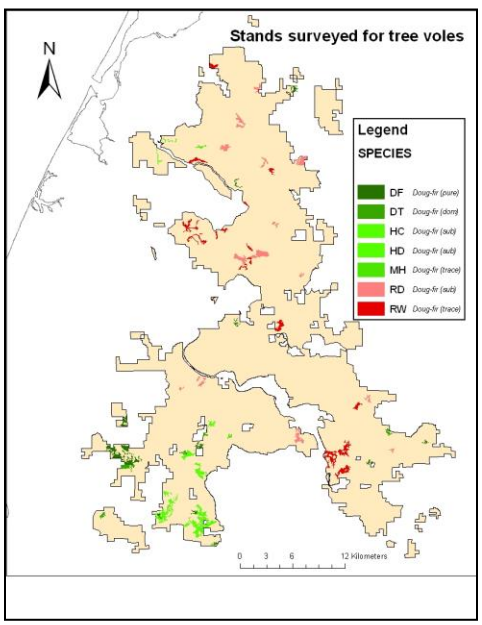
Sonoma Tree Vole Summary Report

2016

February 1, 2017



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Project Description

Title: Sonoma Tree Vole Summary Report 2016

Purpose: Habitat Conservation Plan (HCP) monitoring

Date Initiated: March 1999

Projected End Date: Ongoing

Manager: Sal Chinnici, Manager, Forest Sciences

Executive Summary:

The HCP (6.9) requires a research and monitoring effort for the Sonoma (formerly "red") tree vole (*Arborimus pomo*) that examines seral stage use and habitat connectivity on HRC lands. The objective is to determine the conditions needed in younger forests to maintain tree vole breeding and dispersal. To pursue this objective we: (1) examined Sonoma tree vole use of pole to mature forest seral stages from 2001 to 2005 at 64 study sites distributed across redwood, mixed conifer, Douglas-fir and Douglas-fir/hardwood stands, (2) conducted a statistical analysis to quantify the relationship between the number of nests and forest stand features, and (3) applied them to the 2011 forest inventory to assess the availability and distribution of Sonoma tree vole habitat.

Summarizing the study: a total of 441 Sonoma tree vole nests were found including 215 active and 226 inactive nests. Mature stands with larger Douglas-fir trees and those with higher densities of Douglas-fir trees tended to have the most nests while pole and young stands with relativity few or no Douglas-fir trees tended to have fewer nests. Therefore, retention of large Douglas-fir trees combined with other conservation strategies such as riparian protection, other species protection measures (e.g. marbled murrelet conservation areas and northern spotted owl nest zones), or as part of a structural element retention strategy wherein large trees with complex structure are retained may help maintain Sonoma tree vole populations.

The HCP conservation strategy for this species was developed to mitigate a management strategy of even-aged (clear cut) harvest of approximately 178 million board feet per year (mmbf). HRC uses primarily uneven-aged (selection and group selection) harvest of approximately 55 mmbf average per year (over a ten year period beginning in 2008-2009). Selection harvest will retain a large tree component in all stands. In addition, HRC also retains all old growth trees meeting the company's old growth policy. Therefore, the HRC management model that will create or retain a multi-aged forest with large Douglas-fir trees across the property is likely to provide tree vole habitat in both the near and longer term.

The habitat model that was developed through the above study is described in the attached manuscript (Chinnici, et al. 2012, In, Standiford, R.B.; Weller, T.J.; Piirto, D.D.; Stuart, J.D., tech. cords. 2012. Proceedings of the coast redwood forests in a changing California: a symposium for scientists and managers. Gen. Tech. Rep. PSW-GTR-238. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station).

We have previously recommended that the habitat model described therein be used to track and report Sonoma tree vole habitat by watershed or sustainability unit (SU) on a periodic basis. At the time the attached manuscript was developed, only a subset of HRC watersheds, including the Mattole, had forest inventory data available for analysis. The property-wide forest inventory was completed in 2014, and final results for all SUs that could be used to run the model were finalized in 2016.

The following table summarizes the results of the model output for each sustainability unit and for the HRC Forestlands as a whole. The Nests/Transect column represents the average of the model output for predicted nests per transect (see Table 2, page 7), weighted by the forested acres of the sustainability unit.

Sustainability Unit	Forested Acres	Nests/Transect
Mad	4518.6	1.182
Freshwater	14429.3	0.973
Elk	20945.5	1.158
Strongs	4595.3	1.028
Yager	17764.0	1.085
Van Duzen	21218.9	1.148
Shively	13280.3	1.092
Larabee	21962.1	1.050
Eel	22325.4	0.928
McCann	7196.7	1.103
Bear	15166.2	1.137
Mattole	15450.5	1.314
Lawrence	13706.4	1.259
All HRC Forestlands	192559.2	1.106

Results indicate that the density of Sonoma tree vole nests is predicted to be higher than the property-wide average in the Mad, Elk, Van Duzen, Bear, Mattole, and Lawrence SUs. Highest model output overall was in the Mattole and Lawrence SUs. These results appear to reflect our findings that mature stands with larger Douglas-fir trees and those with higher densities of Douglas-fir trees tend to have higher relative densities of tree vole nests, while pole and young stands with relativity little to no Douglas-fir trees tend to have fewer nests. The Mattole and Bear SUs have stands with higher densities of Douglas-fir trees, and also mature Douglas-fir stands. The Lawrence SU has a relatively large stand of mature Douglas-fir in the Bell-Lawrence Marbled Murrelet Conservation Area. The Mad SU contains stands of Douglas-fir and hardwood, due to the more inland location, and therefore a higher score. Higher model output for the Elk and Van Duzen SUs are somewhat surprising given the dominance of redwood in those SUs, however there appears to be enough density of Douglas-fir as a stand component that these SUs can provide suitable tree vole habitat as well.

HRC will continue to use the habitat model to track and report Sonoma tree vole habitat by sustainability unit on a periodic basis, or as changes in inventory and stand-typing occur.

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Sonoma Tree Vole Habitat on Managed Redwood and Douglas-fir Forestlands in North Coastal California[1]

ABSTRACT

The Sonoma Tree Vole (*Arborimus pomo*) – a small arboreal mammal associated with mature forests – is a California Species of Special Concern due to concerns regarding loss of habitat from harvest, fire, and conversion. By counting their nests, we examined *A. pomo* use of pole to mature forest seral stages from 2001 to 2005 using line transects at 64 study sites distributed across redwood (*Sequoia sempervirens*), mixed conifer, Douglas-fir (*Pseudotsuga menziesii*), and hardwood dominated stands. A total of 441 nests were found including 215 active and 226 inactive nests. The highest percentage (33 percent) of nests was in unharvested and partially harvested old growth Douglas-fir stands. All pole and young stands, and stands that were predominantly redwood, had 77 percent fewer nests. This study suggests that *A. pomo* could benefit from forest management strategies aimed at retaining a mature Douglas-fir stand component.

Key words: conservation, Douglas-fir, forest inventory, habitat, modeling, redwood, Sonoma tree vole

INTRODUCTION

Tree voles (*Arborimus* sp.) are small nocturnal mammals that primarily inhabit coniferous forests dominated by Douglas-fir, but they also live where Douglas-fir co-occurs with other species, including redwood, Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) or grand fir (*Abies grandis)* (Jones 2003). Even in such forests, populations appear to have a patchy distribution (Carey 1991).

With their arboreal nature and diet almost entirely of Douglas-fir needles, tree voles are among the most unique and highly specialized rodents in the world. Further, their habitat use patterns and behavior make studies problematic. As a result, tree vole presence and relative abundance is

[1] This paper was presented at the Redwood Science Symposium: Coast Redwood Forests in a Changing California. June 21-23, 2011, Santa Cruz, California.

most commonly inferred by their nests, distinguishable from other nests by discarded resin ducts from the needles they have consumed (Carey 1991, Thompson and Diller 2002).

The abundance and distribution of suitable habitat may be a limiting factor for tree voles (Carey 1989). Although some studies (Wooster and Town 1998, Thompson and Diller 2002, Swingle 2005) have shown that tree voles nest in younger forests, several studies (Corn and Bury 1986, Aubry and others 1991, Gillesberg and Carey 1991, Huff and others 1992, Gomez and Anthony 1998, Martin 1998) suggest that the species is most abundant in older forests. Thus, timber harvest may impact the species.

In northwestern California, the Sonoma tree vole is restricted to coastal forests of Humboldt, Mendocino, and Sonoma counties (Jones 2003). The Sonoma tree vole is recognized in California as Species of Special Concern (California Department of Fish and Game 2011). In addition to its status, tree voles are important prey species of the northern spotted owl (Forsman and others 1984), the Humboldt marten (*Martes americana humboldtensis*), and the Pacific fisher (*Pekania pennanti*)[2].

The Sonoma tree vole is a covered species of the Humboldt Redwood Company (HRC) Habitat Conservation Plan (HCP) (PALCO 1999). A HCP management objective for the Sonoma tree vole is to sustain viable tree vole populations through retention of suitable habitat. Given the difficulties surrounding the study of this species and the questions concerning its habitat, we developed this study to test the assumptions regarding the availability and distribution of habitat that then could inform models relating timber management to vole abundance, and map current distribution on HCP lands.

For this case study we: (1) examined Sonoma tree vole use of pole to mature forest seral stages from 2001 to 2005 at 64 study sites distributed across redwood, mixed conifer, Douglas-fir and Douglas-fir/hardwood stands, (2) conducted a statistical analysis to quantify the relationship between the number of nests and forest stand features, and (3) applied them to the current (2011) forest inventory to assess the availability and distribution of Sonoma tree vole habitat.

5 Slauson, K. 2011. Unpublished data on file, USDA Forest Service, Pacific Southwest Research Station, Redwood Sciences Laboratory, Arcata, CA.

STUDY AREA

HRC lands encompass approximately 84,000 ha, and are located in coastal Humboldt County, California. These lands are characterized by mountainous terrain, a maritime climate, and dense coniferous forests, primarily dominated by coastal redwood and Douglas-fir, with an understory typically composed of tanoak (*Lithocarpus densiflorus*), Pacific madrone (*Arbutus menziesii*), salal (*Gaultheria shallon*), and sword fern (*Polystichum munitum*). Elevations range from 45 m on river or creek benches to over 800 m along ridges.

METHODS

Study sites (n = 64) were randomly selected based on the following stand types: (1) Douglas-fir, (2) redwood, (3) Douglas-fir/hardwood, and (4) Douglas-fir/redwood. All sites contained canopy closure >25 percent and were a minimum of 10 ha in area. Within each type, 16 sites were selected among three seral stages: pole (15 – 28 cm Diameter at Breast Height [DBH]), young-growth (29 – 61 cm DBH), and mature (>61 cm DBH).

From 2001 to 2005, we surveyed according to the draft study plan developed by the Pacific Northwest Research Station (Biswell and others 1999). Following Anderson and others (1979), surveyors recorded tree vole nests along five 100 meter transects in each stand. We attempted to distribute transects 60 meters apart and parallel to elevation contour lines. The UTM locations of each transect's mid-point was located with a GPS.

We attempted to locate Sonoma tree vole nests with a visual search of trees along both sides of the transect line. When a suspected nest structure was detected, the ground below the nest was searched for resin ducts, evidence indicative of tree vole activity (Jones 2003). If a nest could not be confirmed as belonging to a tree vole from the ground, the tree was climbed and the nest was inspected.

A general linear mixed-model analysis of variance (ANOVA) was used to quantify the relationship between the number of nests and habitat type as derived from forest inventory information. The number of nests per transect was the dependent variable. Tree size class (20-40 cm, 40-60 cm, 60-80 cm, and 80-100 cm) and density of Douglas-fir by canopy cover (trace [<25 percent], sub-dominant [25-50 percent], dominant [50-75 percent], and pure [>75 percent]) were linear continuous effects. Site was treated as a random effect. The variance component was selected for the covariance structure. The full maximum likelihood estimation was used to model the fixed effects.

To address the habitat mapping objective using 2011 forest inventory information, the Sonoma tree vole nest model was applied to HRC lands in the Mattole River watershed near Petrolia, CA using current vegetation type mapping and forest inventory data.

RESULTS

FIELD STUDY

A total of 441 Sonoma tree vole nests in the 64 sites were found, with 215 active and 226 not active. Occupancy was detected in 57 of the 64 surveyed sites (89 percent). The sites varied widely in terms of stand area and vegetative characteristics. Stand size ranged from relatively small stands of 10 ha (minimum stand size) to relatively large contiguous stands of 898 ha. Stand characteristics ranged from un-harvested old growth stands with dense canopies, to thinned pole sites with thick brushy understory vegetation.

The greatest numbers of nests were in Douglas-fir trees (Table 1). Twenty-nine trees were found to contain multiple vole nests. The diameter breast height (DBH) of trees with active nests ranged from 10.5 to 226.3 cm (mean 100.6 cm).

Table 1. Percentage of Arborimus pomo nests by tree species on HRC land in northwestern California, 2001 to 2005 (n = 395).

Common name	Scientific name	# A. pomo nests	Percent of total nest trees
Douglas-fir	*Pseudotsuga menziesii*	337	85.3
Grand fir	*Abies grandis*	29	7.3
Tan oak	*Lithocarpus densiflorus*	17	4.3
Redwood	*Sequoia sempervirens*	8	2.0
Pacific madrone	*Arbutus menziesii*	2	0.5
Interior live oak	*Quercus wislizenii*	1	0.3
Pepperwood	*Umbellularia californica*	1	0.3

Sonoma tree vole nests were in all seral stages except the young growth Douglas-fir/hardwood type (Figure 1). By stand type and seral stage, the largest number (33 percent) of vole nests was in mature Douglas-fir stands, followed by mature redwood/Douglas-fir stands (21 percent). Within stand types, mature stages contained the most nests and pole had the least. Approximately 11 percent of Sonoma tree vole nests were in pole Douglas-fir/hardwood stands. Contrary to the general positive relationship of nest density with seral stage, this finding may be due to the presence of residual old growth Douglas-fir trees at a density that did not affect stand classification but still provided the structure for nesting and an adequate food source. Sonoma tree vole nests were not found in three of the hardwood pole sites, two of the redwood pole sites, and two of the redwood young growth sites.

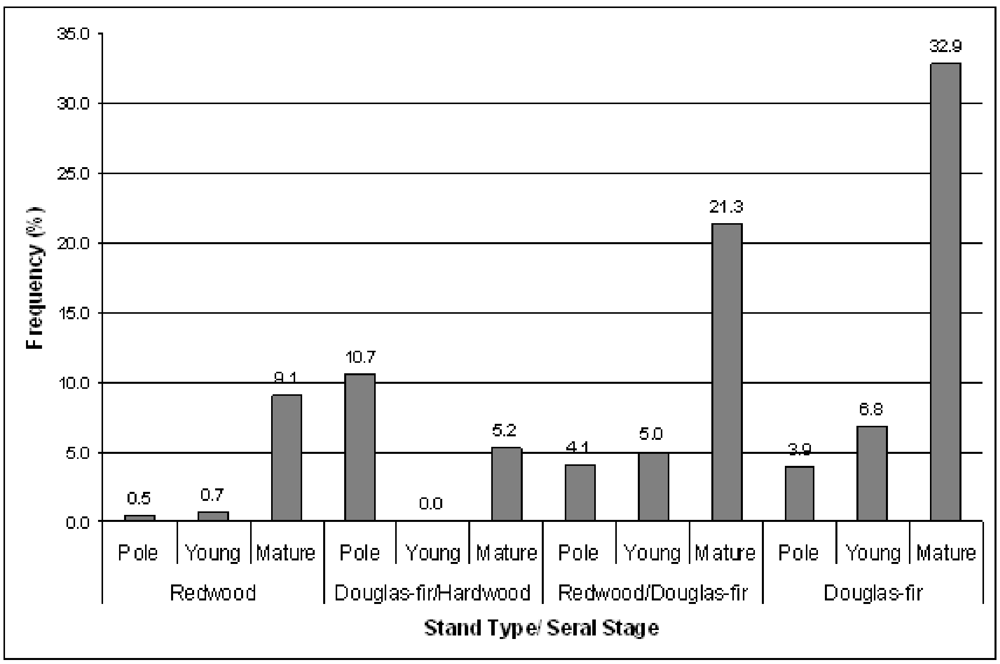

Figure 1. Percent of Arborimus pomo nests in pole, young, and mature stands relative to species composition for stands surveyed on HRC land in northwestern California, 2001 to 2005 (n = 441).

HABITAT ANALYSIS

When the stand size class increased, the number of nests per transect also increased (Figure 2). The estimated slope describing the relationship between tree size class and number of nests ($b = 0.659 \pm 0.174$ ($\pm$1SEM)) was significantly greater than zero ($t62 = 3.79$, $p < 0.001$,). When the relative density of Douglas-fir increased from stand to stand, the number of nests per transect also increased (Figure 3). The estimated slope describing the relationship between relative density of Douglas-fir and nests ($b = 0.519 \pm 0.177$ ($\pm$1SEM)) was significantly greater than zero ($t62 = 2.931$, $p = 0.005$).

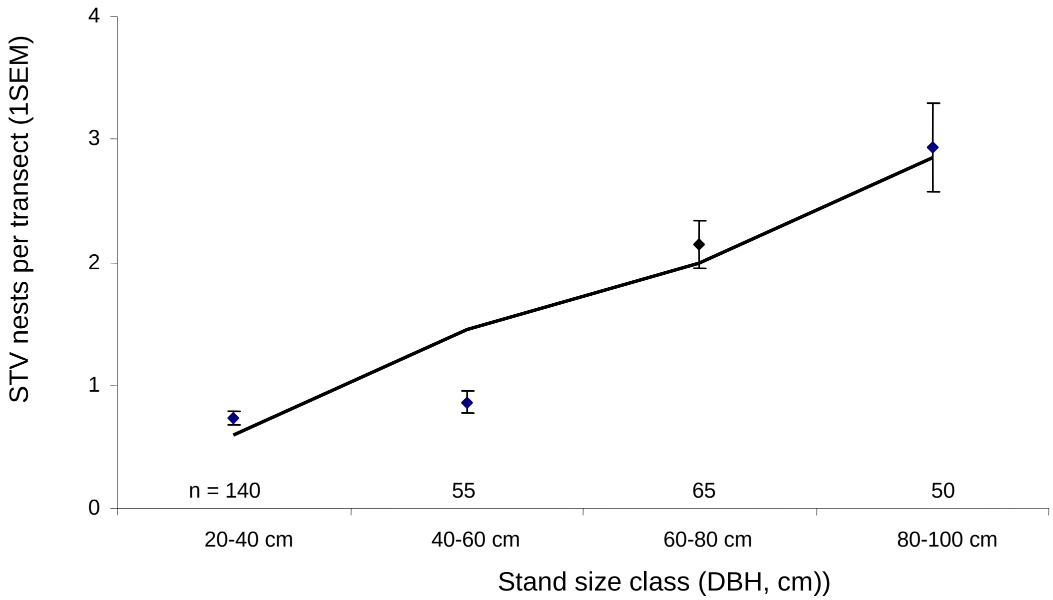

Figure 2. Number of Sonoma tree vole (STV) nests in relation to a stand's tree size class. Each point is the mean number of nests across transects, error bars are ±1SEM, n is the number of transects that were surveyed.

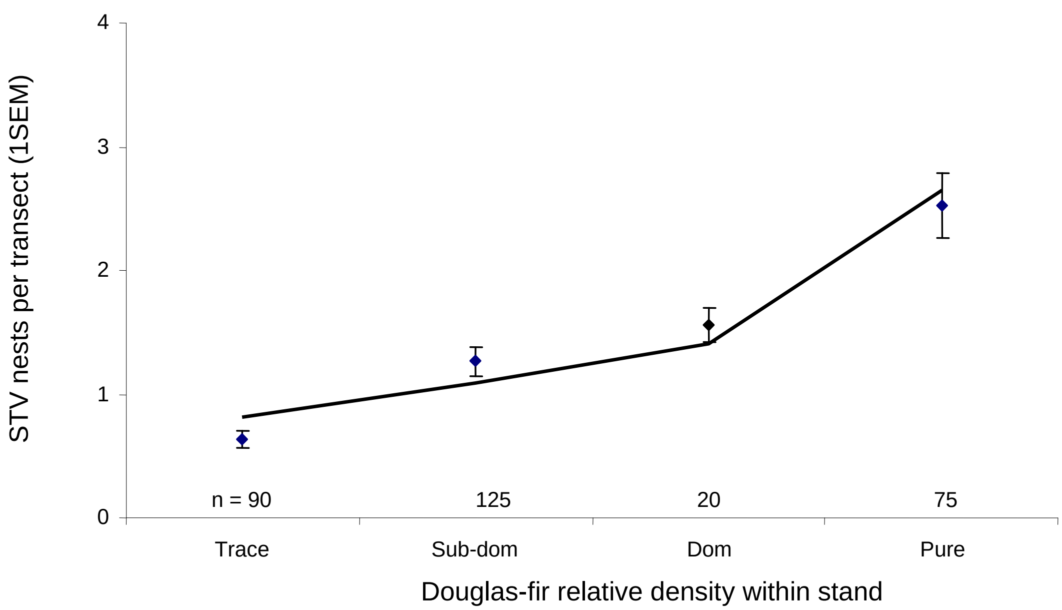

Figure 3. Number of Sonoma tree vole (STV) nests in relation to Douglas-fir relative density within stand. Each point is the mean number of nests across transects, error bars are ±1SEM, n is the number of transects that were surveyed.

The following equation describes the model:

***Nests* = -1.934 + 0.659(SIZECLASS) + 0.519(DFRANK)**

Where *Nests* is the number vole nests along a 100 m transect. SIZECLASS is the tree size class where 3 = 20-40 cm; 4 = 40-60 cm; 5 = 60-80 cm, and 6 = 80-100 cm. DFRANK is the relative density of Douglas-fir where 0 = trace; 1 = sub-dominant; 2 = dominant; and 3 = pure.

APPLICATION OF HABITAT MODEL TO CURRENT (2011) TIMBER INVENTORY

The Sonoma tree vole nest model was applied to HRC lands using current (2011) vegetation type mapping. As an example, the estimated number of Sonoma tree vole nests per transect and the area of relative tree vole habitat are shown for the Mattole River watershed (Table 2).

Table 2. Relative density of Sonoma tree vole nests predicted per 100 m transect and habitat area relative to Douglas-fir size and rank from the 2011 HRC forest inventory in the Mattole River watershed on HRC land in Humboldt County, CA.

Size Class	DF Rank	Nests/transect	Acres	Hectares
3	0	0.0	4847.3	1938.9
3	1	0.6	644.4	257.8
4	0	0.7	255.7	102.3
3	2	1.1	576.3	230.5
3	3	1.6	726.3	290.5
4	3	2.3	1702.5	681.0
5	3	2.9	2047.7	819.1
6	3	3.6	529.4	211.8

The habitat information resulting from the vegetation typing was used to map the estimated density per transect of vole nests on HRC lands in the Mattole River watershed (Figure 4). On Figure 4 black and dark grey areas represent locations where nests should be dense or moderately dense respectively. Stippled areas represent places the model predicts nests to be absent or few, or non-forested.

In the Douglas-fir dominated Mattole River watershed, approximately 38 percent of habitat (1711.2 ha) is in the high density category and is scattered throughout the forestlands, with some relatively significant concentrations to the northwest on Long Ridge and near Taylor Peak (Table 2 and Figure 4).

With the exception of Long Ridge and Taylor Peak, the best habitat appears to be relatively scattered but connected by stands with lower suitability and riparian zones. Thus, in this watershed retention of clumps of habitat and the connectivity between them would likely benefit Sonoma tree voles.

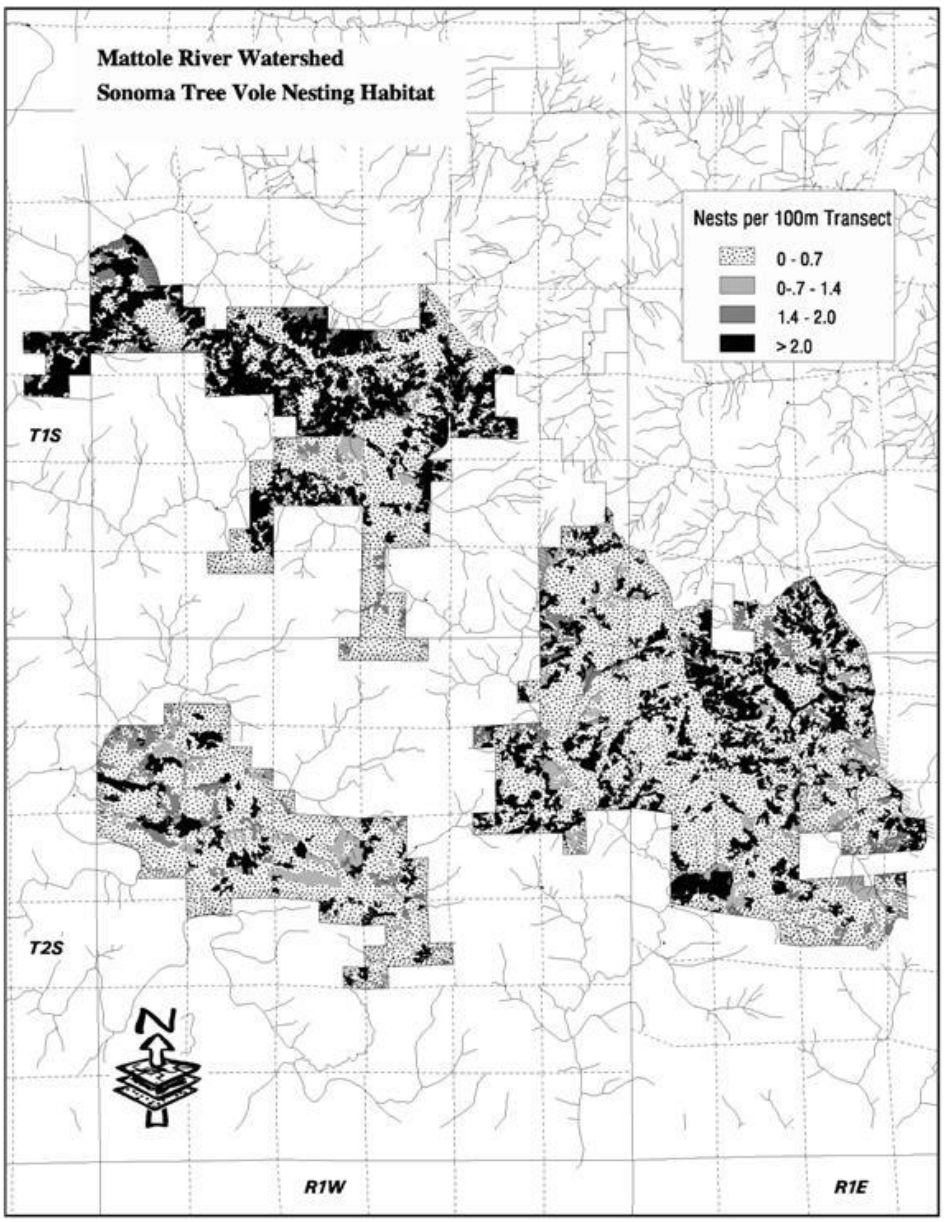

Figure 4. Relative density of Sonoma tree vole nests on HRC lands in the Mattole River Watershed, Humboldt County, CA.

MANAGEMENT IMPLICATIONS

Swingle (2005) found through comparisons of nests located by visual searches from the ground versus nests located by following radio collared voles that many active nests could not be seen from the ground, and that nests located by visual searches were biased towards larger nests. Thus, our surveys should best be considered indices to relative abundance because we do not know the true number of nests in any stand type. Findings of this study relative to Sonoma tree vole habitat are consistent with others (e.g., Thompson and Diller 2002, Jones 2003). Mature stands with larger Douglas-fir trees and those with higher densities of Douglas-fir tend to have the most nests while pole and young stands with relatively few or no Douglas-fir trees tend to have fewer nests (Figure 2 and Figure 3). The retention of large Douglas-fir trees combined with other conservation strategies such as riparian protection, other species protection measures (e.g. northern spotted owl nest zones), or as part of a structural element retention strategy wherein large trees with complex structure are retained may help maintain Sonoma tree vole populations.

Maps of Sonoma tree vole habitat derived by applying the habitat model to timber inventory (e.g., Figure 4) as the inventory is renewed over time can enable changes in Sonoma tree vole habitat to be visualized and monitored. Validating the model by predicting Sonoma Tree Vole nest density in stands outside the stands and watersheds where the model was developed would add confidence to its use for monitoring purposes.

Looking forward, HRC plans to use the ForSee growth and yield model (California Growth and Yield Modeling Cooperative 2009) to project future stand conditions under planned management scenarios. The ForSee model produces present and future stand characteristics that can be used as input to the vole nest model enabling forecasts of tree vole habitat value. Next steps for HRC will be to explore opportunities for refinement of the model using new or different inputs. Other forestland ownerships that have forest inventory data and Geographic Information System technology may be able to use these techniques as a tool for evaluating species conservation programs.

ACKNOWLEDGEMENTS

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REFERENCES

Anderson, D.R.; Laake, J.L.; Cain, B.R.; and Burnham, D.P. 1979. **Guidelines for line transect sampling of biological populations.** Journal of Wildlife Management 43: 70-78.

Aubry, K.B.; Crites, M.J.; and West, S.D. 1991. **Regional patterns of small mammal abundance and community composition in Oregon and Washington.** Pp 285-294 in Wildlife and vegetation of unmanaged Douglas-fir forests (L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.H. Huff, tech cords.). United States Department of Agriculture, Forest Service General Technical Report PNW-285. Pacific Northwest Research Station, Portland, Oregon.

Biswell, B.; Blow, M.; Finley, L.; Madsen, S.; and Schmidt, K. 1999. **Survey protocol for the red tree vole *Arborimus longicaudus.*** (Interim Version 2.0). U.S. Forest Service, Pacific Northwest Research Station. Portland, OR. 31 pp. Unpublished.

California Department of Fish and Game. 2011. **Special Animals.** State of California, The Natural Resources Agency, Biogeographic Data Branch, California Natural Diversity Database.January2011. *See* www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf

California Growth and Yield Modeling Cooperative. ForSee growth and yield model. [Computer program, V 2.0]. 2009. Available from: California Growth and Yield Modeling Cooperative. *See* www.cagym.com

Carey, A.B. 1989. **Wildlife associated with old-growth forests in the Pacific Northwest.** Natural Areas Journal 9:151-162.

Carey, A.B. 1991. **The biology of arboreal rodents in Douglas-fir forests.** United States Department of Agriculture, Forest Service General Technical Report PNW-GTR-276. Pacific Northwest Research Station, Portland, Oregon.

Corn, P.S. and Bury, R.B. 1986. **Habitat use and terrestrial activity by red tree voles (*Arborimus longicaudus*) in Oregon.** Journal of Mammalogy 67:404-406.

Forsman, E.D.; Meslow, E.C.; and Wight, H.M. 1984. **Distribution and biology of the spotted owl in Oregon.** Wildlife Monograph 87: 1-64.

Gillesberg, A.M.; and Carey, A.B. 1991. **Arboreal nests of *Phenacomys longicaudus* in Oregon.** Journal of Mammalogy. 72:784-787.

Gomez, D.M.; and Anthony, R.G. 1998. **Small mammal abundance in riparian and upland areas of five seral stages in western Oregon.** Northwest Science 72:293-302.

Huff, M.H.; Holthausen, R.S.; and Aubry, K.B. 1992. **Habitat and management for red tree voles in Douglas-fir forests.** United States Department of Agriculture, Forest Service General Technical Report PNW-GTR-302, Portland, Oregon.

Jones, J.M. 2003. **Habitat associations and ecology of the Sonoma tree vole (*Arborimus pomo*) in northwestern California.** Arcata, CA: Humboldt State University. M.A. Thesis; 55p.

Martin, K.J. 1998. **Habitat associations of small mammals and amphibians in the central Oregon coast range.** Corvallis, Oregon: Oregon State University. Ph.D dissertation.

PALCO. 1999, **Habitat conservation plan for the properties of The Pacific Lumber Company, Scotia Pacific Company, LLC, and Salmon Creek Corporation.** Scotia, CA: The Pacific Lumber Company; 138p.

Swingle, J.K. 2005**. Daily activity patterns, survival, and movements of red tree voles (*Arborimus longicaudus*) in western Oregon.** Corvallis, OR: Oregon State University. M.S. Thesis; 118p.

Thompson, J.L.; and Diller, L.V. 2002. **Relative abundance, nest site characteristics and nest dynamics of Sonoma tree voles on managed timberlands in coastal northwest California.** Northwestern Naturalist 83:91-100.

Wooster, T.W.; and Town, P. 1998. **California red tree voles within a coastal second-growth forest.** Unpublished Report. State of California, Department of Fish and Game, Yountville, CA.