Woodland Vole (*Microtus pinetorum*) Species Guidance

Family: Cricetidae – the mice

Formerly known as northern pine mouse

Species of Greatest Conservation Need (SGCN)

State Status: SC/N (Special Concern/no laws regulating use, possession, or harvest) (1992)

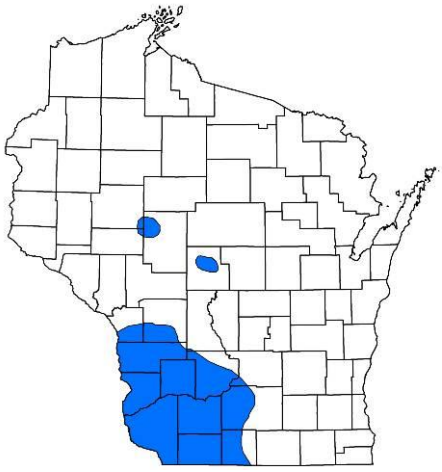
State Rank: S2

Federal Status: None

Global Rank: G5

Wildlife Action Plan Mean Risk Score: 3.1

Wildlife Action Plan Area of Importance Score: 2



Counties with documented locations of woodland voles in Wisconsin. Source: Natural Heritage Inventory Database, April 2013.

Photo by Greg Greer

Species Information

General Description: The woodland vole (*Microtus pinetorum*), also known as the pine vole, is a member of the genus *Microtus*, which includes two other Wisconsin species – the meadow vole (*M. pennsylvanicus*) and prairie vole (*M. ochrogaster*). Some taxonomists, however, place both the woodland vole and prairie vole in the genus *Pitymys*. Adult woodland voles weigh 20-39 g (0.7-1.4 oz) (Smolen 1981). Total length, including the tail, ranges from 102-139 mm (4.0-5.5 in), and tail length is 16-26 mm (0.6-1.0 in), hindfoot length is 14.5-18 mm (0.6-0.7 in), and ear height is seven to nine milimeters (0.27-0.35 in) (Jackson 1961, Smolen 1981). The woodland vole's body is long and slender and its silky pelage, or fur, is reddish to chestnut brown above, and gray below. The woodland vole's eyes are small and the ears and tail are short, making this animal well adapted to its semi-fossorial (burrowing and surface foraging) lifestyle.

Definitive Identification: The woodland vole can be quickly differentiated from most Wisconsin small mammals by its short tail, which is scarcely longer than the hind foot. The combination of short tail, small eyes, and silky red pelage set this vole apart from all other Wisconsin rodent species.

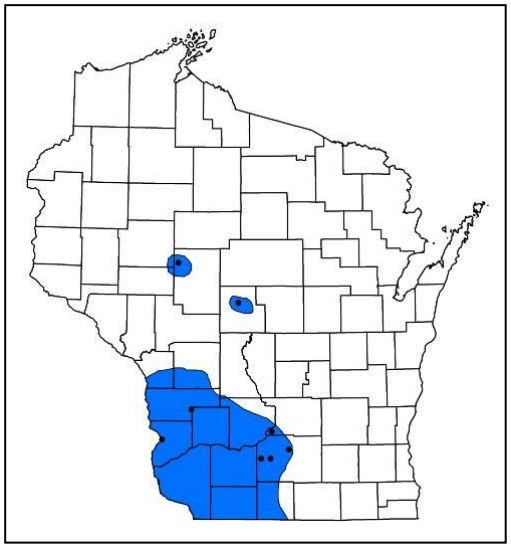
Similar Species: For the beginning mammalogist, the northern short-tailed shrew (*Blarina brevicauda*) can appear externally similar to the woodland vole because both species have small eyes, silky pelage, and a short tail. However, although the pelage (fur) of the northern short-tailed shrew may occasionally have a reddish tint, it is generally dark gray to black in color. The snout of the northern short-tailed shrew is also much more acute, or pointed, and ear pinnae (external parts of the ear) are absent compared to the relatively blunt snout and reduced ears of the woodland vole. The southern bog lemming (*Synaptomys cooperi*) also has a short tail, but its coarse, grizzled pelage sets it apart from the silky woodland vole. The southern bog lemming also has a conspicuous, grooved upper incisor that is absent in the woodland vole. All other vole species in Wisconsin, including the red-colored, southern red-backed vole (*Myodes gapperi*), have tails longer than 26 mm.

Associated Species: Although tunnels made by the woodland vole afford them some protection, voles have numerous avian predators, including the long-eared owl (*Strix otus*), eastern screech owl (*Otus asio*), short-eared owl (*Asio flammeus*), great horned owl (*Bubo virginianus*), barred owl (*Strix varia*), red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), and northern harrier (*Circus cyaneus*) (Benton 1955). Mammalian predators include the red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and mink (*Neovison vison*) (Benton 1955). House cats (*Felis catus*) also kill woodland voles. Jackson (1961) commented that primary threats to the woodland vole may come from the northern short-tailed shrew (*Blarina brevicauda*) and least weasel (*Mustela nivalis*), which can enter burrows. Striped skunks (*Mephitis mephitis*) may also dig up burrows and consume young and adult voles (Jackson 1961). Other commonly

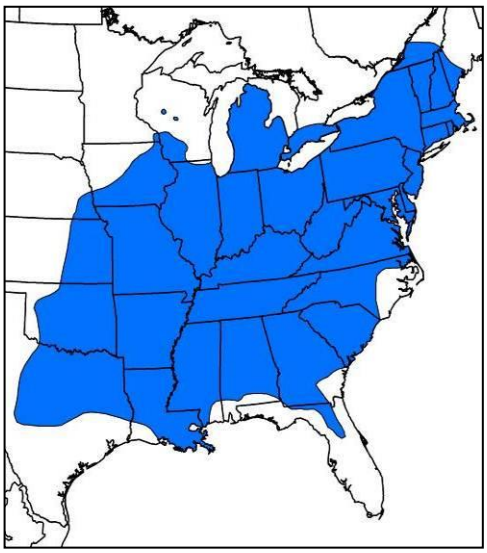
associated small mammals include the meadow jumping mouse (*Zapus hudsonius*), masked shrew (*Sorex cinereus*), southern flying squirrel (*Glaucomys volans*), and white-footed mouse (*Peromyscus leucopus*) (Benton 1955, Hanson 1944).

State Distribution and Abundance: The first records of the woodland vole in Wisconsin are from 1925 (Schmidt 1931). Thirty-four specimens were collected from this location in Warden Township, Clark County, but with the exception of this locality, the woodland vole has not been captured in any appreciable abundance anywhere in Wisconsin (Schmidt 1931, Jackson 1961). In total, this species is known from less than 50 museum records collected in Clark, Wood, Crawford, Sauk (M. Mossman pers. comm.), Columbia, and Dane Counties (Fig. 1). A putative record also exists as an owl kill from Brown County in 1944 (Jackson 1961), but this specimen was lost from the Neville Museum in Green Bay and the species identification may be questionable (Long 2008). Because of the patchy nature and overall dearth of records in Wisconsin, the statewide distribution of the woodland vole is not well understood. Current distribution data for this species may therefore not reflect the species' full extent in Wisconsin. Additionally, given the difficulty in capturing this semi-fossorial species (see "Survey Guidelines" section below), the woodland vole may be more widely distributed and abundant than museum records currently indicate.

Global Distribution and Abundance: The woodland vole ranges broadly throughout eastern North America (Fig. 2). In the United States it occurs in the north from southern Maine, throughout Michigan, and into central Wisconsin. It reaches its southern distribution in northern Florida, southern Louisiana, and Central Texas. Its western range limit occurs in Texas, Oklahoma, and Nebraska. In Canada, the woodland vole is found in southern Ontario and Quebec, where it is listed as a special concern species (Ross 1997). Throughout the woodland vole's range, it is often locally distributed but may reach high densities, especially in southern orchards and other agricultural fields (Hamilton 1938, Paul 1966, Smolen 1981). In some circumstances, woodland voles cause considerable damage to trees, and can even kill them by girdling the bark at the base of the trunk (Davis 1976, Smolen 1981).



Distribution of the woodland vole in Wisconsin. Dots represent museum records (Stephens 2012).



Range of woodland vole in North America (Modified from Smolen 1981).

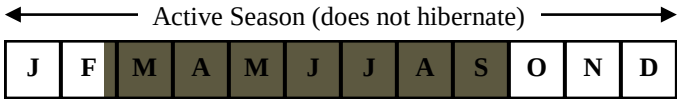
Diet: The woodland vole diet is diverse and seasonally variable, and includes bulbs, roots, tubers, nuts, seeds, and even animal material (Hamilton 1938, Benton 1955). The only information on diet in Wisconsin is finely chewed roots in vole stomachs and a cache of dutchman's breeches (*Dicentra cucullaria*) tubers in a burrow (Clark County; Schmidt 1931). Voles in a New York apple orchard consumed grass roots and stems during the summer months, fruits and seeds in the fall, and bark and tree roots during the winter (Benton 1955) and in North Carolina they consume rootstalks of Virginia creeper (*Parthenocissus quinquefolia*), apple tree roots (*Malus domestica*), and even pine tree roots (*Pinus* spp.) (Paul 1966). Burrows also contained herbaceous cuttings (Paul 1966). Woodland voles in feeding trials preferred white oak (*Quarcus alba*) seedlings over those of northern red oak (*Quercus rubra*), back walnut (*Juglans nigra*) and black cherry (*Prunus serotina*) (Schreiber and Swihart 2009). Seedlings three to six weeks old were preferred over those 12 to 15 weeks old (Schreiber and Swihart 2009). Woodland voles mostly feed within the confines of tunnels or close to the mouth of a burrow opening, and they consume fallen apples in an apple orchard by tunneling from below and eating the apple from the inside out (Paul 1966).

Reproductive Cycle: Little is known about woodland vole reproduction in Wisconsin. Jackson (1961) speculated that the breeding season in Wisconsin extended from late February to the end of September (Jackson 1961). Breeding in New York takes place from January to October, with a peak in March and April (Benton 1955), and breeding in Connecticut occurs from mid-February to mid-November (Miller and Getz 1969). Woodland voles breed throughout the year in North Carolina, with depressions during the winter (Paul 1966). Ovulation is induced by the presence of a male, and females can have between one and four litters in a single year

(Kirkpatrick and Valentine 1970, Goertz 1971, Schadler and Butterstein 1979). In South Carolina, a female was found to be pregnant seven times during an 18-month period (Gentry 1968). Females have a post-partum estrus and can breed within three days of giving birth (Kirkpatrick and Valentine 1970, Schadler and Butterstein 1979). Time between litters may vary from 24-72 days (Schadler and Butterstein 1979). Gestation is 24 days, and pups are born with eyes and ears closed (Hamilton 1938, Kirkpatrick and Valentine 1970). Woodland vole litter size is smaller than that of other voles, and averages two to three pups (Paul 1966, Hamilton 1938). Number of pups born in captivity ranged from one to six (Schadler and Butterstein 1979). Females have only four mammae, compared to six in meadow voles, and young attach firmly to their mothers after birth (Hamilton 1938). Litters over four often fail, and even in captivity only 40% of litters with five pups survived to weaning age and no females successively weaned litters of six pups (Schadler and Butterstein 1979). Weaning takes place about three weeks after birth (Benton 1955). Males become sexually mature between six and eight weeks and females between 10 and 12 weeks (Schadler and Butterstein 1979).

Ecology: Woodland voles are active year-round - they do not hibernate. They may be active day or night, with a tendency toward nocturnal activity, but challenges of tracking this semi-fossorial species make it difficult to determine how much activity goes on below ground (Benton 1955, Paul 1966, Miller and Getz 1969). Movement above ground may be restricted by hot weather (Gentry 1968). Voles in North Carolina are active between dawn and 10 am and from 4 pm to dark (Paul 1966). Voles in the wild live an average of 2.6 months (Miller and Getz 1969). Gentry (1968) found that winter survival in South Carolina varied from 12% to 70%. In Connecticut, Miller and Getz (1969) found that only 19.4% of females and 19.1% of males were captured the next year. The maximum lifespan is likely just over a year. In Maryland, a vole lived at least 14 months (Stickel and Warbach 1960).

Woodland voles live in extended family groups of two to nine individuals (average 4.2), and are socially monogamous like prairie voles (FitzGerald and Madison 1983). These family groups share nests and a burrow system. During the breeding season, family groups consist of a breeding female, at least one reproductive male, one or more non-reproductive females, and one or more sub-adult or juvenile individuals (FitzGerald and Madison 1983). Although woodland voles are socially monogamous, they do not exhibit complete mate fidelity and will breed with other individuals when a mate is removed (Renfro et al. 2009). Solomon et al. (1998) found that when a breeding female was removed from a family group, another breeding female moved in. In addition to being socially monogamous, woodland voles also practice cooperative breeding in which individuals that share a burrow system help care for the young by brooding, grooming, and retrieving younger siblings, and by maintaining nests, runway systems, and food caches (Powell and Fried 1992). In fact, when mothers are away from young, juveniles increase the amount of time they spend brooding and grooming younger siblings (Powell and Fried 1992). Powell and Fried (1992) hypothesized that this cooperative breeding system evolved from the woodland vole's semi-fossorial nature. Tunnels are used for dispersal, and limited availability of tunnels and the high energetic costs of creating new tunnels likely limits dispersal of woodland voles (Powell and Fried 1992).



Natural Community Associations (WDNR 2005 and WDNR 2009, but modified based on Jackson 1961 and Long 2008)**:**
Significant: southern dry forest, southern dry-mesic forest, southern mesic forest
Moderate: central sands pine – oak forest
Minimal: oak barrens, pine relict

Southern dry forest, Sauk County (a), Mike Mossman, Wisconsin DNR, Southern dry-mesic forest, Iowa County (b), © Ryan Stephens, Thick leaf layer in a southern dry-mesic forest, Vernon County (c). © Ryan Stephens

Habitat: Despite the species' frequently used common name "pine vole" and species epithet *pinetorum* (belonging to a place of pines), most woodland voles occur in well-drained deciduous woodlands (Hamilton 1938, Smolen 1981). Woodland voles are often associated with old forests where leaf litter accumulates (Urban and Swihart 2011), and a thick leaf layer and abundant herbaceous cover are often associated with woodland voles throughout their range (Paul 1966). Leaf litter provides protection from terrestrial or avian predators, represents a food source, and may moderate effects of temperature and precipitation (Paul 1966). In Wisconsin, Schmidt (1931) found woodland voles exclusively in hardwood forests in Clark County, and Hanson (1944) found woodland voles in southern-Wisconsin oak forests with a thick layer of leaf litter. In the eastern United States, woodland voles occur in a variety of habitats, from marsh grassland to cropland (Paul 1966), but generally avoid areas with saturated soils such as swamps (Benton 1955, Miller and Getz 1969). In North Carolina voles were commonly found in forest openings or along forest edges with abundant herbaceous cover and leaf litter (Paul 1966). In the east, apple orchards make excellent habitat, where they can do considerable damage to crop trees (Paul 1966, Davis 1976), but this does not seem to be the case in Wisconsin (Jackson 1961, Long 2008). Soil type is also extremely important; woodland voles prefer light soils and a deep humus and litter layer (Benton 1955). Mesic soils are favored over dry friable soils; this strong preference may be a consequence of the fact that moist soils are easier to dig and tunnel in, whereas dry soils do not support burrow construction (Benton 1955). Together, a combination of deep leaf litter and well drained soils may be the best indicators of quality woodland vole habitat (Smolen 1981).

Density and home range: No data exist on density or home ranges of woodland voles in Wisconsin. Unusually high densities of over 200 voles/acre have been reported in fruit orchards elsewhere (Benton 1955), but densities in natural habitats may range from near zero to 5.9 per acre (Miller and Getz 1969). Home range is often small and limited to the burrow system. Home range size (diameter) varies by state and may range from 19.0-32.7 m (62.4-73 ft) (Paul 1966, Benton 1955, Miller and Getz 1969). Male and female home ranges are often similar (Miller and Getz 1969, FitzGerald and Madison 1983).

Burrows and runways: The woodland vole mainly uses tunnel systems constructed below-ground or just below the leaf litter. Burrow depth varies depending on soil type, from just below the leaf layer to 20.3-25.4 cm (8-10 in) below the surface (Schmidt 1931, Hamilton 1938, Davis 1976). Surface burrows can form a network extending more than 10 m (32.8 ft) in a given direction (Schmidt 1931). Subterranean burrows superficially resemble those made by other small mammal species (Benton 1955). Burrows are approximately 30-35 mm wide and 25-30 mm high (Schmidt 1931). Soil from burrow excavation is pushed beneath the leaf layer with the forefeet, into piles 10 cm (4 in) wide and 7.5 cm (3 in) high (Schmidt 1931). Slight tunnel enlargements are used to store tubers and other food, but food is not cached in areas where food is plentiful (Benton 1955). Woodland voles in laboratory experiments selected soil that was light and friable over soils that had gravel or stones (Rhodes and Richmond1985). This selectivity may be because these kinds of soil hold tunnels without collapsing (Rhodes and Richmond1985). Soil moisture was also found to be an important factor in tunneling, and voles selected moist soils over soils that were wet or dry (Rhodes and Richmond1985). Moist soils may decrease energy costs involved in burrowing, and help prevent tunnels from collapsing (Rhodes and Richmond1985).

Nesting: Woodland voles build nests in enlarged tunnels approximately 13-15 cm (5-6 in) below ground (Paul 1966). In Wisconsin, Schmidt (1931) found two nests approximately 5 cm (2 in) below the surface. Voles often build nests at the base of trees or under logs or other fallen debris (Benton 1955, Paul 1966), and their globular nests are 17.8-22.9 cm (7-10 in) wide and made from dried grasses or other available material (Hamilton 1938, Paul 1966, Davis 1976). Soil temperature may be limiting for nest construction. Nests in a lab experiment were constructed more in soil that was kept at 19˚ C (66.2˚ F) than soil kept at 30˚ C (86˚ F) (Rhodes and Richmond 1985).

Woodland vole burrows. © Ryan Stephens

Threats: Forest fragmentation by roads or development may adversely affect populations by limiting available habitat and dispersal. Soil compaction from logging or forest roads may create soil conditions unsuitable for burrowing, and reduce habitat quality. Over-browse by deer may reduce potential food sources, as well as cover necessary to create suitable habitat (Byman 2011). It took six years of deer exclusion in a Pennsylvania oak/maple hardwood forest before woodland voles colonized the area (Byman 2011).

Invasive, exotic earthworms may pose one of the most severe negative impacts on woodland voles. Throughout the woodland vole's distribution, a thick layer of leaf litter seems to be characteristic of good woodland vole habitat. These earthworms can reduce the leaf litter to nearly bare soil and alter plant composition in hardwood forests (Hale et al. 2005). Earthworms not only reduce the leaf layer, but they also decrease the diversity and abundance of herbaceous plants and tree seedlings (Hale et al. 2006), which reduces both the amount of food available for woodland voles and the cover necessary to conceal runways.

Climate Change Impacts: Increasing temperature in Wisconsin (WICCI 2011) will likely have no direct negative impact on a species that reaches its highest densities in states such as North and South Carolina. In fact, warming temperatures are predicted to improve conditions for deciduous hardwood forests in Wisconsin, especially oak-dominated ecotypes (Iverson 2001). Based on these projections, woodland voles would be expected to shift their distribution to correspond with the expansion of oak-hickory forests in the state, wherever landscape connectivity and propagule (seed) availability allow such expansion.

Survey Guidelines: Little is known about the distribution or basic ecology of Wisconsin's woodland voles, and survey-based research is an important conservation objective for this species. If surveys are being conducted for regulatory purposes, however, then survey protocols and surveyor qualifications must first be approved by the Endangered Resources Review Program (see *Contact Information*). The woodland voles' semi-fossorial nature makes it exceedingly difficult to detect and capture, but several techniques, including live trapping or pitfall traps, can help increase capture probability. Live trapping for the woodland vole should only be attempted by individuals experienced in trapping and handling small mammals.

Woodland vole burrows superficially resemble those made by other small mammal species and often the only way to confirm occupancy is by trapping (Benton 1955). However, woodland voles burrows can sometimes be distinguished from burrows of the star-nosed mole (*Condylura cristata*) because the mole pushes soil on top of leaves, whereas the woodland vole pushes soil from beneath in small piles 10 cm (4 in) wide and 7.5 cm (3 in) high (Schmidt 1931). Areas in deciduous hardwoods with tunneling are good areas to focus trapping effort. Only 1.3% of voles were captured outside of the recognized burrow system in a North Carolina study (Paul 1966), so traps should be placed as close to burrow openings as possible or along surface runways. Sherman live traps or snap traps may be effective for capturing woodland voles (Mengak and Guynn1987, Byman 2011), as long as the trap is placed within burrows or at the mouth of a burrow opening (Paul 1966). Jackson (1961) recommends using two-quart to gallon pitfall traps dug on a runway or burrow. If snap traps are used, they should be discontinued after one animal is captured, and an alternative trap such as a Sherman live trap or pitfall trap should be used to continue trapping. Although rolled oats and peanut butter, or a combination of the two, work well as bait, Paul (1966) found that the best bait was sliced apple. Voles were two to 10 times more likely to be captured with apple than with rolled oats and peanut butter (Paul 1966). This species, however, learns food selection from other voles (Solomon et al. 2002), and because the study was conducted in an apple orchard, bait preference may not be true for wild populations. Many populations have depressions in capture rates during the summer (Paul 1966). The chance that an animal captured one week would be captured the next in a South Carolina study (Gentry 1968) was 33% in summer and 67% chance in winter. Winter trapping in Wisconsin is generally not feasible, however, and the best survey time is in the fall from late August to November.

Summarize results, including survey dates, times, weather conditions, number of detections, detection locations, and behavioral data and submit via the WDNR online report: <http://dnr.wi.gov, keyword "rare animal field report form">.

Management Guidelines

The following guidelines typically describe actions that will help maintain or enhance habitat for the species. These actions are not mandatory unless required by a permit, authorization or approval.

Management can benefit the woodland vole in wooded areas in the southwest savanna and western coulee and ridges ecological landscapes, and to a lesser extent in the central sand plains and the extreme southwestern portion of the southeast glacial plains ecological landscapes. Hillsides with deciduous hardwood forest and a deep leaf layer are good potential habitat for the woodland vole, and management in these areas should focus on maintaining overhead and herbaceous cover while minimizing leaf-litter disturbance or destruction. Mowing is a well-known method of reducing habitat quality in orchards (Davis 1976), and should be avoided during forest management.

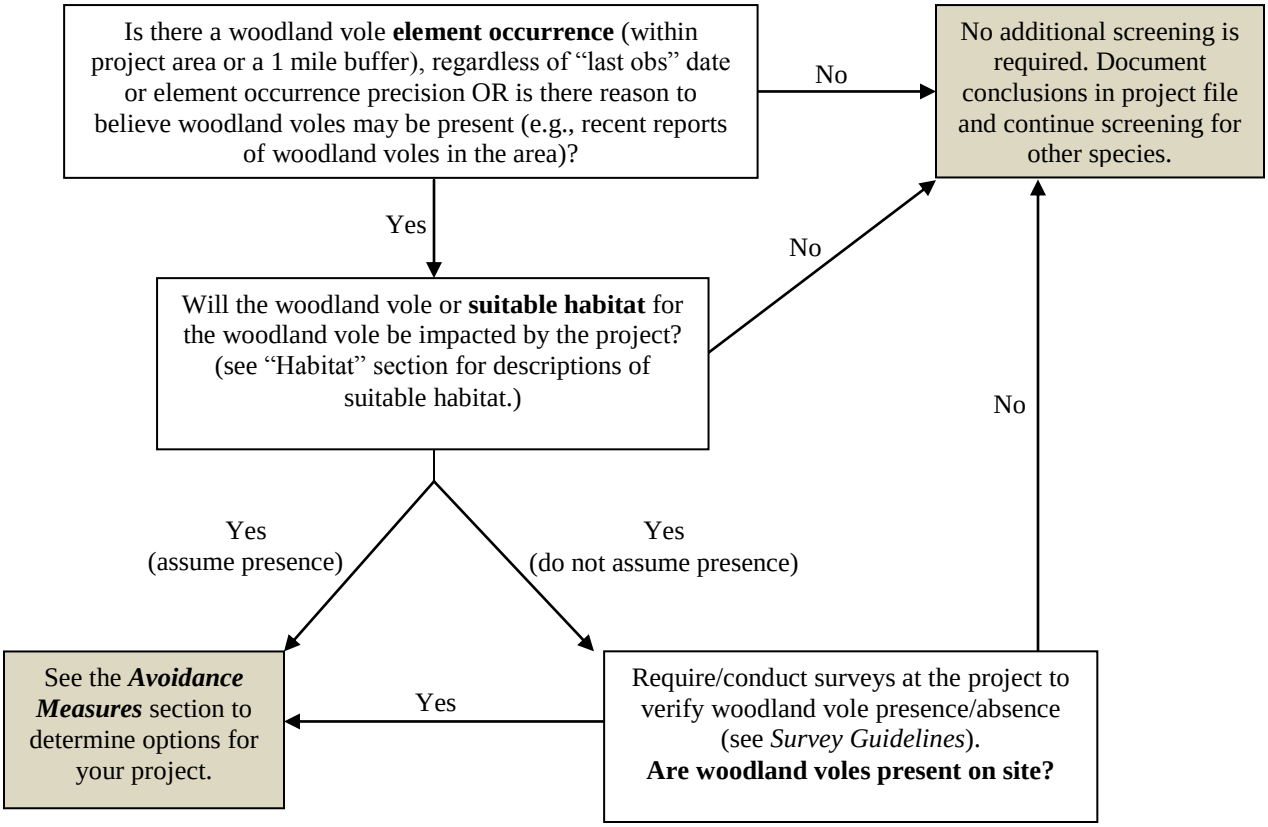
Ideal silvicultural practices promote understory growth necessary for food and cover, and retain overhead cover and a source for leaf litter accumulation. Although woodland voles are less tied to coarse woody debris than are other small mammals, they often build

nests near fallen logs or stumps, so forest management should strive to maintain these structures. Soil compaction may be detrimental to burrowing and surface runways, so logging practices should minimize soil compaction and erosion.

Screening Procedures

The following procedures should be followed by DNR staff reviewing proposed projects for potential impacts to the species.

Follow the "Conducting Endangered Resources Reviews: A Step-by-Step Guide for Wisconsin DNR Staff" document (summarized below) to determine if woodland voles will be impacted by a project (WDNR 2012):



Avoidance Measures

The following measures are specific actions required by DNR to avoid take (mortality) of state threatened or endangered species per Wisconsin's Endangered Species law (s. 29.604, Wis. Stats.) These guidelines are typically not mandatory for non-listed species (e.g., special concern species) unless required by a permit, authorization or approval.

If you have not yet read through *Screening Procedures*, please review them first to determine if avoidance measures are necessary for the project.

The only way to completely avoid take of woodland voles is to avoid known woodland vole locations and areas of suitable habitat (described above in the "Habitat" section and in *Screening Procedures*). This approach would include avoiding active management in forests where the species is known or suspected to occur. However, this species is not protected by law, is difficult to avoid because it occurs in widely distributed natural communities, and benefits from some types of active habitat management. When take cannot be avoided, we recommend referring to the *Management Guidelines* above for practices that can minimize impacts or even enhance habitat and improve this species' ability to persist over the long-term.

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Linked Websites:

- Natural Communities of Wisconsin: <http://dnr.wi.gov, key word "natural communities">
- Rare Animal Field Report Form: <http://dnr.wi.gov, key word "rare animal field report form">
- Wisconsin Endangered and Threatened Species: <http://dnr.wi.gov, key word "endangered resources">
- Wisconsin Wildlife Action Plan: <http://dnr.wi.gov, key word "Wildlife Action Plan">

Funding

- Natural Resources Foundation of Wisconsin: <http://www.wisconservation.org/>
- USFWS State Wildlife Grants Program: <http://wsfrprograms.fws.gov/subpages/grantprograms/swg/swg.htm>
- Wisconsin Natural Heritage Conservation Fund
- Wisconsin DNR Division of Forestry

Contact Information

- *Endangered Resources Review Program:* WI Department of Natural Resources, Bureau of Natural Heritage Conservation (608-264-6057, DNRERReview@wisconsin.gov)

Suggested Citation

- Wisconsin Department of Natural Resources. 2013. Wisconsin Woodland Vole Species Guidance. Bureau of Natural Heritage Conservation, Wisconsin Department of Natural Resources, Madison, Wisconsin. PUB-ER-691.

Developed by

- Ryan B. Stephens and Eric M. Anderson, primary authors
- Gregor W. Schuurman, primary editor

Wisconsin Department of Natural Resources
Bureau of Natural Heritage Conservation
PO Box 7921
Madison, WI 53707-7921
http://dnr.wi.gov, keyword "ER"