2008 Humboldt Redwood Company (HRC) Habitat Conservation Plan (HCP)
Sonoma Tree Vole Annual Report (HCP 6.9)
HRC Forest Science Department
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Summary

The Sonoma tree vole (Arborimus pomo) is a covered species under the landowner's HCP (HCP 6.9). The HCP's conservation strategy for this species is a habitat-based approach with a monitoring/research component, in recognition that additional information is needed on the habitat use of the species. This annual report summarizes surveys conducted from 2001-2005 and provides preliminary habitat analyses.

Introduction

Sonoma tree voles are small nocturnal mammals that are restricted to coastal temperate forests in northwestern California (Jones 2003). They are among the most unique and highly specialized microtine rodents in the world. Tree voles primarily inhabit coniferous forests dominated by Douglas-fir (*Pseudotsuga menziesii*) but they also live in forests where Douglas-fir occurs with redwood (*Sequoia sempervirens*), Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) or grand fir (*Abies grandis* – True 1890; Taylor 1915; Walker 1928; Benson and Borell 1931).

Red tree voles were considered one species prior to 1991. Chromosomal analysis subsequently distinguished two distinct species whose ranges separate near the Oregon-California border (Johnson and George 1991). The American Society of Mammalogists now recognizes populations within California as *A. pomo* and those within Oregon as *A. longicaudus* (Wilson and Reeder 1993). Information from more recent DNA analysis suggests that the range of *A. longicaudus* extends from the Columbia River in northwestern Oregon south to Del Norte County in northern California, and the Sonoma tree vole is found in northwestern California from Del Norte County south to Sonoma County (Johnson and George 1991; Murray 1995).

Tree voles have a highly specialized diet consisting almost entirely of Douglas-fir needles (Benson and Borell 1931). The physiological cost of converting conifer needles into energy for metabolism is thought to be responsible for the long gestation period, small litter sizes, and slow growth rates relative to other rodents (Hamilton 1962, Carey 1991). Higher capture frequencies of tree voles in pitfall traps in old forests have led many to suggest that tree voles are most abundant in old forests (Corn and Bury 1986; Aubry et al. 1991; Gillesberg and Carey 1991; Huff et al. 1992; Gomez and Anthony 1998; Martin 1998). Although some authors have speculated that young forests do not provide suitable habitat for tree voles (Carey 1989, 1991; Aubry et al. 1991), many tree voles have been captured in young forests (Jewett 1920; Howell 1926; Clifton 1960; Maser 1966). Surveys by the Bureau of Land Management and U.S. Forest Service have located large numbers of tree vole nests in young forests, although generally lower numbers than in old forests (USDA Forest Service and USDI Bureau of Land Management Survey and Manage Program Interagency Species Management System, ISMS, unpubl. data). These inconsistencies suggest that there is a need for better data on the abundance, distribution, and habitat associations of tree voles.

Effective management of wildlife populations largely depends upon understanding and predicting their habitat needs (Clark et al. 1993). *Arborimus pomo* is a difficult species to manage because its habitat requirements are not well known. Tree vole studies are problematic due to their nocturnal nature and because they live almost exclusively in the forest canopy (Jones 2003). Populations appear to have a patchy distribution (Carey 1991). Activity is most commonly identified by the presence of nests, which are constructed of fine twigs, conifer needles, feces, lichens, and discarded resin ducts (Carey 1991). Nests range in size from very small ephemeral structures of 6 inches in diameter, to large maternal nests reaching in excess of 3 feet that can encircle the entire bole of the tree (Taylor 1915; Howell 1926; Verts and Carraway 1998; Swingle 2005). Tree vole nests vary in their locations and placement, often they are placed on a branch whorl against a tree trunk, however in older trees with large crowns and extensive branch structures with large limbs, many nests are built out on limbs some distance from the trunk (Taylor 1915; Howell 1926; Benson and Borell 1931; Swingle 2005). A select number of ground nests (Howell 1926; Maser et al. 1989; Thompson and Diller 2002) and nests in tree cavities have also been observed (Walker 1928; Maser 1966; Gillesberg and Carey 1991; Swingle 2005) however little is known about the relative frequency of these types of nests. Occupied or recently occupied nests can commonly be identified by the presence of fresh cuttings piled on top of the nest and green resin ducts and green fecal pellets inside the nest (Howell 1926; Swingle 2005). These resin ducts are the remains of conifer needles after the central fleshy portion of the needle is consumed, leaving the other edges to be discarded (Benson and Borell 1931).

Tree vole nests can be located by visually searching trees using a ground based approach. Nest materials can commonly be found below nests. The nest can be confirmed as of that belonging to *Arborimus pomo* if resin ducts are found in the accumulation of material. If nest material is not found, climbing and closely inspecting the nest is required for confirmation of a tree vole nest (Thompson and Diller 2002). Swingle (2005) found through comparisons of nests located by visual searches from the ground versus nests located by following radio collared voles it was indicated that many active nests could not be seen from the ground, and that nests located by visual searches were biased towards large nests, thus indicating that historic collections of tree voles captured by naturalists who visually searched for nests were potentially biased towards females, which tend to occupy larger nests than males.

Methods

The study area was confined to Pacific Lumber Company (now Humboldt Redwood Company) owned lands managed under the conservation objectives of the HCP in Humboldt County, northwest California. We compared Sonoma tree vole abundance using nest counts among pole, young, and mature stands. Stands were randomly selected from PALCO's Geographic Information System (GIS) database. Sixty-four sites were randomly selected based on the following stand types: (1) Douglas-fir (*Pseudotsuga menziesii)*, (2) redwood (*Sequoia sempervirens)*, (3) Douglas-fir/hardwood, and (4) Douglas-fir/redwood. Within each stand type a total of 16 sites were selected in three different seral stages. The seral stages were classified into mature, young growth, and pole categories. Stands which met the criteria for mature and young growth Douglas-fir/hardwood were limited in number, therefore additional Douglas-fir/hardwood pole stands were selected to compensate. This allowed us to maintain an equal sample size representative of stand types and seral stages. A "stand" was defined as contiguous forest with uniform disturbance history (e.g., fire, timber harvesting) (Jones 2003).

The forest type categories were classified from PALCO's forest inventory database based on diameter at breast height (DBH) measurements. Pole stands consisted primarily of 15-28 cm DBH trees with ≥ 75% canopy closure and ranged in age from 20-50 years. Young growth stands (29-61 cm DBH) had been harvested or burned approximately 50-90 years ago and had an average canopy closure of ≥50 %. Mature stands were dominated by trees >61 cm DBH, had complex multi-layered canopy structures, and were remnants of previously contiguous forest now surrounded by patches of young forest (10-50 years old) (Jones 2003). The majority of the young stands were initially clearcut, while none of the mature stands had been previously harvested. Elevations of the 64 stands ranged from 38-911 m.

All 64 sites contained canopy closure >25% and were a minimum of 25 acres. Any stands that were contained in proposed or active Timber Harvesting Plans (THPs) were eliminated, as well as stands that were on non-HCP lands. A total of 48 back-up sites were also randomly selected in the event that selected sites needed to be eliminated (e.g., stands are too linear in size to place five transect lines, or property sales that occurred between PALCO and other private parties or state/federal agencies).

We conducted surveys according to the draft study plan developed by the Pacific Northwest Research Station (Biswell et al. 1999). Surveyors were trained to identify STV nests using a line transect method as described by Anderson et al. (1979). Five 100 meter transects totaling 500 meters were surveyed in each stand. We attempted to distribute transects 60 meters apart and parallel to elevation contour lines, with the middle of the transect centered on the site location point. The UTM locations of each transects 50 meter mid-points were determined with a GARMIN® III-Plus global positioning system unit (GARMIN International, Inc., Olathe, Kansas).

Sonoma tree vole nests were located by visually searching trees along both sides of the transect line. When a nest structure was detected, the ground below the nest was searched for characteristic signs of tree vole activity. Since no other animal discards the lateral resin ducts of conifer needles as they feed, the presence of resin ducts was assumed to be evidence of tree vole activity (Jones 2003). We used a spotting scope to try and identify resin ducts in the nest structure if they were not found at the base of the nest tree. In the event that a nest could not be confirmed as belonging to a Sonoma tree vole from the ground, the tree was climbed and closely inspected to determine the nest type. Trees with confirmed STV nests were flagged, recorded and then mapped. Information we recorded for each nest included: perpendicular distance to the transect line, nest and tree height, nest and tree diameters, nest support, percent slope, aspect and tree species. Nest diameters were visually estimated.

Results

A total of 441 Sonoma tree vole nests in 64 sites were found over the course of the study, with 215 active and 226 not active. Sonoma tree vole occupancy was detected in 57 of the 64 surveyed sites. The sites varied widely in terms of stand size and vegetative characteristics. Stand size varied from small areas of only 25 acres to large areas containing over 700 acres. Stand characteristics ranged from uncut old growth sites with dense canopies to thinned, pole sites with thick understory vegetation.

Sonoma tree vole nests were found within all seral stages with the exception of the mature Douglas-fir/hardwood stand type. The greatest numbers of nests were found in Douglas-fir (*Pseudotsuga menziesii*) trees, followed by grand-fir (*Albies grandis*), tan oak (*Lithocarpus densiflora*), redwood (*Sequoia semprivirens*), pacific madrone (*Arbutus menziesii*), interior live oak (*Quercus wislizenii*), and pepperwood (*Umbellularia californica*). Twenty-nine trees were found to contain more than one Sonoma tree vole nest, with varying locations and heights of nests. Over 50 percent of nests found were located on branches, 37 percent located on semi-whorls, over 3 percent found on whorls, forked boles and in cavities and over 1 percent located on forked top trees..

The largest number of Sonoma tree vole nests we detected per site was in mature Douglas-fir stands, followed by redwood/Douglas-fir stands, and Douglas-fir/hardwood stands. Redwood had the fewest nests. Within stands, mature stands contained the most nests and pole had the least amount of nests. Interestingly, a large amount of Sonoma tree vole nests were found in pole Douglas-fir/hardwood stands. We think this is primarily due to the consistency of a large residual Douglas-fir presence throughout the hardwood pole stands providing the necessary structure for nest placement and an abundant food source to sustain Sonoma tree vole populations.

No Sonoma tree vole nests were found in: (1) three of the hardwood pole sites, (2) two of the redwood pole sites, and (3) two of the redwood young growth sites.

Table 1. Percentage of *Arborimus pomo* nests by tree species on Pacific Lumber Company land in northwestern California, 2001-2005 (n = 395).

Common name	Scientific name	# *A. pomo* nests	% of total nest trees
Douglas-fir	*Pseudotsuga menziesii*	337	85.32
Grand fir	*Albies grandis*	29	7.34
Tan oak	*Lithocarpus densiflora*	17	4.30
Redwood	*Sequoia semprivirens*	8	2.03
Pacific madrone	*Arbutus menziesii*	2	0.51
Interior live oak	*Quercus wislizenii*	1	0.25
Pepper wood	*Umbellularia californica*	1	0.25

Table 2. Locations of *Arborimus pomo* nests in trees on Pacific Lumber Company land in northwestern California, 2001-2005 (n = 441).

Nest location	Frequency %
Branch [a]	52.2
Semi-whorl [b]	37.0
Forked bole [c]	3.6
Cavity [d]	3.6
Whorl [e]	2.0
Forked top [f]	1.6

[a] on a branch away from the tree bole.
[b] around part of the tree bole on a semi-whorl of branches.
[c] inside a tree cavity.
[d] within the split of a tree bole.
[e] around the entire tree bole on a whorl of branches.
[f] within the split of a forked tree top.

Table 3. Summary data and median density of active *Arborimus pomo* nests across a range of dbh (diameter at breast height) categories on Pacific Lumber Company land in northwestern California 2001-2005.

	Nest tree size category (dbh in cm)		
Parameter	15-28	29-61	>61
Number of stands searched	24	12	28
Number of stands with nests	19	10	26
Total transect distance (m)	12000	6000	14000
Total number of nests	84	55	302
Number of active nests	44	36	136
Median density of active nests (number / ha)			

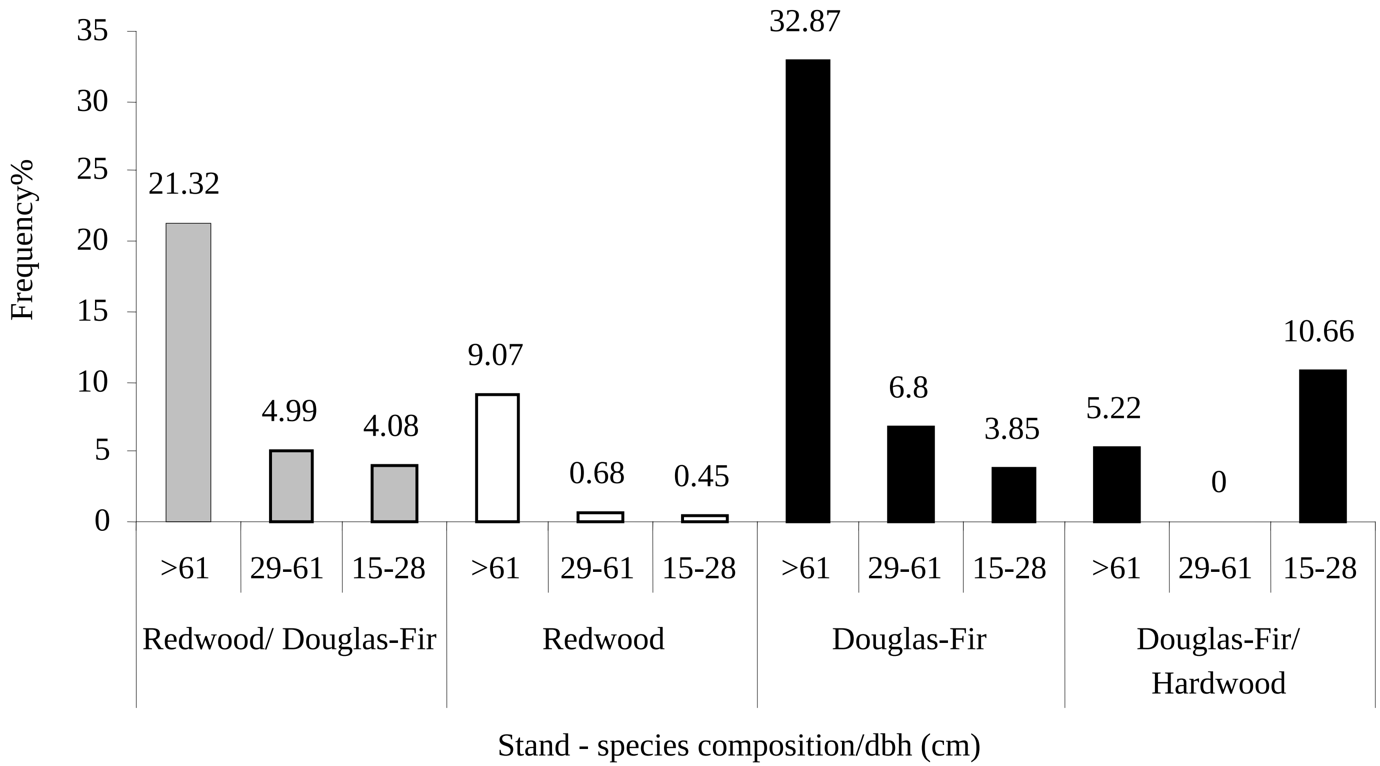

Figure 1. Proportion of *Arborimus pomo* nests in a range of dbh (diameter at breast height) size classes relative to species composition of stands surveyed on Pacific Lumber Company land in northwestern California, 2001-2005 (n = 441).

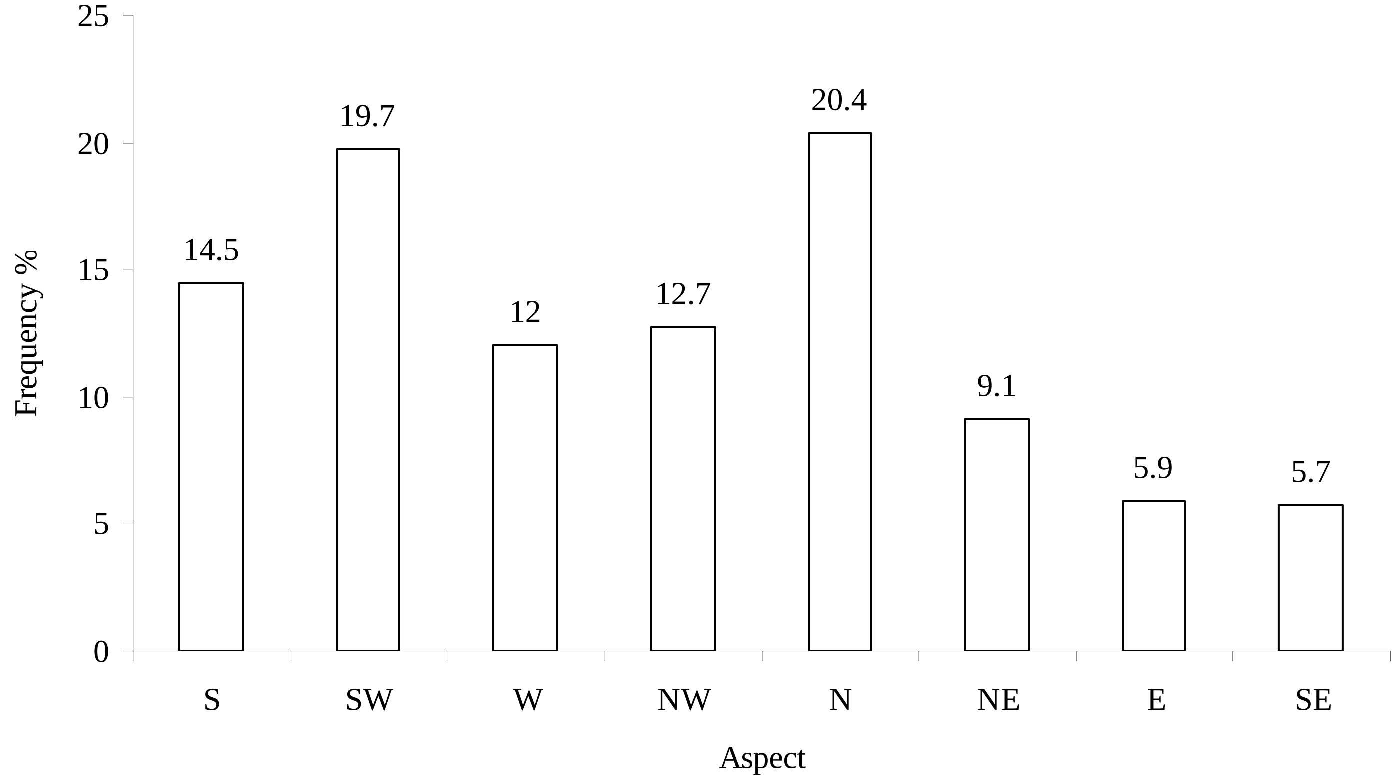

Figure 2. Proportion of *Arborimus pomo* nests by nest aspect on Pacific Lumber Company land in northwestern California, 2001-2005 (n = 441).

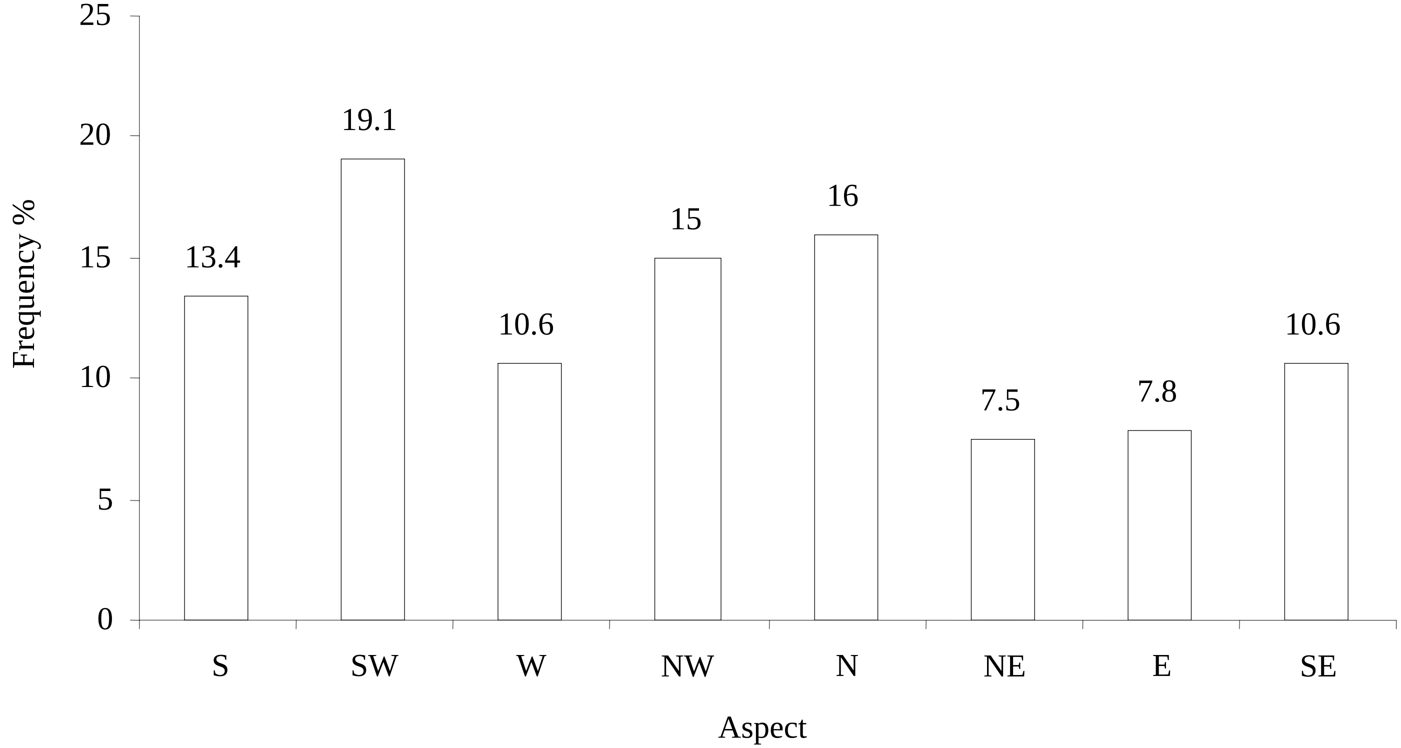

Figure 3. Proportion of transects by slope aspect on Pacific Lumber Company land in northwestern California, 2001-2005 (t = 320).

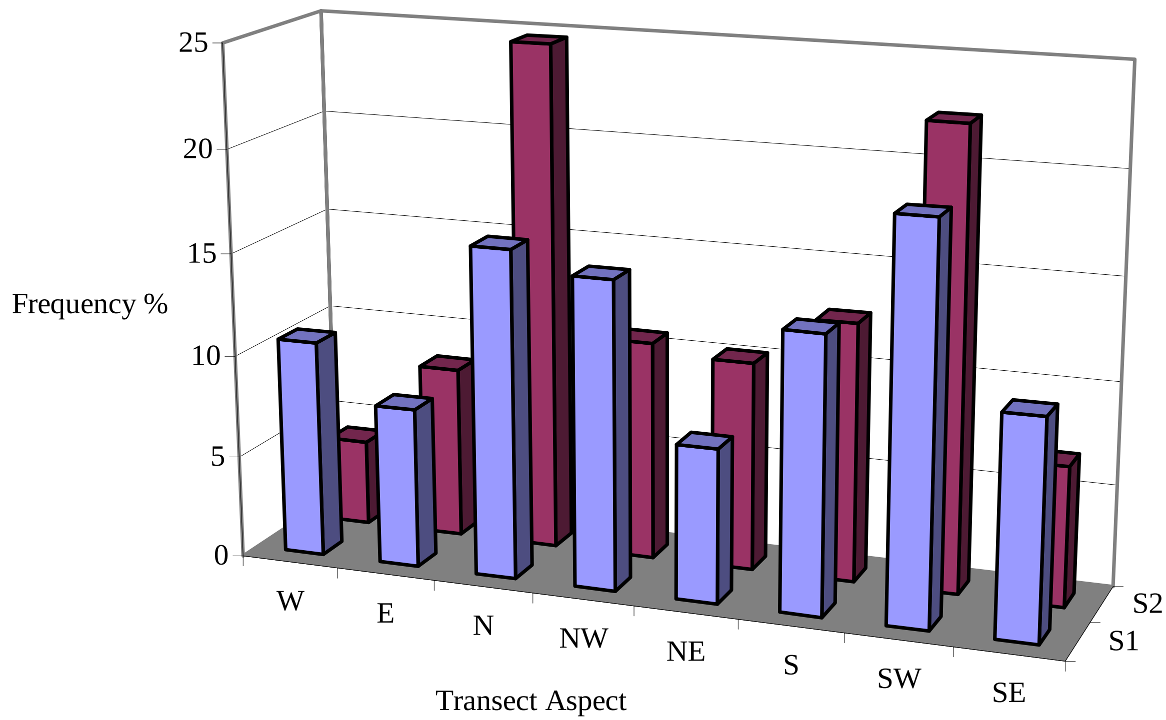

Figure 4. Proportion of *Arborimus pomo* nests/transect lines relative to slope aspect on Pacific Lumber Company land in northwestern California, 2001-2005 (n = 441).

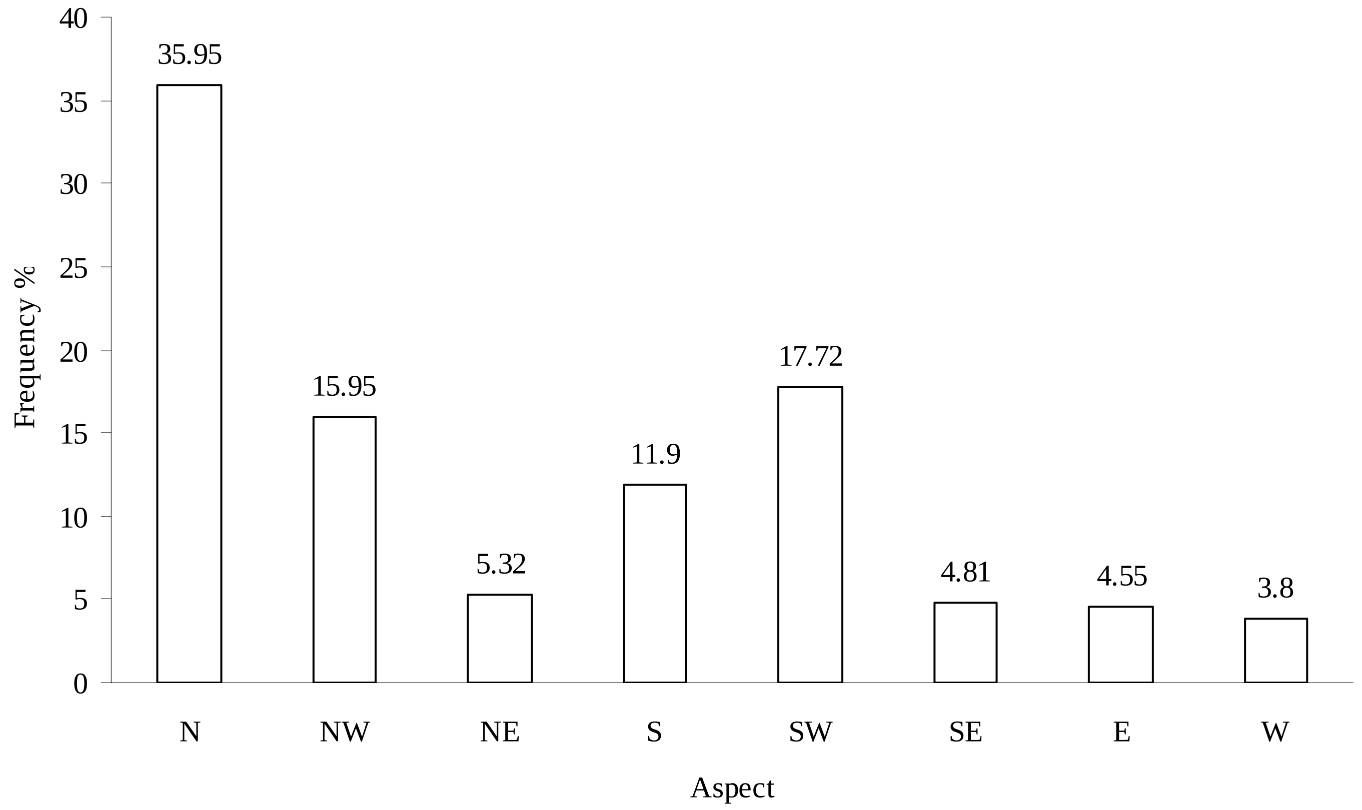

Figure 5. Proportion of *Arborimus pomo* nest trees by slope aspect on Pacific Lumber Company land in northwestern California, 2001-2005 (n = 395).

Discussion

The preliminary results of this study indicate that mature stands (24"-40") with the most Douglas-fir have the most nests while young stands (8"-24") with relativity few or no Douglas-Fir trees have few nests. Younger stands with a large, mature Douglas-fir component also appear to maintain suitable tree vole habitat.

We intend to conduct further data analyses in the attempt to construct a habitat model that can be used to track tree vole habitat over time. Such a model could be directly applied to the most current forest inventory to identify areas used by voles across the property and to assess the connectivity of these areas via other stands and management zones. The resulting information could be used to evaluate the effectiveness of vole conservation measures under the HCP. Once linked to the forestry inventory, changes in tree vole habitat can be tracked and monitored as the forest stands change from one year to the next.

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