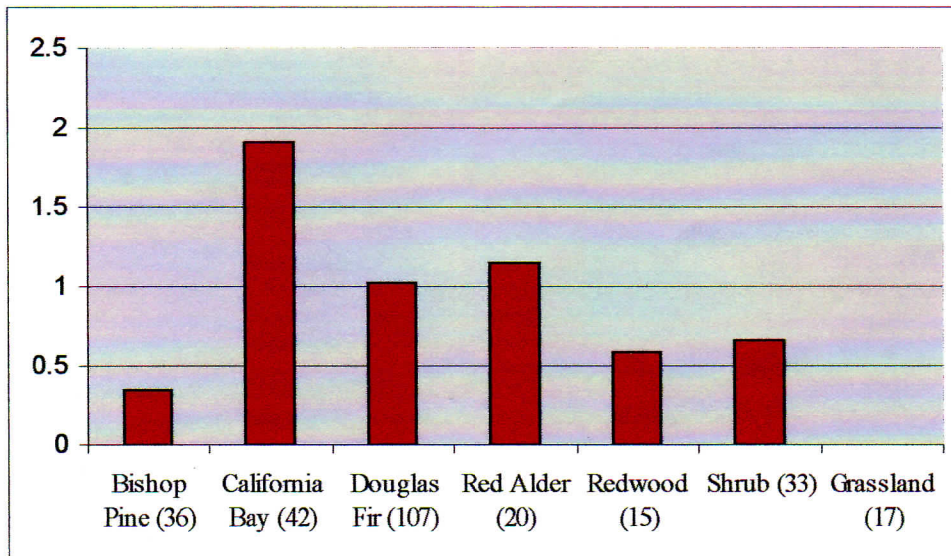


Figure 2. Active woodrat houses per hectare (# plots sampled).

Our most dense plot (in California bay habitat) with 14 houses/ha is still not as high as the average of 36.0 houses/ha measured in Marin County (Willy 1992). This difference is difficult to explain although Willy may have sampled more scrub and riparian habitats and these areas generally have higher densities of woodrats (Williams et al. 1992). Densities in habitat similar to that sampled here were lower, measuring 0.41 woodrats/ha in large old growth habitat (Sakai and Noon 1993) and 0.9 woodrats/ha measured in late seral mixed evergreen forests in northwest California (Ward et al. 1998). We found an overall average across all habitat types of 0.95 houses/ha (and 0.95 woodrats/ha). Sakai and Noon (1993) found their highest densities in early seral sapling/brushy poletimber habitat (81.12 woodrats/ha) and this habitat type is not well represented in our study area.

Road surveys

We surveyed a total of 12 roads, walking a total of 27,204 linear meters, located 85 woodrat houses, and 86% of these houses were determined to be active. Woodrat house density was determined at 5, 6, and 7m wide transects however there was no difference between densities in the 3 different transect widths and we report densities for the 7m transect width here. We examined house densities by individual road and for the total area surveyed (Figure 3). Woodrat house densities along roads were much higher than those found in the plot samples for all habitats and averaged 1.9 houses/ha for all roads. Half of the roads had densities higher than the highest plot density in California bay habitat. The roads with the highest densities were McCarthy Court and Noren Way, both located at the south end of the area surveyed and both contain extensive California bay habitat (Figure 4).

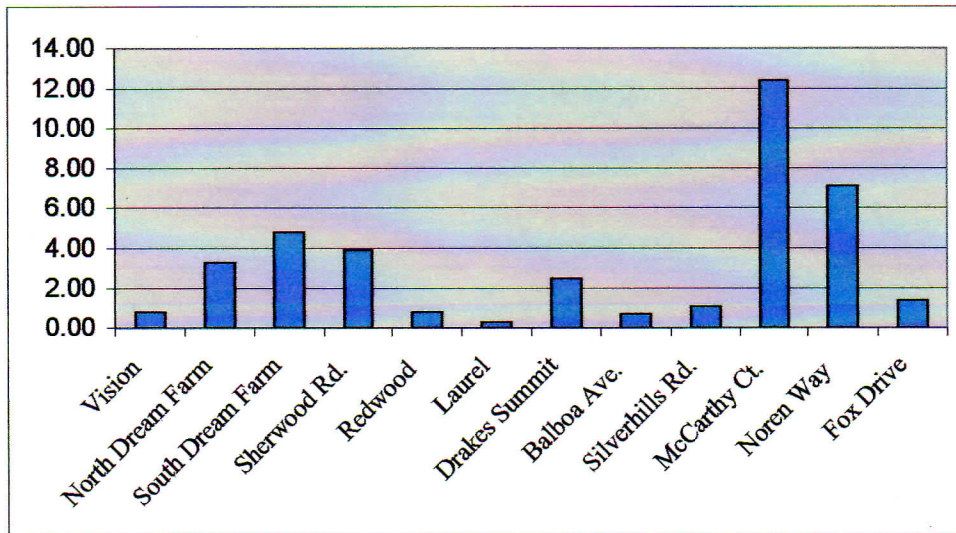


Figure 3. Active houses per hectare by road, average 1.9.

Extensive portions of these roads are landscaped or otherwise cleared of native vegetation. Since our surveys started at the edge of the road and encompassed some of these cleared areas, actual densities would be even higher if the cleared areas were excluded from calculations.

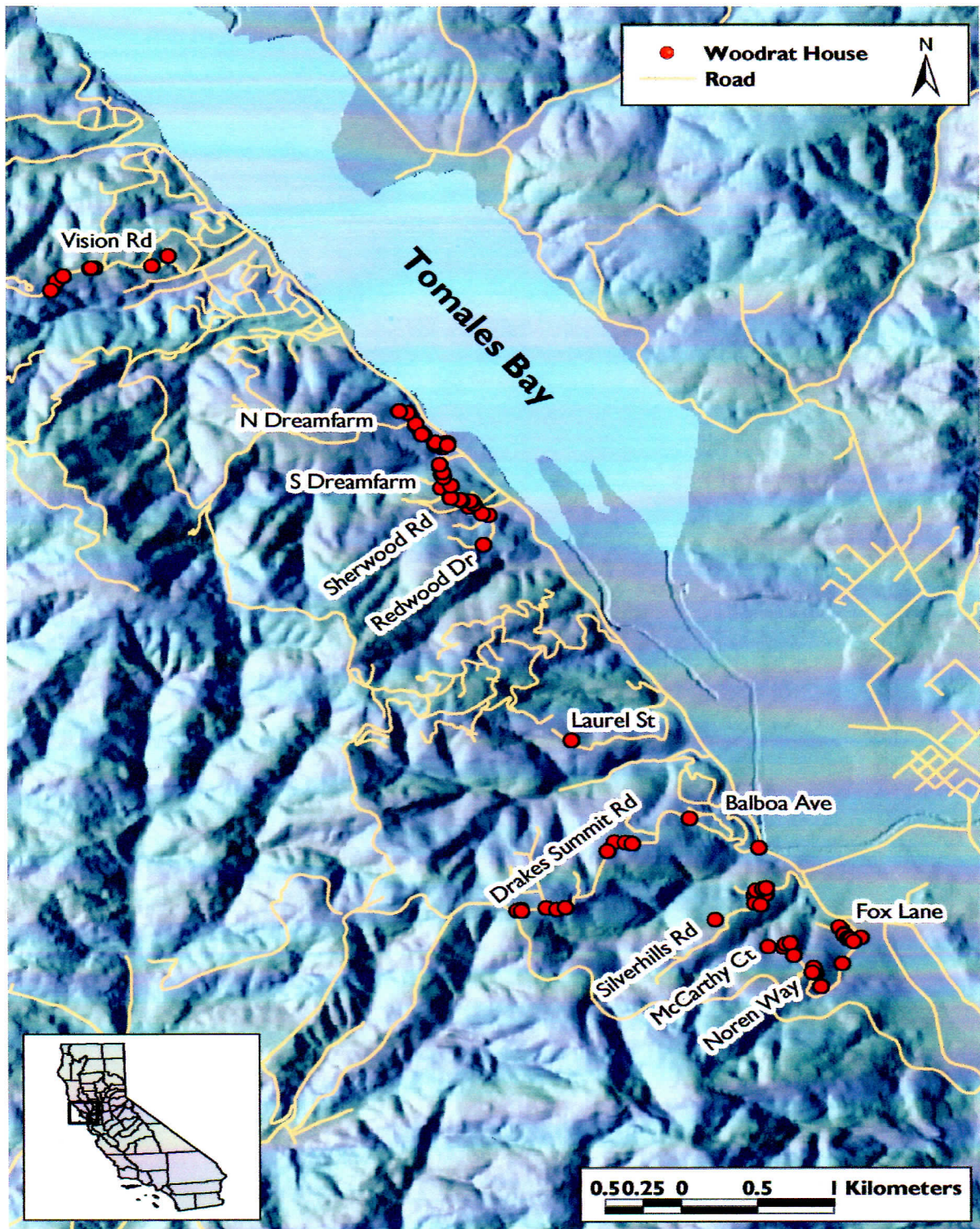


Figure 4. Woodrat house locations along surveyed roadsides.

Pellet Analysis

We examined a total of 206 pellets (97 collected from 21 sites in 2002, 109 collected from 13 sites in 1997) containing 357 individual prey items. Pellets contained 1-7 individual prey items. The majority of pellets (over 85% for both years) contained 1-3 individual prey items. There were 7 mammal genera found including *Microtus*, *Mus*, *Neotoma*, *Peromyscus*, *Rattus*, *Sylvilagus*, and *Thomomys* along with birds and insect parts (Table 1). For those pellets where there were bones, but no teeth to identify the sample to genus, rat-like and mouse-like categories were created. The rat-like category includes *Neotoma*, *Thomomys*, and *Rattus*, and mouse-like includes *Microtus* and *Peromyscus*. Of these species *Neotoma* made up most of confirmed large prey. Thus we will assume most of the rat-like category is also *Neotoma*. Using feathers, the bird samples were determined to be Purple Finch (*Carpodacus purpureus*), Varied Thrush (*Ixoreus naevius*), jay species and woodpecker species.

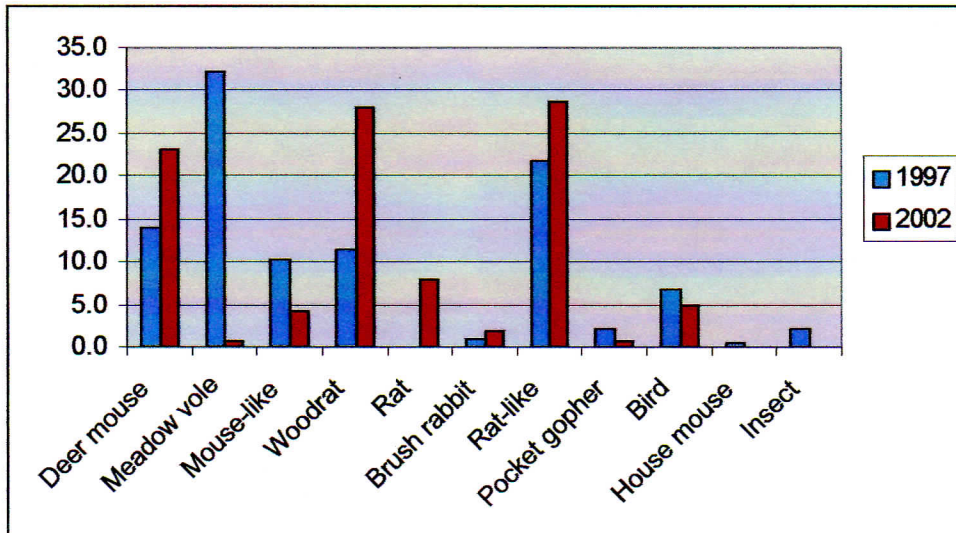


Figure 5. Frequency of Prey (by number) in Owl Pellets

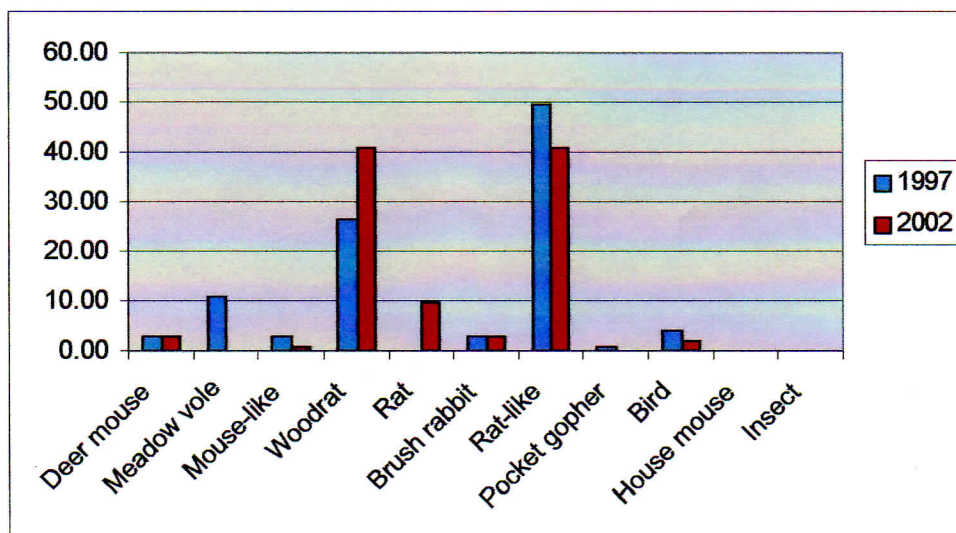


Figure 6. Percent of Prey Biomass in Owl Pellets

The frequency of prey items (Figure 5) indicates that the most frequent prey species in 1997 were meadow vole and rat-like while in 2002 they were deer mouse, woodrat, and rat-like. The percentage of prey type by biomass (Figure 6) shows that in both 1997 and 2002, prey providing the most weight were woodrat and rat-like. Grouping large prey items (>225g: woodrat, rat, brush rabbit and rat-like) indicates they made up 79 and 94% of the biomass consumed, respectively. These results match 1996 results from Marin showing this group of large prey also made up 79 to 94% of the diet by weight depending on habitat type (Chow and Allen 1997). It is also similar to a study from Humboldt County where these large prey items made up over 77% of the diet by weight (Ward et al. 1998).

As has been well-documented, spotted owls take a wide variety of prey, however the majority of their food comes from a few key species (eg. Forsman et al. 1984, Ward et al. 1998, Seamans and Gutierrez 1999, Smith et al. 1999, Hamer et al. 2001). The differences between years probably reflect annual variation in abundance of prey and not a major shift to new prey items (Forsman et al. 2001). Black rats, Norway rats and house mice may be correlated with ranch buildings (Fellers and Pratt 2002) so depending on where the pellets were collected, these prey could show different frequencies. Our results reconfirm the relative importance of *Neotoma* as a major prey item of the Northern Spotted Owl in Marin.

MANAGEMENT RECOMMENDATIONS

We recommend that woodrat houses be left undisturbed and that some sticks created during treatments be left as house building material. Due to the higher woodrat densities, we recommend that fire prevention activities should be limited in California bay and red alder habitats. If possible, fuel reductions should be focused in grassland and bishop pine habitats.

Given the high woodrat densities along roads, roadside clearing may have the biggest negative impact on woodrat populations. Roads, which serve as firebreaks and need to be cleared for safe vehicle passage, are reasonable locations to focus fuel reduction activities. Searching for and flagging houses so roadside clearing crews can avoid these structures appeared to work well. It is essential these surveys be repeated prior to new treatments. According to Vestal (1938), when houses were disturbed, all were rebuilt in the same location; hence marking existing houses can serve as relevant information for many years in the future.

In areas where burning is planned, woodrat houses should be disturbed or deconstructed prior to burning in order to dislodge resident rats and allow them to move out of the burn area. According to the high percentage of woodrat biomass found in our pellet analysis, protection of woodrats should be emphasized when attempting to minimize impacts to Northern Spotted Owl populations.

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