(Photo: Chris Maser)

Petition to List the Dusky Tree Vole (*Arborimus longicaudus silvicola)* as Threatened or Endangered under the Endangered Species Act

June 18, 2007

Petitioners:

Center for Biological Diversity
Oregon Chapter of the Sierra Club
Audubon Society of Portland
Cascadia Wildlands Project
OregonWild

June 18, 2007

Mr. Dirk Kempthorne
Secretary of the Interior
Office of the Secretary
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

CC: Ren Loehoffner, Regional Director
US Fish and Wildlife Service
911 NE 11th Ave
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Mr. Kempthorne,

The Center for Biological Diversity, Oregon Chapter of the Sierra Club, Cascadia Wildlands Project, Oregon Wild, Audubon Society of Portland, Noah Greenwald and Amanda Garty hereby formally petition the U.S. Fish and Wildlife Service (FWS) to list the Dusky Tree Vole (*Arborimus longicaudus silvicol*a) as threatened or endangered pursuant to the Endangered Species Act (herein after the "Act" or "ESA"), and to designate critical habitat for it concurrent with listing. Petitioners file this petition under the ESA, 16 U.S.C. sections 1531-1543 (1982). This petition is filed under 5 U.S.C. section 553(e), and 50 C.F.R. part 424.14 (1990), which grants interested parties the right to petition for issuance of a rule from the Assistant Secretary of the Interior. The petitioners request that Critical Habitat be designated as required by 16 U.S.C. 1533(b)(6)(C) and 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553). Petitioners realize this petition sets in motion a specific process placing definite response requirements on the FWS and very specific time constraints upon those responses.

The U.S. Fish and Wildlife Service has several options for listing the Dusky Tree Vole as a threatened or endangered species. They can either list *A. l. silvicol*a as a valid subspecies, the North Coast population of the Red Tree Vole (*Arborimus longicaudus*) as a distinct population segment because it meets the criteria of FWS's policy for recognition of distinct population segments, or the entire range of *A. longicaudus* in Oregon because it is threatened or endangered in a significant portion of range, including the North Coast, as well as other areas.

Addressing the decline of the Dusky Tree Vole by protecting them under the ESA will serve to restore and maintain the health not only of this unique species, but of native terrestrial ecosystems in the watersheds subject to this petition.

Petitioners:

The petitioners are conservation organizations. Failure to grant the requested petition will adversely affect the aesthetic, recreational, commercial, research, and scientific interests of petitioning organizations' members and of the citizens of the United States. Aesthetically, recreationally, and commercially, the public shows increasing demand and concern for wild ecosystems and for biodiversity in general.

Center for Biological Diversity is a conservation organization dedicated to preserving all native wild plants and animals, communities, and naturally functioning ecosystems in the Northern Hemisphere.

Sierra Club is a nonprofit organization whose mission is to explore, enjoy and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives.

Audubon Society of Portland promotes the understanding, enjoyment, and protection of native birds, other wildlife, and their habitats. We focus on our local community and the Pacific Northwest.

The Cascadia Wildlands Project works to protect biodiversity in the Pacific Northwest. We have over 500 members and offices in Eugene, OR and Cordova, AK.

Oregon Wild works to aggressively protect and restore the wildlands, wildlife, and waters of the Greater Oregon Ecosystem as an enduring legacy.

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EXECUTIVE SUMMARY

Found in the forests of North Coast Oregon, the Dusky Tree Vole (*Arborimus longicaudus silvicol*a) is widely acknowledged to be rare. Recent surveys in areas where Dusky Tree Voles were easily collected between 1950 and 1975 failed to find voles or only found voles after extensive effort.

Unique to western Oregon and northern California, tree voles are perhaps the most arboreal mammals in North America and the Dusky Tree Vole is no exception. As such, the Dusky Tree Vole is sensitive to logging and can't survive stand removal by clearcutting or fire. This sensitivity is increased by the fact that tree voles have extremely low mobility, relatively low productivity, and make their nests in tree deformities, such as forked and broken tree tops and witches brooms, which are often targeted during commercial thinning operations.

Remaining populations of the Dusky Tree Vole are isolated and threatened by the continued loss and fragmentation of habitat by logging and development and likely environmental and demographic stochasticity. Current regulations do not adequately protect the Dusky Tree Vole, failing to require surveys or protection for known sites and allowing continued destruction and fragmentation of habitat. This lack of regulation is likely to result in further population decline.

The Dusky Tree Vole is a recognized subspecies of the Red Tree Vole (*Arborimus longicaudus longicaudus)* that, based on its apparent rarity and sensitivity to logging and other disturbance, qualifies as a threatened or endangered species. However, the validity of the Dusky Tree Vole as a subspecies has been questioned by some researchers. Should the U.S. Fish and Wildlife Service (FWS) not accept the Dusky Tree Vole as a valid subspecies, they then should protect it as a distinct population segment (DPS) because it is geographically, reproductively and genetically isolated from Red Tree Vole populations in the remainder of Oregon, and significant to the taxon as a whole because it occurs in a unique ecological setting, is markedly and genetically different from other tree vole populations, and its loss would result in a significant gap in the range of the Red Tree Vole. Alternately, FWS should list the Red Tree Vole because it is threatened or endangered in a significant portion of its range, including the entire range of the Dusky Tree Vole and the many areas in Oregon that are managed as short-rotation, plantations, where tree voles are unlikely to persist.

The Endangered Species Act specifies that a species, subspecies, or distinct population segment of any vertebrate species (collectively referred to as a "species" throughout this document) shall be determined to be endangered or threatened based on any one of five factors (16 U.S.C. 1533 (a)(1). The Dusky Tree Vole meets three of the five factors:

A. The present or threatened destruction, modification, or curtailment of the Dusky Tree Vole's habitat or range.

- Numerous studies show a close association between tree voles and characteristics associated with late-successional forests, such as high canopy closure, broken-tops and complex branch structure. Tree voles have also been found in young forests, but like in late-successional forest, they were found in association with structural complexity, particularly tree deformities. In combination with the tree vole's small home range and limited dispersal ability, these habitat requirements make the tree vole highly sensitive to stand-destroying disturbances, such as clearcutting and fire. Although tree voles occur in second growth, this can only occur if there is adjacent uncut habitat to act as a population source, and if these stands are not intensively managed through pre-commercial and commercial thinning. Given the extensive loss and fragmentation of late-successional forests to logging and fire in the range of the Dusky Tree Vole, and intensive management of most second growth stands, including extensive thinning and short rotations, the Dusky Tree Vole has likely disappeared from much of its former range.

-Remaining populations of the Dusky Tree Vole are highly threatened because most of their habitat occurs on private industrial and state lands that are managed primarily for wood production, and where intensive forestry management such as short rotations, replanting of same species plantations, and intensive thinning are practiced. All of the above forest management techniques remove important structural components of forests (i.e. forked tops, mistletoe brooms, epicormic branches, canopy cover) that tree voles require, and prevent late-successional forest components from developing. Moreover, unlike the Red Tree Vole, the Dusky Tree Vole forages on the needles of Spruce and Hemlock trees. Replanting following logging and fire has resulted in the conversion of many Spruce and Hemlock stands in the range of the Dusky Tree Vole to single-species plantations of Douglas-fir, dramatically altering the species' habitat.

-Dusky Tree Vole habitat is also threatened by the development of homes, hotels and resorts along the Coast, and existing roads that continue to fragment habitat and isolate populations.

B. The inadequacy of existing regulatory mechanisms

-Throughout the North Oregon Coast, most Dusky Tree Vole habitat is owned by private logging companies or is managed by the state, where there are no specific regulations to protect or enhance the Dusky Tree Vole (USDA, USDI 2000) and as noted above, existing forest management is not conducive to tree vole persistence. Currently, private timber companies and the state are not funding or conducting surveys for the Dusky Tree Vole or providing protection for existing sites.

-Very little federal land is located in the range of the Dusky Tree Vole, and therefore protection measures on federal lands provide little benefit to the Dusky Tree Vole or its habitat (USDA, USDI 1994, 2000, 2004). All federal lands in the North Coast are managed as the North Coast Range Adaptive Management Area, of which nearly 70% is managed as Late-successional Reserve (LSR). While LSRs are managed to maintain and restore late-successional forest conditions, thinning and salvage logging is still occurring, which may additionally impact Dusky Tree Vole populations. Outside of reserves, the

Dusky Tree Vole receives a modicum of protection from the Survey and Manage Program.

C. Other natural or manmade factors affecting its continued existence

-The small size and isolation of Dusky Tree Vole populations places the species at high risk of extinction from inbreeding depression and demographic and environmental stochasticity, independent of anthropogenic factors.

-In combination with habitat loss from logging, infrequent (every 400-600 years), high intensity fires pose a potential threat to the Dusky Tree Vole. The proliferation of even-aged, high density plantations from clearcutting may be increasing fire risk because such areas effectively carry fire.

-The life history traits of the Tree Vole, including limited dispersal ability, low reproductive potential and strict requirements of conifers for food, nesting, and travel, place the species at risk of extinction in the face of rapid habitat destruction.

Red Tree Vole

Similar to and including the Dusky Tree Vole, the distribution of the Red Tree Vole (*Arborimus longicaudus longicaudus*) has likely been reduced and is threatened with further decline because of logging, development and natural disturbance. Current regulations are not adequate to protect Red Tree Vole populations from further declines in significant portions of its range.

Reserves created by the Northwest Forest Plan likely provide habitat for Tree Voles in portions of their range. Many of these reserves, however, are currently dominated by young stands that will take many years to develop into prime tree vole habitat. Of substantial concern, the Forest Service is actively engaged in thinning many of these stands with little consideration of Tree Vole populations or habitat.

Logging and thinning of matrix lands is continuing to fragment habitat, likely resulting in loss and isolation of remaining populations thereby increasing extinction risk from loss of genetic diversity and demographic and environmental stochasticity.

The Red Tree Vole currently receives some protection from the Survey and Manage Program of the Northwest Forest Plan in some portions of its range. This protection, however, is uncertain. It was discontinued in 2004, and only recently has a federal court forced the Forest Service and BLM to reconsider their decision and reinstate the program while the agencies remedy the court ruled deficiencies. Therefore, the Survey and Manage program should not be considered a firm regulatory program to protect and recover Red Tree Vole populations.

Other protection for the Red Tree Vole on Federal lands, such as the sensitive species program, do not adequately protect tree vole populations because surveys mitigation, or research are optional and unlikely to be carried out (USDA, USDI 2004).

Introduction

The Dusky Tree Vole is a distinctive rodent that lives nearly the entirety of its life in trees, building its nests on tree branches or inside cavities, and foraging on the needles of conifers. The Tree Vole's dependence on forests and in particular on tree deformities makes them an excellent indicator of late-successional forest characteristics required by a plethora of other species. Added to the fact that they are important food sources for a variety of forest dwelling animals including Northern Spotted Owls, Saw-whet Owls, Long-eared Owls, and weasels, Tree Voles are an excellent indicator of ecological integrity.

The Dusky Tree Vole, a subspecies of the Red Tree Vole, has a very small home range, found only in the coastal zone of northern Oregon. The Dusky Tree Vole has diverged from its closest relative, the Red Tree Vole, and developed unique life history traits. In particular, Dusky Tree Voles preferentially forage on hemlock and spruce needles, rather than Douglas-fir.

Most of the original old-growth, hemlock, spruce and Douglas-fir forests that blanketed the North Coast Range at the turn of the century have been converted into young, single species, Douglas-fir plantations following clearcut logging and large-scale fires. Although incomplete, recent studies indicate the Dusky Tree Vole is extirpated or sharply reduced in much of its historic range. Remaining populations are isolated and likely at critically low levels, placing them at risk of local extinction.

There are no regulations that specifically address the protection of the Dusky Tree Vole on private or state lands, which comprise more than 80% of its habitat. Federal regulations on public lands provide some protection from the Survey and Manage program. However, survival and recovery of the Dusky Tree Vole based on federal management policies is unlikely because only 16% of forested lands in the North Oregon Coast are federally managed. For the Red Tree Vole, the Survey and Manage measures can not be considered adequate to protect the remaining tree vole populations because the federal agencies are in the process of eliminating the program. The federally run Special Status Species programs awards even less protection to the Red Tree Vole on federal lands because implementation is discretionary.

To survive and recover, Dusky Tree Voles require protections provided by the Endangered Species Act, including designation of critical habitat, development of a recovery plan and prohibition of take. Thus, we petition to list the Dusky Tree Vole as a threatened or endangered species under the Endangered Species Act, as a subspecies (*A. l. silvicola*) or distinct population segment. Alternately, we petition FWS to consider listing the Red Tree Vole as a whole because it is threatened or endangered in a significant portion of range.

I. Natural History

A. Description

Tree voles are small rodents that weigh between 25-40 grams, are reddish-brown in color and have long, furry tail (Hayes 1996). Tree voles have thick, relatively long fur. Tree voles in northwest Oregon are unique in that they are reddish brown,on the back and sides, whereas tree voles in the rest of the range of the species are typically cinnamon red or orangeish in color (Maser et al. 1981). Melanistic and cream-colored variants have also been recorded, but are rare (Hayes 1996, Swingle 2006). The color of the tail is black in the north coast compared to brown in the south (Hayes 1996, Maser et al. 1981). The tail usually accounts for more than 50% of the total length of the head and body combined (Hayes 1996). Juveniles are not as brightly colored, are a duller brown on the dorsal side, and have black tails (Hayes 1996, Maser et al. 1981). In adults, the ears range between 10-12 mm long with a minimal amount of fine hair (Johnson 1973). They have sharp, pointed, curved claws assisting them in climbing (Maser et al. 1981). Females are slightly larger than males.

B. Taxonomy

The Red Tree Vole (*Arborimus longicaudus)* or Oregon Red Tree Vole, is in the order Rodentia, and belongs to the family *Cricetidae* and genus *Arborimus* (Musser and Carleton 2005). The Red Tree Vole was formerly of the family *Muridae* but, based on molecular data, is now recognized as a member of its sister family, *Cricetidae* (Steppan et al. 2004, Musser and Carleton 2005). There are two congeners overlapping in range with the Red Tree Vole: the White-Footed Vole, *A. albipes* in western Oregon and northwestern California; and the Sonoma Tree Vole, *A. pomo* that inhabits northwestern California. A close relative, the Heather Vole, *Phenacomys intermedius*, also overlaps in range and once shared the same genus with *longicaudus*, *albipes*, and *pomo*. All four species differ from close relatives in the subfamily Microtinae by cranial and morphological differences (Hinton 1926, Howell 1926).

The Red Tree Vole was first described by True (1890) and was originally placed in the genus *Phenacomys*. The Red Tree Vole was later relegated to the genus *Arborimus (*formerly a subgenus of *Phenacomys*) by Johnson (1973), after he discovered a "major evolutionary divergence."

> "The results outlined show clearly that the genus Phenacomys can be separated from the genus Arborimus by many and diverse characters. Compared to other recognized microtinae genera, the diversity equals or exceeds that currently accepted as valid at the generic level (Johnson 1973)".

However, mammologists are still disputing the generic classification of *Arborimus.* Placement of *longicaudus* in the genus *Arborimus* is supported by Johnson and Maser (1982), Johnson and George (1991), Murray (1995), Hayes (1996), Adam and Hayes (1998), Baker et al. (2003), and Musser and Carleton (2005). Continued placement of *longicaudus* in the genus *Phenacomys* is used by Hall (1981), Repenning and Grady

(1989), McKenna and Bell (1997), Verts and Carraway (1998), and Bellinger et al. (2005). Johnson and Maser (1982) outlined significant structural, reproductive, and geographical distinctions between the *Arborimus* and *Phenacomys* groups, placing *longicaudus* within the *Arborimus* complex. Similarly, Hayes (1996) also recognizes *Arborimus* as the proper genus recognition based on genetic analyses by Murray (1995), and morphological studies reported in Johnson (1973) and Johnson and Maser (1982). Hayes (1996) states, "These data suggest that *Arborimus* is a distinct genus, and should not be considered to be a subgenus of *Phenacomys*". However, there is still contention on the proper genus recognition for *longicaudus*, with taxonomists agreeing that more genetic studies are required (Bellinger et al. 2005, Musser and Carleton 2005). We have continued to classify the Red Tree Vole within the genus *Arborimus*. Regardless of which genus the Red Tree Vole is considered, it remains a valid species, and thus it and any subspecies or distinct population segments are listable entities under the Endangered Species Act.

There are two recognized subspecies of *Arborimus longicaudus*; *Arborimus l. silvicola*, the Dusky Red Tree Vole that occupies the North Coast of Oregon and *Arborimus l. longicaudus*, the Oregon Red Tree Vole (or Red Tree Vole) that occupies the remainder of the species' current range. This separation was based on observed differences in color and morphology (Howell 1921, Howell 1926, Johnson 1968, Hall 1981). The two recognized subspecies of *Arborimus longicaudus* are currently in debate with Johnson and George (1991) questioning the validity of morphological differences and Bellinger et al. (2005) failing to find differences in mtDNA. However, a recent study by Miller et al. (2006) found a genetic discontinuity between north and south coastal Oregon populations. We continue to recognize two subspecies of *Arborimus longicaudus*. Should the U.S. Fish and Wildlife Service not accept that *Arborimus l. silvicola* is a valid subspecies, we request listing of the Dusky Tree Vole as a distinct population segment.

C. Diet

Red Tree Voles, and presumably Dusky Tree Voles as well, have a specialized diet consisting almost entirely of conifer needles of Douglas-fir trees and to a lesser extent other species (Benson and Borell 1931, Hamilton 1962, Maser et al. 1981, 1998, Hayes 1996, Verts and Carraway 1998, Forsman et al. 2004).[1] The exception to the Red Tree Vole's preference for Douglas fir occurs on the North Coast, where some studies have shown tree voles selecting Western Hemlock and Sitka Spruce needles over Douglas-fir (Walker 1930, Forsman and Swingle pers comm.). In 1929, Walker (1930) captured a single tree vole in Tillamook County from a felled Sitka Spruce. He observed that the captive vole would select and eat the needles of Hemlock, even when Spruce and Douglas-fir needles were available. Walker (1930) concluded,

[1] Because most biological studies have not been conducted on Dusky Tree Vole, we report the results of work on Red Tree Vole, assuming until further work is conducted that this information also applies to *Arborimus l. silvicola*

> "As previously noted, hemlock twigs were found on the nest examined in the hemlock tree and only spruce twigs on the nests in spruce trees. It seems probable that the young are fed entirely on the twigs of the tree in which they live and when fully grown still have a decided preference for the same kind of food."

Furthermore, Dr. Murray L. Johnson captured tree voles from the Tillamook area in the 1960s and 1970s and raised them in captivity in Tacoma Washington, where many of them later died because he was not able to feed them Sitka Spruce or Hemlock needles (Swingle, pers comm.). More recently a tree vole nest in a Douglas-fir tree on Cape Meares near Tillamook was found to include only clippings from western hemlock, indicating that the vole was ignoring a ready supply of Douglas-fir needles and obtaining its food by foraging in adjacent hemlock trees (E. Forsman pers comm.) The region where this nest was located was historically dominated by western hemlock and spruce forests, and has only recently been converted to Douglas-fir plantations, after most of the native forests were clear-cut in the 1960's and 1970's (E. Forsman pers comm.). Thus, current evidence suggests that this population has evolved within a different habitat and as such, may have developed a more specialized diet of Hemlock and Spruce needles.

Tree voles forage primarily at night. They chew off the tips of branches and drag the clippings back to their nests, where they store them for consumption during the day. When feeding on Douglas-fir they chew off and discard the edges of each needle, which contain the resin ducts, and then eat the rest of the needle (Maser et al. 1981, 1966). When feeding on hemlock or spruce they often eat the entire needle without removing the resin ducts. If they do remove the resin ducts from hemlock, they eat the edges of the needle and discard the midrib, which is where the resin duct is located in hemlock (E. Forsman pers comm.).

Tree Voles obtain most of their water from the foliage they eat, but they also "lick dew and rain off the needles of coniferous trees in the vicinity of their nests" (Hamilton1962, Maser et al. 1981).

D. Reproduction

Tree vole litters have been detected throughout the year, but the main breeding season is from February to September (Howell 1926, Benson and Borell 1931, Maser et al. 1981, Corn and Bury 1986, 1999, Swingle 2006). The normal gestation period is 28 days, although longer gestation periods have been documented (Clifton 1960, Hamilton 1962). Females often breed within a few days after producing a litter (post-partum mating), and it is common for one litter to be born while the young from the previous litter are still in the nest (Hamilton 1962). Litters range from 1 to 4, but 2 to 3 appears more typical (Howell 1926, Clifton 1960, Hamilton 1962, Maser 1965, Maser et al. 1981, Maser 1998). Females wean their young at a more delayed rate than other microtines, anywhere from 30 to 40 days, with young leaving their birth nest at around the same time (Hamilton 1962, Maser et al. 1981, Maser 1998). The longer period of development for young in the nest is thought to be an adaptation to a low energy diet and to life in the trees, where a considerable learning period is required before the young become

proficient at climbing and harvesting food (Maser et al. 1981, Maser 1998). Maser (1998: pg. 223) suggested that ,

> "...when they leave the nursery nest at a more advanced age than their ground dwelling cousins, the meadow voles (who can reproduce when 25 days old) tree voles have relatively good balance in addition to being more self-sufficient. Extensive wandering outside a nest before they are adequately developed would increase accidental mortality-such as fatal falls- and predation."

Because of their small litter size and long period of development, tree voles have low productivity compared to other microtines (Hamilton 1962, Carey 1999, Maser 1998, Forsman et. al 2004, Swingle 2006). This makes them highly vulnerable to habitat loss because they cannot recover as quickly if their populations are reduced (USDA, USDI 2000). The USDA, USDI (2000: pg. 376) report states that for tree voles, "…given a high turnover, populations in younger and older forests must be reproductively successful every year or the old populations will likely be extirpated".

E. Mortality

Sources of tree vole mortality, besides old age and disease, are predation, logging and stochastic disturbance, such as fire and wind (Maser et al. 1981). Because of the arboreal nature of tree voles and their limited mobility, clear-cut logging probably results in mortality of most tree voles in the stand, except for the fortunate few that survive the fall to the ground and are able to disperse into adjacent forests. Death of tree voles due to trees being felled has been well documented in published papers (Forsman, unpub. data). and in the unpublished notes of M. L. Johnson, who obtained large numbers of tree voles, both alive and dead , from loggers. Predators of tree voles include Northern Spotted Owls, Saw-whet Owls, Long-eared Owls, Pygmy owls, Red-tailed Hawks, weasels, ringtails, and occasionally Great Horned Owls (Forsman and Maser 1970, Forsman 1975, Reynolds 1970, Maser et al. 1981, Maser 1965, 1998, Alexander et al. 1994, Graham and Mires 2005, Swingle 2006). Maser et al. (1981) also listed Stellers Jay, raccoon, and marten as potential predators. Tree voles account for up to 50% of the diet of Northern Spotted Owl's in some locations (Forsman et al. 1984, 2004a,b). A recent study by Swingle (2006) using radio telemetry determined the predation rate for tree voles was high, mostly due to weasels. Logging and fire are major causes of mortality of tree voles because of the scale of impact (Maser et al. 1981, Huff et al. 1992, Corn and Bury 1988, Maser et al. 1981, Hayes 1996, USDA, USDI 2000, Forsman et al. 2004). In addition, the effects of mortality by fire or logging are different than the effects of mortality by predation. Fire and logging not only kill voles, but reduce the carrying capacity of the disturbed area for many years post disturbance, or permanently if the area is subsequently intensively managed to maximize wood production. In contrast, mortality due to predation is a short-term phenomena that is quickly reversible from a population perspective, and does not reduce the long-term carrying capacity of the forest to produce more tree voles.

F. Habitat

Tree voles are arboreal rodents that spend almost their entire life cycle in trees. Although studies do show some terrestrial activity, it is believed to be minimal, and only to travel from tree to tree when no other route is available (Benson and Borell 1931, Corn and Bury 1986, 1991, Swingle 2006). They inhabit coniferous forests of Douglas-fir, Western Hemlock, and Sitka Spruce, but can also be found in mixed-coniferous-deciduous forest (Maser et. al. 1981, Corn and Bury 1986, 1988, Hayes 1996, Maser 1998, Verts and Carraway 1998, Forsman et al. 2004). The subspecies *A. l. silvicola*, is often found in Sitka Spruce and Hemlock forests unlike *A. l. longicaudus*, which is mainly a resident of Douglas-fir forests (Booth 1950, Maser 1965, Forsman, personal communication, Swingle 2006). Tree voles are largely viewed as old-growth dependant species, but they also occur in young forests that are structurally complex (Forsman, personal communication, Swingle 2006). Their habitat is being reduced and degraded by logging and development throughout their range, but especially in the North Coast Ranges of Oregon where there is little federal land and where most lands are managed to maximize timber production, thus causing significant population declines and preventing recovery.

1. General Habitat Requirements

Tree voles are found primarily in Douglas-fir forests. One exception is in the North Coast Ranges of Oregon where the Dusky Tree Vole frequently nests in Sitka Spruce and Western Hemlock (Walker 1930, Booth 1950, Maser 1966, Swingle 2006, Forsman, personal comm.). Booth (1950: pg. 144) stated that the habits of *A. l. silvicola* "…are similar [to P. longicaudus], except that it lives mainly in Sitka Spruce and Hemlock trees rather than in Douglas-firs". Maser (1966; pg. 42), however, stated that "Though it appears to be a valid contention that the coastal population has been predominantly collected in spruce trees, no evidence shows them to be restricted to this habitat". More recent observations show that Dusky Tree Voles preferentially feed on hemlock and spruce near the coast, but occur in Douglas-fir forests further inland. This suggests that the subpopulation near the coast may be restricted primarily to spruce and hemlock. Swingle (personal communication) speculates that in the North Coast "tree voles may be associated with hemlock and spruce, and to a lesser extent, Douglas-fir." At the time of settlement by Europeans, the forests of northwest Oregon were dominated by hemlock and spruce near the coast, and Douglas-fir farther inland. This has changed considerably in the last century, as areas previously dominated by spruce and hemlock have been planted with Douglas-fir (ODF 2001). It is unclear how this has effected tree voles, but the preferential use of spruce and hemlock by tree voles near the coast suggests that voles in that area are adapted to life in spruce and hemlock forests, and do not easily switch to life in other forest types.

A number of studies have suggested that tree voles are most numerous in mature and old-growth forests (Corn and Bury 1986, 1988, 1991, Carey 1989, Carey et. al 1991, Huff et. al 1992, Hayes 1996, Meiselman and Doyle 1996, USDA, USDI 2000). Based on numbers of voles captured in pitfall traps, Corn and Bury (1986, 1991) concluded that tree voles were more abundant in old-growth than in young and mature stands in the

Coast Ranges and Western Cascades of Oregon. Gilbert and Allwine (1991) and Gomez and Anthony (1998) also reported higher numbers of tree voles in old forests in Oregon, based on data from pitfall traps. Meiselman and Doyle (1996) detected nearly one-half (39/79) of tree vole nests in old-growth forests from visual searches (one-third of the stands they surveyed). They also found a positive correlation between greater mean diameter of trees, a typical characteristic of mature and old-growth forests, and occurrence of tree voles. While all of these methods have biases that could influence the results (Swingle 2006), the preponderance of evidence suggests that old forests are the preferred habitat of the vole.

The use of terrestrial surveys is an effective way to locate tree vole nests, but Swingle (2006: pg. 80) cautioned "…that detectability of nests may be slightly lower in old forests than in younger forests. This could result in underestimates of relative abundance of tree voles in old forests compared with younger forest."

Although tree voles are most closely associated with old-growth, biologists have also frequently located tree voles in young forests (Maser 1966, Zentner 1977, Corn and Bury 1986, Gillsberg and Carey 1991, Meiselman and Doyle 1996, Forsman, personal communication, Swingle 2006). In a recent study using radio telemetry to monitor tree voles, Swingle (2006) detected 42 of 61 tree voles in young forests, and 19 in old and mixed aged forests. He did, however, note a bias toward young forests in his samples for several reasons. First, his study areas were not randomly chosen; they were selected because previous surveys had documented considerable numbers of tree vole nests in the young stands. Additionally, he had difficulty detecting nests in older forests. Nevertheless, his results show that tree voles do use younger forests, but it is unclear to what extent. Swingle (2006: pg. 94) warned against using his study to refute the long-held belief that tree voles are closely associated with old-growth stands, but does suggest that young forests may play a more important role in the life cycle of tree voles than has been previously acknowledged. He states,

> "While we agree that old forests are probably a more stable environment for tree voles, and that many young stands have low densities of tree voles, we, and many others, have found that some young forests have relatively high numbers of tree voles, including many breeding females (Jewett 1920; Howell 1926; Clifton 1960; Maser 1966, Thompson and Diller 2002, M. L. Johnson field notes on file at UWBM). While these results are often ignored or discounted because they are based on non-random collection methods, we believe they actually indicate that young forests play an important role in the dispersal and persistence of tree vole populations and should not be dismissed as unimportant or unsuitable habitat for tree voles. In many areas young forests may be the only chance for persistence of the species, especially in landscapes where old forests have been largely eliminated or are restricted to remnant patches interspersed within extensive areas of young forests."

An important point regarding use of young forests by tree voles is that, in all of the studies where tree voles were located in young stands, the stands shared similar

characteristics; they were structurally dense. Meiselman and Doyle (1996; pg. 135) found tree voles utilizing second-growth in visual surveys, but they also noted "significantly" different habitat characteristics between unoccupied habitat and occupied habitat, throughout all seral stages. They state:

> "Phenacomys [Arborimus] longicaudus habitats were characterized by higher percent canopy cover, more stumps, lower elevation and fewer snags than unoccupied habitats."

Similarly, Forsman (personal communication) stated that even in second-growth stands where tree voles were found, they were stands containing high canopy cover and structural density, with lots of tree limbs and deformed tree tops for nests. Swingle (2006) suggested that dispersal through young stands by tree voles is dependant upon crown closure, spacing of trees, and tree structure. Swingle (2006: pg. 89) states:

> "Young stands with open canopies and tall, straight trunks are probably much more inhospitable to dispersing tree voles than are young stands with dense canopies and high concentrations of trees with structures that provide substrates for temporary or permanent nests (broken tops, fork trunks, dense limb whorls, bushy crowns, etc.)"

Thus, tree voles are unlikely to be found in stands that are maintained by industrial forestry methods, and continually managed with thinning. Stands with 50-60 year rotations and two to three previous clear-cuts that eliminate the kinds of forest structure needed by tree voles will result in the elimination of tree voles. Swingle (2006) warned that thinning in young stands will remove the characteristics that allow tree voles to survive there, including interconnected tree crowns and deformed or forked tops, which are preferred nest substrates. Swingle (2006; pg. 95) states,

> "managers should consider non-treatment of forest stands occupied by tree voles as an option for management, especially in regions such as the northern Coast Range of Oregon, where recent surveys suggest that tree voles are extremely uncommon (USDA Forest Service and USDI Bureau of Land Management Survey and Manage Program Interagency Species Management System, ISMS, unpublished data). Trees with broken tops, densely spaced branch clusters, deformed limbs, bushy crowns, and forked trunks should be retained in managed forests as they are important habitat components for arboreal tree voles."

We may still be trying to fully understand to what extent tree voles inhabit old-growth and younger stands, however, one thing is certain; tree voles inhabit trees, and thus depend upon them for survival. Indeed, "The red tree vole lives (nests, feeds, breeds, sleeps) in trees" (Carey et al. 1991; pg. 3). Carey (1996: pg. 75) adds:

> "The red tree vole has the narrowest niche of the arboreal mammals. It spends almost all its time in trees (rarely traveling between trees on the ground), eats conifer needles (primarily Douglas-fir, Pseudotsuga menziesii, needles), and obtains water from fog drip on needles, moss, and lichens)."

Because tree voles depend entirely upon trees throughout their whole life cycle, management of forests is a critical element to their survival. Much of their habitat has been destroyed due to clear-cut logging in the Pacific Northwest (PNW) (FEMAT 1993, Maser et al. 1981, Corn et al. 1988, Carey 1991, Corn and Bury 1991, Maser 1998, Verts and Carraway 1998, USDA, USDI 2000, Forsman et al. 2004). Corn et al. (1988: pg. 349) state, "the extensive logging of low-elevation old-growth forests in Oregon has probably eliminated much of the habitat of Red Tree Voles". According to the USDA, USDI (2000: pg. 387) report for the Survey and Manage program, "surveys have not found red tree voles to be very abundant in many younger lowland forests in the northern third of its range in areas where they were previously collected" (USDA, USDI Species Review Panel 1999a). In the North Coast Range, logging has had a disproportionately greater effect on tree vole habitat than in the central and southern part of the state because most of the land in this region is owned by private timber companies and the Oregon Department of Forestry, and consequently has been extensively logged (FEMAT 1993, USDA, USDI 1994, ONHIC 2004, Forsman, personal communication, Swingle 2006).

2. Home Range Size

Although numerous authors have speculated about the size of tree vole home ranges (e.g., Taylor 1915, Carey 1999) the only data on actual home ranges were collected by Biswell (unpubl. data) and Swingle (2006). Swingle found that 20 of 52 radio-collared tree voles used only 1 nest tree and occasionally foraged in one or more neighboring trees. The other 32 voles traveled between multiple nests that were spaced up to 131 m apart. Biswell radio-collared 12 voles and found that they used 2-7 nest trees each (in Swingle 2006). Swingle (2006) found that all the radio-collared voles stayed within the same home ranges, showing very limited dispersal. Therefore, tree voles, because of their small home ranges and weak dispersal abilities, are vulnerable to any habitat disturbance that would require them to travel far and recolonize nearby areas (USDA, USDI 2000).

3. Indicator Species

The tree vole's unique and specialized life history characteristics make it an important indicator of biotic diversity and forest health because it is highly vulnerable to ecological disturbance (Carey 1991, Carey et al. 1991, Parmer 2000). As Chris Maser (pers comm.) succinctly put it, "A forest without tree voles is not a forest." Parmer (2000: online) stated that;

> "Due to their unique life history and highly specialized ecological niche, tree voles may become a more important indicator of overall forest health and changing climactic conditions in temperate coastal environments."

Therefore, adequate protection is critical not only to sustain populations of tree voles, but also to protect the ecosystem in which it, and other plants and wildlife, depend upon.

G. Historic and current distribution

Tree voles are restricted to high-moisture, coniferous forests of the western Cascades at elevations from sea-level to 1200 m (Howell 1926, Johnson 1973, Maser et al. 1981, Hall 1981, Corn and Bury 1986, 1988, Verts and Carraway 1998, USDA, USDI 2000, Forsman et al. 2004). Hayes (1996: pg. 3) states, "Limited availability of water may restrict their eastern distribution" (cite Hamilton 1962, Maser 1965). Maser (1998) also suggested that the condensed fog along rivers, such as the Columbia, "is also an important source of water for the voles, and allows them to extend their geographical range farther eastward than would otherwise be possible".

1. Dusky Tree Vole

The range of the Dusky Tree Vole extends throughout north coastal Oregon, in Clatsop, Tillamook and Lincoln counties (Maser 1966, Verts and Carraway 1998, USDA, USDI 2000, ONHIC 2004). The State of Oregon and private timber companies are the primary land managers in the range of the Dusky Tree Vole, followed by the Forest Service and BLM (USDA, USDI 2000, ODF 2001,Campbell et al. 2004):

Forest Industry: 670,000 (41.3%)
State Forest: 449,000 (27.7%)
National Forest: 257,000 (15.84%)
Other Private: 176,000 (10.86%)
BLM: 70,000 (4.32%)

The Dusky Tree Vole in the North Coast has declined in both distribution and abundance and is possibly threatened with extinction(Maser et al. 1981, Carey 1991, ONHIC 2004, USDI, USDA 2000, Forsman et al. 2004). The USDA, USDI (2000) concludes:

> "Based on distribution of known sites and our understanding of the historic pattern and distribution of old-growth and older mixed-age forests within the tree vole's range, combined with available information about timber harvest, fire, and other disturbances of the past several decades, it seems reasonable to assume that the historic distribution across all land ownerships combined was more extensive than today."

Logging, fire, intensive forest management, and development have claimed and degraded many areas of forest that were once prime habitat for the Dusky Tree Vole, effectively fragmenting habitat and isolating and reducing populations (ONHIC 20004, USDA, USDI 2000, USDA, USDI Species Review Panel 2001, Forsman, personal communication, Swingle 2006). The heavy impact that logging has inflicted in this portion of the tree vole's range is largely due to the fact that there is little federally managed lands in the North Coast (USDA, USDI 2000, ODF 2001), and that logging has been much more extensive and intensive in this region than in most other areas occupied by tree voles. The majority of forested parcels are state and privately owned (timber companies) and as such, are managed to maximize wood production or income to

shareholders (FEMAT 1993 ODF 2001). As a result, populations and the distribution of the Dusky Tree Vole have undergone severe declines (USDA, USDI 2000).

Preproject surveys conducted by the Survey and Manage program between September 1999 and December 2000 detected no new sites in the Northern Coast Ranges, while a more recent retrospective study of historical tree vole locations also found very few sites in the North Coast Range (USDA, USDI 2004, ONHIC 2004, Biswell, pers. comm., Forsman, ubpub. report). Likewise, a recent study conducted by Forsman et al. (2004) attempted to determine the relative abundance and distribution of tree voles by investigating prey items in Northern Spotted Owl pellets, one of the primary predators of tree voles. The study indicated tree voles are most common in the South and Central Coast Regions and Central Cascades, "with highest densities in the South Coast Regions", and the lowest in the Northern Coast Ranges and Northern Cascades. Forsman et al. (2004: pg. 1) stated that the data was too "sparse" in the North Coastal region to determine the distribution or abundance of the Dusky Tree Vole, but concluded overall:

> "Although or data indicate that tree voles are widespread in Oregon, and fairly common in some regions, it is likely that tree vole populations have declined in areas where logging, fire, and human development have produced landscapes dominated by young forests."

Dusky Tree Vole populations appear to be alarmingly low, indicating the subspecies is threatened with extinction, at least in the northern Coastal Ranges of Oregon (Maser et al. 1981, Corn and Bury 1988, 1992, Verts and Carraway 1998, USDI, USDA 2000, ONHIC 2004, Forsman et al. 2004, Forsman, personal communication).

2. Red Tree Vole

Red Tree Voles are found in the forests of western Oregon, on the west slope of the Cascade Mountains, southward along the coast to northern California (Howell 1926, Johnson 1973, Maser et al. 1981, Hall 1981, Corn and Bury 1988, Verts and Carraway 1998, USDA, USDI 2000), including approximately 16.3 million acres. More than 70 percent of known tree vole sites, and 47 percent of its estimated range, occur on federally managed lands (USDA, USDI 2004). Like the Dusky Tree Vole, the Red Tree Vole has declined or been extirpated in significant portions of its range, including millions of acres where intensive, short-rotation forestry is practiced.

II. Dusky Tree Vole is a listable entity under the ESA

A. Dusky Tree Vole is a subspecies of the Red Tree Vole.

Arborimus l. silvicola, the Dusky Tree Vole, is a recognized subspecies of *Arborimus longicaudus*, the Red Tree Vole, and thus qualifies for listing under the Endangered Species Act.

There are two recognized subspecies of *Arborimus longicaudus*, *A. l. longicaudus*, and *A. l. silvicola*, that are distinguished based on cranial and pelage differences (Howell 1926, Johnson 1968, Hall 1981). In 1921, after studying a single dead specimen, Howell (1921) first described *Arborimus* [*Phenacomys*] *silvicola* as a separate species. Howell (1921: pg. 1) described *Arborimus silvicola* as follows:

> "Externally, closest to Phenacomys [Arborimus] longicaudus, with a general appearance and tail very similar to that form; but darker and with smaller ears. The skull is longer than that of longicaudus of corresponding age, with narrower braincase having temporal ridges, with much heavier moariform teeth of a different pattern, and with pterygoid plates which flare anteriourly on their outer edges."

The differences between the Dusky Tree Vole and the Red Tree Vole were further elaborated by Howell in 1926 (Howell 1926: pg. 35), "The incissors of this species are short and light, and if anything more sharply decurved than in *longicaudus*". He went on to explain (pg. 35):

> "Coloration, combined with sooty face and the character of the tail, readily distinguishes this species externally, while the presence of the parallel temporal ridges is sufficient to characterize the skull. Furthermore, it may be distinguished from longicaudus by the almost entire suppression of the postorbital processes. The first impulse is to consider it as a subspecies of longicaudus. A closer scrutiny of the evidence, however, argues for full specific separation of the two, at least for the present."

In 1981, Hall classified *A. l. silvicola* as a subspecies based on pelage dissimilarities between the two subspecies He stated (Hall 1981: pg. 788):

> "Upper parts uniform cinnamon, near ochraceous tawny with many hairs sparingly tipped with black in P. l. longicaudus; upper parts near cinnamon brown in P. l. silvicola; underparts whitish and tail long and well haired in both subspecies."

Although these studies found distinct morphological disparity between *A. l. longicaudus* and *A. l. silvicola*, later and more recent studies question the validity of subspecific rank of the Dusky Tree Vole. Johnson and George (1991: pg. 12) studied morphometric and karyologic variability between *A. l. longicaudus* and *A. l. silvicola* and determined:

> "There is not any strong morphometric or karyologic differentiation between A. l. longicaudus and A. l. silvicola in Oregon. The two taxa have been distinguished primarily on the basis of color (Hall 1981) but now can be properly delineated geographically."

A study of mitochondrial DNA conducted by Bellinger et al. (2005) resulted in "no clear difference between the two Oregon subspecies of Red Tree Vole", *A. l. longicaudus* and *A. l. silvicola*, leading Bellinger et al. (2005: pg. 207) to conclude:

> "The original description of P. l. silvicola (Howell 1921) was based on differences in pelage color and cranial characteristics, some of which have not been consistently present in subsequent analyses (Johnson and George 1991). The absence of detectable genetic differences between P. l. longicaudus and P. l. silvicola (Johnson 1968, this study) and lack of consistently verifiable morphological differences suggest that subspecific status might not be warranted."

Despite the results from Johnson and George (1991) and Bellinger et al. (2005), there has yet to be a final determination on the classification of the subspecies of *A. longicaudus* into a single species. A genetics study by Miller et al. (2006) did, however, confirm a north/south discontinuity in Red Tree Vole populations that may provide support for distinguishing genetic differences between the subspecies. They analyzed sequence data from the mitochondrial DNA and verified a genetic divergence between northern and southern haplotypes.

B. The Dusky Tree Vole qualifies as a distinct population segment

If the Fish and Wildlife does not consider the Dusky Tree Vole as a subspecies of the Red Tree Vole, they should alternately list the Dusky Tree Vole as a Distinct Population Segment (DPS). The U.S. Fish and Wildlife Service (Fish and Wildlife) will consider a population a DPS if it is "discrete" in "relation to the remainder of the species to which it belongs" *and* it is "significant" to the species to which it belongs. According to Fish and Wildlife's current policy regarding recognition of distinct vertebrate populations (Federal Register V. 61, No. 26, February 7, 1996), a species is considered discrete if it is "markedly separated from other populations" because of "physical, physiological, ecological, or behavioral factors;" *or* it is "delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1) (D)". The policy further clarifies that a population need not have "absolute reproductive isolation" to be recognized as discrete. A population is considered significant based on, but not limited to, the following factors: 1.) "persistence of the discrete population in an unusual or unique ecological setting;" 2.) "loss of the discrete population would result in a significant gap in range;" 3.) the population "represents the only surviving natural occurrence of an otherwise widespread population that was introduced;" or 4.) the population "differs markedly in its genetic characteristics" (Federal Register V. 61, No. 26, February 7, 1996).

1. Discreteness

The Dusky Tree Vole qualifies as discrete because of geographical, ecological, and behavioral factors that separate it from other populations. The Dusky Tree Vole is

geographically isolated from other populations of tree voles by the Willamette Valley, severe fragmentation from logging, urban sprawl, and roads. Tree voles are further restricted, both behaviorally and ecologically, by their inability to travel long distances and through large expanses of treeless areas, preventing them from responding to habitat disturbance and recolonizing nearby, undisturbed locations. Current evidence strongly indicates genetic isolation is occurring in the Dusky Tree Vole from remaining populations of tree voles. For example, Miller et al. (2006: pg. 155) concluded:

> "..the Willamette Valley, which separates the Coast Ranges and Cascades Mountains, is now covered primarily by farmlands, grasslands and oak (Quercus) woodlands (Franklin and Dryness 1988; Taft and Haig 2003) that do not provide habitat for tree voles. Thus, combined evidence of historical processes, contemporary habitat variation, and genetic data suggest that gene flow between regions has been minimal".

The Dusky Tree Vole is also isolated from the central and southern Coast Range populations because of extensive habitat fragmentation, as well as highway I-20 (USDA, USDI 2000). Most forests in the northern Coast Range are owned by private industry and the Oregon Department of Forestry, where intensive forest management and vast clear-cuts have left tree vole habitat in isolated patches (FEMAT 1993, USDA, USDI 2000, ONHIC 2004, Forsman, personal communication). USDA, USDI (2000: pg. 380) report stated:

> "There is a high level of uncertainty relative to the current abundance and distribution of red tree vole populations in the Northern Coast Range of Oregon, due to geographic isolation and a federal management pattern that is limited in extent and surrounded by nonfedral ownerships. There are approximately 25 known sites, many from private lands in the Coast Range north of Corvallis. Natural connectivity between red tree vole populations in this region and the Cascade populations are blocked by the Willamette Valley. The general pattern of federally managed lands and private land ownership has a substantial influence on species distribution. If it is assumed that little late-successional forest will remain on nonfederal lands, then substantial gaps and isolations of local populations will result due to land ownership alone".

U.S. Route 20 is also a direct barrier between Dusky Tree Vole and Red Tree Vole populations. A study by Forman and Alexander (1998) reported that for small mammals, the probability that they will cross a lightly traveled road (6-15 meters wide) may be less than 10% of that for movement across adjacent habitats. The probability is likely even lower for small arboreal mammals, like tree voles, that seldom are found on the ground and in areas without trees (Swingle 2006). Thus, there is a low probability that tree voles, who have extremely low ground travel and migration rates, would travel across a high traffic, two-lane road such as U.S. Route 20.

Behavioral and ecological limitations act as additional isolating mechanisms for tree voles. Tree voles are small animals that spend their entire life in one tree to multiple

neighboring trees and have not evolved traveling long distances (Swingle 2006). The USDA, USDI (2000: pg. 377) report states,

> "A combination of other factors, including physical limitations, behavior, and the expected survival characteristics to transient individuals, suggest red tree voles would move a few hundred feet or less if they leave their natal areas at all. Microtines in general have not evolved as long distance movers and it would be unrealistic to expect a red tree vole to successfully cross miles of non-habitat to re-colonize habitat patches".

In the event their habitat is destroyed such as by logging, fire, or windstorms, they will likely remain isolated from other populations due to their inability to relocate through migration. Added to their low mobility, tree voles are vulnerable to isolation because they require trees through every stage of their life cycle and are not able to migrate through treeless areas like clear-cuts. Carey (1991: pg. 8) explains:

> "The red tree vole is the most highly specialized vole in the world (Maser and others 1981). Its dependence on Douglas-fir for shelter and food and its restricted diet have resulted in life history characteristics that permit only slow growth of the population and that are adaptive only in a relatively stable environment".

Therefore, they will likely survive long periods in areas devoid of conifers, preventing migration following disturbance and leading to increased isolation (Maser et al. 1981, Carey 1991, USDA, USDI 2000).

An mtDNA study by Miller et al. (2006) discovered genetic differences between northern and southern populations of tree voles, which suggest that there has been some isolation in the past, if not now. Miller et al. (2006: pg. 154) state:

> "In the case of *P. longicaudus*, we suggest that the overt pattern revealed by the presence of separate northern and southern haplotype groups reflects processes that may be attributable to older (and perhaps more extensive) glaciation events during the Pleistocene. In contrast, the more recent Wisconsin glacier may have instead worked to produce patterns that bore the signature of habitat fragmentation that was also revealed by our analyses".

The Dusky Tree Vole is clearly a discrete population in relation to the remaining population of Oregon Red Tree Voles because it is isolated from populations in the Cascades by the Willamette Valley, and also isolated from central and southern coastal populations because extensive logging has reduced its habitat to fragmented stands. Coupled with the tree vole's ecological and behavioral limitations- their limited dispersal ability and strict dependence of conifers- the Dusky Tree Vole has become even more isolated. Isolation of the Dusky Tree Vole is evident in both mtDNA dissimilarities. For these reasons, the Dusky Tree Vole should be considered discrete.

2. Significance

The Dusky Tree Vole meets three of the four factors identified by the U.S. Fish and Wildlife's policy for determining that a population is significant (Federal Register V. 61, No. 26, February 7, 1996). The Dusky Tree Vole inhabits a unique ecological setting and loss of the population would result in a significant gap in range of the entire Red Tree Vole population. Furthermore, studies show genetic differences between the two populations.

The Dusky Tree Vole is significant to the rest of the population to which it belongs because it inhabits a unique ecological setting of hemlock, spruce, and Douglas-fir forests, in contrast to the rest of the population, which occurs primarily in Douglas-fir forests (Jewett 1920, Walker 1930, Booth 1950, USDA, USDI 2000, Forsman, personal communication, Swingle 2006). Additionally, hemlock and spruce needles constitute a larger portion of the Dusky Tree Vole's diet, distinct from Red Tree Vole populations south of the Dusky Tree Vole's range that forage entirely on the needles of Douglas-fir (Walker 1930, Swingle 2006).

Loss of the Dusky Tree Vole would result in a significant gap in the range of the Red Tree Vole. The Red Tree Vole's entire range constitutes a relatively small area from the Columbia River in the north, to the Klamath River in northern California to the south (USDA, USDI 2000). The loss of the Dusky Tree Vole, which is found along the coast from the Columbia River Valley, south through Lincoln County, would result in a loss estimated to be 21% of the Red Tree Voles entire range. Loss of the Dusky Tree Vole would also eliminate nearly half of the Red Tree Vole's coastal range, which according to Miller et al. (2006) is distinct from tree voles in the Cascade Range. Thus, loss of the North Coast population would result in a significant portion of the Red Tree Vole population.

The Dusky Tree Vole also has marked genetic differences from the Red Tree Vole. Miller et al. (2006) recently studied mtDNA of Red Tree Voles and discovered a distinct genetic split in northern and southern populations. Miller et al. (2006: pg. 153) state,

> "Our phylogenetic analyses indicated generalized support for the presence of a group of northern haplotypes that were distinct from those detected among southern locations."

Combined with observations of morphological differences in Dusky Tree Voles and differences in diet compared to Red Tree Voles, observed differences in mtDNA clearly show that the Dusky Tree Vole has marked genetic differences from Red Tree Voles.

For all of the reasons stated above, the North Coast population or Dusky Tree Vole is discrete from and significant to the Red Tree Vole and thus qualifies as a DPS.

C. List the Red Tree Vole throughout its range

If the Fish and Wildlife Service elects not to list the Dusky Tree Vole as a subspecies or DPS, they should alternately list the Red Tree Vole because it is threatened or endangered in a significant portion of its range, including the entire North Coast combined with the millions of acres of industrial timberland that are managed in a manner that will not sustain Red Tree Voles.

III. Population Status

Current evidence strongly indicates that Dusky Tree Vole populations are dangerously low and at serious risk of extinction. Even in the remaining portion of the Red Tree Vole's range, populations have been reduced and are patchy. Population threats for both subspecies of tree voles include small population size, isolation, low reproductive capacity, high predation rates, threats from logging and fire, and the inability to disperse long distances.

A. Dusky Tree Vole

Several factors place the Dusky Tree Vole at risk of extinction, including isolation, small population size, and demographic and environmental stochasticity, low reproductive capacity, and ongoing habitat loss (Maser et al. 1981, Carey 1991, USDA, USDI 2000). As noted above, Dusky Tree Vole populations are isolated throughout most of the species' range by extensive habitat fragmentation caused by logging, roads and development (USDA, USDI 2000, Verts and Carraway 1998).

Isolated populations are at greater risk of extinction because of genetic isolation, which can lead to reduced population fitness, and demographic (random shifts in birth gender ratios, poor reproductive years, etc) and environmental (storms, fires, etc) stochasticity, which can lead to population extirpation (Gilpin and Soule' 1986). Once isolated populations are lost, there is little to no chance for population rescue through recolonization (Gilpin and Soule' 1986).

Several studies indicate that the Dusky Tree Vole is at critically low levels throughout a large extent of its range (USDA, USDI 2000, ONHIC 2004). During a study on the impacts of forest thinning on small mammal abundance, no Dusky Tree Voles were located (Dr. John Hayes, pers. comm.). While not systematically surveying for tree voles, Dr. John Hayes (pers. comm..) said there was informal effort by surveyors to visually locate nests, as well as the incidental capture of tree voles in pitfall traps. The study set out 25 pit fall traps per stand, on 38 stands (12 sties) from Tillamook County in the north, to Coos Country in the south and found no Dusky Tree Voles.

Another study by Forsman et al. (2004) found further evidence of the rarity of tree voles in the North Coast. In a study of the contents of pellets of Northern Spotted Owls, they found very low tree vole numbers in the North Coast. By comparison, tree voles comprised one of the most-common prey items of Spotted Owls in other portions of Oregon. Forsman et al. (2004) warn that the sample size for the North Coast was small and pellets were not collected in the lowest elevations (<760 m) where tree voles tend to

be more prevalent; but nevertheless concluded that the data in this portion of their range "suggested comparatively low numbers of voles in those regions" (pg. 1)

Not only are there few documented tree vole sites in the North Coast, but local extirpations have been documented, suggesting that the number of sites may be declining (ONHIC 2004). In a retrospective study, which is still in progress, Forsman et al. (unpubl. data) searched for tree voles in areas where museum specimens were obtained by early naturalists. In the Tillamook State Forest, despite 248 hours of search effort, only 2 tree voles were observed and 4 nests located (Forsman et al. unpubl. data). For comparison, in areas where tree voles are moderately abundant, 21-31 active and moderately old nests were found within 198-389 hours of survey effort throughout the Alsea and Columbia Rivers respectively. In the Clatsop State Forest and surrounding areas, no tree voles or their nests were located where they were once found, although only 12 hours of search effort was expended. In the southernmost portion of the Dusky Tree Vole's range, surveys at Cascade Head found 2 live tree voles and 12 nests, both active and moderately old nests during 203 hours of search effort (Forsman et al. unpubl. data).

In the same study, Forsman et al. (unpubl. data) found only 1 occupied nest and 2 recently occupied Tree Vole nests on Cape Meares. This is an area where historic records suggest that tree voles were once common. A logger named Doug Bake collected at least 98 tree voles in felled trees on Cape Meares and other areas around Tillamook and Lincoln City between 1966 and 1977 (Swingle, personal communication). Collectively, these studies suggest low numbers of tree voles in the region north of Highway 18.

Small populations are at risk of inbreeding depression and vulnerable to environmental and stochastic events that could either decimate very small local populations, or repeatedly reduce populations beyond the population's ability to recover (Gilpin and Soule' 1986). Gilpin and Soule' (1986: pg. 25) explain:

> "Stochastic extinctions are those that result from normal, random changes or environmental perturbations. Usually such perturbations thin a population but do not destroy it; once thinned, however, the population is at an increased risk from the same or from a different kind of random event. The smaller a population, the greater its vulnerability to such perturbations. Also, the shorter the interval between such events, the more likely the population will be pushed over the brink before it can recover to a safe size".

Tree vole populations continue to be at a high risk of extinction because of continued logging of their habitat, which directly destroys habitat, can decimate localized populations, and further isolate remaining populations (Maser et al. 1981, Corn and Bury 1986, Huff et al. 1992, USDA, USDI 2000).

Because tree vole abundance appears so low throughout the North Oregon Coast, the loss of one site could have devastating impacts for the entire population. The USDA, USDI

(2004: pg. 208) report concluded that, “Since there is so little federally managed land and so few animals [in the northern Coast Range], every site is critical for persistence”. Thus, because logging is capable of wiping out entire local populations, it is a high priority threat affecting the long-term survival and recovery of Dusky Tree Vole populations (Carey 1991).

There are many factors that affect the degree of vulnerability of small, isolated populations, including an animal’s reproductive, dispersal, and migration potential (Gilpin and Soule’ 1986). With relatively low fecundity, tree voles are slow to recover from population declines and are at a greater risk of extinction (Hamilton 1962, Maser 1998, USDA, USDI 2000). Swingle (2006) suggested that, because tree voles have a relatively low reproductive rate and low annual survival rate, tree vole populations will probably grow slowly, even under the optimal environmental conditions. Further, the USDA, USDI (2000: pg. 377) report concluded that for tree voles: “Given a high turnover, populations in younger and older forests must be reproductively successful every year or the local populations will likely be extirpated”.

Likewise, they have a limited ability to respond to environmental disturbance and demographic shifts through migration and recolonization. Tree voles have very low dispersal capabilities (USDA, USDI 2000). This limitation acts as an additional threat to tree vole populations because they have a smaller chance of recovery through recolonization and genetic interchange following environmental impacts (logging, fire, windstorms), or decreased populations size (Gilpin and Soule’ 1986). They are thus at a greater risk of extinction in the presence of both environmental and stochastic disturbance.

During the Northwest Forest Plan development process, The Forest Ecosystem Management Assessment Team (FEMAT) rated the Red Tree Vole as having only a 73% likelihood of having populations that are “stable, and well distributed across federally managed lands in the Northwest Forest Plan area,” which was below the objectives of the Northwest Forest Plan (USDA, USDI 2003). In response, the Red Tree Vole was included in the Survey and Manage Program, which was believed to raise their likelihood of being well distributed to over 80% (USDA, USDI 1994). Despite the mitigation measures, however, the fate of populations in the North Oregon Coast was still uncertain (USDA, USDI 1994). USDA, USDI (2004: pgs. 207-208) stated:

> “Red tree voles may be eliminated from significant portions of their historic range, particularly in the northern Oregon Coast Range and foothills of the Willamette Valley, where there is little federally managed lands”.

The small number of Dusky Tree Vole sites, its decreased distribution, biological vulnerabilities, and ongoing habitat destruction led the Oregon Natural Heritage Program (2004) to conclude that the Dusky Tree Vole “must be considered to be a very endangered subspecies”.

B. Red Tree Vole

Studies show that the Red Tree Voles throughout western Oregon have also experienced significant population reductions. As previously mentioned, a study by Forsman et al. (2004) suggests historical declines of Red Tree Voles and concluded that although tree voles may be widespread and "fairly common in some regions", tree vole populations have likely been reduced in forests that have been impacted and converted into young stands. USDA, USDI (2004) have specifically identified these areas as a significant portion of range, strongly indicating the Red Tree Vole warrants further consideration for listing as a threatened or endangered species.

Pre-disturbance surveys required by the Survey Manage Program of the Northwest Forest Plan (NWP) found low densities in many areas throughout its range, even in areas within the southern portion where it is considered more widespread and with the most potential habitat. The Survey and Manage (2000: pg. 376) report states:

> "Since 1995, 323 stands were located that contained confirmed red tree vole nest trees. These surveys detected 1,399 red tree vole nest trees; 19.7 percent (276) were confirmed as being occupied (active nests) at the time of the survey. The remaining 80.3 percent (1,123) were old, inactive nests or current usage could not be determined. Six percent (19) of the new red tree vole sites consisted of only a single active nest and 6.5 percent (21) of new sites contained a single active nest with a number of old nests in the area. Eleven percent (37) of new sites had 2 to 5 active nests while only 11 sites (3.4 percent) had more than 5 active nest trees. The remaining 217 of 323 sites (68 percent) contained only inactive nests or nests of unconfirmed status. Sites comprised of only "unconfirmed activity status nests" contained from 1 to 36 nests.

The Survey and Manage (USDA, USDI 2000: pg. 376) report thus classified tree vole populations as likely being unstable, stating:

> "The low number of active nests reported at sites identified during pre-project surveys (USDA, USDI Species Review Panel 2000), as well as the total number of confirmed nest trees detected at these sites, suggest low red tree vole densities, when compared to density levels needed to maintain normal species interaction. Population stability is best ensured when the number of individuals in a population is large enough to ensure attainment of reproductive potential, normal interactions within the local population, and sufficient genetic variation to allow a species to adapt. Low red tree vole densities, occurring at many sites, may indicate that these localized populations may not be stable because of low abundance".

Moreover, Forsman (pers. comm..) stated that many of the sites that were considered "active" in the USDA, USDI (2000) report, were not actually occupied by tree voles.

The report for the Survey and Manage program (USDA, USDI 2000: pg. 387) concluded:

> "In general, pre-disturbance surveys since the Northwest Forest Plan have not indicated the species is more abundant than previously expected. Surveys have found new localities, but, to date, the data has not clarified habitat relationships for the species. Surveys have not found red tree voles to be very abundant in many younger lowland forests in the northern third of its range (USDA, USDI Species Review Panel 1999a) in areas where they were previously collected. Other survey efforts, such as the Mt. Hood National Forest surveys (1996), have not located many sites despite substantial survey effort in habitat conditions where they were expected to occur".

More recent surveys have found additional Red Tree Vole sites, but have also confirmed that in many areas they are still uncommon (USDA, USDI 2006). Since 2004, Random Double Surveys (RDS) and preproject surveys conducted as part of the Survey and Manage Program, as well as retrospective surveys identified active nests at 252 new sites in the northern Mesic and Xeric Zones (USDA, USDI 2006). However, RDS on the Salem District BLM and the Mt. Hood National Forest in the Northern Mesic Zone located recently occupied nests at only 7% to 8% of surveyed areas respectively (USDA, USDI 2006). Moreover, the same studies revealed Red Tree Vole populations throughout the Mesic portion of southern Oregon are "unevenly distributed and relatively rare" (USDA, USDI 2006; pg. 107). Range-wide, RDS detected recently active nests on only 22% (81 of 368) of the 2 hectare plots surveyed (USDA, USDI 2007).

Thus, similar to the Dusky Tree Vole, it is likely that Red Tree Voles have undergone population declines. Populations are susceptible to further declines because of continued logging of their habitat, isolation, limited dispersal capability, low reproductive potential, and environmental and demographic stochastic events (USDA, USDI 2000).

IV. Present or threatened destruction, modification, or curtailment of the tree vole's habitat or range

A. Logging

1. Dusky Tree Vole

Logging is cited as one of the leading factors in the decline of the Dusky Tree Vole by significantly reducing, degrading, and fragmenting large areas of its habitat (Maser et al. 1981, Corn and Bury 1988, 1991, Verts and Carraway 1998, Huff et al. 1992, Hayes 1996, Carey 1991, USDA, USDI 2000, Forsman et al. 2004, Swingle 2006). The forests of Northwest Oregon have been severely altered by large-scale logging and fire, and intensive forest management over the past century. As a result, populations of Dusky Tree Voles have been significantly reduced and isolated, increasing their risk of extinction (USDA, USDI 2000).

Much of the range of the Dusky Tree Vole is on state and privately owned lands (ODF 2001, Campbell et al. 2004). State lands include the Clatsop and Tillamook State Forests, and scattered forests in the West Oregon District (ODF 2001). Federal lands comprise the northern part of the Siuslaw National Forest (Hebo Ranger District) and scattered parcels of BLM lands (western half of the Salem District) (USDA, USDI 2000). The remaining majority of the forest land within the range of the Dusky Tree Vole is privately owned by timber companies and other private landowners (ODF 2006, Campbell et al. 2004) and is managed primarily on short rotations to produce lumber.

a. Northwest Oregon forest history

Forest history in Northwest Oregon includes widespread logging and fire over the past century that has significantly altered and degraded forest conditions (FEMAT 1993, USDA, USDI 2000, ODF 2001). The Clatsop State Forest of the Astoria District, the northern most portion of the Dusky Tree Vole's range, was privately owned and much of the area was clear-cut between 1910 and 1940. After most of the valuable tress were logged and many of the private companies defaulted on their taxes and failed to replant, many lands were turned over to the state and subsequently replanted (ODF 2001). The Tillamook State Forest in the Tillamook and Forest Grove Districts includes 364,000 acres of forest, of which 255,000 acres were severely burned during the "Tillamook Burn", a series of catastrophic fires in 1933, 1939, 1945, and 1951. Before 1933 and the Tillamook Burn, this area was privately owned. The area burned a total of 355,000 acres of large, old-growth Douglas-firs, cedars, and hemlocks. Following massive salvage logging to remove large trees or snags, which removed many of the structures that could have contributed to stands reaching an old-growth state sooner, most of the area was turned over to the state similar to above. Rehabilitation and reforestation was carried out between 1948 and 1973 by the Oregon Department of Forestry who planted single species Douglas-fir plantations (ODF 2001). The remaining 100,000 acres of the Tillamook Burn that is not in state hands is owned by private timber companies (ODF 2001). The northern portion of the West Oregon District covers minimal and scattered patches of the southern most portion of the Dusky Tree Vole's range. Most of the land in the Western District is privately owned (ODF 2001). As a result of logging and fire throughout the entire range of the Dusky Tree Vole, the remaining habitat consists of young, even-aged, single species stands that are highly fragmented and threaten the continued existence of Dusky Tree Vole populations (USDA, USDI 2000, ODF 2001, Haynes 2005).

b. Method of logging

Clearcutting, which removes all, to nearly all trees in a stand in a single cutting, is the predominant method of logging on forests in Northwest Oregon (USDA, USDI 2000, ODF 2001). Private land owners in the state of Oregon are free to manage their lands much to their own discretion. Johnson (2005) states:

> "Private landowners in [Washington and Oregon] retain considerable freedom to manage their lands to achieve economic and other goals, especially in the

> uplands. They can, to a significant degree, choose the rotation age and harvest flow pattern that fits their needs. Restrictions on clearcut size still allow harvest of considerable areas over a few decades".

Because clearcutting produces the highest yields compared to other logging methods, maximizing short-term profit, clearcutting is the preferred method on industrial forest lands. On private lands in Oregon, clearcutting has been the predominant method used over the past decade. In 2001 alone it was reported that 88,912 acres were clear-cut on private forest industry lands in western Oregon, compared to zero total partial-cut acres (ODF 2001a, Johnson 2005). Likewise on state lands, the Forest Plan for the Tillamook State Forest projects that nearly double the acres harvested annually will be clear-cut rather than partial cut (ODF 2003b).

Clear-cut logging fragments forest stands, degrades forest conditions, and reduces overall forest health (USDA, USDI 2000). Lehmkuhl and Ruggiero (1991: pg. 36) state:

> "Forest fragmentation typically is the creation of a complex spatial and temporal mosaic of forest patches by staggered-set clearcutting, in which small (<20 ha) clearcuts are scattered over the landscape. Aside from the loss of old-growth forest habitats that results from this practice, the remaining forest patches become smaller and more isolated as logging continue".

Moreover, Lehmkuhl and Ruggiero (1991: pg. 35) state that forest fragmentation and "its effects on biotic diversity have been recognized during the last decade as one of the most pressing problems faced by conservation biologists".

Relating to the forests of northwest Oregon, the ODF (2001c: pg.2-16) additionally explains:

> "In the northwest Oregon state forests, the amount of late-successional habitat is important in achieving biodiversity goals because it is rare and has a unique ecological role within the forest. Patch size, distribution, and linkages among areas of late-successional habitat may be as important as the total quantity. When late-successional forests are fragmented, they lose interior habitat (habitat sheltered from other influences). Thus fragmentation can reduce late-successional habitat function well beyond well beyond the actual acres of habitat lost".

The continued destruction and fragmentation of forests in Northwest Oregon due to clearcutting is a serious threat to the continued existence of the Dusky Tree Vole.

In addition to clearcutting, partial cutting is utilized on state, federal and, to a lesser degree, private lands over the past decade (ODF 2001, ODF 2003a, 2003b). Without adequate precaution, partial cutting can degrade, destroy and fragment Dusky Tree Vole

habitat. According to the Oregon Department of Forestry (2003b), partial cutting includes three levels- light, moderate, and heavy. Light partial cutting retains a residual stand density index (SDI) of a minimum of 40%, moderate partial cutting retains 25-35%, and heavy partial cutting retains less than 25%. Thus, even the most minimal and "light" partial cuts remove more than 50% of the trees in a stand, and the latter two partial cut methods nearly three-fourths of the trees (ODF 2003b). Ultimately, this has a comparable effect on tree vole habitat as clear-cut logging by similarly destroying significant amounts of trees in a stand, fragmenting habitat, and removing important structural components of forests (i.e. crown closure, limbs of trees, etc.) that are important to tree voles.

c. Extent of logging and current forest conditions

During the past century, industrial logging and fire have resulted in the near total loss of old-growth forest in northwest Oregon (USDA, USDI 2000, ODF 2001). Calculations by the Oregon Department of Forestry (ODF 2002) determined less than 1 percent of old-growth remains on the 615,000 acres of state lands in Northwest Oregon. Most of the remaining old-growth in Northwest Oregon is on federal territory, located on the eastern slope of the Coast Range on Bureau of Land Management lands, and occurs as small, isolated patches of stands (USDA, USDI 2000). The FEMAT (1993: pg. IV-7) report states:

> "The Northern half [Coast Range] is largely in private and state ownership. Heavy logging and a number of extensive wildfires during the last century have eliminated most late-successional/old-growth forests in the northern half of the province. Older forests in the southern half of the province are highly fragmented, especially on Bureau of Land Management lands, which are typically intermixed with cutover private lands in a checkerboard pattern of alternating square-mile sections".

In addition to clear-cut logging, short rotations, replanting of single-species stands, and intensive thinning have contributed to the declining integrity of Northwest Oregon forests, the lack of late-successional forest characteristics, and the removal of habitat characteristics essential to the Dusky Tree Vole (FEMAT 1993, ODF 2002). Because stands are managed with short-rotations of 40-80 years, forests are not able to attain the late-successional conditions preferred by tree voles, particularly since many of these stands will be partial cut in the interim, resulting in the removal of key habitat features for Dusky Tree Voles. Over the next 10 years, of all partial-cut acres harvested annually, the Tillamook District estimates that 90% will occur on stands less than 50 years old, the Astoria District estimates 65%, and the Forest Grove District estimates 50% (ODF 2003a, ODF 2003b, ODF 2003c). On private lands, rotation ages are further dropping down to 35-40 years in order produce high yields to meet global demands (Johnson 2005). Most of the forests throughout the range of the Dusky Tree Vole are less than 85 years old (ODF 2001, 2002) and are being cut and thinned at an alarming rate.

Before logging and fire, the forest in the North Coast were old-growth hemlock, cedar, and Douglas-fir stands, with dense understory and varying aged trees (ODF 2001, 2002). Following the Tillamook Burn, the area was intensively salvage logged, removing the remaining legacies of old-growth forest, such as large live and dead trees, and areas were replanted solely with Douglas-fir, creating single species plantations. Currently, the state and private forests that constitute Dusky Tree Vole habitat are even-aged, tightly packed stands of Douglas-fir that "fall short of providing varied habitat for wildlife", including the Dusky Tree Vole (ODF 2002: pg. 3).

High density stands, like those covering much of the North Coast, encourage the effective spread of many pathogens (ODF 2001). Currently, Swiss Needle Cast, a fungal disease, is affecting nearly 75,000 acres of northwest state forest within 20 miles of the coast (ODF 2002). This disease, already wiping out thousands of acres of forests, is being managed primarily by clearcutting, increasing the amount of acres that are clear-cut and further impacting tree vole habitat and populations (ODF 2001). The increased spread of Swiss Needle Cast caused forest managers from the ODF (2001c: pg. 2-40) to state that the "Tillamook and Clatsop forests may not be as healthy as once thought". They also state that Swiss Needle Cast is affecting the growth of forests in some areas to the degree that "the future of many stands is uncertain" (ODF 2001c: 2-40). They conclude (ODF 2001c: 2-41):

> "Growth loss over the entire Coast Range is much greater [than 22 percent reduction in volume growth], and in some stands exceeds 50 percent of normal growth. The growth reduction, especially if sustained, will not only reduce yields but also will affect our ability to manage stands into desired structures and compositions".

Thus, Swiss Needle Cast continues to destroy and degrade large tracts of forests and habitat in the range of the Dusky Tree Vole, while management of the disease by means of clear-cutting contributes to increased fragmentation of forests, impacting Dusky Tree Vole populations.

In conclusion, logging and fire in the range of the Dusky Tree Vole has largely reduced and fragmented its habitat. Short rotations, clear-cutting, partial-cutting, and replanting of single species plantations continue to degrade forest conditions and maintain young stands, thus impacting tree vole populations. In the Northwest Oregon state forest plan, the Oregon Department of Forestry (2001c: pg. 2-22) summarizes the history and current condition of the Coast Range forests:

> "Today's forests have been greatly influenced by historic large fires, extensive logging of old growth forests, recent decades of fire suppression, and intensive forest management. Plantation forestry began as early as 1915 in the Coast Range. There are now many acres of uniform stands, mostly of the commercially valuable Douglas-fir. The forests average age has decreased as old growth was replaced with younger trees. Many plantations were planted at high density, which allows the efficient spread of pathogens such as root diseases. Short

> rotations, clearcutting, and intensive site preparation (both mechanical and burning) reduced the number and size of snags and the amount of decayed wood in the forest, and also the amount of hemlock dwarf mistletoe".

d. Impact of logging on the Dusky Tree Vole

Logging is cited as one of the primary threats to Dusky Tree Vole populations, and is responsible for the large-scale decline and fragmentation of its habitat, and annihilation and isolation of populations. Maser et al. (1981: pg. 206) states:

> "Forest fires and logging operations take the greatest toll of tree vole populations in specific areas. Since red tree voles seldom inhabit trees under 25 years of age, clear-cut logging decimates entire populations and is responsible for the disappearance of tree vole populations in many areas and in large measure, for their widely scattered present distribution".

Logging, especially by clearcutting, is responsible for fragmenting forest stands and isolating tree vole populations. Tree voles are vulnerable to the impacts of logging because they depend entirely on trees for their survival, are small mammals with low mobility, and have low reproductive rates, all of which make them unable to respond to logging impacts (Maser et al. 1981, Carey 1989, 1991, Huff et al. 1992, Hayes 1996, USDA, USDI 2000, ONHIC 2004). For these reasons, tree voles were rated as the most vulnerable arboreal mammal to both loss of habitat and habitat fragmentation, both effects of clear-cut logging (Huff et al. 1992). Huff et al. (1992: pg. 1) explain:

> "We rated the red tree vole as the most vulnerable of the arboreal rodents to local extirpations resulting from the loss or fragmentation of old-growth Douglas-fir forests. This species has a unique life history (Maser and others 1981). Red tree voles select large, live trees with large branches for nest sites and shelter, specializing in Doulgas-fir (and to a lesser extent, western hemlock, grand fir, and Sitka spruce); have life history characteristics that prevent rapid population growth; have a restricted geographic distribution limited to western Oregon and northwestern California; and are poor dispersers, which may prevent them from maintaining populations in extensively fragmented landscapes (Carey 1991).

Carey (1989: pg. 157) also explains:

> "The vole is probably a weak disperser incapable of dispersing through clearcuts or other clearings (or blow-downs). If a stand is destroyed, the voles may perish; recolonization of new stands may have to come from adjacent old stands, after the new stand has developed a closed canopy".

Lehmkuhl and Ruggiero (1991) rated animals with limited dispersal ability, like the tree vole, as being at high risk from the impacts of forest fragmentation because of the potential population threats caused by inbreeding. They explain (1991: pg. 41):

> "Risk [from fragmentation] decreased with increasing vagility because high vagility enables dispersing individuals to rescue failing subpopulations in isolated habitat patches, or to recolonize patches with locally extinct subpopulations".

For the Dusky Tree Vole, isolation has very dangerous implications because their populations have been severely reduced, and will likely require genetic interchange with other populations to protect against inbreeding if they are to persist (USDA, USDI 2000).

Fragmentation of forest habitat in the range of the Dusky Tree Vole is exacerbated by land ownership patterns. Varying degrees of logging occur on private, state and public lands. Unfortunately, the majority of Dusky Tree Vole habitat is located on state and private lands where the greatest amount of logging and clearcutting occurs.

In conclusion, logging has significantly reduced Dusky Tree Vole populations by reducing and fragmenting its habitat, and isolating populations. Logging is not only responsible for their historical population declines, but is an ongoing threat that may lead to their extirpation.

2. Red Tree Vole

Like Dusky Tree Voles, Red Tree Voles have been adversely impacted by logging and intensive forest management across western Oregon forests (USDA, USDI 2000. Logging continues to threaten future habitat conditions of Red Tree Vole populations, with high logging projections over the next 50 years (Zhou et al. 1995).

A significant portion of the Red Tree Vole population is located on National Forest lands, but also on BLM and private lands (ONHIC 2004, USDA, USDI 2000) The National Forests include Mt. Hood, Siuslaw, Willamette, Umpqua, Rogue River, and Klamath National Forests. BLM lands are within the Eugene, Roseburg, Coos Bay, and Medford Districts (USDA, USDI 2000).

Logging in western Oregon has resulted in the loss of the majority of old-growth forests, and impacted Red Tree Vole populations by reducing, fragmenting, and degrading tree vole habitat, and annihilating and isolating populations. Forsman et al. (2004: pg. 301) explains,

> "Extensive areas of state, private, and federal land in western Oregon have been converted to intensively managed young forests during the last century, and some evidence suggests that tree voles are less common in such forests than in old forests".

Intensive forestry practices such as short-rotations and intensive thinning impacts Red Tree Vole habitat the same as Dusky Tree Vole habitat, by maintaining young stands and removing important components of the forest structure that tree voles are associated with such as limbs and canopy closure (Carey 1991, Meiselman and Doyle 1996, ODF 2001b, Swingle 2006). Carey et al. (1991) states:

> "The red tree vole may be highly sensitive to forest management at the level of the landscape; in other words, the pattern of cutting, rate of cutting, and the rotation age will determine if the red tree vole persist in the future".

Despite the fact that surveys from the Survey and Manage Program found the highest density of tree vole nests in the southern portion of the range, surveys still found local populations to be small and isolated, likely a result of the regions long history of extensive logging (USDA, USDI 2000).

Like the Dusky Tree Vole, the Red Tree Vole is vulnerable to the impacts of logging because of its dependence on trees for food and shelter, its limited dispersal ability, and low reproductive rates (Maser et al. 1981, Carey 1991, USDA, USDI 2000).

The greatest amount of logging in Oregon over the next 50 years is projected to occur in the southern portion of the Red Tree Vole's range, where the tree vole is considered the most widespread (USDA, USDI 2000, Haynes 2003, in Zhou et al. 2005). The fifth Forest and Rangeland Renewable Resource Planning Act (RPA 1997) reported by Haynes (2003, in Zhou et al. 2005), projected harvest levels of timberland in Oregon between 1997 and 2046. It was reported that Douglas, Lane, and Coos counties will produce the most timber, and 50% of all timber from the state will come from 10 west Oregon counties including Linn and Clatsop, in the range of the Dusky Tree Vole. Furthermore, 48% of lands in Josephine, Douglas, Jackson, and Curry Counties are Common School Forest Lands (CSFL) (ODF 2001b). The management goal for CSFL lands is the "maximization of income to the Common School Fund over the long-term", explicitly prioritizing financial yields over conservation on a significant portion of forests that serve as Red Tree Vole habitat (ODF 2001b). Moreover, similar to CSFLs, Oregon and California (O&C) lands are also managed "for permanent forest production..contributiong to the economic stability of local communities and industries" (H.R. 7618-Public-No-405, Ch. 876). A recent settlement agreement between the BLM and the Counties in western Oregon regarding thousands of miles of O&C lands could lead to a substantial increase in logging throughout western Oregon, including selecting harvest of old-growth forest. Thus, despite the fact that most of the remaining portion of Red Tree Vole habitat is found on federal lands, presumably with the most protection, logging is still widespread, and projected harvest levels may only increase on a large portions of tree vole habitat.

In conclusion, widespread industrial logging throughout western Oregon has reduced vast areas of prime tree vole habitat, while intensive forestry practices have continued to degrade forest conditions. The threats from logging in western Oregon are ongoing with lofty future harvest levels, and the potential for elevated levels on O&C lands.

B. Development

1. Dusky Tree Vole

Development in the North Oregon Coast is a threat to the Dusky Tree Vole, having a similar impact on Dusky Tree Vole habitat as logging by directly removing trees and impacting populations, and clearing expansive forested areas. Kline et al. (2004: pg. 33) states:

> "What often is referred to as the wildland/urban interface is characterized by expansion of residential and other developed land uses onto traditionally forested landscapes in a manner that threatens forestlands as productive socioeconomic and ecological resources".

Moreover, McBride et al. (1996) describes the impacts of development on forested areas:

> "Construction of structures, roads, and other infrastructure elements in forests often necessitates the removal of trees and results in reduction of canopy cover and tree density. Trees may also be removed to facilitate access to sunlight, especially in more densely wooded areas. Conversion of tree cover to lawn also contributes to the decrease in tree canopy cover and density".

By converting forests into nonforested areas, studies suggest that urban development likely increases the frequency of fires (Kline et al. 2004). Kline et al. (2004: pg. 34) states:

> "From an ecological perspective, changes in management and harvesting resulting from population growth and urban expansion can affect forests as ecological resources that provide wildlife habitat and other benefits. These changes also can play a significant role in determining potential fuel loads that will influence wildfire risks in new wildland/urban settings".

Population growth throughout Oregon has been rapid over the past century, and is expected to continue at a rate that exceeds the national average (ODF 2001). Oregon's population has increased by 19 percent since 1980, with the growth of Clatsop and Tillamook counties, in the range of the Dusky Tree Vole, increasing in the same period albeit not as rapidly (ODF 2001). Clatsop County grew 7% between 1990 and 2000, and 2% between 2000 and 2004 (U.S. Census Bureau 2006). Tillamook County's population has also been on the rise growing 12.5% between 1990 and 2000, and 2.7% between 2000 and 2004 (U.S. Census Bureau 2006). This population growth throughout the North Oregon Coast is expected to continue (ODF 2001).

Evidence suggests that increasing human populations correlate with less trees and overall forests, conditions unfavorable to the Dusky Tree Vole (Kline et al. 2004). In a study between 1974 and 1994 in western Oregon, Kline et al. (2004) determined that higher population densities are associated with a decreased incidence of forest stocking and replanting of trees after harvesting. They state (Kline et al. 2004: pg. 41):

> "Our results generally are consistent with previous studies, and suggest that precommerical thinning and planting following harvest are less likely, and forest stocking somewhat lower on forest landscapes comprised of higher population densities in western in Oregon".

In the Coast Ranges, development is partially a result of tourism, which constitutes a significant portion of the economy in this region (ODF 2001). Tourism creates a demand for the development of resorts, hotels, and restaurants, which requires the clearing of forests and trees. In a study of the economy in Tillamook and Clatsop County, the ODF (2001) reported that tourists in the North Coast spend most of their money on hotels, resorts, lodges, amusement and recreation services, and eating and drinking places.

Thus, development, like logging, threatens Dusky Tree Vole habitat by eliminating trees and converting forests into grassland (USDA, USDI 2000).

2. Red Tree Vole

Development of western Oregon has converted vast areas of forest in the range of both subpopulations of tree voles. It is estimated that in western Oregon, 247,000 acres of forest were lost between 1961 and 1986 (MacLean 1990). These figures are only calculating land converted for the building of homes and roads. Furthermore, Measure 37, which requires Oregon counties to reimburse landowners or waive regulations if such regulations reduce the value of their land, loosens restrictions on development of private forest lands in Oregon, which is speculated to contribute to an increasing pace of development. Johnson (2005) explains:

> "Land-use controls have been especially important in Oregon where they slowed development of private forest land to a crawl. In 2004, however, the citizens of Oregon voted for Measure 37 which calls for landowners to be compensated if state or local regulations reduce the value of their property or for the requirement to be waived. Since State and local governments do not have money for compensation, landowners who have owned their forests since the 1970s (before the land-use regulations came into effect) can develop them as they see fit. Also, Measure 37 will have a chilling effect on additional land use regulations. In sum, we can expect to see more homes and housing developments scattered throughout the forests of Oregon."

This development threatens the Red Tree Vole in significant portions of its range.

C. Roads

The range of the Dusky Tree Vole is dissected by many thousands of miles of single-lane and larger roads. For example, the Astoria, Tillamook, and Forest Grove Districts have 670, 1,437, and 450 miles of road, respectively (ODF 2001). This is not including the myriad of state and interstate highways and private roads in Northwest Oregon.

Roads adversely impact tree voles by destroying and fragmenting their habitat, which prevents dispersion and further isolates populations. Small mammals, especially forest species, are particularly vulnerable to the impacts of road fragmentation. Randgaard (2006) explains:

> "Wide, heavily trafficked highways create a formidable obstacle to small mammal movements through the landscape (Richardson et al. 1997). Forest dwelling small mammals avoid open spaces, and they avoid venturing onto highways with a wide clearance between forest margins (Oxley et al. 1974)".

In a study of the barrier effects of roads on wildlife, Forman and Alexander (1998) reported that for small mammals, the probability that they will cross a lightly traveled road (6-15 meters wide) may be less than 10% of that for movement across adjacent habitats.

The probability is likely even lower for small arboreal mammals, like tree voles, that seldom are found on the ground or areas without trees (Swingle 2006). Moreover, these fragmented parcels of land that serve as dispersal obstacles to small mammal such as tree voles lead to genetic bottlenecking (Forman and Alexander 1998). Forman and Alexander (1998: pg. 216) state:

> "The barrier effect tends to create metapopulations, e.g. where roads divide a large continuous population into smaller, partially isolated local populations (subpopulations). Small populations fluctuate more widely over time and have a higher probability of extinction than do large populations. Furthermore, the recolonization process is also blocked by road barriers, often accentuated by road widening or increases in traffic".

For the Dusky Tree Vole, which has a low population that may be below the limits considered healthy to maintain a viable population, dispersal obstacles caused by roads and increased fragmentation may be severely detrimental.
Likewise, the Red Tree Vole is impacted by an extensive network of roads throughout its range that serve as barriers to tree vole dispersal and lead to the loss and isolation of populations.

D. Recreation

Recreation threatens tree vole habitat much the same as development and logging, by removing trees and clearing areas of forest for campgrounds and other recreational facilities. According to the Statewide Comprehensive Outdoor Recreation Plan (SCARP), statewide demand for outdoor recreation exceeds the growth of the population throughout the entire state (ODF 2001). The demand for recreational facilities like campgrounds is highest in the North Coast, the range of the Dusky Tree Vole, and Portland metropolitan areas (ODF 2001). However, throughout western Oregon and in the entire range of the Red Tree Vole, state and federal lands are at times crowded with recreational visitors (ODF 2001). The ODF (2001: pg. 2-64) states:

> "In the Coast Range the Siuslaw National Forest expects demand to exceed supply for semi-primitive settings in the next ten years…The Mt. Hood National Forest, located in the Cascades east of Portland, is already reaching full capacity for recreation on its lands, with overuse occurring in some wilderness areas…On BLM lands south of the Tillamook State Forest, demand already exceeds supply for picnic and campground facilities along the Nestucca River during the summer. Demand also exceeds supply at the state parks along the coast, where as many as 100 campers per night are turned away during the summer".

The population in Portland and throughout the Willamette Valley is expanding dramatically, which places an increasing demand on recreation on forest lands throughout northwest Oregon and in the range of the Dusky Tree Vole. In the Willamette Valley, 70% of the 3.4 million people in Oregon reside there, and the population is expected to grow by 1.3 million people in the next 40 years (references in Kline et al. 2002). The ODF (2001: pg. 2-64) states:

> "State forest lands comprise a significant percentage of public forest lands in parts of northwest Oregon. In several counties, they are the largest ownership open to the public for recreational use. Most of these lands lie within a two-hour drive of a major city such as Portland or Salem, and recreational use is growing rapidly".

Thus, recreation and its overwhelming demand throughout western Oregon is necessitating the development of park facility structures and camp grounds, contributing to the reduction and degradation of tree vole habitat throughout its entire range.

V. Other natural or manmade factors affecting the continued existence of the tree vole

A. Fire

Because of the high moisture climate in the North Oregon Coast Range, forest fires were infrequent, taking place on intervals of 300-400 years (Agee 1993, ODF 2001). The fires that do occur tend to be stand-replacing both because of the severe weather associated with fires in such a moist region and because of the lack of fire-tolerance of the predominant tree species (Agee 1993, ODF 2001).

High intensity fire has a similar impact on tree voles as clear-cut logging, eradicating trees, their primary source of food and shelter, and directly impacting populations. Carey (1991: pg. 8) states:

> "Limiting factors within the landscape that determine the pattern of abundance and persistence of red tree vole colonies are the major catastrophes (fire, windstorm, clearcutting) that destroy stable, old growth and result in rapidly developing (changing, unstable) younger forests".

Clearcuts and young plantations effectively initiate and carry fire and thus likely increase landscape fire risk (USDA, USDI 1994, DellaSala et al. 1995, Morrison and others 2000, in DellaSala et al. 2001). Removal of the canopy increases sun exposure, drying soils and vegetation and increasing temperature (Countryman 1955, in DellaSalla et al. 1995). The dry vegetation is not only a good source of fire ignition but efficiently carries fire, increasing spread and extent. DellaSala et al. (1995: pg. 349) explains:

> "..although clearcuts represented nearly 40% of the largest fire area (6,000 ha) in western Montana in 1994, the fire speed increased and spread to adjacent stands when it hit the fine, unshaded fuels in clearcuts (B. Flamm, The Missoulan, 21 Feb 1995)".

Tree plantations that replace forests after logging also increase fire risk for many reasons. DellaSalla et al. (2001: pg. 13) concludes:

> "Tree plantations are particularly susceptible to fire because live fuels are often continuous, concentrations of flammable slash are often present from past logging, and small trees have little resistance to fire (Morrison and others 2000)".

And USDI, USDA (1994: pg. 3&4-49) concludes:

> "…the plantations [in Late-successional Reserves] are densely stocked with young Douglas-fir trees, and are unlikely to follow natural stand development pathways toward late-successional stand conditions…young plantations often increase the occurrence of human-caused wildfires, as well as increases the rate of spread and extent of fire and other disturbances across the landscape".

Thus, there is a possible elevated risk of fire to tree vole habitat and populations in the North Coast because most Dusky Tree Vole habitat is located on private industry and state lands were both clear-cut logging and plantation forestry is practiced, and its habitat is interspersed with extensively cut over areas and plantation forests.

B. Population size and genetic isolation

The Dusky Tree Vole may additionally be at risk of extinction because of small population size and genetic isolation. Small, isolated populations are at risk of extirpation because of inbreeding depression and demographic and environmental stochasticity (USDA, USDI 2000). These factors can lead to irreversible population crashes (e.g. Hansiki and Moilanen 1996). Lehmkuhl and Ruggiero (1991: pg. 37) state:

> "The persistence of a population is primarily a function of its size, with extinction (local or global) invariably preceded by reduced population size (Gilpin and Soul) 1986, Good man 1987a ,b, Newmark 1987, Pimm and others 1988, Soul and others 1988, Wilcox 1980). The reduction may result from natural or human-caused disturbance; in our case [habitat fragmentation] smaller populations are a

> consequence of a quantitative or qualitative loss of habitat. In circumstances where population size is reduced below a threshold number for recovery, the subsequent extinction of the reduced population may be deterministic and unavoidable. More often, extinction depends on the interplay of stochastic (random) factors with population and environmental factors (Gilpin and Soul) 1986, Shaffer 1981)".

Studies have found very few Dusky Tree Vole sites, as well low abundance at identified sites, indicating that they may be at dangerously low levels (USDA, USDI 2000, 2003, Forsman et al. 2004, ONHIC 2004, Suzuki, personal communication, Hayes, personal communication). These small populations are at risk of extinction from factors associated with environmental and demographic stochastic events, such as variation in birth and death rates, fluctuations in gender ratio, inbreeding depression, or random environmental disturbance (i.e. fire, wind, climatic shifts, etc.) (Gilpin and Soule' 1986, references in Lehmkuhl and Ruggiero 1991). Genetic inbreeding as a function of small population size may already be taking place in throughout the entire tree vole population, exhibited by the presence of both cream and black-colored voles (Swingle 2006). The USDA, USDI (2000: pg. 376) report states:

> "Currently, it is not definitively known how red tree voles interact. There is indication (Johnson and George 1991) that genetic variation within and between populations, possibly due to small population size and inbreeding, may have long-range effects on persistence".

Increasing the risks posed by small population size is that Dusky Tree Vole populations are isolated, which guarantees that declining populations will not be rescued through genetic interchange and population augmentation (references in Lehmkuhl and Ruggiero 1991). Independent of population size, tree voles are highly sensitive to anthropogenic disturbance and stochastic events because of their strict habitat requirements, low reproductive rates, and low mobility, thus increasing their risk of extirpation from small populations (Maser et al. 1981, Carey 1991, USDA, USDI 2000).

C. Life history traits

Tree voles have life history characteristics that increase their vulnerability to population extinction, such as narrow habitat requirements, small home ranges, and low vagility and reproductive potential (Maser et al. 1981, Carey 1991, USDA, USDI 2000). The USDA, USDI (2000: pg. 376) states:

> "The red tree vole has many life history characteristics that, given current information, cumulatively raise concerns for long-term persistence of local populations in portions of its geographic range (Carey 1989 and Maser et al 1981). These life history characteristics include very small home ranges, low dispersal capability, a sensitivity to stand level disturbances relative to many ground dwelling rodents, and low reproductive potential relative to other

> microtines (rodent species in the subfamily Microtinae which includes voles and lemmings)".

Tree voles depend on the canopies of conifers for nesting, foraging, travelling, cover from predators, and obtaining moisture (Maser et al. 1981). Thus, disturbance that destroys conifers such as logging, development, or fire, could cause extirpation of tree vole populations. Furthermore, tree voles have small home ranges and exhibit low dispersal ability, which decreases their ability to migrate in the presence of environmental or demographic events (USDA, USDI 2000). After a study that radiotracked tree voles, Swingle (2006: pg. 88) concluded:

> "Our data on dispersal behavior of 2 juveniles and 7 subadult tree voles suggest that most tree voles disperse only a short distance before settling. This result would seem to support previous speculation that tree voles are relatively weak dispersers and, therefore, may be slow to colonize new areas and susceptible to local extirpation if they become isolated in patchy environments (Cary 1996, 1999, Maser 1998, Huff et al. 2001)".

Tree voles also have very low reproductive potential which means that they have a slow reproductive response to recover from declines. Even under the most favorable conditions, tree vole populations probably grow slowly (Carey 1991, Swingle 2006).

Any disturbance to tree vole habitat, either anthropogenic or natural, can have severe impacts on tree voles because of their limited behavioral and limited ability to respond to disturbance.

VI. Inadequacy of existing regulatory mechanisms to protect the Dusky Tree Vole

The Dusky Tree Vole is threatened because of low and isolated populations, and loss and fragmentation of habitat. In order to protect and recover existing populations, management needs to provide protection for existing population sites, provide for greater connectivity between populations, and protect and recover existing habitat (USDA, USDI 1994). Currently, there are no adequate protection measures on either private, state, or federal lands. Startlingly, of the approximately 1,588,000 acres of available timberland in all three counties where the Dusky Tree Vole is found (Clatsop, Lincoln, and Tillamook), only 11,000 acres are reserved (U.S. Department of Commerce 1990, in Campbell et al. 2004).

A. Private lands

There are no specific measures on private lands to protect the Dusky Tree Vole, nor are there regulations to protect and recover their habitat. Because more than half of the total forest acres in the range of the Dusky Tree Vole are owned by private forest industry, management of these lands is critical to the survival of the Dusky Tree Vole. Existing management fails to protect known populations, and allows nearly unlimited logging of

habitat, resulting in loss and isolation of populations. For these reasons, USDA, USDI (2000: pg. 380) concluded:

> "There is a high level of uncertainty relative to the current abundance and distribution of red tree vole populations in the Northern Coast Range of Oregon, due to geographic isolation and a federal management pattern that is limited in extent and surrounded by nonfederal ownerships….The general pattern of federally managed lands and private land ownership has a substantial influence on species distribution. If it is assumed that little late-successional forest will remain on nonfederal lands, then substantial gaps and isolation of local populations will result due to land ownership alone".

As a result of the "limited amounts of public lands" in the North Oregon Coast Range that has led to severe logging and fragmentation of its habitat, The Oregon Natural Heritage program stated that threats to the Dusky Tree Vole are "substantial and imminent" (ONHIC 2004).

Harvest restrictions on private forest lands are regulated by the Oregon Forest Practices Act (FPA), which is defined in the Oregon Administrative Rules (OAR). None of the OAR regulations adequately protect the Dusky Tree Vole by requiring surveys for tree voles, protection of known sites, conservation of tree vole habitat, or ensuring travel corridors between populations. On the contrary, many of the OAR regulations regarding harvest restrictions allow logging activities that could lead to the further reduction and eventual extinction of the Dusky Tree Vole.

1. Standards for harvesting significantly impact the Dusky Tree Vole

The Oregon Administrative Rules regulate clearcut harvesting by limiting clearcuts to120 acres within a single ownership, with a maximum of 240 acres with State Forester approval (OAR 629-605-0175 (1)(2). These Rules allow clearcut practices to occur across significant portions of the landscape, and clearcutting is the primary harvesting method on private lands in the North Coast (ODF 2001a, Johnson 2005). Because Dusky Tree Vole populations are critically low, loss of even one site from clearcutting can have serious consequences to their long-term survival.

Following clearcut harvesting of stands greater than 25 acres, the FPA also requires 2 snags or 2 green trees that are at least 30 ft and 11 inches DBH to be left behind, 50 percent of which must be conifers. While these retention standards help maintain minimum legacy features for developing forests, for arboreal animals like tree voles that require trees for nesting and feeding and are associated with stands with high canopy cover, two to three trees in a cutover stand will not provide sufficient habitat or protect surviving individuals or local populations (Swingle 2006, Eric Forsman, pers. comm.).

There are no OAR regulations that prohibit or regulate thinning activities on private lands. Intensive thinning operations degrade tree vole habitat, likely preventing

populations from repopulating younger stands by removing key structural features of Tree Vole habitat, such as branch clusters, broken tops and other tree deformities (Swingle 2006). Swingle (2006: pg. 95) explains:

> "..managers should consider non-treatment of forest stands occupied by tree voles as an option for management, especially in regions such as the northern Coast Range of Oregon, where recent surveys suggest that tree voles are extremely uncommon (USDA Forest Service and USDI Bureau of Land Management Survey and Manage Program Interagency Species Management System, ISMS, unpublished data). Trees with broken tops, densely spaced branch clusters, deformed limbs, bushy crowns, and forked trunks should be retained in managed forests as they are important habitat components for arboreal tree voles."

Lack of substantial regulation of thinning on private lands will allow the take of existing Tree Vole populations and stymie recolonization of habitat by Tree Voles.

OAR regulations fail to require protection or enhancement of late-successional forests on private lands. Private lands managers in the North Coast primarily use short rotations ranging from 35-50 years, far younger than the age at which stands develop late-successional characteristics (FEMAT 1993, Johnson 2005). Thus, very little Dusky Tree Vole habitat will develop or be retained on private lands, which occupy more than half of forest lands in the species' range. Lack of management on private forests will likely be the primary factor preventing the recovery of the Dusky Tree Vole and subsequent loss of populations.

2. Streamside, lake, and estuary buffers do not provide substantial protection for Dusky Tree Vole habitat

The Rules require timber companies to protect streamside buffers, which could provide some protection for Dusky Tree Vole habitat. Streamside Buffers required by the rules vary depending on the type (fish bearing, domestic use, or both) and size (small, medium, large) of the stream, ranging from 20 foot buffer zones for small, domestic use streams up to 100 feet for large, fish bearing or domestic use streams. The minimum number of trees that must be retained within each buffer zone ranges from 10 to 40 live conifers of 8 to 11 inches DBH per every 1000 ft. (OAR 629-640-0100 (5), OAR 629-640-0200). Harvest activities near estuaries and lakes must create 100 ft. buffers and 50 to 100 ft. buffers respectively, that protect 50 percent of live trees by species in each of the following classes; 6 to 10 inches, 11 to 20 inches, 21 to 30 inches; and larger than 30 inches (OAR 629-645-0010 (1)(a)(b)(c)(d)), (OAR 629-650-0000 (2)(a)(b), OAR 629-650-0010 (1)(a)(b)(c)(d)). These riparian buffers will not afford a substantial amount of protection to the Dusky Tree Vole because they are not large enough to support tree vole populations, do not require monitoring or protection of tree vole populations, and fail to require protection of forest structures utilized by the tree vole.

Moreover, alternative plans that deviate from the above stream buffer requirements are allowed if, but not limited to: "the potential of the streamside stand to achieve basal area

and stand density similar to mature conifer forest stands in a 'timely manner' is questionable; or In-stream conditions are impaired due to inadequate large woody debris or other factors" (629-640-0400 (2)(a)(b)). Thus, even the nominal protection provided to the Dusky Tree Vole by the streamside buffers is not guaranteed, with the State Forester having the discretion to allow projects to move forward despite not meeting the above restrictions for retention of live conifers along streams.

3. Protection for threatened and endangered species on private lands is not adequate to protect the Dusky Tree Vole

Private landowners must comply with federal regulations that prohibit "take" of a threatened or endangered species, which is defined as disruption or impairment of feeding, breeding or sheltering. In Oregon, the Northern Spotted Owl (NSO) and Bald Eagle are the only endangered and threatened species that the Oregon Administrative Rules provides standards for avoiding "take" for private landowners.

The Rules require private landowners to develop 70 acre buffers around Northern Spotted Owl nests (OAR 629-665-0210 (1)(a) and, for Bald Eagles, 330 ft. buffers around nesting sites and a 300 ft. buffer surrounding roosting sites, including perching, fledging, and replacement trees (OAR 629-665-0230 (2)(c), OAR 629-665-0220 (2)(c)). If important foraging trees are identified by the State Forester, than the tree must also be protected (629-665-0240 (1)). Structural and temporal exceptions can be granted for both Northern Spotted Owl and Bald Eagle sites if granted an incidental take permit by the USFWS under the endangered species act (OAR 629-665-0210 (5), OAR 629-665-0220(3)).

Nest buffers for Bald Eagles and Northern Spotted Owls may inadvertently protect some tree vole individuals. Because these protections are not targeted to maintain tree vole populations, cover a very small and fragmented percentage of the landscape, and will only be in effect as long as the site is occupied by the target species, these buffers are highly unlikely to protect viable tree vole populations.

For the Marbled Murrelet and other federally listed species, there are no OAR regulations that guide private lands owners on how to comply with the Endangered Species Act and avoid take of a species. Presumably, private landowners who have Murrelet sites on their land are prohibited from cutting occupied stands, but given that there are no requirements to survey and that USFWS has no system of reporting, there is no way to know whether such protection actually occurs. Therefore, potential protection of an endangered species on private lands should not be considered an adequate form of protection to recover Dusky Tree Vole habitat and protect population sites.

There is no way to guarantee that regulations guiding protection of threatened and endangered species on private lands will also protect Dusky Tree Vole sites without specifically surveying for tree voles. The protection sites will, at best, lead to incidental protection of tree vole populations; however, even those sites will likely be scattered and isolated occurrences and increase the risk of genetic isolation. Thus, federal regulations for threatened and endangered species will not prevent the Dusky Tree Vole from

continuing to decline, nor ensure adequate protection of habitat, especially for species where there are no guidelines for private landowners or regulatory oversight on private lands.

B. State lands

1. State forest management plans do not adequately protect the Dusky Tree Vole

The Northwest Oregon State Forest Management Plan governs of the Tillamook and Clatsop forest, which occupy 615,000 acres in the range of the Dusky Tree Vole (ODF 2000). The Plan requires managing forests to maintain 25% "older forest structure" (OFS), retention of 5 trees per acre in regeneration harvests and all existing snags in harvest units and the creation of snags when less than 2 per acre are present. The plan also requires the retention of approximately 600 to 900 cubic feet of hard conifer logs, when available, 2 trees >24 inches diameter per acre, and the creation of multi layered canopies. In addition, the plan will create Riparian Management Areas (RMA) where within 25'of most streams harvest is prohibited, within 25-100' of all fish bearing and medium and large non-fish bearing streams management should encourage development of mature forest condition, and within 100-170', depending on size and presence of fish, 0-45 trees will be retained (ODF 2003).

As on private lands, the Plan fails to require survey for tree voles, or protection for known sites and thus allows for the continued take of Dusky Tree Vole populations. The Plan also is unlikely to provide sufficient habitat across the landscape to ensure the survival and recovery of the Dusky Tree Vole. The requirement to retain late-successional characteristics on 25% of the landscape is inadequate because it fails to protect existing populations, and fails to ensure that habitat is distributed across the landscape in a manner that will connect Dusky Tree Vole populations. Instead, older stands will likely occur as scattered and isolated parcels, placing any tree vole populations occupying these stands at risk of extirpation from the effects of population isolation, including both environmental (e.g. stand disturbance from wind or fire) and demographic (e.g. random shifts in gender ratios) stochasticity.

The riparian management areas will provide some potential habitat for the tree vole, but like areas maintained for late-successional characteristics, these areas are likely to be fragmented and not large enough to maintain viable populations. The Riparian Management Areas were also not established to protect known tree vole populations or habitats, but rather to protect aquatic habitats, and thus are unlikely to ensure the survival and recovery of the Dusky Tree Vole.

The retention standards of the plan will not maintain sufficient canopy closure for the tree vole or protect structures utilized for nesting and thus will not maintain tree vole populations or habitat. Instead, they allow for the continued loss and destruction of tree vole habitat.

Finally, the inadequate measures of the Plan are uncertain, as the Oregon Department of Forestry has indicated their intention to revise the FMPs with a goal of increasing timber revenues by increasing cutting (letter from State Forester Marvin Brown of June 6, 2006 attached), and almost certainly resulting in additional impacts to remaining tree vole populations and habitat. Thus, even the weak protections provided by the FMP cannot be relied on to protect the tree vole.

2. **Protection of threatened and endangered species do not provide substantial protection to the Dusky Tree Vole**

Throughout the North Oregon Coast Range, there are 3 federally listed species that have been identified on state forests: the Northern Spotted Owl, Marbled Murrelet, and Bald Eagle. The Astoria District contains 1 Marbled Murrelet Management Area (MMMA) totaling 1,130 acres, as well as 6 pairs and 1 single Spotted Owl site (ODF 2003a). In the Beneke Basin of the Astoria District, >50% of the 9,715 acre basin is reserved for a NSO cluster, and >60% of the 19,218 acre Buster Basin for another NSO cluster (ODF 2003a). Throughout the Tillamook District, a total of 11,200 acres (3,638 habitat acres and 7,588 buffer acres) is managed to protect the Marbled Murrelet, and 3 NSO pair sites totaling 8,556 acres, along with another NSO protected area of 8,733 acres that is jointly managed with the BLM (ODF 2003b). The only federally listed species located on the Forest Grove District is the Northern Spotted Owl, (2 pairs and 1 single resident) with 2,522 acres of associated protected area (ODF 2003c). There is a 689 acre management unit for 1 male NSO on the northern half of the West Oregon District, along with 488 acres that are managed on state lands for 2 NSO sites located on adjacent lands. The West Oregon District also contains an MMMA that totals 1,043 acres (3,163 acres buffers) (ODF 2003d).

Individuals wishing to avoid “take” of a Northern Spotted Owl on state lands in the North Oregon Coast must, as binded in the “Agreement” between the U.S. Fish and Wildlife Service and the Oregon Department of Forestry, “not allow logging in current or future use stands in core use areas for owl sites in the North Coast” (ODF 2001: pg. 2). Core use areas are determined using telemetry studies or, if no telemetry studies are available, designate a 250 acre core area. If no core use area is designated than an established 600 meter radius around the owl sites must be designated (ODF 2001). If, however, home ranges for owl pairs have been established, then the home ranges will be the basis of protection, which includes no logging within current or future stands if the activity will result in less than 500 acres of suitable owl habitat within a 0.7 mile radius of an owl site; or that results in less than 40 percent coverage of suitable owl habitat within the home ranges of owls in the North Coast. Additionally, logging of medium and high quality habitat is prohibited if it is within 0.7 mile radius of an owl site when the habitat composes less than 500 acres with the 0.7 mile radius, or the habitat constitutes less than 40% of the acreage with the home ranges (ODF 2001).

Marbled Murrelet Operational Policies for state lands require surveys of potential habitat with survey stations required for every 30 acres, and each survey site not exceeding 140 acres, next to and within proposed project areas (ODF 3.2, 3.5.1, 3.5.2). Where Murrelets

have been detected, a biological assessment must be developed before activities are to ensue, and a management area is designated that prohibits habitat disturbing activities within 330 ft. of nesting areas between April 1 and September 15 unless awarded permission by the Area Biologist (ODF 3.14- 3.16.8).

Some protection may be provided to the Dusky Tree by the buffer requirements for NSOs and Marbled Murrelets. There is no guarantee, however, that protection of Northern Spotted Owls or Marbled Murrelet sites will protect or lead to the recovery of the Dusky Tree Vole. Because the Dusky Tree Vole is to some degree associated with late-successional stands similar to the Northern Spotted Owl and Marbled Murrelet, the protective buffers may have a greater likelihood of also protecting habitat where Dusky Tree Vole populations are located (Corn and Bury 1991, Huff et. al 1992, Hayes 1996, Meiselman and Doyle 1996, USDA, USDI 2000, Swingle 2006). However, the NSO and Marbled Murrelet measures do not require surveys to identify if tree voles are located within the NSO and Marbled Murrelet site areas, nor do they require recovering large contiguous blocks of habitat that could reduce the impacts of isolation on the Dusky Tree Vole. For Marbled Murrelets, sites are only protected during the summer breeding months of April and May, not affording incidental protection to the Dusky Tree Vole throughout the rest of the year. Moreover, activities such as partial thinning are still allowed in protective areas if approved by a state wildlife biologist (ODF 2003). Dusky Tree Voles also occur in a broader range of stands, which are likely not protected by the buffers, which cover only a small fraction of the landscape.

Bald Eagle sites on state lands are managed the same as on private, the designation of 330 ft. buffers around nesting sites, and a 300 ft. buffer surrounding roosting sites that include perching, fledging, and replacement trees (OAR 629-665-0230 (2)(c), OAR 629-665-0220 (2)(c)), and the protection of forage trees (629-665-0240 (1)). The only known and protected Bald Eagle sites on state lands in the North Coast are located in the Astoria District. These protected areas will provide little protection to the Dusky Tree Vole because no surveys are required within the management units to search and protect Tree Vole sites. Furthermore, the 330 ft. buffer sites will likely only contribute to further isolating tree vole populations by acting like an island surrounded by managed areas.

ODF can request an exemption from the above take protections based on a Habitat Conservation Plan (HCP). There is currently a Draft Western Oregon Habitat Conservation Forest Plan between the ODF and the USFW; however, according to the Oregon Department of Forestry, this HCP is on hold and thus not considered active or official (Wilson, personal communication, Forsman, personal communication).

C. Federal lands

Only approximately 16% of forestland in the North Oregon Coast Range is managed by federal agencies, therefore, federal protection alone is not enough to ensure adequate protection and recovery of the Dusky Tree Vole. Moreover, federal management still allows activities that will reduce and degrade Dusky Tree Vole habitat and possibly lead to the loss of populations.

1. Northwest Forest Plan

The Hebo Ranger District of the Siuslaw National Forest and the western half of the Salem District BLM are the agencies in charge of managing Dusky Tree Vole habitat on federal lands. Federal land managers in this region are required to follow the management guidelines of the Northwest Forest Plan, which provide some form of protection to the Dusky Tree Vole from the Standards and Guidelines for management of Late-successional Reserves, Congressionally Withdrawn Areas, Riparian Reserves, Adaptive Management Areas, Reserved Pair Areas for NSOs, as well as the Survey and Manage program (USDA, USDI 1994).

The Northwest Forest Plan was based largely on the Forest Ecosystem Management Assessment Team's environmental and biological assessments of and recommendations for protecting late-successional and old-growth dependant species. The mission of the FEMAT included "maintenance or restoration of habitat conditions to support viable populations, well distributed across their current range, of species known or reasonably suspected to be associated with old-growth forest conditions" (FEMAT 1993: pg. 6).

The Team determined that for the Red Tree Vole, the Northwest Forest Plan and its Reserve areas would not be adequate to maintain "stable, well distributed [populations] across federally managed lands in the Northwest Forest Plan area" because of "its apparent association with old-growth forests, its very limited dispersal capabilities, and general concern about the extent to which information is lacking on its distribution, habitat requirements, and population status" (USDA, USDI 2004: pg. 207).

Based on this information, the USDA, USDI (1994) report concluded that management on federal lands needed do three important things in order to provide for more widespread and healthy tree vole populations, and prevent further population declines: **Reduce fragmentation; Provide dispersal corridors; and Identify and protect occupied sites** (USDA, USDI 1994). The Survey and Manage program was then added in order to provide these increased protective measures for the Red Tree Vole. The Survey and Manage Program was, however, removed in 2004 and only reinstated by court order in August of 2005 (Molina et al. 2006). The Agencies are currently preparing an Environmental Impact Statement to again eliminate the program throughout most of the tree vole's range, excluding the Northern Mesic portion that includes the northern Coast Range, northern Oregon Cascades, and the southern Willamette Valley (USDA, USDI 2006).

Under the Northwest Forest Plan, federal lands in the north Coast Range are designated as an Adaptive Management Area ("Northern Coast Range Adaptive Management Area"), which contains a total of 281,000 acres. The BLM manages 133,000 acres in the Tillamook and Mary's Peak Resource Areas, and 135,000 acres are administered by the Siuslaw National Forest, Hebo Ranger District (USDA, USDI 1998). Late-successional Reserves constitute 66% of the AMA, 5% is Administratively Withdrawn and

Congressionally Reserved lands, and 29% percent are managed solely under the guidance of the Adaptive Management Area (USDA, USDI 1998).

a. Inadequacy of NFP Reserves

Because the majority (more than 80%) of forest land in the North Coast is under state and private ownership, the protection provided on federal lands will only provide a nominal amount of protection to the Dusky Tree Vole. In assessing the status of the Dusky Tree Vole on federal lands, USDA, USDI (1994) determined that both the Reserve Areas and the Survey and Manage program would still not guarantee that Dusky Tree Vole populations would stabilize and remain well distributed on federal lands when considering the limited amount of federal lands in the North Coast (USDA, USDI 1994, 2000, 2004). The USDA, USDI (2004: pgs. 207-208) report states:

> "Cumulative effects assessment in the Northwest Forest Plan SEIS disclosed that federally managed lands would likely provide for large, well-distributed populations of the species, except possibly in the northern Coast Range of Oregon (USDA, USDI, 1994a, Appendix J2, p. J2-474). **Red tree voles may be eliminated from significant portions of their historic range, particularly in the northern Oregon Coast Range and foothills of the Willamette Valley, where there is little federally managed land.** Few nests have been located on federally managed lands in this region (Forsman, unpublished data). Although 93 percent of federally managed lands in the northern Coast are in Late-Successional Reserves or Late-Successional Reserve-like in their management, land management practices on nonfederal lands reduced the potential connectivity between these blocks of federally managed lands (USDA, USDI, 2000a, p. 391). Riparian Reserves and Matrix Standard and Guidelines provide additional levels of protection for red tree voles on federally managed lands, but do not eliminate the high risk that there is insufficient habitat in this particular area. Since there is so little federally manage lands and so few animals here, every site is critical for persistence" (Highlighting added).

Silvicultural activities are still allowed throughout all of the Reserve in the North Coast Range AMA and may additionally impact Dusky Tree Vole sites on federal lands (USDA, USDI 1998). Late-Successional Reserves make up two-thirds of the North Coast Range AMA, with the Hebo Ranger District LSR containing the most contiguous late-successional forest in the North Coast Range AMA (USDA, USDI 1998). All of the LSRs are designated critical habitat for the Marbled Murrelet and most is designated critical habitat for the Northern Spotted Owl.

Standards and Guidelines for management of LSRs prohibit logging except activities that promote the growth of late-successional forest conditions (ROD 1994, ROD 1995, Siuslaw National Forest 1996). The North Coast Range AMA, however, has less restricted guidelines than other Late-Successional Reserves throughout the NFP planning area, allowing greater room for silvicultural treatments and logging (ROD 1994, USDA,

USDI 1998). The ROD (1994) for the NFP explains that the more relaxed restrictions for the North Coast Range AMA are allowed in order to "meet objectives for Riparian Reserves and Key Watersheds". The ROD (1994; attachment A, D-15) also states:

> "Because much of the Adaptive Management Area is Late-Successional Reserve, primarily designated for a single species about which information is still being developed, the designation and/or standards and guidelines for Late-Successional Reserves may be reconsidered in the Adaptive Management Area plan".

Thinning is taking place in LSRs in the North Coast Range AMA (USDA, USDI 1997), and studies have shown that heavy thinning will prevent tree voles from inhabiting treated stands that no longer exhibit a dense structure of limbs and branches on trees that are vital to tree voles and their nests (Swingle 2006, Forsman, personal communication).

Moreover, postfire salvage logging in LSRs has accelerated since the Bush Administration altered the appeal regulation of the NFP to allow declaration of an "economic emergency" (Strittholdt et al. 2006). Salvage logging not only fragments tree vole habitat, but could also remove trees that harbor nests or could potentially harbor nests in the future. Estimated levels of both salvage logging and thinning are increasing in Late-successional Reserves in the entire NFP area, which have led recent studies to question the degree that LSRs should even be considered truly protected areas (Thomas et al. 2006, Strittholdt et al. 2006).

Outside of designated LSRs in the remainder of the AMA, logging activities are allowed (USDA, USDI 1994, USDA, USDI 1998). The North Coast Range AMA plan states that "programmed timber harvest is not only permitted, but expected in those portions of the AMA that are not LSR" (USDA, USDI 1997; pg. 68).

The 1997 estimate for the projected annual harvest from the North Coast Range AMA is 775-1614 acres, contributing to the total loss and fragmentation of Dusky Tree Vole habitat and potential sites on federal lands outside of the Reserves.

Specific guidelines directing logging operations in the AMA outside of LSRs require managers to retain 6-8 green trees and snags per acre following timber harvest, as well as the retention of 240 linear ft. of logs and coarse woody debris (ROD 1994, ROD 1995). On BLM land, some of the AMA is managed as Connectivity/Diversity Blocks. The specific guidelines for these parcels require land units to total 640 acres that are managed on 150 year rotations where, following harvest operations, 12-18 trees must be retained and at least 25 to 30 percent of each block must be in late-successional forest at any time (ROD 1994, ROD 1995). Neither of these guidelines provides substantial protection to the Dusky Tree Vole because the retention standards are not large enough to sustain local populations over a long period of time and would also fragment stands, leaving populations isolated.

The AMA also contains designated riparian reserves that are intended to, in addition to protecting aquatic species and their habitat, provide habitat that would assist in dispersal

for wildlife species across federal lands in the NFP area, including the tree vole (ROD 1994). Buffer widths along riparian areas depend on the stream type (fish and nonfish bearing) and extend up to the height of one site potential tree or 150 ft slope distance (ROD 1994). Guidelines for management prohibit logging in Riparian Reserves except to enhance riparian conditions, or for salvage logging following a catastrophic event (ROD 1994, Siuslaw National Forest 1996). However, the USDA, USDI (1998) report for the North Coast Range AMA determined that Riparian Reserves may not be adequate dispersal corridors for the tree vole:

> "Between patches of mature forest, connectivity and suitable habitat for the red tree vole should be provided in fifth-field watersheds with over ten percent federal lands which are 40 percent forested with stands at least 30 years old (USDA, USDI 1996b). Riparian Reserves may not provide the necessary connectivity between habitats because red tree voles are associated with mid to upper slopes".

The Cascade Head Scenic Research Area, congressionally designated in 1974, is considered to be an important connective corridor between late-successional forests within the North Coast Range AMA (USDA, USDI 1998). There are a total of 13,265 acres within the Research Area including both Congressionally Reserved and Administratively Withdrawn lands (USDA, USDA 1998). The Hebo Ranger District manages 7,200 acres and private individuals manage 3,300 acres, with 2,133 acres being spotted owl Habitat Areas (Siuslaw National Forest 1990). Research is conducted across 7,210 acres of the CHSR on the Cascade Head Experimental Forest (USDA, USDI 1998). Logging within the remaining reserve is allowed if the activities are in association with research activities or to protect forests conditions (Siuslaw National Forest 1990). There are no specific regulations that require locating and protecting Dusky Tree Vole populations, therefore silvicultural treatments in association with research may still result in the loss of Dusky Tree Vole sites.

b. Inadequacy of the Survey and Manage Program

The Dusky Tree Vole currently receives some protection on federal lands from the Survey and Manage mitigation measures. There is, however, uncertainty as to the future of this program.

During the development of the Final EIS for the NFP, additional analysis was conducted for the Red Tree Vole and other late-successional dependant species. The Oregon Red Tree Vole, scoring below the 80 percent threshold, did not pass the screens when assessing whether habitat on federal lands would be sufficient to provide for well distributed and stable populations (USDA, USDI 1994). The report (USDA, USDI 1994; App-J2-55) explains:

> "Because this species is believed to be almost exclusively canopy dwelling, forest fragmentation and isolation of late-successional patches may prevent gene flow and detrimentally affect metapopulation dynamics. The species

> failed to pass the screens largely because of concern that the provisions of Alternative 9 would not adequately provide for connectivity among late successional patches for dispersal and gene flow".

The researchers assessed different mitigation measures that would raise the likelihood that the Red Tree Vole would be able to sustain healthy populations on federal lands. The researchers concluded:

> "Implementing mitigation measures that would reduce levels of forest fragmentation and provide dispersal corridors for red tree voles, and identify and protect occupied sites will raise the rating under Outcome A above 80 percent" (USDA, USDI 1994; App-J2-55).

The primary mitigation measure that was adopted was the Survey and Manage Program, which required surveys for tree voles before ground disturbing activities in order to identify and protect new sites (USDA, USDI 1994). Unfortunately, because surveys were only required in areas that contained more than 10 percent federal lands and that were considered potential tree vole habitat with, for example, greater than 60 percent crown closure and conifers at least 10 inches dbh, no surveys were conducted in the North Coast until September of 1999 (Biswell, pers. comm.).

Later, in 2001, the Survey and Manage mitigation measures were modified to address the lack of surveys for tree voles by adding strategic surveys and the identification of high priority sites for the Dusky Tree Vole (USDA, USDI 2000). The USDA, USDI (2000; pg. 340) again restates the importance of surveying for tree voles:

> "The addition of strategic surveys under Alternatives 1 and 3 have important implication because they provide valuable information needed to assess the species' present status and develop Management Recommendations. There are critical gaps in the understanding of red tree vole ecology. Strategic surveys would help further refine and revise the Survey Protocol and provide information for development of long-term Management Recommendations".

Despite the critical need to survey for tree voles and protect known locations to ensure persistence and recovery of populations, both of which was determined during the development of the NFP Final EIS and again in the 2001 Final EIS to modify the Survey and Manage program, the Bush Administration eliminated the program in 2004. In the Final EIS (2004; pg. 207-208)) to remove the program, the report admits:

"Red tree voles may be eliminated from significant portions of their historic range, particularly in the northern Oregon Coast Range and foothills of the Willamette Valley, where there is little federally managed land… Riparian Reserves and Matrix Standards and Guidelines provide additional levels of protection for red tree voles on federally managed lands, but do not eliminate the high risk that there is insufficient habitat in this particular area. Since there is so little federally managed land and do few animals here, every site is critical for persistence."

Following the removal of the Survey and Manage program, the Dusky Tree Vole was moved to the Forest Service's and BLM's Special Status Species program, which provides substantially less protection than the Survey and Manage program by making surveying for and protecting their populations discretionary (USDA, USDI 2004).

In January 2006, a U.S. District Court ruled that the elimination of the Survey and Manage Program violated the National Environmental Policy Act and subsequently reinstated the program (NEPA) (Stephanie Parent, pers. comm., USDA, USDI 2004). Currently, however, the federal agencies plan to remedy the NEPA inadequacies by revising their Environmental Impact Statement. A recent draft to amend the 2004 FEIS to remove the program was released in July, 2006 that adds some mitigation measures for tree vole populations in the Mesic Distribution (including the north coast) and Xeric zones. The mitigation measures include preproject surveys and protection of known sites on forest service lands, but only protection of known sites on BLM lands (USDA, USDI 2006). At present, it is unclear the level of protection that the Survey and Manage program will award the Dusky Tree Vole in the future. However, because most forest land in the north coast is managed by state and private owners, the Survey and Manage protection measures will not, alone, be enough to protect and recover declining Dusky Tree Vole populations.

2. Special Status Species Program

The Special Status Species Program (SSS) of the Forest Service and Bureau of Land Management will not have a substantial impact on the protection and recovery of the Dusky Tree Vole. Added to the fact that there is limited federally managed land in the North Oregon Coast, survey and mitigation measures under the BLM, Bureau Sensitive and Forest Service, Sensitive Species are optional (USDA, USDI 2004). The USDA, USDI (2004) report to remove the Survey and Manage summarized the guidelines:

> **BLM- BS**: "May conduct other activities on some known sites. Must manage to avoid moving the species significantly toward listing. Species only included if the BLM has capability to significantly affect the conservation status of the species through management".
>
> **FS- SS:** "May conduct other activities on some known sites. Biological Evaluation necessary to show loss of site or habitat will not result in loss of species viability or create significant trends toward federal listing. Species only included if sufficient information is available on habitat relationships, life history, etc. to evaluate potential effect".

Thus, projects are allowed to continue even if there is direct impact to localized populations, thereby not assuring that sites will be identified or protected, or that local populations will not be extirpated by forest activities (USDA, USDI 2004).

D. Red Tree Vole

In western Oregon across the entire range of the Red Tree Vole, more than 70 percent of the known sites and approximately 47 percent of the known and suspected range is on federally managed lands (USDA, USDI Species Review Panel 200b, in USDA, USDI 2000). Management of federal lands in western Oregon does provide some protection to the Red Tree Vole through the Reserve areas of the Northwest Forest Plan. However, logging and silvicultural treatments in both Matrix and Reserve areas continue to threaten future habitat conditions for the Red Tree Vole. A study of projected harvest levels throughout Oregon over the next 50 years determined the greatest timber yields will be retrieved from forests in southern Oregon (Haynes 2003, in Zhou et al. 2005) and salvage logging and silvicultural treatments are only increasing with the recent elevated fear of forest fires (Thomas et al. 2006, Strittholdt et al. 2006). Accelerating the use of thinning in forests of western Oregon will only slow the rate of late-successional development and remove the structural components of forests that tree voles need to build nests and inhabit stands (USDA, USDI 2000). Many of the Reserve areas throughout western Oregon are already young, simplified stands from a long history of clearcut logging, plantation forestry, and short-rotation cycles that do not provide Tree Vole habitat. The USDA, USDI (2000; pg. 386) report explains:

> "Within the range of the red tree vole, approximately 34 percent of the land base designated as Congressionally Withdrawn, Late-Successional Reserve, and Administratively Withdrawn Areas is currently in conifer stands with dominant and codominant trees averaging greater than or equal to a 20-inch dbh threshold (USDA, USDI Species Review Panel 1999b). While some nests have been found in stands with canopy trees less than 20 inches dbh, the majority of sites with higher population levels (greater than 2 active trees per acre) have been in stands with dominant and codominant trees averaging greater than or equal to 20 inches dbh. This suggests that, currently much of the reserve lands are not likely to provide good habitat for red tree voles".

Moreover, in the 2003 Annual Species Review (ASR), the Agencies removed the Red Tree Vole from the Survey and Manage Program from most of the central portion of its range (Siuslaw National Forest (Mapleton Ranger District); Roseburg District BLM; Umpqua National Forest (North Umpqua Ranger District); Eugene District BLM (Coast Range Resource Area); Medford District BLM (Glendale Resource Area) within Douglas County; Coos Bay District BLM within Coos and Douglas County) (USDA, USDI 2004). A recent court ruling by the the 9th Circuit found the removal of the Red Tree Vole from the program to be illegal and forced the agencies to reinstate surveys for tree voles under the 2001 ROD guidelines. However, the Survey and Manage program is still facing another attack, as the Forest Service is in the midst of a court battle to scrap the program all together throughout most of western Oregon excluding the north coast region. Thus, management under the Survey and Manage program in western Oregon is entirely uncertain and should not be grounds to claim sufficient management of tree vole populations.

The Red Tree Vole is not included in the federal agencies' Special Status Species program in the central and southern portion of its range and will, therefore, award the Red Tree Vole no protection on federal lands (USDA, USDI 2004).

Same as for the Dusky Tree Vole, the Red Tree Vole will not be protected on private lands because the FPA does not require protection Red Tree Vole sites or prevent the use of forest activities that destroys potential habitat. On private lands in western Oregon, clearcut logging, heavy thinning, and short rotations are the primary silvicultural activities, which only contribute to the continued destruction and degradation of Tree Vole habitat, loss of populations, and increased isolation of populations from those on federal lands.

Because there is so little state owned lands in central and southern Oregon, state land management will have little impact on the recovery and protection of the Red Tree Vole and its habitat.

Thus, even for the Red Tree Vole, regulations on federal, private, and state lands will not ensure that the Red Tree Vole will not continue to decline and eventually be lost throughout a significant portion of its entire range.

VII. Designation of Critical Habitat

Petitioners request and strongly recommend the designation of critical habitat for the Dusky Tree Vole coincident with its listing. The primary threat to the Dusky Tree Vole is due to habitat destruction, primarily from logging. What little habitat that remains in the North Coast is located on state and private lands where no regulations to protect against logging or other sources of habitat disturbing activities are present and thus remains unimpeded. Therefore, protecting Dusky Tree Vole habitat is vital and would provide a clear and measurable benefit for the species.

VIII. Conclusion

The Dusky Tree Vole is an incredibly unique animal in its own right, as well as an important prey for many other forest species. Populations are at critically low levels, and with most of its current habitat occurring on state and private lands that are managed primarily for timber production with no protections for tree voles, the remaining populations have a very uncertain future. With so little federal lands in the north coast, protection of public lands alone will not guarantee the protection and recovery of the Dusky Tree Vole. Moreover, throughout western Oregon, the strongest protection on federal lands is awarded by the Survey and Manage program which will likely be eliminated in the future, excluding possibly the north coast, leaving no protection for most of the Red Tree Vole's remaining populations. The protection provided under the Endangered Specie Act along with accompanying critical habitat designation that would require protection of populations and habitat is necessary to avoid the extinction of the Dusky Tree Vole.

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