WINTER MORTALITY OF COTTONTAIL RABBITS ON BEAGLE FIELD TRIAL ENCLOSURES

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Abstract: Winter mortality of cottontail rabbits (*Sylvilagus floridanus*) was studied within 2 beagle field trial enclosures. Population estimates based on live-trapping indicated a September to February mortality of 45 and 75% on the 2 areas. Predation by hawks and owls was the most important identifiable mortality factor on both enclosures. Flush censuses indicated that imported rabbits suffered a higher rate of mortality than native rabbits. Recommendations for the management of field trial grounds are given.

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Field trial beagling, a nonconsumptive, recreational use of wildlife, has long been established in the Southeast and is increasing in popularity (Heard 1963). Welborn and Pelton (1973) reported the existence of 15 active beagle clubs in Tennessee and 394 in the United States.

The primary concern of most clubs is the maintenance of a high population of rabbits to insure successful field trials. Many clubs have enclosed their property to keep the rabbits in and the predators out. Stocking imported rabbits is also a common practice. Cottontails are purchased, usually from suppliers in Kansas, Missouri, or Texas, at a price of over $40 per dozen.

In view of the money and effort that is being expended to increase these cottontail populations, it is desirable to understand the source and nature of the factors operating to decrease them. In enclosures emigration ceases to be a factor causing changes in numbers of rabbits and all population losses must be attributed to mortality. The present study represents an attempt to quantify the winter mortality of cottontail rabbits in enclosed areas of natural habitat.

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STUDY AREA

This study was conducted on 2 beagle field trial enclosures in Knox County, TN. The Smoky Mountain Beagle Club (SMBC) enclosure lies at the food of 1 of the numerous ridges of the area. This enclosure covers 12.2 ha and extends from a base elevation of 300 m up the ridge slope to an elevation of about 330 m. Approximately 50% of the area is covered by a near-mature second-growth woodland of mixed hardwoods and shortleaf pines (*Pinus echinata*). Principle hardwood species are chestnut oak (*Quercus prinus*), white oak (*Q. alba*), and mockernut hickory (*Carya tomentosa*). The remainder of the area is an early, abandoned field with numerous red cedar (*Juniperus virginiana*) and blackberry (*Rubus sp.*) invading sparse fescue (*Festuca arundinacea*) and orchard grass (*Dactylis glomerata*) areas.

The Atomic Beagle Club (ABC) enclosure covers 45 ha of a very old alluvial plain of the Clinch River. It can be characterized topographically as steeply rolling with elevations varying between 270 m and 320 m. Only about 30% of this enclosure is managed for cottontails. This area is a patchwork of blackberry brambles, feed strips, and planted

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loblolly pine (*P. taeda*). About 45% of the enclosure is devoted to cattle grazing. The largest part of the grazed area is fescue pasture. It also contains yellow poplar (*Liriodendron tulipifera*) and white ash (*Fraxinus americana*), and about 1 ha of shortleaf pine. The remaining 25% of the enclosure is covered by a mature oak-hickory woods interspersed with old clearings which have revegetated to dense growths of honeysuckle (*Lonicera japonica*), blackberry, and yellow poplar.

The design of the enclosure fence is similar on both study areas. The fence is approximately 1.0 m high and constructed of 17 ga, 5.1 cm hexmesh poultry fencing. About 30 cm of the fencing is folded inward at the bottom and staked down to prevent rabbits from burrowing under it.

MATERIALS AND METHODS

Four 2-week trapping periods were conducted on each study area beginning in September 1972 and ending in February 1973. Wooden box traps constructed of 1.6 cm exterior plywood were utilized. Traps were placed in a grid pattern at a rate of 1 trap per 0.4 ha. Grid points were permanently marked, but each trap was shifted periodically about its respective grid point to insure interaction with all cottontail home ranges.

Between the first and second trapping periods both study areas were stocked with imported rabbits. Seventy-one rabbits were released on the SMBC enclosure and 123 were released on the ABC enclosure.

All cottontails handled, both trapped natives and imported individuals, were marked with eartags and pelage dyes. Detailed descriptions of marking techniques are given by Melchior and Iwen (1965) and Brady and Pelton (1976a).

Immediately following each trapping period on the SMBC enclosure a systematic census drive was conducted. A team of 8 to 10 individuals, approximately 3 m apart, walking abreast, covered the area. The tail and eartag color of flushed rabbits were noted. The origin and direction of the flush were plotted on a field map to help avoid recounting the rabbit. Due to its large size, the ABC enclosure was not flush-censused.

Carcasses and/or remains of cottontails were often found while checking traps or conducting census drives. Records were maintained on each carcass or remains including a complete description of its appearance. Field sign such as scats, tracks, or feathers which might help classify the cause of death were also noted. Field necropsies were performed when possible to search for lesions which might indicate the cause of death.

Mortality rates were calculated from population estimates derived by applying the Eberhardt (1969) formula to the livetrapping data. The rationale for using this estimator has been previously discussed (Brady and Pelton 1976b).

RESULTS AND DISCUSSION

On the SMBC enclosure 1629 trapnights (TN) yielded 89 captures, involving 66 individuals and 23 recaptures. On the ABC enclosure 5726 TN resulted in 204 captures involving 148 individuals and 56 recaptures.

Population estimates for each trapping period and the implied mortality occurring between trapping periods are presented in Table 1. On both study areas no mortality was shown between the first and second trapping periods. Since stocking of imported rabbits caused the estimator to reflect a population increase, no mortality was implied. On the SMBC enclosure sufficient livetrapping data for population estimates were gathered during the second and fourth trapping periods. These estimates show a decline from 130 rabbits in November to 71 rabbits in February inferring a total mortality of 59 rabbits (45%).

Population estimates were possible for all 4 trapping periods on the ABC enclosure. Between the November census and the January census the population declined from 261 to 114 rabbits, a loss of 147 rabbits (56%). From the January census to the February

Table 1. Mortality of cottontail rabbits implied from periodic population estimates of two enclosures in east Tennessee.

	Smoky Mountain Beagle Club			Atomic Beagle Club		
Trapping period	*Population estimates*	*Implied mortality*	*Percent*	*Population estimates*	*Implied mortality*	*Percent*
1	37	59	45	124		
2	130			261		
3	-a	59	45	114	147	56
4	71			64	50	19
Totals		59	45		197	75

[a]Insufficient data for population estimates.

census, the population lost another 50 rabbits (19%). Therefore, between November and February, the ABC enclosure lost 197 rabbits yielding a mortality rate of 75%.

Mortality estimates of 45% on the SMBC area and 75% on the ABC area indicate considerable variability in winter cottontail mortality among field trial enclosures. In a similar study of enclosed rabbit populations Bowers (1967), using 2 population estimators, calculated winter mortality estimates of 31 and 50% on a 20 ha enclosure and 71 and 72% on a 40 ha enclosure. On unenclosed areas Kline and Hendrickson (1954) found a mortality rate of 78% between November and January census, and Lord (1959) reported an 86% mortality rate between September and February.

During the study period, the remains of 60 cottontails were located on the 2 enclosures. With 50 of these remains there was sufficient evidence to determine the cause of death.

Twelve of these losses (4 on SMBC and 8 on ABC) were attributed to predation by owls or hawks. Sign of raptor predation usually included some fur plucked off in tufts or strips and entrails strung out on the ground. The association of this field sign with avian predators was substantiated on 2 occasions by locating owl feathers in the grass at the site of the attack. Furthermore, rabbit remains of this description were usually found in small clearings or feed strips where cottontails are probably most vulnerable to avian attack.

Predation by house cats (*Felis domesticus*) occurred on both study areas, but was primarily trap-related. Of 9 rabbits determined killed by cats on the SMBC area, 8 were killed in traps. On the ABC area 2 of 3 rabbits found killed by cats were taken from traps. On 2 occasions, cats were captured inside the trap while making a kill In all cases involving cats, whether trap-related or not, the killing and eating techniques were distinctive. The point of attack was the back of the neck. The head was severed from the carcass and the entire neck region and mandibles were eaten. The remaining carcass, relatively untouched, and the upper portion of the skull were left in the trap or nearby, covered lightly with grass and leaves.

Free-roaming dogs (*Canis familiaris*) were present on the ABC enclosure. The enclosure fence on that area was old and rusted and the dogs wer able to jump over it at several locations. Fourteen rabbits, 12 of which were taken from traps, were killed by dogs.

Only 2 rabbits were known to be lost to foxes during the study. These losses occurred on the SMBC enclosure. In both cases, snow covered the ground and the fox tracks, rabbit tracks, and evidence of a struggle were easily identified. The legs, skull and entrails were hidden among some rocks a short distance from the kills.

Eight rabbits were lost to predators of unknown identity. The remains of these rabbits were regularly of 2 types: 1) some fur, blood and fresh meat scraps were insufficient evidence to identify the predator, and 2) whole carcasses with fresh wounds but no other sign.

On the ABC enclosure 4 rabbits were found dead 2 days after they were stocked. These rabbits had been part of a shipment of animals in generally poor condition. Once stocked, they were probably too weak to survive.

One rabbit was found dead in the trap where it had been captured. Since there was no visible lesions, it was felt that the animal died from shock and/or exposure associated with the capture. Twelve more rabbits were found, but no cause of death could be assigned. These animals showed no lesions and predation was not indicated.

If it is assumed that the carcasses located on the study areas, other than those associated with trapping activities, constitute a random sample of the total mortality, then each cause of mortality should be responsible for the same proportion of the total mortality as in the sample (observed mortality). Based on that assumption, Table 2 presents the estimated total mortality (from Table 1) proportioned among the various causes of death as suggested by the sample mortality.

The number of trap-related deaths was considered to be a total count instead of a sample since essentially all the victims were found in or near the traps. Trap predation resulted in the deaths of 8 rabbits on the SMBC enclosure and 14 rabbits on the ABC enclosure. Trapping stress took 1 rabbit on the ABC enclosure.

The data indicate that predation was the most important mortality factor on both areas, accounting for 60 and 66% of the total mortality (not including trap-related mortality). This indicates a loss to predation of 34 rabbits on the SMBC enclosure and 148 rabbits on the ABC enclosure.

Other factors among the sample mortality were "stocking stress" and "unknown factors." Losses associated with stocking appeared only on the ABC enclosure where sample mortality indicated that 29 rabbits were lost to this factor. Unknown factors were responsible for 33.4% on the SMBC enclosure and 24% of the ABC enclosure indicating a total loss of 17 and 44 rabbits, respectively.

The basic assumption necessary for the above calculations, that observed mortality was truly a random sample of the total mortality, is critical. It is also possible that this assumption is invalid. Mortality factors such as disease and starvation may not be as obvious to the field observer as predation, thus making the sample non-random with respect to cause. However, we believe that factors such as disease and starvation may be most often predisposing factors to predation and that these less easily identified causes of mortality are adequately represented in the category of "unknown mortality factors" (Table 2).

It has been suggested that introduced individuals have lower survival rates than native individuals (Dice 1927, Buele 1946, Studholm 1948, and Metzgar 1967). In the present study, insufficient data prevented comparisons of mortality among native and stocked rabbits using population estimates. However, results of flush censuses on the SMBC enclosure provided an indication of the relative mortality of these 2 groups (Fig. 1). The numbers of rabbits flushed increased through the first 3 census drives from 16 to 33. The number of flushes then dropped to an intermediate level of 21 rabbits on the final census drive in February. Since 71 rabbits were stocked between the first and second census drives, an increased flush yield would be expected in the second drive. However, since no rabbits were stocked between the second and third census drives the continued increase in flushes through the third census drive cannot be attributed to the stocking of additional rabbits. It appears that as the escape cover deteriorated with the advance of winter, cottontails were more easily flushed and seen. If flushes did increase because of deteriorating concealment qualities of the vegetation, then the final census in February should have yielded the greatest number of flushes. However, by February, mortality in the rabbit population likely compensated for the effects of increased ease of flushing, the result being a decreased flush count in the final census.

Table 2. Total mortality of cottontail rabbits divided among the various mortality factors based on the proportions indicated by observed mortality on 2 enclosures in east Tennessee.

	Smoky Mountain Beagle Club					*Atomic Beagle Club*				
Mortality factors	*Sample observed*		*Percentage*	*Total indicated*		*Sample observed*		*Percentage*	*Total indicated*	
Predation	8		66.6	34		15		60.0	148	
fox		2	16.7		9		0	0.0		0
dog		0	0.0		0		2	8.0		15
cat		1	8.3		4		1	4.0		7
avian		4	33.3		17		8	32.0		58
unknown		1	8.3		4		4	16.0		29
Stocking	0		0.0	0		4		16.0	29	
Unknown	4		33.4	17		6		24.0	44	
Subtotal	12			51		6			182	
Trapping stress	0			0		1			1	
Trapping predation	8			8		14			14	
Total	20			59[a]		40			197[a]	

[a]Derived from estimates in Table 1.

Flushes of native and stocked rabbits are compared in Fig. 1. The relationship of stocked and native rabbit flushes remains nearly the same during the period of increasing flushes (census 2 and 3), but in the fourth census where flushes indicate a decrease in overall population, the stocked component shows a proportionately greater decrease than does the native component. This seems to indicate that the stocked rabbits suffered a greater proportion of the mortality than the native rabbits. Chi square analysis shows that the probability of higher mortality existing among stocked rabbits is restricted to the 90% level.

CONCLUSION

Enclosure fences are expensive to construct. Therefore, the decision of whether to invest in a fence should be based on an understanding of the benefits it will bring. Most enclosures are built in hopes that by excluding ground predators and restricting dispersal of rabbits, higher rabbit populations will result. In the present study although terrestrial predation appeared to be unimportant, winter mortality of rabbits in enclosures still varied from about 45 to 75%. Avian predators which are unaffected by enclosure fences were the most important identifiable mortality factor. Furthermore, to eliminate terrestrial predators effectively, some feature such as an electrical shock wire would be needed in addition to the basic fence. On large areas, due to maintenance problems, this is often not feasible. Therefore, with regard to mortality, a limited terrestrial predator control program may provide equal or greater benefit than a fence.

An enclosure fence will, however, eliminate dispersal of rabbits from the field trial ground and therefore may be effective for maintaining a temporary elevated population density especially where rabbits are imported for field trials.

Because stocked cottontails may not survive as well, field trial organizations should emphasize the production of native rabbits through intensive habitat management on their property whether enclosed or not. Then if additional rabbits are needed for an important field trial, stocking should be done just prior to the event.

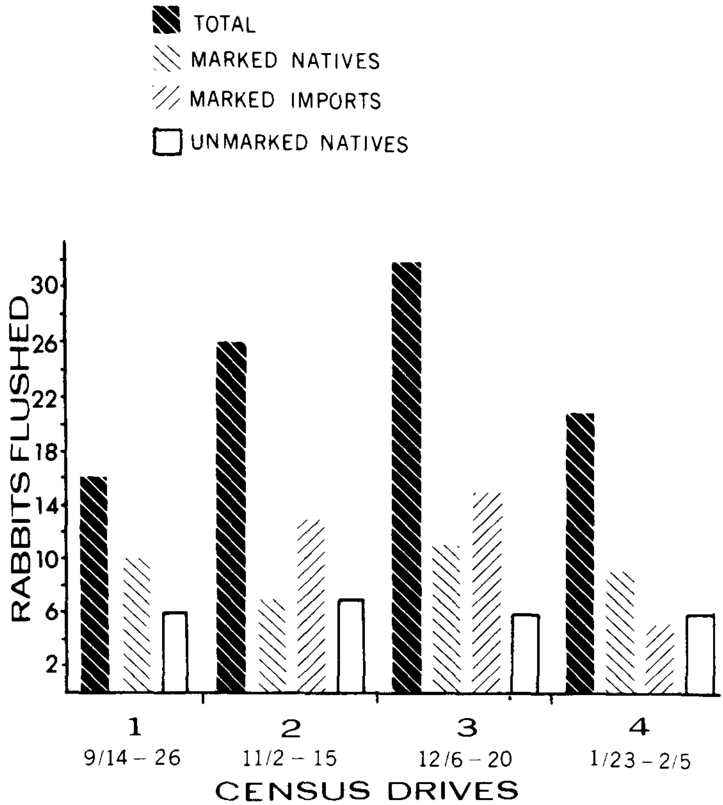

Fig. 1. Number of rabbits flushed during census drives on the Smoky Mountain Beagle Club enclosure.

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