MANAGEMENT RECOMMENDATIONS

FOR THE

OREGON RED TREE VOLE

Arborimus longicaudus

Phenacomys longicaudus
in the Record of Decision
for the Northwest Forest Plan

Version 2.0

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EXECUTIVE SUMMARY

Species: Oregon Red Tree Vole (*Arborimus longicaudus)* (= *Phenacomys longicaudus* in the Record of Decision (ROD) of the Northwest Forest Plan (NFP)

Taxonomic Group: Mammal
Other Management Status: None
Survey and Manage Component: Component 2, Survey before ground-disturbing activities

Range: The Oregon red tree vole is endemic to moist coniferous forests of western Oregon and extreme northwest California and its known and suspected range extends from the Columbia River south through western Oregon and the Siskiyou Mountains, south to the Salmon and Klamath Rivers in northern California.

Habitat: The literature on the Oregon red tree vole indicates that the species inhabits conifer forests containing Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), Sitka spruce (*Picea sitchensis*) western hemlock (*Tsuga heterophylla*) (Johnson and George 1991) and white fir (*Abies concolor*) (Manning and Maguire 1999). Carey (1991) identifies optimal habitat for red tree voles to be old-growth Douglas-fir forests. Gomez (1992) did not capture the species in hardwood stands, and generally hardwoods are not recognized as an important habitat component. Aubry et al. (1991) found that red tree voles occur in old-growth forests significantly more than in younger forests, and also suggested that the parameters associated with age (such as large, live, old-growth trees) are important habitat components. Voles do occur in younger stands (Maser 1966; Corn and Bury 1986, 1991; Carey 1991; Johnson and George 1991; Aubry et al. 1991; Gillesburg and Carey 1991; Gomez 1992), but Carey (1991) suggested these younger forests may be population sinks rather than sources.

Based on the literature, old-growth habitat appears to provide optimum conditions for red tree vole populations. The tall, multi-layered canopies of old growth retain humidity and intercept fog, which functions as a climatic buffer and a source of free water. Large branches provide stable support for nests, protection from storms, and travel routes (Gillesberg and Carey 1991). Active nests have been found in remnant older trees in younger stands indicating the importance of legacy structural characteristics (Biswell, unpublished data). Sites with large numbers of nests tend to occur in stands with large trees, multiple-layered canopies and more canopy structure based on Interagency Species Management System (ISMS) data, field observations, and administrative reports. However, little is known about the minimum number or size of conifer trees, or other stand characteristics, required to sustain a local population of red tree voles.

Red tree voles have been documented in conifer stands from sea level to 5,500 feet in elevation (Manning and Maguire 1999). They are suspected to occur in forested stands up to 6,000 feet when stands contain some Douglas-fir trees.

Threats: The Oregon red tree vole has many life history characteristics that cumulatively raise concerns for its long-term persistence such as very small home ranges, low dispersal capability, extremely low reproductive potential, and a sensitivity to stand level disturbances.

Information Needs: Current survey protocols and management guidelines could be improved with information on the species' reproductive potential, demographics, population status or trend, and the spatial extent of known sites. Generally, the scientific information needed for management cannot come

solely from pre-project type surveys. To date, pre-project surveys have been limited to locating new sites and collecting incomplete counts of the number of nest trees within projects. More studies are vital to improving our understanding of red tree vole ecology, range and distribution, habitat relationships, population trends and management options. There are also questions concerning ecological differences between *Arborimus longicaudus* and *A. pomo* that need to be studied. Further genetic research is needed to resolve the geographic distribution of these two species, and to determine if red tree voles occur in a series of genetically distinct sub-populations, or are distributed in a single population without unique geographic genotypes.

Management Recommendations: Delineation and management of Habitat Areas is recommended to maintain habitat where red tree voles are known or assumed to occur, in accordance with the ROD direction to "manage habitat for the species on sites where they are located (USDA, USDI 1994a, page C-5)." These Habitat Areas are designed to protect the physical integrity of the nests from both management activities and natural disturbances such as windthrow, and to provide a short-term approach to maintaining habitat at red tree vole sites until a stand-scale, landscape strategy is devised. These provisions provide incrementally greater protection for sites with a higher number of nest trees in the Habitat Area, and also maintain sites with few nests to preserve management options in the future. Habitat Areas encompass active and undetermined red tree vole sites, and are not delineated for inactive sites.

The minimum size of 10 acres for a Habitat Area was used in the management recommendations for red tree vole nests contained in the U.S. Forest Service (R6) and Bureau of Land Management memorandum (1736-PFP BLM-OR931/1950 FS; BLM Instruction Memorandum No. OR-97-009 dated November 4, 1996) on interim guidance on the red tree vole. While the individual home range size for this species is not well known, Biswell (in prep) found individual adult red tree voles radio-tracked for 35-106 days, used 2-7 (median = 5) nest trees and males occupied a mean area of 0.35 hectare (0.86 acre) and females used a mean area of 0.15 hectare (0.37 acre). This information is based on a small number of individuals that were tracked for less than one year, therefore these areas may be minimum estimates of the area used by an individual. These estimates were used as the rationale for the establishment of the one acre per nest. The 4.0 hectare (10-acre) habitat area is not derived from specific information concerning the species habitat requirements around a nest tree. However, overnight movements of 75.8 meters (248.7 feet) have been documented. This distance would equate to an area of 1.8 hectares (4.5 acres) if that distance were used as a radius of a circle around the nest tree. The10-acre habitat area is intended to provide for protection of the physical integrity of the nest(s) and retain adequate habitat for expansion in the number of active nests at that site. The Habitat Area that is delineated for sites with greater than 10 nests is either 1.0 acre per nest, or a polygon encompassing the site, whichever is greater and must include a one site potential tree buffer around nests on the outer edge of such polygons.

Any management that occurs within a Habitat Area should not remove or modify nest trees, the canopy structure of the stand, or remove any of the dominant, codominant, or intermediate (Daniel et al. 1979) crowns**.** This includes activities that may isolate nest trees or alter the microclimate within the stand. Some activities may be appropriate if they maintain or improve, and do not degrade (short- or long-term), the habitat condition in the Habitat Area. Examples of these activities are provided.

Other management issues and considerations are discussed, and both stand- and landscape-level approaches are recommended that could be incorporated into current project- and watershed- level planning. These issues and considerations include (1) habitat surrounding and adjacent to Habitat Areas; (2) connectivity of Habitat Areas to NFP land allocations; (3) management of inactive sites; and (4) fuels management and prescribed fire adjacent to Habitat Areas.

DEFINITION OF TERMS

The following definitions are provided for the purposes of these management recommendations:

Nest Types	
Confirmed Red Tree Vole Nest:	An arboreal nest that is confirmed as belonging to a red tree vole, and the activity status is undetermined.
Confirmed Active Red Tree Vole Nest:	An arboreal nest that is confirmed as belonging to a red tree vole and is currently being used by a red tree vole
Confirmed Inactive Red Tree Vole Nest:	An arboreal nest that is confirmed as belonging to a red tree vole and determined not to be currently in use by a red tree vole.
Unconfirmed Species Nest	Any arboreal nest that is not confirmed as belonging to a red tree vole or any other species. Some of these undetermined structures may not be rodents nests but rather a bird nest or accumulations of litter fall
Nests confirmed to species other than red tree vole	Any arboreal nest structure confirmed to not have been used by a red tree vole.

Site Types	
Red Tree Vole Site	A red tree vole site is an individual nest tree or a collection of nest trees within a local area (all nest trees in a stand and adjacent stands that are not isolated from other clumps of nest trees by more than 100 m [330 ft])
Active Site	A location with one or more confirmed active nests.
Inactive Site	A location where all confirmed nests are determined to be not active.
Undetermined Site	Activity or species use has not been determined, and the site is assumed to be active for management purposes.
Stand	A stand is usually the management unit. A stand can be defined as a reasonably homogeneous unit that can be clearly differentiated from surrounding stands by its age, composition, structure, site quality, or geography (Daniel et al. 1979, pg 38).
Resin Duct	A structure found along the outer edge of a Douglas-fir needle that red tree voles split off and discard as feeding refuse before eating the remainder of the needle. These small, thread-like ducts accumulate in the nest and are used to line the nest chamber. A description of resin ducts as ``mid-veins" is incorrect since the vascular bundle found in the middle of the needle is eaten, not discarded.
Canopy	For the purposes of this document the canopy includes the following crown classifications: Dominant, Codominant, and Intermediate (Daniel et al, 1979 and Johnson, 1998.) *Dominant*- Tree crowns receive full light from above and partly from the sides. Crowns extend above the general level of the canopy. *Codominant*- Tree crowns receive full light from above, and little from the side. Crowns usually form the general level of the canopy. *Intermediate* - Tree crowns receive little direct light from above, and none from the sides. Crowns are below or extend into the general level of the canopy
Habitat Area	An area that is delineated to maintain habitat where red tree voles are known or assumed to occur.

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Scientific name:	*Arborimus longicaudus* (True, 1890)
Common name:	Oregon Red Tree Vole
Family:	Muridae
Subfamily:	Arvicolinae (Musser and Carleton 1993)
Recognized Subspecies:	Oregon Red Tree Vole (*A. l. longicaudus)*
	Dusky Red Tree Vole (*A. l. silvicola)* (Howell, 1921)
Synonyms:	*Phenacomys longicaudus*

The Oregon red tree vole (*Arborimus longicaudus*) was described from a specimen collected in 1890 from Marshfield, Coos County, Oregon, and given the scientific name *Phenacomys longicaudus*. Johnson (1968) elevated the subgenus *Arborimus* to full generic rank and included the red tree vole and the white-footed vole (*A. albipes*) in this new genus. In 1991 Johnson and George (1991) split the sibling species, *Arborimus pomo*, from *A. longicaudus*. Their new species included tree voles found along the California Coast and effectively split the red tree vole's range in half near the California-Oregon border. Subsequently, Murray (1995) presented DNA information suggesting specimens from the Wilson Creek drainage in Del Norte County, California, were more similar to the Oregon tree voles than to other California populations.

Currently there are two recognized subspecies of Oregon tree voles: *Arborimus longicaudus longicaudus* and *A. l. silvicola*. Taxonomists still disagree on whether *Arborimus* should have full generic status; therefore even recent scientific publications vary as to which genus they list for the species. For example, Verts and Carraway (1998) still use the genus *Phenacomys* while Carey (1999), Hayes (1996) and Maser (1998) all used *Arborimus*. Some recent DNA analysis (Murray 1995) supports *Arborimus* as an independent genus but these taxonomic issues are more academic and have no effect on the survey status of this species under the Northwest Forest Plan (NFP).

B. Species Description

1. Morphology

The red tree vole is a small microtine rodent with individual weight varying from about 25-50 grams (.87-1.75 ounces) (Hayes 1996). Total length (body and tail) for males ranges from 15.8-17.6 centimeters (6.2-6.9 inches) and females, from 17.0-18.7 centimeters (6.7-7.3 inches) (Hall 1981). The tail, which is relatively long, accounts for about 40 percent of the total length and is used for balance while moving along small branches.

The color of the dorsal pelage ranges from rust to cinnamon with some hairs tipped with black. Ventral pelage is whitish (Hall 1981). The well-haired tail is black to brown in color (Maser and Storm 1970; Whitaker 1988). Juveniles tend to be browner in coloration with black tails (Maser and Storm 1970). Melanistic individuals have been observed (Hayes 1996).

2. Reproductive Biology

Reproduction in this species is characterized by an unusually long gestation period, small litter size, delayed implantation during lactation, and slow development of nursing young (Hamilton 1962, Maser et.al.1981). The gestation time for non-lactating females is approximately 28 days (Hamilton 1962) but may extend to 48 days if the female is lactating in support of an earlier litter

(Carey 1991). Postpartum breeding occurs occasionally (Hamilton 1962; Brown, 1964) but some captive females have remained unreceptive to breeding for 48 to 65 days (Hamilton 1962). Red tree voles are believed to breed throughout the year, but generally litters are produced from February through September (Carey 1991). Litters range in size from one to four (Hamilton 1962) but average two (Howell 1926) and females can have more than one litter in a given year (Hamilton, 1962).

Weaning of healthy young takes place at from 30 to 35 days (Hamilton 1962) and the young start to venture from the nest at about 4 weeks of age (Howell 1926).

3. Ecology

Red tree voles are the most arboreal mammals in the Pacific Northwest (Carey 1996) and are endemic to moist coniferous forests of western Oregon and extreme northwest California. Their distribution is patchy and limited to coniferous forests west of the crest of the Cascade Mountains. Red tree voles depend on conifer tree canopies for nesting sites, foraging, travel routes, escape cover, and moisture (Carey 1991). Douglas-fir (*Pseudotsuga menziesii*) needles provide the primary food and building materials for nests.

The vole is important prey for the threatened northern spotted owl, though saw-whet and other owl species, raccoons, marten, ringtail, and fishers prey upon them as well (Maser et al. 1981; Whitaker 1988; Forsman and Maser 1970). During a study of spotted owl diet conducted in the 1970's, the red tree vole's contribution to total prey varied in different portions of the range of the owl, from a low of 3.7 % of the total prey items in the northen Oregon Cascades to a high of 49.1 percent for two owl pairs in the Douglas-fir /coast redwood zone along the southern Oregon Coast (Forsman et al. 1984). The mean contribution that red tree voles made to total owl diet items, across 7 study areas, was 15.1% of all prey items (Forsman et al. 1984). Due to their small size, red tree voles provided 2 to19 percent of the total diet biomass and were the third most abundant prey item (Forsman et al. 1984).

Red tree voles were rated as highly vulnerable to local extirpations from habitat fragmentation or loss (Huff et al. 1992), and are recognized as closely associated with old-growth forest habitat (Carey 1989, Ruggiero et al. 1991). Significant declines in tree vole populations are expected from major reductions in old-growth Douglas-fir habitat (Huff et al. 1992). Some sites in old forest conditions have many nests and can cover several hundred acres. Sites with one to a few nests are believed to be either a part of a declining residual site or associated with an individual attempting to disperse. Both types of sites are important to identify during pre-project surveys. Large sites containing many nests will provide major support for tree vole population persistence, while sites with only one to a few nests may help maintain the species distribution and connectivity throughout its geographic range.

C. Range and Known Sites

The Oregon red tree vole is endemic to moist coniferous forests of western Oregon and extreme northwest California. Our understanding of the geographic range of the Oregon red tree vole has improved since the issuance of the NFP Record of Decision (USDA, USDI 1994a). Recent surveys have identified new vole sites in the Rogue, Applegate, and Illinois River Valleys that helped expand and delineate the eastern extent of the vole range in these dry forest communities. In addition, Zentner (1977) identified active tree vole nests in Siskiyou County, California in the vicinity of Happy Camp. These nests are geographically closer to *A. longicaudus* and are many miles east of the accepted range of *A. pomo* and therefore suggest the inclusion of this area into the known and suspected ranges of the Oregon tree vole.

The most significant change in the species range since the NFP, however, is a clarification in the taxonomic relationship of populations in northern California. In the original NFP Supplemental Environmental Impact Statement (SEIS) analysis, the agencies followed the range suggested by Johnson and George (1991) when they originally split the sibling species, *Arborimus pomo,* from the Oregon tree vole. They suggested there was a break in the distribution between the two species near the California - Oregon border. Murray (1995) subsequently presented DNA data suggesting specimens from adjacent to the Smith River drainage in Del Norte County, California, were more similar to Oregon tree voles than to other California populations. In addition, based on his collecting in the Smith River drainage, Maser (1998) also suggests populations from the Smith River are *A. longicaudus.* The map in Figure 3 displays the known and suspected range of the Oregon red tree vole for the purpose of management under the NFP.

The known and suspected geographic range of *A. longicaudus* extends from northern Oregon near the Columbia River south along the 6,000 foot elevation contour west of the crest of the Cascade Mountains to Prospect, Oregon. From Prospect, the eastern range line extends along the Rogue River to Medford, then south along Interstate 5 to the Siskiyou Mountain crest, then west along the crest to Condrey Mountain. The boundary then extends south from Condrey Mountain south along Buckhorn Creek to the Klamath River, and west along the Klamath River to the mouth of the Scott River. From the confluence of the Scott and Klamath Rivers, the range follows the boundary between the Happy Camp and Scott River Ranger Districts of the Klamath National Forest (NF) to the Marble Mountain Wilderness, then along the west side of the Marble Mountain Wilderness to the Salmon River. The line then follows the Salmon River to the Klamath River, and continues west along the Klamath River to the Pacific Ocean. Table 1 lists the counties contained within this known and suspected range.

Table 1. Counties in western Oregon and northern California within the Known and Suspected Range of the Oregon red tree vole.

Western Oregon Counties		
Benton	Clackamas	Clatsop
Columbia	Coos	Curry
Douglas	Jackson	Josephine
Lane	Lincoln	Linn
Marion	Multnomah	Polk
Tillamook	Washington	Yamhill
Northern California Counties		
Del Norte	Humboldt	Siskiyou

These management recommendations were developed for sites found within the known and suspected range of the Oregon red tree vole, *A. longicaudus*. The Survey and Manage requirements under the NFP do not apply to populations of *A. pomo* (USDA, USDI 1994a).

D. Habitat Characteristics and Species Abundance

1. Habitat

The literature on the red tree vole indicates that the species inhabits conifer forests containing

Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), Sitka spruce (*Picea sitchensis*) western hemlock (*Tsuga heterophylla*) (Johnson and George 1991) and white fir (*Abies concolor*) (Manning and Maguire 1999). Carey (1991) identifies optimal habitat for red tree voles to be old-growth Douglas-fir forests. Gomez (1992) did not capture the species in hardwood stands, and generally hardwoods are not recognized as an important habitat component.

Huff et al. (1992) reported that voles were captured from the Oregon Cascade and Coast Ranges in 28% of the old-growth stands surveyed but in only 5% of the unmanaged young and mature stands. Because young and mature stands represented nearly 45% of the total stands surveyed in this study, the likelihood was low that red tree voles were captured in five times as many old-growth stands through chance alone. Aubry et al. (1991) found that red tree voles occur in old-growth forests significantly more than in younger forests, and also suggested that the parameters associated with stand age (such as large, live, old-growth trees) are important habitat components. Voles do occur in younger stands (Maser 1966; Corn and Bury 1986, 1991; Carey 1991; Johnson and George 1991; Aubry et al. 1991; Gillesburg and Carey 1991; Gomez 1992), but Carey (1991) suggested these younger forests may be population sinks rather than sources.

Based on the literature, old-growth habitat appears to provide optimum conditions for red tree vole populations. The tall, multi-layered canopies of old growth retain humidity and intercept fog, which functions as a climatic buffer and a source of free water. Large branches provide stable support for nests, protection from storms, and travel routes (Gillesberg and Carey 1991). Active nests have been found in remnant older trees in younger stands indicating the importance of legacy structural characteristics (Biswell, unpublished data). Sites with large numbers of nests tend to occur in stands with large trees, multiple layered canopies and more canopy structure based on Interagency Species Management System (ISMS) data, field observations, and administrative reports. However, little is known about the minimum number or size of conifer trees, or other stand characteristics, required to sustain a local population of red tree voles.

The overall effect of stand size or topographic position on maintaining vole populations is also uncertain. In one study in the Cascades and Oregon Coast Range (Huff et al. 1992), captures declined in old-growth stands less than 100 acres in size. There have been no studies conducted on the stand size needed to sustain a red tree vole population.

Red tree voles have been documented in conifer stands from sea level to 5,500 feet in elevation (Manning and Maguire 1999). They are suspected to occur in forested stands up to 6,000 feet when stands contain some Douglas-fir trees.

2. Nests

Red tree voles build nests wherever there is a suitable foundation and a readily accessible food supply. Generally, only one adult occupies each nest but multiple nests can be found in large trees. One adult may use multiple nests within the same or different trees. Nests are constructed of resin ducts, lichen, feces, conifer branchlets, and fine twigs (Gillesberg and Carey 1991). Single large branches, mistletoe brooms, and re-sprouted branch clusters provide stable foundations for nests in larger trees, while whorls of branches or forked tops in smaller trees can also provide a protected location. Some vole nests have also have been found in cavities (Gillesberg and Carey 1991) in decadent old trees or broken top trees. Nests have been found from 2 to 65 meters above the ground.

Inactive nests indicate vole presence in the area at some time in the past. Old unoccupied nests are believed to sometimes remain in the canopy for as long as 5 years or more. The diagnostic features of these inactive nests may also be observed for 5 or more years which may lead a surveyor to

identify a new site long after the voles have disappeared. Inspection of nest material may give indications of when the nest was last used, but will not provide information to predict if the nest may be re-used in the future.

Inactive nests in suitable habitat may be reused at any time by the last resident individual, or re-colonized by a new individual (Biswell, unpublished data). The number of individuals in the area and the location or availability of suitable nest trees in the stand may affect the likelihood of re-use or re-colonization of an individual nest. Red tree vole sites typically contain some inactive nests along with the active nests. The ecological function and importance of inactive nests is not fully understood.

3. Home Range/Dispersal

The species is nocturnal, and some individuals may spend the majority of their lives in the canopy, moving from tree to tree through the canopy (Carey 1991). Though they are almost exclusively arboreal, some terrestrial activity does occur; and occasionally individuals have been captured on the ground (Corn and Bury 1986; Raphael 1988; Gomez 1992). The individual home range size for this species is not well known. Biswell (in prep) found individual adult red tree voles radio-tracked for 35-106 days, used 2-7 (median = 5) nest trees and males occupied a mean area of 0.35 hectare (0.86 acre) and females used a mean area of 0.15 hectare (0.37 acre) . The greatest straight-line distance between consecutively occupied nest trees was an overnight move of 75.8 meters (248.7 feet). Mean distances moved between consecutive nest trees for males and females combined was 31.4 meters (SE=6.49) (112.8 feet). When moving to a new nest tree, adult voles re-occupied previously constructed nest structures at least 68 percent of the time. Thirty-six percent of 39 nest trees located via telemetry contained more than a single nest, and one tree contained 7 nests.

The greatest documented distance moved by a red tree vole was by a dispersing subadult male. Tracked by radio telemetry for 40 days, he was located in five different trees and reached a maximum straight-line distance from his natal nest tree of 340 meters (1115 feet) (Biswell, unpublished data). While this subadult moved a greater distance than any adults, subadults in this study had extremely low survival rates. Red tree voles tracked using telemetry crossed small forest (dirt) roads, small first-order streams, and canopy gaps of 10 to 20 meters (33 to 66 feet) while traveling between nest trees.

4. Abundance

Red tree voles are hard to locate but assessing the number of voles at individual sites and determining the number of sites are critical statistics used in the species assessment process. Estimates of the number of pre-1994 red tree vole sites, based on published lists of museum specimens, spotted owl pellet collection sites and small mammal collection localities, indicate there were approximately 245-310 locations where the species had been found prior to the signing of the NFP. Since 1994, more than 660 pre-disturbance surveys have been conducted by the Bureau of Land Management (BLM) and National Forests in western Oregon. These surveys covered greater than 86,000 acres (USDA, USDI 1999b) and located 323 new locations' containing confirmed red tree vole nests; of those locations 114 (35 %) had one or more confirmed active nests (USDA, USDI Species Review Panel 2000). The distribution of this survey effort has not been uniform across the species range but concentrated on a few administrative units. For example, Medford District BLM has conducted 84% of all pre-disturbance surveys and surveyed more than 44% of the total area surveyed to date. They have found 72% (234) of all new locations; however, three watersheds within the district produced the majority of these sites. The Trail Creek watershed alone produced 14% (45) of all new red tree vole locations (USDA, USDI Species

Review Panel 2000a). This concentration of survey effort and vole detections within limited portions of the species range confounds our ability to extrapolate across the range or fully assess the species status.

Recent survey and historical data indicate that tree vole abundance may vary within and among physiographic provinces. Major survey efforts in some regions have detected only few new sites. For example, in 1995 the Mt. Hood N. F. surveyed 38,611 acres, including 62 percent (26,976 acres) of all primary red tree vole habitats on the Forest, and verified only nine red tree vole nests (USDA Mt. Hood NF 1996). Primary habitat included the most likely habitat conditions for finding red tree vole populations, defined as stands of large conifer (>21 dbh), below 3,000 feet elevation, within the western hemlock or Pacific silver fir vegetation zones, and greater than 300 acres in size. Additional surveys in 1997 added only three additional sites each containing single nest trees (USDA Mt. Hood NF 1997). In general, federal lands in the northern half of the Cascade Range including the Sandy, Clackamas, and North Santiam River basins, contain relatively few new or recently identified red tree vole sites. However, these watersheds contain a number sites where museum specimens were collected and these sites suggest tree voles were historically distributed throughout the region at some currently unknown density.

In contrast, between 1996 and 1999 the Medford District BLM surveyed 37,421 acres (Survey and Manage SEIS Team 1999b) and identified 234 timber sale units with new red tree vole sites. This survey effort represents approximately 44% of all the acres surveyed range wide, 84% of all pre-project surveys, and 72% of all new sites.

Roseburg District BLM conducted pre-project surveys on approximately 2202 acres in 82 sale units from December 1999 through February 2000. They detected 935 arboreal structures. Thirty-five (3.7 %) were confirmed active red tree vole nests, 70 (7.5 %) were confirmed inactive red tree vole nests and 830 (88.8 %) were unconfirmed species nests (USDI Roseburg District BLM 2000).

Estimates of red tree vole nest tree densities within sites are good indicators of site quality and densities do vary across the species range. In 16 stands (9 old, 7 young) on the Rock Creek watershed in the central Coast Range there were significantly more nest trees per acre in stands greater than 125 years old than in young stands 30-125 years. Mean densities were 2.04 (SE=0.46, maximum 5) nest trees per acre in the older stands and 0.45 (SE=0.33) nest trees per acre in 30-125 year old stands (Biswell, in prep). Estimated nest tree densities from 14 stands with confirmed nests in the Grants Pass Resource Area averaged 0.17 (SE = 0.07) nest trees per acre (USDA, USDI Species Review Panel 1999a). These 14 stands were out of 101 locations surveyed for potential timber sales distributed over 5 fifth-field watersheds. Lower nest tree densities and fewer numbers of stands containing tree voles in Grants Pass Resource Area may represent the effect of the dry climate on developed canopy structures or more limited habitat conditions.

II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standard and Guideline

Using the process from the FEMAT Report (FEMAT 1993), Option 9 of the Draft Supplemental Environmental Impact Statement (DSEIS) on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA, USDI 1993) rated the Oregon red tree vole as having a 73% likelihood of having habitat of sufficient quality, distribution, and abundance to allow the species population to stabilize, well-distributed across federal lands (FEMAT Report 1993, Table IV-38). Additional information was gathered between the DSEIS and the Final SEIS identifying species for further analysis. Under the Record of Decision for the Final

SEIS (USDA, USDI 1994a) species were identified for special consideration if they rated under an 80% likelihood of achieving adequate, stable and well-distributed populations under Option 9 (USDA, USDI 1994c, Appendix J-2).

The outcome of this additional analysis for the Oregon red tree vole concluded that to improve the likelihood to > 80% of achieving adequate, stable, well-distributed populations, additional mitigation measures were needed for this species. Two combinations of mitigations were determined to accomplish >80% likelihood: Survey and manage known breeding colonies in the Matrix and either (1) implement Riparian Reserve Scenario 1, OR (2) implement additional landscape controls (Appendix J2-475). Implementation of surveys prior to activities and managing sites is important to help provide for well distributed breeding colonies of red tree voles (USDA, USDI 1994b, Vol. 1, page 185) while implementing Riparian Reserve Scenario 1 was determined to be important for connectivity of forest stands (FEMAT IV-173).

The Oregon red tree vole was added to Survey and Manage mitigation during the NFP Final Supplemental Environmental Impact Statement (FSEIS) (USDA, USDI 1994b) analysis because the species was believed to need more protection than provided by the standards and guidelines, Riparian Reserves, Late-Successional Reserves (LSRs) and other land allocations of the NFP. The assumption was made that each LSR would likely support large populations of red tree voles, but each of these populations may be isolated from others. Therefore, connectivity of LSRs is necessary to provide for reproductive populations between large reserves to facilitate gene flow from one reserve to another. Therefore, stable, well-distributed tree vole populations depend on maintaining habitat for reproduction and dispersal within non-reserved land allocations. No studies have been conducted, to date, that provides information on how well Riparian Reserves contribute to connectivity or dispersal routes between LSRs for red tree voles.

B. Major Habitat and Viability Considerations

All recent studies have concluded that Oregon red tree voles are more abundant in older forest conditions than in younger stands (Gillesberg and Carey 1991; Huff et al. 1992; Gomez 1992; Zentner 1977). The limited dispersal capabilities of this species increases the importance of providing well-distributed reproductive populations between reserves that were designed with an average spacing to support dispersal of northern spotted owls. The distribution and connectivity of late-successional habitats must be adequate to provide for reproductive populations.

The viability assessment conducted by the Scientific Analysis Team (SAT) (Thomas et al. 1993, page 372) rated the red tree vole as scarce everywhere within the range of the northern spotted owl. Surveys that have been conducted to date, the limited number of known sites that have been found relative to the species' geographic range, and the lack of confirmation of extant sites on federal ownership has not contradicted the SAT assessment.

Within portions of the Oregon red tree vole's range, habitat conditions and scarcity of active sites continues to suggest concern for the species' long term persistence. Most areas of low elevation federal forest lands have a limited number of acres qualifying as red tree vole habitat and checkerboard ownership patterns that may limit dispersal.

Additional concerns include:

- A subspecies of the red tree vole (*A. l. silvicola*) occurs only in the Northern Coast Range, and this area is geographically isolated with low levels of Federal ownership (USDA, USDI 1994c, page 474);

- In the Northern Cascades, a low number of red tree vole sites have been found even with significant survey effort; the incremental loss of any sites could lead to gaps in their historic range;

- In the eastern portion of the Klamath Province, the amount and suitability of red tree vole habitat is limited due to natural fragmentation of forest vegetation and lower amounts of mesic forest conditions; there is a limited understanding of the species' needs in these drier forest types;

- In the southern Willamette Valley, habitat connectivity is low because of the checkerboard ownership pattern and declining due to forest management within the matrix land allocation and on private lands; and

- Sites that contain very low nest tree densities, occupy small stands, and are located in low-quality habitat may not provide for species' persistence.

C. Threats to the Species

The Oregon red tree vole has many life history characteristics that, given current information, cumulatively raise concerns for its long-term persistence such as very small home range, low dispersal capability, a sensitivity to stand level disturbances, and extremely low reproductive potential relative to other microtines. This is also a species that turns over its populations rapidly (a characteristic of all microtine rodents). That is, individuals show short life span and a countering high reproductive rates as compared to larger mammals. Thus, given a high turnover, populations in younger forests must be reproductively successful every year or they will quickly go extinct.

The general concerns for this species include:

- Forest fragmentation and isolation of late-successional patches that may prevent gene flow and detrimentally affect metapopulation dynamics (USDA USDI 1994c, page 55);

- Continued loss of small isolated sites and the increased geographic isolation of remaining populations;

- Management activities which alter forest microclimate conditions, target the removal of mistletoe and older trees, and remove older stand types through regeneration harvest should be considered threats to this species;

- Loss of suitable habitats to stand replacing fires and use of prescribed fire that generates heat or smoke into the canopy of stands occupied by red tree voles;

- Management activities and landscape planning that do not provide for dispersal between LSRs;

- The potential loss of genetic variability in populations; and

- The effects of reduction in patch size on short- and long-term survival and successful reproduction.

D. Distribution Relative to Land Allocations in the Northwest Forest Plan

Most known sites on federal lands are not within reserve land allocations. Approximately 46% of the sites known prior to implementation of the NFP fall within the following reserved land allocations: 3% Congressionally Withdrawn; 2% Administratively Withdrawn; and 38% LSR. Of the remaining sites, 17% fall in Adaptive Management Areas and 37% fall in Matrix/Riparian Reserves. However, due to the spacial resolution of mapped red tree vole locations, Riparian Reserves can not be differentiated

from the general Matrix land allocation. Almost all new sites found after implementation of the NFP have been in Matrix/Riparian Reserves allocations due to the emphasis of surveys in areas proposed for habitat-disturbing activities.

About 41% of the current range on federal lands is in reserved land allocations (Congressionally Withdrawn, Administratively Withdrawn, and LSR excluding Riparian Reserves). Approximately 35% of the range within reserved land allocations consists of the potential primary red tree vole habitat (conifer forest that are greater than 20 inches d.b.h.) based on estimates using the BLM Western Oregon Digital Image Project (WODIP) vegetation map for western Oregon.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

The goal of red tree vole management under the NFP is to provide habitat of sufficient quality, distribution, and abundance to allow the species population to stabilize in a well-distributed pattern across federal lands (USDA, USDI 1994c). Management recommendations in this document will only contribute to maintaining the physical integrity of certain types of sites until adequate information is available to develop management strategies to meet the above goal.

Issues associated with distribution, dispersal, and persistence at local and landscape scales are not directly addressed. These issues will be more appropriately addressed following completion of strategic surveys for this species.

These management recommendations were designed to meet the direction in the Record of Decision for the NFP. It is recognized that these recommendations are being developed with insufficient information to address all the concerns for the species. They are intended to serve as a short-term approach to management until further information is available, such as strategic and pre-project surveys.

B. Specific Objectives

The specific objectives for these management recommendations come from the language in the NFP ROD (USDA, USDI 1994a, page C-5) standards and guidelines for the red tree vole that state "management standards will be developed to manage habitat for the species on sites where they are located". These objectives are to:

1. Maintain the physical integrity of the habitat at active and undetermined sites;

2. Maintain red tree vole populations at sites where they currently occur;

3. Prevent the inadvertent loss of red tree voles at sites where the species is assumed to occur but were not detected due to incomplete surveys.

IV. HABITAT MANAGEMENT

A. Lessons from History

Pre-project surveys have been the primary source of recent information but do not consistently collect quantitative data on species abundance or habitat associations at new sites, nor determine population

trend or other demographic information essential to developing management recommendations for this species. Data from pre-project surveys have not been fully analyzed**.**

Surveys and field observations in thinned stands and shelterwood treatments occasionally detect a number of old, inactive red tree vole nests but no occupied nests (Personal observations, B. Biswell and L. Finley). These results may indicate that red tree voles are susceptible to stand level disturbances that alter the canopy within their habitats and may cause sites to become unsuitable. Potential disturbances include reductions in overstory canopy volume and structure associated with felling trees adjacent to nest trees or logging operations (e.g. canopy removal for creation of skid roads and cable corridors). Red tree voles may be indirectly impacted by changes in the habitat caused by shifts in microclimate and stand structure due to natural and human caused disturbances

B. Identification of Habitat Areas for Management

"Habitat Areas" are delineated to maintain habitat where red tree voles are known or assumed to occur, in accordance with the ROD direction to "manage habitat for the species on sites where they are located (USDA, USDI 1994a, page C-5)." These Habitat Areas are designed to protect the physical integrity of the nests from both management activities and natural disturbances such as windthrow, and to provide a short-term approach to maintaining habitat at red tree vole sites until a stand-scale, landscape strategy is devised.

The guidelines for delineating Habitat Areas provide incrementally greater protection for sites with a higher number of nest trees, and maintain sites with only one or few nests to preserve management options in the future. The minimum size of 10 acres for a Habitat Area was used in the management recommendations for red tree vole nests contained in the U.S. Forest Service (R6) and Bureau of Land Management memorandum (1736-PFP BLM-OR931/1950 FS; BLM Instruction Memorandum No. OR-97-009 dated November 4, 1996) on interim guidance on the red tree vole. While the individual home range size for this species is not well known, Biswell (in prep) found individual adult red tree voles radio-tracked for 35-106 days used 2-7 (median = 5) nest trees; males occupied a mean area of 0.35 hectare (0.86 acre) and females used a mean area of 0.15 hectare (0.37 acre). This information is based on a small number of individuals that were tracked for less than one year, therefore these areas may be minimum estimates of the area used by an individual. These estimates were used as the rationale for the establishment of the one acre per nest. The 4.0 hectare (10-acre) habitat area is not derived from specific information concerning the species habitat requirements around a nest tree. However, overnight movements of 75.8 meters (248.7 feet) have been documented. This distance would equate to an area of 1.8 hectares (4.5 acres) if that distance were used as a radius of a circle around the nest tree.

The10-acre habitat area is intended to provide for protection of the physical integrity of the nest(s) and retain adequate habitat for expansion in the number of active nests at that site. The Habitat Area that is delineated for sites with greater than 10 nests is either 1.0 acre per nest, or a polygon encompassing the site, whichever is greater and must include a one site potential tree buffer around nests on the outer edge of such polygons.

1. Delineation of Habitat Areas

Surveys completed to protocol (USDA, USDI 2000b) result in identification of a red tree vole site, defined as an individual nest tree or a collection of nest trees within a local area (all nest trees in a stand and adjacent stands that are not isolated from other clumps of nest trees by more than 100 meters (330 feet)). The site can be a single point representing one nest tree or a polygon connecting the outer nest trees in a multiple nest tree site.

The Habitat Area should be the greater of the following:

1) The site(s) represented by the point or polygon described above, plus one site potential tree height surrounding the point or polygon;

OR

2) 1.0 acre multiplied by the number of all nest trees (of all types, including those that are confirmed inactive) contained in the site plus one site potential tree around the outer nests of a cluster of nests;

OR

3) 10 acres, when the total number of nest trees is less than 10, maintaining one site potential tree height between the nest tree and the habitat area boundary.

The shape of the Habitat Area should accommodate site specific considerations for project design and other resources while maintaining at least one site potential tree distance between all nest trees and the edge of the Habitat Area. If sites are in close proximity, it is possible for a Habitat Area to encompass more than one red tree vole site. When Habitat Areas are in close proximity, the union of overlapping Habitat Area polygons will result in the creation of one larger Habitat Area. Delineation of Habitat Areas is illustrated in Figure 1 and Figure 2.

In situations where a survey is not completed and a stand is assumed to contain active nests, the Habitat Area that is delineated should include the portion of the stand where the habitat is assumed to be occupied, plus one site potential tree distance around the periphery. This situation can only occur when the manager decides that climbing is not an option in old-growth stands when nests are likely to occur but are not found during surveys (as described in the survey protocol, USDA, USDI 2000b, "Additional Survey Guidelines for Old-Growth Conifer Stands", page 13), and the assumption is made that red tree voles are present.

2. Types of Red Tree Vole Sites Where Habitat Areas Are Delineated

Habitat Areas encompass active and undetermined red tree vole sites, and are not delineated for inactive sites.

Active sites where Habitat Areas are delineated include:

a. Confirmed active red tree vole nests;

b. Confirmed red tree vole nests (activity status is unknown, but assumed active for management purposes rather than completing the survey to determine activity;

c. Confirmed inactive red tree vole nests that are located within 100 meters (330 feet) of a or b above;

d. Locations where clumps of resin ducts were found on the ground within 100 meters (330 feet) of a or b above but surveys did not detect nests in the trees above.

Undetermined sites where Habitat Areas are delineated include:

a. Nests, or portions of old-growth stands, where activity or species use has not been determined, and the site is assumed to be active for management purposes (as described in the survey protocol, USDA, USDI 2000b, "Additional Survey Guidelines for Old-Growth

Conifer Stands", page 13);

b. Confirmed inactive red tree vole nests that are located within 100meters (330 feet)of nests where activity or species use has not been determined;

c. Locations where clumps of resin ducts were found on the ground within 100 meters (330 feet)of nests where activity or species use has not been determined but surveys did not detect nests in the adjacent trees.

Habitat Areas are not delineated for:

a. Inactive sites that contain only confirmed inactive red tree vole nests;

b. Locations where nests are all confirmed to a species other than a red tree vole.

C. Management Within Habitat Areas

Any management that occurs within a Habitat Area should not remove or modify nest trees, the canopy structure of the stand, or remove any of the dominant, codominant, or intermediate (Daniel et al. 1979) crowns. This includes activities that may isolate nest trees or alter the microclimate within the stand. Some activities may be appropriate if they maintain or improve, and do not degrade (short- or long-term), the habitat condition in the Habitat Area. Examples of these activities include planting, road de-commissioning, trail and road maintenance, culvert replacement, manual vegetation maintenance, special forest product removal, and hand piling and jackpot burning to reduce fire hazard. Because red tree voles are potentially affected by heat and smoke that penetrates the crown, burning should not occur beneath nest trees or where heat and smoke would penetrate the crown.

D. Other Management Issues and Considerations

The delineation of Habitat Areas addresses the objective identified in the ROD to develop management standards on sites where red tree voles are located, but additional management issues also need to be considered. Generally, it is expected that implementation of Habitat Areas alone will result in small, isolated sites. Landscape-level management recommendations are needed to fully address the concerns summarized in Appendix J2 (USDA, USDI 1994c). These concerns focus on the species limited dispersal capability and genetic isolation in areas of the NFP matrix allocation without patches of late-successional forest habitat to connect populations among LSRs. Although this "bigger picture" approach is not available at this time, and is expected to be developed using data collected in strategic survey efforts, there are stand- and landscape-level approaches that could be incorporated into current project- and watershed- level planning to address these concerns.

1. Habitat Surrounding and Adjacent to Habitat Areas

The habitat structure and size of the stand surrounding and adjacent to Habitat Areas contributes to persistence of the site and connectivity to other sites. Silvicultural prescriptions and treatments could be designed to further the development of red tree vole habitat conditions, including increased vertical canopy diversity, larger diameter conifers with full dense crowns, and large limbs lower in the crown. Stands that may benefit from treatment include those with high conifer stem densities, single-canopy layers, low live crown ratios, and trees with small lateral limbs, thin and whispy crowns, and high levels of dead lower branches. Development of habitat in shelterwoods, heavily-thinned, and naturally-disturbed mature stands surrounding Habitat Areas could include retention of residual, large, live trees and promotion of conifer growth in the understory. Tree species composition should be the same as that originally at the site.

2. Connectivity to NFP Land Allocations

At the project scale, management that achieves connectivity between Habitat Areas and NFP allocations that retain late-successional habitat could greatly improve the viability of a local site and reduce isolation. Mitigation measures that would benefit the conservation of the red tree vole that were recommended in Appendix J2 (USDA, USDI 1994c) included "reserving the oldest and largest green trees in prescriptions for green-tree retention and protection of additional old-growth and late-successional forest." Ways that these approaches could be incorporated in project design and planning where red tree vole Habitat Areas are located include:

a. Co-location of green tree retention areas or individual trees within or adjacent to Habitat Areas;

b. Connection of Habitat Areas with Riparian Reserves, Late-Successional Reserves, 100-acre Spotted Owl Core Areas, protected habitat associated with Occupied Marbled Murrelet Sites, and Connectivity Blocks;

c. Linking Habitat Areas with sites managed for other Survey and Manage species or with retention of late-successional/old-growth fragments (USDA, USDI 1994a, page C-44).

3. Management of Inactive Sites

An additional consideration for red tree vole habitat is the management of confirmed inactive sites, which consist solely of inactive nests. These sites are not included in Habitat Areas in these management recommendations due to the ROD direction to "manage habitat for the species on sites where they are located (USDA, USDI 1994a, page C-5)". The primary concern for inactive sites is whether they have been "permanently" abandoned or may be in some phase of metapopulation dynamics in which the nests have been "temporarily" unoccupied and will be re-used. The presence of inactive nests indicates that a stand at one time was suitable for red tree voles.

If the habitat containing the inactive site is currently suitable for red tree voles, or is anticipated to achieve the desired condition through natural processes, then no treatment would be needed. However, treatment may be appropriate at inactive sites if there is opportunity to increase the potential for re-colonization by red tree voles in the future by:

(1) improving or accelerating the development of habitat conditions in younger stands;

or

(2) re-establishing habitat when past management activities or natural disturbance has eliminated most of the components of suitable habitat.

For example, in circumstance (1), inactive nests may be found in stands that have some large trees but are densely stocked and lack large lateral limbs or structural diversity. In (2), inactive nests may be found in shelterwood or thinning units that no longer provide sufficient microclimate or canopy structure. In all situations where treatment occurs at these sites, surveys must have been completed according to the protocol and covered a sufficient area (minimum 100 meters out from nest trees) to assure these inactive nests were not part of a site with active nests.

4. Fuels Management and Prescribed Fire Adjacent to Habitat Areas

Fuels management has become an important part of ecosystem management and community protection on NF and BLM lands within these areas. Pile or jackpot burning can be used to reduce excessive accumulations of fuels. Understory burning can be used to reduce fuel loading and vertical fuel continuity. Wildfires in stands that are managed using underburning are generally less severe, and fire suppression is more effective.

Fuels treatment should be considered adjacent to Habitat Areas to provide further protection where natural fire frequencies have been altered or where fire hazard is high. Burning should be conducted during a time of year when the likelihood of fire escaping into the tree canopy is lowest, but may occur during any time of year under appropriate weather conditions. However, because red tree voles are potentially affected by heat and smoke that penetrates the crown, burning prescriptions should direct heat and smoke away from Habitat Areas.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

A. Data Gaps and Information Needs

Survey efforts have identified new red tree vole sites and helped delineate range boundaries. However, our overall understanding of red tree vole habitat relationships and ecology has advanced little since implementation of the NFP. Additional information is needed to improve understanding of the population status to help managers make better informed decisions. Advances in our knowledge in the following areas would be particularly helpful:

- **Population Trend, Abundance and Local Distribution at Sites Identified through Pre-Project Surveys.** There is a lack of information specific to the status of the populations, patterns of abundance, patterns of distribution, and habitat characteristics at sites identified through pre-project survey efforts.

- **Status of Populations at Historical Sites.** None of the sites identified prior to 1994 have been revisited and may no longer be extant. These historic sites have not been visited for twenty years and they need to be re-surveyed and their present status documented.

- **Susceptibility to Isolation of Local Populations.** Johnson and George (1991) suggested Oregon red tree voles occur in a series of geographically and genetically distinct sub-populations. Genetically distinct sub-populations would make the species more susceptible to local isolation and limit their ability to disperse across fragmented landscapes. A study is needed to determine if the species occurs in a series of genetically distinct sub-populations, or is distributed in a single population without unique geographic genotypes.

- **Clarification of the Species= Range in Northern California.** Surveys must be conducted to delineate the southern and eastern extent of this species in northern California. After populations are identified, specimens need to be collected to aid in the determination of their phylogenetic relationship to other populations.

- **Phylogenetic Relationships.** A study built on the work of Johnson and George (1991) and Murray (1995) is needed to determine, with better precision, the range boundaries between *A. longicaudus* and its sibling species *A. pomo* and zones of overlap. This should be combined with study of the susceptibility to isolation of local populations.

- **Effects of Silvicultural Treatments.** The short- and long-term effects of silvicultural treatments on the persistence of vole populations and habitat quality at the local and landscape scales should be evaluated. This assessment should include sites treated with various thinning regimes and

intensities, and include sites throughout the species range.

- **Effects of Prescribed Fire.** The effects of fuels management prescriptions (including prescribed burns) on the persistence of vole populations and habitat quality at the local and landscape scales need to be determined.

- **Habitat Relationships for Active Sites.** Evaluation of stand size, management history, habitat conditions, and the juxtaposition of landscape characteristics around newly-located vole sites is needed to improve our understanding of tree vole habitat relationships. Specifically, the differences in habitat characteristics between sites with high densities of active nests and sites with very low active nest densities should be determined.

- **The Function of Younger Forests.** Studies are needed to determine how younger forests contribute to abundance, persistence, and dispersal. This should be examined at all scales particularly in landscapes dominated by younger seral stages.

- **Predictive Habitat Model.** A predictive model that evaluates a range of habitat and environmental variables and assists in identifying primary habitat conditions needs to developed to determine high priority sites for management.

- **Home Range Size and Dispersal Distances.** Home range size and dispersal patterns warrant further study to assess the species' ability to colonize habitat patches. In addition, home range and dispersal need to be examined to refine the current definition of a site.

- **Role of Riparian Reserves.** More information is needed on the role of riparian reserves regarding dispersal and connectivity between larger population centers and LSRs.

B. Research Questions

- What is the southern and eastern limit of the species' range in northern California ?

- Are there any zones of hybridization between *Arborimus longicaudus* and its sibling species *A. pomo* ?

- What is the range of stand characteristics (e.g., seral stage, canopy closure and complexity, plant association, stand size) that support high densities of active tree vole nest trees ?

- Are there differences in required habitat characteristics from north to south or west to east across the species' known and suspected range ?

- Can a predictive model be developed that identifies the most important habitat variables and allows land managers to best manage for the correct habitat attributes of this species?

- What are the effects of past management practices on this species ?

- How well does the species persist in stands commercially thinned at various levels of canopy closure and trees per acre ?

- How do riparian reserves in the Matrix function as habitat for this species?

Topics to examine include: dispersal, connectivity, level of occupancy (number of sites and numbers of nests within sites)

C. Monitoring Needs and Recommendations

The management recommendations in this document should be monitored in relation to the:

- Practicality and ease of implementation;
- Where and how these recommendations were implemented;
- Persistence of known sites when recommendations are applied;
- Effects of treatment (silviculture and fire) designed to enhance red tree vole habitat at confirmed inactive sites;
- Documentation of location, number and type of nests, habitat features, and stand characteristics of Habitat Areas and adjacent stands.

Other monitoring needs for the red tree vole include:

- Monitor red tree vole activity levels and persistence through time as stands containing tree vole sites undergo vegetative succession and natural disturbances;
- Monitor the persistence of tree voles at sites treated under the interim management recommendations.

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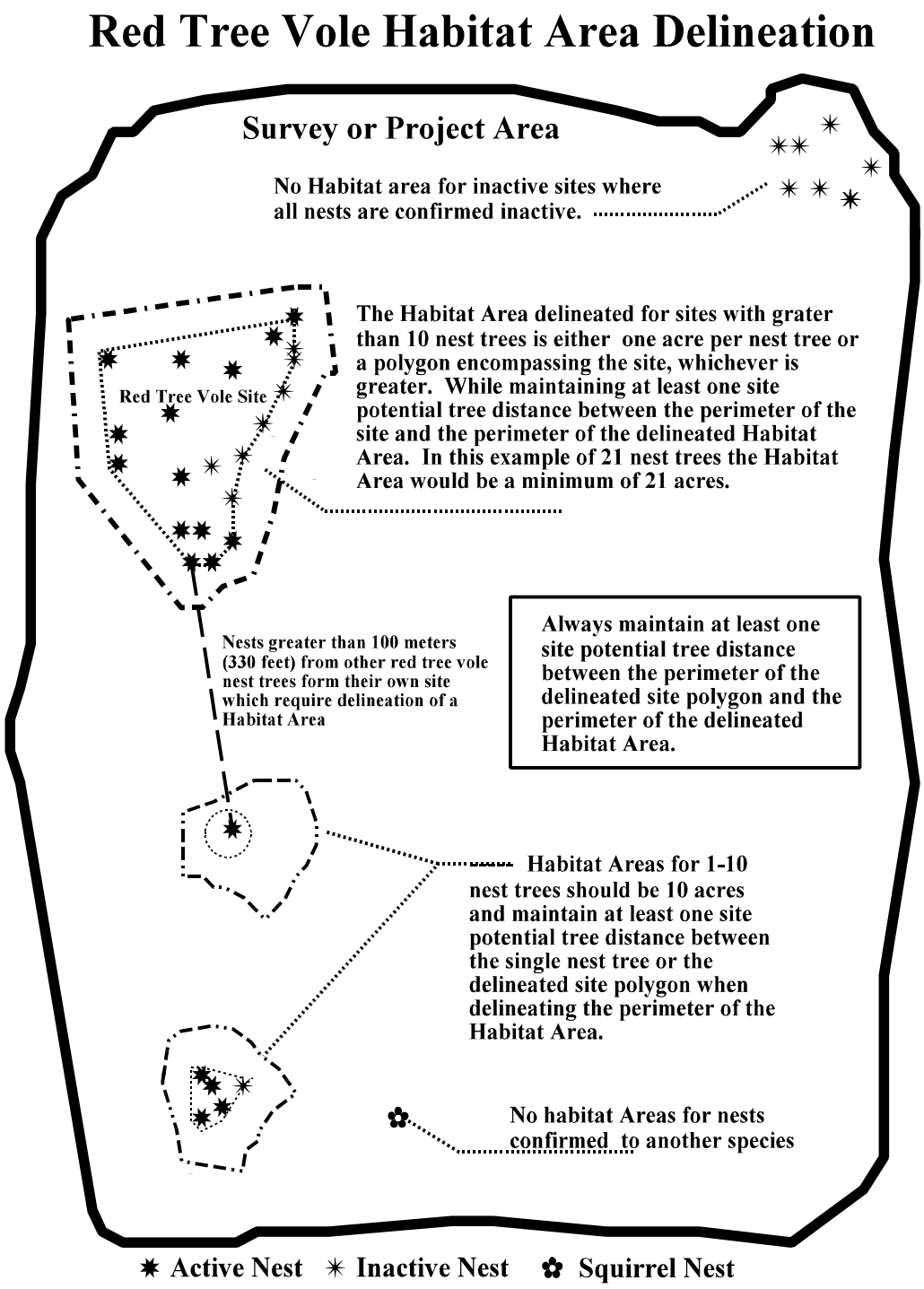

Figure 1. Delineate Red Tree Vole Habitat Areas for active or assumed sites. Stay one site-potential tree away from all nest trees at site or establish a Habitat Area of one acre per nest tree for multiple nest tree site, which ever is larger. See text for details on size of habitat areas and instructions of delineating the habitat.

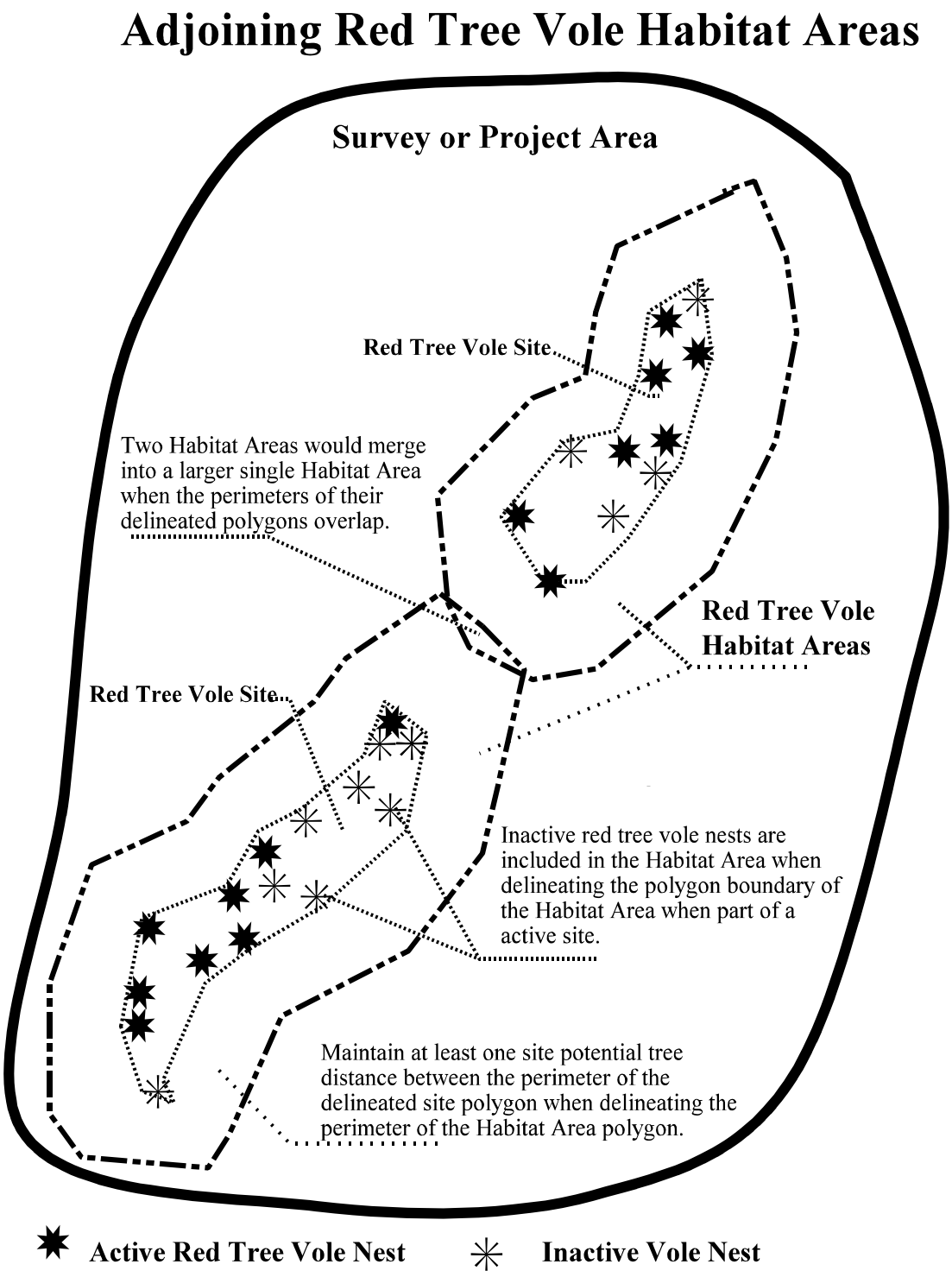

Figure 2. Adjoining red tree vole Habitat Areas would merge into a larger single habitat area when the perimeters of their delineated polygons overlap.

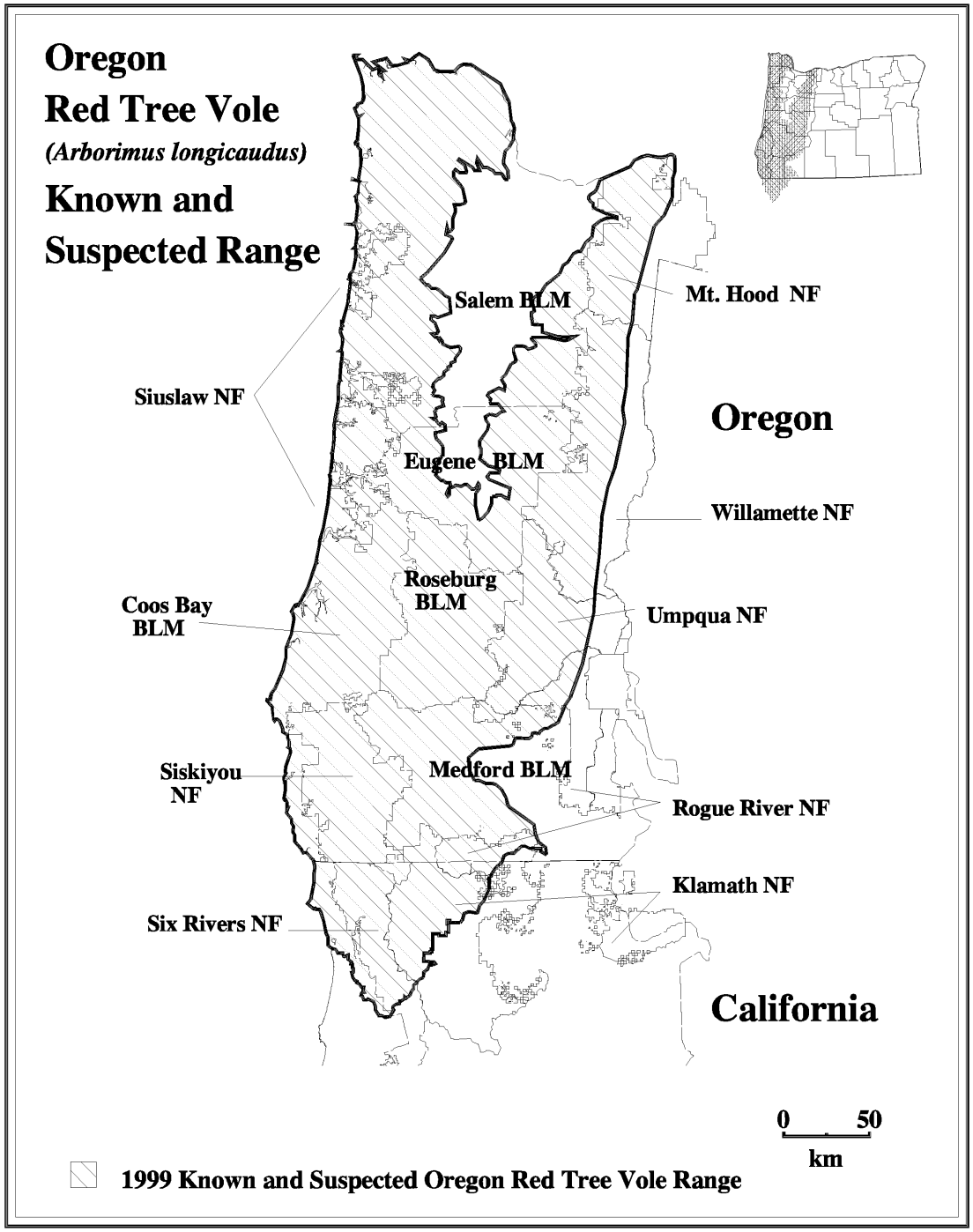

Figure 3: Known and Suspected Range of the Oregon Red Tree Vole (*Arborimus longicaudus*)