DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R1–ES–2008–0086; 92210–5008–3922–10–B2]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List a Distinct Population Segment of the Red Tree Vole as Endangered or Threatened

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on a petition to list a distinct population segment of the red tree vole (*Arborimus longicaudus*) as endangered or threatened and to designate critical habitat under the Endangered Species Act of 1973, as amended (Act). The Petition provided three listing options for the Service to consider: Listing the dusky tree vole subspecies throughout its range; listing the North Oregon Coast population of the red tree vole (*Arborimus longicaudus*) as a distinct population segment (DPS); or listing the red tree vole because it is endangered or threatened in a significant portion of its range.

After review of the best available scientific and commercial information, we have determined that listing the North Oregon Coast population of the red tree vole as a DPS is warranted. However, the development of a proposed listing rule is precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Upon publication of this 12-month petition finding, we will add this DPS of the red tree vole to our candidate species list. We will develop a proposed rule to list this DPS of the red tree vole as our priorities allow. We will make any determination on critical habitat during development of the proposed listing rule. In any interim period, we will address the status of the candidate taxon through our annual Candidate Notice of Review (CNOR).

DATES: This finding was made on October 13, 2011.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov.* Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, 2600 S.E. 98th Ave., Suite 100, Portland, OR 97266; telephone 503–231–6179; facsimile 503–231–6195. Please submit any new information, materials, comments, or questions concerning this finding to the above street address.

FOR FURTHER INFORMATION CONTACT: Paul Henson, Ph.D., Field Supervisor, U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office (see **ADDRESSES** section). If you use a telecommunications device for the deaf (TDD), call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Endangered Species Act (Act) (16 U.S.C. 1531 *et seq.*) requires that, for any petition to revise the Federal Lists of Endangered and Threatened Wildlife and Plants that contains substantial scientific and commercial information indicating that listing may be warranted, we make a finding within 12 months of the date of receipt of the petition on whether the petitioned action is: (1) Not warranted; (2) warranted; or (3) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are endangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding; that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register.**

Previous Federal Actions

On June 22, 2007, we received a petition dated June 18, 2007, from the Center for Biological Diversity and six other organizations and individuals (hereafter, ''the petitioners''), requesting that we list the dusky tree vole as an endangered or threatened species and designate critical habitat. The petitioners requested that if we found the dusky tree vole was not a listable entity as a subspecies, we either list the North Oregon Coast population of the red tree vole as a distinct population segment (DPS), or list the red tree vole because it is endangered or threatened in a significant portion of its range, including the North Oregon Coast population. On September 26, 2007, we sent a letter to Noah Greenwald, Center for Biological Diversity, acknowledging our receipt of the petition and providing our determination that emergency listing was not warranted for the species at that time.

On October 28, 2008, we published a 90-day finding for the dusky tree vole in the **Federal Register** (73 FR 63919). We found that the petition presented substantial information indicating that listing one of the following three entities as endangered or threatened may be warranted:

(1) The dusky tree vole subspecies of the red tree vole;

(2) The North Oregon Coast DPS of the red tree vole; or

(3) The red tree vole because it is endangered or threatened in a significant portion of its range.

As a result of that finding, we also initiated a status review of the species, including an evaluation of the North Oregon Coast population of red tree vole and the red tree vole throughout its range. This notice constitutes our 12-month finding for the petition to list the dusky tree vole as endangered or threatened.

Species Information

As a putative subspecies, the dusky tree vole is a member of the red tree vole taxon. Some of the scientific literature is specific to the ''dusky tree vole,'' but much of it describes the red tree vole and does not distinguish among subspecies. For that reason, available information on the red tree vole is presented below with the assumption that it also applies to the dusky tree vole. If the information source makes distinctions between the two, they are noted, as appropriate. Published literature on the red tree vole also includes work conducted on the closely related Sonoma tree vole (*Arborimus pomo*). Prior to 1991, these taxa were both considered red tree vole (Johnson and George 1991, entire). Where pertinent information is lacking or limited for the red tree vole, information on the Sonoma tree vole is presented because there have been no ecological or life-history differences noted for the two species (Smith *et al.* 2003, p. 187).

Tree voles are small, mouse-sized rodents that live in conifer forests and spend almost all of their time in the tree canopy. Tree voles rarely come to the ground, and do so only to move briefly between trees. They are one of the few animals to persist on a diet of conifer needles, which is their principal food. When eating, tree voles strip away the resin ducts within conifer needles and eat the remaining portion; resin ducts contain terpenoid chemicals that make them unpalatable to most species. Red tree voles live singly (or with young, in the case of females) in nests made of vegetation and other materials. Swingle (2005, p. 2) summarized the sizes of red tree vole nests as ranging from ''very small ephemeral structures about the size of a grapefruit, to large old maternal nests that may be nearly as large as a bushel basket and completely encircle the trunk of the tree (Taylor 1915; Howell 1926; Verts and Carraway 1998).'' Nests of females tend to be larger than those of males. Males and females live separate lives once leaving the nest, only coming together to breed. Further details of the life-history characteristics of tree voles are presented below.

Taxonomy and Description

Tree voles are less than 8.2 inches (in) (209 millimeters (mm)) long and weigh up to 1.7 ounces (oz) (49 grams (g)) (Hayes 1996, p. 1; Verts and Carraway 1998, p. 301; Forsman 2010, pers. comm.). Pelage (fur) color ranges from brownish red to bright brownish-red or orange-red (Maser *et al.* 1981, p. 201). The darker coat color has been attributed to the dusky tree vole (Bailey 1936, p. 198; Maser *et al.* 1981, p. 201). Melanistic (all black) forms of the dusky (Hayes 1996, p. 1) and red tree vole (Swingle 2005, p. 46), as well as cream-colored red tree voles (Swingle 2005, p. 82), rarely occur.

Howell (1926, p. 35) described several physical differences between voles described as dusky tree voles and red tree voles. These differences include coat color, as well as skull and dental characteristics. However, Howell (1926, p. 34) based his description of the red tree vole on the observations of 40 tree voles, 32 of which were from California. At least 28 of the California tree voles were collected from Carlotta, Humboldt County, within the range of what is now considered the Sonoma tree vole (Howell 1926, p. 41; Blois and Arbogast 2006, pp. 953–956). Howell's description of the red tree vole was therefore based on a collection that was actually comprised primarily of Sonoma tree voles, rendering the comparison to dusky tree voles of questionable value.

The taxonomic history of red and dusky tree voles is complex; a comprehensive description can be found in Miller *et al.* (2010, pp. 64–65). The red tree vole was first described from a specimen collected in Coos County, Oregon (True 1890, pp. 303–304), and originally placed in the genus *Phenacomys.* The dusky tree vole was first described from a dead specimen found in Tillamook County and originally classified as a distinct species, *P. silvicolus* (Howell 1921, entire), later renamed *P. silvicola* (Miller 1924, p. 400). Taylor (1915, p. 156) established the subgenus *Arborimus* for tree voles, which Johnson (1968, p. 27; 1973, p. 243) later proposed elevating to full generic rank, although this genus has not been universally adopted (e.g., Verts and Carraway 1998, pp. 309–311). For the purpose of this finding, we use the generic classification, *Arborimus,* adopted by the petitioners.

Johnson (1968, p. 27) concluded that analysis of blood proteins and hemoglobin from dusky and red tree voles ''* * * suggested combining the named forms of *Arborimus* into a single species * * *''. Hall (1981, p. 788) cited Johnson (1968, p. 27) as suggesting a ''subspecific relationship of the two taxa,'' and others have cited Johnson as well in supporting the classification of the dusky tree vole as a subspecies (e.g., Maser and Storm 1970, p. 64; Johnson and George 1991, p. 1). However, based on a lack of detectable genetic differences and a lack of consistently verifiable morphological differences between dusky and red tree voles, Bellinger *et al.* (2005, p. 207) suggested subspecific status of the dusky tree vole may not be warranted.

Miller *et al.* (2006a, entire) analyzed mitochondrial DNA sequences from red tree voles throughout their range in Oregon. This study was not designed to address red tree vole taxonomy, but rather, how historical processes may have affected the genetic diversity and structure of the red tree vole across much of its range. The authors found significant genetic discontinuities based on unique haplotypes that result in three genetically distinct groupings of red tree voles. A primary discontinuity divided the red tree vole's range into a northern and a southern region in terms of genetic makeup as determined from mitochondrial DNA. Some overlap of these two genetic groups occurred, but in general, red tree voles north of Douglas and southeastern Lane Counties were genetically different from tree voles to the south (Miller *et al.* 2006a, Fig.1, pp. 146, 151–152). There are no known geographic or geological features that coincide with this genetic discontinuity that might explain this genetic break. The northern genetic group was further subdivided by a secondary discontinuity that coincided with the Willamette Valley, a non-forested barrier currently separating individuals in the northern Oregon Coast Range to the west from the Cascade Range to the east (Miller *et al.* 2006a, Fig.1, pp. 146, 151–152).

Although Miller *et al.* (2006a, entire) found genetic discontinuities in the red tree vole in Oregon, the authors did not comment on the taxonomic status of the species. Subsequent conversations with the geneticists who authored this paper indicated that the genetic differences described in Miller *et al.* (2006a, entire) were substantial enough to potentially warrant taxonomically classifying the three genetically distinct groups as separate subspecies if there were corresponding differences in other traits, such as behavior or morphology, to provide additional support (Miller and Haig 2009, pers. comm.). Recent review of external morphological characters by Miller *et al.* (2010, entire) did not distinguish dusky tree voles from red tree voles, but the authors noted that additional analysis of other physical characteristics (e.g., fur color) would be required to better determine the dusky tree vole's taxonomic status. The Integrated Taxonomic Information System (ITIS), a database maintained by a partnership of U.S., Canadian, and Mexican agencies, other organizations, and taxonomic specialists to provide scientifically credible taxonomic information, does not recognize the dusky tree vole as a subspecies of the red tree vole (information retrieved 15 March 2011, from the ITIS database). Wilson and Reeder (2005, entire) is the industry standard for mammalian taxonomy. Subspecies were not recognized until the most recent edition, published in 2005. Although Wilson and Reeder (2005, pp. 962–963) recognize the dusky tree vole as a subspecies, the more recent research on tree vole genetics and analyses attempting to clarify the taxonomic status of the dusky tree vole have only become available subsequent to that review, and therefore were not considered at the time that volume was published.

Range and Distribution

Tree voles are endemic to the humid, coniferous forests of western Oregon and northwestern California (Maser 1966, p. 7). The red tree vole occurs in western Oregon from below the crest of the Cascade Range to the Pacific coast (Hayes 1996, p. 2; Verts and Carraway 1998, pp. 309–310), with a geographic range covering approximately 16.3 million acres (ac) (6.6 million hectares (ha)) across multiple ownerships (USDA and USDI 2007, p. 287) (Figure 1).

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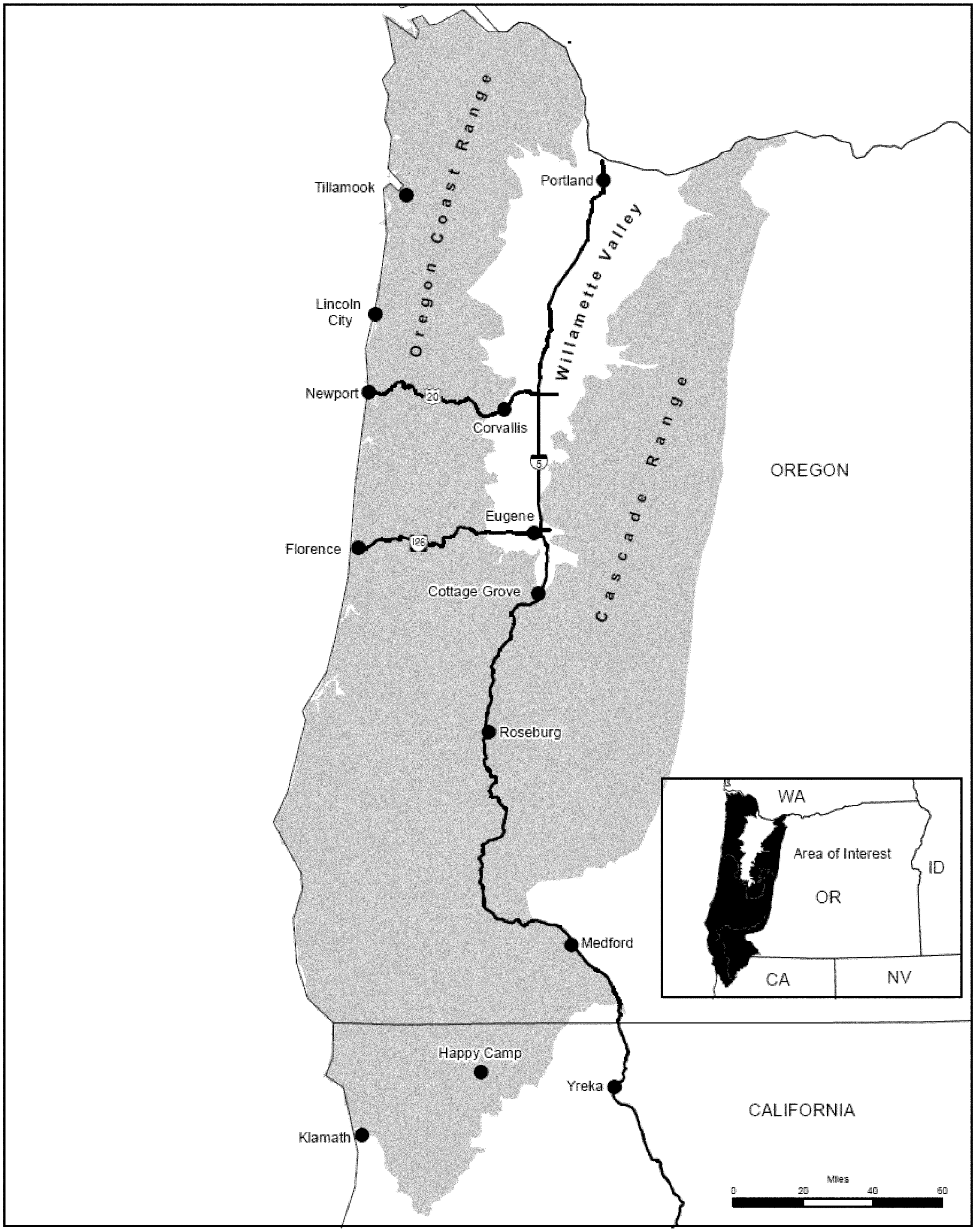

Figure 1. Range of the Red Tree Vole.

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The southern boundary of the range of the red tree vole borders the range of the Sonoma tree vole, which Johnson and George (1991, p. 12) classified as a separate species from the red tree vole. Johnson and George (1991, pp. 11–12) suggested the break between the ranges of these two species was the Klamath Mountains along the Oregon-California border. Murray (1995, p. 26) considered the boundary between the two species to be the Klamath River in northwestern California. A recent mitochondrial DNA analysis supports the classification of tree voles in northwestern California (Del Norte County) as *Arborimus longicaudus* (Blois and Arbogast 2006, pp. 956, 958).

The red tree vole has not been found north of the Columbia River (Verts and Carraway 1998, p. 309), but the actual northern limit of its historical distribution in northwestern Oregon is unclear. Within the Oregon Coast Range, the northernmost tree vole collection site was in the vicinity of Saddle Mountain in central Clatsop County (Verts and Carraway 1998, pp. 310, 546; Forsman and Swingle 2009, pers. comm.). Although no tree voles have been detected in recent search efforts in northern Clatsop and Columbia

Counties (Forsman and Swingle 2009, unpublished data), the area historically had extensive forests with large Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) trees conducive to tree vole habitat (Robbins 1997, pp. 205–206). Therefore, we believe it is reasonable to assume that tree voles were present in those areas prior to the late 1800s and early 1900s when virtually all old forests in the region were clear-cut or burned. The Columbia River was considered Oregon's most productive logging center in the late 1800s (Robbins 1997, p. 220), and it is likely that virtually all of the suitable tree vole habitat in Clatsop, Columbia, and Washington Counties was removed before tree vole occurrence could be recorded. Whether tree voles may persist undetected in Columbia County and northern Clatsop County is not known at this time; although not detected in the most recent search efforts, tree voles may be overlooked if they are sparsely distributed or few in number.

Farther east, the red tree vole occurs in the Columbia River Gorge from Wahkenna Creek to Seneca Fouts State Park, 4 miles (mi) (6 kilometers (km)) west of Hood River (Forsman *et al.* 2009b, p. 230). The red tree vole range had been described as west of the crest of the Cascade Range in Oregon (Corn and Bury 1986, p. 405). However, recent surveys have also found them just east of the Cascade Range crest, in the headwaters of the Lake Branch of Hood River, 19 mi (30 km) southwest of the town of Hood River (Forsman *et al.* 2009b, p. 227).

Surveys conducted for red tree voles by the Forest Service and the Bureau of Land Management as part of the Survey and Manage program under the Northwest Forest Plan (NWFP) have provided additional information on the distribution of the red tree vole (USDA and USDI 2007, p. 289). These surveys indicate red tree voles are uncommon and sparsely distributed in much of the northern Coast Range and northern Cascade Range of Oregon. Forsman *et al.* (2004, p. 300) reached the same conclusion based on remains of red tree voles in pellets of northern spotted owls (*Strix occidentalis caurina*), although data were sparse from the northern Oregon Coast Range compared to the rest of the red tree vole's range. Based on these surveys and data from owl pellets, the eastern limit of red tree vole distribution in southwestern Oregon appears to include forested areas in Josephine County and a narrow band along the western and northern edges of Jackson County (Forsman *et al.* 2004, pp. 297–298; USDA and USDI 2007, p. 289).

Red tree voles are generally restricted to lower elevation coniferous forests, although there are a few records of this species above 4,265 feet (ft) (1,300 meters (m)) (Manning and Maguire 1999, entire; Forsman *et al.* 2004, p. 300). Hamilton (1962, p. 503) suggested red tree voles may be limited to lower elevations because their nests do not provide adequate insulation during winter. Because tree voles are active throughout the year, it is also possible they are absent from high-elevation areas because they find it difficult to forage on limbs covered with snow and ice during winter (Forsman *et al.* 2004, p. 300).

The range of the putative dusky tree vole is less clear than that of the red tree vole. Johnson and George (1991, p. 12) described its range as restricted to the western slope of the Coast Range in Tillamook and Lincoln Counties. However, Maser (1966, p. 16) summarized collection and nest records for the dusky tree vole from locations east of the crest of the Coast Range down to the western edge of the Willamette Valley in Washington, Yamhill, Polk, Benton, and Lane Counties. Maser (2009, pers. comm.) believed the southern limit of the dusky tree vole to be in the vicinity of the Smith or Umpqua Rivers (western Douglas County) based on a shift in vole behavior and habitat type. Brown (1964, p. 648) mentioned four dusky tree vole museum specimens collected near Molalla in Clackamas County east of the Willamette Valley. Howell (1926, p. 34) referred to Stanley Jewett, a fellow naturalist, finding ''unmistakable evidence'' of red tree voles in old nests near Bonneville, in far eastern Multnomah County at the foot of the Cascade Range, and then goes on to say, ''Though this sign may possibly have been of *longicaudus,* it is considered more likely to have been of *silvicola.''* However, he did not elaborate on why he concluded that it was indicative of the dusky tree vole. Maser (1966, p. 8) observed that tree voles historically collected north of Eugene and west of the Willamette Valley were typically classified as dusky tree voles, while those collected north of Eugene and east of the Willamette Valley were almost all identified as red tree voles.

Home Range and Dispersal

The only published data on home range sizes and dispersal come from red tree voles radio-collared in the southern Coast Range and southern Cascades of Douglas County in southwestern Oregon (Swingle 2005, pp. 51–63, 84–89; Swingle and Forsman 2009, entire). Of 45 radio-collared red tree voles, 18 had home ranges consisting of their nest tree and a few adjacent trees, whereas the remainder occupied up to 6 different nests spaced up to 532 ft (162 m) apart in different trees (Swingle and Forsman 2009, p. 277). Mean and median home ranges were 0.43 ac (0.17 ha) and 0.19 ac (0.08 ha), respectively (Swingle and Forsman 2009, p. 278). Home range sizes did not differ among gender, age, or among voles occurring in young (22–55 years old) versus old (110–260 years old) forests (Swingle and Forsman 2009, pp. 277–279). An unpublished study conducted by Brian Biswell and Chuck Meslow found mean male home ranges of 0.86 ac (0.35 ha) and mean female home ranges of 0.37 ac (0.15 ha) (Biswell and Meslow, unpublished data referenced in USDA and USDI 2000b, p. 8). Dispersal distances of nine subadults ranged from 10 to 246 ft (3 to 75 m) (Swingle 2005, p. 63). The longest known straight-line dispersal distance was for a subadult male who traveled 1,115 ft (340 m) over the course of 40 days (Biswell and Meslow, unpublished data referenced in USDA and USDI 2000b, p. 8).

Habitat

Red tree voles are found exclusively in conifer forests or in mixed forests of conifers and hardwoods (Hayes 1996, p. 3). Throughout most of their range, they are principally associated with Douglas-fir for foraging and nesting (Jewett 1920, p. 165; Bailey 1936, p. 195). However, their nests have also been documented in Sitka spruce (*Picea sitchensis*) (Jewett 1920, p. 165), grand fir (*Abies grandis*), western hemlock, Pacific yew (*Taxus brevifolia*), and non-conifers such as bigleaf maple (*Acer macrophyllum*) and golden chinquapin (*Castanopsis chrysophylla*) (Swingle 2005, p. 31). Hardwoods are generally not recognized as an important habitat component (USDA and USDI 2002, p. 1). Tree vole nests are located in the forest canopy and are constructed from twigs and resin ducts discarded from feeding, as well as fecal pellets, lichens, dead twigs, and conifer needles (Howell 1926, p. 46; Clifton 1960, pp. 53–60; Maser 1966, pp. 94–96; Gillesberg and Carey 1991, p. 785; Forsman *et al.* 2009a, p. 266). On the occasions when tree voles nest in non-conifers or snags, they are virtually always in trees that have limbs interconnected with adjacent live conifers where the voles can obtain food (Maser 1966, p. 78; Swingle 2005, p. 31). Within the northern Oregon Coast Range, primarily in the Sitka spruce plant series (see Distinct Vertebrate Population Segment Analysis for plant series description), tree vole diet and nest tree species selection favors western hemlock and Sitka spruce (Walker 1930, pp. 233–234; Forsman *et al.* 2008, Table 2; Forsman and Swingle 2009, pers. comm.; Maser 2009, pers. comm.), although some vole nests have been found in Douglas-fir in this plant series (Howell 1921, p. 99; Jewett 1930, pp. 81–83; Forsman and Swingle 2009, pers. comm.).

Based on their study of small mammal habitat associations in the Oregon Coast Range, Martin and McComb (2002, p. 262) considered red tree voles to be habitat specialists. In that study of forests of different patch types, red tree voles selected ''conifer large sawtimber patch types'' and landscapes that minimize fragmentation of mature conifer forest (Martin and McComb 2002, pp. 259, 261, 262). The vegetation classification scheme used by Martin and McComb (2002, p. 257) defines the conifer large sawtimber patch type as forest patches with greater than 70 percent conifer composition, more than 20 percent canopy cover, and mean diameter at breast height (dbh) of greater than 21 in (53.3 cm) (it should be noted that studies where researchers actually measured the canopy cover of stands used by red tree voles indicate the minimum canopy cover requirements of red tree voles are much higher, on the order of 53 to 66 percent (e.g., Swingle 2005, p. 39)). Red tree voles were most abundant in contiguous mature conifer forest (unfragmented landscapes), and were negatively affected by increasing patch densities at the landscape scale (Martin and McComb 2002, p. 262).

Although red and Sonoma tree voles occur and nest in young forests (Jewett 1920, p. 165; Brown 1964, p. 647; Maser 1966, p. 40; Corn and Bury 1986, p. 404; Thompson and Diller 2002, entire; Swingle and Forsman 2009, p. 277), most comparisons of relative abundance from pitfall trapping and nest presence data show increased occurrence in older forests throughout the range of these species (Corn and Bury 1986, p. 404; Corn and Bury 1991, pp. 251–252; Ruggiero *et al.* 1991, p. 460; Meiselman and Doyle 1996, p. 38; Gomez and Anthony 1998, p. 296; Martin and McComb 2002, p. 261; Jones 2003, p. 29; Dunk and Hawley 2009, entire). The occurrence of active nests in remnant older trees in younger stands indicates the importance of legacy structural characteristics (USDA and USDI 2002, p. 1). Although the bulk of the evidence points to forests with late-successional characteristics as important to the red tree vole, we lack specific data on the minimum size of trees or stands required to sustain populations of the red tree vole over the long term.

There is no single description of red tree vole habitat and a wide variety of terms have been used to describe the older forest stands the tree voles tend to select (e.g., late-successional, old-growth, large conifer, mature, structurally complex). Where these terms appear in cited literature, or where specific ages are referred to, we refer to them in this analysis. Otherwise, we use the term ''older forest'' when collectively referring to these stand conditions. In using the term ''older forest,'' we are not implying a specific stand age that represents tree vole habitat. Rather, we use the term to represent the mixture of old and large trees, multiple canopy layers, snags and other decay elements, understory development and biologically complex structure and composition often found in forests selected by tree voles.

The most extensive and intensive analysis of red tree vole habitat associations on Federal lands throughout the vole's range found a strong association between tree vole nest presence and late-successional and old-growth forest conditions (forests over 80 years old), with optimal red tree vole habitat being especially rare (Dunk and Hawley 2009, p. 632). Throughout their range on Federal land, the probability of red tree vole nest presence (Po) in the highest quality habitat (forest exhibiting late-successional structural characteristics) was 7 times more than expected based on the proportional availability of that habitat, whereas in lowest quality, early-seral forest conditions, Po was 7.6 times less than expected based on availability (Dunk and Hawley 2009, p. 632). In other words, red tree voles demonstrated strong selection for nesting in stands with older forest characteristics, even though that forest type was relatively rare across the landscape. Conversely, tree voles avoided nesting in younger stand types that were much more common across the landscape.

Trees containing tree vole nests are significantly larger in diameter and height than those without nests (Gillesberg and Carey 1991, p. 785; Meiselman and Doyle 1996, p. 36 for the Sonoma tree vole). Other forest conditions associated with red tree vole habitat include the number of large trees and variety of tree size distribution (Dunk and Hawley 2009, p. 632). Carey (1991, p. 8) suggested that tree voles seem especially well-suited to the stable conditions of old-growth Douglas-fir forests (multi-layered stands over 200 years old, with decay elements). Old-growth trees may be optimum tree vole habitat because primary production is high and needles are concentrated, providing maximum food availability (Carey 1991, p. 8). In addition, old-growth canopy buffers weather changes and has high water-holding capacity, providing fresh foliage and a water source (Gillesberg and Carey 1991, pp. 786–787), as well as numerous cavities and large limbs that provide stable nest substrates.

As noted above, tree voles can be found in younger forests, sometimes at fairly high densities (Howell 1926, pp. 41–45: Maser 1966, pp. 216–217; Thompson and Diller 2002, p. 95). It is not understood how younger forests influence the abundance, persistence, or dispersal of red tree voles. Carey (1991, p. 34) suggested younger forests were population sinks for red tree voles. Based on surveys in young forests (22–55 years old) and observations of radio-collared tree voles, Swingle (2005, pp. 78, 94) and Swingle and Forsman (2009, pp. 283–284) concluded that some young forests may be important habitat for tree voles, particularly in landscapes where old forests have largely been eliminated or currently exist in isolated patches. However, Swingle (2005, pp. 78, 94) cautioned against using the occasional presence of tree voles in young forests to refute the importance of old forest habitats to tree voles. Young forest stands may serve as interim habitat for tree voles and may provide connectivity between remnant patches of older forest, but whether younger forests are capable of supporting viable populations of tree voles over the long term is uncertain. The limited evidence available suggests that tree vole occupation of younger forest stands may be relatively short-lived (Diller 2010, pers. comm.) or intermittent (Hopkins 2010, pers. comm.).

After weighing all of the best available information, we conclude that although red tree voles may use younger forest types to some degree, the preponderance of evidence suggests red tree voles demonstrate strong selection for forests with older forest conditions, as well as contiguous forest conditions. Whether tree voles can potentially persist in younger forests over the long term is unknown (USDA and USDI 2007, p. 291). However, although the data are limited, the available evidence suggests that red tree voles likely do not maintain long-term or consistent populations in younger stands (Diller 2010, pers. comm.; Hopkins 2010, pers. comm.). There is a relatively large body of evidence, on the other hand, that red tree voles exhibit strong selection for areas of contiguous habitat exhibiting conditions characteristics of older, mature forests (Corn and Bury 1986, p. 404; Corn and Bury 1991, pp. 251–252; Ruggiero *et al.* 1991, p. 460; Meiselman and Doyle 1996, p. 38; Gomez and Anthony 1998, p. 296; Martin and McComb 2002, p. 261; Jones 2003, p. 29; Dunk and Hawley 2009, entire). We therefore further conclude that unfragmented forests with late-successional characteristics are thus most likely to provide for the long-term persistence of the species, and in this finding we consider these older forest types as representative of high-quality habitat for the red tree vole.

Tree voles may tolerate some forest fragmentation, but the point at which forest gaps become large enough to impede their movements or successful dispersal is not known. Howell (1926, p. 40) suggested that ''considerable'' expanses of land without suitable trees are a barrier to tree vole movements. However, as noted earlier, known dispersal distances for red tree voles are quite short, ranging from 10 to 246 ft (3 to 75 m) (Swingle 2005, p. 63), with 1,115 ft (340 m) being the longest known dispersal distance (Biswell and Meslow, unpublished data referenced in USDA and USDI 2000b, p. 8). This suggests that relatively small distances, roughly less than 1,200 ft (366 m) between forest patches, may serve as effective barriers to dispersal or recolonization for red tree voles. Radio-collared tree voles crossed logging roads, first-order streams, and canopy gaps up to 82 ft (25 m) wide (Biswell and Meslow, unpublished data referenced in USDA and USDI 2000b, p. 8; Swingle and Forsman 2009, p. 283). Some of these crossings occurred on multiple occasions by a single vole. This suggests that ''small forest gaps'' (Swingle 2005, p. 79) may not greatly impair tree vole movement, but increasing gap size may be expected to limit tree vole movement. In addition, Swingle (2005, p. 79) suggested that the necessity of descending to the ground to cross openings may reduce survival. There are three records of red tree voles captured in clearcuts (Borrecco 1973, pp. 34, 36; Corn and Bury 1986, pp. 404–405; Verts and Carraway 1998, p. 310), in one case over 656 ft (200 m) from the forest edge. In two of these instances, the authors suggested the individuals were most likely in the act of dispersing.

In summary, based on our evaluation of the best scientific and commercial data available, as detailed above, for the purposes of this finding we consider older forests with late-successional characteristics to represent high-quality habitat for red tree voles, and younger forests in early-seral condition to represent low-quality, transitional habitat for red tree voles. In addition, we consider it likely that younger forests only play a role as interim, low-quality habitat for red tree voles if they occur in association with older forest patches or remnants.

Reproduction

Red tree vole litter sizes are among the smallest compared to other rodents of the same subfamily, averaging 2.9 young per litter (range 1 to 4) (Maser *et al.* 1981, p. 205; Verts and Carraway 1998, p. 310). Clifton (1960, pp. 119–120) reported that captive tree voles became sexually mature at 2.5 to 3.0 months of age. Females breed throughout the year, with most reproduction occurring between February and September (Swingle 2005, p. 71). Red tree voles are capable of breeding and becoming pregnant immediately after a litter is born (Clifton 1960, p. 130; Hamilton 1962, pp. 492–495; Brown 1964, pp. 647–648), resulting in the potential for females to have two litters of differently aged young in their nests (Swingle 2005, p. 71; Forsman *et al.* 2009a, p. 270). Captive tree voles may have litters just over a month apart (Clifton 1960, p. 130). Forsman *et al.* (2009a, p. 270) observed two female voles in the wild that produced litters at 30 to 35 day intervals. Young tree voles develop more slowly than similar-sized rodents of the same subfamily (Howell 1926, pp. 49–50; Maser *et al.* 1981, p. 205), first exiting the nest at 30 to 35 days old, and not dispersing until they are 47 to 60 days old (Swingle 2005, p. 63; Forsman *et al.* 2009a, pp. 268–269).

Diet

Tree voles are unique in that they feed exclusively on conifer needles and the tender bark of twigs that they harvest from conifers. In most of their range, they feed primarily on Douglas-fir (Howell 1926, p. 52; Benson and Borell 1931, p. 230; Maser *et al.* 1981, p. 205). In portions of the northern coastal counties of Oregon (Lincoln, Tillamook, and Clatsop), tree voles also consume needles from western hemlock and Sitka spruce, and in some parts of their range they feed on grand fir, bishop pine (*Pinus muricata*), and introduced Monterrey pine (*P. radiata*) (Jewett 1920, p. 166; Howell 1926, pp. 52–53; Walker 1930, p. 234; Wooster and Town 2002, pp. 182–183; Forsman and Swingle 2009, pers. comm.; Swingle 2010, pers. comm.). Conifer needles contain filamentous resin ducts that are filled with terpenoids, chemicals that serve as defensive mechanisms for trees by making the leaves unpalatable. Tree voles have adapted to their diet of conifer needles by stripping away these resin ducts and eating the more palatable portion of the needle (Benson and Borell 1931, pp. 228–230; Perry 1994, pp. 453–454; Maser 1998, pp. 220–221; Kelsey *et al.* 2009, entire). Resin ducts typically run the length of the needle, but may be located in different portions of the needle, depending on the tree species; this forces the tree vole to behave differently depending on the tree species on which they forage. As an example, the resin ducts in Douglas-fir needles are located along the outer edges of the needle, so tree voles remove the outside edge and consume the remaining middle portion of the needle. Conversely, the resin ducts of western hemlock are located away from the outside edges along the midline of the needle. Thus, voles foraging on hemlock needles will consume the outer edge of the needle and discard the center (Clifton 1960, pp. 35–45; Forsman and Swingle 2009, pers. comm.; Kelsey *et al.* 2009, entire; Maser 2009, pers. comm.).

Within the Sitka spruce plant series of the northern Oregon Coast Range of Oregon, tree voles appear to prefer, and perhaps require, a diet of western hemlock and Sitka spruce needles (Walker 1930, p. 234; Forsman and Swingle 2009, pers. comm.; Maser 2009, pers. comm.;). Voles in the Sitka spruce plant series rarely forage on Douglas-fir, even where it is available; foraging on Douglas-fir only becomes more evident where the Sitka spruce plant series transitions into the adjacent western hemlock series (Forsman and Swingle 2009, pers. comm.; Forsman and Swingle 2009, unpublished data). Maser (2009, pers. comm.) observed that tree voles adapted to a diet of western hemlock starved to death in captivity because they would not eat the Douglas-fir needles they were offered. Because the resin ducts of western hemlock, Sitka spruce, and Douglas-fir needles are in different locations on the needle, their removal requires a different behavior depending on which species is being eaten (Clifton 1960, pp. 35–49; Kelsey *et al.* 2009, entire). Maser (2009, pers. comm.) suspected that voles raised in stands of western hemlock never learned the required behavior for eating Douglas-fir, although Walker (1930, p. 234) observed a captive vole raised on hemlock needles that preferred hemlock but would eat fir or spruce in the absence of hemlock. Conversely, voles taken from Douglas-fir stands have been observed to eat both Douglas-fir and western hemlock in captivity (Clifton

1960, p. 44; Maser 2009, pers. comm.), although voles appear to be reluctant to switch between tree species (Walker 1930, p. 234; Forsman 2010, pers. comm.).

Tree voles appear to obtain water from their food and by licking water off of tree foliage (Clifton 1960, p. 49; Maser 1966, p. 148; Maser *et al.* 1981, p. 205; Carey 1996, p. 75). In keeping captive Sonoma tree voles, Hamilton (1962, p. 503) noted that it was important to keep leaves upon which they fed moist, otherwise the voles would lose weight and die. The need for free water in the form of rain or dew on foliage may explain why the distribution of tree voles is limited to relatively humid forests in western Oregon and California (Howell 1926, p. 40; Hamilton 1962, p. 503). However, there are no quantitative data on water consumption by tree voles, and some forests in which they occur (e.g., portions of southwestern Oregon) have little rain or dew during the summer months. How they are able to persist under such conditions is unclear.

Mortality

In the only quantitative study conducted to date, Swingle *et al.* (2010, p. 258) found that weasels (*Mustela* spp.) were the primary predators of red tree voles. However, many other animals feed on tree voles, including ringtails (*Bassariscus astutus*) (Alexander *et al.* 1994, p. 97), fisher (*Martes pennanti*) (Golightly *et al.* 2006, p. 17), northern spotted owls (Forsman *et al.,* 1984, p. 40), barred owls (*Strix varia)* (Wiens 2010, pers. comm.), and a variety of other nocturnal and diurnal raptors (Miller 1933, entire; Maser 1965a, entire; Maser 1965b, entire; Forsman and Maser 1970, entire; Reynolds 1970, entire; Graham and Mires 2005, entire). Other documented predators include the Steller's jay (*Cyanocitta stelleri*) (Howell 1926, p. 60), a gopher snake (*Pituophis catenifer*) (Swingle *et al.* 2010, p. 258), domestic dogs (*Canis familiaris*) (Swingle *et al.* 2010, p. 258), and house cats (*Felis catus*) (Swingle 2005, pp. 90–91). In addition, Maser (1966, p. 164) found tree vole nests that had been torn apart and inferred the destruction was likely caused by northern flying squirrels (*Glaucomys sabrinus*), raccoons (*Procyon lotor*), western gray squirrels (*Sciurus griseus*), or Douglas' squirrels (*Tamiasciurus douglasii*), apparently in search of young voles. Forsman (2010, pers. comm.) recorded video footage of northern flying squirrels, western gray squirrels, and Douglas' squirrels chasing tree voles or tearing into tree vole nests in what appeared to be attempts to capture voles.

Swingle *et al.* (2010, p. 259) estimated annual survival of radio-collared tree voles to be 15 percent. Little is known about the vulnerability of red tree voles to predators in different habitats. Swingle (2005, pp. 64, 90) found that of 25 documented cases of predation on radio-collared voles, most occurred in young (22–55 years old) forests (Forsman and Swingle 2009, pers. comm.). Predation by weasels, which accounted for 60 percent of the predation events, occurred only in the 22–55-year-old forests, and 80 percent of the weasel predation was on female voles. Most of the radio-collared sample consisted of females and were in young forest, so forest age and vole gender explained little of the variation in the data (Forsman 2010, pers. comm.; Swingle 2010, pers. comm.). Although there was no statistical difference in predation rates among forest ages and vole gender, Swingle *et al.* (2010, p. 260) suspected weasel predation on tree voles may be inversely proportional to nest height. Tree vole nests tend to be found in the lower portion of the tree crown (Gillesburg and Carey 1991, pp. 785–786; Swingle 2005, pp. 29–30), and tree vole nests tend to be higher above the ground in older stands or larger trees than in younger stands or smaller trees (Zentner 1966, pp. 18–20; Vrieze 1980, pp. 18, 32–33; Meiselman and Doyle 1996, p. 38; Swingle 2005, pp. 29–30). Thus, tree voles could be more prone to predation in shorter trees that comprise younger stands and limit the height of nests above the ground. Swingle *et al.* (2010, p. 261) also suggested that female tree voles may be more susceptible to predation than males because they occupy larger, more conspicuous nests and spend more time outside the nest collecting food for their young.

Other mortality sources include disease, old age, storms, forest fires, and logging (Maser *et al.* 1981, p. 206). Carey (1991, p. 8) suggested that forest fires and logging are far more important mortality factors than predation in limiting vole abundance.

Defining a Species Under the Act

Section 3(16) of the Act defines ''species'' to include any species or ''subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature'' (16 U.S.C. 1532(16)). Our implementing regulations at 50 CFR 424.11 provide further guidance for determining whether a particular taxon or population is a species for the purposes of the Act: ''[T]he Secretary shall rely on standard taxonomic distinctions and the biological expertise of the Department and the scientific community concerning the relevant taxonomic group'' (50 CFR 424.11(a)). As previously noted, we were petitioned to list the dusky tree vole as a subspecies of the red tree vole. The petitioners requested that if we found that the dusky tree vole was not a listable entity as a subspecies, then we subsequently consider whether it should be listed as the North Oregon Coast DPS of the red tree vole. Alternatively, the petitioners requested that the dusky tree vole be protected by listing the red tree vole because it is endangered or threatened in a significant portion of its range. The analysis to determine whether this is a viable subspecies or DPS according to section 3(16) of the Act follows.

Subspecies Analysis

There is no universally accepted definition of what constitutes a subspecies, and the use of the term subspecies may vary among taxonomic groups (Haig *et al.* 2006, entire). To be operationally useful, subspecies must be discernible from one another (i.e., diagnosable), not merely exhibit mean differences (Patten and Unitt 2002, pp. 28, 34). This element of ''diagnosability,'' or the ability to consistently distinguish between populations, is a common thread that runs through all subspecies concepts. It is important to use multiple sources of information when evaluating a taxon's status. The greater the concurrence among multiple morphological, molecular, ecological, behavioral, and physiological characteristics, the higher the level of confidence in the taxonomic classification (Haig *et al.* 2006, p. 1591). To assess subspecies classification for the dusky tree vole, we evaluated all the available data to determine whether the evidence points to a consistent separation of the putative dusky tree voles from the remaining population of red tree voles. If the assessment of these multiple characteristics provides a clear and consistent separation of the putative dusky tree vole subspecies from the remaining red tree vole population, such that any individual from the range of the dusky tree vole would likely be correctly assigned to that subspecies on the basis of the suite of characteristics analyzed, that evidence would be considered indicative of a likely valid subspecies.

Geography

As described under *Range and Distribution,* there is no clear demarcation for the range of the putative dusky tree vole. All descriptions include the western slope of the northern Oregon Coast Range, typically Tillamook and Lincoln Counties. Other descriptions expand this range to include the east slope of the Oregon Coast Range (Maser 1966, p. 16), and south to include the coastal portion of Douglas County (Maser 2009, pers. comm.). Still others suggest tree voles found in the foothills of the Cascade Range (Brown 1964, p. 648) and in the Columbia River Gorge (Howell 1926, p. 34) were dusky tree voles. Contemporary descriptions of the dusky tree vole range usually reference Johnson and George (1991, p. 12), who, despite not finding any strong morphometric or karyologic (chromosomal) differences between the subspecies, state the two taxa, ''* * * now can be properly delineated geographically.'' Johnson and George (1991, p. 12) go on to describe the dusky tree vole range as the Pacific slope of the Oregon Coast Range in Tillamook and Lincoln Counties without substantiating the basis for their geographic delineation. There is thus no clear and consistent description of what may constitute the range of the ''dusky tree vole.''

Blood Proteins

Johnson (1968, p. 27) analyzed blood proteins of dusky tree voles, red tree voles, and heather voles (*Phenacomys intermedius*) to determine whether *Arborimus* should remain as a subgenus under *Phenacomys* or be elevated to a full genus. Multiple authors cite this work to support the classification of the dusky tree vole as a subspecies of the red tree vole (e.g., Maser and Storm 1970, p. 64; Hall 1981, p. 788; Johnson and George 1991, p. 1). However, we fail to reach this conclusion based on Johnson's (1968, p. 27) work. Johnson (1968, p. 27) describes his results as follows:

> The tree mice of the species *Arborimus longicaudus* (including A. silvicola) have in the past been included with the heather vole, *Phenacomys intermedius.* Two specimens of *P. intermedius* (of two subspecies) and 16 specimens of *A. longicaudus* (of two subspecies) were examined. In these two species the serum proteins and hemoglobins have suggested combining the named forms of *Arborimus* into a single species, and separating the genera *Arborimus* and *Phenacomys.*

Although Johnson (1968, p. 27) concluded that the named forms *longicaudus* and *silvicola* should be combined, he did not make any further determination on whether or not *silvicola* should be retained as a subspecies. We therefore question whether Johnson (1968, p. 27) definitively designates *silvicola* as a subspecies. While Hall (1981, p. 788) cited Johnson (1968, p. 27) as suggesting a ''subspecific relationship of the two taxa,'' he also notes that this designation is a ''provisional arrangement'' because of the existing uncertainty about the relationship of the two taxa.

Genetics

In this section and the *Summary* section below we describe and analyze the research on tree vole genetics as it relates to answering the question of whether or not the dusky tree vole is a taxonomically valid subspecies of the red tree vole. This should not be confused with our analysis later in this document (see Distinct Vertebrate Population Segment Analysis) wherein we evaluate the genetics research as it relates to its contribution towards determining the discreteness and significance of a potential DPS of the red tree vole.

Bellinger *et al.* (2005, p. 207) failed to find detectable genetic differences between dusky and red tree voles, suggesting that subspecific status may not be warranted. Miller *et al.* (2006a, p. 145) found three distinct genetic entities in their analysis of mitochondrial DNA of red tree voles throughout Oregon. For this analysis, we are interested in the genetic entity that Miller *et al.* (2006a, p. 151) labeled the ''Northern Coast range'' sequence. While Miller *et al.* (2006a, entire) do not describe specific boundaries for this entity, the sampling locations in this entity are distributed across the northern Oregon Coast Range, extending south to latitudes roughly equivalent with the cities of Eugene and Florence (see Figure 1 for city locations). This genetic entity encapsulates most of the range descriptions of the putative dusky tree vole. Although the objective of Miller *et al.* (2006a, entire) was not to address the taxonomy of the dusky tree vole, in subsequent conversations with the authors, they concluded that the genetic differences between these groups were sufficient to potentially support subspecies recognition if there were congruent differentiations in other characteristics (Miller and Haig 2009, pers. comm.).

Morphology

The dusky tree vole has been described as darker than the red tree vole (Bailey 1936, p. 198; Maser *et al.* 1981, p. 201; Hall 1981, p. 788; Johnson and George 1991, p. 12), but there has been no analysis to indicate an identifiable change in coat color either between the two entities or that corresponds with the boundaries of the haplotype groups found in Miller *et al.* (2006a, entire) (see *Genetics,* above). Maser (2007, pers. comm.; 2009, pers. comm.) postulated that the darker coat color in voles from the northern Oregon Coast Range was due to the denser, darker forests in which a darker coat provided a more cryptic coloration than a lighter coat color. Assuming this hypothesis is correct, because there is a gradual transition of tree species and forest composition as one progresses south in the Coast Range, it is reasonable to hypothesize that a corresponding change in coat color may also be gradual rather than abrupt and thus not easily discernable from the red tree vole. This needs to be evaluated using a consistent and repeatable method for comparing pelage color. Such an analysis is currently being conducted but is not available for this review (Forsman 2010, pers. comm.).

In measuring multiple morphometric features, Johnson and George (1991, p. 5) found statistical differences distinguishing Oregon tree voles from California samples, but were not able to easily detect discernable differences between samples within Oregon or California. Miller *et al.* (2010, p. 69) found statistically significant differences in some external morphological features between putative dusky tree voles and red tree voles. Although these differences were statistically significant in distinguishing between groups of tree voles, they were of little diagnostic utility because they were so subtle they could not be used to reliably classify an individual tree vole as a dusky tree vole or a red tree vole (Miller *et al.* 2010, p. 67). A possible explanation for the statistical difference, yet lack of diagnostic utility, is that the morphological features measured also exhibited a positive correlation with latitude; tree voles from the northern part of the range were larger than tree voles from the southern part of the range. This is a clinal pattern consistent with Bergmann's Rule, an ecological principle stating that larger forms of species tend to be associated with cooler climate and higher latitude (Miller *et al.* 2010, p. 69).

Behavior

Tree voles within the narrow band of Sitka spruce found along the coastal portion of the northern Oregon Coast Range north of Newport exhibit a different diet than voles in the rest of the range, foraging on Sitka spruce or western hemlock rather than on Douglas-fir (Walker 1930, p. 234; Forsman and Swingle 2009, pers. comm.) (see above under *Diet*). This diet requires a different treatment of needles than in other areas because resin ducts in spruce and hemlock are located in different parts of the needle than in Douglas-fir (Kelsey *et al.* 2009, pp. 12–13). While this behavioral difference exists primarily in the Sitka spruce plant series of the northern Oregon Coast Range, it comprises only a small portion of the area within the northern Coast Range genetic sequence found by Miller *et al.* (2006a, pp. 150–151; see *Genetics,* above) and does not correspond to the general boundaries of that genetic entity, nor does it correspond to any of the various boundaries of the putative dusky tree vole's range.

Summary

Bellinger *et al.* (2005, p. 207) concluded that the absence of detectable genetic differences between red tree voles and putative dusky tree voles, combined with the lack of consistently verifiable morphological differences, suggested that the subspecific status of the dusky tree vole might not be warranted. Miller *et al.* (2006a, entire) found evidence of marked genetic differences in the red tree vole that could indicate the existence of a possible subspecies, although they did not explicitly address the implications of their work on red tree vole taxonomy. Subsequent conversations with the authors, however, indicated that observed genetic differences were sufficient to potentially support recognition of the dusky tree vole as a subspecies if there were additional differentiations in identifiable characteristics and if the boundaries of those differentiations were congruent with the ''Northern Coast range'' genetic grouping identified in Miller *et al.* (2006a, p. 151). However, our review of the best and most current data on the genetics, behavior, morphology, and range of the putative dusky tree vole reveals no other characteristics of diagnostic utility that correspond with the ''Northern Coast range'' haplotype grouping identified by Miller *et al.* (2006a, p. 151). There is not a consistent and well-substantiated range description of the dusky tree vole. Although some morphological differences may occur between the red tree vole and the putative dusky tree vole, these differences have little diagnostic utility and may only represent a clinal variation, as would be expected between northern and southern populations of the red tree vole based on Bergmann's Rule (an ecogeographic principle that states that animals at more northerly latitudes tend to be larger than individuals of the same species at more southerly latitudes) (Miller *et al.* 2010, entire). The prevailing behavior of foraging on western hemlock and Sitka spruce within the Sitka spruce plant series does not correspond to the geographic range of the ''Northern Coast range'' genetic entity described by Miller *et al.* (2006a, p. 151), but comprises only a small portion of the range of that haplotype group. Presumptive differences in coloration, which served as one of the primary bases for the original subspecies distinction of the dusky tree vole, have never been quantified. Such a conventional approach to subspecies designation, used historically and frequently based on apparent geographic or clinal variation, is often not supported when tested by more rigorous analyses of multiple characters (e.g., Thorpe 1987, pp. 7, 9).

Given the lack of diagnostic characteristics that correspond with the ''Northern Coast range'' haplotype group described by Miller *et al.* (2006a, p. 151) and the findings of Bellinger *et al.* (2005 entire) and Miller *et al.* (2010 entire) that there are no detectable genetic or morphological differences yet found between dusky tree voles and red tree voles, we do not believe there is sufficient evidence to indicate that the dusky tree vole is a distinct subspecies. Although the dusky tree vole was recognized as a subspecies in Wilson and Reeder's Mammal Species of the World (2005, pp. 962–963), we note that this reference did not recognize, or was published prior to, the availability of the work of Bellinger *et al.* (2005, entire) and Miller *et al.* (2006a, entire; 2010 entire). Subsequent to the publication of some of these latter works, the Oregon Natural Heritage Information Center ceased recognition of the dusky tree vole as a subspecies (ORNHIC 2007, p. 17), as did the U.S. Forest Service and Bureau of Land Management's Survey and Manage program (USDA and USDI 2007, p. 289). Finally, the dusky tree vole is not recognized as a valid subspecies of the red tree vole in the Integrated Taxonomic Information System (ITIS 2011). Therefore, based on the best available scientific and commercial data, as described above, we have concluded that the dusky tree vole is not a valid subspecies, and therefore is not eligible for listing as such under the Act. We must next evaluate whether the North Oregon Coast population of the red tree vole is a DPS to determine whether it would constitute a listable entity under the Act.

Distinct Vertebrate Population Segment Analysis

The Service and the National Marine Fisheries Service (now the National Oceanic and Atmospheric Administration—Fisheries), published the Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act (DPS Policy) in the **Federal Register** on February 7, 1996 (61 FR 4722) to guide the implementation of the DPS provisions of the Act. Under the DPS Policy, three elements are considered in the decision regarding the establishment and classification of a population of a vertebrate species as a possible DPS. These are applied similarly for additions to and removals from the Lists of Endangered and Threatened Wildlife and Plants. These elements are:

(1) The discreteness of a population in relation to the remainder of the species to which it belongs;

(2) The significance of the population segment to the species to which it belongs; and

(3) The population segment's conservation status in relation to the Act's standards for listing, delisting, or reclassification (i.e., is the population segment endangered or threatened?).

In the petition, we were asked to consider listing a DPS for the red tree vole in the North Oregon Coast portion of its range if we did not conclude that the dusky tree vole was a valid subspecies of the red tree vole. In accordance with our DPS Policy, this section details our analysis of the first two elements, described above, to assess whether the vertebrate population segment under consideration for listing may qualify as a DPS.

Specific to red tree vole genetics, as we noted above (see Subspecies Analysis), in this section we have reviewed the research on red tree vole genetics and evaluated whether or not the genetics evidence supports identifying a population segment that meets the discreteness and significance standards described above. Although genetic research indicates that the putative dusky tree vole may not be a valid subspecies (e.g. Bellinger *et al.* 2005, entire; Miller *et al.* 2010, entire), whether or not a population segment is discrete and significant is a different question and these works do not exclude the possibility that there is a discrete and significant population segment for the red tree vole.

Discreteness

The DPS Policy's standard for discreteness requires an entity to be adequately defined and described in some way that distinguishes it from other representatives of its species. A population segment of a vertebrate species may be considered discrete if it satisfies either of the following two conditions:

(1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or

(2) It is delimited by international governmental boundaries within which significant differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist.

The North Oregon Coast portion of the red tree vole range is markedly separated from the rest of the species' range based on the genetic discontinuities described by Miller *et al.* (2006a, pp. 150–151). Miller *et al.* (2006a, entire) examined phylogeographical patterns by analyzing mitochondrial control region sequences of 169 red tree voles sampled from 18 areas across the range of the species in Oregon. In addition, they analyzed Cytochrome *b* sequences from a subset of these samples. Through phylogenetic network and spatial genetic analyses, the researchers found a primary genetic discontinuity separating red tree voles from the northern (areas A through F (Miller *et al.* 2006a, Figure 1, pp. 146, 151–152)) and southern (areas G through R (Miller *et al.* 2006a, Figure 1, pp. 146, 151–152)) sampling areas; a secondary discontinuity separated the northern sampling areas into eastern (areas B, E, and G (Miller *et al.* 2006a, Figure 1, pp. 146, 151–152)) and western (areas A, C, D, and F (Miller *et al.* 2006a, Figure 1, pp. 146, 151–152)) subdivisions separated by the Willamette Valley (Miller *et al.* 2006a, pp. 150–153). Miller *et al.* (2006a, p. 151) labeled the eastern subdivision as the ''Northern Cascade range'' sequence, and the western subdivision the ''Northern Coast range'' sequence, reflecting the associated mountain ranges. As described in the *Taxonomy and Description* section, above, genetic researchers considered the degree of genetic difference between the 3 groupings of red tree voles to be highly significant (Miller and Haig 2009, pers. comm.). We thus consider the population of red tree voles represented by the ''Northern Coast range'' haplotypes to be markedly separated from other populations of the taxon as evidenced by quantitative measures of genetic discontinuity.

Red tree voles within the ''Northern Coast range'' haplotype (genetic) group identified by Miller *et al.* (2006a, pp. 150–151) came from several specific sampling locations, but the researchers did not attempt to delineate precise boundaries between the three genetic groupings of red tree voles in Oregon. We have therefore defined the boundary of the northern Coast Range population of red tree voles based on a combination of convergent genetic, physical, and ecological characteristics. To assist in this delineation, we relied in part on the physiographic provinces used in the Northwest Forest Plan because they incorporate physical, biological, and environmental factors that shape large landscapes (FEMAT 1993, p. IV–5). In addition, much of the forest-related research relevant to our analysis has been based on these province delineations. We interpret the area occupied by the ''Northern Coast range'' genetic group of red tree voles to include that portion of the Oregon Coast Range Physiographic Province (FEMAT 1993, pp. II–27, IV–7) from the Columbia River south to the Siuslaw River. In addition, the Willamette Valley to the east of the northern Oregon Coast Range provides a geographic barrier for genetic exchange between red tree voles found in the northern Oregon Coast Range and those found in the northern Cascade Range; the western edge of the Willamette Valley thus forms a natural eastern boundary for the red tree vole population in the northern Oregon Coast Range.

As for the southern limit of the ''Northern Coast range'' haplotypes, there is no identifiable geographic boundary that may act as a genetic barrier. We chose the Siuslaw River as an identifiable feature that approximates a divide between Miller *et al.*'s (2006a, pp. 150–151) southern and northern haplotypes in the Oregon Coast Range. This is an area where vegetation transitions from more mesic vegetation species in the north to drier vegetation in the south (Franklin and Dyrness 1973, p. 72; McCain 2009, pers. comm.). In addition, the Siuslaw River creates an approximate break between ecosystems that experience longer fire return intervals to the north and shorter return intervals to the south (Hardt 2009, pers. comm.). This area transitions into the southern end of the western hemlock vegetation zone, which has a patchier fire severity distribution as compared to the northern Oregon Coast Range, which is characterized by high fire severities (Agee 1993, pp. 211–213). This delineation of the boundary of the northern Oregon Coast Range population of the red tree vole, described above, is shown in Figure 2.

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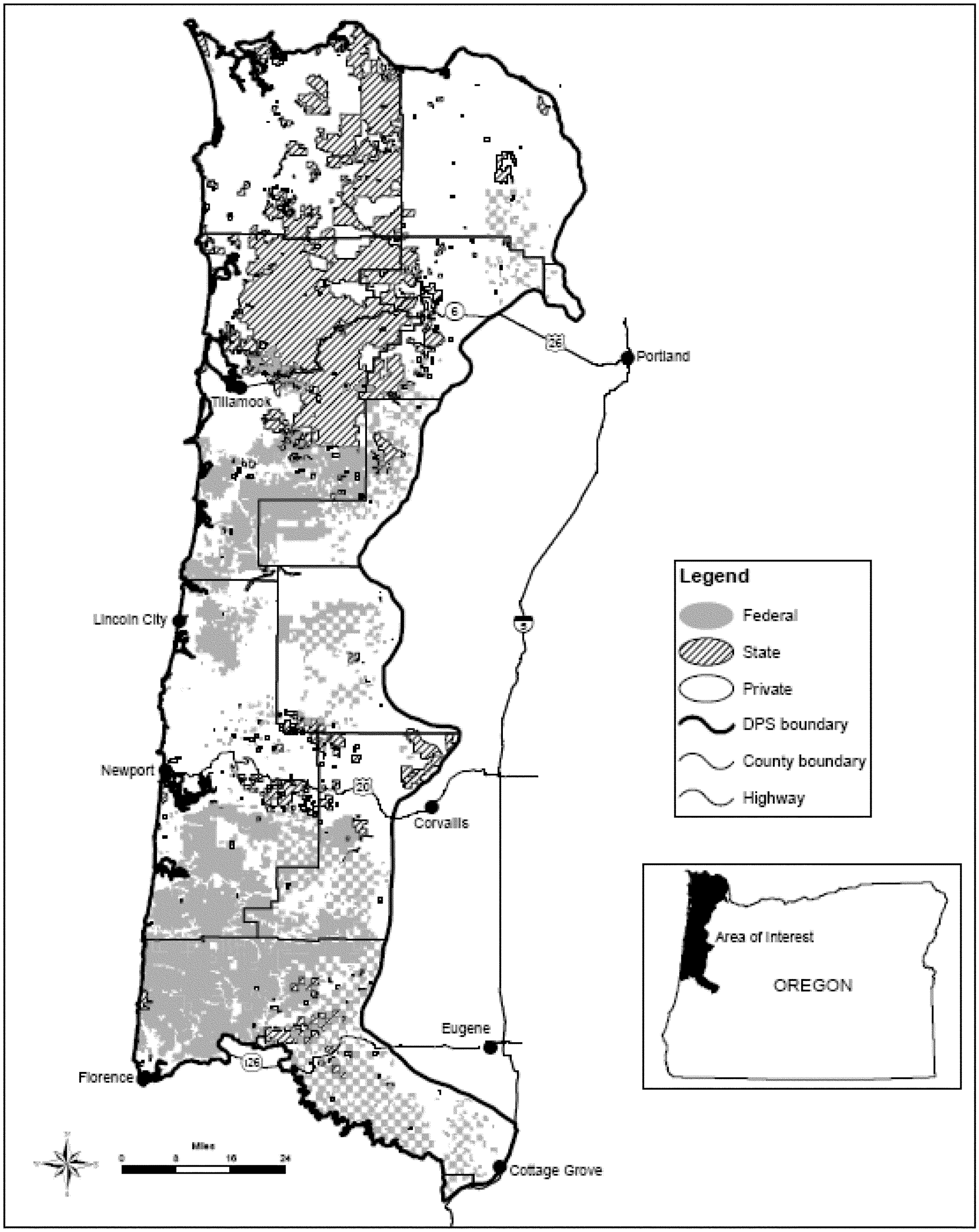

Figure 2. North Oregon Coast Distinct Population Segment (DPS) of the Red Tree Vole.

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There is some overlap of haplotypes in the lineage of sequences unique to the northern Oregon Coast Range and the southern portion of the tree vole range (Miller *et al.* 2006a, pp. 153–154). This overlap, combined with the absence of an obvious geographical barrier to genetic interchange, leads to a hypothesis that the observed genetic discontinuity in this area represents a zone of secondary contact between lineages that were divided during the most recent glaciation approximately 12,000 years ago (Miller *et al.* 2006a, p. 154). Although the Cordilleran ice sheet of the Wisconsin glaciation did not overlay present-day Oregon, associated climate change during the glaciation fragmented the forest landscape (Bonnicksen 2000, pp. 8–10, 15–16, 24–25). Subalpine forests occupied much of northwestern Oregon, with western hemlock and Sitka spruce remaining only in isolated, protected areas (Bonnicksen 2000, p. 25). These potential bottlenecks in northern populations may have separated red tree voles into separate lineages that continue to exist today (Miller *et al.* 2006a, p. 154). A similar genetic discontinuity is found in the southern torrent salamander (*Rhyacotriton* *variegatus*) in this vicinity (Miller *et al.* 2006b, p. 565). In addition, multiple plant species exhibit genetic discontinuities in the vicinity of the central Oregon Coast (Soltis *et al.* 1997, pp. 353–359).

We conclude that the North Oregon Coast population of the red tree vole is markedly separated from the remainder of the red tree vole population and meets the discreteness criterion for the DPS Policy based on quantitative measures of genetic discontinuity. Genetic distribution in the red tree vole is not random, with a markedly distinct group of haplotypes located in the northern Oregon coast. The Willamette Valley likely serves as a genetic barrier between the North Oregon Coast tree vole population and tree voles in the northern Cascades. While there is no currently identifiable geographic barrier to the south, glacial activity at the end of the Pleistocene Epoch may have been responsible for creating multiple lineages of red tree voles, as well as other species, that are still identifiable today. The Siuslaw River is an identifiable feature that appears to be approximately coincident with the southernmost boundary of the ''Northern Coast range'' genetic group of the red tree vole (Miller *et al.* 2006a, p. 151).

Significance

If we have determined that a vertebrate population segment is discrete under our DPS Policy, we then consider its biological and ecological significance to the taxon to which it belongs in light of Congressional guidance (see Senate Report 151, 96th Congress, 1st Session) that the authority to list a DPS be used ''sparingly'' while encouraging the conservation of genetic diversity. To evaluate whether a discrete vertebrate population may be significant to the taxon to which it belongs, we consider the best available scientific evidence. As precise circumstances are likely to vary considerably from case to case, the DPS Policy does not describe all the classes of information that might be used in determining the biological and ecological significance of a discrete population. However, the DPS Policy describes four possible classes of information that provide evidence of a population segment's biological and ecological significance to the taxon to which it belongs. This evaluation may include, but is not limited to:

(1) Persistence of the discrete population segment in an ecological setting that is unusual or unique for the taxon;

(2) Evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon;

(3) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range; or

(4) Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

Persistence of the DPS in an ecological setting that is unique or unusual for the taxon. The Sitka spruce plant series in the northern Oregon coast appears to be a unique ecological setting for a portion of the population of the red tree vole that was determined to be discrete. The Sitka spruce series occurs in the strongly maritime climate near the ocean, following the coastal fog up river valleys. Sitka spruce ranges from southcentral Alaska to northern California, with the most extensive portion of its range occurring in southeastern Alaska and northern British Columbia, Canada (Burns and Honkala 1990, Sitka spruce chapter). Although present at some level along most of the Oregon coastline, it is more limited in this southern portion of its range, but extends much farther inland toward the northern part of the Oregon Coast Range than in the southern portion, where ridge systems along the coastline intercept the fog layer (Franklin and Dyrness 1973, pp. 58–70; McCain and Diaz 2002, p. 59). With the exception of scattered small patches on the southern and central Oregon coast, the majority of the Sitka spruce plant series in Oregon lies in the area encompassed by the North Oregon Coast population of red tree voles (McCain and Diaz 2002, p. 61). It is in the Sitka spruce plant series that the alternative tree vole diet of western hemlock and Sitka spruce needles predominates (see *Diet* section). Douglas-fir appears to have been historically uncommon in the Sitka spruce series (Agee 1993, p. 194). Little variation in annual temperature, minor summer plant moisture stress, and very high precipitation make the Sitka spruce series extremely productive, producing large trees relatively quickly, and containing plant associations that tend to develop and maintain older forest characteristics important to a variety of wildlife species.

The Sitka spruce plant series is the only portion of the red tree vole range where the consumption of western hemlock and Sitka spruce is the dominant foraging behavior. Within the extent of the ''Northern Coast range'' genetic grouping identified by Miller *et al.* (2006a, p. 151), this behavior is exhibited by tree voles in the western portions of Lincoln, Tillamook, and Clatsop Counties. While there is evidence of individual red tree voles elsewhere in the range foraging on species other than Douglas-fir, these are rare occurrences and nowhere else in the range of the red tree vole does a non-Douglas-fir diet dominate. This alternative diet appears well ingrained, as evidenced by wild voles adapted to a diet of western hemlock refusing to eat Douglas-fir in captivity and ultimately starving to death (Maser 2009, pers. comm.). This ecological setting has resulted in a foraging behavior that appears relatively inflexible and unique to the red tree voles in this area, as red tree voles in forests dominated by Douglas-fir apparently exhibit greater behavioral plasticity and have been observed to eat western hemlock and Sitka spruce in captivity (Clifton 1960, p. 44; Maser 2009, pers. comm.).

The ecological setting and unique foraging behavior of red tree voles in the northern Oregon Coast Range create different selective pressures for the animals in this portion of their range relative to red tree voles in the remainder of the taxon's range. Such selective pressures are the foundation of speciation, and such distinct traits may be crucial to species adaptation in the face of changing environments (Lesica and Allendorf 1995, p. 756). We find the discrete population of tree voles in the northern Oregon Coast Range contains a unique ecological setting in the form of the Sitka spruce plant series because the plant series is extremely limited within the red tree vole range, and because of the relatively unique and inflexible foraging behavior tied to this plant series that may be indicative of ongoing speciation. However, the geographic range in which this ecological setting and associated unusual foraging behavior is expressed does not correspond to the range of the tree voles identified under the discreteness criterion, above, as it occurs in only a subset of the range of tree voles with the ''Northern Coast range'' genetic grouping (Miller *et al.* 2006a, p. 151). Therefore, although we recognize this ecological setting and the associated unique foraging behavior of tree voles to be potentially important from an evolutionary perspective, we find that the discrete population of tree voles in the northern Coast Range as a whole do not meet this significance criterion under the DPS policy.

Evidence that loss of the DPS would result in a significant gap in the range of the taxon. The loss of the North

Oregon Coast portion of the red tree vole range would result in a roughly 24 percent reduction in the range of the red tree vole. This loss is significant for multiple reasons, in addition to the fact that it represents nearly one-quarter of the total range of the species. For one, it would occur in the part of the range where the alternative foraging behavior of feeding on spruce and hemlock is the dominant behavior observed. Although this behavior is expressed in only a subset of this portion of the range, it is unique to this portion of the range and is of potential evolutionary significance, therefore its loss would be significant to the taxon as a whole. Secondly, while loss of the North Oregon Coast population would not create discontinuity in the remaining range, species at the edge of their range may be important in maintaining opportunities for speciation and future biodiversity (Fraser 1999, p. 50), allowing adaptation to future environmental changes (Lesica and Allendorf 1995, p. 756). Furthermore, peripheral populations may represent refugia for species as their range is reduced, as described by Lomolino and Channell (1995, p. 339), who found range collapses in mammal species to be directed towards the periphery. Genetically divergent peripheral populations, such as the North Oregon Coast population of the red tree vole, are often of disproportionate importance to the species in terms of maintaining genetic diversity and therefore the capacity for evolutionary adaptation (Lesica and Allendorf 1995, p. 756). Finally, in the face of predictions that climate change will result in species' ranges shifting northward and to higher elevations (Parmesan 2006, pp. 648–649; IPCC 2007, p. 8; Marris 2007, entire) (see *Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence*), the northern Oregon Coast Range may become a valuable refugium from climate change effects for the species, as it includes the northernmost portion of the red tree vole's range as well as higher elevations near the Oregon Coast Range summit. Based on the above considerations, we therefore conclude that loss of the North Oregon Coast population of the red tree vole would result in a significant gap in the range of the taxon.

Evidence that the DPS represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range. As part of a determination of significance, our DPS Policy suggests that we consider whether there is evidence that the population represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range. The North Oregon Coast population of the red tree vole is not the only surviving natural occurrence of the species and has not been introduced outside of its historical range. Consequently, this factor is not relevant to our determination regarding significance.

Evidence that the DPS differs markedly from other populations of the species in its genetic characteristics. Red tree voles exhibit marked genetic structure. As described under *Discreteness,* above, Miller *et al.* (2006a, entire) characterized patterns of genetic divergence across the range of the red tree vole in western Oregon based on analyses of mitochondrial DNA from 18 sampling areas. The results of their spatial analysis of molecular variance revealed three distinctive genetic groupings of red tree voles in Oregon: A ''southern'' haplotype group, and a ''northern'' haplotype group that was further subdivided into 2 groups, the ''Northern Cascade range'' and ''Northern Coast range'' groups (Miller *et al.* 2006a, Figure 3, p. 151). The sampling areas that correspond to the ''Northern Coast range'' subdivision of the ''northern'' group (Areas A, C, D, and F) correspond to the entity we have described here as the North Oregon Coast population of the red tree vole. In the 4 sampling areas for the ''Northern Coast range'' genetic sequence (Miller *et al.* 2006a, p. 151), 20 out of the 21 D-loop haplotypes identified were unique to those locations, and in 3 of 4 sampling areas, 100 percent of the individuals sampled had a location-specific haplotype (60 percent of the individuals had a location-specific haplotype in the fourth sampling area; a single haplotype from Area C was also detected in Area N) (Miller *et al.* 2006a, Table 1, p. 148; Appendix, pp. 158–159). Although the researchers could not identify a strict discontinuity or barrier between the northern and southern groupings, which exhibited the greatest genetic distances, they suggest that the Willamette Valley serves as an important phylogeographical barrier that is likely responsible for the secondary genetic discontinuity identified between red tree voles in the western (''Northern Coast range'' sequence) and eastern (''Northern Cascade range'' sequence) portions of the northern haplotypes group (Miller *et al.* 2006a, pp. 151, 155).

Loss of the North Oregon Coast population of the red tree vole would eliminate a unique set of genetic haplotypes from the red tree vole population. Retaining genetic variation provides a wider capability for species to adapt to changing environmental conditions (Frankham *et al.* 2002, p. 46). Peripheral populations that are known to be genetically divergent from other conspecific populations, such as the North Oregon Coast population of the red tree vole, may have great conservation value in providing a species with the capacity to adapt and evolve in response to accelerated environmental changes (Lesica and Allendorf 1995, p. 757). Changing environmental conditions are almost a certainty for the red tree vole, given the prevailing recognition that warming of the climate system is unequivocal (IPCC 2007, p. 30). The importance of maximizing the genetic capacity to adapt and respond to the environmental changes anticipated is therefore magnified. Furthermore, preservation of red tree voles and their unique genetic composition at the northern extent of their range may be particularly important in the face of climate change, as most northern-hemisphere temperate species are shifting their ranges northward in response to that phenomenon, and species that cannot shift northward have suffered range contractions from loss of the southernmost populations (Parmesan 2006, pp. 647–648, 753; IPCC 2007, p. 8). Given that the Columbia River presents an apparent absolute barrier to northward expansion of the species, the northern Coast Range population of the red tree vole may provide an important refugium for the persistence of the species if more southerly populations are extirpated in the face of climate change. Losing an entire unique genetic component of the red tree vole, with its inherent adaptive capabilities, is significant and could compromise the long-term viability of the species as a whole. We therefore conclude the marked difference in genetic characteristics of the North Oregon Coast population relative to other populations of the red tree vole meets the significance criterion of the DPS Policy.

DPS Conclusion

We have evaluated the North Oregon Coast population of the red tree vole to determine whether it meets the definition of a DPS, addressing discreteness and significance as required by our policy. We have considered the genetic differences of the North Oregon Coast population relative to the remainder of the taxon, the ecological setting of the northern Oregon Coast Range, and the proportion of the range of the red tree vole that the North Oregon Coast population comprises. We conclude that the North Oregon Coast population of the red tree voles is a valid distinct population segment under the 1996 DPS Policy (Figure 2). The North Oregon Coast population meets the discreteness criterion of the DPS Policy because it is markedly separated from the remainder of the taxon based on genetic differences. Genetic distribution in the red tree vole is not random, but exhibits a markedly distinct group of haplotypes located in the northern Oregon Coast Range (Miller *et al.* 2006a, entire). We also conclude that the North Oregon Coast population of red tree voles is significant on multiple accounts. The loss of this population would virtually eliminate a unique genetic component of the red tree vole, substantially reducing genetic diversity and consequently limiting the species' ability to evolve and adapt to changing environments. Loss of this population, which comprises 24 percent of the range of the red tree vole, would result in a significant gap in the range, primarily because of the value of peripheral populations in maintaining diversity and evolutionary adaptation, and because this area may provide a valuable refugium in the event of predicted climate change. The loss of red tree voles in the northern Oregon Coast Range would also result in the loss of a unique alternative foraging behavior exhibited by tree voles in the Sitka spruce plant series. Although this behavior occurs in a subset of the area encompassed by the North Oregon Coast population (Forsman and Swingle 2009, unpublished data), it is of potential evolutionary significance to the species; therefore the loss of that portion of the species' range that includes this subpopulation would be of significance to the taxon as a whole.

Because this population segment meets both the discreteness and significance elements of our DPS Policy, the North Oregon Coast population segment of the red tree vole qualifies as a DPS in accordance with our DPS Policy, and as such, is a listable entity under the Act (hereafter ''North Oregon Coast DPS'' of the red tree vole). Because we have determined the DPS to be a listable entity, we do not need to analyze the alternative presented by the petitioners, which was protecting what they labeled the dusky tree vole via listing the red tree vole because it is endangered or threatened in a significant portion of its range. Below we provide an analysis of threats to the North Oregon Coast DPS of the red tree vole, based on the five listing factors established by the Act.

Summary of Information Pertaining to the Five Factors

Section 4 of the Act (16 U.S.C. 1533), and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

(1) The present or threatened destruction, modification, or curtailment of its habitat or range;

(2) Overutilization for commercial, recreational, scientific, or educational purposes;

(3) Disease or predation;

(4) The inadequacy of existing regulatory mechanisms; and

(5) Other natural or manmade factors affecting its continued existence.

In making this finding, information pertaining to the North Oregon Coast DPS of the red tree vole in relation to the five factors provided in section 4(a)(1) of the Act is discussed below. In considering what factors might constitute threats to a species, we must look beyond the exposure of the species to a particular factor to evaluate whether the species may respond to that factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat and, during the status review, we attempt to determine how significant a threat it is. The identification of factors that could impact a species negatively may not be sufficient to compel a finding that the species warrants listing. The information must include evidence sufficient to suggest that these factors, singly or in combination, are operative threats that act on the species to the point that the species may meet the definition of endangered or threatened under the Act.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Past and Current Range and Abundance

Because of its arboreal existence and difficulty to observe and capture, little is known about the past and current population sizes of red tree voles. It is difficult to accurately estimate the size of a local tree vole population, let alone the population of the entire species (Howell 1926, p. 56; Blois and Arbogast 2006, p. 958). Estimates indicate that observers using ground-based survey methods may only see approximately half of the nests, with a bias towards observing more nests in younger forests than in older forests due to the greater visibility (Howell 1926, p. 45; Swingle 2005, pp. 78, 80–81; Swingle and Forsman 2009, p. 284). While nests can be counted and assessments have been made of the activity status of the nests, translating nest counts to numbers of voles does not yield good population estimates because some nests will be missed, some individuals occupy multiple nests, and determining whether nests are actively occupied is not possible without climbing to the nests and dissecting or probing them for voles (Swingle and Forsman 2009, p. 284). Using the presence or absence of green resin ducts and cuttings to determine the activity status of nests, which formerly had been a common method used in tree vole surveys, is now known to be unreliable for assessing actual nest occupancy by voles because the resin ducts can retain a fresh appearance for long periods of time if stored in the nest or out of sunlight, resulting in potential overestimates of active nest occupancy (USDA and USDI 2007, p. 290).

Although historical observations of tree voles are useful for assessing the range of the species, they may also be biased because collectors did not sample randomly. Thus, historical locations of tree voles tend to occur in clusters where a few collectors spent a lot of time searching for them. Until extensive surveys were conducted by the Forest Service and BLM as part of the Survey and Manage program adopted in 1994 under the NWFP, much of the range of the red tree vole had never been searched. The lack of historical documentation of tree vole presence thus cannot be interpreted as meaning that tree voles had limited populations or were historically absent from an area, especially if that area formerly provided suitable forest habitat for tree voles and was contiguous with known occupied areas. Surveys by naturalists in the late 1800s and early 1900s were more of an inventory to find new species and to determine species presence as opposed to determining abundance of a particular species (Jobanek 1988, p. 370). Only portions of Oregon were surveyed, and coverage was cursory and localized. Given the arboreal existence of the red tree vole and difficulty of finding and observing them, few specimens were collected or observed until more was understood about their life history (Bailey 1936, p. 195; Jobanek 1988, pp. 380–381). Many nests were simply inaccessible to early naturalists. Nests were often high up in big trees, many of which were too large to climb without the benefit of modern climbing equipment, or the trees lacked enough branches on the lower bole to readily free-climb (e.g. Jobanek 1988, p. 391). Howell (1921, p. 99) noted that there was little hope for finding tree voles in virgin timber because of the large trees and the abundant moss that might conceal ''a score of hidden nests.'' Vernon Bailey, Chief Naturalist of the U.S. Bureau of Biological Survey, considered the red tree vole to be abundant in the wild yet rare in museum collections because of the difficulty in collecting them (Jobanek 1988, p. 382). Murray Johnson, the most prolific early collector of tree voles, spent most of his time searching in young forests because he could not climb big trees (Forsman 2010, pers. comm.).

Red tree voles are found on both the eastern and western slopes of the Oregon Coast Range. Although there are no records of red tree voles in Clatsop County north of Saddle Mountain or in Columbia County, there is no reason to believe that tree voles did not once occur there given the presence of historical habitat (see *Range and Distribution*). There is a gap in the distribution of tree vole specimens and nests south of Saddle Mountain State Park in south-central Clatsop County, through the eastern two-thirds of Tillamook County south to the town of Tillamook (Forsman *et al.* 2009b, p. 229). There are no historical records of voles collected in this area, but there is also no evidence that early naturalists searched this area for tree voles. This gap in the range corresponds roughly with the area of the Tillamook burn, a stand-replacing fire that burned over 300,000 acres (121,400 ha) in 1933 (Pyne 1982, pp. 330–331). This area reburned in three successive fires over the next 18 years, for a combined total burn area of 350,000 acres (141,650 ha) (Pyne 1982, pp. 330–331). It is reasonable to conclude that voles were present in this area prior to the fire, considering that much of the burned area contained older forest similar to forests occupied by tree voles in areas adjacent to the burn.

Extensive surveys done throughout the range of the red tree vole as part of the NWFP Survey and Manage program have resulted in information that has helped to refine the distribution of the red tree vole (USDA and USDI 2000a, p. 376; USDA and USDI 2007, pp. 289–290). Information gleaned from these more recent surveys indicate that tree voles continue to be widely distributed throughout much of their range in Oregon with the exception of the northern Oregon Coast Range, particularly the area within the DPS north of Highway 20. This portion of the Coast Range north of Highway 20 accounts for nearly three-quarters of the DPS. Within the DPS, 36 percent of the Federal land, 92 percent of the State and County ownership, and 77 percent of the private ownership lies north of Highway 20 (Figure 2). In other words, this portion of the DPS is primarily in State, County, and private ownership, with relatively little Federal land. In the northern Oregon Coast Range north of Highway 20, tree voles are now considered uncommon and sparsely distributed compared to the rest of the range, based on observations of vole nests classified as recently occupied (USDA and USDI 2007, pp. 289, 294). Furthermore, the few nests that are recorded in this portion of the DPS likely result in overestimation of tree vole occupancy given errors in nest activity classification (USDA and USDI 2007, p. 290) and the difficulty in translating nest counts to vole numbers discussed earlier in this section.

Descriptions of historical search efforts for red and Sonoma tree voles indicate that once the species' behavior and life history were understood, searchers were more successful in finding tree voles, often with little difficulty. Observers typically noted the patchy distribution of voles, and once they found voles, they tended to readily find multiple nests and voles in the same area (Taylor 1915, pp. 140–141; Howell 1926, pp. 42–43; Clifton 1960, pp. 24–30; Maser 1966, pp. 170, 216–217; Maser 2009, pers. comm.; Forsman and Swingle 2010, p. 104). For example, Clifton (1960, pp. 24–30) averaged one day searching for every red tree vole ''colony'' found near Newberg, Oregon, and Howell described more than 50 Sonoma tree voles being collected over 2 days near Carlotta, California in 1913 (Howell 1926, p. 43).

In contrast, between 2002 and 2006, Forsman and Swingle (2006, unpublished data) spent 1,143 person-hours searching potential vole habitat in or near areas where voles historically occurred in or immediately adjacent to the DPS and captured or observed only 27 voles, equating to 42 hours of search effort per vole found. Although a rigorous quantitative comparison cannot be made between recent and historical observation data, the above anecdotal information indicates that tree vole numbers are greatly reduced in the DPS—red tree voles are now scarce in the same areas where they were once found with relative ease. Similarly, decreases in Sonoma tree vole numbers have been observed, although not quantified, over the past decade (Diller 2010, pers. comm.). The weight of evidence suggesting that tree voles are less abundant now increases upon considering that most historical observations were by naturalists who primarily collected voles from younger forests where nests were more easily observable and accessible by free-climbing (e.g. Howell 1926, p. 42; Clifton 1960, p. 34; Maser 2009, pers. comm.; Forsman 2010, pers. comm.). These early naturalists were limited in the size and form (e.g., presence or absence of low-lying limbs that allowed for free-climbing) of trees they could climb, unlike current researchers, yet found many voles with relatively little effort. In contrast, researchers in recent years searching these same areas have captured comparatively few voles per unit effort, using state-of-the-art climbing gear to access every potential nest observed, regardless of tree form or size (Forsman 2009, pers. comm.; Forsman and Swingle 2006, unpublished data; 2009, pers. comm.). Although rigorous population estimates cannot be determined from these data, the evidence suggests that red tree voles are now much less abundant within the DPS than they were historically.

Habitat loss appears to at least partly explain the apparent reduction in tree vole numbers, both rangewide and within the DPS. As an example, many researchers have noted a continual decrease in both habitat and numbers of Sonoma tree voles near Carlotta, California, from 1913 through 1977 (Howell 1926, p. 43; Benson and Borell 1931, p. 226; Zentner 1966, p. 45). Specific to the North Oregon Coast DPS, Forsman and Swingle (2009, pers. comm.) noted the reduction or loss of habitat in areas where tree voles historically occurred; habitat loss seemed especially prominent in coastal areas and along the Willamette Valley margin, where Forsman and Swingle (2009, unpublished data; 2009, pers. comm.) observed that some historical collecting sites had since been logged and found fewer voles than were historically collected from these areas. The apparently significant decline in tree vole abundance within the North Oregon Coast DPS of the red tree vole appears to correspond with the extensive historical loss of the older forest type that provides the highest quality habitat for the red tree vole, as well as the ongoing harvest of timber on short rotation schedules that maintains the remaining forest in lower quality early seral conditions in perpetuity. In addition, continuing timber harvest in younger forest areas adjacent to remaining patches of older forest diminishes the habitat quality of these stands by maintaining them in an isolated and fragmented condition that may not allow for persistent populations of red tree voles.

Landscapes in the Oregon Coast Range have become increasingly fragmented and dominated by younger patches of forest, as old and mature forests have been converted to younger stands through anthropogenic alteration (Wimberly *et al.* 2000, p. 175; Martin and McComb 2002, p. 255; Wimberly 2002, p. 1322; Wimberly *et al.* 2004, p. 152; Wimberly and Ohmann 2004, pp. 631, 635, 642). The historical loss of large contiguous stands of older forest has manifested in the current primary threats to the North Oregon Coast DPS of the red tree vole of insufficient habitat, habitat fragmentation, and isolation of small populations; these threats are addressed under *Factor E,* below. Here we address the effects of varying levels of ongoing habitat loss and modification in the North Oregon Coast DPS of the red tree vole. We first provide some background on the historical environmental conditions in the DPS, as this provides important context for understanding the effects of ongoing timber harvest on the habitat of the red tree vole.

Modification of Oregon Coast Range Vegetation

Within the Oregon Coast Range Province, the amount of forests that have the type of structure and composition favored by red tree voles has experienced significant loss over the past century, primarily due to timber harvest. While the total area of closed canopy forest remained fairly stable from 1936 to 1996, major shifts have occurred in the distribution, age, and structure of these forested cover classes. Most germane to red tree voles, there has been a change from a landscape dominated by large conifers with quadratic mean tree diameters greater than or equal to 20 in (51 cm) to a landscape dominated by smaller conifers. Specifically, the percent cover of large conifers in the Coast Range Province declined from 42 percent in 1936 to 17 percent in 1996 (Wimberly and Ohmann 2004, p. 631). On Federal lands, timber harvest has declined substantially since the inception of the NWFP in 1994 (Spies *et al.* 2007a, p. 7). Moeur *et al.* (2005, pp. 95–100) even showed a 19 percent increase in older forests (minimum quadratic mean diameter 20 in (51 cm) and canopy cover greater than 10 percent, regardless of structural complexity) on Federal lands in the NWFP during the first 10 years of its implementation. However, more recently, better data and analysis methods have indicated that in fact there has been a slight net decline in older forest on Federal lands between 1994 and 2007. Specifically on Federal lands in the Oregon Coast Range, older forest has declined from 44.2 percent to 42.9 percent (Moeur *et al.* 2010a, Figure 1).

There is some indication that managed second-growth forests are not developing characteristics identical to natural late-successional forests, and that second-growth forests and clearcuts exhibit reduced diversity of native mammals typically associated with old-growth forest conditions (Lomolino and Perault 2000, pp. 1526, 1529). The historical losses of late-successional forest and ongoing management of most forests on State, County, and private lands for harvest on a short-rotation schedule have resulted in the destruction of the older forest habitats favored by red tree voles; these older forest habitats now persist largely in small, isolated fragments across the DPS. Because of the historical loss of older forest stands, the remaining habitat now contains forests in earlier seral stages, which provide lower-quality habitat for red tree voles. The ongoing management of much of the forest within the DPS for timber harvest on relatively short rotation schedules, particularly on State, County, and private lands, contributes to the ongoing modification of tree vole habitat by maintaining forests in low quality condition; most of the younger forest types within the DPS are avoided by tree voles for nesting. Although younger forests may provide important interim or dispersal habitats for red tree voles, it is unlikely that forests lacking the complexity and structural characteristics typical of older forests can support viable populations of red tree voles over the long term. These concepts are explored further in the section, Continuing Modification and Current Condition of Red Tree Vole Habitat, below.

Habitat Loss From Timber Harvest

In their analysis of forest trends, Wimberly and Ohmann (2004, p. 643) found that land ownership had the greatest influence on changes in forest structure between 1936 and 1996, with State and Federal ownership retaining more large-conifer structure than private lands. Loss of large-conifer stands to development was not considered a primary cause of forest type change. Instead, loss to disturbance, primarily timber harvest, was the biggest cause, with fires accounting for a small portion of the loss (Wimberly and Ohmann 2004, pp. 643–644). Between 1972 and 1995, timber clearcut harvest rates in all stand types were nearly three times higher on private land (1.7 percent of private land per year) than public land (0.6 percent of public land per year), with the Coast Range dominated by private industrial ownership and having the greatest amount of timber harvest as compared to the adjacent Klamath Mountain and Western Cascades Provinces (Cohen *et al.* 2002, pp. 122, 124, 128). Within the Coast Range, there has been a substantial shift in timber harvest from Federal to State and private lands since the 1980s, with an 80 to 90 percent reduction in timber harvest rates on Federal lands (Azuma *et al.* 2004, p. 1; Spies *et al.* 2007b, p. 50).

More than 75 percent of the future tree harvest is expected to come from private timberlands (Johnson *et al.* 2007, entire; Spies *et al.* 2007b, p. 50) and modeling of future timber harvests over the next 50 years indicates that current harvest levels on private lands in western Oregon can be maintained at that rate (Adams and Latta 2007, p. 13). Loss and modification of tree vole habitat within the northern Oregon Coast Range is thus expected to continue, albeit at a lower rate on State and Federal lands compared to private lands (see discussion under *Factor D,* below). However, even on Federal lands, which provide the majority of remaining suitable habitat for red tree voles within the DPS, some timber harvest is expected to continue in those land allocations where allowed under their management plans. Although some forms of harvest may not exert a significant negative impact on red tree voles if managed appropriately (for example, thinning in Late-Successional Reserves (LSRs) or Late-Successional Management Areas (LSMAs) with the goal of enhancing late-successional characteristics over the long term), lands in the Timber Management Area (TMA) and Matrix allocation are intended for multiple uses, including timber harvest. As an example, since the inception of the NWFP, 55 percent of the timber harvest on BLM lands within the DPS came from the Matrix allocation, 20 percent from Adaptive Management Areas (AMAs), and 25 percent came from LSRs both within and outside the AMA (BLM 2010, unpublished data). These numbers do not include harvest within Riparian Reserves, which overlay all land allocations. Within the DPS, approximately 156,844 ac (63,475 ha) are in the Matrix and TMA allocations, combined.

Continuing Modification and Current Condition of Red Tree Vole Habitat

The loss of much of the older forest within the DPS has reduced high-quality habitat for tree voles to relatively small, isolated patches; these conditions pose a significant threat to red tree voles, which are especially vulnerable to the effects of isolation and fragmentation due to their life-history characteristics (see *Factor E,* below). Tree voles are naturally associated with unfragmented landscapes, and are considered habitat specialists that select areas of contiguous mature forest; they are not adapted to fragmented landscapes and early seral habitat patches (Martin and McComb 2002, p. 262). At present and for the foreseeable future, however, much of the remaining forest on State and private lands in the North Coast Range DPS is managed for timber production, as are lands within the Matrix and TMA allocations of the Federal lands (see *Factor D* below). Managing for timber production either removes existing habitat or prevents younger stands from developing into suitable habitat due to short harvest rotations. Remaining older forest habitat tends to be in small, isolated patches (see *Factor E* below); we consider such forest conditions to provide poor habitat for the red tree vole and unlikely to sustain the species over the long term. Although some State land and much of the Federal ownership is managed for development or maintenance of late-successional habitat or old-forest structure conditions, active management such as thinning activities are allowed and encouraged to develop the desired stand conditions. However, thinning stands occupied by tree voles can reduce vole numbers or eliminate them (see below).

The most comprehensive analysis of current red tree vole habitat conditions specific to the North Coast Range DPS is a report by Dunk (2009, entire). Dunk (2009, p. 1) applied a red tree vole habitat suitability model (Dunk and Hawley 2009, entire) to 388 Forest Inventory Analysis (FIA) plots systematically distributed on all ownerships throughout the DPS (the FIA is a program administered by the USDA Forest Service, and is a national scientific inventory system based on permanent plots designed to monitor the status, conditions, and trends of U.S. forests). FIA plots are resampled every 10 years to monitor changes in forest vegetation. The red tree vole habitat suitability model estimates the probability of red tree vole nest presence (Po) from 0 to 1; the larger values of Po (e.g., 0.9 or 0.8) represent a greater probability of nest presence and correlate to presumed higher quality habitat. Based on their model results, Dunk and Hawley (2009, p. 630) considered a Po of greater than or equal to 0.25 as likely having presence of a tree vole nest in an FIA plot; a Po of less than 0.25 was considered as not likely to have a tree vole nest. The Po cutoff point of 0.25 represents the value that achieved the highest correct classification of occupied and non-occupied sites while attempting to reduce the error of misclassifying plots that actually had nests as plots without nests; plots with Po greater than 0.25 are assumed to represent suitable tree vole habitat. Based on this assumption that a Po value of 0.25 represents suitable tree vole habitat, Dunk (2009, pp. 4, 7) found that 30 percent of the plots on Federal lands within the DPS had suitable habitat, but only 4 and 5 percent of the plots on private and State lands within the DPS, respectively, had suitable habitat. Across all landownerships in the DPS collectively, 11 percent of the plots had potentially suitable habitat for red tree voles. Thus within the DPS, there is relatively little suitable habitat remaining for the red tree vole, and this suitable habitat is largely restricted to Federal lands. State and private lands, which comprise the majority of the DPS (78 percent of the land area), provide little suitable habitat for tree voles.

Dunk and Hawley (2009, p. 631) also compared red tree vole usage of forest types with their proportional availability on the landscape; this is an important measure of habitat selection by the species. If red tree voles do not select for any particular forest type condition, we would expect usage of different forest types to be proportional to their availability. If a forest type is used less than expected based on its availability, that is assumed to represent selection against that forest type; in other words, the species avoids using that forest type, even though it is available. If a forest type is used more than expected based on availability, that is assumed to represent selection for that forest type; the species is seeking out that forest type, despite the fact that it is less readily available. The forest type that tree voles select is assumed to be suitable habitat.

Combining the strength of selection analysis done by Dunk and Hawley (2009, p. 631) with the current habitat condition in the DPS based on FIA data, almost 90 percent of the DPS is in a forest type condition that red tree voles tend to avoid, while only 0.3 percent of the DPS is in a forest type that red tree voles tend to strongly select for (Figure 3). This is based on evaluation of the FIA plots, comparing those with the lowest probability of selection by tree voles for nesting (lowest 20 percent of probability classes; nearly 87.3 percent of FIA plots across all landownerships within the DPS were in this condition) with those with the greatest strength of selection (highest 20 percent of probability classes; 0.3 percent of FIA plots across all landownerships were in this condition). Assuming that tree voles exhibit the strongest selection for the highest quality habitats, this translates into roughly 11,605 ac (4,700 ha) of high-quality habitat remaining for red tree voles distributed across a DPS roughly 3.8 million ac (1.6 million ha) in size. Furthermore, although some nests may have been missed during tree vole surveys, the nest estimates used by Dunk and Hawley (2009, entire), and subsequently applied by Dunk (2009, entire), likely overestimate probable tree vole occupancy for two reasons. First, occupied sites were based on locations of tree vole nests, and as explained earlier, the presence of nests, even those classified as ''active,'' do not necessarily equate to tree vole occupancy. Second, the analyses were based on plot-level data at the scale of less than 2.5 ac (1 ha). The distribution of tree vole habitat and effects of habitat fragmentation, connectivity, and possible metapopulation dynamics may also influence the presence of tree voles on a site such that a 2.5 ac (1 ha) plot of highly suitable habitat isolated from other suitable habitat is less likely to contain or sustain tree voles than connected stands (Dunk 2009, p. 9). Thus, its actual likelihood of occupancy may be lower than predicted by the model due to its landscape context. The sample patch size used by Dunk (2009, entire) is less than the 5–10 acres (2–4 ha) in which Hopkins (2010, pers. comm.) found nests of tree voles and substantially less than the minimum forest stand size of 75 ac (30 ha) in which individual tree voles have been found (Huff *et al.* 1992, p. 7). Whether either of these minimum patch sizes can sustain a population of red tree voles over the long term is unknown and is influenced by such things as habitat quality within and surrounding the stand, position of the stand within the landscape, and the ability of individuals to move among stands (Huff *et al.* 1992, p. 7; Martin and McComb 2003, pp. 571–579). Given the conservative assumptions of the model, the amount of remaining likely suitable habitat within the DPS reported by Dunk (2009, entire) may represent a best-case scenario, and the amount of remaining habitat suitable for red tree voles is likely less than estimated here.

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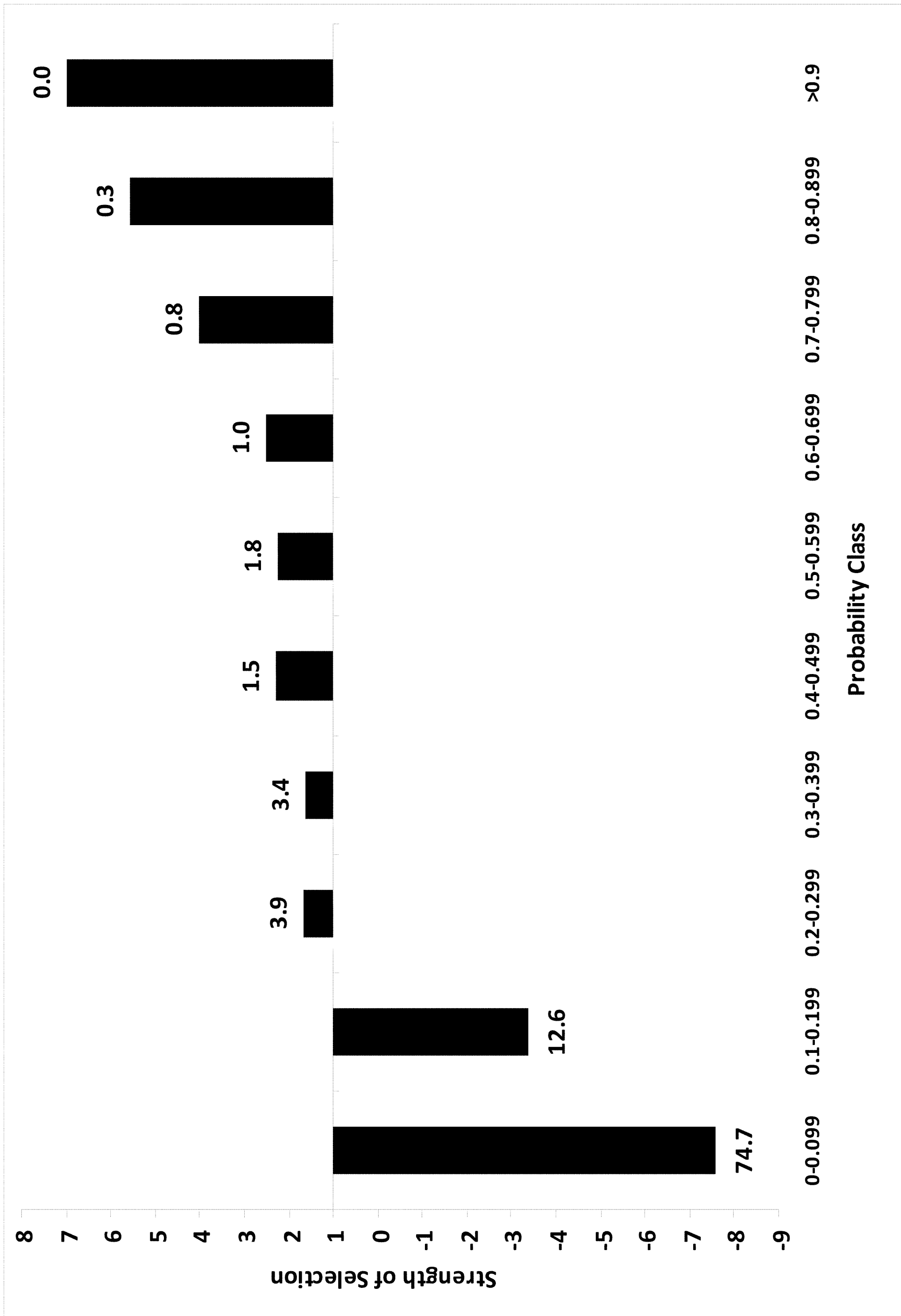

Figure 3. Strength of habitat selection by red tree voles on Federal land throughout their range in Oregon and percentage of FIA plots in DPS within each Probability Class. Probability Classes are the probability of occurrence of red tree vole nests in a plot with certain habitat characteristics, with probabilities divided into 10 equally sized groups. Bars represent the strength of selection by red tree voles for each Probability Class, with values less than 1 (below the line) indicating habitat avoidance and values greater than 1 (above the line) indicating habitat selection within a specific Probability Class. The gradient in strength of selection exhibited by red tree voles ranged from strongest selection for the highest Probability Classes (bars to the right of the graph) to strong selection against the lowest Probability Classes (bars to the left of the graph). The number at the end of each bar is the percentage of plots within the DPS within that Probability Class.

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Spies *et al.* (2007b, entire) modeled red tree vole habitat in the Coast Range Physiographic Province of Oregon (physiographic provinces are geographic divisions of areas of distinctive topography and geomorphic structure).

Their results indicated that tree vole habitat currently makes up almost 50 percent of the province, with just under half of that habitat occurring on private lands (Spies *et al.* 2007a, p. 10, Figure 2). While this assessment of the current condition of tree vole habitat in coastal Oregon differs from Dunk (2009, entire), we believe Dunk to be a more accurate description of red tree vole habitat in the DPS and rely more heavily on that work for the following reasons. Dunk's analysis is specific to the DPS, whereas the Coast Range Physiographic Province, which includes the DPS, covers an additional 1.8 million acres (728,000 ha) extending to the south of the DPS. Second, Spies *et al.* (2007b, p. 51, Appendix D) assessed tree vole habitat by developing habitat capability index models that reflect habitat characteristics important for survival and reproduction based on literature and expert opinion. The variables they used were restricted to existing geographic information system layers that could be projected into the future using forest dynamics models. They were not able to empirically verify their red tree vole habitat capability index model with independent data, although it was reviewed by two published experts. Dunk's analysis (2009, entire) relied on the red tree vole habitat model described in Dunk and Hawley (2009, entire), which was empirically developed based on presence or absence of red tree vole nests in FIA plots on Federal lands throughout most of the tree vole range. Dunk (2009, entire) then applied that model to FIA plots across all ownerships within the DPS to describe current tree vole habitat distribution based on existing field data.

As noted earlier, although red tree voles are widely considered habitat specialists strongly associated with older forests, they may also be found in younger stands (Maser 1966, pp. 216–217; Thompson and Diller 2002, p. 95; Swingle and Forsman 2009, pp. 278, 284), which are much more abundant in the DPS. Although some have suggested that these young forests may be population sinks (Carey 1991, p. 34), the role of younger stands in tree vole population dynamics is unclear. Tree voles in young stands may represent attempts of emigrants to establish territories, or may be residual populations that tolerate habitat disturbance (USDA and USDI 2000a, p. 378). It is possible that some young stands are on unique microsites where tree voles are able to reinvade and persist in the developing stands (Forsman 2010, pers. comm.). Younger stands may also be important for allowing dispersal and short-term persistence in landscapes where older forests are either isolated in remnant patches or have been largely eliminated (Swingle 2005, p. 94). The presence of individuals within a particular habitat condition does not necessarily mean the habitat is optimal, and individuals may be driven into marginal habitat if it is all that is available (Gaston *et al.* 2002, p. 374). Swingle and Forsman (2009, entire) found radio-collared tree voles in young stands throughout the year, but occupancy of younger stands appears to be short-term or intermittent (USDA and USDI 2000a, p. 378; Diller 2010, pers. comm.; Hopkins 2010, pers. comm.).

There are few data on survival of tree voles in younger stands. The only study conducted to date suggested no difference in annual survival of tree voles in young (22–55 years) and old (110–260 years) stands, but the authors cautioned that their sample sizes were small and had low power to detect effects (Swingle 2005, p. 64; Forsman and Swingle 2009, pers. comm.). Thinning younger stands occupied by tree voles can reduce or eliminate voles from these stands (Biswell 2010, pers. comm.; Swingle 2010, pers. comm.), and Carey (1991, p. 8) suggests activities that result in rapidly developing (changing, unstable) younger forests are a limiting factor for red tree voles. Conversely, when vole nests classified as occupied (based on indication of activity such as presence of fresh green resin ducts) were protected with a 10-acre buffer zone during thinning treatments, Hopkins (2010, pers. comm.) continued to find signs of occupancy at these nests post-treatment, although signs of occupancy were intermittent through time. However, Hopkins' (2010, pers. comm.) results are subject to the limitations of using the presence or absence of green resin ducts to determine the activity status of nests (see the beginning of *Factor A,* above). Red tree voles may ultimately come back to a treated stand, but how long it will be after the treatment before the stand is reoccupied is unknown. If and when tree voles return likely depends on a multitude of factors including magnitude, intensity and frequency of the treatment within the stand, type and amount of structure left after treatment (e.g., large trees), and whether or not there is a refugium or source population nearby that is available to supply voles for recruitment when the treated stand becomes suitable again (Biswell 2010, pers. comm.; Forsman 2010, pers. comm.; Hopkins 2010, pers. comm.; Swingle 2010, pers. comm.). Thus, while the value of younger stands as suitable habitat to voles is unclear, they may provide some value in otherwise denuded landscapes, and thinning treatments in these stands have the potential to further reduce vole numbers, especially if thinning design does not account for structural features and the connectivity of those features that are important to red tree voles (Swingle and Forsman 2009, p. 284). Swingle (2005, pp. 78, 94), however, cautions against using the occasional presence of tree voles in young forests to refute the importance of old forest habitats to tree voles.

In summary, whether red tree voles in younger forests can persist over long periods or are ephemeral populations that contribute little to overall long-term population viability remains unknown at this time (USDA and USDI 2007, p. 291). However, the recent work of Dunk (2009, entire) and Dunk and Hawley (2009, entire) indicate that red tree voles display strong selection for forests with late-successional structural characteristics.

Although the role of younger forest is uncertain, based on our evaluation of the best available scientific data, as described above, we conclude that older forests are necessary habitat for red tree voles and that younger stands will rarely substitute as habitat in the complete or near absence of older stands. While some State land and much of the Federal ownership is managed for development or maintenance of late-successional habitat or old-forest structure conditions, full development of this habitat has yet to occur (see below). In addition, thinning activities designed to achieve these objectives can reduce or eliminate tree voles from these stands. The ongoing management of forests in most of the North Oregon Coast DPS for the purposes of timber production thus contributes to the threat of habitat modification for the red tree vole, as forest habitats are prevented from attaining the high-quality older forest characteristics naturally selected by red tree voles and are maintained in a low-quality condition for red tree voles in the DPS. Our evaluation of the remaining older forest patches within the DPS indicate they are likely insufficient to sustain red tree voles over the long term due to their relatively small size and isolated nature (see *Factor E,* below).

Projected Trends in Red Tree Vole Habitat

Implementing current land management policies in the Coast Range Province is projected to provide an increase (approximately 20 percent) in red tree vole habitat over the next 100 years, primarily on Federal and State lands (Spies *et al.* 2007b, p. 53). Vegetation simulations indicate that private industrial timber lands will generally be dominated by open and small- and medium-sized conifer forests. Old forest structure and habitat will strongly increase on Federal and State lands, and large, continuous blocks of forest will increase primarily on Forest Service and State lands (Johnson *et al.* 2007, pp. 41–42). The estimate of older forests on State lands, however, may be a substantial overestimate because the analysis was not able to fully incorporate the complexity of the State forest management plan (Johnson *et al.* 2007, p. 43; Spies *et al.* 2007a, p. 11). In addition, the Oregon Department of Forestry (ODF) has since reduced the targeted level of old forest to be developed in northwestern Oregon forests (ODF 2001, p. 4–48; 2010c, p. 4–48). Yet even with the projected increase, the amounts of old forest will not approach historical levels estimated to have occurred over the last 1,000 years in the Coast Range Province (Spies *et al.* 2007a, pp. 10–11), and these blocks of restored older forest will continue to be separated by forests in earlier seral stages on private lands. Although restoration of Oregon Coast Range forests to historical levels of older forest conditions is not requisite for the conservation of red tree voles, we have no evidence to suggest the present dearth of suitable habitat for the red tree vole will be alleviated by the modest projected increases in older forest conditions on Federal and State lands within the DPS. Even though the amount of suitable habitat on public lands may eventually increase, these patches of suitable habitat will remain fragmented due to landownership patterns and associated differences in management within the DPS. Furthermore, the time required for stand development to achieve these improved conditions, 100 years, is substantial; whether these gradual changes will occur in time to benefit the red tree vole in the North Oregon Coast DPS is unknown. However, we anticipate that any patches of suitable habitat that may be found on public lands within the DPS 100 years from now will continue to be fragmented and isolated, due to the management practices on intervening private lands that inhibit connectivity. Thus, although projected future conditions represent a potential improvement in suitable habitat for the red tree vole, the time lag in achieving these conditions and the fragmented nature of public lands in the northern Oregon Coast Range suggests that a potential gain of 20 percent more suitable habitat 100 years from now is likely not sufficient to offset the loss, modification, and fragmentation of habitat and isolation of populations that collectively pose an immediate threat to the red tree vole in the DPS.

Loss of forest land to development is projected to occur in 10 percent of the Coast Range Province, and would most likely occur on non-industrial private lands, near large metropolitan areas, and along the Willamette Valley margin (Johnson *et al.* 2007, p. 41; Spies *et al.* 2007a, p. 11). Although timber production in the Coast Range has shifted by ownership class, declining on Federal lands and increasing on private lands, overall production is projected to stay at recent harvest levels. Actual production may result in levels higher than projected because harvest levels estimated for private industrial timberland were conservative (Johnson *et al.* 2007, pp. 42–43) and timber production on State lands may be underestimated by 20 to 50 percent (Johnson *et al.* 2007, p. 43). Johnson *et al.* (2007, pp. 45–46) described several key uncertainties that were not accounted for in their projections of future trends in the Coast Range that could potentially affect their results. These uncertainties include: effects of climate change; recently adopted initiatives that may result in an increased loss of forest land to cities, towns, and small developments; a possible decrease in global competitiveness of the Coast Range forest industry; sales of industrial forests to Timber Management Investment Organizations that may result in a shift of land use to other types of development; the effects of Swiss needle cast on the future of plantation forestry; and effects of wildfire. Most of these scenarios would result in a loss of existing or potential tree vole habitat, contributing further to the present loss, modification, fragmentation, and isolation of habitat for the red tree vole within the DPS, although the magnitude of that loss is uncertain. In conclusion, while modest increases in tree vole habitat are expected to occur in the Oregon Coast Range over the next century, they are limited primarily to Federal lands and, to some lesser degree, State lands, although the amount of older forests on State lands may be an overestimate. As described above, the time lag in achieving this potential increase in suitable habitat and the fragmented nature of public lands, especially those Federal lands with the highest quality habitats, suggests that any future gains are likely not sufficient to offset the present threat of habitat loss, modification, or fragmentation, and its ongoing contribution to the isolation of red tree voles in the DPS.

Summary of Factor A

The North Oregon Coast DPS of the red tree vole is threatened by the effects of both past and current habitat loss, including ongoing habitat modification that results in the maintenance of poor quality forest habitats and insufficient older forest habitats, addressed here, and habitat fragmentation and isolation of small populations, addressed under *Factor E.* Most of the DPS, nearly 80 percent, is in State, County, and private ownership, and most of the forested areas are managed for timber production. Ongoing timber harvest on a short rotation schedule over most of this area maintains these forest habitats in a low-quality condition, preventing these younger stands from developing the older forest conditions most suitable for red tree voles. Although the role of younger forest stands is not entirely clear, we conclude the preponderance of the best available information suggests that red tree voles are habitat specialists strongly associated with unfragmented forests that exhibit late-successional characteristics; while younger forests may play an important role as interim or dispersal habitat, older forests are required to maintain viable populations of red tree voles over the long term. The ongoing management of forests in the North Oregon Coast DPS for the purposes of timber harvest thus contributes to the threat of habitat modification for the red tree vole, as forest habitats are prevented from attaining the high-quality older forest characteristics naturally selected by red tree voles and are maintained in a low-quality condition for red tree voles in the DPS.

Factors that hinder the development and maturation of younger forest stages into late-successional forest conditions contribute to the ongoing modification of suitable habitat and maintain the present condition of insufficient remaining older forest habitat for the red tree vole in the DPS. The persistence and development of high-quality tree vole habitat over the next century under existing management policies is likely to occur primarily on Federal lands, and to a lesser degree on State lands. However, as Federal lands make up less than a quarter of the area of the DPS, even with eventually improved conditions, suitable red tree vole habitat will remain restricted in size and in a fragmented, isolated condition for the foreseeable future. In the interim, thinning activities designed to accelerate the development of late-successional forest structure conducive to tree vole habitat may reduce or eliminate local populations for an undetermined amount of time.

Declines in the amount of older forest within the Coast Range Province are unprecedented in recent history (Wimberly *et al.* 2000, pp. 176–178). This decline has translated into substantial habitat loss for red tree voles, with only 11 percent (approximately 425,000 ac (173,000 ha)) of the nearly 4 million acres (1.6 million ha) within the DPS boundary assumed to be potentially suitable habitat (Dunk 2009, p. 5). Most of this suitable habitat is restricted to Federal lands that lie in two discontinuous clusters within the DPS. State and private lands, which collectively comprise nearly 80 percent of the DPS area, provide very little suitable habitat; roughly 4 to 5 percent of the State and private lands are considered potentially suitable habitat for red tree voles (Dunk 2009, pp. 6–7).

Nearly 90 percent of the DPS is currently in a habitat condition avoided by red tree voles, and only 0.3 percent of the DPS is in a condition for which red tree voles show strong selection for nesting (Dunk 2009, p. 7). Given that nest presence does not correspond exactly with vole presence, and that the FIA sampling design may include habitat that is unavailable to tree voles, this is likely an overestimate of potential red tree vole habitat. Although Federal lands offer some protection and management of red tree vole habitat, indications are that there may not be enough habitat in suitable condition to support red tree voles north of U.S. Highway 20. In this area of the DPS Federal land is limited, connectivity between blocks of Federal land is restricted, and there are few known vole sites currently available to potentially recolonize habitat as it matures into suitable condition. Surrounding private timber lands are not expected to provide long-term tree vole habitat over the next century, and projections of suitable tree vole habitat on State land may be overestimates.

Conclusion for Factor A

Recent surveys at locations within the DPS where voles were readily captured 30 to 40 years ago have resulted in significantly fewer voles captured per unit of survey effort compared to historical collections. This suggests that tree vole numbers have declined in many areas where voles were once readily obtained by early collectors such as Alex Walker, Murray Johnson, Doug Bake, Chris Maser, and Percy Clifton (Forsman 2009, pers. comm.). Although standardized quantitative data are not available to rigorously assess population trends of red tree voles, we believe it is reasonable to conclude that, based on information from retrospective surveys of historical vole collection sites, red tree voles have declined in the DPS and no longer occur, or are now scarce, in areas where they were once relatively abundant. Loss of habitat in the DPS, primarily due to timber harvest, has been substantial and has probably been a significant contributor to the apparent decline in tree vole numbers. Current management practices for timber production, particularly on the State, and privately-owned lands that comprise the vast majority of the DPS, keep the majority of the remaining forest habitat from maturing and developing the late-successional characteristics that comprise highly suitable habitat for red tree voles. Current management for timber harvest thereby contributes to the ongoing modification of tree vole habitat, as well as the fragmented and isolated condition of the remaining limited older forest habitat for the species. Indications are that the remaining older forest patches are likely too small and isolated to maintain red tree voles over the long term (see *Factor E,* below). The biology and life history of red tree voles render the species especially vulnerable to habitat fragmentation, isolation, and chance environmental disturbances such as large-scale fires that could reasonably be expected to occur within the DPS within the foreseeable future (Martin and McComb 2003, p. 583; also addressed in *Factor E*). Based on our evaluation of present and likely future habitat conditions, we conclude that the ongoing effects of the destruction, modification, and curtailment of its habitat, in conjunction with other factors described in this finding, pose a significant threat to the persistence of the North Oregon Coast DPS of the red tree vole.

We have evaluated the best available scientific and commercial data on the present or threatened destruction, modification, or curtailment of the habitat or range of the North Oregon Coast DPS of the red tree vole, and determined that this factor poses a significant threat to the continued existence of the North Oregon Coast DPS of the red tree vole, when we consider this factor in concert with the other factors impacting the DPS.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

We are not aware of any information that indicates that overutilization for commercial, recreational, scientific, or educational purposes threatens the continued existence of the North Oregon Coast DPS of the red tree vole and have determined that this factor does not pose a significant threat to the viability of the North Oregon Coast DPS of the red tree vole.

Factor C. Disease or Predation

We are not aware of any information that indicates that disease threatens the North Oregon Coast DPS of the red tree vole, now or in the foreseeable future. With respect to predation, the red tree vole is prey for a variety of mammals and birds (see above under *Mortality*), although voles persist in many areas despite the large numbers of predators (Forsman *et al.* 2004, p. 300). However, barred owls have recently expanded into the Pacific Northwest and are a relatively new predator of red tree voles. Although a recent pellet study indicates that barred owls occasionally prey on tree voles (Wiens 2010, pers. comm.), the long-term effects of this new predator are uncertain. Barred owls have a more diverse diet than northern spotted owls, an established tree vole predator (Courtney *et al.* 2004, p. 7–40). While the varied diet of the barred owl may potentially limit their pressure as predators on tree voles, the fact that they outnumber spotted owls in the southern portion of the DPS by a 4:1 ratio (Wiens 2010, pers. comm.) may increase that pressure. Whether predation on red tree voles may significantly increase as a result of growing numbers of barred owls is unknown. Therefore, we cannot draw any conclusions as to the impact of barred owl predation on red tree voles in the DPS at this time.

Conclusion for Factor C

While predators undoubtedly have some effect on annual fluctuations in tree vole numbers, there is no evidence to suggest that changes in predation rates have caused or will cause long-term declines in tree vole numbers. Tree voles are exposed to a variety of predators and as a prey species they have adapted traits that reduce their exposure and vulnerability to predation; examples include cryptic coloration and leaping from trees when pursued (Maser *et al.* 1981, p. 204), or minimizing the duration of individual foraging bouts outside of the nest (Forsman *et al.* 2009a, p. 269). While habitat alterations may affect the exposure and vulnerability of tree voles to predators (see above under *Mortality*), predators themselves do not appear to be a principal threat affecting long-term trends in red tree vole numbers. We therefore conclude that the continued existence of the red tree vole in the North Oregon Coast DPS is not threatened by disease or predation, nor is likely to become so.

We have evaluated the best available scientific and commercial data on the effects of disease or predation on the North Oregon Coast DPS of the red tree vole, and determined that this factor does not pose a significant threat to the viability of the North Oregon Coast DPS of the red tree vole.

Factor D. Inadequacy of Existing Regulatory Mechanisms

Timber harvest has been identified as the primary cause of vegetation change and loss of red tree vole habitat in the Oregon Coast Range Province (Wimberly and Ohmann 2004, pp. 643–644) (see *Factor A* discussion, above). Although most of the losses of late-successional forest conditions occurred historically, these losses, combined with current management of younger forests on both private and public lands, contribute to the ongoing modification, curtailment, fragmentation, and isolation of habitat for the red tree vole in the DPS. The inadequacy of existing regulatory mechanisms in regard to timber harvest contributes to these threats. Regulations for timber harvest differ among land ownerships and are explained in separate sections below.

Regulatory Mechanisms on Private Land

Private lands make up 62 percent of the DPS, and over 75 percent of timber harvest in the Coast Range Province is expected to come from private forest lands (Johnson *et al.* 2007, entire; Spies *et al.* 2007b, p. 50). The Oregon Forest Practice Administrative Rules and Forest Practices Act (OAR) (Oregon Department of Forestry 2010a, entire) apply on all private and State-owned lands in Oregon, regulating activities that are part of the commercial growing and harvesting of trees, including timber harvesting, road construction and maintenance, slash treatment, reforestation, and pesticide and fertilizer use. The OAR provide additional guidelines intended for protection of soils, water, fish and wildlife habitat, and specific wildlife species while engaging in tree growing and harvesting activities. The red tree vole is not one of the specific species provided for in the OAR, and we are not aware of any proactive management for tree voles on private timberlands in Oregon.

Per the Oregon Revised Statute, an average of two snags or green trees per ac (0.8 per ha) greater than 30 ft (9 m) tall and 11 in (28 cm) diameter are required to be left in harvest units greater than 25 ac (10 ha) (ORS 527.676); up to half of these trees may be hardwoods. Retention buffers are required around northern spotted owl nest sites (70 ac (28 ha) of suitable habitat) (OAR 629–665–0210), bald eagle nest sites (330-ft (100-m) buffer) (OAR 629–665–0220,), bald eagle roost sites (300-ft (100-m) buffer) (OAR 629–665–0230), and great blue heron nest sites (300-ft (91-m) buffer) (OAR 629–665–0120). In addition, foraging trees used by bald eagles (OAR 629–665–0240) and osprey nest trees and associated key nest site trees (OAR 629–665–0110) are also protected from timber harvest. In all cases, protections of these sites are lifted when the site is no longer considered active (OAR 629–665–0010).

Within the Coast Range, small perennial streams that are neither fish bearing nor a domestic water source have no tree retention requirements. With respect to all other perennial streams, no harvest is allowed within 20 ft (6 m). In addition, riparian management areas are established around all fish-bearing streams and large or medium non-fish-bearing streams; their distances range from 20 to 100 ft (6 to 30 m) beyond the stream, depending on the stream size and fish-bearing status. Within these riparian management areas, from 40 to 300 square ft (4 to 28 square m) of basal area must be retained for every 1,000 ft (305 m) of stream; basal area retention levels depend on stream size, fish presence, and type of harvest (OAR 629–640–0100 through 629–640–0400). Trees within the no-harvest 20-ft (6-m) buffer count towards these retention requirements. To meet the basal area requirement within the riparian management areas of large and medium streams, a minimum number of live conifers must be retained to meet shade requirements. Depending on stream size and fish-bearing status, live conifer retention requirements range from 10 to 40 per 1,000 ft (305 m) of stream, with a minimum size of either 8 or 11 in (20 or 28 cm) dbh. If the basal area requirements are still not met with the minimum conifer retention, the remainder can be met with trees greater than 6 in (15 cm); a portion of this retention can be met with snags and hardwoods (excluding red alder (*Alnus rubra*)). For all streams where the pre-harvest basal area of the riparian area is less than the targeted retention level, timber harvest may still occur (section 6 of OAR 629–640–0100 and section 7 of OAR 629–640–0200). In addition, basal area credits may be granted, upon approval, for other stream enhancements, such as placing downed logs in streams to enhance large woody debris conditions (OAR 629–640–0110). Thus, while basal area credits may produce in-stream enhancements, they simultaneously reduce potential arboreal habitat for red tree voles.

Given the extensive network of streams within the Coast Range, riparian management areas appear to have potential in providing connectivity habitat for red tree voles between large patches of remnant older forest stands. However, given the minimum tree retention sizes and numbers prescribed under the OAR, we believe them to be insufficient to provide adequate habitat to sustain populations of red tree voles, and likely not sufficient to provide connectivity between large patches of remnant older forest stands. As an example, the streamside rules applying the most protection apply around fish-bearing streams (sections 5–7 of OAR 629–640–100). Although these sections require retention of 40 live conifer trees per 1,000 ft (305 m) along large streams, and 30 live conifer trees along medium streams, these trees need only be 11 in (28 cm) dbh for larger streams and 8 in (20 cm) dbh for medium streams to count toward these requirements. Although these regulatory requirements are stated as minimums, they potentially allow for conditions such that the remaining trees will likely be far smaller than those generally utilized by red tree voles, and the remaining trees may be relatively widely dispersed along the riparian corridor, thereby impeding arboreal movement. Furthermore, the purpose of tree retention in riparian management areas is to retain stream shade, and retaining a minimum number of live conifers is designed to distribute that shade along the stream reach by retaining more, smaller trees to meet the basal area requirements rather than concentrate the targeted basal area into a few large trees. Consequently, there is little incentive to retain any larger trees within the riparian management areas.

Although in general biological corridors are believed to be beneficial for the conservation of fragmented populations by allowing for genetic interchange and potential recolonization (e.g., Bennett 1990, entire; Fahrig and Merriam 1994, p. 51; Rosenberg *et al.* 1997, p. 677), possible disadvantages may include potential increases in predation, parasitism, and invasion of interior habitats by introduced species (e.g., Wilcove *et al.* 1986, pp. 249–250; Simberloff and Cox 1987, pp. 66–67; Yahner 1988, p. 337; Simberloff *et al.* 1992, p. 498). Long, narrow strips of habitat suffer from a high ratio of edge to interior, resulting in ''edge effects'' such as altered microclimates and potentially increased vulnerability to generalist predators (Yahner 1988, p. 337; Saunders *et al.* 1991, pp. 20–22; Chen *et al.* 1993, p. 220). In old-growth Douglas-fir forests, altered environmental conditions may extend up to 137 m (450 ft) from the forest edge, to the extent that patches less than 10 ha (25 ac) in size provide essentially no forest interior habitat (Chen *et al.* 1992, p. 395).

The successful use of corridors to maintain regional populations is highly species-specific (Rosenberg *et al.* 1997, p. 683; Debinski and Holt 2000, p. 351), and depends on the spatial configuration of the remaining habitat, the quality of the corridor habitat, and the habitat specificity and dispersal ability of the species in question (Henein and Merriam 1990, p. 157; Fahrig and Merriam 1994, p. 53; With and Crist 1995, entire; Rosenberg *et al.* 1997, entire). In general, habitat specialists with limited dispersal capabilities, such as the red tree vole, have a lower ''critical threshold'' for responding to fragmented habitats; such species may experience the environment as functionally disconnected even when their preferred habitat still comprises nearly half of the landscape (With and Crist 1995, p. 2452; Pardini *et al.* 2010, p. 6). Reduced survival probability for animals moving through linear corridors of habitat may potentially be offset by large numbers of dispersers, but for animals with relatively low reproductive rates and low mobility, such as the red tree vole, survival probability may be compromised under such conditions (Martin and McComb 2003, p. 578). Poor-quality habitat conditions for red tree voles in riparian management areas, such as from reduced canopy cover, may reduce their probability of survival in moving through such a patch (Martin and McComb 2003, p. 577). For example, there is some evidence that small mammals may experience increased risk and local extinction events of predation in narrow corridors or isolated fragments of habitat (e.g., Henderson *et al.* 1985, p. 103; Mahan and Yahner 1999, pp. 1995–1996). Although riparian buffers are frequently suggested as potential corridors for dispersal, Soulé and Simberloff (1986, pp. 33–34) specifically suggest that forest interior species such as the red tree vole would likely avoid using such areas for movement between remaining patches of conifer forest. Observations that red tree voles are now apparently absent from forest stands where they historically occurred indicate riparian management areas are likely not functioning as successful corridors for dispersal and recolonization by red tree voles in the DPS.

Although the OAR do not specifically provide protection for red tree voles, some protections may be afforded to individuals that are incidentally found within buffers retained for sensitive wildlife sites. However, such scattered remnants of possible habitat are unlikely to protect viable populations due to their small size and fragmented and isolated nature. In addition, these protected areas can be logged if the site is no longer occupied by the target species. The short timber harvest rotations (e.g., in calculating its riparian rule standards, OAR assume 50-year rotations for even-aged stands, and 25-year entry intervals for uneven-aged management) in the surrounding landscape further limits the potential for a well-connected tree vole population. Although tree voles have been found in these younger stands, frequent thinnings, larger harvest units, and the tendency for these large harvest units to aggregate into larger blocks of younger stands that are unlikely to develop into red tree vole habitat (Cohen *et al.* 2002, p. 131) decrease the likelihood that tree voles will persist on industrial private timber lands even with protections afforded to other species per the OAR. Therefore, based on the above assessment, we conclude that existing regulatory mechanisms on private land are inadequate to ameliorate the threat of habitat loss and fragmentation and provide for the conservation of the North Oregon Coast DPS of the red tree vole.

Summary of Regulatory Mechanisms on Private Land

Private lands comprise more than 60 percent of the DPS, and most of the projected future timber harvest in the Oregon Coast Range is anticipated to come from these lands. The Oregon Forest Practices Administrative Rules and Forest Practices Act (OAR) provide the current regulatory mechanism for timber harvest on private lands within the DPS. The stated goal of the OAR is to provide for commercial growing and harvesting of trees. The OAR additionally provide guidelines intended to protect soils, water, and fish and wildlife habitat, including protection of specific wildlife species, during the course of these activities. The red tree vole is not one of the specific species protected by the OAR, and due to its relatively specialized habitat requirements and limited dispersal capability, provisions intended to conserve habitat for other wildlife species are likely inadequate to provide for the conservation of the red tree vole. Despite the incidental benefits provided by protective measures for aquatic resources and other wildlife, management under this regulatory mechanism results in much of the habitat for the red tree vole being continually modified such that insufficient high-quality habitat (well-connected stands with older forest characteristics) is maintained, and remnant older forest patches remain fragmented and isolated due to intensive management in the surrounding landscape. We therefore conclude that existing regulatory mechanisms on private land are inadequate to provide for the conservation of the North Oregon Coast DPS of the red tree vole, as they contribute to threats of habitat destruction, modification, or curtailment under Factor A, as well as the threats of habitat fragmentation and isolation of small populations under Factor E.

Regulatory Mechanisms on State Land

State lands make up 16 percent of the DPS, totaling just over 600,000 ac (242,800 ha). Although there are some scattered State parks located primarily along the coastal headlands, virtually all of the State ownership in the DPS is land managed by the Oregon Department of Forestry (ODF) in the Tillamook and Clatsop State Forests, as well as other scattered parcels of State forest land in the southern half of the DPS. State forest lands are to be actively managed, assuring a sustainable timber supply and revenue to the State, counties, and local taxing districts (ODF 2010c, pp. 3–2, 3–4 to 3–5). Annual timber harvests projected over the next decade for each of the three State Forest districts within the DPS sum to 181 million board feet (422,000 cubic m) (ODF 2009, p. 59; 2011a, p. 69; 2011b, p. 65). Harvest intensities (annual harvest per acre of landbase) differ by district; harvest intensity for the Tillamook District, which comprises half of the State Forest ownership within the DPS, is projected at 188 board feet per acre (0.526 and 0.530 cubic m per ha) per year. The Astoria and Forest Grove Districts project substantially higher harvest intensities of 526 and 530 board feet per acre per year, respectively. Acreages used to calculate harvest intensity may include acres that are not capable of producing forest and may be a slight underestimate.

The overarching statutory goal for management of State forest lands is to provide, ''healthy, productive, and sustainable forest ecosystems that over time and across the landscape provide a full range of social, economic, and environmental benefits to the people of Oregon'' (ODF 2010c, p. 3–12). Common School Forest Lands comprise 3 percent of the northwestern Oregon State Forests, and they are to be managed to maximize income to the Common School Fund (ODF 2010c, p. 3–2). To the extent that it is compatible with these statute-based goals, wildlife resources are to be managed in a regional context, providing habitats that contribute to maintaining or enhancing native wildlife populations at self-sustaining levels (ODF 2010c, pp. 3–12, 3–14).

The Northwestern Oregon State Forest Management Plan provides management direction for the State Forests within the DPS (ODF 2010c, p. 1–3). There is no specific direction in the ODF northwestern forest management plan recommending or requiring surveys or protecting tree vole sites if they are found on State lands. ODF personnel are recording tree vole nest locations as ancillary information collected during climbing inspections of marbled murrelet (*Brachyramphus marmoratus*) nests (Gostin 2009, pers. comm.), but are not implementing management or conservation measures to known sites beyond recording the nests.

Red tree voles are, however, one of several species of concern identified by ODF for which anchor habitats have been established (ODF 2010c, pp. 4–82 to 4–83, E–42). Anchor habitats are, ''intended to provide locales where populations will receive a higher level of protection in the short-term until additional suitable habitat is created across the landscape'' (ODF 2010c, p. 4–82). They are not intended to be permanent reserves. Terrestrial anchor habitats are intended to benefit species associated with older forest and interior habitat conditions, and management within them will promote the development of complex forest structure (ODF 2010c, pp. 4–82 to 4–83). Within the State Forests in the DPS, there are 11 terrestrial anchor habitat areas totaling 40,706 ac (16,474 ha) with a mean size of 3,701 ac (1,498 ha) (ODF 2011, unpublished data).

Although the OAR apply on all State lands, the ODF may develop additional site-specific management regulations that are potentially more stringent than those set forth in the OAR. With respect to management around marbled murrelet and northern spotted owl sites, ODF exceeds the protections called for by the OAR. Spotted owl sites are protected by a 250-acre (101-ha) core area around the nest, maintenance of 500 acres of suitable habitat within 0.7 mi (1.1 km) of the nest, and 40 percent of habitat within 1.5 mi (2.4 km) of the nest (ODF 2008, 2010b). Currently there are three owl sites on ODF State Forests within the DPS, and another six in adjacent lands wherein buffers from these sites overlap onto ODF ownership (ODF 2011, unpublished data). Marbled murrelet management areas (MMMA) are established around marbled murrelet occupied sites (ODF 2010d) with the purpose of retaining habitat function. There are 42 MMMAs within the DPS totaling 6,281 acres (2,542 ha), averaging 150 acres (61 ha), and ranging in size from 13 to 623 acres (5 to 252 ha) (ODF 2011, unpublished data). Sixteen percent of the MMMA acres occur within terrestrial anchor areas. ODF also applies the OAR protection buffers for bald eagle nests and roosts, and great blue heron nests (see Regulatory Mechanisms on Private Land above).

ODF regulations for fish-bearing streams provide a 170-ft (52 m) buffer on each side, with no harvest within 25 ft (7.6 m), management for mature forest (basal area of 220 square ft (20 square m) of trees greater than 11 in (28 cm) dbh) between 25 and 100 ft (7.6 and 30 m) of the stream, and retention of 10 to 45 conifers and snags per acre (4 to 18 per ha) between 100 and 170 ft (30 and 52 m) of the stream (ODF 2010c, p. J–7). Large and medium streams that are not fish-bearing have management standards similar to fish-bearing streams except that conifer and snag retention levels between 100 and 170 ft (30 to 52 m) from the stream are reduced to 10 per ac (4 per ha) (ODF 2010c, p. J–8). Management standards for small, perennial, non-fish-bearing streams, as well as intermittent streams considered ''high energy reaches'' (ODF 2010c, pp. J–9—J–10), apply to at least 75 percent of the stream reach and include no harvest within 25 ft (7.6 m), retain 15 to 25 conifer trees and snags per acre (6 to 10 per ha) between 25 to 100 ft (7.6 to 30 m) of the stream, and retain 0 to 10 conifer trees and snags per acre (0 to 4 per ha) between 100 to 170 ft (30 to 52 m). Additional management standards also apply within 100 ft (30 m) of intermittent streams (ODF 2010c, p. J–10). Within harvest units, all snags are to be retained, and green tree retention must average 5 per ac (2 per ha) (ODF 2010c, pp. 4–53 to 4–54). Although riparian retention levels on ODF lands are larger than what is required on private lands, they still allow for a reduction in existing habitat suitability for red tree voles, with minimum retention levels not meeting tree vole habitat requirements due to reduced stand densities and lack of crown continuity.

State forests are managed for specific amounts of forest structural stages. The objective is to develop 15 to 25 percent of the landscape into older forest structure (32 in (81 cm) minimum diameter trees, multiple canopy layers, diverse structural features, and diverse understory) and 15 to 25 percent into layered structure (two canopy layers, diverse multi-species shrub layering, and greater than 18 in (46 cm) diameter trees mixed with younger trees) over the long term (ODF 2010c, p. 4–48). Attainment of these objectives would benefit the red tree vole; however, this is not the current condition of State forests within the DPS, and these desired future conditions are not projected to be reached for at least 70 years (ODF 2010c, p I–13). At present, only about 1 percent of the State forests in northwestern Oregon is currently in older forest structure and 12 percent is in a layered structure condition (ODF 2003a, pp. 4, 12; ODF 2003b, pp. 4, 16; ODF 2009, pp. 4, 21; ODF 2011a, pp. 6, 20, 23; ODF 2011b, pp. 6, 25). While 13 percent of the State forests is in a complex structure category (old forest and layered forest structure, combined), only a small subset of this likely provides tree vole habitat given that only 5 percent of the State land is considered actual red tree vole habitat (Dunk 2009, pp. 5, 7).

Given the description provided (ODF 2010c, p. 4–48), we estimate the older forest structure condition as defined by the ODF would generally provide red tree vole habitat. However, only some portion of the layered structure condition appears to be suitable tree vole habitat, and that is likely to be stands with more complexity that are closer in condition to that found in stands classed as old forest structure. Thus, stands that currently meet tree vole habitat requirements on State lands are limited to 5 percent of the ownership and, given such a low proportion, most likely isolated. Furthermore, the direction is to actively manage these landscapes to meet the targeted forest structure stages via thinning activities that promote desired structural features. The use of thinning activities to create stands that may be suitable habitat for red tree voles has not been tested; to the extent we can develop the appropriate structure and conditions in the long term, such treatments in the surrounding landscape over the short term likely further limits the potential for a well-connected tree vole population in the interim. Meanwhile, tree voles would have to persist in these small patches of suitable habitat for decades before more suitable habitat developed.

The effects of thinning treatments on red tree voles is not well understood. Younger stands may be important for allowing dispersal and short-term persistence of tree voles in landscapes where older forests are either isolated in remnant patches or have been largely eliminated (Swingle 2005, p. 94). Thinning these younger stands, while designed to develop late-successional habitat characteristics in the long term, has the potential to degrade or remove tree vole habitat in the short term, especially if thinning design does not account for structural features and the connectivity of those features that are important to red tree voles (Swingle and Forsman 2009, p. 284). As reported in USDA and USDI (2002, p. 13), although old, inactive red tree vole nests have been found in thinned stands and shelterwood treatments, no occupied nests have been found, suggesting that red tree voles are susceptible to stand level disturbances that alter the canopy layer and may cause sites to become unsuitable. Biswell (2010, pers. comm.) and Swingle (2010, pers. comm.) have also observed reduction in numbers or elimination of red tree voles from stands that have been thinned. Hopkins (2010, pers. comm.) found that buffering nests with a 10-ac (4-ha) buffer would result in the presence of nests post-thinning, but he did not attempt to verify vole occupancy through visual observations of voles.

Although State Forest lands are managing part of their landbase to retain and develop some older forest habitat, the lack of survey and protection mechanisms to protect existing tree vole sites, combined with the limited availability of current suitable habitat and intensity of harvest and thinning activities between protected areas, leads us to conclude that existing regulatory mechanisms on State lands are inadequate to ameliorate the threat of habitat loss and fragmentation and provide for the conservation of the North Oregon Coast DPS of the red tree vole.

Summary of Regulatory Mechanisms on State Land

As discussed above under ‘‘Regulatory Mechanisms on Private Land,’’ there may be some ancillary benefits to red tree voles from actions taken to protect other wildlife species. In addition to OAR requirements to provide buffers to protect certain wildlife species, ODF provides additional buffers for spotted owls and marbled murrelets, as well as additional retention blocks in the form of terrestrial anchor habitats scattered throughout its ownership. While these areas provide for some habitat retention, some are likely too small and most too isolated to provide for a species with limited dispersal ability, such as the red tree vole. Furthermore, without pre-project surveys for voles, the species will need to serendipitously be in these retention blocks to be afforded any protections. Occupied vole sites outside these areas would be lost with any timber harvest activity. This precludes the opportunity to potentially reduce isolation and provide for additional retention blocks elsewhere on the landscape where tree voles may actually be present, thereby improving their dispersal potential.

Because of the small amounts (13 percent) of complex forest habitat (1 percent older forest and 12 percent layered forest structure) currently available on State lands throughout the DPS, there is limited ability to maintain persistent populations of red tree voles on this ownership. Also, not all areas of these combined structure categories may provide tree vole habitat, considering that empirical evidence indicates only 5 percent of the State ownership within the DPS is currently considered tree vole habitat (Dunk 2009, pp. 5, 7). State Forest Management Plans call for developing more of these older habitats, but these conditions are not expected to be reached for at least 70 years. Moreover, the use of thinning activities to create stands that may be suitable habitat for red tree voles has not been tested; to the extent we can develop the appropriate structure and conditions, it is reasonable to conclude that much of the 15 to 25 percent of the landscape targeted as older forest structural condition may eventually be suitable tree vole habitat. However, as described above, based on the currently observed proportion of suitable red tree vole habitat relative to layered forest conditions, it is likely only some undetermined portion of the 15 to 25 percent of the landscape targeted as layered forest condition may provide suitable habitat. Finally, thinning activities designed to meet these long-term structure targets may place additional limitations on the ability of tree vole populations to be well connected over those next 70 years.

Although the State does manage their forests with an eventual increase in older forest conditions as a goal, most of the State lands within the DPS are managed for some level of continuing timber harvest. The loss and modification of red tree vole habitat on State lands, compounded by isolation of existing habitat as a result of timber harvest, continues under existing regulatory mechanisms. In addition, there are no mechanisms in place to protect existing occupied tree vole sites outside of retention areas. We therefore conclude that existing regulatory mechanisms on State land are inadequate to provide for the conservation of the North Oregon Coast DPS of the red tree vole, as they contribute to threats of habitat destruction, modification, or curtailment under Factor A, as well as the threats of habitat fragmentation and isolation of small populations under Factor E.

Regulatory Mechanisms on Federal Land

Federal lands comprise 22 percent of the DPS (851,000 ac (344,400 ha)) and are concentrated in two separate areas. The southernmost portion lies between U.S. Highway 20 and the Siuslaw River, and makes up roughly two-thirds of the Federal lands within the DPS (Figure 2). The remaining Federal ownership, although more fragmented and dispersed than the southern portion in terms of ownership pattern, is generally located between Lincoln City and Tillamook, with a few scattered parcels of BLM land in Columbia and Washington Counties. The Siuslaw National Forest comprises 41 percent of the Federal land in the DPS, and the Salem and Eugene BLM Districts make up the remainder. Federal lands have been managed under the Northwest Forest Plan (NWFP) (USDA and USDI 1994, entire), although there is past and ongoing litigation that has, and will continue to, affect management planning for BLM within the DPS (see below). Implementation of the NWFP resulted in an 80 to 90 percent reduction of timber harvests from Federal lands in the Coast Range compared to levels in the 1980s (Spies *et al.* 2007b, p. 50). Approximate timber harvests projected for the next 2 years on the Federal ownership in the North Oregon Coast DPS sum to 99 million board feet (231,000 cubic m) on average per year (Herrin 2011, pers. comm.; Nowack 2011, pers. comm.; Wilson 2011, pers. comm.). This may include harvest in some areas within an administrative unit that is not encompassed by the DPS, primarily that portion of the Siuslaw National Forest that lies south of the Siuslaw River (approximately 15 percent of the forest acreage). Currently, all the harvest on

Federal land in the North Oregon Coast DPS occurs as thinning. Harvest intensity (annual harvest per acre of landbase) differs by administrative unit and ranges from 66 board feet per acre (0.066 cubic m per ha) per year on the Siuslaw National Forest to 154 board feet per acre (0.154 cubic m per ha) per year on that portion of the Eugene BLM District within the DPS. Acreages used to calculate harvest intensity may include acres that are not capable of producing forest, and may be slightly underestimated.

Within the DPS, BLM has operated under two different management plans over the past several years. On December 30, 2008, BLM published Records of Decision (ROD) for the Western Oregon Plan Revisions (WOPR), which revised the Resource Management Plans for the BLM units in western Oregon, including those units within the DPS. The WOPR meant that BLM would no longer be managing their land under the standards and guidelines of BLM's 1995 Resource Management Plans, which had adopted the Northwest Forest Plan. On July 16, 2009, the Acting Assistant Secretary for Lands and Minerals administratively withdrew the WOPR RODs. The administrative withdrawal of WOPR was challenged in court (*Douglas Timber Operators, Inc.* v. *Salazar,* 09–1704 JDB (D.D.C.). On March 31, 2011, the United States District Court for the District of Columbia vacated and remanded the administrative withdrawal of the WOPR RODs, effectively reinstating the WOPR RODs as the operative Resource Management Plan for BLM lands within the DPS. However, there remains ongoing litigation, the result of which could affect the implementation of WOPR (e.g. *Pacific Rivers Council* v. *Shepard,* Case No. 3:2011–cv–00442 (D. Or.); *AFRC* v. *Salazar-DOI/Locke,* Case No. 1:11–cv–01174 (D.D.C.)). Our analysis of existing regulatory mechanisms on Federal lands reflects the current management plans that are officially in place. That is, the NWFP for Forest Service lands, and the WOPR for BLM lands.

Of the Federal lands in the DPS, 34 percent are managed as LSRs, and 14 percent are managed as an Adaptive Management Area (AMA), which includes additional LSR management in portions of the AMA (see below). Another 18 percent are managed as Late-Successional Management Area (LSMA). The primary management objectives in LSRs, an NWFP allocation, are to protect and enhance late-successional forest conditions (USDA and USDI 1994, p. C–11). The LSMAs, established under WOPR, have a similar objective as LSRs, with a focus on maintaining and developing habitat for northern spotted owls and marbled murrelets (USDI 2008, p. 2–28). The combined area of LSR and LSMA equals 52 percent of the Federal ownership managed for the purpose of developing and maintaining late-successional conditions, although not all of the acres in these allocations currently meet that condition. Although forest structure can vary widely with vegetation type, disturbance regime, and developmental stage, in Douglas-fir stands of western Oregon, 80 years of age is the point at which stands can begin to develop the structural complexity that is of value to late-successional species (e.g., canopy differentiation and multiple canopy layers; understory development; large limbs; large snags and logs; tree decay and deformities in the form of hollow trees, broken tops, large cavities; and epicormic branching) (USDA and USDI 1994, pp. B–2 through B–7). Thinning and other silvicultural treatments are allowed in LSRs and LSMAs if needed to create and maintain late-successional forest conditions. Within LSRs, thinning is allowed in stands up to 80 years old, except for the Northern Coast AMA, where it is allowed in stands up to 110 years (USDA and USDI 1994, p. C–12). There is no age limit for thinning in LSMAs (USDI 2008, p. 2–28). Salvage after stand-replacement disturbances is allowed in LSRs and LSMAs, although there are different standards and guidelines in place for these allocations (USDA and USDI 1994, pp. C–13 through C–16; USDI 2008, pp. Summary-9, 2–28 to 2–32).

The emphasis of the Northern Coast Range AMA, an NWFP allocation, is to restore and maintain late-successional forest habitat consistent with marbled murrelet guidelines (USDA and USDI 1994, p. D–15) through developing and testing new approaches that integrate ecological, economic, and other social objectives. Although 14 percent of the Federal land in the DPS is allocated as AMA, 10 percent of Federal land is managed as LSR within the AMA, meaning that LSR standards and guidelines are to be followed unless reconsidered as part of the AMA plan. The current AMA plan has retained the original NWFP standards and guidelines for LSRs, so in effect 62 percent of the Federal ownership is currently managed as LSR (52 percent LSR and LSMA, combined, and 10 percent AMA managed as LSR). The one difference in LSR management within the AMA as compared to the rest of the NWFP area is that thinning is allowed in stands up to 110 years of age in the AMA, as described above. Additional areas of older and more structurally complex forest is retained under the WOPR in the Deferred Timber Management Area allocation, but only through the year 2023; this land allocation makes up less than 0.5 percent of the Federal ownership within the DPS.

Of the 34 percent of Federal lands not designated as LSR or AMA in the DPS, 18 percent is classified as either Matrix (6 percent) or Timber Management Area (TMA) (12 percent), NWFP and WOPR land allocations, respectively. These allocations are where commercial timber harvest is expected to occur (*e.g.,* regeneration harvest such as clearcuts).

Allocations to protect streams and other water bodies include Riparian Management Areas (RMA) under the WOPR, and Riparian Reserves (RR) under the NWFP. Under the WOPR, the width of RMAs are reduced for most water bodies by up to half the distances compared to Riparian Reserves under the NWFP (USDA and USDI 1994b, pp. C–30 through C–31; USDI 2008, p. 2–33). Silvicultural activities, such as thinning, are allowed in these allocations to meet specific aquatic and riparian objectives (USDA and USDI 1994, pp. C–30 through C–31; USDI 2008, 2–32 through 2–34). Riparian Management Areas have been mapped under WOPR and comprise 4 percent of the Federal ownership within the DPS. Under the NWFP, stream densities in the Coast Range result in much of the Matrix allocation being overlain by Riparian Reserves that can be anywhere from 150 to 500 ft (76 to 152 m) wide on each side of the stream, depending on the waterbody and site condition (USDA and USDI 1994b, pp. C–30 through C–31; Davis 2009, pers. comm.). Overlaying Riparian Reserves and protections for other species called for in the NWFP can substantially reduce the area of Matrix available for timber harvest. For example, between riparian reserves and other protections required by the NWFP, only 3 percent of the Siuslaw National Forest is available for timber harvest other than thinning treatments designed to meet ecological objectives (Davis 2009, pers. comm.).

The remaining 10 percent of lands in the DPS under Federal ownership are in Congressional Reserves, Administratively Withdrawn Areas, and other areas under special management and not available for timber harvest. These areas may or may not be conducive to developing and maintaining older forest conditions, depending on their underlying management emphasis.

In 2007, the BLM and the Forest Service signed Records of Decision

(USDA 2007, entire; USDI 2007, entire) that eliminated the Survey and Manage mitigation measures from the BLM Resource Management Plans and the Forest Service Land and Resource Management Plans. These decisions were challenged in court (*Conservation Northwest* v. *Rey,* Case No. C–08–1067–JCC (W.D. Wash.)). On December 17, 2009, the court issued a decision finding multiple National Environmental Policy Act (NEPA) inadequacies in the 2007 Final Supplemental Environmental Impact Statement. The parties to this litigation reached a settlement agreement that was approved by the court on July 6, 2011. The settlement agreement reinstates the 2001 Survey and Manage ROD (USDA and USDI 2001, entire), as modified by the settlement agreement, for those Forest Service and BLM units within the area covered by the NWFP. The 2011 Settlement Agreement makes four modifications to the 2001 ROD. It (1) acknowledges existing exemptions (Pechman exemptions) from Survey and Manage Standards and Guidelines as a result of an earlier court-approved stipulation from different litigation (*Northwest Ecosystem Alliance* v. *Rey,* Case No. 04–844–MJP (W.D. Wash.)); (2) updates the 2001 Survey and Manage species list; (3) establishes a transition period for application of the species list; and, (4) establishes new exemption categories (2011 Exemptions), to which known site management may apply. Under the 2011 settlement agreement, the Pechman exemptions continue to apply to projects classified into four categories and include thinning in stands younger than 80 years old, replacing or removing culverts, improving riparian and stream habitat, and using prescribed fire to treat hazardous fuels.

The 2011 settlement agreement establishes seven categories of new exemptions.

The following categories of activities are exempt from pre-disturbance surveys for species on the Survey and Manage list, but known site management may apply: (1) Recreation; (2) fish and wildlife habitat restoration; (3) treatment of weeds and sudden oak death; (4) certain hazardous fuel treatments in Wildland Urban Interface; (5) bridges; (6) non-commercial fuel treatments; and (7) restoration projects involving commercial logging. The 2011 settlement agreement contains specific directions applying known site management for projects applying the 2011 exemptions, which vary depending upon the 2011 exemption applied, and a species' Survey and Manage category.

Although the Survey and Manage standards and guidelines are an artifact of the NWFP—and BLM is currently operating under the WOPR and not the NWFP—as signatories to the Survey and Manage settlement agreement, they are applying the Survey and Manage program, as described above, on their ownership within the DPS. The red tree vole falls under the Survey and Manage standards and guidelines; thus, prior to certain habitat-disturbing activities, surveys and subsequent management of high-priority sites are required for red tree voles. All sites on Federal land within the DPS are considered high-priority sites with the exception of 198,000 ac (80,130 ha) of the southernmost portion of the DPS (primarily located within the Siuslaw River drainage). Some tree vole sites on Federal land in this portion of the DPS would not be considered high-priority sites, depending on the amount of reserve land allocation in the watershed, habitat quality, number of active vole nests detected in survey areas, and the total survey effort (USDA and USDI 2003).

Although federally managed lands are expected to provide for large, well-distributed populations of red tree voles throughout most of their range, the northern Oregon Coast Range north of Highway 20 within the DPS is an exception. For this area, despite of the majority of the Federal land being managed as LSRs or LSMAs, the Final Environmental Impact Statement analyzing the effects of discontinuing the NWFP Survey and Manage program concluded that regardless of the tree vole's status as a Survey and Manage species, the combination of small amounts of Federal land, limited connectivity between these lands, and few known vole sites would result in habitat insufficient to support stable populations of red tree voles north of Highway 20 (USDA and USDI 2007, pp. 291–292). Federal lands provide more habitat for red tree voles than other ownerships in the DPS and have land allocations, such as LSRs, that require management to maintain and restore late-successional conditions that are more suitable as red tree vole habitat. However, the limited amount of Federal lands in the DPS restricts red tree vole distribution and magnifies the effect of habitat loss occurring from stochastic events, further limiting the red tree vole's ability to persist in an area or recolonize new sites (see Factors A and E).

Thinning treatments are allowed in LSRs and LSMAs, but their effect on red tree voles is not well understood. Younger stands may be important for allowing dispersal and short-term persistence of tree voles in landscapes where older forests are either isolated in remnant patches or have been largely eliminated (Swingle 2005, p. 94). Thinning these younger stands, while designed to develop late-successional habitat characteristics in the long term, has the potential to degrade or remove tree vole habitat characteristics in the short term, especially if thinning design does not account for structural features and the connectivity of those features that are important to red tree voles (Swingle and Forsman 2009, p. 284). As reported in USDA and USDI (2002, p. 13), although old, inactive red tree vole nests have been found in thinned stands and shelterwood treatments, no occupied nests have been found, suggesting that red tree voles are susceptible to stand-level disturbances that alter the canopy layer and may cause sites to become unsuitable. Biswell (2010, pers. comm.) and Swingle (2010, pers. comm.) have also observed reduction in numbers or elimination of red tree voles from stands that have been thinned. Hopkins (2010, pers. comm.) found that buffering nests with a 10-ac (4-ha) buffer would result in the presence of nests post-thinning, but he did not attempt to verify vole occupancy through visual observations of voles.

Red tree voles are afforded more protection on Federal lands than on State Forest and private lands within the DPS, primarily as a result of the Survey and Manage protections. Before commencing timber harvest activities (except for thinning activities in stands under 80 years old), projects must be surveyed for tree voles and high priority sites protected. Thirty percent of the Federal ownership is currently considered tree vole habitat; 62 percent of the Federal ownership is in a land allocation wherein management objectives call for retaining and developing late-successional and old forest structural conditions. Another 10 percent are in allocations that preclude timber harvest, although not all of these allocations may develop habitat suitable for tree voles. However, most of the Federal landbase should develop into conditions suitable as red tree vole habitat at some point in the future given the current Federal land management. In addition, conifer-dominated forests in Riparian Reserves and Riparian Management Areas may provide additional future habitat. Thinning activities designed to develop older forest conditions in the long term may limit the dispersal capability and connectivity of local tree vole populations in the short term. Except for the limited amount and isolated nature of Federal lands north of Highway 20, federally managed lands are expected to provide for large, well-distributed populations of red tree voles throughout the rest of their range within the DPS. Based on the above assessment, we conclude that existing regulatory mechanisms on Federal land are adequate to provide for the conservation of the North Oregon Coast DPS of the red tree vole.

Summary of Regulatory Mechanisms on Federal Land

Although they comprise less than one-quarter of the land area within the DPS, Federal lands provide the majority of remaining high-quality, older forest habitat for red tree voles within the DPS. The implementation of the Northwest Forest Plan in 1994 led to a dramatic decrease in timber harvest on Federal lands. Management direction for the Forest Service (under the NWFP) and BLM (under the WOPR) calls for maintaining or restoring late-successional forest conditions on a majority of these lands within the DPS. Although some level of timber harvest continues on these Federal lands, particularly in the Matrix and Timber Management Area allocations, it affects less than a quarter of the DPS. Some degree of thinning also occurs within LSRs and LSMAs within the DPS, but if managed according to the standards and guidelines of the respective management plans, and if such thinning does not exceed the current rates, the effects of such treatments on red tree voles are believed to be relatively minor. The recent reinstatement of Survey and Manage standards and guidelines contributes to the conservation of the red tree vole and its habitat within the DPS. We therefore consider existing regulatory mechanisms adequate to provide for the conservation of the red tree vole on Federal lands where they occur within the DPS. However, the insufficient quantity of Federal lands and their distribution within the DPS contribute to the threat of habitat fragmentation, isolation, and potential extirpation of local populations due to stochastic events, as detailed in Factor E, below.

Conclusion for Factor D

Existing regulatory mechanisms are inadequate to provide for the protection and management of red tree voles on the 78 percent of the DPS made up of non-Federal (private and State) lands. The State of Oregon has regulatory mechanisms in place on private and State lands designed to provide for commercial timber harvest on relatively short rotation schedules, while simultaneously conserving habitat and protecting specific wildlife species during the course of activities associated with timber growth and harvest. The red tree vole is not one of those specific species targeted for protection under the OAR, and, due to its relatively specialized habitat requirements and limited dispersal abilities, many of the guidelines intended to conserve other wildlife species are not sufficient to provide adequate habitat for the red tree vole. Although some individual red tree voles may enjoy incidental benefits if they are located within tree retention or buffer areas, these small buffer areas are not expected to provide for long-term persistence of red tree vole populations given their isolated nature and the allowance for removal of some buffers if the target species are no longer present. In addition, short rotations and intensive management of the surrounding stands will not likely develop or retain the structural features advantageous to red tree voles, thus contributing to the threat of habitat modification and maintaining the isolation of any tree voles that may be present in these areas. Timber harvest rates are expected to continue at current levels on private lands. Protection measures in addition to the OAR regulations are provided on State Forest lands, allowing for more retained and protected areas on the landscape. State Forests are also being managed to increase the amount of structurally complex forests. However, loss and modification of red tree vole habitat on private and State lands as a result of timber harvest continues under existing regulatory mechanisms. Furthermore, there are no mechanisms in place to locate and protect existing occupied tree vole sites outside of retention areas.

Although Federal lands offer some habitat protection and management, there may not be enough habitat in a condition to provide for the red tree vole north of U.S. Highway 20 where Federal land is limited. There is restricted connectivity among blocks of Federal land in this area, and few known vole sites currently available to recolonize habitat. Given survey and protection measures in place for tree voles, the low level of timber harvest compared to other ownerships, and the projected management of over 62 percent of their landbase to maintain or develop late-successional conditions, current regulatory mechanisms appear to be adequate on Federal lands. However, because we find that existing regulatory mechanisms are not adequate to protect habitat for tree voles on the nearly 80 percent of the DPS that is made up of State or private lands, we conclude that overall, existing regulatory mechanisms are not adequate to protect the DPS from the threats discussed under Factors A and E and, in conjunction with these additional factors, pose a significant threat to the persistence of the North Oregon Coast DPS of the red tree vole.

We have evaluated the best available scientific and commercial data on the inadequacy of existing regulatory mechanisms, and determined that this factor poses a significant threat to the viability of the North Oregon Coast DPS of the red tree vole, when we consider this factor in concert with the other factors impacting the DPS.

Factor E. Other Natural or Manmade Factors Affecting the Species' Continued Existence

Fragmentation and Isolation of Older Forest Habitats

Tree voles in the northern Oregon Coast Range evolved in vast, well-distributed expanses of primarily late-successional forest. By 1936, the amount of large-conifer forest was already below the historical range of 52 to 85 percent of the Coast Range estimated to contain late-successional forest (greater than 80 years old) over the past 1,000 years (Wimberly *et al.* 2000, p. 175; Wimberly and Ohmann 2004, p. 642). In 1936, extensive patches of large-conifer Douglas-fir forest connected much of the central and southern portions of the Coast Range Province. In the northern quarter of the province, patches of large Douglas-fir combined with large spruce-hemlock forest and intermingled with large patches of open and very young stands (Wimberly and Ohmann 2004, pp. 635, 639). Most of those open and young stands encompassed the 300,000 acres (121,410 ha) burned in the 1933 Tillamook fire. By 1996, large blocks of the remaining large-conifer forest were restricted to Federal and State lands in the central portion of the Coast Range Province, having been eliminated from most private lands (Wimberly and Ohmann 2004, p. 635). Elsewhere, large-conifer forests were primarily isolated in scattered fragments on public land. The 1936 area of the Coast Range Province covered by large Douglas-fir (2,052 square mi (5,315 square km)) and large spruce-hemlock (344 square mi (891 square km)) cover types declined by 1996, primarily as a result of timber harvest, resulting in a 58 percent reduction in the total area of large-conifer forest. Conversely, the combined area of small Douglas-fir and spruce-hemlock forests increased by 87 percent (Wimberly and Ohmann 2004, pp. 639–641).

Not only have amounts of older forest decreased, but the spatial distribution of those forests has changed. Prior to European settlement, vegetation simulations indicate that mature (80–200 years) and old-growth forest (greater than 200 years) patches had the highest densities of all successional stages within the Coast Range Province. In addition, old-growth patches were large, ranging from 810 to 3,280 square mi (2,100 to 8,500 square km), with a median of 1,660 square mi (4,300 square km), while patches of less than 80-year-old forests were generally less than 770 square mi (2,000 square km) (Wimberly 2002, p. 1322). In the Coast Range Province today, the largest old-growth patch is 2.5 square mi (6.5 square km), while the largest patch of early-seral forest (less than 30 years old) is larger than 1,900 square mi (5,000 square km), and the largest patch of 30 to 80-year-old forest is larger than 1,150 square mi (3,000 square km) (Wimberly *et al.* 2004, p. 152).

Within the DPS, we analyzed data compiled as part of the NWFP effectiveness monitoring program (USDA/USDI 2010, unpublished data) for the distribution of late-successional and old-growth (LSOG) patches within the DPS. As part of our analysis, we wanted to see what proportion of the LSOG habitat comprised patches large enough to support tree voles, and how close these patches were to other suitable patches. There is little information on minimum stand sizes used by tree voles and a complete lack of information on what is needed to sustain tree vole populations (USDA and USDI 2000b, p. 7). In Polk and Tillamook Counties, Hopkins (2010, pers. comm.) found vole nests in forest patches as small as 5 to 10 acres (2 to 4 ha) in the oldest (350–400 years), most structurally complex stands available. Huff *et al.* (1992, pp. 6–7) compiled data on actual red tree vole presence and found the mean age of stands in which tree voles were found in the Coast Range was 340 years and the minimum stand size was 75 ac (30 ha), with mean and median stand sizes of 475 and 318 ac (192 and 129 ha), respectively. Whether a minimum patch size of 5 to 10 ac (2 to 4 ha) or even 75 ac (30 ha) can sustain a population of red tree voles over the long term is unknown and is influenced by such things as habitat quality within and surrounding the stand, the position of the stand within the landscape, and the ability of individuals to move among stands (Huff *et al.* 1992, p. 7; Martin and McComb 2003, pp. 571–579). However, in the absence of better information on the stand size needed to sustain tree vole populations (USDA and USDI 2000b, p. 7), we consider the 75-ac (30-ha) minimum patch size identified by Huff *et al.* (1992, pp. 6–7) the best available information to use for our analysis because it represents actual tree vole occurrence and not just presence of a nest. As part of our analysis, we found that 59 percent of the area mapped as LSOG occurred in patches larger than 75 ac (30 ha). If we extrapolate this proportion to Dunk's (2009, p. 7) analysis showing only 11 percent of the DPS containing actual tree vole habitat (418,000 ac (169,165 ha)), we find the suitability potentially further reduced to only 246,620 ac (99,807 ha), or 6 percent of the DPS. This is consistent with Dunk (2009, p. 9), who noted that his work did not take into account habitat fragmentation, connectivity, and metapopulation dynamics that may influence whether populations or individual tree voles could occur within his area of analysis.

It is important to note that even the forested areas identified as individual "patches" through a geographic information systems (GIS) program do not necessarily represent areas of forest with continuous canopy cover. Although these patches of forest are technically connected at some level, inspection of the data reveal that they are for the most part highly porous and discontinuous, and we performed no analysis to filter out stands that may be so porous or discontinuous as to provide no interior habitat. Furthermore, the LSOG definition used as part of the NWFP monitoring program (mean tree DBH of 20 in (50.8 cm) or greater; canopy cover 10 percent or greater; all tree species included) can include stands that do not necessarily equate to red tree vole habitat and represents a substantial overestimate. For example, while the LSOG dataset identified 759,968 ac (307,559 ha) of LSOG within the DPS, Dunk (2009, pp. 4, 7) found red tree vole habitat to comprise approximately 425,000 ac (172,000 ha) of the DPS (see Continuing Modification and Current Condition of Red Tree Vole Habitat in Factor A, above). There are several reasons why the LSOG database represents a liberal (i.e., overly generous) description of red tree vole habitat. First, the dataset included stands with canopy cover as low as 10 percent, which is well below the minimum canopy cover of 53 percent and even further below the mean of 78 percent for stands in which Swingle (2005, p. 39), as one example, found tree vole nests. The dataset also included hardwood species as part of the canopy cover component allowing for the possibility of LSOG patches comprising primarily hardwood stands with scattered large conifers. While tree voles have been found in mixed conifer/hardwood stands, their exclusive diet of conifer needles would limit the habitat capability of stands that are primarily hardwood. Therefore, our analysis of remaining older forest patches in the DPS provides an overestimate in terms of remaining potential tree vole habitat, given that the LSOG data used provide a liberal characterization of tree vole habitat. Furthermore, the GIS pixel aggregation used likely characterized some of the data as patches that would in reality be too porous to function as tree vole habitat, increasing the potential for overestimation. Applying the proportion of this LSOG data set that meets the minimum forest patch size to the area of DPS considered suitable tree vole habitat (Dunk 2009, p. 7), an analysis considered a likely overestimate of tree vole occupancy (see *Factor A.* Continuing Modification and Current Condition of Red Tree Vole Habitat, above), we find only 6 percent of the DPS may be in suitable habitat that is of a large enough patch size to sustain tree voles. This suggests that the remaining potentially suitable habitat for tree voles is highly fragmented, which further lessens the probability of long-term persistence of red tree voles under current conditions in the DPS.

In simulated pre-European settlement forests of the Coast Range Province, most forests less than 200 years old were within 0.4 mi (1 km) of an old-growth forest patch. This pattern has reversed, with a considerable increase in isolation of old-growth forest patches (Wimberly *et al.* 2004, p. 152). Our analysis of the LSOG forest data provided by the NWFP effectiveness monitoring program indicates that in the DPS, the average distance between LSOG forest patches greater than 75 ac (30 ha) in size was 1,745 ft (532 m). Larger patches greater than 500 ac (202 ha) in size were separated by 6,158 ft (1,877 m) on average. This increasing isolation of LSOG forest patches due to maintenance of younger stands in the intervening areas poses a threat to the red tree vole, as the dispersal capability of this species is so limited. As noted earlier, the greatest known dispersal distance for an individual red tree vole is 1,115 ft (340 m) (Biswell and Meslow, unpublished data referenced in USDA and USDI 2000b, p. 8), but shorter distances from 10 to 246 ft (3 to 75 m) appear to be more the norm for dispersing subadults (Swingle 2005, p.

63). The current average distance between patches of LSOG forest in the DPS thus exceeds the known dispersal distances of red tree voles. A matrix of surrounding younger forest is not entirely inhospitable habitat for dispersing red tree voles, but survivorship in such habitats is likely reduced. Whether red tree voles can successfully disperse between remaining patches of fragmented habitat depends on their vagility and tolerance for the intervening matrix habitat (Pardini 2004, p. 2581).

Historically, dispersal between trees in areas of more contiguous older forest would not have been a limiting factor for red tree voles, but under the current conditions of fragmentation, the ability of individuals to disperse between patches of remaining high quality habitat is restricted. Limited dispersal can translate into a lack of sufficient gene flow to maintain diversity and evolutionary potential within the population, possible inbreeding depression, Allee effects (e.g., failure to locate a mate), and other problems (e.g., Soulé 1980, entire; Terborgh and Winter 1980, pp. 129–130; Shaffer 1981, p. 131; Gilpin and Soulé 1986, pp. 26–27; Lande 1988, pp. 1457–1458). The potential for the local loss of populations is high, as remnant habitat patches formerly occupied by tree voles may not be recolonized due to the distance between habitat fragments and the short-distance dispersal of the species, leading to local extirpation and further isolation of the remaining small populations, and possibly eventual extinction (see Isolation of Populations and Small Population Size, below). As noted above, although we do not have standardized, quantitative survey data, the fact that red tree voles are increasingly difficult to find and have apparently disappeared from some areas where they were formerly known to occur suggests that current habitat conditions are not conducive to the successful dispersal or maintenance of red tree vole populations within the DPS.

Highly suitable red tree vole habitat (that with the greatest strength of selection) is quite rare throughout the range of the red tree vole (Dunk and Hawley 2009, p. 632) and is even more restricted within the North Oregon Coast DPS (Dunk 2009, pp. 4–5). Moreover, large blocks of older forest (greater than 1,000 ac (400 ha)) are restricted primarily to Federal lands, with contiguous blocks separated by great distances (Moeur *et al.* 2005, p. 77). Fragmentation complicates habitat availability for red tree voles, which select for patches of large tree structure where fragmentation is minimized (Martin and McComb 2002, p. 262); having evolved in extensive areas of relatively more contiguous late-successional forest, tree voles are especially vulnerable to the negative effects of fragmentation and isolation due to their limited dispersal capability. Within the DPS, virtually all of the Federal land lies in two widely separated clusters (Figure 2). Much of the southern portion of the DPS, south of U.S. Highway 20, is Federal land, with the other cluster of Federal land lying north of Highway 20, mainly between Lincoln City and Tillamook. As most of the remaining high-quality habitat for red tree voles within the DPS is restricted to these two clusters of Federal lands, there is little redundancy for tree vole populations within the DPS, and loss of either cluster would result in the single remaining cluster and its associated tree vole population being highly vulnerable to extirpation through some stochastic event, such as wildfire. These two blocks of Federal ownership are separated by primarily private and some State lands. Except for a small patch of checkerboard BLM ownership in southeast Columbia and northeast Yamhill Counties, along with a few small State parks, ownership north of Tillamook consists almost entirely of private timberland and lands managed by the Oregon Department of Forestry (Tillamook and Clatsop State Forests).

Implementing current land management policies in the Coast Range is projected to provide a modest increase (approximately 20 percent) in red tree vole habitat over the next 100 years, primarily on public lands (Spies *et al.* 2007b, p. 53). However, red tree vole populations appear to be decreasing in the face of current threats to their habitat. Therefore, we conclude that this limited increase in suitable habitat that may develop on public lands over an extended length of time will not be sufficient to address the lack of connectivity that currently exists between Federal lands, due to land management practices on the intervening lands (USDA and USDI 2007, p. 291). Furthermore, currently small, isolated populations of tree voles may not be capable of persisting over the length of time required to enjoy the benefits of this projected increase in suitable habitat, but may more likely be subject to local extirpations in the intervening time period. The Final Environmental Impact Statement analyzing the effects of discontinuing the NWFP Survey and Manage program concluded that the combination of small amounts of Federal land, limited connectivity between these lands, and few known vole sites north of Highway 20 would result in habitat insufficient to support stable populations of red tree voles (USDA and USDI 2007, pp. 291–292). The authors of the report further concluded that due to these vulnerabilities, ‘‘every site is critical for persistence’’ for the red tree vole in Oregon's North Coast Range north of Highway 20 (USDA and USDI 2007, p. 292). Given the fragmented nature of Federal lands providing late-successional conditions in the DPS and the limited connectivity between these remaining blocks, it is unlikely that the small projected increase in suitable habitat that may develop over the next 100 years on Federal lands will be sufficient to offset the more immediate threats of habitat destruction, modification, and fragmentation that threaten the North Oregon Coast population of the red tree vole.

Summary of Fragmentation and Isolation of Older Forest Habitats

Red tree voles are considered habitat specialists and are strongly associated with large, relatively more contiguous areas of conifer forests with late-successional characteristics; they are not adapted to fragmented or patchy habitats (Martin and McComb 2002, p. 262). The older forest habitat associated with red tree voles has been significantly reduced through historical timber harvest, and as discussed under *Factor A,* above, ongoing management for timber production maintains much of the remaining older forest habitat in a fragmented and isolated condition, surrounded by younger forests of lower quality habitat for tree voles. We analyzed data compiled as part of the NWFP effectiveness monitoring program (USDA/USDI 2010, unpublished data) and found that of the remaining older forest within the DPS, 59 percent is in patches greater than 75 ac (30 ha), but these patches comprise only 6 percent of the entire DPS. The average distance between the remaining patches that are at least 75 ac (30 ha) in size exceeds the known dispersal distances of red tree voles. This suggests that red tree voles are unlikely to persist over the long term in most of the remaining patches of older forest habitats within the DPS, because most of them are likely too small or too isolated to support tree vole populations. Although the surrounding younger forests may serve as interim or dispersal habitat, the evidence suggests that such forest conditions are unlikely to support persistent populations of red tree voles. Furthermore, our evaluation suggests that the remaining older forest habitat for tree voles is highly fragmented, which further lessens the probability of long-term persistence of red tree voles under current conditions in the DPS due to the limited dispersal capability of the species, and other consequences of isolation (see Isolation of Populations and Small Population Size, below).

Most of the remaining high-quality habitat for red tree voles in the DPS is restricted to Federal lands; however, these lands make up only 22 percent of the area within the DPS, and they occur in two widely spaced clusters, one north of Highway 20 and one south of Highway 20. Thus, there is little redundancy for tree vole populations within the DPS, and loss of either cluster on Federal lands would result in the single remaining cluster and its associated tree vole population being highly vulnerable to extirpation or even extinction through some stochastic event, such as wildfire (see Climate Change, below). Under present conditions, the Federal lands north of Highway 20 are already considered insufficient to support stable populations of red tree voles (USDA and USDI 2007, pp. 291–292).

Under the current conditions of habitat fragmentation within the DPS, the ability of red tree voles to disperse between patches of remaining high-quality habitat are extremely restricted, and the evidence suggests that any remaining tree vole populations within the DPS are likely relatively small. The potential for the local loss of populations is therefore high, as remnant habitat patches formerly occupied by tree voles may not be recolonized due to the distance between habitat fragments and the short-distance dispersal capabilities of the species, leading to local extirpation and further isolation of the remaining small populations, and possibly eventual extinction (see Isolation of Populations and Small Population Size, below). Furthermore, ongoing timber harvest in surrounding areas of younger forests contributes to the threat of habitat fragmentation and isolation, as discussed above in Factors A and D. Therefore, based on the above evaluation, we conclude that the fragmentation and isolation of older forest habitats pose a significant threat to the North Oregon Coast DPS of the red tree vole.

Climate Change

General Impacts. Climate change presents substantial uncertainty regarding future vegetation and habitat conditions in the North Oregon Coast DPS. Reduction and isolation of red tree vole habitat has been identified as a substantial threat to their persistence. Changing climate could further reduce tree vole habitat in ways that are difficult to predict.

Globally, poleward and upward elevational shifts in the ranges of plant and animal species are being observed and evidence indicates recent warming is influencing this change in distribution (Parmesan 2006, pp. 648–649; IPCC 2007, p. 8; Marris 2007, entire). In North America, and specifically in the Pacific Northwest, effects of forest pathogens, insects, and fire on forests are expected to increase, resulting in an extended period of high fire risk and large increases in area burned (IPCC 2007, p. 14; Karl *et al.* 2009, pp. 136–137; OCCRI 2010, pp. 16–18; Shafer *et al.* 2010, pp. 183–185). The pattern of higher summer temperatures and earlier spring snowmelt, leading to greater summer moisture deficits and consequent increased fire risk, has already been observed in the forests of the Pacific Northwest (Karl *et al.* 2009, p. 136). Ecosystem resilience is expected to be exceeded by the unprecedented combination of climate change, its associated disturbances, and other ecosystem pressures such as land-use change and resource over-exploitation (IPCC 2007, p. 11). These projections discussed above indicate further reduction and isolation of red tree vole habitat over the next century.

Red tree voles in the North Oregon Coast DPS cannot shift their range farther north due to the existing barrier of the Columbia River, which defines the northern boundary of their current and historical range. In addition, their range already occupies the summit of the Oregon Coast Range, so a shift to higher elevations is also not possible. Climate change assessments predict possible extinctions of such local populations if they cannot shift their ranges in response to environmental change (Karl *et al.* 2009, p. 137).

Increased Frequency and Magnitude of Wildfire due to Climate Change. In the western hemlock and Sitka spruce plant series that dominates the Coast Range, fires tend to be rare but are usually stand-replacing events when they take place, although low and moderate severity fires also occur (Impara 1997, p. 92). Sediment core data show mean fire return intervals of 230 to 240 years over the past 2,700 years (Long *et al.* 1998, p. 786; Long and Whitlock 2002, p. 223). Three large fires, ranging from 300,000 to 800,000 acres (120,000 to 325,000 ha), occurred in the DPS in the 1800s, in addition to the Tillamook fires of 1933–1951 (Morris 1934, pp. 317–322, 328; Pyne 1982, pp. 336–337; Agee 1993, p. 212; Wimberly *et al.* 2000, p. 172). Starting in the mid-1800s, climate change, combined with Euro-American settlement, may have influenced the onset of large-scale fires (Weisberg and Swanson 2003, p. 25). Another complication in these wetter forests has been a pattern of multiple reburns that occurred, such as the Tillamook burns of 1933, 1939, 1945, and 1951. Reburns may or may not add large amounts of additional area to the original burn, but they have the potential to impede the development of the stand for decades, delaying the ultimate return to older forest habitat suitable for red tree voles (Agee 1993, p. 213). Forests in the Pacific Northwest face a possible increased risk of large-scale fires within the foreseeable future; under the conditions of anticipated climate change, the effects of forest pathogens and fire on forests are expected to increase, resulting in an extended period of high fire risk and large increases in area burned (IPCC 2007, p. 14; Karl *et al.* 2009, pp. 136–137). Most recently, the Oregon Climate Change Research Institute predicted that large fires will become more common in the forests west of the Cascades, which includes the forests of the North Oregon Coast Range; estimated increases in regional forest areas burned over the next century ranged from 180 to 300 percent (OCCRI 2010, p. 16).

Considering that the majority of the remaining tree vole habitat in the DPS is limited to Federal land, which comprises a total of roughly 850,000 ac (344,000 ha) and is restricted to two separate clusters in the DPS, it is certainly possible to lose much of the Federal land in either of these blocks to a single stand-replacement fire, further limiting habitat and restricting the range of the tree vole in the DPS. Fire suppression organization and tactics have improved since the large fires of the last two centuries, resulting in a reduction in stand-replacement fires (Wimberly *et al.* 2000, p. 178), although Weisberg and Swanson (2003, p. 25) note that suppression success may have been influenced by the reduction in fuel accumulations that these extensive fires accomplished. Regardless, the intense, large, high-severity fires that can occur in the Coast Range are driven by severe weather events (droughts or east wind patterns) (Agee 1997, p. 154), conditions under which fire suppression is severely hampered at best and ineffectual at worst (Impara 1997, pp. 262–263). Although large fires occurred within the DPS historically, in the past there were many additional areas of older forest that were less isolated from other older forest stands and could serve as refugia for tree voles displaced from forests that burned; under current conditions, there are few such refugia available (Wimberly 2002, p. 1322; Wimberly *et al.* 2004, p. 152) (see Modification of Oregon Coast Range Vegetation above). Given that we have evidence of past fires in the Coast Range that burned areas of up to 800,000 ac (325,000 ha), an amount roughly twice as large as either of the remaining clusters of Federal land within the DPS, and that projections under anticipated conditions of climate change point to the increased risk and magnitude of fire in this region (e.g., OCCRI 2010, p. 16), we believe it is reasonably likely that a single stand-replacing fire could occur within the foreseeable future that would eliminate much of the remaining suitable habitat for tree voles within the DPS.

Summary of Climate Change

The uncertainty in climate change models prevents a specific assessment of potential future threats to the North Oregon Coast DPS of the red tree vole as a consequence of projected warming trends and the various environmental and ecological changes associated with increasing temperatures. However, the direction of these future trends indicate that climate change will likely exacerbate some of the key threats to the DPS, such as an increased probability of large wildfires which may result in the further destruction, modification, fragmentation, and isolation of older forest habitats, and evidence suggests that such changes may already be occurring. High-quality habitat for red tree voles within the DPS is largely restricted to two clusters of Federal lands, and these areas are small enough that a single stand-replacing fire could potentially concentrate the remaining red tree voles to primarily a single population that would be highly vulnerable to extirpation or extinction from future stochastic events. Furthermore, red tree voles within the DPS are restricted in their ability to shift their range in response to changes that may take place as a consequence of climate change. We therefore conclude that the environmental effects resulting from climate change, by itself or in combination with other factors, exacerbate threats to the North Oregon Coast DPS of the red tree vole.

Swiss Needle Cast

A large-scale disturbance event currently ongoing in the Oregon Coast Range is the spread of Swiss needle cast, a foliage disease specific to Douglas-fir caused by the fungus *Phaeocryptopus gaeumannii.* It is typically found in Douglas-fir grown outside of its native range, but in western Oregon it is primarily found, and is more consistently severe, along the western slope of the central and northern Oregon Coast Range, which overlaps both the Sitka spruce and western hemlock plant series. Douglas-fir accounted for less than 20 percent of the forest composition prior to the 1940s in this portion of the Coast Range, but timber harvest and large-scale planting of Douglas-fir on cutover areas make it the dominant species today. The wetter, milder weather, combined with a uniform distribution of the host species, favor the fungus and help spread the disease (Hansen *et al.* 2000, p. 777; Shaw 2008, pp. 1, 3). In Oregon, Swiss needle cast is geographically limited to western Oregon and there is no evidence of it expanding. Even so, it has affected about 1 million ac (405,000 ha), much of that in the northern and central Oregon Coast Range of the DPS. It is roughly estimated that about half of the land base is moderately afflicted by Swiss needle cast, and about 10 percent of the area is severely afflicted by this disease (Filip 2009, pers. comm.).

Swiss needle cast causes premature needle loss which, although rarely lethal, reduces tree growth rates by 20 to 55 percent (Shaw 2008, pp. 1–2). Most of the research on this disease has occurred in managed plantations less than 40 years old (Shaw 2009, pers. comm.), although it is known to limit growth in established overstory trees greater than 100 years old, even within mixed-species stands (Black *et al.* 2010, p. 1680). Forest pathologists are just beginning to understand how to manage this disease. Thinning treatments to improve tree vigor in infected stands do not appear to exacerbate the spread of the disease or its effects on tree health. However, young Douglas-firs infected with the pathogen are not expected to outgrow the disease (Black *et al.* 2010, p. 1680) and may never develop the large structures that are integral features of older forests. Given our current knowledge, a likely scenario in these stands is that the non-host Sitka spruce and western hemlock will become the dominant cover, moving these sites closer to the historical species composition present before earlier forest management converted them to Douglas-fir (Filip 2009, pers. comm.). Where these non-host species are deficient or absent in infected stands, reestablishing them in the stand is the only known treatment certain to reduce the spread and extent of the disease. There is still much uncertainty in our understanding of this pathogen to project future trends in vegetation. While it could result in a return of western hemlock and Sitka spruce that were removed as a result of conversion to Douglas-fir plantations, the commercial value of Douglas-fir is a major incentive to continue research to develop pathogen treatments that would allow continued existence of healthy Douglas-fir stands. In addition, projected effects of climate change (see *Increased Frequency and Magnitude of Wildfire due to Climate Change,* above) could alter the extent of the fog zone in which Swiss needle cast is prevalent.

Summary of Swiss Needle Cast

Swiss needle cast is a foliage disease specific to Douglas-fir, and is found in western Oregon along the western slope of the central and northern Oregon Coast Range. Some of the most severe infestations of Swiss needle cast occur in the Sitka spruce plant series, which is the plant series in the DPS where tree voles forage primarily on western hemlock and Sitka spruce. However, the disease also occurs in the western hemlock plant series on the western slope of the Oregon Coast Range, where most of the voles that forage on Douglas-fir tend to occur. Thus, while the disease may ultimately improve foraging sources for some red tree voles over the long term, it may remove forage for others. In addition, Swiss needle cast may affect forest characteristics in mixed species stands that affect tree voles and are unrelated to foraging, such as canopy closure and structural components that may provide cover. Therefore, the potential impact that this disease may have on the tree vole population is not well understood at this time. Although Swiss needle cast may potentially have some negative effects on red tree voles, at this point in time we do not have evidence that the impacts of Swiss needle cast are so severe as to pose a significant threat to the North Oregon Coast DPS of the red tree vole.

Isolation of Populations and Small Population Size

There are multiple features of red tree vole biology and life history that limit their ability to respond to habitat loss and alteration, as well as to stochastic environmental events. Due to their current restricted distribution within the DPS, stochastic events could further isolate individuals and consequently limit their recolonization capability. Small home ranges and limited dispersal distances of red tree voles, as well as their apparent reluctance to cross large openings, likely make it difficult for them to recolonize isolated habitat patches. As discussed above in the section ''Fragmentation and Isolation of Older Forest Habitats,'' within the DPS, forests with the late-successional characteristics that represent high-quality habitat for red tree voles presently exist in a highly fragmented state, the average distance between the minimum patch sizes associated with nesting exceeded the known maximum dispersal distance of red tree voles. Based on this information, we conclude that high-quality older forest habitats for red tree voles within the DPS are in a highly fragmented and isolated condition.

Without the ability to move between isolated patches of occupied habitat, local populations act essentially as islands vulnerable to local extirpation, resulting from a disequilibrium between local extinction and immigration events (Brown and Kodric-Brown 1977, p. 445). Some species are adapted to living in patchy environments and may exist as a series of local populations connected by occasional movement of individuals between them, known as ''metapopulations'' (e.g., Hanski and Gilpin 1991, p. 7). However, it is presumed that the red tree vole was formerly more continuously distributed throughout the late-successional forests of the Oregon Coast Range and has only recently become ''insularized'' (isolated into islands of habitat) through habitat fragmentation. The limited dispersal ability of the red tree vole indicates this species is not adapted to living in a patchy environment, where long-distance movements between populations are occasionally required. Although in many cases the tree voles within the DPS are not separated by completely inhospitable matrix habitat, but may only be isolated by surrounding areas of forest in earlier seral stages, the apparent disappearance of red tree voles from many areas where they were formerly found leads us to believe that successful recolonization of formerly occupied areas is likely infrequent, if it occurs at all (see discussion of Past and Current Range and Abundance under Factor A, above). As noted above, the average distance between patches of potentially suitable habitat at a minimum of 75 ac (30 ha) in size in the DPS exceeds the greatest known dispersal distance for a red tree vole. The apparent disappearance of red tree voles from areas where they were formerly found, combined with the isolation of remaining habitat patches at distances on average greater than the known dispersal capability of red tree voles, leads us to conclude that movement of individuals between patches of older forest habitat is infrequent at best. Therefore, we conclude that at present, the red tree vole most likely persists as a set of relatively isolated populations in discrete patches of older forest habitat and surrounding lower quality, younger forest, with little if any interaction between these populations.

Although we do not have direct evidence of red tree vole population sizes within the DPS, the evidence before us suggests that remaining local tree vole populations are likely relatively small and isolated. We base this conclusion on the limited amount of tree vole habitat remaining within the DPS, on the fragmented and isolated nature of the remaining habitat, and on evidence from recent search efforts, which have yielded few voles relative to historical search efforts, suggesting that red tree vole numbers are greatly reduced in the DPS compared to historical conditions (see Background and Past and Current Range and Abundance under Factor A, above, for details). That isolated populations are more likely to decline than those that are not isolated (e.g., Davies *et al.* 2000, p. 1456) is discussed above. In addition to isolation, population size also plays an important role in extinction risk. Small, isolated populations place species at greater risk of local extirpation or extinction due to a variety of factors, including loss of genetic variability, inbreeding depression, demographic stochasticity, environmental stochasticity, and natural catastrophes (Franklin 1980, entire; Shaffer 1981, p. 131; Gilpin and Soulé 1986, pp. 25–33; Soulé and Simberloff 1986, pp. 28–32; Lehmkuhl and Ruggiero 1991, p. 37; Lande 1994, entire). Stochastic events that put small populations at risk of extinction include, but are not limited to, variation in birth and death rates, fluctuations in gender ratio, inbreeding depression, and random environmental disturbances such as fire, wind, and climatic shifts (e.g., Shaffer 1981, p. 131; Gilpin and Soulé 1986, p. 27; Blomqvist *et al.* 2010, entire). The isolation of populations and consequent loss of genetic interchange may lead to genetic deterioration, for example, that has negative impacts on the population at different timescales. In the short term, populations may suffer the deleterious consequences of inbreeding; over the long term, the loss of genetic variability diminishes the capacity of the species to evolve by adapting to changes in the environment (e.g., Franklin 1980, pp. 140–144; Soulé and Simberloff 1986, pp. 28–29; Nunney and Campbell 1993, pp. 236–237; Reed and Frankham 2003, pp. 233–234; Blomqvist *et al.* 2010, entire). Although we do not have any information on relative levels of genetic variability in red tree vole populations, Swingle (2005, p. 82) suggested that genetic inbreeding may be maintaining cream-colored and melanistic tree vole pelage polymorphisms at a few populations within the red tree vole's range. Swingle (2005, p. 82) did not elaborate on his suggestion, nor account for the possibility that alternative processes may be maintaining these different color forms.

Based on this evaluation, we conclude that the isolation of red tree vole populations due to fragmentation of their remaining older forest habitat, independent of the total area of suitable habitat that may be left, poses a significant threat to the red tree vole within the DPS.

Summary of Isolation of Populations and Small Population Size

Remaining red tree vole populations in the North Oregon Coast DPS likely persist primarily in isolated patches of fragmented, older forest habitat, and the surrounding younger forest habitats are subject to continuing habitat modification due to timber harvest that tends to maintain the forest in this highly fragmented condition (see Factor A discussion and Fragmentation and Isolation of Older Forest Habitats, above). Red tree voles are considered highly vulnerable to local extirpations due to habitat fragmentation or loss (Huff *et al.* 1992, p. 1). Species that have recently become isolated through habitat fragmentation do not necessarily function as a metapopulation and, especially in the case of species with poor dispersal abilities, local populations run a high risk of extinction when extirpations outpace dispersal and immigration (Gilpin 1987, pp. 136, 138; Hanski and Gilpin 1991, p. 13; Hanski *et al.* 1996, p. 539; Harrison 2008, pp. 82–83; Sodhi *et al.* 2009, p. 518). Some conservation biologists suggest that for species with poor dispersal abilities, habitat fragmentation is likely more important than habitat area as a determinant of extinction probability (Shaffer and Sansom 1985, p. 146). The low reproductive rate and lengthy development period of young, relative to other vole species, adds further to the inherent vulnerabilities of the red tree vole and may limit population growth; the isolation of tree voles through insularization likely exacerbates these inherent vulnerabilities (Bolger *et al.* 1997, p. 562).

For the reasons given above, based on the observed level of habitat fragmentation and isolation that has occurred within the DPS, the presumed small size of remaining tree vole populations, and the inherent vulnerabilities of the red tree vole to local extirpation or extinction due to its life history characteristics, we conclude that the isolation of populations and the consequences of small population size pose a significant threat to the red tree vole within the North Oregon Coast DPS.

Summary of Factor E

Population isolation, presumed small local population size, and potential loss of populations to large-scale disturbance events exacerbated by climate change, combined with the life-history traits that put red tree voles at a disadvantage in moving between and recolonizing new habitats in an already fragmented landscape, are the principal threats considered under this factor that significantly affect the species. Although precise quantitative estimates are not available, recent surveys suggest that populations have substantially declined in the DPS, and that red tree voles are likely at greatly reduced numbers relative to their historical abundance. Furthermore, our analysis of LSOG data from the NWFP effectiveness monitoring program indicates that, within the DPS, any remaining highly suitable habitat is highly fragmented and patchy in occurrence. Patches of forest meeting older forest standards that are overly generous for red tree voles, and thus are likely overestimating the size and number of remaining patches that provide suitable habitat, indicate that the average distance between the remaining patches that are at least 75 ac (30 ha) in size exceeds the known dispersal distances of red tree voles, and the difference is even greater for patches that are more than 500 ac (202 ha) in size.

The narrow habitat requirements, low mobility, low reproductive potential, and low dispersal ability of red tree voles limits their movement among existing patches of remnant habitat, and analysis of remaining large patches of potentially suitable habitat suggests that populations of red tree voles in the DPS likely are largely isolated from one another. This information, in conjunction with evidence that the older forest habitats associated with red tree voles are highly fragmented and restricted in size, leads us to conclude that remaining populations of red tree voles are likely small in size. Furthermore, with little or no exchange of individuals between them, these small, isolated populations are at risk of local extirpation due to a variety of factors, including loss of genetic variability, inbreeding depression, demographic stochasticity, environmental stochasticity, and disturbance events. The lack of redundancy in red tree vole populations within the North Oregon Coast DPS renders these populations highly vulnerable to large-scale catastrophes or disturbance events, such as wildfire, and this vulnerability is exacerbated by climate change.

Conclusion for Factor E

Red tree voles are considered highly vulnerable to local extirpations due to habitat fragmentation or loss, and the evidence suggests that the vast majority of forest with potentially suitable characteristics for tree voles persists in very small, disconnected patches in the DPS. The continuing modification of forest habitats, as discussed under Factor A, maintains the older forest habitats associated with red tree voles in this fragmented and isolated condition. The narrow habitat requirements, low mobility, relatively low reproductive potential, and low dispersal ability of red tree voles limits their movement among existing patches of remnant habitat. This fragmentation of habitat, resulting in small, isolated populations of tree voles, can have significant negative impacts on the North Oregon Coast DPS of the red tree vole, including potential inbreeding depression, loss of genetic diversity, and vulnerability to extirpation as a consequence of various stochastic events. Although large-scale disturbance events such as fire are not common in the Coast Range, we have historical evidence of occasional very large fires in this region, and climate change projections indicate a likely increase in both fire risk and fire size. At present, red tree voles are thus largely without available refugia to sustain the population in the face of events such as severe, large-scale fires. Under these conditions, red tree voles in the North Oregon Coast DPS are unlikely to experience the habitat connectivity and redundancy needed to sustain their populations over the long term. Based on the above evaluation, we conclude that the threats of continued fragmentation and isolation of older forest habitats, as potentially exacerbated by the environmental effects of climate change, and the isolation of populations and consequences of small population size pose a significant threat to the red tree vole within the North Oregon Coast DPS. We did not have sufficient evidence to suggest that Swiss needle cast poses a significant threat to the DPS at this point in time.

We have evaluated the best available scientific and commercial data on other natural or manmade factors affecting the continued existence of the North Oregon Coast DPS of the red tree vole, including the effects of habitat fragmentation, as exacerbated by the environmental effects of climate change, isolation of small populations, and consequences of small population size, and determined that this factor poses a significant threat to the viability of the North Oregon Coast DPS of the red tree vole, when we consider this factor in concert with the other factors impacting the DPS.

Finding

As required by the Act, we considered the five factors in assessing whether the North Oregon Coast DPS of the red tree vole is threatened or endangered throughout all of its range. We have carefully assessed the best scientific and commercial data available regarding the past, present, and future threats faced by the North Oregon Coast DPS of the red tree vole. We reviewed the petition, information available in our files, and other published and unpublished information submitted to us by the public following our 90-day petition finding, and we consulted with recognized experts on red tree vole biology, habitat, and genetics, as well as with experts on the vegetation of the northern Oregon Coast Range. In addition, we consulted with other Federal and State resource agencies and completed our own analyses of the available data.

On the basis of the best scientific and commercial data available, we find that the population segment satisfies the discreteness and significance elements of the DPS policy and therefore qualifies as a DPS under our policy. We further find that listing the North Oregon Coast DPS of the red tree vole is warranted. However, listing the North Oregon Coast DPS of the red tree vole is precluded by higher priority listing actions at this time, as discussed in the *Preclusion and Expeditious Progress* section below.

Although quantitative data are not available to estimate red tree vole populations, comparing past collection efforts with recent surveys leads us to conclude that tree voles are substantially more difficult to find now than they were historically. In some areas within the DPS, red tree voles are now not found, or are scarce, where they were formerly relatively abundant. This information, in conjunction with the knowledge that red tree voles are closely associated with older forest habitats and strong quantitative data showing an unprecedented loss of older forest habitat in the Oregon Coast Range Province, insufficient area of remaining late-successional old-growth habitat, and large distances between those remaining older forest patches that exceed known dispersal distances of tree voles, leads us to conclude that tree vole populations have substantially declined from past levels. Whereas, the literature provides multiple examples of voles nesting in younger stands, virtually all analyses comparing vole nest presence or relative abundance of nests in younger versus older stands have shown an increased use or selection of older stands. Alhough the role of younger stands is unclear, in weighing the available evidence, including a recent modeling effort specific to habitat suitability for red tree voles, we conclude that older forests are necessary habitat for red tree voles and that younger stands will rarely substitute as habitat in the complete absence of older stands. However, we recognize that younger stands may facilitate dispersal or short-term persistence in landscapes where older forests are isolated or infrequent.

Amounts of older forest habitat within the Coast Range Province have been reduced below historical levels, primarily through timber harvest (Wimberley *et al.* 2000, p. 176). The occurrence of forest structural conditions outside of the historical range of variability may not in itself be a problem with respect to red tree vole persistence, considering their persistence through historical large-scale fires that removed habitat. However, the frequency and duration of those conditions outside the historical range of variability will ultimately affect the persistence of the red tree vole. Historically, old-growth forest (greater than 200 years old) was well dispersed (Wimberly *et al.* 2004, p. 152) within the Oregon Coast Province and there were large tracts of suitable habitat that served as refugia in which tree voles could persist while adjacent disturbed areas grew into habitat (Wimberley *et al.* 2000, p. 177). Such areas likely served as source areas to recolonize newly developed habitats (Pulliam 1988, pp. 658–660; Dias 1996, p. 326). However, if the amount or duration of unsuitable habitat exceeds the ability of the species to persist in refugia and ultimately recolonize available areas, the species may eventually be extirpated. Hence, the longer habitat stays in an unsuitable condition, the greater the risk to the population (Wimberly *et al.* 2000, p. 177).

Under current management conditions, the vast majority of remaining red tree vole habitat in the DPS is, and will continue to be, limited to Federal lands. Federal lands make up less than a quarter of the area within the DPS, and are limited to two disparate clusters of land. Although 62 percent of the Federal ownership in the DPS is currently managed under the NWFP and the WOPR to develop and maintain late-successional conditions that would be conducive to red tree vole habitat, only 30 percent of these Federal lands are currently estimated to provide suitable habitat for red tree voles (Dunk 2009, pp. 5, 7). Even if the entire Federal ownership provided older forest habitat conducive to red tree vole occupation, this would still represent a significant reduction of older forest habitat based on estimates from simulations of forest conditions in the Coast Range Province during the past 3,000 years (Wimberly *et al.* 2000, pp. 173–175; Nonaka and Spies 2005, p. 1740). Although much of this loss was historical, it led to the present condition of insufficient habitat for red tree voles today; at present, less than 1 percent of the habitat within the DPS is in the condition for which red tree voles showed the greatest strength of selection for nesting, and nearly 90 percent of the DPS is in a condition avoided by red tree voles. Most of the lands in the nearly 80 percent of the DPS under State and private ownership are managed for timber production. Although regulatory mechanisms exist that are intended to provide for the conservation of wildlife and habitats during the course of timber harvest activities on private and State lands, the habitat requirements and life-history characteristics of the red tree vole are such that these regulatory mechanisms are inadequate to prevent the ongoing modification, fragmentation, and isolation of red tree vole habitat on these lands.

Our own analysis of NWFP data demonstrates the fragmentation and isolation of large patches of older forest remain within the DPS. Fifty-nine percent of the LSOG within the DPS comprised patches greater than 75 ac (30 ha), the minimum stand size in which tree voles are found, and the average distance between these patches exceeds the known dispersal limits of tree voles (USFWS 2010, unpublished data). Furthermore, the criteria used to define the initial dataset of late-successional forest used in our analysis includes forest conditions that are not suitable for red tree voles (e.g., low canopy cover, predominant hardwood cover), so these results are overestimates of habitat remaining for red tree voles. Finally, applying the proportion of large patches within the DPS onto the amount of tree vole habitat estimated within the DPS (Dunk 2009, p. 7) indicates only about 6 percent of the DPS is in a condition of suitable habitat in patches large enough to provide for tree voles, and this analysis is considered a likely overestimate of tree vole habitat. Clearly, existing and projected amounts of older conifer forest habitat conducive to red tree vole persistence are less than the amounts projected to have occurred historically and with which tree voles have evolved. High-quality older forest habitat remains in isolated fragments, most of which are too small to support tree voles, and are so widely separated as to be likely well beyond the dispersal capability of the species. Unlike historical conditions, which were highly stochastic, these changes are likely to be permanent. Based on our analysis of best available information, we conclude the remaining high-quality habitat within the DPS is likely insufficient to support red tree voles over the long term, and persists in a fragmented and isolated condition that renders local populations of red tree voles vulnerable to extirpation or extinction through a variety of processes, including genetic stochasticity, demographic stochasticity, environmental stochasticity, and natural catastrophes.

The significant historical losses of older forest with the late-successional characteristics selected by red tree voles, in conjunction with ongoing practices that maintain the remaining patches of older forest in a highly fragmented and isolated condition by managing the surrounding younger forest stands on short-rotation schedules, pose a threat to the persistence of the North Oregon Coast DPS of the red tree vole through the destruction, modification, or curtailment of its habitat or range.

Furthermore, barring a significant change in the Oregon Forest Practices Rules and Act, loss, modification, and fragmentation of red tree vole habitat is likely to continue on most of the 62 percent of the DPS that is privately owned. Forecasts for State forest land, which makes up almost all of the 16 percent of the DPS in State ownership, are to manage 15 to 25 percent of their land in older forest structure, with another 15 to 25 percent to be managed as layered forest structure. However, it is expected to take 70 years before reaching these amounts, with only 8 percent of the State lands currently existing in these structural conditions. Active management via thinning to reach these targeted structures, while potentially developing suitable tree vole habitat in the long term, may further limit the potential for well-connected tree vole populations in the ensuing 70 years. Current regulations on private and State lands provide for timber harvest on relatively short rotation schedules; this contributes to the modification of older forest habitat, and maintains forest in a low-quality condition for red tree voles. Although some incidental benefits may accrue to individual red tree voles from the buffers put in place to protect habitat and targeted wildlife species under the Forest Practices Rules, in general the patches of forest remaining under these guidelines are too small and isolated to provide for the persistence of red tree voles. In some harvest units, the regulations require the retention of only two trees per ac (0.8 trees per ha), and the size of these trees is well below that normally used by red tree voles. The linear perpendicular extent of tree retention along fishbearing streams under the State regulations is dramatically less (about one-fifteenth) than that conserved under Federal regulations. The scarcity of red tree voles throughout much of the DPS where they were formerly found with ease further suggests the forest areas retained under the existing regulatory mechanisms are insufficient to support persistent tree vole populations or successful dispersal and recolonization. Finally, unlike on Federal lands, there are no mechanisms in place on private or State lands to survey for tree voles and manage for sites that are located. We have therefore found existing regulatory mechanisms on private and State lands inadequate to provide for the conservation of the red tree vole within the DPS.

The current presumed limited population size and distribution of the red tree vole within a small portion of the DPS makes the species particularly vulnerable to random environmental disturbances such as fires. Evidence from past fire events indicates that stand replacement fires have historically occurred in this area large enough that, if fires of similar size were to occur now or in the foreseeable future, could eliminate most, if not all, of the largest patches of remaining high-quality older forest habitat in the DPS. This is of particular concern since the stronghold of the red tree vole population in this DPS is likely concentrated in a single cluster of Federal lands south of Highway 20, and the potential loss of the high quality habitat on these lands to an event such as a fire would remove the greatest source population of red tree voles in the DPS. Other populations are more fragmented and isolated and have little potential to contribute to the overall persistence of the DPS under current conditions of habitat fragmentation. Population connectivity is thus a particular concern given the species' reduced numbers, habitat specialization and limited dispersal capabilities, combined with the limited distribution of older forests located primarily on Federal land within the range of the red tree vole (USDA and USDI 2000a, p. 186). Even on the cluster of Federal lands north of Highway 20, remaining habitat has been deemed insufficient to support stable populations of red tree voles (USDA and USDI 2007, pp. 291–292).

Finally, though the precise effects of environmental changes resulting from climate change on red tree vole habitat are unknown, the projected increase in size and severity of forest disturbance vectors such as fire and pathogens are expected to further reduce and isolate habitat and tree vole populations. In addition, projected shifts in the range of species to the north and to increased elevations would further reduce the available habitat for the red tree vole, given that it is already at its northern and elevational limit within the North Oregon Coast DPS. Therefore, we have additionally found that the North Oregon Coast DPS of the red tree vole is threatened by the exacerbating effects of other natural or manmade factors affecting its continued existence.

Given the threats described above, we find that the North Oregon Coast DPS of the red tree vole is in danger of extinction now or in the foreseeable future and therefore warrants listing. We have considered time spans of several projections of forest conditions and associated tree vole response and other measures of biodiversity to determine how far into the future is reasonably foreseeable. Trends in timber harvest and biodiversity in the Oregon Coast Range are projected for the next century (Johnson *et al.* 2007, entire; Spies *et al.* 2007a, b, entire). Although older forest structure is expected to develop on some areas of State land and in those Federal land allocations managed for late-successional conditions, existing stands are in a variety of age and structural stages and it will be several decades before those stands develop older forest structure and late-successional conditions. For example, on State lands, it is estimated that it will take at least 70 years to develop the targeted amounts of forest complexity (ODF 2010c, p. I–13). Congruent with the time spans stated above, we have determined the foreseeable future for the red tree vole to be approximately 70 to 100 years.

In summary, several threats, combined with the limited ability of the red tree vole to respond to those threats, contribute to our finding that the North Oregon Coast DPS of the red tree vole is in danger of extinction now or in the foreseeable future. Older forest habitats that provide for red tree voles are limited and highly fragmented, while ongoing forest practices in much of the DPS maintain the remaining patches of older forest in a highly fragmented and isolated condition by managing the surrounding younger forest stands on short-rotation schedules. Existing regulatory mechanisms on private and State lands result in the maintenance of this condition on most of their ownership. Although a portion of the State forest land will be managed towards older forest structure, it is expected to take 70 years before reaching these conditions. Red tree vole populations within the North Oregon Coast DPS appear to be relatively small and isolated. Multiple features of red tree vole biology and life history limit their ability to respond to the above noted habitat loss and alteration. These features include small home ranges, limited dispersal distances, low reproductive potential relative to other closely related rodents, a reluctance to cross large openings, and likely increased exposure to predation in certain habitat conditions (e.g. younger stands or in areas with insufficient canopy cover that forces voles to leave trees and travel on the ground). Such life history characteristics make it difficult for red tree voles to persist in or recolonize already isolated habitat patches. Although some land management allocations within the DPS call for developing older forest conditions that may provide habitat for the red tree vole, it will be decades before those areas attain those conditions. In the interim, the red tree vole remains vulnerable to random environmental disturbances that may remove or further isolate large blocks of already limited habitat (e.g. large wind storms or stand-replacing fire events). Finally, small and isolated populations such as the red tree vole are more vulnerable to extirpation within the DPS due to a variety of factors including loss of genetic variability, inbreeding depression, and demographic stochasticity. Because of the existing habitat conditions, the limited ability of the red tree vole to persist in much of the DPS, and its vulnerability in the foreseeable future until habitat conditions improve, we find that the North Oregon Coast DPS of the red tree vole is in danger of extinction now or in the foreseeable future.

We reviewed the available information to determine if the existing and foreseeable threats render the DPS at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act is warranted. We have determined that issuing an emergency regulation temporarily listing the species is not warranted for the North Oregon Coast DPS of the red tree vole at this time, because voles are currently distributed across multiple areas within the DPS and we do not believe there are any potential threats of such great immediacy, severity, or scope that would simultaneously threaten all of the known populations with the imminent risk of extinction. However, if at any time we determine that an emergency regulation temporarily listing of the North Oregon Coast DPS of the red tree vole is warranted, we will initiate this action at that time.

Listing Priority Number

The Service adopted guidelines on September 21, 1983 (48 FR 43098) to establish a rational system for utilizing available appropriations to the highest priority species when adding species to the Lists of Endangered or Threatened Wildlife and Plants or reclassifying threatened species to endangered status. These guidelines, titled ''Endangered and Threatened Species Listing and Recovery Priority Guidelines'' address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates). The lower the listing priority number (LPN), the higher the listing priority (that is, a species with an LPN of 1 would have the highest listing priority).

As a result of our analysis of the best available scientific and commercial information, we assigned the North Oregon Coast DPS of the red tree vole an LPN of 9, based on our finding that the DPS faces threats that are imminent and of moderate to low magnitude, including the present or threatened destruction, modification, or curtailment of its habitat; the inadequacy of existing regulatory mechanisms; and the impacts of chance environmental and demographic events on an already isolated population. We consider the threat magnitude moderate because, although the entire population is experiencing threats, the impact of those threats is more pronounced on private and State ownerships than on Federal lands, where more of the existing tree vole habitat is likely to remain. For example, our analysis indicates that remaining forested habitat on Federal lands provides a measure of security to extant vole populations. Although timber harvest across the DPS is a concern, the loss of suitable vole habitat to timber harvest has declined, and the current status of the species may reflect a lag effect from previous timber harvest. At the same time, much of the Federal forested lands are growing toward older conditions and management of these lands is targeted toward increasing the older forest condition of the landscape. In consideration of all these factors, we find the magnitude of threats to be moderate to low. We consider all of these threats imminent because they are currently occurring within the DPS.

Preclusion and Expeditious Progress

Preclusion is a function of the listing priority of a species in relation to the resources that are available and the cost and relative priority of competing demands for those resources. Thus, in any given fiscal year (FY), multiple factors dictate whether it will be possible to undertake work on a listing proposal regulation or whether promulgation of such a proposal is precluded by higher priority listing actions.

The resources available for listing actions are determined through the annual Congressional appropriations process. The appropriation for the Listing Program is available to support work involving the following listing actions: Proposed and final listing rules; 90-day and 12-month findings on petitions to add species to the Lists of Endangered and Threatened Wildlife and Plants (Lists) or to change the status of a species from threatened to endangered; annual ''resubmitted'' petition findings on prior warranted-but-precluded petition findings as required under section 4(b)(3)(C)(i) of the Act; critical habitat petition findings; proposed and final rules designating critical habitat; and litigation-related, administrative, and program-management functions (including preparing and allocating budgets, responding to Congressional and public inquiries, and conducting public outreach regarding listing and critical habitat). The work involved in preparing various listing documents can be extensive and may include, but is not limited to: Gathering and assessing the best scientific and commercial data available and conducting analyses used as the basis for our decisions; writing and publishing documents; and obtaining, reviewing, and evaluating public comments and peer review comments on proposed rules and incorporating relevant information into final rules. The number of listing actions that we can undertake in a given year also is influenced by the complexity of those listing actions; that is, more complex actions generally are more costly. The median cost for preparing and publishing a 90-day finding is $39,276; for a 12-month finding, $100,690; for a proposed rule with critical habitat, $345,000; and for a final listing rule with critical habitat, $305,000.

We cannot spend more than is appropriated for the Listing Program without violating the Anti-Deficiency Act (see 31 U.S.C. 1341(a)(1)(A)). In addition, in FY 1998 and for each fiscal year since then, Congress has placed a statutory cap on funds that may be expended for the Listing Program, equal to the amount expressly appropriated for that purpose in that fiscal year. This cap was designed to prevent funds appropriated for other functions under the Act (for example, recovery funds for removing species from the Lists), or for other Service programs, from being used for Listing Program actions (see House Report 105–163, 105th Congress, 1st Session, July 1, 1997).

Since FY 2002, the Service's budget has included a critical habitat subcap to ensure that some funds are available for other work in the Listing Program (''The critical habitat designation subcap will ensure that some funding is available to address other listing activities'' (House Report No. 107–103, 107th Congress, 1st Session, June 19, 2001)). In FY 2002 and each year until FY 2006, the Service has had to use virtually the entire critical habitat subcap to address court-mandated designations of critical habitat, and consequently none of the critical habitat subcap funds have been available for other listing activities. In some FYs since 2006, we have been able to use some of the critical habitat subcap funds to fund proposed listing determinations for high-priority candidate species. In other FYs, while we were unable to use any of the critical habitat subcap funds to fund proposed listing determinations, we did use some of this money to fund the critical habitat portion of some proposed listing determinations so that the proposed listing determination and proposed critical habitat designation could be combined into one rule, thereby being more efficient in our work. At this time, for FY 2011, we plan to use some of the critical habitat subcap funds to fund proposed listing determinations.

We make our determinations of preclusion on a nationwide basis to ensure that the species most in need of listing will be addressed first and also because we allocate our listing budget on a nationwide basis. Through the listing cap, the critical habitat subcap, and the amount of funds needed to address court-mandated critical habitat designations, Congress and the courts have in effect determined the amount of money available for other listing activities nationwide. Therefore, the funds in the listing cap, other than those needed to address court-mandated critical habitat for already listed species, set the limits on our determinations of preclusion and expeditious progress.

Congress identified the availability of resources as the only basis for deferring the initiation of a rulemaking that is warranted. The Conference Report accompanying Public Law 97–304 (Endangered Species Act Amendments of 1982), which established the current statutory deadlines and the warranted-but-precluded finding, states that the amendments were ''not intended to allow the Secretary to delay commencing the rulemaking process for any reason other than that the existence of pending or imminent proposals to list species subject to a greater degree of threat would make allocation of resources to such a petition [that is, for a lower-ranking species] unwise.'' Although that statement appeared to refer specifically to the ''to the maximum extent practicable'' limitation on the 90-day deadline for making a ''substantial information'' finding, that finding is made at the point when the Service is deciding whether or not to commence a status review that will determine the degree of threats facing the species, and therefore the analysis underlying the statement is more relevant to the use of the warranted-but-precluded finding, which is made when the Service has already determined the degree of threats facing the species and is deciding whether or not to commence a rulemaking.

In FY 2011, on April 15, 2011, Congress passed the Full-Year Continuing Appropriations Act (Pub. L. 112–10), which provides funding through September 30, 2011. The Service has $20,902,000 for the listing program. Of that, $9,472,000 is being used for determinations of critical habitat for already listed species. Also $500,000 is appropriated for foreign species listings under the Act. The Service thus has $10,930,000 available to fund work in the following categories: Compliance with court orders and court-approved settlement agreements requiring that petition findings or listing determinations be completed by a specific date; section 4 (of the Act) listing actions with absolute statutory deadlines; essential litigation-related, administrative, and listing program-management functions; and high-priority listing actions for some of our candidate species. In FY 2010, the Service received many new petitions and a single petition to list 404 species. The receipt of petitions for a large number of species is consuming the Service's listing funding that is not dedicated to meeting court-ordered commitments. Absent some ability to balance effort among listing duties under existing funding levels, the Service is only able to initiate a few new listing determinations for candidate species in FY 2011.

In 2009, the responsibility for listing foreign species under the Act was transferred from the Division of Scientific Authority, International Affairs Program, to the Endangered Species Program. Therefore, starting in FY 2010, we used a portion of our funding to work on the actions described above for listing actions related to foreign species. In FY 2011, we anticipate using $1,500,000 for work on listing actions for foreign species, which reduces funding available for domestic listing actions; however, currently only $500,000 has been allocated for this function. Although there are no foreign species issues included in our high-priority listing actions at this time, many actions have statutory or court-approved settlement deadlines, thus increasing their priority. The budget allocations for each specific listing action are identified in the Service's FY 2011 Allocation Table (part of our record).

For the above reasons, funding a proposed listing determination for the North Oregon Coast DPS of the red tree vole is precluded by court-ordered and court-approved settlement agreements, listing actions with absolute statutory deadlines, and work on proposed listing determinations for those candidate species with a higher listing priority (*i.e.*, candidate species with LPNs of 1–8).

Based on our September 21, 1983, guidelines for assigning an LPN for each candidate species (48 FR 43098), we have a significant number of species with a LPN of 2. Using these guidelines, we assign each candidate an LPN of 1 to 12, depending on the magnitude of threats (high or moderate to low), immediacy of threats (imminent or nonimminent), and taxonomic status of the species (in order of priority: monotypic genus (a species that is the sole member of a genus); species; or part of a species (subspecies, or distinct population segment)). The lower the listing priority number, the higher the listing priority (that is, a species with an LPN of 1 would have the highest listing priority).

Because of the large number of high-priority species, we have further ranked the candidate species with an LPN of 2 by using the following extinction-risk type criteria: International Union for the Conservation of Nature and Natural Resources (IUCN) Red list status/rank, Heritage rank (provided by NatureServe), Heritage threat rank (provided by NatureServe), and species currently with fewer than 50 individuals, or 4 or fewer populations. Those species with the highest IUCN rank (critically endangered), the highest Heritage rank (G1), the highest Heritage threat rank (substantial, imminent threats), and currently with fewer than 50 individuals, or fewer than 4 populations, originally comprised a group of approximately 40 candidate species (''Top 40''). These 40 candidate species have had the highest priority to receive funding to work on a proposed listing determination. As we work on proposed and final listing rules for those 40 candidates, we apply the ranking criteria to the next group of candidates with an LPN of 2 and 3 to determine the next set of highest priority candidate species. Finally, proposed rules for reclassification of threatened species to endangered species are lower priority, because as listed species, they are already afforded the protections of the Act and implementing regulations. However, for efficiency reasons, we may choose to work on a proposed rule to reclassify a species to endangered if we can combine this with work that is subject to a court-determined deadline.

With our workload so much bigger than the amount of funds we have to accomplish it, it is important that we be as efficient as possible in our listing process. Therefore, as we work on proposed rules for the highest priority species in the next several years, we are preparing multi-species proposals when appropriate, and these may include species with lower priority if they overlap geographically or have the same threats as a species with an LPN of 2. In addition, we take into consideration the availability of staff resources when we determine which high-priority species will receive funding to minimize the amount of time and resources required to complete each listing action.

As explained above, a determination that listing is warranted but precluded must also demonstrate that expeditious progress is being made to add and remove qualified species to and from the Lists of Endangered and Threatened Wildlife and Plants. As with our ''precluded'' finding, the evaluation of whether progress in adding qualified species to the Lists has been expeditious is a function of the resources available for listing and the competing demands for those funds. (Although we do not discuss it in detail here, we are also making expeditious progress in removing species from the list under the Recovery program in light of the resource available for delisting, which is funded by a separate line item in the budget of the Endangered Species Program. So far during FY 2011, we have completed delisting rules for three species.) Given the limited resources available for listing, we find that we are making expeditious progress in FY 2011 in the Listing Program. This progress included preparing and publishing the following determinations:

FY 2011 COMPLETED LISTING ACTIONS

Publication date	Title	Actions	FR pages
10/6/2010	Endangered Status for the Altamaha Spinymussel and Designation of Critical Habitat.	Proposed Listing Endangered	75 FR 61664–61690.
10/7/2010	12-Month Finding on a Petition to list the Sacramento Splittail as Endangered or Threatened.	Notice of 12-month petition finding, Not warranted.	75 FR 62070–62095.
10/28/2010	Endangered Status and Designation of Critical Habitat for Spikedace and Loach Minnow.	Proposed Listing Endangered (uplisting).	75 FR 66481–66552.
11/2/2010	90-Day Finding on a Petition to List the Bay Springs Salamander as Endangered.	Notice of 90-day Petition Finding, Not substantial.	75 FR 67341–67343.
11/2/2010	Determination of Endangered Status for the Georgia Pigtoe Mussel, Interrupted Rocksnail, and Rough Hornsnail and Designation of Critical Habitat.	Final Listing Endangered	75 FR 67511–67550.
11/2/2010	Listing the Rayed Bean and Snuffbox as Endangered	Proposed Listing Endangered	75 FR 67551–67583.
11/4/2010	12-Month Finding on a Petition to List Cirsium wrightii (Wright's Marsh Thistle) as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 67925–67944.
12/14/2010	Endangered Status for Dunes Sagebrush Lizard	Proposed Listing Endangered	75 FR 77801–77817.
12/14/2010	12-Month Finding on a Petition to List the North American Wolverine as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 78029–78061.
12/14/2010	12-Month Finding on a Petition to List the Sonoran Population of the Desert Tortoise as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 78093–78146.
12/15/2010	12-Month Finding on a Petition to List *Astragalus microcymbus and Astragalus schmolliae* as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 78513–78556.
12/28/2010	Listing Seven Brazilian Bird Species as Endangered Throughout Their Range.	Final Listing Endangered	75 FR 81793–81815.
1/4/2011	90-Day Finding on a Petition to List the Red Knot subspecies *Calidris canutus roselaari* as Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 304–311.
1/19/2011	Endangered Status for the Sheepnose and Spectaclecase Mussels.	Proposed Listing Endangered	76 FR 3392–3420.
2/10/2011	12-Month Finding on a Petition to List the Pacific Walrus as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 7634–7679.
2/17/2011	90-Day Finding on a Petition To List the Sand Verbena Moth as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 9309–9318.
2/22/2011	Determination of Threatened Status for the New Zealand-Australia Distinct Population Segment of the Southern Rockhopper Penguin.	Final Listing Threatened	76 FR 9681–9692.
2/22/2011	12-Month Finding on a Petition to List *Solanum conocarpum* (marron bacora) as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 9722–9733.
2/23/2011	12-Month Finding on a Petition to List Thorne's Hairstreak Butterfly as Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 9991–10003.
2/23/2011	12-Month Finding on a Petition to List *Astragalus hamiltonii, Penstemon flowersii, Eriogonum soredium, Lepidium ostleri,* and *Trifolium friscanum* as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded & Not Warranted.	76 FR 10166–10203.
2/24/2011	90-Day Finding on a Petition to List the Wild Plains Bison or Each of Four Distinct Population Segments as Threatened.	Notice of 90-day Petition Finding, Not substantial.	76 FR 10299–10310.
2/24/2011	90-Day Finding on a Petition to List the Unsilvered Fritillary Butterfly as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 10310–10319.
3/8/2011	12-Month Finding on a Petition to List the Mt. Charleston Blue Butterfly as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 12667–12683.
3/8/2011	90-Day Finding on a Petition to List the Texas Kangaroo Rat as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 12683–12690.
3/10/2011	Initiation of Status Review for Longfin Smelt	Notice of Status Review	76 FR 13121–13122.
3/15/2011	Withdrawal of Proposed Rule to List the Flat-tailed Horned Lizard as Threatened.	Proposed rule withdrawal	76 FR 14210–14268.
3/15/2011	Proposed Threatened Status for the Chiricahua Leopard Frog and Proposed Designation of Critical Habitat.	Proposed Listing Threatened; Proposed Designation of Critical Habitat.	76 FR 14126–14207.
3/22/2011	12-Month Finding on a Petition to List the Berry Cave Salamander as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 15919–15932.
4/1/2011	90-Day Finding on a Petition to List the Spring Pygmy Sunfish as Endangered.	Notice of 90-day Petition Finding, Substantial.	76 FR 18138–18143.
4/5/2011	12-Month Finding on a Petition to List the Bearmouth Mountainsnail, Byrne Resort Mountainsnail, and Meltwater Lednian Stonefly as Endangered or Threatened.	Notice of 12-month petition finding, Not Warranted and Warranted but precluded.	76 FR 18684–18701.

FY 2011 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR pages
4/5/2011	90-Day Finding on a Petition To List the Peary Caribou and Dolphin and Union population of the Barren-ground Caribou as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 18701–18706.
4/12/2011	Proposed Endangered Status for the Three Forks Springsnail and San Bernardino Springsnail, and Proposed Designation of Critical Habitat.	Proposed Listing Endangered; Proposed Designation of Critical Habitat.	76 FR 20464–20488.
4/13/2011	90-Day Finding on a Petition To List Spring Mountains Acastus Checkerspot Butterfly as Endangered.	Notice of 90-day Petition Finding, Substantial.	76 FR 20613–20622.
4/14/2011	90-Day Finding on a Petition to List the Prairie Chub as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	76 FR 20911–20918.
4/14/2011	12-Month Finding on a Petition to List Hermes Copper Butterfly as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 20918–20939.
4/26/2011	90-Day Finding on a Petition to List the Arapahoe Snowfly as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 23256–23265.
4/26/2011	90-Day Finding on a Petition to List the Smooth-Billed Ani as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 23265–23271.
5/12/2011	Withdrawal of the Proposed Rule to List the Mountain Plover as Threatened.	Proposed Rule, Withdrawal	76 FR 27756–27799.
5/25/2011	90-Day Finding on a Petition To List the Spot-tailed Earless Lizard as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 30082–30087.
5/26/2011	Listing the Salmon-Crested Cockatoo as Threatened Throughout its Range with Special Rule.	Final Listing Threatened	76 FR 30758–30780.
5/31/2011	12-Month Finding on a Petition to List Puerto Rican Harlequin Butterfly as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 31282–31294.
6/2/2011	90-Day Finding on a Petition to Reclassify the Straight-Horned Markhor (*Capra falconeri jerdoni*) of Torghar Hills as Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 31903–31906.
6/2/2011	90-Day Finding on a Petition to List the Golden-winged Warbler as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 31920–31926.
6/7/2011	12-Month Finding on a Petition to List the Striped Newt as Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 32911–32929.
6/9/2011	12-Month Finding on a Petition to List *Abronia ammophila, Agrostis rossiae, Astragalus proimanthus, Boechera* (*Arabis*) *pusilla,* and *Penstemon gibbensii* as Threatened or Endangered.	Notice of 12-month petition finding, Not Warranted and Warranted but precluded.	76 FR 33924–33965.
6/21/2011	90-Day Finding on a Petition to List the Utah Population of the Gila Monster as an Endangered or a Threatened Distinct Population Segment.	Notice of 90-day Petition Finding, Not substantial.	76 FR 36049–36053.
6/21/2011	Revised 90-Day Finding on a Petition To Reclassify the Utah Prairie Dog From Threatened to Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 36053–36068.
6/28/2011	12-Month Finding on a Petition to List *Castanea pumila* var. *ozarkensis* as Threatened or Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 37706–37716.
6/29/2011	90-Day Finding on a Petition to List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	76 FR 38095–38106.
6/30/2011	12-Month Finding on a Petition to List a Distinct Population Segment of the Fisher in Its United States Northern Rocky Mountain Range as Endangered or Threatened with Critical Habitat.	Notice of 12-month petition finding, Not warranted.	76 FR 38504–38532.
7/12/2011	90-Day Finding on a Petition to List the Bay Skipper as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	76 FR 40868–40871.
7/19/2011	12-Month Finding on a Petition to List *Pinus albicaulis* as Endangered or Threatened with Critical Habitat.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 42631–42654.
7/19/2011	Petition To List Grand Canyon Cave Pseudoscorpion	Notice of 12-month petition finding, Not warranted.	76 FR 42654–42658.
7/26/2011	12-Month Finding on a Petition to List the Giant Palouse Earthworm (*Drilolerius americanus*) as Threatened or Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 44547–44564.
7/26/2011	12-Month Finding on a Petition to List the Frigid Ambersnail as Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 44566–44569.
7/27/2011	Determination of Endangered Status for *Ipomopsis polyantha* (Pagosa Skyrocket) and Threatened Status for *Penstemon debilis* (Parachute Beardtongue) and *Phacelia submutica* (DeBeque Phacelia).	Final Listing Endangered, Threatened.	76 FR 45054–45075.
7/27/2011	12-Month Finding on a Petition to List the Gopher Tortoise as Threatened in the Eastern Portion of its Range.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 45130–45162.
8/2/2011	Proposed Endangered Status for the Chupadera Springsnail (*Pyrgulopsis chupaderae*) and Proposed Designation of Critical Habitat.	Proposed Listing Endangered ...	76 FR 46218–46234.
8/2/2011	90-Day Finding on a Petition to List the Straight Snowfly and Idaho Snowfly as Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 46238–46251.
8/2/2011	12-Month Finding on a Petition to List the Redrock Stonefly as Endangered or Threatened.	Notice of 12-month petition finding, Not warranted.	76 FR 46251–46266.

FY 2011 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR pages
8/2/2011	Listing 23 Species on Oahu as Endangered and Designating Critical Habitat for 124 Species.	Proposed Listing Endangered	76 FR 46362–46594.
8/4/2011	90-Day Finding on a Petition To List Six Sand Dune Beetles as Endangered or Threatened.	Notice of 90-day Petition Finding, Not substantial and substantial.	76 FR 47123–47133.
8/9/2011	Endangered Status for the Cumberland Darter, Rush Darter, Yellowcheek Darter, Chucky Madtom, and Laurel Dace.	Final Listing Endangered	76 FR 48722–48741.
8/9/2011	12-Month Finding on a Petition to List the Nueces River and Plateau Shiners as Threatened or Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 48777–48788.
8/9/2011	Four Foreign Parrot Species [crimson shining parrot, white cockatoo, Philippine cockatoo, yellow-crested cockatoo].	Proposed Listing Endangered and Threatened; Notice of 12-month petition finding, Not warranted.	76 FR 49202–49236.
8/10/2011	Proposed Listing of the Miami Blue Butterfly as Endangered, and Proposed Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly.	Proposed Listing Endangered Similarity of Appearance.	76 FR 49408–49412.
8/10/2011	90-Day Finding on a Petition To List the Saltmarsh Topminnow as Threatened or Endangered Under the Endangered Species Act.	Notice of 90-day Petition Finding, Substantial.	76 FR 49412–49417.
8/10/2011	Emergency Listing of the Miami Blue Butterfly as Endangered, and Emergency Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly.	Emergency Listing Endangered Similarity of Appearance.	76 FR 49542–49567.
8/11/2011	Listing Six Foreign Birds as Endangered Throughout Their Range.	Final Listing Endangered	76 FR 50052–50080.
8/17/2011	90-Day Finding on a Petition to List the Leona's Little Blue Butterfly as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial.	76 FR 50971–50979.

Our expeditious progress also includes work on listing actions that we funded in FY 2010 and FY 2011 but have not yet been completed to date. These actions are listed below. Actions in the top section of the table are being conducted under a deadline set by a court. Actions in the middle section of the table are being conducted to meet statutory timelines, that is, timelines required under the Act. Actions in the bottom section of the table are high-priority listing actions. These actions include work primarily on species with an LPN of 2, and, as discussed above, selection of these species is partially based on available staff resources, and when appropriate, include species with a lower priority if they overlap geographically or have the same threats as the species with the high priority. Including these species together in the same proposed rule results in considerable savings in time and funding, when compared to preparing separate proposed rules for each of them in the future.

ACTIONS FUNDED IN FY 2010 AND FY 2011 BUT NOT YET COMPLETED

Species	Action
Actions Subject to Court Order/Settlement Agreement	
4 parrot species (military macaw, yellow-billed parrot, red-crowned parrot, scarlet macaw) [5]	12-month petition finding.
4 parrot species (blue-headed macaw, great green macaw, grey-cheeked parakeet, hyacinth macaw) [5]	12-month petition finding.
Longfin smelt	12-month petition finding.
Actions with Statutory Deadlines	
Casey's june beetle	Final listing determination.
5 Bird species from Colombia and Ecuador	Final listing determination.
Queen Charlotte goshawk	Final listing determination.
Ozark hellbender [4]	Final listing determination.
Altamaha spinymussel [3]	Final listing determination.
6 Birds from Peru & Bolivia	Final listing determination.
Loggerhead sea turtle (assist National Marine Fisheries Service) [5]	Final listing determination.
2 mussels (rayed bean (LPN = 2), snuffbox No LPN) [5]	Final listing determination.
CA golden trout [4]	12-month petition finding.
Black-footed albatross	12-month petition finding.
Mojave fringe-toed lizard [1]	12-month petition finding.
Kokanee—Lake Sammamish population [1]	12-month petition finding.
Cactus ferruginous pygmy-owl [1]	12-month petition finding.
Northern leopard frog	12-month petition finding.
Tehachapi slender salamander	12-month petition finding.
Coqui Llanero	12-month petition finding/ Proposed listing.
Dusky tree vole	12-month petition finding.

ACTIONS FUNDED IN FY 2010 AND FY 2011 BUT NOT YET COMPLETED—Continued

Species	Action
Leatherside chub (from 206 species petition)	12-month petition finding.
Platte River caddisfly (from 206 species petition)[5]	12-month petition finding.
3 Texas moths (*Ursia furtiva, Sphingicampa blanchardi, Agapema galbina*) (from 475 species petition)	12-month petition finding.
3 South Arizona plants (*Erigeron piscaticus, Astragalus hypoxylus, Amoreuxia gonzalezii*) (from 475 species petition).	12-month petition finding.
5 Central Texas mussel species (3 from 475 species petition)	12-month petition finding.
14 parrots (foreign species)	12-month petition finding.
Mohave Ground Squirrel[1]	12-month petition finding.
Western gull-billed tern	12-month petition finding.
OK grass pink (*Calopogon oklahomensis*)[1]	12-month petition finding.
Ashy storm-petrel[5]	12-month petition finding.
Honduran emerald	12-month petition finding.
Eagle Lake trout[1]	90-day petition finding.
32 Pacific Northwest mollusks species (snails and slugs)[1]	90-day petition finding.
42 snail species (Nevada & Utah)	90-day petition finding.
Spring Mountains checkerspot butterfly	90-day petition finding.
10 species of Great Basin butterfly	90-day petition finding.
404 Southeast species	90-day petition finding.
Franklin's bumble bee[4]	90-day petition finding.
American eel[4]	90-day petition finding.
Aztec gilia[5]	90-day petition finding.
White-tailed ptarmigan[5]	90-day petition finding.
San Bernardino flying squirrel[5]	90-day petition finding.
Bicknell's thrush[5]	90-day petition finding.
Sonoran talussnail[5]	90-day petition finding.
2 AZ Sky Island plants (*Graptopetalum bartrami* & *Pectis imberbis*)[5]	90-day petition finding.
I'iwi[5]	90-day petition finding.
Humboldt marten	90-day petition finding.
Desert massasauga	90-day petition finding.
Western glacier stonefly (*Zapada glacier*)	90-day petition finding.
Thermophilic ostracod (*Potamocypris hunteri*)	90-day petition finding.
Sierra Nevada red fox[5]	90-day petition finding.
Boreal toad (eastern or southern Rocky Mtn population)[5]	90-day petition finding.
High-Priority Listing Actions	
20 Maui-Nui candidate species[2] (17 plants, 3 tree snails) (14 with LPN = 2, 2 with LPN = 3, 3 with LPN = 8)	Proposed listing.
8 Gulf Coast mussels (southern kidneyshell (LPN = 2), round ebonyshell (LPN = 2), Alabama pearlshell (LPN = 2), southern sandshell (LPN = 5), fuzzy pigtoe (LPN = 5), Choctaw bean (LPN = 5), narrow pigtoe (LPN = 5), and tapered pigtoe (LPN = 11))[4].	Proposed listing.
Umtanum buckwheat (LPN = 2) and white bluffs bladderpod (LPN = 9)[4]	Proposed listing.
Grotto sculpin (LPN = 2)[4]	Proposed listing.
2 Arkansas mussels (Neosho mucket (LPN = 2) & Rabbitsfoot (LPN = 9))[4]	Proposed listing.
Diamond darter (LPN = 2)[4]	Proposed listing.
Gunnison sage-grouse (LPN = 2)[4]	Proposed listing.
Coral Pink Sand Dunes Tiger Beetle (LPN = 2)[5]	Proposed listing.
Lesser prairie chicken (LPN = 2)	Proposed listing.
4 Texas salamanders (Austin blind salamander (LPN = 2), Salado salamander (LPN = 2), Georgetown salamander (LPN = 8), Jollyville Plateau (LPN = 8))[3].	Proposed listing.
5 SW aquatics (Gonzales Spring Snail (LPN = 2), Diamond Y springsnail (LPN = 2), Phantom springsnail (LPN = 2), Phantom Cave snail (LPN = 2), Diminutive amphipod (LPN = 2))[3].	Proposed listing.
2 Texas plants (Texas golden gladecress (*Leavenworthia texana*) (LPN = 2), Neches River rose-mallow (*Hibiscus dasycalyx*) (LPN = 2))[3].	Proposed listing.
4 AZ plants (Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*) (LPN = 3), Fickeisen plains cactus (*Pediocactus peeblesianus fickeiseniae*) (LPN = 3), Lemmon fleabane (*Erigeron lemmonii*) (LPN = 8), Gierisch mallow (*Sphaeralcea gierischii*) (LPN = 2))[5].	Proposed listing.
FL bonneted bat (LPN = 2)[3]	Proposed listing.
3 Southern FL plants (Florida semaphore cactus (*Consolea corallicola*) (LPN = 2), shellmound applecactus (*Harrisia* (=*Cereus*) *aboriginum* (=*gracilis*)) (LPN = 2), Cape Sable thoroughwort (*Chromolaena frustrata*) (LPN = 2))[5].	Proposed listing.
21 Big Island (HI) species[5] (includes 8 candidate species—6 plants & 2 animals; 4 with LPN = 2, 1 with LPN = 3, 1 with LPN = 4, 2 with LPN = 8).	Proposed listing.
12 Puget Sound prairie species (9 subspecies of pocket gopher (*Thomomys mazama* ssp.) (LPN = 3), streaked horned lark (LPN = 3), Taylor's checkerspot (LPN = 3), Mardon skipper (LPN = 8))[3].	Proposed listing.
2 TN River mussels (fluted kidneyshell (LPN = 2), slabside pearlymussel (LPN = 2))[5]	Proposed listing.
Jemez Mountain salamander (LPN = 2)[5]	Proposed listing.

[1] Funds for listing actions for these species were provided in previous FYs.
[2] Although funds for these high-priority listing actions were provided in FY 2008 or 2009, due to the complexity of these actions and competing priorities, these actions are still being developed.
[3] Partially funded with FY 2010 funds and FY 2011 funds.
[4] Funded with FY 2010 funds.
[5] Funded with FY 2011 funds.

We have endeavored to make our listing actions as efficient and timely as possible, given the requirements of the relevant law and regulations, and constraints relating to workload and personnel. We are continually considering ways to streamline processes or achieve economies of scale, such as by batching related actions together. Given our limited budget for implementing section 4 of the Act, these actions described above collectively constitute expeditious progress.

The North Oregon Coast DPS of the red tree vole will be added to the list of candidate species upon publication of this 12-month finding. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

We intend that any proposed listing action for the North Oregon Coast DPS of the red tree vole will be as accurate as possible. Therefore, we will continue to accept additional information and comments from all concerned governmental agencies, the scientific community, industry, or any other interested party concerning this finding.

References Cited

A complete list of all references cited is available on the internet at *http://www.regulations.gov* and on request from the Oregon Fish and Wildlife Office (see **ADDRESSES**).

Authors

The primary authors of this document are the staff members of the Oregon Fish and Wildlife Office.

Authority

The authority for this action is the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: September 19, 2011.

Daniel M. Ashe,

Director, Fish and Wildlife Service.

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