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maturation of the red blood cell. Results of a study on the blood of young rats from the time they were weaned until they were four months old are reported. All rats were fed a casein diet, free of vitamin B, but adequate with respect to caloric intake and other vitamin needs. The blood of 70 rats, arranged into 7 groups of 10 rats each was studied. The rôles of thiamin, riboflavin, pyrodoxine and the filtrate factor as contained in rice polish concentrates were observed. Preliminary results would seem to indicate that the maturation of the red cell is not a function of any particular fraction of the B-complex. Only after marked organic deficiencies had appeared in the animal were significant changes noted in the blood picture.

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A MANAGEMENT PROGRAM FOR MINNESOTA MUSKRAT

PAUL R. HIGHBY

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The history of muskrat trapping in Minnesota for the past ten years indicates the need for a carefully planned management system for this important fur resource.

Since 1925 the law has permitted a season of not over thirty days between March 1 and April 30 for the trapping of muskrats. Since 1930 there have been 5 closed seasons, 4 in which part of the state was opened to trapping, and three state-wide open seasons. These three occurred in 1930, 1938 and 1940. These seasons extended from twenty to twenty-seven days, opened from the 16th to the 20th of March, and closed between April 7 to April 14. These seasons in general occurred so late in the spring that the setting of bank-sets and floating trap sets in the open water was resorted to by trappers with the result that so many muskrats were taken as to seriously deplete the breeding stock and necessitate the closing of the whole or the major portion of the state the following year.

There is no record of the estimated catch in 1930 but that of 1938 is estimated at about 270,000 with a value of 75c per pelt, or \$200,000 to the trappers. The 1940 muskrat catch is estimated at 850,815 pelts based on about 4,000 trappers reports, a 14% sample of the 29,000 licensed trappers of the state. The average price obtained by the trapper in 1940 is reported at \$1.03 each. When the unlicensed farm boy is considered the income to muskrat trappers in 1940 may be estimated at over one million dollars. The possibilities of this resource are, therefore, of great importance to the people of Minnesota.

There is evidence that licensed trappers are increasing in number in the state for in the last two state-wide trapping seasons the

sale of licenses increased from 20,000 to 29,000 or about 45 per cent. It would be advisable under an increasing trapping pressure to place the trapping of muskrat on a system that would permit of a sustained annual yield.

For some species a system of refuges has proved to be effective in such a management program. There is evidence that the muskrat, too, would be susceptible to a system of inviolate muskrat breeding grounds. Such a system would close a small marsh to muskrat trapping in order to repopulate surrounding marshes within a radius of four to six miles that had been opened to trapping. On streams a stretch of a half mile or so would be selected at intervals of every six miles and in very large marshes a corner or a bay might be blocked off as breeding grounds. This system would take advantage of the spring dispersal habit of the species to restock trapped out areas by means of winter survivors from selected wintering habitats. (Errington, 1940).

In order to operate such a system of muskrat breeding grounds, it would be advisable to have the trapping season in early winter for the population increase is derived only from the winter survivors. Such survivors would carry through better by some reduction of their numbers before their critical season sets in. Competition for food would thus be reduced and wintering conditions improved for the remainder.

The importance of having survivors of the winter in good condition is realized when it is understood that the only increase during the breeding season is derived from those that have survived the winter. It has not been demonstrated that sub-adults reproduce during the first year of their lives. A popular fallacy among trappers is the belief that muskrats reproduce before they are one year old.

Further reasons for harvesting in early winter are to decrease the following losses:

1. *Winter kill by freezing out.*—In the past, the law has provided that the Director of the Division of Game and Fish may issue permits for the taking of muskrat in shallow marshes which are in danger of destruction by freezing. This, in effect, has amounted to an open season for a limited number of trappers in certain sections of the state where losses by freezing out have frequently occurred. In certain winters, as in 1940–1941 where an early heavy snowfall protected rats, very few permits were issued. However, in the winter of 1939–1940, there was a tremendous loss by freezing and many permits were issued. The winter open season would provide a more equable distribution of these muskrats among trappers at large, and convert a substantial loss into profitable gain.

2. *Winter kill by food shortage.*—Late winter is the critical season for muskrats, and in the interest of food economy for the surviving spring breeding stock it is advantageous to reduce the population before the available food supply has been materially

reduced. Here, too, where muskrat are in danger of destruction by starvation, the law has provided for permits for their removal by trappers. Again, such removal could be more fairly administered by an open season.

3. *Winter kill by disease.*—There is considerable evidence that in muskrat concentrations, disease takes a serious toll in late winter. Most observations of deaths by disease have occurred in relatively dense populations and so it is expected that the incidence of disease would be less frequent when the population has been thinned out by trapping. In this connection, winter trapping provides a double advantage, for not only would some of the muskrats which are expected to die of disease be pelted and a loss converted into a profit, but the effect of early winter trapping would operate as a preventive measure to curb the spread of disease among the remaining breeding stock.

4. *Loss by migration.*—Mass movements or so-called "migrations" have been noted frequently by various observers and these are difficult of interpretation. However, it has been noted that muskrats will move out overland to escape a situation where shortage of food, imminent freezing out, or other unfavorable conditions have threatened their existence in their winter homes. Such homeless moving muskrats are almost certain to be lost to predators, dogs, and highway traffic, or if they succeed in finding another occupied habitat, they are forced to defend themselves as invaders. This loss could likewise be reduced by a winter trapping season.

5. *Loss by Mink Predation.*—Predation by mink is more severe when the prey is concentrated. Thinning of muskrat concentrations by trapping in early winter would in some measure reduce this loss.

6. *Loss by Mink Trapping.*—Traps set for mink frequently take muskrat and the trapper is obliged to submit the accidentally taken muskrat to the warden for a fifty per cent pelting fee. A season partly synchronized with the mink season (November 1 to January 31) would permit greater returns to the mink trapper for this incidental take.

7. *Loss by Damage to Pelts.*—One of the most serious objections to a season in late spring is the loss entailed by damage to the pelts due to fighting as the mating season approaches. Such damaged pelts taken in early April have been found to have as many as fifty to sixty holes resulting from fighting among the males.

8. Some criticism of an early winter trapping season is based upon the percentage of kits or small pelts that would be taken in early winter as compared to the smaller fraction of undersized pelts that would occur in a spring season's catch. An undetermined fraction of muskrats do not attain full size by the coming of winter due to lateness of birth in summer or retarded growth from other causes. However, this seeming advantage of the spring season may be counterbalanced by the losses due to damaged pelts at this season.

9. *Seasonal Value of Pelts.*—A popular notion among trappers is that furs reach the peak of their primeness in late spring. The fur trade, however, finds the December pelt from this region entirely acceptable for their purposes. This may be illustrated by analysis of the sales at public auction of confiscated, seized, and legalized muskrat pelts during the year 1940 by the Division of Game and Fish. Four auction sales were held in 1940 in the months of January, February, April and June, at which a total of 33,570 muskrat pelts were sold. The grading of these pelts into lots was not based on the quality and the size of the pelts and so the sale prices obtained at this auction cannot be compared with the prices of the fur auctions of New York where furs are offered in lots graded according to quality of fur.

The lots offered on the Minnesota auctions were of mixed quality composed of illegal furs seized by law enforcement officers as well as furs taken by permit and submitted to the state by the trappers for a pelting fee.

In the January sale 5 lots consisting of 2,323 pelts sold by lot for as low as 60 cents and as high as \$1.05 or an average of 94 cents per pelt. Most of the pelts offered in the January sale were caught before December and were therefore of inferior quality as might be expected from a fall catch. The February sale, however, offered pelts that were taken for the most part in December and January and yielded the highest returns for the four sales of the year, thirty-eight lots of 18,033 pelts sold for an average of \$1.21 per pelt, which is a 29% increase over the average for the January sale.

The April sale consisted mostly of February and March pelts and sold for 5% less than the pelts of the February sale. The June sale consisted mostly of April pelts and the average sale price dropped 12% below that of the February sale. The accompanying table and chart illustrate their analysis. We may conclude that in Minnesota our native muskrat pelts of December and January bring the highest returns on our local raw furs market.

MUSKRAT FUR SALES
MINNESOTA DEPARTMENT OF CONSERVATION
PUBLIC AUCTION OF SEIZURES
AND LEGALIZATIONS

Month Year	Lots	No. of Pelts	Price Range	Avg. Unit Sale Price
Feb. 1939	1	896	.69	.69
May 1939	3	2,882	.61— .79	.70
Aug. 1939	1	2,298	.85	.85
Jan. 1940	5	2,323	.60—1.05	.94
Feb. 1940	38	18,033	.73—1.37	1.21
Apr. 1940	31	11,943	.83—1.31	1.15
June 1940	4	1,271	.91—1.23	1.08
Feb. 1941	11	3,477	.95—1.75	1.53
(Feb. in part)	(8)	(2,422)	(1.52—1.75)	(1.65)

A further illustration of the seasonal variation in fur values in Minnesota may be had from the experience of a trapper in Anoka County. During the three months open season on mink from November 1st 1940 to January 31st, 1941, this trapper took 38 muskrats in his mink traps which were turned over to the state for legalization and sale. They were sold at public auction for \$1.62 each. The same man trapping in the same county during the 10 day open muskrat season in March, 1941 took 100 muskrats which sold for an average of \$1.51 each, a further illustration of the higher market value of the winter-caught muskrats.

Unpublished work being pursued at present in Michigan on the wearing qualities of furs taken at different seasons is also expected to throw new light upon what is meant by "primeness" of furs.

For these reasons, biological and economic, it is proposed to establish the muskrat trapping season in early winter. The harvest would be taken as soon as the pelts are prime and before the heavy winter losses occur. The winter survivors will be left unmolested during the breeding season which begins in Minnesota in the month of March.

It is further proposed to try out experimentally a system of inviolate muskrat grounds in certain regions of the state in order to determine its effectiveness as a management measure.

Further proposed activities are expected to yield the following information regarding muskrat populations:

1. The causes of natural deaths.
2. Determination of annual or cyclic fluctuations.
3. Tagging experiments to determine:
 - (a) Radius of the spring dispersal.
 - (b) Cause of mass movements.
 - (c) Cause of individual winter movements.
 - (d) Breeding habits.
4. Feasibility of manipulating the environment to improve muskrat habitat for the purpose of increasing the yield of fur on state owned lands. It is proposed to operate jointly with the Division of Water Resources and Engineering to raise and maintain stable water levels for this purpose.

It is proposed also to project educational work among the trappers of the state to inform them of the proper trapping techniques for a winter season and other observances for the conservation and increased yield of the muskrat resource of Minnesota.

Errington, Paul L., 1940. Natural Restocking of Muskrat-vacant habitats. *Jour. Wildlife Management* 4: 173-185.