VOLES AND FOREST PLANTATIONS

PHASE 3

Grass Seeding, Habitat, and Vole Populations in Forest Plantations

FSP Y092081

Contract No. 4880001

Annual Report Submitted to:

LOUISIANA-PACIFIC CANADA Ltd.
P.O. Box 170, 800 9th Street North
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Forest Investment Account
2008-09

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1.0 Executive Summary

This report summarizes an FIA-sponsored program with Louisiana-Pacific Canada Ltd. in 2008-09 that was focused on the impact of grass-seeded habitat on vole populations in forest plantations. The program is concerned with voles of the genus *Microtus* which are major mammalian pests in coniferous tree plantations in the Golden TSA. Voles feed on tree seedlings and saplings, particularly during winter months of peak years in abundance. This damage may result in direct mortality from girdling and clipping of tree stems or reduced growth of surviving trees which have sub-lethal injuries. In terms of conservation and sustainability of temperate forests, this feeding damage may limit regeneration of appropriate tree species in certain forest ecosystems. In addition, this damage increases the cost to reforest these stands in time for Free Growing Status, decreases net productive forested area, and results in loss of Mean Annual Increment. Feeding damage appears to be associated with high populations of voles in early successional habitats that develop after clearcut harvesting. The problem is widespread throughout the southern and central interior of B.C.

The 2008-09 project was designed to (1) determine the distribution and seasonal fluctuation of voles in relation to grass-seeded and non-grass-seeded areas in forest plantations; (2) assess the incidence of feeding damage by voles to plantation trees and its relationship to grass habitat; and (3) relate vole population data to grass habitat and other vegetation over a range of plantations and site characteristics, and develop a "third approximation" of a forecast model of when and where voles will be a problem. Additional objectives from the Forest Science Program (FSP Y092081) were: (4) continue long-term monitoring of vole populations from the time of clearcut harvesting, and (5) compare vole populations in clearcut versus variable retention harvested sites to determine the influence of silvicultural system on habitat and population dynamics of voles.

Project areas were located on 7 units at Glenogle Creek and Roth Creek, ca. 25 km east of Golden, and covered a range of harvesting ages, systems, and sites. Units were selected to provide a range of grass habitat conditions on landings, skid trails, and roadsides to assist in developing phase 3 of a forecast model of when and where vole populations will be a problem in plantations. Long-term monitoring units are 821-58 (grid C), 825-1 (grid D), 825-6 (grid E), and 821-2 (grid F). All sites were selected on the basis of operational scale, reasonable proximity to one another, and have been monitored since the time of harvesting (2004). The variable retention (VR) units are located in habitats with residual Douglas-fir trees: 821-58 (grid J), 825-1 (grid K), and 825-3 (grid L). Clearcut (CC) units for comparison are those habitats without any retention of live overstory trees (grids C, D, and E).

There was a significant (r=0.46; P=0.01) positive relationship between numbers of long-tailed voles (*Microtus longicaudus*) on grids and percentage cover of grasses in the index-line survey (n=15) of plantation units. This pattern was also observed for percentage cover of total herbs, but the trend only approached significance (r=0.33; P=0.07). Similarly, mean numbers of long-tailed voles on grids were consistently higher

(1.5 to 2.6 times) in grass than non-grass habitats during 2005 and early 2006, and were 1.4 to 3.7 times higher in 2008 . Mean crown volume index (m^3/0.01 ha) of grasses was 3.67 in the grass habitats and 0.00 in the non-grass habitats in this analysis.

A third approximation of a forecast model and evaluation of grass habitats and other site characteristics for predicting vole damage to plantations was revised. Time since clearcut harvesting at 3-4 years in large contiguous units (from mountain pine beetle (MPB) salvage) seems to increase susceptibility to population buildups of voles and subsequent damage to plantation trees. Comparison of vole responses to clearcutting and variable retention systems should help clarify the role of harvesting method, where this is a flexible operational scenario. The IDF_{dk} and MS_{dk} subzones also appear to be most susceptible to vole damage. Seeding of grass species (pasture seed mixes) clearly creates habitat conditions for population buildups and maintenance of vole populations. At least 50% ground cover of grasses is required to generate population densities of voles that result in a “high” risk level for tree damage. A risk rating for grass-voles-trees was derived from the significant positive relationship of percentage tree mortality and abundance of voles (*Microtus*), based on our earlier work. Voles reach a “high” risk rating in plantations with grass habitats, at 30-50 animals/ha.

Potential future investigations might include 1) completion of monitoring voles in grass and non-grass habitats in spring (May and June) 2009; 2) evaluation of tree guards to prevent or reduce feeding damage by voles; 3) investigate summer damage to newly planted trees by voles, prior to application of diversionary food (mouse pucks) to new plantations in October 2009; 4) Preparation of a manuscript and extension brochure: “Vole feeding damage and forest plantation protection in the Golden TSA: Susceptibility of new plantations”.

2.0 Background

2.1 The Problem

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 and Eurasia (Moore, 1940; Myllymäki, 1977; Byers, 1984; Getz, 1985; Conover, 2002). In forestry, voles of the genera *Microtus* and *Clethrionomys* are considered the major mammalian species affecting coniferous and deciduous tree plantations in North America (Sartz, 1970; Radvanyi, 1980; Bergeron and Jodoin, 1989; Sullivan et al., 1990), Europe (Hansson, 1985; 1991), and Asia (Shu, 1985; Sullivan et al., 1991). Populations of some species of voles tend to have cyclic fluctuations in abundance in northern latitudes with a peak every 3 to 5 years, although these periods may be interspersed with annual fluctuations in abundance (Krebs and Myers, 1974; Taitt and Krebs, 1985; Körpimaki and Krebs, 1996; Boonstra et al., 1998).

Voles of the genus *Microtus* are considered one of the major mammalian pests in coniferous tree plantations in the Golden TSA. The diet of voles consists primarily of grasses, sedges, and forbs. However, these rodents will feed on tree seedlings and saplings, particularly during winter months of peak years in abundance. Voles may feed on bark, vascular tissues, and sometimes roots of trees. This damage may result in direct mortality from girdling and clipping of tree stems or reduced growth of surviving trees which have sub-lethal injuries (Fig. 1). Planted trees, with their nursery fertilization regime and enhanced palatability and nutrition, are nearly always preferred by voles over wildlings arising from natural regeneration (Sullivan and Martin 1991). In terms of conservation and sustainability of temperate forests, this feeding damage may limit regeneration of appropriate tree species in certain forest ecosystems. In addition, this damage increases the cost to reforest these stands in time for Free Growing Status, decreases net productive forested area, and results in loss of Mean Annual Increment. Feeding damage appears to be associated with high populations of voles in early successional habitats that develop after harvesting. The problem is widespread throughout the southern and central interior of B.C.

Three species of *Microtus*, the long-tailed vole (*M. longicaudus*), the meadow vole (*M. pennsylvanicus*), and the montane vole (*M. montanus*) are implicated as major consumers of tree seedlings (Fig. 2a, b, and c). A fourth species, the heather vole (*Phenacomys intermedius*) is also present in these small mammal communities but exists at low abundance (< 5 animals/ha) (Fig. 3a). In addition, populations of the southern red-backed vole (*Myodes gapperi,* formerly *Clethrionomys gapperi*) occur primarily in mature stands of timber (Merritt 1981) but may spill over into recently cut areas for 1-2 years after harvest (Fig. 3b). It is likely that these voles already lived on the forested site prior to logging and continue there for a few years afterward, possibly feeding on lodgepole pine seed from cone slash. Red-backed voles disappear from harvested sites by 2 years post-logging, probably because their preferred food source, hypogeous fungi, are in short supply (Sullivan and Sullivan 2001; Klenner and Sullivan 2003, 2009).

Fig. 1. Examples of feeding damage by voles to lodgepole pine and D. fir seedlings.

Figure 2. (a) Long-tailed vole; (b) Meadow vole; (c) Montane vole.

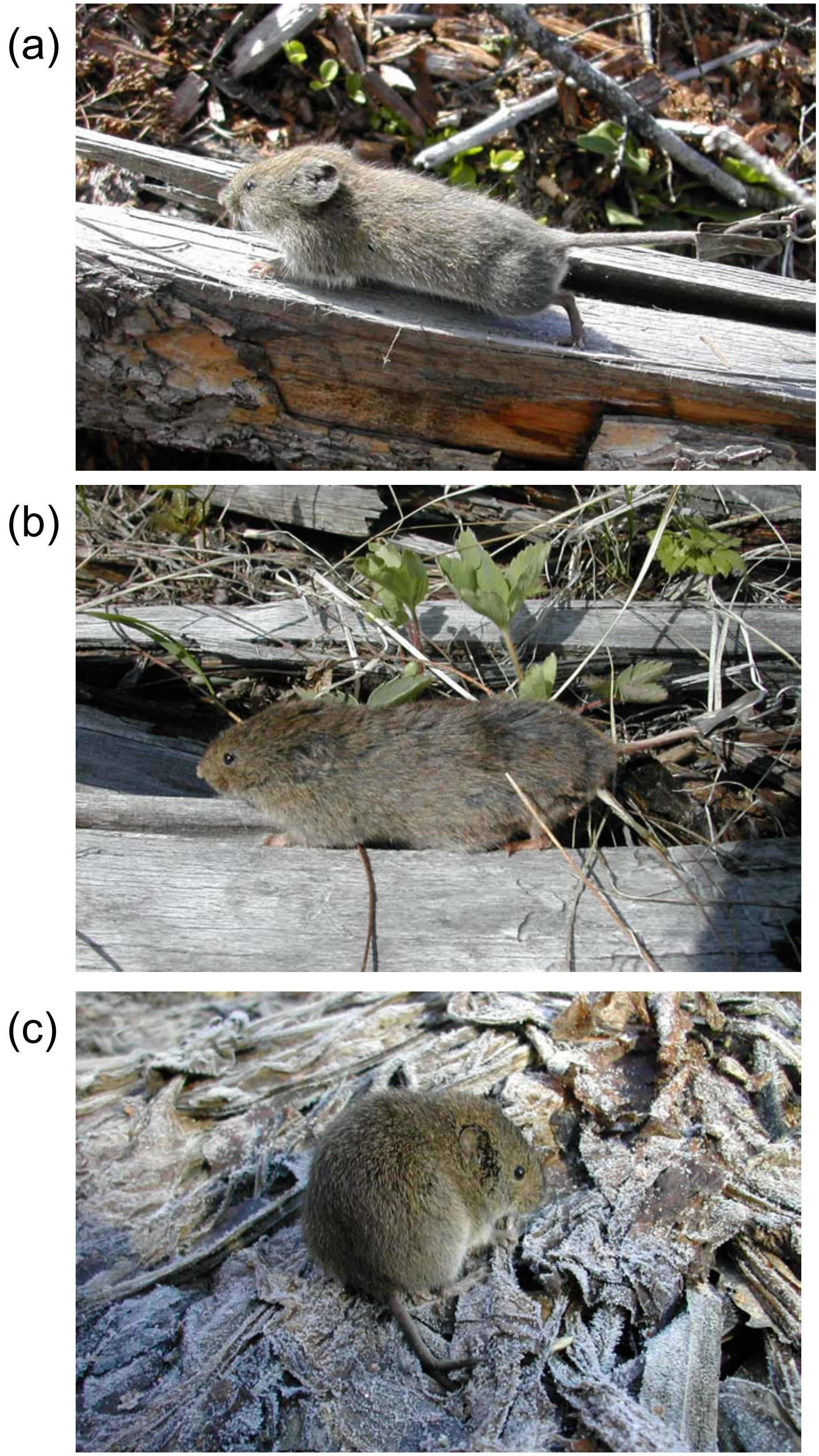


Figure 3. (a) Heather vole. (b) Red-backed vole.

(a)

(b)

Abundance of *Microtus* populations and degree of damage is usually highest in early successional habitats that develop after forest harvesting by clearcutting (Hansson, 1989; 1991; Sullivan and Sullivan, 2001; Sullivan et al., 2001), wildfires (Fisher and Wilkinson 2005), and in old fields (perennial grasslands) undergoing afforestation (Radvanyi, 1980; Bergeron and Jodoin, 1989; Ostfeld and Canham, 1993; Ostfeld et al., 1997). Grasses, herbs, and shrubs in these habitats provide food and cover for *Microtus* voles (Batzli, 1985; Ostfeld, 1985). The preference of *M. longicaudus* and *M. pennsylvanicus* for the early-successional habitats of clearcut and seed-tree origin may be explained by the abundance of herbs and grasses providing food and cover (Reich 1981; Getz 1985). The occurrence of *M. longicaudus* on clearcut and seed-tree sites, and to some degree on patch-cut sites, fits the variety of habitats occupied by this vole (Halvorson 1982; Van Horne 1982; Morris 1984; Smolen and Keller 1987). Habitats with some open areas and shrub and sapling cover at 7 to 10 years after clearcutting, appeared optimum for *M. longicaudus* in Alaska (Van Horne 1982). Later seral stages with less understory vegetation and thick canopies appear to have lower densities of long-tailed voles.

2.2 Monitoring of Vole Populations

Population fluctuations of *Microtus* are generally unknown in the Golden TSA, and it appears that vole populations may be high on some sites every year.
This monitoring component is a continuation of Forest Science Project (FSP) Y073138 which was initiated in 2004, and continued through to 2006, with four installations to follow population fluctuations of the four species of voles in the Glenogle and Roth Creek study areas east of Golden. Monitoring has been conducted from June to September 2004, and May to September 2005 and 2006, yielding 16 monthly datasets for analysis. We continued monitoring vole populations on these sites in 2007 and 2008 (FSP Y092081) and will do so for an additional year (2009), to record when populations start declining. In addition, we will compare vole populations in clearcut versus variable retention harvested sites to determine the influence of silvicultural system on habitat and population dynamics of voles.

Because of habitat preferences, *Microtus* occur frequently on forested areas harvested by clearcutting, up to almost 10 years after logging. The red-backed vole may be present for 1 - 2 years after clearcut logging, but persists in small patch-cuts and potentially within the understory of snags, whether created by wildfire or attack by mountain pine beetle (MPB). There has been much research on the importance of habitat heterogeneity in population dynamics of small mammals. Clearcutting of forests yields relatively homogeneous early-successional habitats. Alternative harvesting practices such as group seed-tree and patch-cutting systems produce heterogeneous habitat patterns compared with clearcutting. The habitat preferences of *Microtus* and red-backed voles over this range of harvesting practices in terms of mean abundance and habitat variables were reported by Sullivan and Sullivan (2001). *Microtus* spp. were inversely related and *M. gapperi* positively related to basal area of residual trees. Similar relationships were recorded for the density of residual trees and the mean abundance of *Microtus* spp. and *M. gapperi* . The mean abundance of *Microtus* spp.

was inversely related to percentage cover and crown volume index of residual trees. The mean abundance of *C. gapperi* tended to be positively related to cover and crown volume index of residual trees.

2.3 Grass and Non-grass Habitats

Grass seeding is currently used to prevent soil erosion, site degradation, and invasion of noxious plant species on newly harvested sites, but there is much disagreement as to the validity and necessity of this practice. The role of seeded pasture grasses providing potentially ideal habitat for buildups of vole populations needs to be addressed. Seeding of landings, road-sides, and skid-trails with these grass species for slope stabilization and erosion control may be an essential practice on some harvested sites. However, the subsequent spread of these grasses may alter the regenerating ecosystems in unfavourable ways. Typical pasture/forage seed mixtures include: introduced species of orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), red fescue (*Festuca rubra*), crested wheatgrass (*Agropyron cristatum*), red top (*Agrostis alba*), alfalfa (*Medicago sylvatica*), and clover (*Trifolium pratense*).

A critical question is: What effects does grass seeding have on the plant community and vole populations occupying recently harvested units? There is a need to know the status of vole populations in many different vegetation complexes, including those with a high component of grasses, in order to identify those sites that are particularly susceptible to feeding damage. Do the seeded grass communities favour development of vole habitat and essentially predispose such sites to severe feeding damage to planted trees? Knowledge of the relationship of vole numbers to availability of grass-seeded habitat, in a given plantation, will also relate to factors such as planting density of trees, tree species selection, Free Growing Status, application of pest management methods, and other decision-making tools.

3.0 Objectives

This project was designed to:

(1) Continue long-term monitoring of vole populations from the time of clearcut harvesting (2004) through 2009 (FSP Y092081).

(2) Compare vole populations in clearcut versus variable retention harvested sites to determine the influence of silvicultural system on habitat and population dynamics of voles.

(3) Determine the distribution and seasonal fluctuation of voles in relation to grass-seeded and non-grass-seeded areas in forest plantations.

(4) Relate vole population data to grass habitat and other vegetation over a range of plantations and site characteristics, and develop a “third approximation” of a forecast model of when and where voles will be a problem.

4.0 Study Areas and Design

4.1 Monitoring of Vole Populations

This project was located at Glenogle Creek and Roth Creek, 25 km east of Golden, in the Golden TSA. Long-term monitoring units are 821-58 (grid C), 825-1 (grid D), 825-6 (grid E), and 821-2 (grid F) (see Fig. 4). All sites were selected on the basis of operational scale, reasonable proximity to one another, and have been monitored since the time of harvesting (2004). All sites are far enough apart to be statistically independent.

The variable retention (VR) units are located in habitats with residual Douglas-fir trees: 821-58 (grid J), 825-1 (grid K), and 825-3 (grid L). Clearcut (CC) units for comparison are those habitats without any retention of live overstory trees (grids C, D, and E).

4.2 Grass and Non-grass Habitats

This project was located on 15 units at Glenogle Creek and Roth Creek, and covered a range of harvesting ages, systems, and sites (Fig. 4; Table 1). Units were selected to provide a range of grass habitat conditions on landings, skid trails, and roadsides to assist in developing phase 3 of a forecast model of when and where vole populations will be a problem in plantations.

5.0 Methods

5.1 Long-term Monitoring of Vole Populations

Vole populations (and other forest floor small mammal species) were sampled at 4-week intervals from May to September 2007, and previously in 2004-2006. Trapping grids (1 ha) had 49 (7 x 7) trap stations at 14.3-m intervals with one Longworth live-trap at each station. Traps were supplied with whole oats, and cotton as bedding. Traps were set on the afternoon of day 1, checked on the morning and afternoon of day 2 and morning of day 3, and then locked open between trapping periods. All small mammals (except shrews and weasels) captured were ear-tagged and immediately released at the point of capture (Krebs et al., 1969). Forest floor small mammal species sampled by this procedure included the long-tailed vole, as well as the meadow vole, heather vole, southern red-backed vole, deer mouse (*Peromyscus maniculatus*), northwestern chipmunk (*Tamias amoenus*), montane shrew (*Sorex monticolus*), common shrew (*S. cinereus*), and short-tailed weasel. Abundance estimates of long-tailed voles, total *Microtus*, and total small mammals were derived from the Jolly-Seber (J-S) stochastic model (Seber 1982).

Inventory Methods for Small Mammals: Shrews, Voles, Mice & Rats (Version 2.0)

3.7.1 Recommended Method: Mark Recapture

3.7.2 Objectives of Surveys
3.7.3 Open vs. closed populations
3.7.4 Models of estimation and methods of analysis
3.7.5 Recommended Models
3.7.6 Office Procedures
3.7.7 Sampling Design
3.7.8 Sampling Effort
3.7.9 Equipment
3.7.10 Field Procedures
Data will be housed with NRIN in the format of Inventory Methods for Small Mammals (Version 2.0).

5.2 Index-line Surveys in Grass and Non-grass Habitats

One index-line was installed in each grass and non-grass habitat (Table 1, Fig. 4) within a given unit and allowed to pre-bait for 4 weeks prior to the actual survey of voles. An overall total of 15 units were sampled with index-line surveys in 2007 and 2008. Traps were supplied with whole oats and cotton and locked open for the pre-bait period. For the survey, index-line traps were set on the afternoon of day 1, checked on the morning and afternoon of day 2 and morning of day 3, and then picked up and moved to the next unit for a pre-bait period. Animals captured were processed in an identical manner to the grid sampling procedure.

5.3 Grid Surveys in Grass and Non-grass Habitats

Three units were selected that had grass-seeded (818-103G, 818-103H, 818-103I) habitats and three units that had little or no grass (818-5, 825-1, 821-2). A 1-ha live-trapping grid was installed in each unit and long-tailed voles were sampled over 8 trapping periods during 2005 and 2006. Methods of capture and processing of animals was identical to those described for the long-term monitoring aspect of this project (section 5.1).

Table 1. Characteristics of all project sites in 2007 and 2008: 1) population monitoring and 2) survey units for index-line monitoring of vole populations in grass and non-grass habitats. [1] Number of growing seasons up to and including 2008.

Unit	Area (ha)	Year of harvest	Silv System	BEC	Age of site[1]	Initial planting	Age of plantation[1]
Population monitoring							
821-58	15.0	2003	CC/VR	MS_{dk}	6	2003	6
825-1	22.3	2004	CC/VR	MS_{dk}	5	2005	4
825-6	10.4	2004	CC	MS_{dk}	5	2004	5
821-2	21.1	2003-04	CC	ICH_{mk}	5	2005	4
825-3	20.4	2004	CC/VR	MS_{dk}	5	2005	4
Survey units							
806-1	20.2	1997	VR	MS_{dk}	11	1999	10
806-4	25.3	1997-98	CC	ICH_{mk}	11	1999	10
812-1	33.5	1998-99	CC	MS_{dk}	10	1999	10
814-4	3.0	1999	CC	MS_{dk}	9	2000	9
818-4	16.4	2001	CC	ICH_{mk}	8	2002	7
818-5	5.6	2001	CC	MS_{dk}	8	2002	7
818-103G	20.0+	2003	CC	MS_{dk}	5	2004	5
818-103H	20.0+	2003	CC	MS_{dk}	5	2004	5
818-103I	9.2	2003	CC	IDF_{dm}	5	2004	5
821-42	2.6	2003	CC	MS_{dk}	5	2003	6
821-44	26.8	2004	CC	ICH_{mk}	4	2005	4
821-46	45.0	2004	CC	ICH_{mk}	4	2005	5
821-47	9.2	2004	CC	ICH_{mk}	4	2005	5
821-48	24.9	2004	CC	ICH_{mk}	4	2005	4
821-58	15.0	2003	CC	MS_{dk}	4	2003	4
825-6	10.4	2004	CC	MS_{dk}	5	2004	5

5.4 Vegetation Sampling

At 5 of the 7 trap stations along each index-line, a 3-m x 3-m plot for sampling shrubs and a 1-m x 1-m plot for sampling herbs was installed (after Stickney 1985). Herb and shrub layers were subdivided into height classes: 0-0.25, 0.25-0.50, 0.50-1.0, 1.0-2.0, 2.0-3.0, and 3.0-5.0 m. A visual estimate of percentage ground cover was made for each species/height class combination within the appropriate nested subplot.

These data were then used to calculate crown volume index (m^3/0.01 ha) for each species. The product of percent cover and representative height gave the volume of a cylindroid which represented the space occupied by the plant in the community. Crown volume index values were then averaged by species for each plot size, and converted to 0.01-ha base to produce the values given for each species and layer (herbs, shrubs, and trees). Total percentage cover for each layer was also estimated for each plot. Sampling was done in July-August 2007 and 2008.

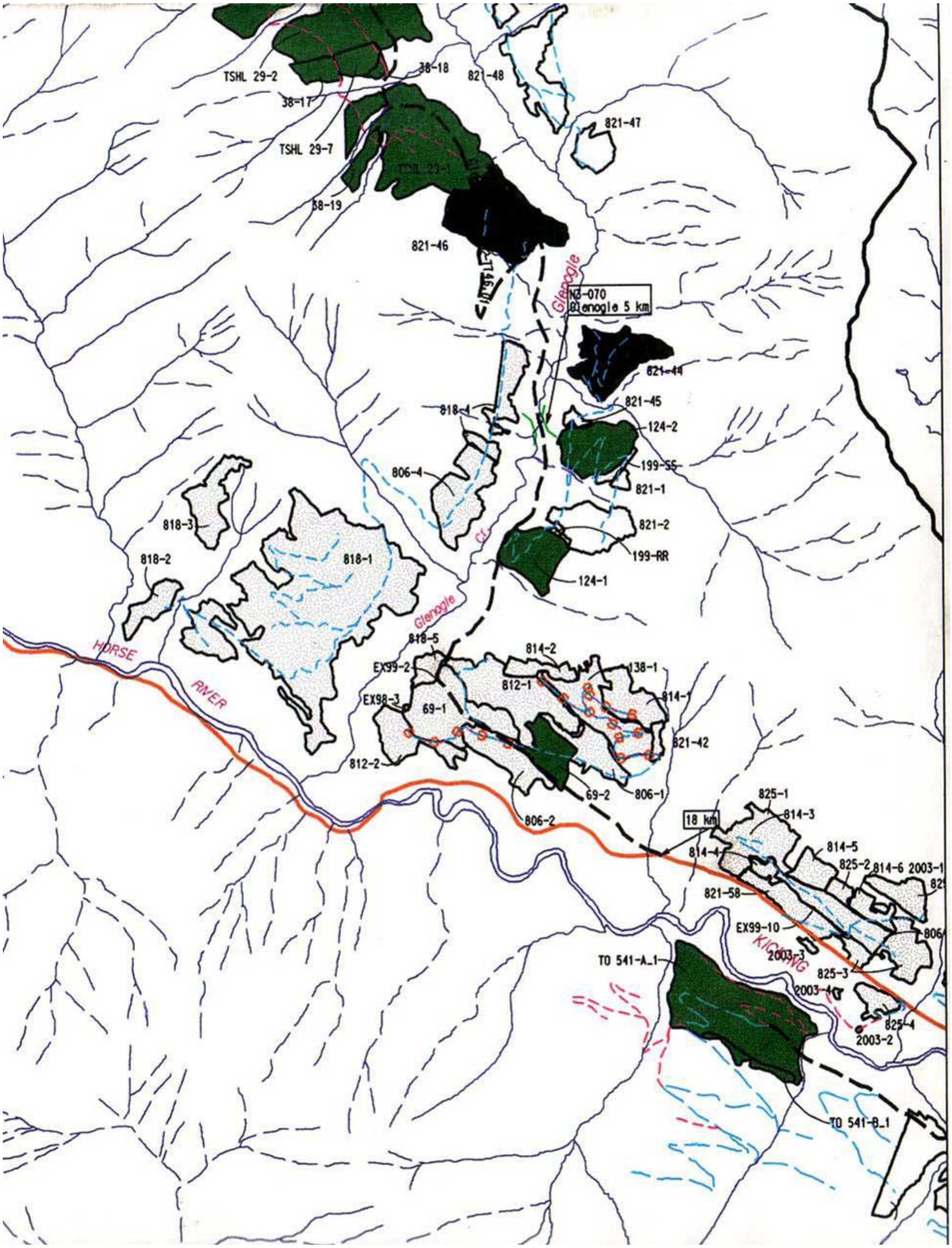
5.5 Grass-Vole-Tree Damage Relationship

A risk rating for feeding damage to trees, based on an index-line survey of voles in a given unit, was derived from the significant ($F_{1,17}$=8.86; P<0.01) positive relationship of percentage tree mortality and abundance of voles (*Microtus*). These data were derived from several study areas in B.C., including Golden project areas, where the number of voles per ha was known in October of a given year. Newly planted tree seedlings (primarily Douglas-fir, lodgepole pine, and some interior spruce) were available on the same sites where vole abundance had been measured and overwinter damage to trees (percentage mortality) by voles was then related to the October population estimate. This relationship is summarized from our 2006-07 project report to determine a grass-vole-tree damage risk rating.

5.6 Statistical Analysis

A linear regression analysis was used to determine the relationship of vole numbers on index-lines to percentage cover of grasses and herbs. An analysis of variance (ANOVA) was used to test the prediction that there was a linear relationship (i.e. $ß \neq 0$) between the independent and dependent variables in these regressions. Proportional data were arcsine-transformed prior to analysis. A *t*-test was used to compare the number of long-tailed voles captured in grass and non-grass habitats on index-lines in the 15 plantation units. In all analyses, the level of significance was at least P = 0.05.

Figure 4. Map of projects units for survey of vole populations and grass habitats at Glenogle Creek and Roth Creek, 25 km east of Golden in the Golden TSA.



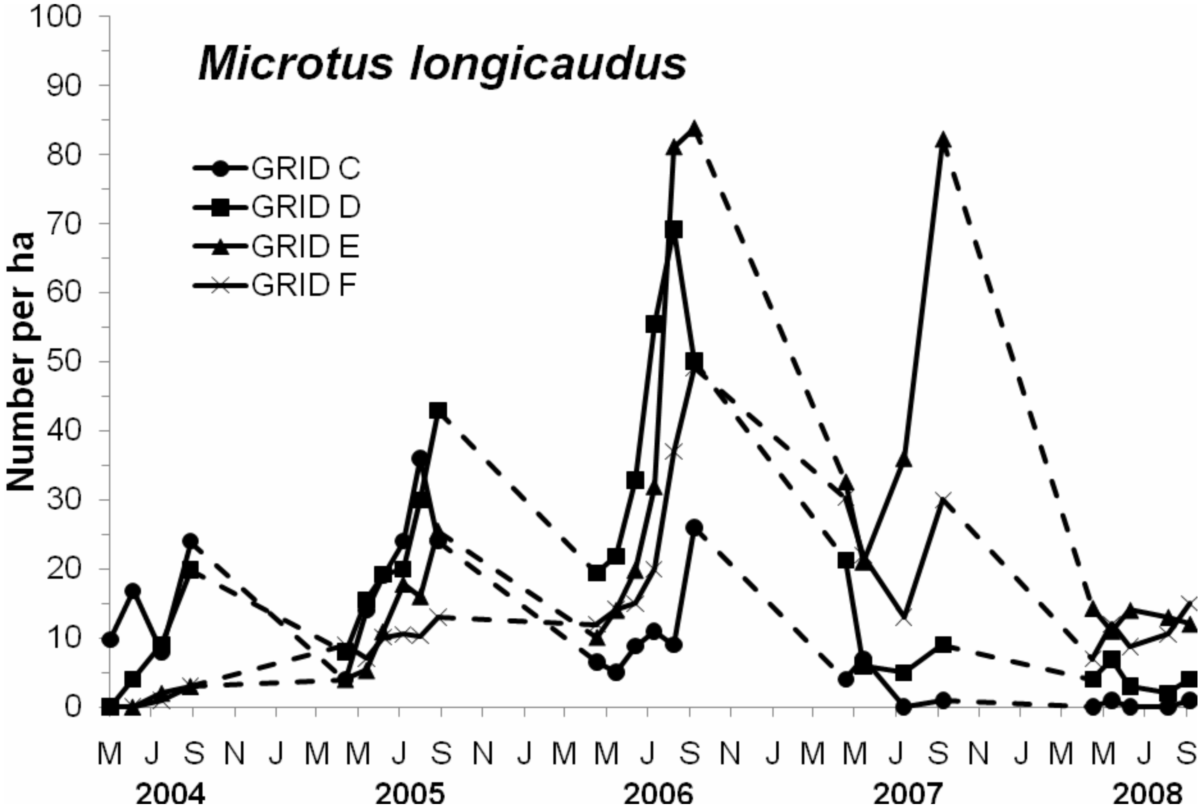
6.0 Results and Discussion

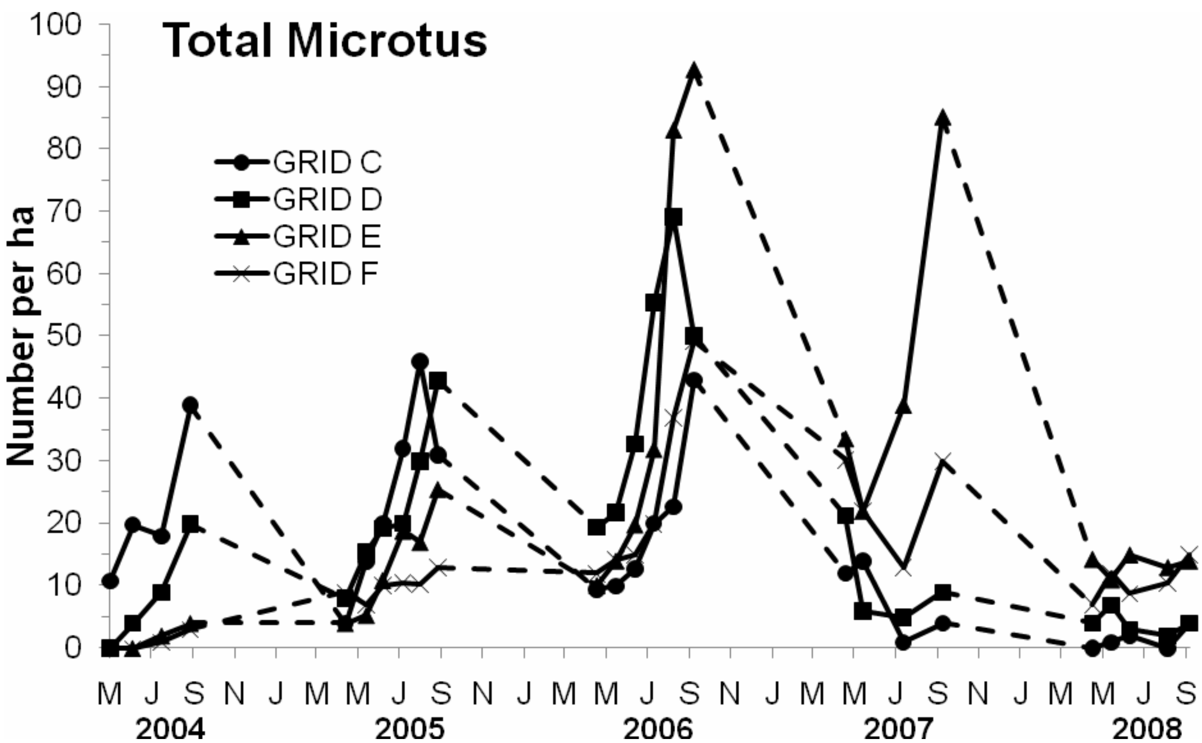
6.1 Long-term Monitoring of Vole Populations

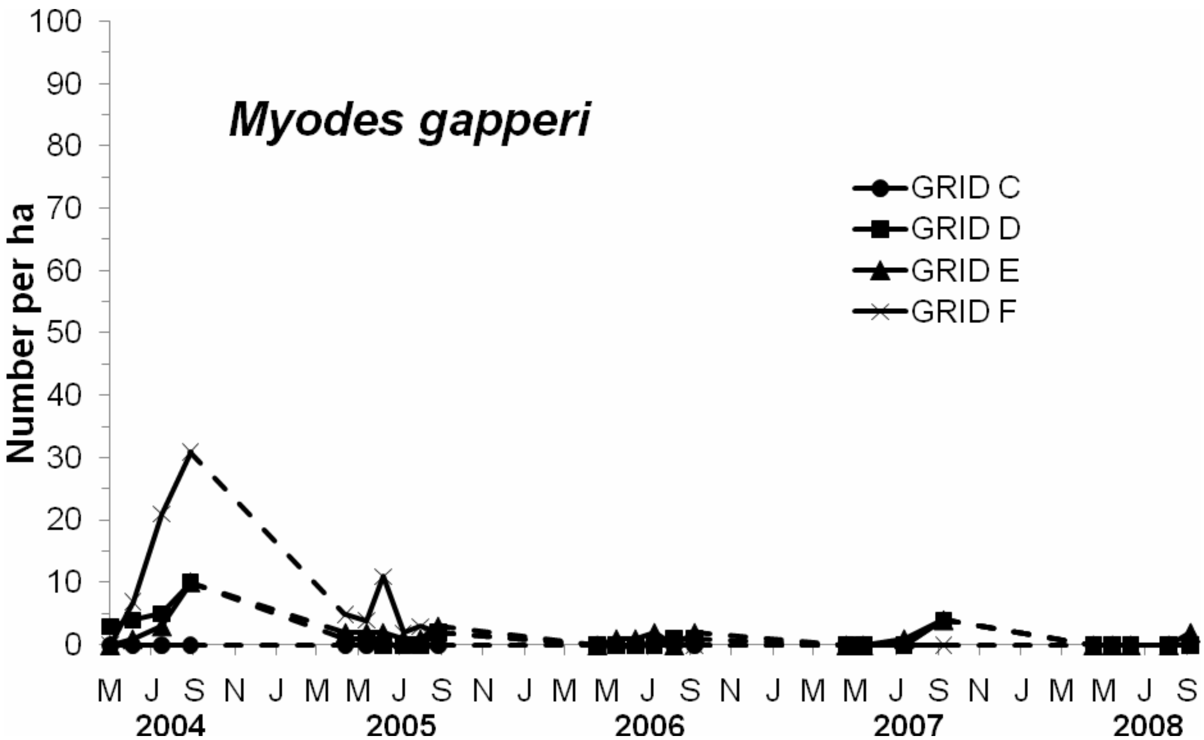
Vole populations have been monitored for five years (2004-2008), since the time of harvesting, to follow how these rodents respond to successional change and reach densities capable of serious feeding damage to newly planted trees (Fig. 5). Mean numbers of voles were quite low (≤ 10/ha) in the first year after harvest. Mean numbers in the second post-harvest year ranged from 13 to 20, and occasionally higher (45/ha), and to annual peaks of 70-80 voles/ha in year 3, if vegetation cover is suitable. However, in the fourth year (2007) since harvesting, numbers of voles have declined, particularly on grids C and D, but overall as well. This decline to low numbers continued in 2008. The long-tailed vole was most common, with the meadow vole also preferring this seral stage. For red-backed voles, in the year after harvesting, mean numbers are as high as 10/ha. However, their numbers declined dramatically at 2 years after harvesting. The heather vole occurs at numbers < 5/ha. These early stages after harvesting provide ideal habitat for many species of small mammals (Fig. 6), in addition to voles.

A comparison of three paired (same age since harvest) clearcut and variable retention sites indicated that numbers of voles (*Microtus*) were consistently higher on clearcut than variable retention sites (Figs. 7 and 8). An apparent exception was the meadow vole where numbers were either similar in the two harvesting regimes, or slightly higher in the variable retention sites. This result was owing primarily to heavy grass cover, from seeding of nearby landings and skid trails, on the variable retention site. Overall, these results, to date, were related to availability of early successional habitat for vole population buildups being more prevalent in clearcut than variable retention sites. Retention of some tree canopy seems to limit vegetative development in the understory and this has direct relevance to vole (*Microtus*) population dynamics. It should be noted that retention of sufficient residual trees may maintain habitat for red-backed voles, which have also been implicated in feeding damage to trees.

Figure 5. Abundance per ha of long-tailed vole (*Microtus longicaudus*), total voles, and red-backed vole (*Myodes gapperi*) populations on the long-term monitoring sites from the time of harvesting (overwinter 2003-04) to the present.

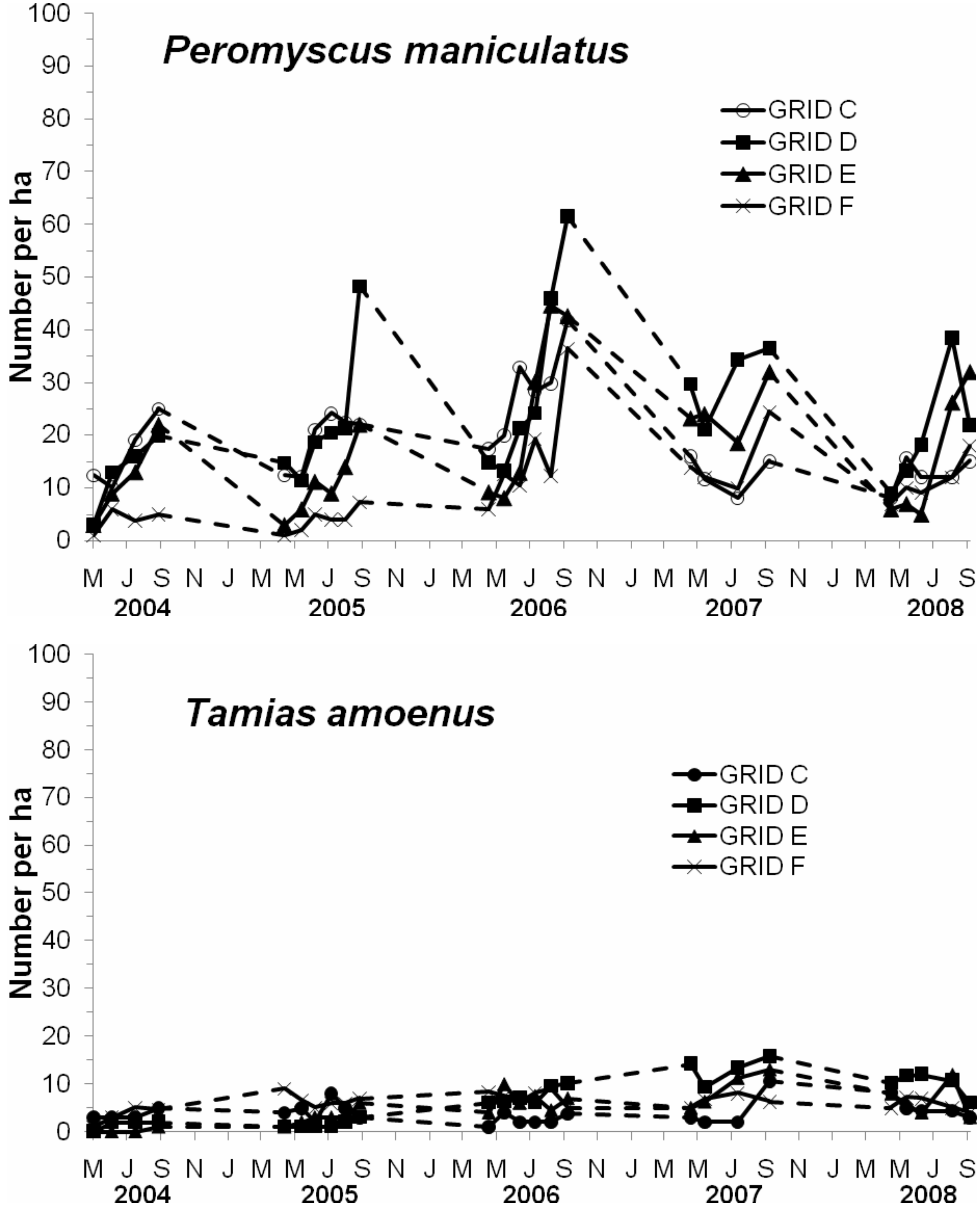


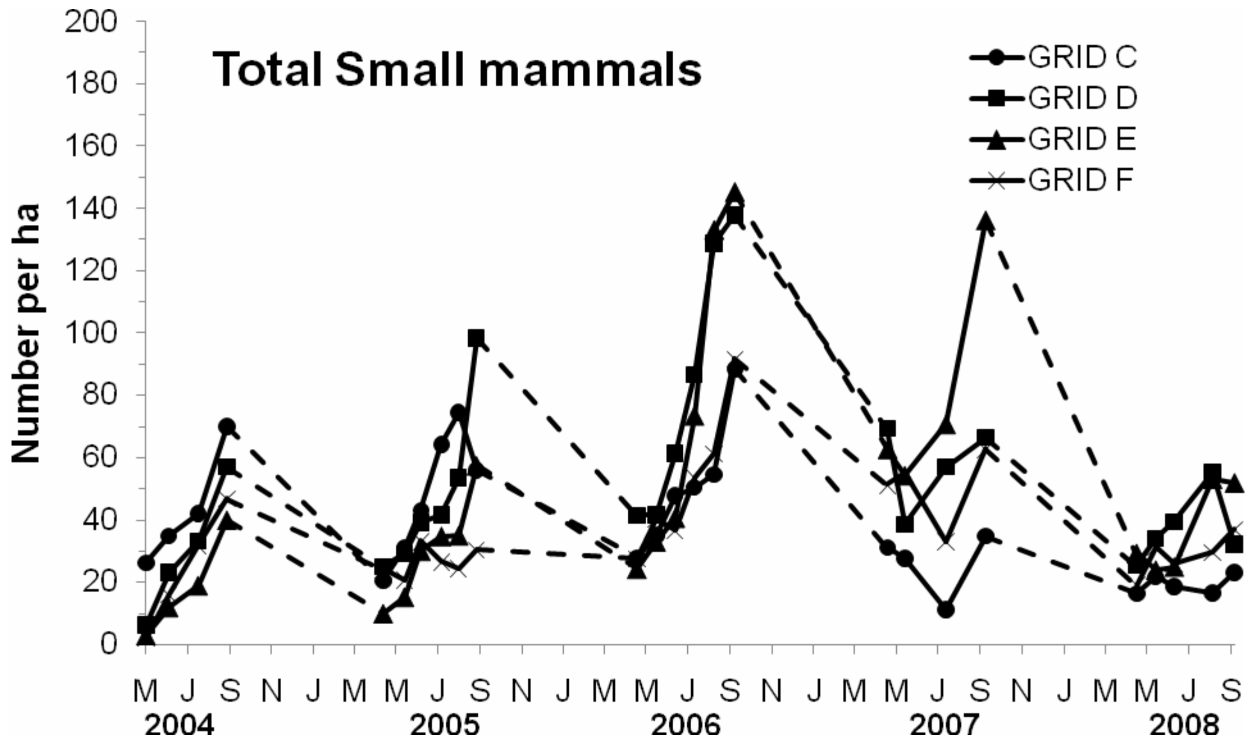




Myodes gapperi
Number per ha
100
90
80
70
60
50
40
30
20
10
0
GRID C
GRID D
GRID E
GRID F
M J S N J M M J S N J M M J S N J M M J S N J M M J S
2004
2005
2006
2007
2008

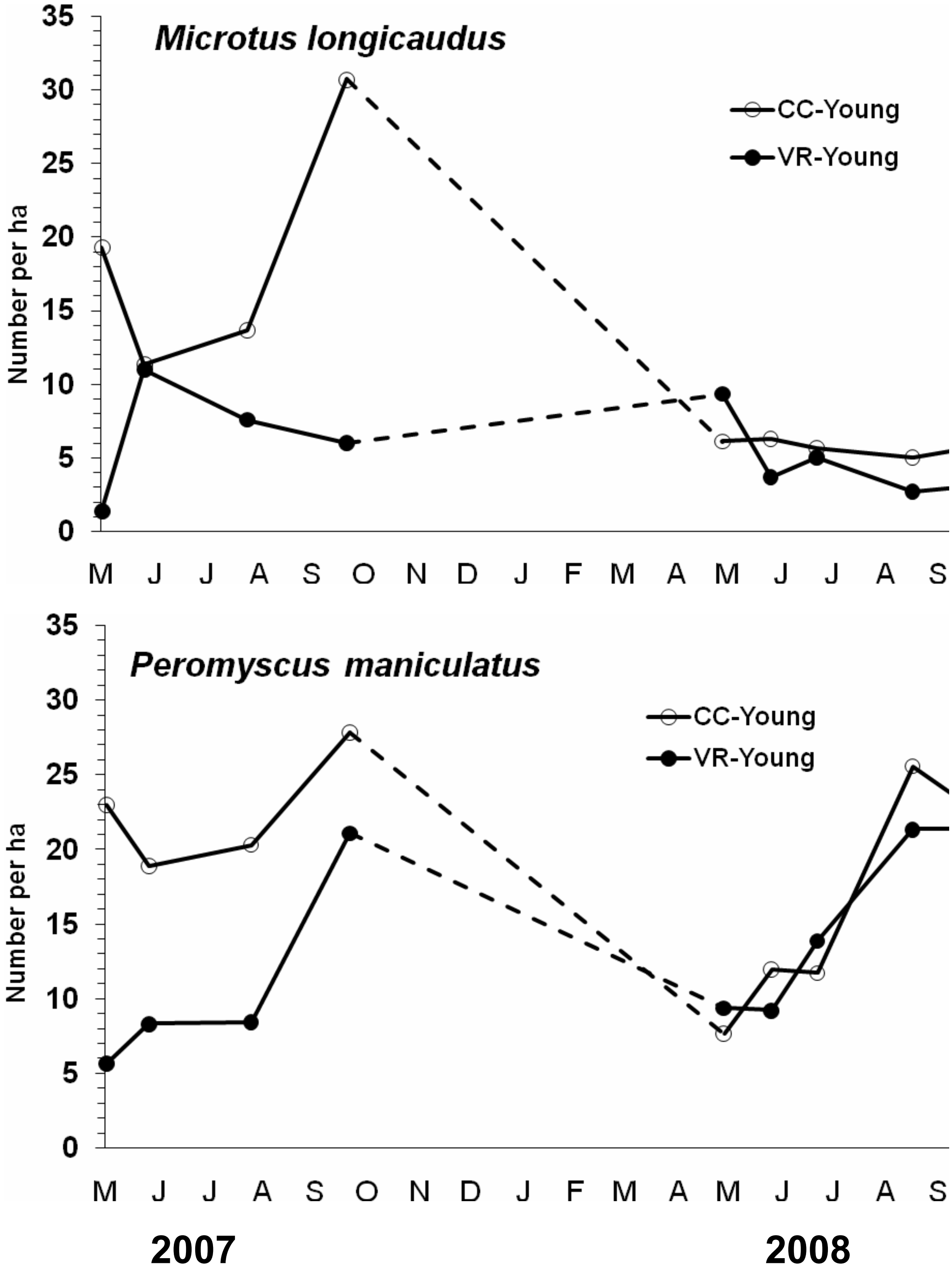
Figure 6. Abundance per ha of deer mice (*Peromyscus maniculatus*), northwestern chipmunk (*Tamias amoenus*), and total small mammal populations on the long-term monitoring sites from the time of harvesting (overwinter 2003-04) to the present.

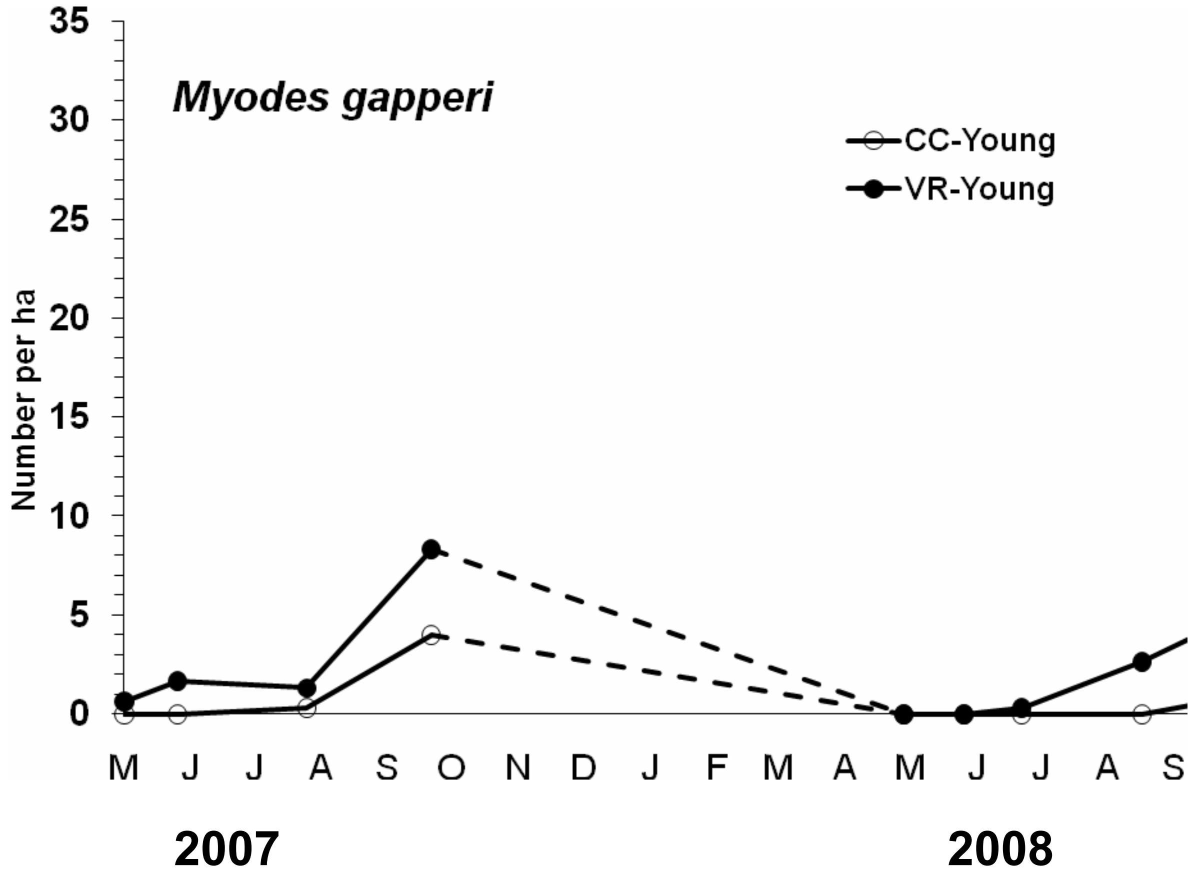




Total Small mammals
GRID C
GRID D
GRID E
GRID F
Number per ha
0
20
40
60
80
100
120
140
160
180
200
M J S N J M M J S N J M M J S N J M M J S N J M M J S
2004
2005
2006
2007
2008

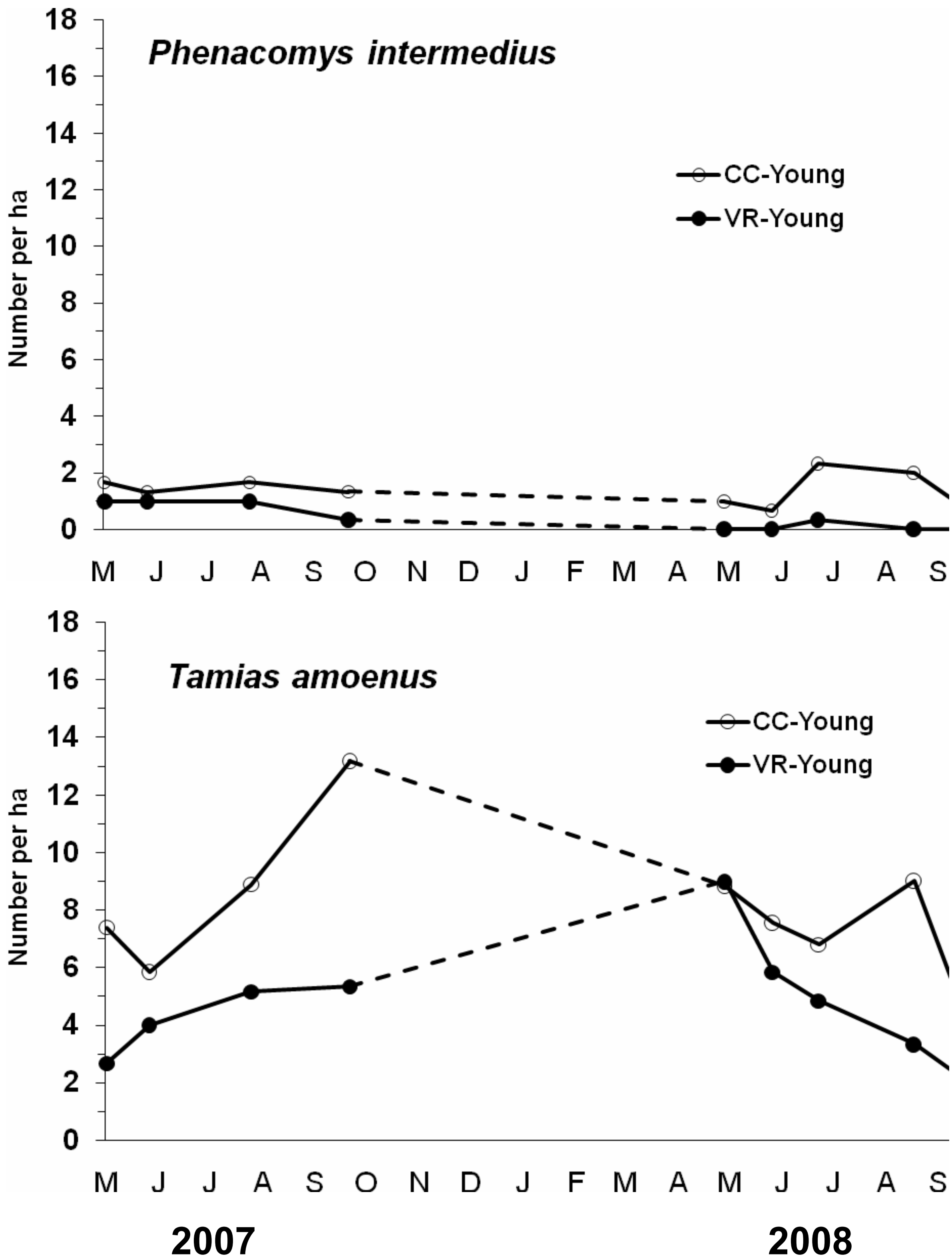
Figure 7. Mean (*n*=3) abundance per ha of long-tailed vole (*Microtus longicaudus*), deer mouse (*Peromyscus maniculatus*), and red-backed vole (*Myodes gapperi*) populations on the clearcut versus variable retention sites during 2007 and 2008.

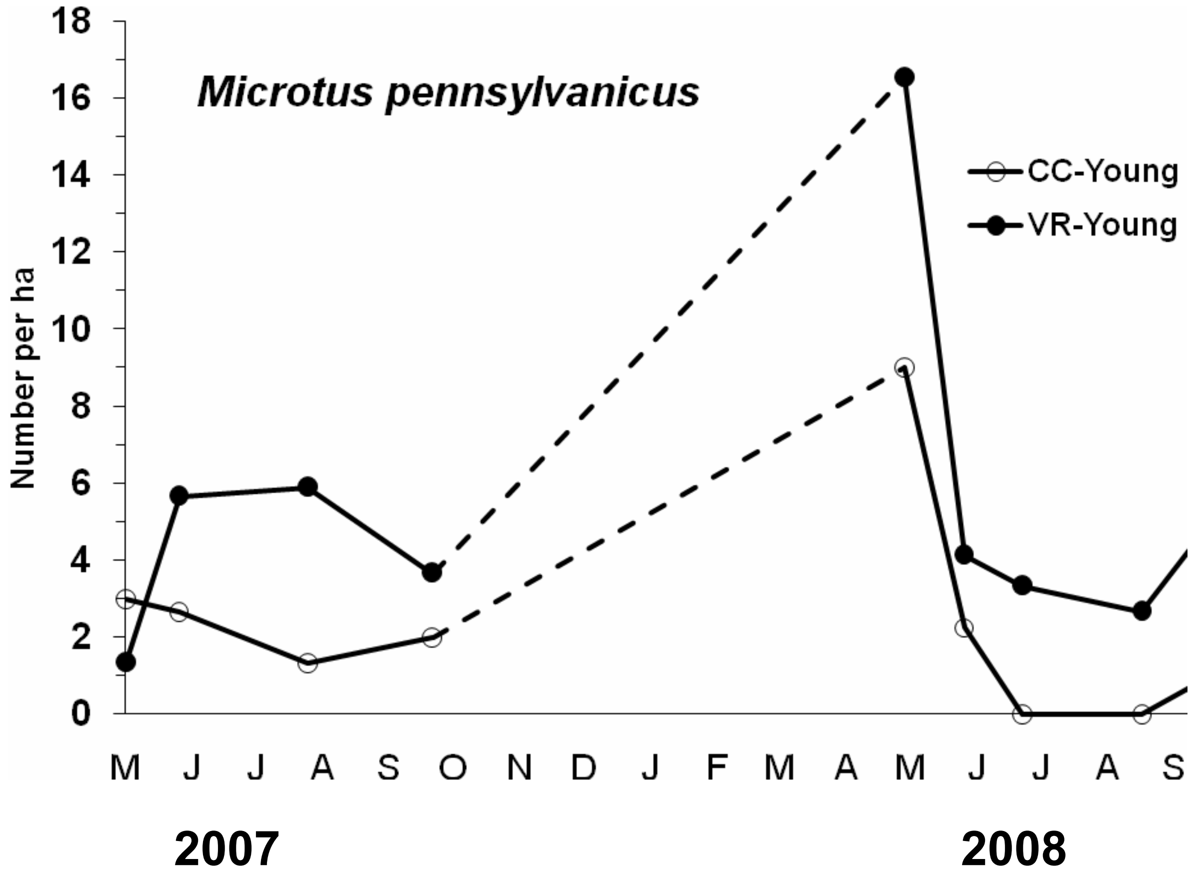




Myodes gapperi
CC-Young
VR-Young
Number per ha
35
30
25
20
15
10
5
0
M J J A S O N D J F M A M J J A S
2007
2008

Figure 8. Mean (n=3) abundance per ha of heather vole (*Phenacomys intermedius*), northwestern chipmunk (*Tamias amoenus*), meadow vole (*Microtus pennsylvanicus*) populations on the clearcut versus variable retention sites during 2007 and 2008.





Microtus pennsylvanicus
CC-Young
VR-Young
Number per ha
18
16
14
12
10
8
6
4
2
0
M J J A S O N D J F M A M J J A S
2007
2008

6.2 Grass and Non-grass Habitats

There was a significant (r=0.46; P=0.01) positive relationship between numbers of long-tailed voles and percentage cover of grasses in the index-line survey (n=15) of plantation units (Fig. 9). A threshold level of 50% grass cover is required to generate suitable habitat for vole numbers to reach tree damage levels. This pattern was also observed for percentage cover of total herbs, but the trend only approached significance (r=0.33; P=0.07) (Fig. 10).

In 2006, there were few significant relationships between abundance of voles on index-lines and most vegetation and site characteristics. However, two exceptions were volume of grasses (r=0.38; P=0.05) and total species richness of all vascular plants (r=0.38; P=0.05). In addition, a multiple regression analysis of the six best independent variables: volume of down wood, volume of herbs, volume of grasses, volume of shrubs and trees, total species richness, and herb structural diversity, did yield an overall significant (r=0.75; P<0.01) result. Thus, our results from 2007 and 2008 appear to support these earlier positive relationships of vole numbers to grass and herbaceous vegetative cover in plantation units.

On grid systems, mean numbers of long-tailed voles were consistently higher (1.5 to 2.6 times) in the grass than non-grass habitats during 2005 and early 2006 (Fig. 11). Mean crown volume index (m^3/0.01 ha) of grasses was 3.67 in the grass habitats and 0.00 in the non-grass habitats in this analysis. Similarly, on index-lines, mean numbers of long-tailed voles also followed this pattern (1.4 to 3.7 times higher) during 2008 (Fig. 12). Thus, in both cases, mean abundance of voles was maintained at a higher level in the grass than non-grass habitats through the summer and fall seasons.

The number of long-tailed voles captured by index-lines in the 15 surveyed plantation units was significantly (t_{14}=4.05; P<0.01) higher in the grass than non-grass habitats. Thus, we have three independent analyses showing clearly that vole numbers are higher in those units with grass-seeded sites, whether they are along skid-trails, roadsides, or miscellaneous seedings. These plantation units may have vole populations that persist through time compared with non-grass units where voles seem to decline by years 4 to 5 after harvest (see Fig. 5).

Figure 9. Linear regression of the relationship of grass cover to number of long-tailed voles (*Microtus longicaudus*) in surveyed plantation units.

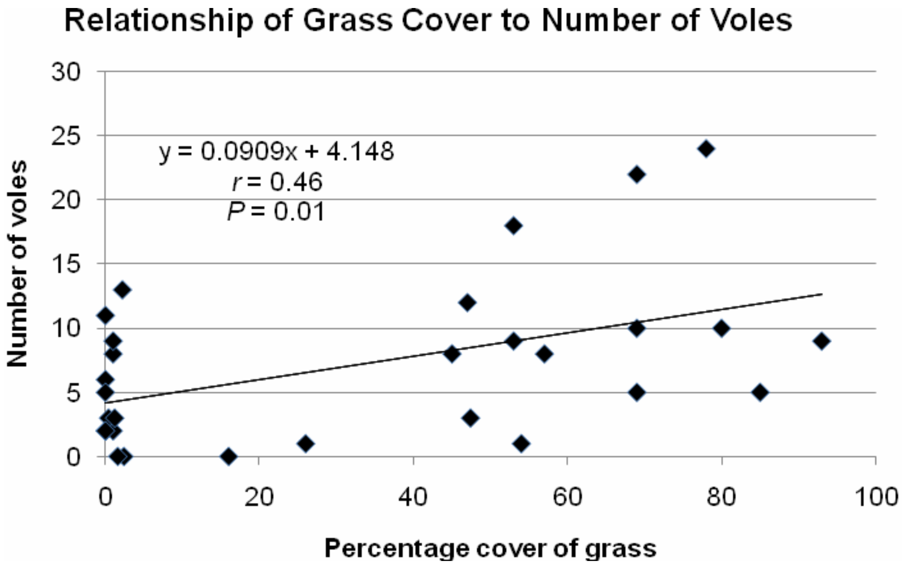


Figure 10. Linear regression of the relationship of herb cover to number of long-tailed voles (*Microtus longicaudus*) in surveyed plantation units.

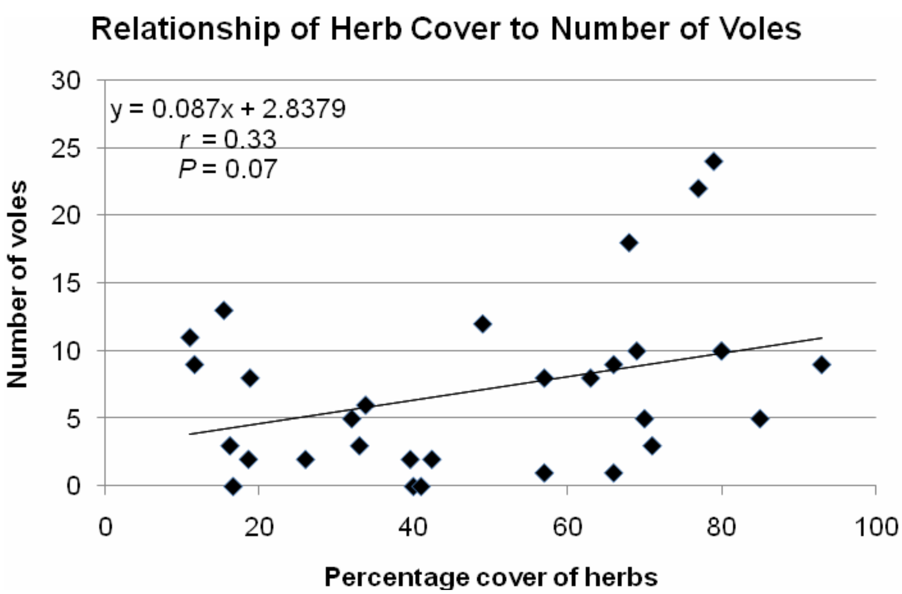


Figure 11. Mean (n=3) abundance of long-tailed voles (*Microtus longicaudus*) per hectare in grass and non-grass habitats in 2005 and 2006.

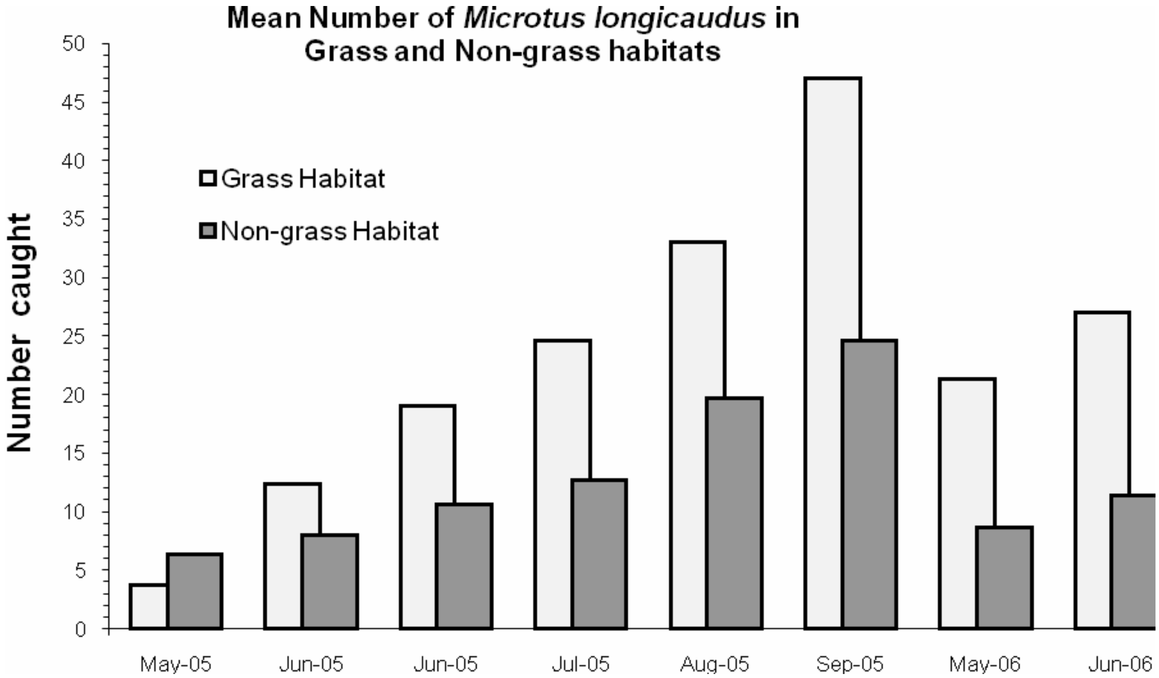
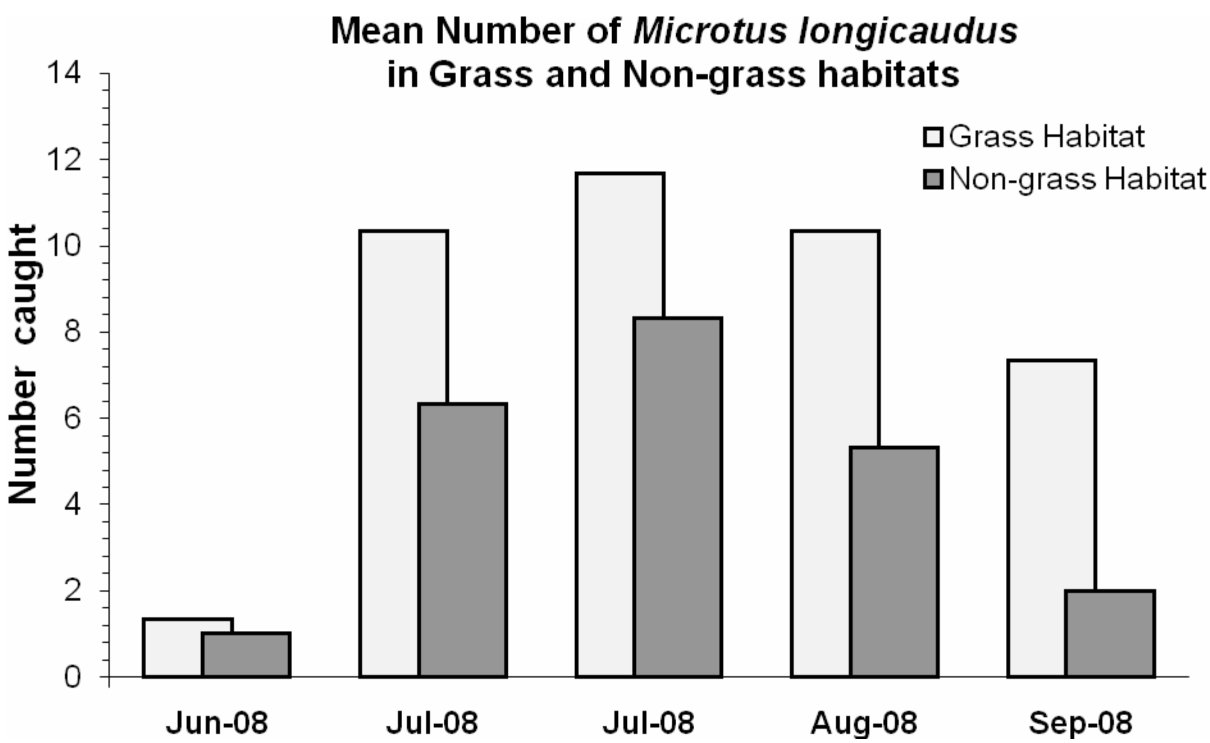


Figure 12. Mean (n=3) abundance of long-tailed voles (*Microtus longicaudus*) per index-line in grass and non-grass habitats in 2008.



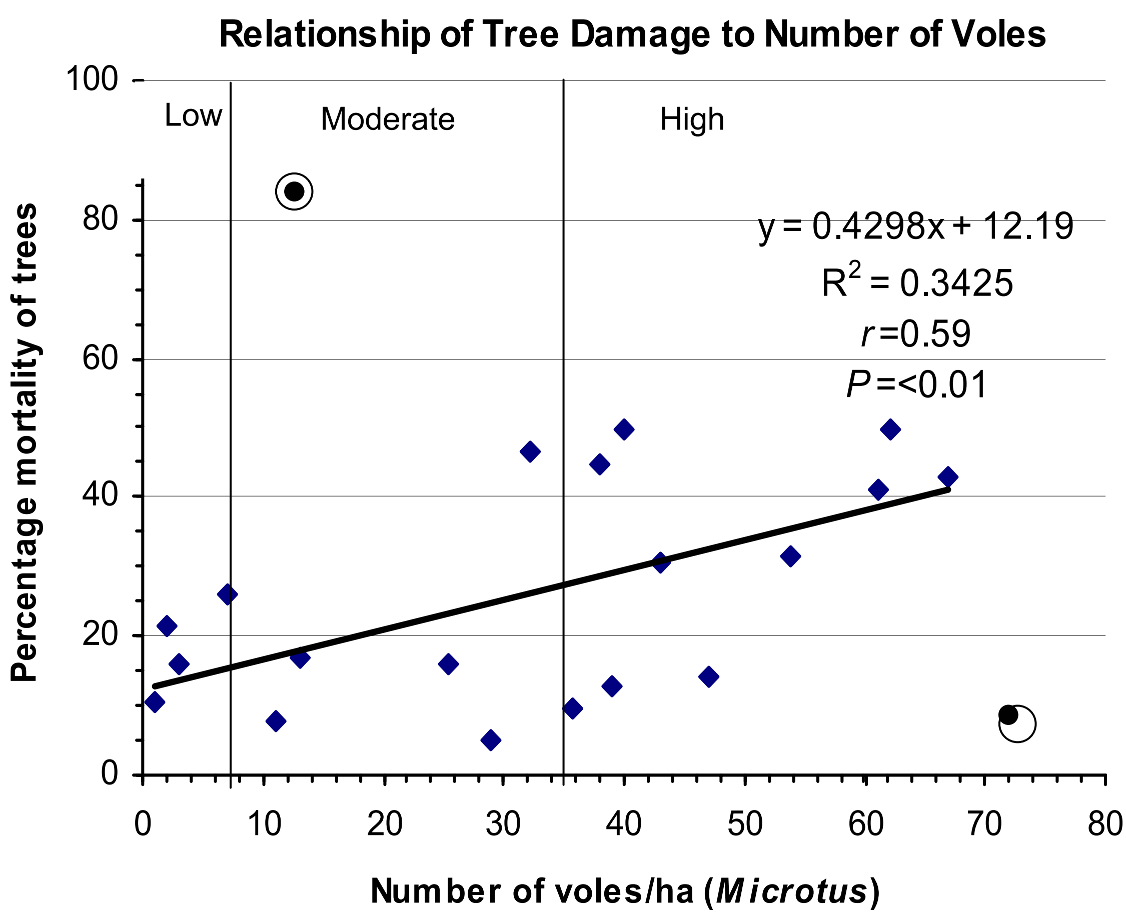
6.3 Vole-Grass-Tree Damage Relationship

The pattern of higher vole abundance in grass-seeded plantation units is directly related to vole numbers and tree mortality from feeding damage:

Number of voles/index-line	Number voles/per ha	Risk of damage to trees
<5	< 7.2	Low
5-10	7.2 – 34.3	Moderate
11-20	34.3 – 88.5	High
>20	> 88.5	Very High

Thus, as determined from Fig. 13 and the above table, the number of voles on a given unit can be related to the potential for feeding damage to trees on that particular unit. It is important to note that 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.

Figure 13. Relationship of percentage tree mortality to abundance of voles. The two datapoints with circles (outliers) and were not part of the regression analysis .



6.4 Forecast Model – Phase 3

A third approximation of a forecast model and evaluation of grass habitats and other site characteristics for predicting vole damage to plantations is illustrated in Fig. 14. Time since clearcut harvesting at 3-4 years in large contiguous units (from mountain pine beetle (MPB) salvage) seems to increase susceptibility to population buildups of voles and subsequent damage to plantation trees. Comparison of vole responses to clearcutting and variable retention systems should help clarify the role of harvesting method, where this is a flexible operational scenario. The IDF_{dk} and MS_{dk} subzones also appear to be most susceptible to vole damage. Seeded grass species (pasture seed mixes) clearly create optimum habitat conditions for voles, generating population densities up to 12 voles per index-line and 30-50 voles/ha, which is in the range of a "high" damage risk to seedlings. The risk rating for feeding damage to trees is derived from the significant positive relationship of percentage tree mortality and abundance of voles (*Microtus*) as indicated in our 2006-07 annual report (Sullivan and Sullivan 2007).

7.0 Future Investigations 2009-10

Potential investigations in the 2009-10 fiscal year include:

1) Completion of monitoring voles in grass and non-grass habitats in spring (May and June) 2009.
2) Evaluation of tree guards to prevent or reduce feeding damage by voles.
3) Investigate summer damage to newly planted trees by voles, prior to application of diversionary food (mouse pucks) to new plantations in October.
4) Preparation of a manuscript: "Vole feeding damage and forest plantation protection: Susceptibility of new plantations"
5) Preparation of an extension brochure as per item (4).

These items are proposed as potential components of an innovative project plan under the Forest Investment Account (FIA) in 2009-10.

Figure 14. A **third approximation** (revisions in red) of a conceptual forecast model to predict when and where there will be feeding damage by voles in forest plantations in the Golden TSA.

FORECAST MODEL

Vole numbers – Risk analysis

Voles on index-lines	Risk to plantations
< 5	Low
5-10	Moderate
11-20	High
> 20	Very High

Grass Seeding = Higher Vole Populations

OUTBREAK OF VOLE DAMAGE

3-4 years

Post-harvest

Clearcut Harvesting
vs
Variable Retention
??

IDF_{dk}
+
MS_{dk} subzones

Large contiguous openings

(MPB salvage units)

8.0 Literature Cited

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