Vole Damage Control in Forest Plantations

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---Field Note---

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ABSTRACT: The effects of five treatments (mowing with broadcast baiting, mowing with hand baiting, hand baiting with no mowing, herbicide, and untreated control) on vole population and damage to forest plantations were evaluated. All treatments caused reductions in vole feeding, as well as reduced seedling damage and potential seedling mortality. This study shows the practical importance of monitoring planting sites for vole populations in the fall prior to and after planting and suggests an immediate control of high and severe vole population ratings with rodenticide with or without mowing to minimize potential seedling mortality.

Key Words: Rodenticide, zinc phosphide (ZP®), peanut butter, baiting, Oust® herbicide.

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As a part of efforts to improve water quality and protect living resources, thousands of acres of hardwood trees have been planted to establish riparian forest buffers on former agricultural fields in Maryland and other States. The meadow vole *(Microtus pennsylvanicus)* and pine vole *(Microtus pinetorum)* has impacted the survival and growth of some of these plantations. The meadow vole (field mouse) is a small, compact rodent, living in grassy habitats where they construct a complex network of surface runways. The pine vole (pine mouse), which is smaller than the meadow vole, spends nearly all of its life in an extensive system of trails and burrows located 1 inch to 2 feet below ground. Vole damage to woody plants usually occurs from fall through early spring. During these months green vegetation is scarce so voles feed on woody plants as sustenance through the dormant season. In recent years many landowners experienced poor survival due to vole damage and mortality. This damage has occurred in new plantations and those that are 4-5 years old. Field observations between 1999 and 2001 in Frederick County, Maryland revealed vole infestation and damage on twelve properties, reducing survival to as low as 5% during fall and winter. Damage of this magnitude requires removal of tree shelters, hand replanting, and shelter reinstall. Besides the high cost, the situation creates ill will with landowners for tree planting programs.

Most studies of vole damage have been undertaken in orchards and nurseries where sites are maintained to reduce vole habitat (Byers 1975, Byers and Carbaugh 1989 and 1991, Kays and Dutky 2000). However, published information on vole damage control for forest plantations is limited. Foresters and other natural resource managers involved with tree planting projects do not always monitor planting sites prior to planting for vole abundance, nor do they understand the different vole management options available to minimize damage to planted trees. A field demonstration was conducted between November 2001 and August 2003 to address this concern and provide recommendations for use by field foresters and landowners.

Methods

Materials and Treatment: The site was located on a five-acre hay field at Monocacy Natural resources Management Area (MNRMA), southern Frederick County, Maryland. The site was machine planted with deciduous tree seedlings and tree shelters installed to protect from deer damage in spring of 2000. Commercial rodenticide and herbicides were used for the treatments. The rodenticide used, ZP® Rodent AG Bait, has as its active ingredient zinc phosphide, which is a fast-acting poison that usually kills voles quickly after one feeding. Zinc phosphide does not bioaccumulate, and is quite safe to secondary animals that may eat dead voles. The herbicide used was Oust®, a post-emergent herbicide that eliminates grasses and forbs and also acts as a pre-emergent to reduce the re-establishment of grass and broadleaf weeds. Five treatments were applied on November 2001 and in March 2002 with no replication of sites. Each treatment area was about 1 acre, roughly square and in close proximity to each other. The treatments include - (T1) Mowing between the tree rows, followed by broadcast application of 8lbs/acre ZP® using a spinner-type hand broadcaster; (T2) Mowing between the tree rows, followed by hand baiting (spot application) of one teaspoon ZP® at the base of each seedling (3lbs/acre); (T3) Hand baiting (spot application) of one teaspoon ZP® at the base of each seedling (3lbs/acre) without mowing; (T4) Habitat modification with broadcast application of 6 oz/acre of Oust® herbicide to remove and suppress the tall fescue grass, and other vegetation, and (T5) Control (no treatment). Vole abundance and condition of the tree seedlings were assessed in each area prior to treatment application. T1, T2 and T3 were baited with ZP® twice (November 2001 and 2002), and mowed four times between rows in November 2001, July and September 2002, and July 2003. Because fall was not the best time to apply Oust® herbicide, T4 was treated only once in March 2002. The cost of material and labor required were calculated for each of the different management options.

Vole population assessment: Ten permanent monitoring stations were established at a regular spacing across the site in the unmowed tree shelter rows in each treatment. Each station was periodically checked and gauged for the status of the vole population and the level of vole activity using a vole-feeding index (FI) (Parkhurst, 1990). The monitoring stations consisted of a 2”x 2” piece of roof shingle (called a “bait shingle”) baited with peanut butter, placed on the ground and covered with a roof shingle. The monitoring stations were baited first in November 2001 and the vole FI assessed as a baseline prior to treatment. The stations were re-baited and the vole FI assessed in January 2002, October 2002, and January 2003. Each station was checked 1 day later for signs of voles feeding (tooth marks and consuming of bait). The same stations were rechecked four days after placement. The percent of the bait consumed was recorded for one of five categories as shown in Table 1a and provided an indication of population level.

Vole damage assessment: Evidence of vole tooth or gnaw marks or girdling at the base of 100 evenly distributed and permanently flagged tree seedlings in each treatment was recorded in one of five categories in the vole damage index (VDI) as shown in Table 1b. Five repeated vole damage assessments using the VDI were completed on the same seedlings prior to and after different treatments in order to have an index as to whether the damage was increasing or the seedling was recovering. The initial damage assessment was completed in early November 2001 along with the vole FI before any treatments to provide a baseline level of damage to seedlings.

Results

Vole population: The vole FI for all treatments indicated a severe population rating at the beginning of November 2001 prior to treatment (Table 2). Ten weeks after treatment, the vole FI was reduced to a low population rating for all mowing and baiting treatments (T1, T2 and T3) compared to before treatment. The as yet untreated T4, and the control (T5), had an increase in vole FI. One year after the initial treatment and just prior to the second rodenticide application, vole FI remained low in mowed treatments receiving hand and broadcast applications of ZP®, while vole FI increased from low to moderate in those treated with ZP® without mowing (T3) (Table 2). Assuming that vole reinvasion was a factor in T3, a 12-feet wide strip buffer zone was created by mowing between T3 and the adjacent untreated area. Vole FI remained severe in the control. Vole FI was reduced to the lowest level in the study in T4 compared to pre-treatment and other treatments, after Oust® was applied in March 2002 (Table 2). The final assessment in January 2003 showed a negligible reduction in vole FI for T1 and T2 after a second rodenticide application. However, hand baiting and no mowing (T3) had a significant reduction in vole FI after a mowed buffer zone was created in the adjacent untreated area. It is likely the lack of mowing in the adjacent untreated area resulted in voles finding suitable habitat to escape the first rodenticide treatment and increase their populations thereafter. While there was no sign of vole activity after Oust® application in T4, thistle growth became a problem, necessitating the application of Transline™ herbicide during the growing season to control thistle. The control plot (T5) continued with severe population levels.

Vole seedling damage: The initial seedling damage assessment in November 2001 using the VDI found that about half of all seedlings had some type of vole damage, as indicated by a category value of 1 to 4. Sixteen to twenty-two percent of all seedlings had either high (category 3) or severe (category 4) damage (Table 2). Ten weeks after ZP® application no additional damage was recorded in T1, T2 and T3, compared to treatments with no ZP® application (T4 and T5) where the percentage of seedlings in damage categories (3) and (4) combined increased from about 17% to about 42% from the baseline value. One year after the initial treatment and just prior the second treatment, seedlings in treatments T1, T2 and T3 recovered dramatically. For example, the percentage of seedlings in VDI category (0) for T1 changed from 49% to 79% after the growing season. Similar trends were recorded in T2 and T3. Even better recovery was recorded for T4 after Oust® herbicide spray in March 2002, increasing the percentage of trees with no damage to 68% after one growing season. The effect of lack of any vole control can be seen clearly by the extremely high VDI levels in T5. VDI values for category 4 seedlings increased consistently from a baseline value of 8% to 38% at the end of the study. Overall, the percentage of seedling with a VDI of 0, 1 and 2 (which can be more or less assured to survive) for treatments T1, T2, T3, T4, and T5 was 81%, 82%, 79%, 68% and 35% respectively.

Potential seedling mortality (PSM): There appears to be a clear relationship between the effect of the treatments on vole FI and the VDI. Vole FI is an index of vole population abundance (Table 1a) and seedlings with a VDI rating (Table 1b) of (3) and (4) are likely to die or be so damaged they are unlikely to contribute to the new forest. Therefore, potential seedling mortality (PSM) (Table 2) is defined as seedlings with a (3) and (4) VDI rating, and it was created to more clearly express this relationship between vole FI (an easy to measure factor) and VDI (which is difficult to measure). The consistent pattern of impacts indicate that the 60% PSM found on the control site (T5) would have been found on other sites if no treatments were applied, instead of the 17-32% PSM values recorded.

Cost of various vole damage control options: Costs for controlling vole damage varied little between treatments. ZP® broadcast baiting with mowing had the highest cost at $120/acre/year followed by ZP® hand baiting at $114/acre/year. The cost for ZP® hand baiting without mowing was lower at $87/acre/year, while it was $37/acre/year for Oust® herbicide treatment. However, an additional $49/acre/year was needed to apply Transline™ at one pint per acres to control invasive thistle as per Maryland state law requiring thistle control.

Conclusion

Overall, the different treatments that utilized herbicide, baiting, and/or mowing reduced vole populations and subsequent seedling mortality. When vole populations were controlled, many seedlings with high levels of damage were able to recover within one growing season. While not a replicated study, the consistent pattern of impacts found on the control site would have been found on other sites if no treatments were applied. The easy to see relationship between vole FI and PSM indicates some thresholds of vole FI that can be used to trigger rodenticide application. Value of 3 or more vole FI clearly indicates the need for immediate treatment, while levels below 1 indicate that PSM will be unaffected by additional application. What is less clear is at what vole FI level between 1 and 3 should rodenticide be applied. More research is needed to answer that question, but vole FI levels above 1 should initiate a seedling damage assessment, and rodenticide treatment above a vole FI level of 2 is probably reasonable.

The importance of early intervention in early fall to reduce vole populations and minimize PSM cannot be overemphasized. In general, total vegetation control through mowing in September is the best way to control vole population and damage to seedlings. However, total vegetation control through the application of Oust®, though effective, creates significant problems with invasive species establishment and additional cost that must be considered. Hand or broadcast baiting of ZP® in early fall, within the plantation and adjacent areas is cost effective and provides good control. ZP® can accomplish quick vole control and will not impact vegetation or wildlife. Since Zinc phosphide does no bioaccumulate, broadcast treatment is quite safe to secondary animals that may eat dead voles.

Recommendations

- Forest plantation sites need to be monitored using the vole FI between fall and spring prior to planting. Mow all grass and other vegetation prior to planting.
- Establish permanent vole monitoring stations (5-10 per acre) and assess vole population for 3-5 years after planting. If the vole FI is greater than 2 apply rodenticide.
- The site should be monitored a week later after rodenticide application, to determine if vole FI was reduced. Depending on the reasons for the lack of impact, a reapplication and subsequent monitoring may be needed.
- Hand baiting is as effective as broadcast baiting, costs were similar, and contractors are easily trained in its use.
- If there is a concern with off target species or the public, rodenticide can be restricted to within or adjacent to the shelter, rather than broadcast. Proper application is necessary to assure the bait is applied on the ground and does not get hung up in the leaves in the shelter.
- Complete vegetation control resulting from a broadcast Oust® application is highly problematic and should be avoided. Invasive species and subsequent vegetation control will

be expensive and time consuming.

- Mowing particularly at the end of the growing season or September can reduce vole habitat and the ability of the voles to reinvade the site during fall and winter, thereby, reducing the need for continual rodenticide treatments.
- It may be advisable to create a barrier by maintaining mowed grass/vegetation-free strips between tree plantations and adjacent meadows to minimize reinvasion of voles. Treat surrounding areas with rodenticide if monitoring and observation indicates high vole activity.

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Table 1: (1a) Vole Feeding Index (FI) was used as an indicator of vole population abundance, and (1b) Vole Damage Index (VDI) was a categorical assessment of actual seedling damage.

1a: Vole Feeding Index (FI)

Category Value	% of Peanut Butter Consumed	Population Rating	FI Ranking
0	None	-	0
1	<25%	Low	<1.0
2	25-50%	Moderate	1.0-1.9
3	51-75%	High	2.0-2.9
4	>75%	Severe	3.0-4.0

1b: Vole Damage Index (VDI)

Category Value	% of Peanut Butter Consumed	Damage Level	Damage Rating	FI Ranking
0	None	None	None	0
1	<25%	Vole tooth or gnaw Mark on stem	Low	<1.0
2	25-50%	About half the stem girdled	Moderate	1.0-1.9
3	51-75%	Over half the stem girdled - will die	High	2.0-2.9
4	>75%	Girdling entire stem - will die	Severe	3.0-4.0

Table 2: Relationship of Vole Feeding Index (FI) to Potential Seedling Mortality (PSM). PSM is the percentage of seedlings with vole damage index (VDI) category values of 3 and 4, which are seedlings, which can be expected to die. T1, T2 and T3 were baited with ZP® twice (early November 2001 and 2002), and mowed four times between rows in November 2001, July and September 2002, and July 2003. T4 was treated with Oust® herbicide only once in March 2002.

	Baseline data before treatments (initial) (11/7/2001)		Ten weeks after the first ZP® application (1/29/2002)		One year after first & prior to the second ZP® application (10/25/02)		Fourteen weeks after the second ZP® application (1/20/2003)		After growing season actual final seedlings mortality (8/26/2003)
Treatment	FI	PSM (%)	FI	PSM (%)	FI	PSM (%)	FI	PSM (%)	(%)
Mow/broadcast bait (T1)	3.4	16	0.4	18	0.6	19	0.4	19	17
Mow/ hand bait (T2)	3.2	22	1	22	0.6	18	0.5	18	19
No mow/ hand bait (T3)	3.5	18	0.8	19	1.7	21	0.6	26	25
Herbicide/no bait (T4)	3.2	17	3.6	41	0.2	30	0	32	32
Control (T5)	3.4	17	3.9	42	3.7	44	3.8	55	60