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Censusing and Control of Small Mammal Populations on Two Hardwood Plantation Areas in Southern Ontario

by

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Introduction

The destructive habits of small mammals have received wide literature coverage in past years. Losses of major proportions have been noted in forest plantations, commercial orchards, vegetable, grain and hay crops. Losses as high as 95 to 99 per cent of plantation grown trees have been recorded by Moore (1940), Eadie (1954) and von Althen (1971), Pank and Matschke (1972).

In 1971, the Canadian Wildlife Service, Western Region, was requested to conduct a preliminary study to assess small mammal populations on the Coulson Tract - an area of abandoned farmland near Toronto, Ontario, on which attempts have been made to establish a hardwood plantation. Many of the young trees had been killed out following girdling by a large rodent population. The primary aims of the 1971 study were to determine what small mammals existed on the area, what population levels prevailed, and over what home ranges individual animals travelled. The study also provided an opportunity to field test the use of Rozol - a new anticoagulant rodenticide being promoted by a manufacturing firm in the United States.

Field studies were carried out on the Coulson Tract during September-October, 1971, and a report prepared (Radvanyi, 1971). The initial rodent control measures using the anticoagulant had not proven entirely satisfactory and after further laboratory testing of the

poison in Edmonton, live-trapping and tagging operations were combined with a poisoning program and carried out on the Coulson Tract during the 1972 field season.

Small mammal studies and control measures were also conducted on a second area at Parkhill, approximately 25 miles northwest of London, Ontario (Hobb's Property study area). This report describes the field operations on the two areas and the laboratory tests conducted on the anticoagulant being used.

Aims of the study:

1. By live-trapping, tagging, and releasing for repeated capture to determine the species, numbers, age composition and home range of the small mammals present on the study areas (the Coulson Tract near Toronto, and the Hobb's Property, near Parkhill, Ontario).
2. To apply Rozol (anticoagulant rodenticide) treated grain bait to the study areas and by repeat of the trapping procedure, to evaluate the effectiveness of the rodenticide application as a possible useful measure in reducing or eliminating harmful small mammal populations.
3. To conduct a late summer reappraisal of the small mammal population level on the Coulson Tract in order to evaluate the rate of re-invasion which could occur from surrounding areas during mid-summer months, and, with a re-application of poisoned bait, reduce the rodent level just prior to when peak amounts of girdling damage would be expected to occur.

The study areas

The Coulson Tract (43°41'N, 79°46'W), shown to the right on Figure 1, had been farmed until 1956, when, upon the death of the owner, the farm became a part of the Halton County Forest under the management of Ontario Department of Lands and Forests. The area was first planted with white ash and basswood seedlings in 1958. Many of these seedlings were soon either girdled by mice, browsed by rabbits, or smothered by weeds. The area was replanted in 1959 with white pine and white spruce spaced 5 feet apart along rows 15 feet apart. From 1960 to 1965, dead trees were replaced each spring. Grasses and weeds between the tree rows were cut each summer with a rotary mower. Despite the application of two pounds of grain per acre treated with Phosbait poison in the autumn of most years, the small mammal population appeared to persist at a high level. Tree losses from girdling damage was especially severe during the winter of 1967-68 (von Althen op. cit.).

At present, the plantation consists of several rows of white pine alternating with several rows of white spruce. Only scattered remnants of the 1958 white ash-basswood planting remain.

By late summer waist to shoulder high wild carrot (Daucus carota L.), Canada thistle (Cirsium arvense L. Scop.), wild aster (Aster spp.), and goldenrod (Solidago spp.) dominate the entire area. These, together with abundant grasses - quack grass (Agropyron repens L. Beauv.), chess (Bromus secalinus L.), downy brome grass (Bromus tectorum L.) and timothy (Phleum pratense L.) provide a most suitable habitat for a

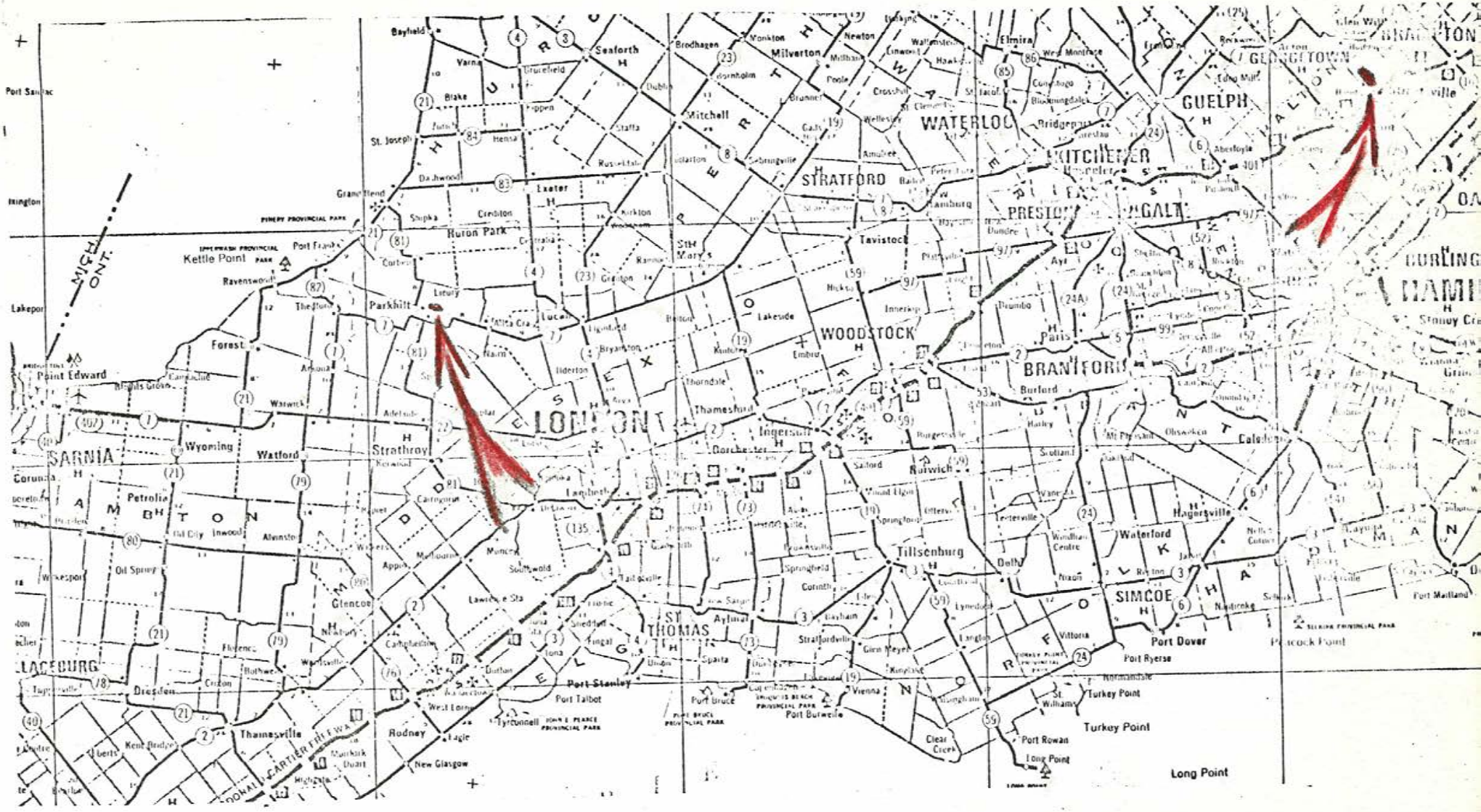


Figure 1. Portion of southwestern Ontario showing locations where small mammal populations were studied during 1972 field season: Hobb's property near Parkhill at left, Coulson Tract near Brampton on right.

large population of small mammals, particularly Microtus pennsylvanicus and Peromyscus maniculatus. Portions of the Coulson Tract suty area are shown in Figures 2 and 3. Distribution of the 300 live traps used in the study area is shown in Figure 4.

Small mammal studies were also carried out on the Ausable River Conservation Authority Hobb's Property near Parkhill, Ontario (43°9'N, 81°41'W), Figure 1. Hawthorn (Crataegus spp.) bushes, willows, (Salix spp.), wild raspberry (Rubus idaeus L.) and wild blackberry (Rubus spp.) were the dominant shrubs on this adandoned farmland. Grasses included timothy (Phleum pratense L.), chess (Bromus secalinus L.), poa (Poa spp.), Old-witch grass (Panicum capillare L.), quack grass (Agropyron repens (L.) Beauv.). Broadleaf weeds included golden-road (Solidago spp.), rib grass (Plantago lanceolata L.), wild strawberry (Fragaria spp. L.), rough-fruited cinquefoil (Potentilla recta L.), St. John's wort (Hypericum perforatum L.), poison ivy (Rhus radicans L.), milkweed (Asclepias spp.), wild carrot (Daucus carota L.), tall butter-cup (Ranunculus acris L.), and common mullein (Verbascum thapsus L.). A general view of this area is shown in Figure 5.

During 1970 young black walnut, black cherry, white ash, red oak and sugar maple trees had been planted along 15 plowed strips on approximately 20 acres of the Hobb's Property. The parallel tilled lines lie approximately 45-feet apart. A grid consisting of 306 individual small mammal live traps set at 26.5 feet intervals along eleven of these lines was established as shown in Figure 6. The grid extended over 8.3 acres - a grid size very similar to that used on the

Figure 2. Portion of Coulson Tract study area showing dense weeds and large spaces where trees had been killed out by small mammals.

Figure 3. Another portion of the Coulson Tract showing wide variation in age classes of trees due to repeated replacement of trees killed out by large resident rodent population.

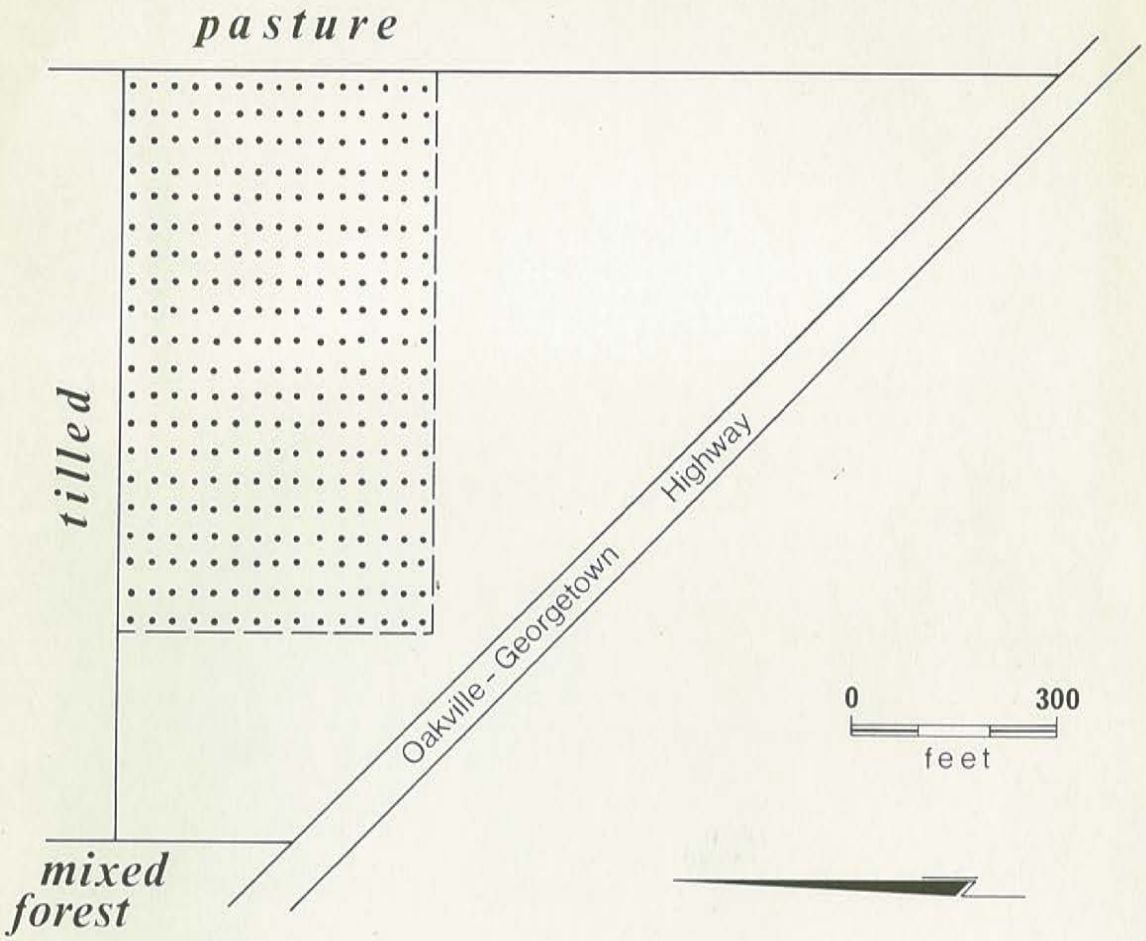


FIGURE 4. Coulson Tract study area. Each dot indicates one of 300 live traps used in small mammal population study.

Figure 5. General view of Hobb's Property study area showing sugar maple planted along plowed strip amongst large hawthorns.

Coulson Tract study area, i.e. one trap per 1192.5 square feet on the Hobb's Property; one trap per 1200 square feet on the Coulson Tract.

Small mammal studies

In the small mammal live trapping and tagging operations, all traps were baited using a paste mixture of ground up beef suet, raisins, walnuts, rolled oats, peanut butter, and oil of aniseed. A thin slice of apple was also placed into each trap as additional bait and as a moisture supplement for trapped animals. A small handful of "terylene fibrefill" placed into the back of the trap provided nesting material to minimize casualties due to chilling. A plywood cover was placed over each trap to prevent excessive overheating by direct exposure to the sun or excessive chilling at night.

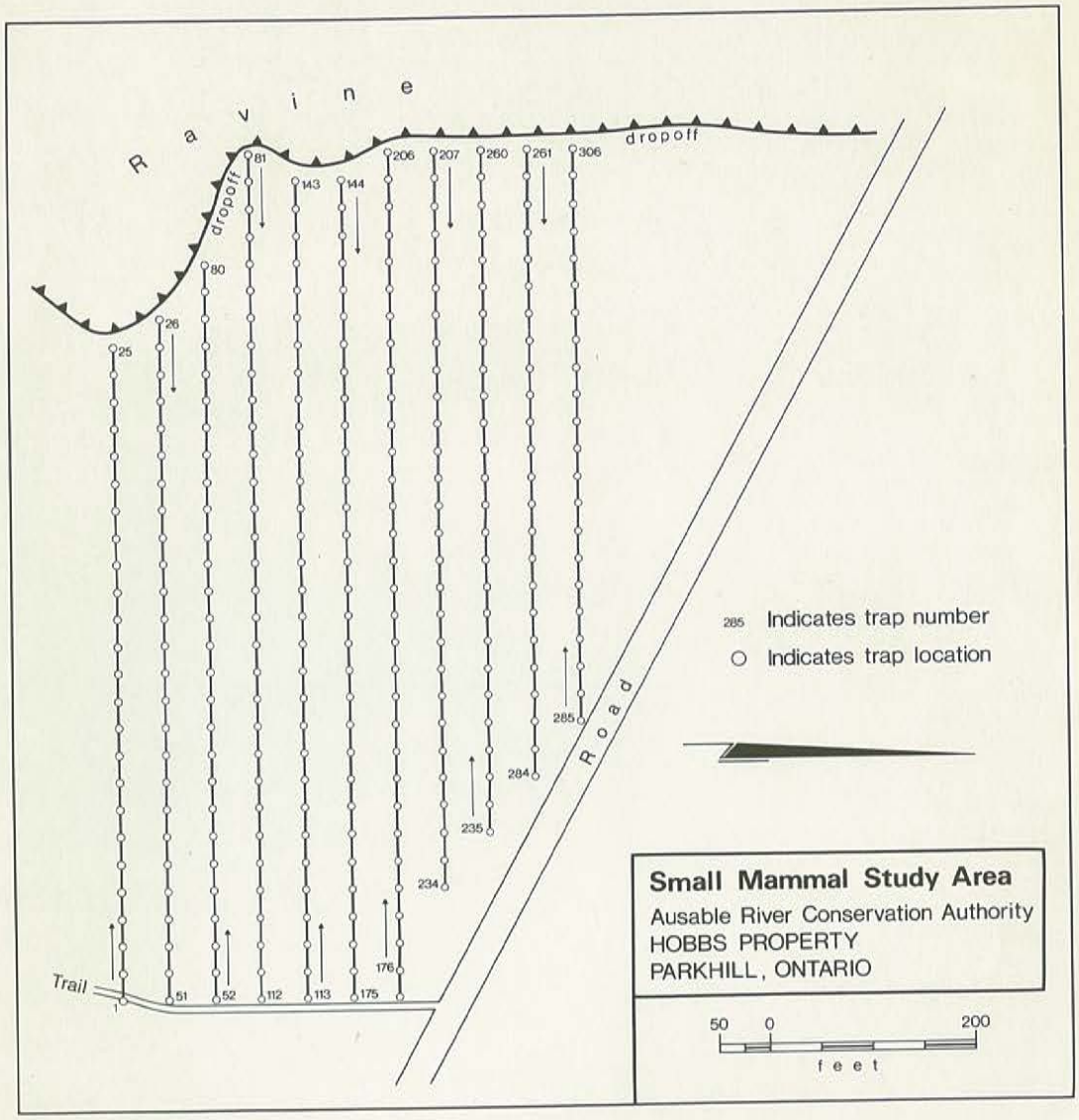


FIGURE **6.** Layout of 306 trap grid covering 8.3 acres of the Hobb's Property small mammal study area.

Once commenced, trapping was carried out for 10 consecutive days. All traps were checked twice daily - usually between 7:00 a.m. and 10:30 a.m. and again between 5:00 p.m. and 7:00 p.m. The bait was generally replaced each time an animal was taken in a trap and fresh bait was supplied to all traps on the fifth day of trapping. Small mammals taken in the traps were identified as to species, sex, age group, trap location, and whether newly captured or recaptured, Figure 7. Prior to release, meadow voles (Microtus pennsylvanicus) and white footed deer mice (Peromyscus maniculatus) were tagged in

Figure 7. Author checking ear tags on a recaptured female Microtus on the Hobb's Property study area.

each ear using numbered fingerling tags; a similar tag applied to the ankle was used to identify short-tailed shrews (Blarina brevicauda), while numbered ring tags were applied to the much smaller cinereus shrews (Sorex cinereus).

Small mammal trapping and poisoning operations were carried out on the Coulson Tract and Hobb's Property in an alternating schedule as outlined in Table 1 below. The sequence followed was intended to

Table 1. Small mammal live-trapping schedule followed on the two study areas in southern Ontario - Summer 1972.

Date	Coulson Tract	Hobb's Property
May 20-30, 1972	10-days trapping	
June 4	Poison bait applied to area	
June 5-15		10-days trapping
June 16		Poison bait applied to area
June 17-27	10-days trapping	
June 28-July 8		10-days trapping
Sept. 11-21	10-days trapping	
Sept. 22	Poison bait applied	
Oct. 3-13	10-days trapping	

permit censusing of the small mammals present during the initial 10 day period. This was followed by application of the control measure and feeding on the poisoned bait during the subsequent 10-14 days.

A second ten-day trapping period was carried out to evaluate the effectiveness of the poisoned bait.

Rozol rodenticide

Just prior to the initial small mammal study on the Coulson Tract in 1971, Chempar Chemicals Ltd., New York, advised the writer of the availability of Rozol. Whereas the small mammal population study was to be done anyway, and as some form of control measure would probably need to be applied, it was decided to field test the product with the hope of reducing the numbers of harmful rodents on the study area. Rozol is available as an oil base liquid which, when blended with a lecithin-mineral oil mixture, is said to penetrate thoroughly into such rodent bait as oat groats. Monastral green dye is included into the formulation to serve as a warning against possible misuse of the treated grain. Rozol is also available in a fine powdered form which is applied to grain bait using a latex adhesive, Rhoplex AC-33 (Rohm and Haas Company of Canada, West Hill, Ontario). Because of the claimed penetrating quality of the oil base and hence an anticipated better retention under possible adverse weather conditions, oat groats treated with the liquid form of Rozol was used in the 1971 study. On the advice of Mr. Rex Marsh, University of California, at Davis, who had made extensive field use of the product in his ground squirrel control studies, application of the treated grain had been at the rate of two and one-half pounds per acre. Four days were allowed to elapse before trapping was re-commenced to evaluate the effectivenss of the control measure. The numbers of small mammals

caught daily during the second trapping period had not diminished as expected. It was considered therefore, that one or more of the following assumptions were valid: 1) the rate of application of Rozol on the grain and/or the rate of application of treated grain in the field (recommended 2½ lb./acre) were inadequate; 2) the dense vegetation on the study area hindered individual animals from finding enough of the grain to kill them within the time period of the field trials, 3) Rozol, as applied, was not effective against Microtus, the predominant rodent species on the area. Fifty tube-type feeder stations, each containing 28 ounces of treated grain, were set up at intervals over the entire study area to provide, hopefully, a long-term control measure during winter months.

With the apparent failure of the initial field trial using Rozol, several pounds of the treated and non-treated oat groats were brought back to the Edmonton laboratory for further testing against live Microtus and Peromyscus.

Laboratory tests with Rozol

Non-treated oat groats and oil-base Rozol-treated oat groats used in the Ontario field trials were provied to Microtus townsendi and Peromyscus maniculatus test animals in laboratory feeding trials. The Microtus were obtained from Dr. Charles Krebs, Zoology Department, University of British Columbia; the Peromyscus from the Department of Zoology, University of Alberta, Edmonton. Each test animal was presented with 500 kernels of non-treated oat groats daily for five

days to ascertain acceptance of this grain as food. The grain was scattered on the floor of a small room in which the animal was permitted to run free. Water and a nest box were also provided. Each morning the floor was swept, the remaining grain retrieved, cleaned by hand and counted, and a new supply put out. On the following sixth to tenth day, 500 kernels of non-treated and 500 kernels of the oil base Rozol-treated oat groats were supplied daily. The results of the two feeding trials are shown in Table 2.

Oat groats, treated with a four-fold increase in concentration of oil-based Rozol over that used in the initial field study was prepared and used in additional feeding trials in the laboratory. Results of tests on six Microtus and one Peromyscus are presented in Table 3.

Feeding trials were carried out on an additional five Microtus and two Peromyscus using the powdered form of Rozol. Rhoplex AC-33 latex was used to adhere the anticoagulant to the oat groats. Results of these tests appear in Table 4.

Trapping results 1972

Small mammals caught in the 300 and 306 live traps on the Coulson Tract and Hobb's Property respectively during the 1972 field season are listed by species, sex and age group, frequency of initial captures and subsequent recaptures in Table 5. A total of 315 small mammals were handled in 535 captures and recaptures on the two areas.

The number of new animals taken alive and dead during each check of the traps, the number of recaptures, alive and dead, the accumulating

Table 2. Results of feeding tests on adult Microtus and Peromyscus fed non-treated and oil base Rozol-treated oat groats used in Ontario field trials.

Animal	*Microtus townsendi*		
Sex	♂		
Duration of test (days)	5	+	5
Type and number seeds presented daily		Non-treated	Non-treated / Treated
		500	500 + 500
No. seeds eaten	(Total/Average)	1318/263.6	886/177.2 / 798/159.6
No. seeds hoarded	(" ")	50/ 10	147/ 29.4 / 128/ 25.6
No. seeds destroyed(removed)	(" ")	1368/273.6	1033/206.6 / 926/185.2
Animal fate	Survived		Died 20 days after test. Slight hemorrhaging in chest cavity.

Animal	*Peroymscus pennsylvanicus*		
Sex	♀		
Duration of test (days)	5	+	5
Type and number seeds presented daily		Non-treated	Non-treated / Treated
		500	500 + 500
No. seed eaten	(Total/Average)	2201/440.2	677/135.4 / 543/108.6
No. seeds hoarded	(" ")	80/ 16	739/147.8 / 714/142.8
No. seeds destroyed(removed)	(" ")	2281/456.2	1416/283.2 / 1257/251.4
Animal fate	Survived		Died 5 days after test. Massive internal hemorrhaging

Table 3. Feeding trials using increased concentration oil based Rozol treated oat groats.

Animal * M	Animal ** P	Sex	Test duration (Days)	No. seeds presented daily: Non-treated	No. seeds presented daily: Treated	No. seeds eaten: Total	No. seeds eaten: Average	No. seeds hoarded: Total	No. seeds hoarded: Average	No. seeds destroyed (removed): Total	No. seeds destroyed (removed): Average	Animal Fate
M-1		♂	17	500		2351	138.3	1543	90.7	3894	229.1	Survived
			6	500		217	36.2	133	22.2	350	58.3	Died 6th day of test.
					500	343	57.2	175	29.2	518	86.3	Hemorraging in chest cavity
M-2		♂	3	500		512	170.7	416	138.7	928	309.3	Died Day 3 on treated
					500	331	110.3	448	149.3	779	259.7	oats. Slight hemorrhaging in lungs.
M-3		♀	3	500		34	11.3	0	0	34	11.3	Died on Day 3. No
					500	62	20.7	0	0	62	20.7	hemorrhaging internally. Cold.
M-4		♂	5	500		106	21.2	0	0	106	21.2	Died on Day 3. Slight
					500	26	5.2	0	0	26	5.2	hemorrhaging. May have died of cold.
M-5		♂	7	500		503	71.9	444	63.4	947	135.3	Died on Day 7.
					500	312	44.6	407	58.1	719	102.7	Internal hemorrhaging.
M-6		♂	5	500		108	21.6	106	21.2	214	42.8	Died on Day 5.
					500	365	73.0	43	8.6	408	81.6	
	P-1	♀	5	500		260	52.0	618	123.6	878	175.6	Died on Day 5.
					500	165	33.0	782	156.4	947	189.4	

* M - Microtus

** P - Peromyscus

Table 4. Feeding trials using powdered form Rozol on oat groats.

Animal	Sex	Test duration (Days)	No. seeds presented daily		No. seeds eaten		No. seeds hoarded		No. seeds destroyed (removed)		Animal Fate
			Non-treated	Treated	Total	Average	Total	Average	Total	Average	
M-1	♂	3	500		1097	365.6	178	59.3	1275	425.0	Survived.
		4	500		780	195.0	142	35.5	922	230.5	Died on Day 4.
				500	227	56.7	74	18.5	301	75.2	Hemorrhaging in lungs.
M-2	♀	3	500		770	256.6	607	202.3	1377	459.0	Survived.
		1	500		51	-	-	-	51	-	Died on Day 1 -
				500	13	-	-	-	13	-	possibly from cold.
M-3	♀	3	500		270	90.0	-	-	270	90.0	Survived.
		3	500		227	75.6	9	3.0	236	78.6	Died on Day 3.
				500	146	48.6	39	13.0	185	61.6	Hemorrhaging in chest cavity
M-4	♂	3	500		842	280.6	598	199.3	1440	480.0	Survived.
		3	500		550	183.3	-	-	550	183.3	Died on Day 3.
				500	108	36.0	-	-	108	36.0	
M-5	♂	3	500		668	222.6	500	166.6	1168	389.3	Survived
		5	500		513	102.6	168	33.6	681	136.2	Died on Day 5.
				500	223	44.6	165	33.0	388	77.6	
P-1	♀	3	500		1302	434.0	-	-	1302	434.0	Survived
		5	500		590	118.0	351	70.2	941	188.2	Animal survived
				500	21	4.2	2	0.4	23	4.6	
P-2	♀	3	500		510	170.0	291	97.0	801	267.0	Survived
		1	500		113	-	152	-	265	-	Died at end of
				500	34	-	179	-	213	-	1st Day.

Table 5. Number of individual small mammals newly handled, sex and age group on 1972 study areas.

Species		Coulson Tract												Hobb's Property							
		Pre-treatment May 20-30			Subtotal	Post-treatment June 17-27			Subtotal	Pre-treatment Sept. 11-21			Subtotal	Post-treatment Oct. 3-13			Subtotal	Pre-treatment June 5-15			Subtotal	Post-treatment June 28-July 8			Subtotal
		A*	S	J		A	S	J		A	S	J		A	S	J		A	S	J		A	S	J	
Microtus pennsylvanicus	♂	22	4	17		3	2	-		36	-	2		11	2	-		12	7	6		1	-	-	
	♀	25	7	18		2	-	-		22	1	2		9	1	-		12	5	8		-	-	-	
					93				7				63				23				50				1
Peromyscus maniculatus	♂	-	-	-		-	-	1		1	1	-		-	1	7		4	2	1		1	1	-	
	♀	-	-	-		1	-	1		1	1	2		1	-	3		5	1	1		2	1	1	
					-				3				6				12				14				6
Sorex cinereus		5	-	-		-	-	-		8	-	-		-	-	-		5	-	-		1	-	-	
					5				-				8				-				5				1
Blarina brevicauda		-	-	-		-	-	-		4	-	-		3	-	-		2	-	-		2	-	-	
					-				-				4				3				2				2
Sylvilagus floridanus	♂	-	-	-		-	-	-		-	-	-		-	-	-		1	-	-		-	-	-	
	♀	-	-	-		-	-	-		-	-	-		-	-	-		-	3	1		-	-	-	
					-				-				-				-				5				2
Total No. animals handled					98				10				81				38				76				12
Total No. recaptures					65				7				75				3				66				4

* A = Adult S = Subadult J = Juvenile

Sex of shrews handled not determined.

number of animals available for recapture, and the ratio of total recaptures in the total daily catch were parameters used in calculating the small mammal population and fiducial limits (95% probability) present on the grid portion of the study areas. Using these parameters, the calculated population levels based on trapping data obtained prior to and after application of the poisoned bait are listed in Table 6. In the October 1972 study on the Coulson Tract, the number of recaptures of tagged animals was so small that the mathematical procedures used previously in calculating the animal populations could not be used meaningfully here. The population figure of 37 animals in this case is based on the known number of animals actually handled. The calculated population is usually 15-20 percent higher than the numbers of animals handled.

Figure 8 shows the numbers of animals tagged and released (and therefore known to be available for recapture) during the pre- and post-poisoning period on the two study areas.

Figure 9 indicates the trap sites at which Microtus and Peromyscus were taken for the first time following poisoning of the Coulson Tract study area in September 1972. Of the 38 animals shown, only two were from those tagged prior to application of the poison bait. The remainder were all new animals.

Difficulties were encountered during the summer field season on both study areas when animals other than, and larger than, mice began robbing bait from the Sherman-type live traps. On the Coulson Tract removal of bait and upsetting of 10-15 traps a night ceased when

Table 6. Calculated small mammal population levels on the Coulson Tract and Hobb's Property study areas 1972.

Trapping period	Coulson Tract						Hobb's Property					
	Calculated population on grid portion of study area	Fiducial limits (95% probability)		#Animals per acre based on calculated population			Calculated population on grid portion of study area	Fiducial limits (95% probability)		#Animals per acre based on calculated population		
		Limit 1	Limit 2	Calculated	L1	L2		Limit 1	Limit 2	Calculated	L1	L2
Pre-treatment May 20-30/72	133.5	106.6	181.6	16.1	12.8	21.9						
Post-treatment June 17-27	27.4	15.4	121.0	3.3	1.9	14.6						
Pre-treatment June 5-15							102.2*	82.7	133.8	12.2	9.8	15.9
Post-treatment June 28-July 8							68.9	25.4	96.2	8.2	3.0	11.5
Pre-treatment Sept. 11-21	104.1	85.9	132.3	12.5	10.3	15.9						
Post-treatment Oct. 3-13	37.0**			4.4								

* Excluding cottontails

** See text re-calculation

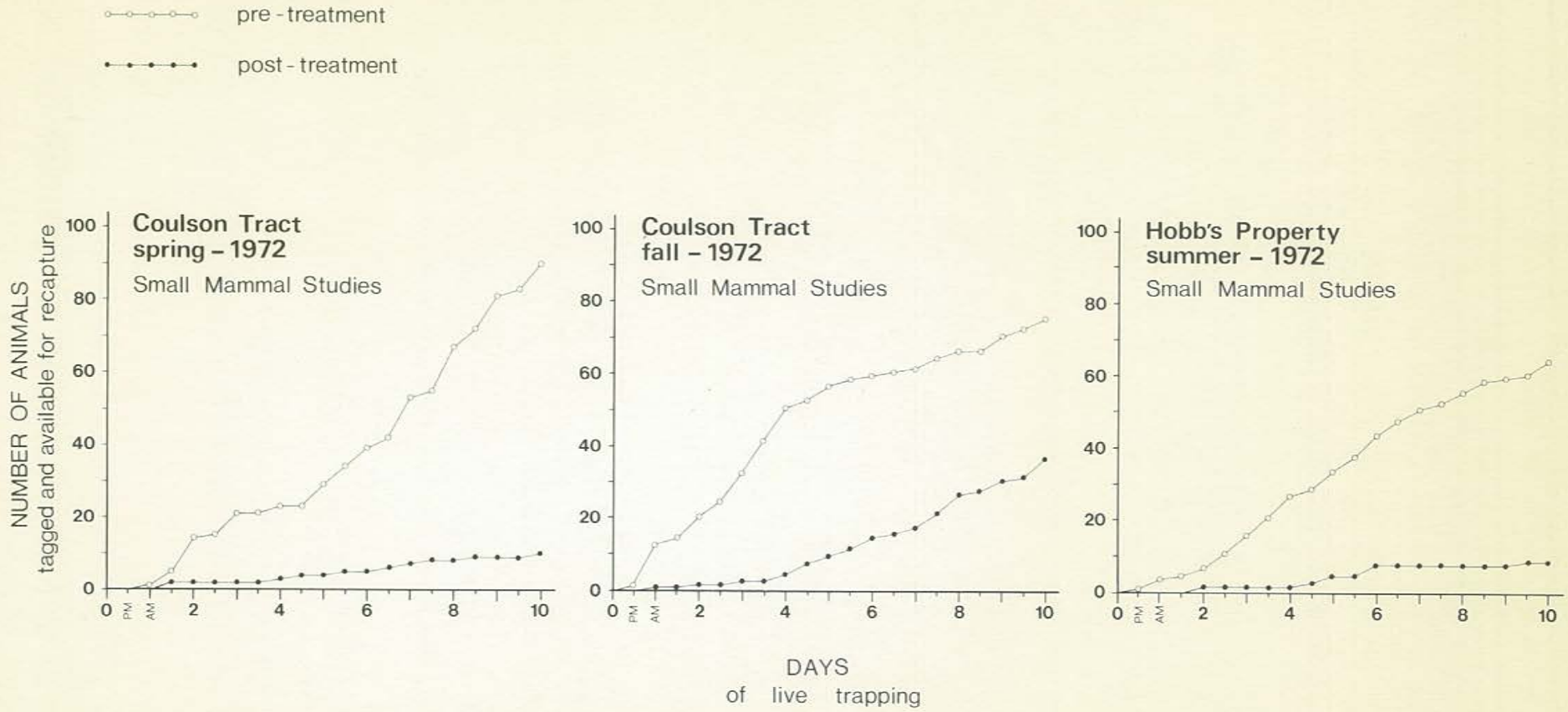
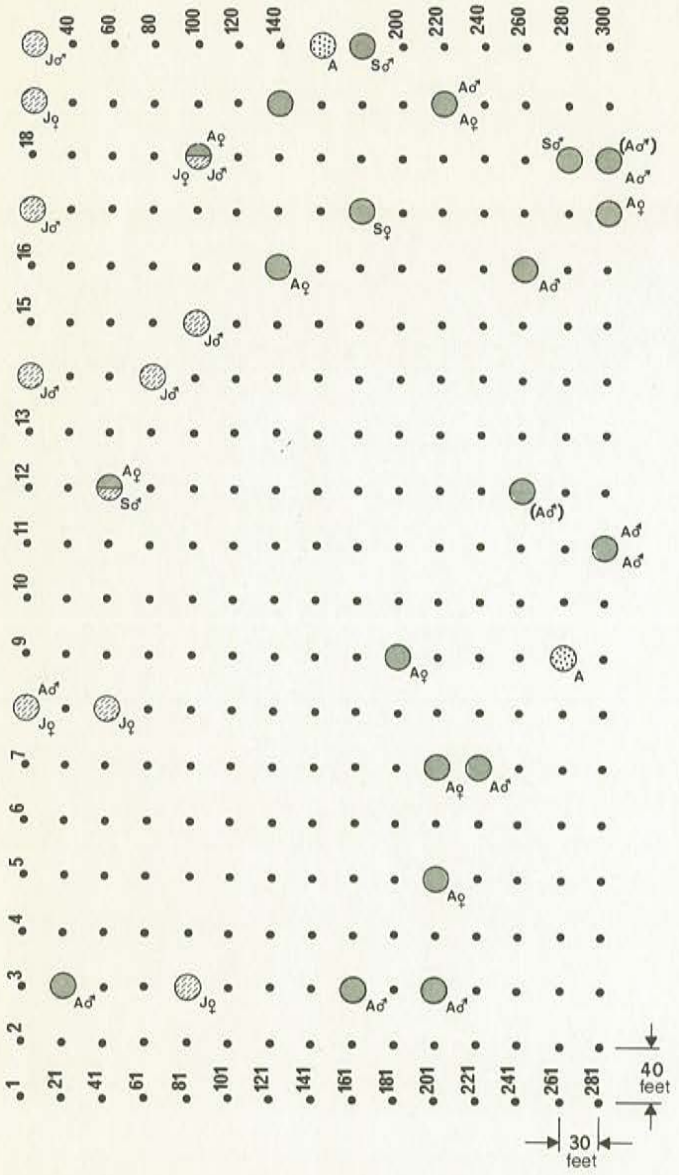


FIGURE 8. Small mammal populations, pre- and post-poisoning treatment of study areas.

FIGURE **9.**

Coulson Tract study area re-invasion by small mammals during ten-days live trapping period following application of poisoned oat bait, October, 1972.



six National live traps were set for several nights and an adult and two subadult woodchucks were captured and moved several miles away during the spring study. A similar problem occurred in the fall trapping period and was solved with the removal of two skunks from the grid area. A third skunk was killed on the highway a short distance away.

The bait robbing situation on the Hobb's property remained unsolved. When a dozen or more traps were being scattered about and the bait removed from traps along the west end of the grid (along the top of the ravine), six strong snap-type rat traps and six National live traps were placed nearby. These, too, were sprung and robbed repeatedly. Two National live traps were removed from the grid area. One was located far down the ravine slope several hundred feet from the original setting; the second trap was never found. The robbing culprit(s) appeared to make their rounds very early in the morning as indicated by the amount of dew on the overturned traps. Raccoon(s) or bobcat were suspected. Dense grass vegetation precluded identification by footprints. A device has subsequently been developed by the writer which will provide a Polaroid flash picture of such bait robbers. The device consists of a baited mouse trap, which when sprung, activates a nearby Polaroid camera mounted on a metal pole. It is hoped that in the future once the identity of the bait robber is known, suitable traps or other means of removal can be employed.

Discussion

Live trapping and tagging studies carried out during September-October 1971, indicated a population of at least thirty-three small mammals per acre existed at that time on the Coulson Tract. These included Microtus pennsylvanicus (78.3%), Sorex cinereus (10.3%), Peromyscus maniculatus (6.4%), and Blarina brevicauda (5.0%). As many of the adult females captured during the study period were still pregnant or lactating, the actual population was presumably nearer to forty animals per acre.

Light snow cover, several ice storms, and the presence of fifty poisoned bait feeder stations distributed over the study area contributed to a marked over winter reduction in the small mammal population. Of the 281 animals handled during the 1971 study period, not one tagged animal was taken again in the May 1972 trapping operation. Nor was a single instance of torn ears noted suggesting loss of tags during the winter months. The tagged population had most likely perished due to adverse weather conditions, due to the presence of poisoned bait, or had moved out.

By the time the Coulson Tract was again studied during the second half of May, 1972, one or more litters had already augmented the small mammal population to a calculated level of 133.5 animals or 16.1 animals per acre (Table 6). Application of 15 pounds of Rozol (powdered form) treated oat groats per acre virtually wiped out the spring small mammal population. Of the 90 animals tagged and known to be available for recapture prior to application of the poisoned bait, again, not

one animal was recaptured during the post-treatment study period. Trapping was commenced ten days after poisoning the area. A total of only ten small mammals were taken and all of these were new animals. The recapture data on these animals suggested a calculated post-treatment population of 27.4 animals or 3.3 animals per acre on the study area. The use of the powdered form of Rozol anticoagulant had been successful in markedly reducing the number of small mammals despite the occurrence of 3.7 inches of rainfall during June, as recorded at Hornby, a half mile from the Coulson Tract study area.

The reduction in small mammal populations on the Hobb's Property appeared, on initial inspection, to be less spectacular than that on the Coulson Tract - (reduced from 12.2 to 8.2 animals per acre). Several factors may have accounted for the difference. Oat groats treated with the oil-base Rozol was applied on the Hobb's Property and may not have withstood the inclement weather as well as did the powdered form of rodenticide. No precipitation data was obtained from the immediate vicinity of the Hobb's Property but while this study area is located only approximately 100 miles west of the Coulson Tract, it would not be expected that the amount of rainfall experienced on the two areas during June would differ appreciably. Both oil-based and the powdered form of Rozol applied to oat groats had successfully killed off test animals within 3-5 days in laboratory trials with slightly quicker results using the powdered form. Differences in bait acceptance may have accounted for these slight differenences in the laboratory and field. Conversely, a more rapid reinvasion of the study

area may also have attributed to the apparently less effective poisoning success of the Hobb's Property. As had been the situation on the Coulson Tract, none of the small mammals taken during the ten days of post-treatment trapping on the Hobb's Property had been tagged previously. As before this suggests that the original small mammal population had been eliminated and new transient animals were being taken in the post-treatment period. Only nine small mammals were taken during the second ten day period.

Laboratory feeding trials and the spring field studies on the Coulson Tract and Hobb's Property all indicated the use of Rozol anticoagulant was effective in eliminating harmful small mammal populations. For how long would such control measures be effective, however, was not known. How long would it be before insufficient amounts of the poisoned bait remained to kill new animals moving in from the surrounding untreated areas? For what duration would the bait formulation withstand exposure to repeated drenching from dew or intermittent showers? Elimination of small mammals from the study areas created, undoubtedly, an ecological vacuum, into which animals from the surrounding areas with their increasing population pressures would move. What would be the rate of reinvasion into an area such as the Coulson Tract study area under such circumstances?

To test this hypothesis, small mammal studies were again carried out on the Coulson Tract during September and October 1972. The May population of 16.1 animals per acre had been eliminated and replaced by 3.3 new animals per acre by the end of June. This population,

through breeding and further invasion from the surrounding area, increased to 12.5 animals per acre by mid-September. What animals had moved into the area of the trapping grid and from where had they most likely originated? As seen in Figure 9, 13 out of 17 small mammals taken on the north half of the trapping grid in the post-treatment period were Peromyscus. Only 3 Peromyscus had been taken in all of the spring studies on this area. Those captured in the October study probably originated from the area indicated in Figure 4 as being "tilled". This portion of the Coulson Tract had been plowed under and disced during 1971 and planted to hardwoods during the spring of 1972. With an abundant source of weed seeds on the adjacent trapping area, the 'tilled' area had become richly endowed with irregular patches of thistles, goldenrod and grass - a habitat most suitable for white-footed mice. Twelve of the 14 new Peromyscus were either juveniles or sub adult - presumably moving out to occupy their own territory. On the other hand, the more dense grass on the southern half of the grid area was again being occupied by Microtus moving in from the hay field on the east or from the untreated portion of the Coulson Tract across the highway. The highway itself did not appear to be a barrier to Microtus movement as animals of this species were frequently seen crossing or found killed by heavy traffic. Only two of 63 Microtus tagged in September were recaptured in October, following the poisoning of the area. The remainder were assumed to be new animals invading the recently depopulated habitat.

The 1972 field studies indicate that application of Rozol anticoagulant treated oat groats at the rate of 15 pounds per acre is an effective method of eliminating harmful small mammal populations from valuable hardwood plantation areas. Re-invasion of such treated areas in southern Ontario, can occur however within a few weeks and is more rapid in late summer than in the spring. Similar rapid re-invasion of poisoned areas have been noted by Pank and Matschke (1972) in Washington State. If the control of small mammal populations is to be one of the criteria which must be met before successful establishment of hardwood plantations in southern Ontario can take place, then consideration will have to be given to the question of time, source, and rate at which such re-invasion can occur. To poison surrounding areas may not always be practical, desirable, or economically feasible. If economics dictate that poisoning operations can be carried out but once a year, then it should be done when small mammal populations are at their peak numbers in late fall and prior to when girdling damage to valuable trees begins. Previous studies by Canadian Forestry Service personnel (von Althen - personal communication) indicated peak girdling damage by Microtus on the Coulson Tract usually occurred during September. No new damage of this nature was seen, however, in this study prior to mid-October during either 1971 or 1972. If such damage was to occur, it would probably be initiated by a reduction of available food caused by the first permanent snowfall. Girdling of young trees in September may have been associated with unusually high rodent populations. Animal numbers should be ascertained by census methods before application of poisoned bait.

Two additional measures might be implemented to render areas such as the Coulson Tract much less suitable habitats for rodent populations. The first of these is to reduce by repeated tilling the abundant weed cover which currently characterizes the area and provides both food and shelter to a large number of harmful animals. Discing out the grass and weeds between the rows of trees would provide more open areas over which mice and voles would have to cross and thereby expose themselves to avian and mammalian predators such as hawks and weasels. Tilling could only be employed during the first years following planting as machinery could damage lateral root development later. Secondly, longer term control measures during the critical early years of a hardwood plantation would appear possible through the use of poisoned bait feeder stations such as were installed experimentally during the 1971 study of the Coulson Tract. Modifications need to be made in the construction of the feeders - - using a one piece moulding or a sturdier binding of two tubes, and of either a plastic or metal material. Each feeder station set up in the fall could conceivably attract and control rodent populations over several hundred feet radius. Production costs would determine the number of feeder stations which could be used. The 1971 field study indicated the mean home range of 55 individual Microtus captured 4 or more times was 7,505 square feet or slightly over 1/5th of an acre. Spacing of five feeder stations per acre should make poisoned bait available to a large sector of the rodent population on such an area. While initial production costs of feeders made of suitable weather resistent material,

may appear high, these costs could be spread over many years. Not only did mice accept the feeder stations as a source of food in the initial field trial, some animals even moved their nests inside the tubes and set up their beds in the pantry! With a snow or all-terrain vehicle, feeder stations could be replenished even after two feet or more snow covered the area and would continue their rodent controlling function throughout the winter months with minimal man-hours being required. Effective control measures are essential if hardwood plantations such as that on the Coulson Tract are to become valuable and productive woodlots rather than mere havens for destructive rodent populations.

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