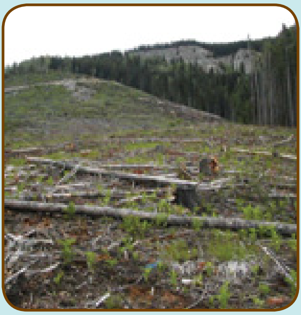
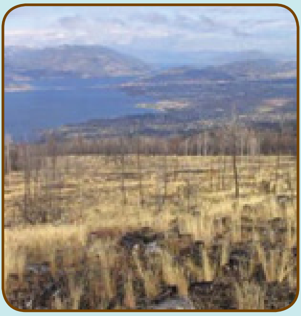
Voles, Hares and Protection of Forest Plantations





Voles

The problem of feeding damage to forest and agricultural crops by herbivorous small mammals has a long history in temperate and boreal ecosystems of North America. In forestry, voles of the genus *Microtus* are considered the major mammalian species affecting coniferous and deciduous tree plantations. Populations of some species of voles tend to have cyclic fluctuations in abundance in northern latitudes with a peak every 3 to 5 years, and these periods may be interspersed with annual fluctuations. Abundance of *Microtus* vole populations and degree of damage is usually highest in early successional habitats where understory vegetation has developed after:

1) Forest harvesting by clearcutting
2) Wildfires
3) Beetle-killed pine stands
4) Sites seeded with pasture grasses and forbs (range seeding).

Meadow vole

Montane vole

Long-tailed vole

Heather vole

Red-backed vole

Grasses, forbs, and shrubs in these four types of habitat provide food and cover for *Microtus* voles.

Three species of *Microtus* (the long-tailed vole, the meadow vole, and the montane vole) are implicated as major consumers of tree seedlings. A fourth species, the heather vole, is also present in these small mammal communities but exists at low abundance (< 5 animals/ha). In addition, populations of the southern red-backed vole (*Myodes gapperi*) occur primarily in mature stands of timber but may spill over into recently cut areas for 1-2 years after harvest.

Meadow voles and long-tailed voles are the major mammalian pests in coniferous tree plantations in the Southern (SIFR) and Northern (NIFR) Interior Forest Regions of B.C. Voles will feed on tree seedlings and saplings, with highest damage during winter months of peak years in abundance. These rodents feed on bark, vascular tissues, and sometimes roots of tree. This damage results in direct mortality from girdling and clipping of tree stems or reduced growth of surviving trees which have sub-lethal injuries. The fertilization regime of nursery-raised seedlings enhances their palatability and nutrition, thereby predisposing them to preferential feeding over natural regeneration. Voles also feed preferentially on tree species, particularly lodgepole pine and Douglas-fir.

Examples of feeding damage by voles to Douglas-fir and lodgepole pine seedlings.

Feeding damage to an older pine tree.

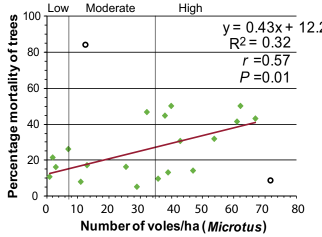
Overwinter feeding by voles on willow.

Why is this a problem?

- Limits regeneration of appropriate tree species
- Lengthens time to free-growing status
- Decreases net productive forest area
- Loss of mean annual increment

Is the amount of feeding damage related to population size of voles?

A risk rating for feeding damage to trees has been derived from the significant **positive relationship between percentage tree mortality and abundance of *Microtus* voles in October**.



Number of Voles/per ha	Risk of damage to trees
< 7	Low
7 – 34	Moderate
35 – 88	High
> 88	Very High

In some cases there can be relatively high numbers of voles (in the moderate category), but little damage to tree seedlings. Conversely, a relatively low number of voles may, in certain situations, damage a high percentage of trees. These two outlier data points are indicated by open circles. It is important to note that occasional "hotspots" of feeding damage to trees, by a few voles, may occur in any year.

Feeding damage is associated with:

- High populations of voles
- Early successional habitats
- Trees in the first year after planting.

Plantation protection - where to start?

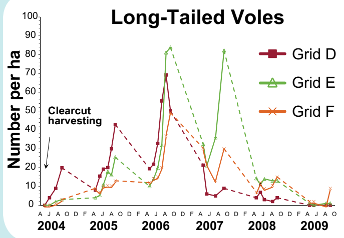
- Need to ID damage agent correctly
- Where are we in the population phase of a given vole species?
- Determine which sites and times are a hazard

When and where will vole damage be a problem?

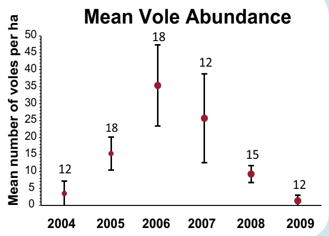
Forest harvesting by clearcutting

Relatively long-term monitoring of vole populations

Vole populations, near Golden B.C., were monitored for six years (2004-2009) since the time of clearcut harvesting to follow how these rodents respond to successional change and reach densities capable of serious feeding damage to newly planted trees. Populations of long-tailed voles were low in the first year after harvest with mean numbers < 5/ha. Mean numbers in the second post-harvest year reached 15/ha and had a strong annual cycle with up to 43 animals/ha in September. Annual maximum densities of 49-84 voles/ha were recorded in 2006, which seemed to be the peak populations on the three grids. However, in the fourth year (2007) since harvesting, numbers of long-tailed voles declined on two grids, with the third grid remaining high, reaching an annual maximum of 82/ha. This decline deepened in 2008 and voles disappeared on two of three grids in 2009. These maximum vole numbers were in the "high" risk of damage to trees.



Abundance of long-tailed voles per hectare on three replicate sampling grids from the time of harvest, 2004-2009.

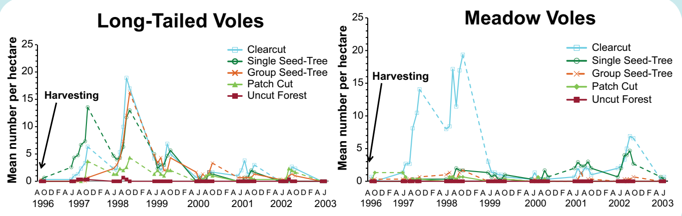


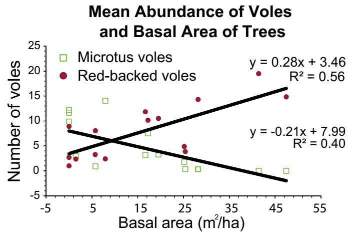
Mean (± 95% C.I.) abundance of long-tailed voles per hectare in each yearof the study. Sample size (number of grid trapping periods) is above upper bar.

For red-backed voles, in the first year after harvesting, mean numbers ranged from 4-15/ha. However, their numbers declined dramatically at two years after harvesting. The heather vole occurred at numbers ≤ 6/ha throughout 2004-2008 and then declined to < 1/ha in 2009.

Vole populations, near Summerland, B.C., were monitored for 8 years (1996-2003), on a gradient of clearcut to partial cutting treatments. A similar pattern was observed on clearcuts for both the long-tailed vole and meadow vole: **at 3 years post-harvest**, vole numbers peaked and then declined thereafter to low levels. These maximum vole numbers were in the "moderate" risk of damage to trees.

Green-tree retention may be helpful in limiting early successional vegetation, and hence *Microtus* voles. Red-backed voles respond positively to increased basal area of retained trees.

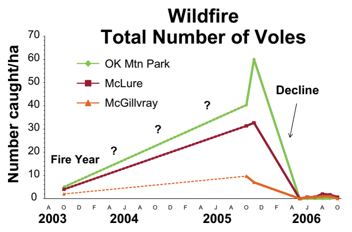




In addition, retention of snags and stub trees, and debris piles, will enhance habitats for birds of prey and small carnivores, respectively.

Wildfires

Following a fire year in 2003, meadow vole, montane vole, and long-tailed vole populations responded positively to post-fire habitat conditions reaching densities high enough for people to observe them, and spilling over into agricultural and residential areas of several communities during the summer and fall of 2005. Proximity of agricultural land and riparian vegetation in the Okanagan Valley may have provided source areas for populations of voles to colonize the burned-over forestland. There was serious feeding damage to seedlings in various plantations during the 2005-06 winter. Voles declined dramatically over winter to numbers < 1/ha from peak populations (50-60/ha) the previous October 2005 at the McLure, McGillvray, and OK Mtn Park fires. This high abundance of voles, occurring in the **second growing season after a wildfire**, has been observed in several locations throughout the southern interior during past fire events. This population peak tends to be independent of other fluctuations in vole numbers.



Wildfire and some types of prescribed burning may convert unavailable mineral nutrients into forms more available to plants. Decomposition of tree roots and greater availability of light, nutrients, and water in beetle-killed stands may also contribute to growth of understory vegetation. These processes may result in a flush of early-successional vegetation that has high forage quality for herbivores. Range seeding also adds several grasses and forbs to the plant community. Voles may thrive on the food and cover provided by this flush of vegetative growth.

Beetle-killed Stands

There is little information available about the responses of voles to residual stands killed by insect epidemics. A study in lodgepole pine forests in northern Utah, where overstory tree mortality of 90% was common, reported that microtine rodents responded positively to the beetle outbreak, at 3-8 years post-attack.

Our data from the NIFR and SIFR provide the first four years and the initial year, post-attack, respectively, of a monitoring program of voles and understory vegetation in beetle-attacked and susceptible pine stands. Changes in understory vegetation with the initial beetle-attack and subsequent mortality of overstory lodgepole pine trees may have profound effects on vole populations and potential damage to planted seedlings.

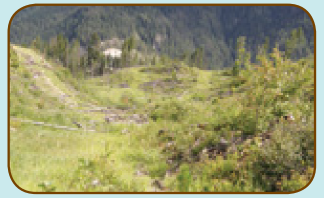
To date, mean numbers of *Microtus* voles (MV) and red-backed voles (RBV) in autumn were **nil to low-moderate risk, for damaging seedlings, in beetle-killed and susceptible pine stands** in the two regions.

Project area	Mean MV/ha	Mean RBV/ha	Risk Rating
SIFR			
Penticton Creek	0	0	Nil
Kamloops	0.8	9.2	Low-Moderate
Summerland	0.1	1.2	Low
Kelowna	0.1	0.6	Nil
NIFR			
Dunkley	3.2	7.4	Low
Prince George	6.3	11.0	Low-Moderate
Vanderhoof	2.4	14.8	Low-Moderate

This successional change should be followed through time to determine how these voles respond to vegetation development in the understory. It is still unclear as to how often red-backed voles feed on planted trees.

Sites seeded with pasture grasses and forbs

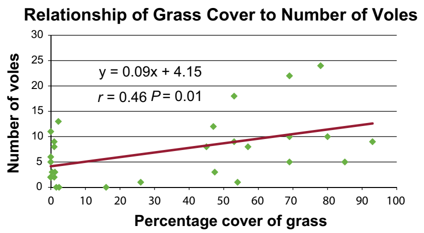
Seeding of landings, road-sides, and skid-trails with forage grass and forb species for slope stabilization and erosion control was conducted, as an operational practice, on some harvested sites. Typical pasture/forage seed mixtures include introduced species of: orchard grass, timothy, red fescue, crested wheatgrass, red top, alfalfa, and clover.



Linear habitats (skid-trails) seeded with pasture grasses on a 5-year-old harvested site at Golden.

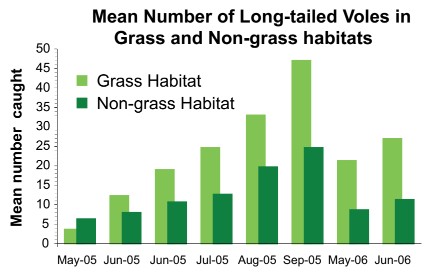
There was a significant positive relationship between numbers of long-tailed voles and percentage cover of grasses in a survey of plantation sites. Mean ground cover of grasses was 61.7% in the grass habitats and 1.8% in the non-grass habitats.

A threshold level of approximately 50% grass cover was required to generate suitable habitat for vole numbers to reach tree damage levels.



Linear regression of the relationship of ground cover of seeded pasture grasses and number of long-tailed voles.

Mean numbers of long-tailed voles were significantly higher (1.5 to 2.6 times) in the grass (mean=24) than non-grass (mean=13) habitats during 2005 and early 2006.



Mean (n=3) abundance of long-tailed voles per ha in grass and non-grass habitats in 2005 and 2006.

Plantation Protection - What to do?

Decision-Making Profile – Voles

Question 1: Is there a history of serious tree damage by voles in your operating area such that sites need to be re-planted?

Yes, then at the planning (pre-harvest) stage, could adjust prescriptions to:

Alternative silvicultural systems

- Green-tree retention (Douglas-fir, spruce) wherever possible
- Avoid contiguous clearcut units (such as MPB salvage)

Enhance habitat for predators and predation

- Debris piles → Small carnivores
- Snags, stub trees → Birds of prey

Seeding of pasture grasses

Avoid this practice; use alternative shrub species (alder, willow) for erosion control

Question 2: Must planting be done immediately after harvest or wildfire, to avoid competing vegetation, or for other reasons?

Yes, then consider the following:

Tree species selection / planting regime

- Plant spruce, subalpine fir, or larch where possible – all are relatively unpalatable to voles compared with lodgepole pine and Douglas-fir
- Plant more trees to accommodate expected damage (e.g., 2000/ha)
- Use larger stock where possible
- Nursery seedlings with reduced fertilization regime
- Tree guards
- Natural regeneration will provide additional seedlings

Diversionary food

- Why are voles feeding on trees?
  - Bark is poor source of nutrients
  - Lack of alternative food supply
- Provide a diversionary food

No, then delay planting until at least the 4th year after clearcutting, or until the 3rd year after wildfire:

- Plant fast growing species Pl and larch > fir > spruce during these low populations
- Use larger stock where possible

Snowshoe hares

Another potentially major problem species to forest plantations is the snowshoe hare, which is considered a keystone species in the boreal forest of North America. Hares have a 9- to 11-year fluctuation in abundance and represent the main prey for many vertebrate predators in northern forests, such as Canada lynx, coyotes, and great horned owls, among others. It is not clear if this cycling behaviour of hares also occurs in the montane western coniferous forests of BC and the northwestern US.

Snowshoe hare in a livetrap.

Abundance of hares in beetle-killed stands increased in the NIFR from 2006 to 2008 based on pellet-plot surveys and live trapping. However, abundance of hares appeared to be similar between 2008 and 2009 for most study sites, and hence a peak may have been reached. Hares are considered more of a potential problem in the NIFR than SIFR, although they may be locally abundant in the southern region.

Lateral clipping of Douglas-fir seedling by snowshoe hares.

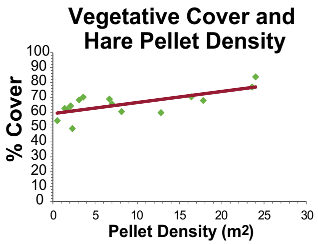
Terminal clipping of lodgepole pine seedling by snowshoe hares.

Hares appear to preferentially feed on newly planted coniferous seedlings during summer and fall after planting (particularly lodgepole pine and Douglas-fir), and saplings during overwinter periods of peak populations when alternative natural foods may be in short supply. Hares damage seedlings by clipping the leader and lateral shoots, leaving an oblique cut surface at a 45° angle. Damage to young seedlings in plantations is usually most severe in or near areas having sufficient cover to provide suitable habitat (often 10-25 years post-harvest).

Snowshoe hares also remove bark from the base of stems and low branches of large seedlings and sapling trees up to about 6 cm in diameter. Feeding damage may occur higher on stems and branches, depending on snow depth. Fecal pellets, which are slightly flattened spherical disks 10 mm in diameter, are usually present at feeding sites.

Trees debarked up to 6 cm dbh.

Use of beetle-killed non-merchantable stands by snowshoe hares (density of pellets as indicative of habitat use) appears strongly linked to percent cover of understory shrubs and trees. This is consistent with many studies that have concluded that hares prefer densely-vegetated sites.



On sites with low to moderate cover, despite relatively high levels of damage to seedlings (> 50%), subsequent survival of seedlings was still very high (> 80%). On those sites with high hare abundance or shrub and tree cover, and low survival of seedlings, controlling this vegetation should substantially reduce hare abundance and proportions of seedlings damaged by hares in treated stands. Vegetation management (brushing) appears to be an effective treatment to reduce stand use by hares. Pellet densities and clipping by hares were reduced by 50% and 90% on two brushed sites when compared with controls (unbrushed sites).

Plantation protection - what to do?

Decision-Making Profile – Snowshoe hares

Question 1: Is there a history of serious tree damage by hares in your operating area such that sites need to be re-planted?

Yes, then on to question 2.

Question 2: Is the hare population cycle near a peak (e.g., start or end of decade)?

Yes, then consider:

- Delay planting until after hare populations have declined
- Prior to planting, implement a vegetation management (brushing) program in those stands with high levels of understory shrubs and trees
- Implement options from Tree Species Selection/Planting Regime outlined for voles

No, damage to planted seedlings should be minimal.

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