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THE NORTH-WESTERN MUSKRAT OF THE MACKENZIE DELTA, NORTHWEST TERRITORIES, 1947-48

by

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Wildlife Management Bulletins are produced to make available to wildlife administrators the information contained in reports which are submitted by officers of the Canadian Wildlife Service.

The reports do not, in most cases, cover extensive studies and are not written primarily for publication. Recommendations arising from the studies are not included.

INTRODUCTION

Continuous investigation of the mammalian fauna of the delta of the Mackenzie River was carried on from June 7, 1947 to September 6, 1948. During the first part of this period the writer assisted in a preliminary survey of the fur resources of the delta conducted by Dr. Ian McT. Cowan, who submitted a report on the survey to the Department of Mines and Resources.

Information gathered subsequently to mid-August, 1947, is presented herewith and data given by Cowan are included, as needed, to provide a more complete account of the problems investigated.

It will be evident that this was only a preliminary investigation. One of the characteristic attributes of natural phenomena is variability, and by following through only one complete yearly cycle of animal behaviour in response to seasonal and physiological rhythms, very few data for comparison were obtained. More complete information provided by subsequent studies may require alteration of some conclusions.

Of all the fur-bearing animals represented in the native biota, the muskrat is by far the most important and, in the Mackenzie Delta at least, it forms the basis of the economy of people engaged in the fur trade. For this reason the investigation was concerned chiefly with the muskrat. Other fur-bearers were dealt with according to their monetary importance and their relationship to the muskrat.

The time spent in field work was divided roughly into three periods by the formation of ice cover on all water surfaces (freeze-up) and the removal of that cover (break-up). There were two ice-free periods of about four months each and one period of about eight months of continuous

ice cover. Each period produced conditions that had a direct effect on the muskrat population.

Ice usually forms at Aklavik during the first week in October and does not break up completely until the first week in June. During that period the muskrats live in a closed habitat from which there is no suitable escape. They must, therefore, adapt themselves to unfavourable conditions or perish. During the summer they are free to move about and may escape adverse conditions. Their critical period, then, is most probably winter and early spring.

During the field work, studies were carried on in five widely separated areas (see map at back) chosen to represent various types of habitat found in the delta. Most of the field work was done in the first three of the study areas mentioned in succeeding paragraphs. The other two study areas were established during the second summer.

Study Area No. 1 was at a system of lakes which constitute the trapping area of A.J. Boxer. This location is only nine miles from the settlement of Aklavik and lies in the region where trapping and hunting pressure is very heavy.

Study Area No. 2 was near the Government Reindeer Range Depot on the East Branch of the Mackenzie River, 40 airline miles north and east of Aklavik - 70 miles by water. This was an important site since it was in favourable habitat and was currently receiving low utilization, making possible a certain amount of control of the harvest of fur taken from it.

Study Area No. 3 was on the trapping area of K.H. Lang, local

trapper-trader. It was 15 air-miles south of Aklavik; 32 miles by water. It was possible to find lakes in this area that had received very light utilization and were used chiefly as reservoirs of breeding stock. Maximum populations were found at these lakes. The most intensive field work was done on this study area.

Study Area No. 4 was on the trapping area of Jim Jones located on Peel Channel in latitude 67° 48' N., longitude 134° 42' W., somewhat nearer to Fort McPherson than to Aklavik. It was at the centre of what was reported to be the most productive muskrat habitat in the whole delta. Break-up is earlier and freeze-up is later at this site than at any of the other four because of its situation in the upper part of the delta and its nearness to the Peel and main Mackenzie Rivers. Lakes in this area are smaller, more irregular, and deeper than they are farther north, and a larger proportion of them have banks high enough to permit only infrequent flooding. Ecological succession in such lakes is more advanced, and there is a relatively larger amount of dry land between them.

The first four study areas were all within the zone characterized by a fairly even stand of white spruce, Picea glauca. Study Area No. 5 was in that sub-marginal cover type which, by reason of its northern location, is devoid of timber. The dominant tree species in this zone are low varieties of willow, Salix spp. There is some alder, Alnus crispa, but no poplar or birch. All the lakes have low banks and flood each year, and are relatively large and shallow. The study area was established on the trapping area of an Eskimo, Johny Alecock, in latitude 69° N., longitude 134° 47' W., about four miles from the old camp site of Tununuk.

The Northwestern Muskrat

General Description

The northwestern muskrat, Ondatra zibethica spatulata, is widely distributed in northern North America from the Yukon River drainage basin of Alaska east to Anderson and Horton Rivers and south to northern British Columbia and Alberta. It is smaller and more pallid than the Rocky Mountain muskrat, O.z. osoyoosensis, whose range lies to the south. A paler form, alba, is found eastward to Hudson Bay. In regions of favourable habitat the typical spatulata has short, heavy underfur and is valued in the fur trade for certain superior qualities of its pelt.

Distribution in Northwestern Canada

In northwestern Canada the muskrat reaches its greatest abundance in the maze of lakes and waterways of the Mackenzie Delta. It is locally important in the fur trade of various other communities, most of them in the Mackenzie River drainage basin. The following concentrations, other than that of the Mackenzie Delta, may be briefly noted.

At Fort Norman there was, in the past, a considerable source of muskrat fur in the lakes feeding Brackett River, especially those below Brackett Lake. Ten or fifteen years ago it was possible for a single hunter in that area to take up to 1,000 pelts in one season. At the present time he is very fortunate to get one-third as many. Reports from interested persons indicate that overtrapping together with rapid deepening of some of the channels, and consequent draining of the lakes, has contributed to this reduction. The reports indicate that there is some opportunity for habitat improvement in this area. An increase in the muskrat population would be especially beneficial to the local economy in view of current

restrictions on the take of other fur animals, and the decline in price of the important furs of the region.

Another source of muskrat fur, and one which seems to be holding its own fairly well, is what is known as the Ramparts River near Fort Good Hope. In this area muskrats co-exist with beavers and the relationship appears to be a favourable one for the smaller animal. Approximately 10,000 muskrat pelts have been exported yearly from Good Hope and most of these came from the lakes and channels comprising the Ramparts and Hume River drainage systems.

North of Fort Good Hope there are no more areas of muskrat abundance until the Mackenzie Delta is reached. In the delta the muskrat populations reach extraordinary size, and they are forced out to less favourable habitats. The various streams flowing into the delta furnish waterways for these local movements. Peel River and adjacent lakes, from Fort McPherson northward, are very valuable habitat, and compare favourably in this respect with the Mackenzie Delta proper. About 450 muskrats have been taken annually in the lakes along the lower Rat River, but this stream has a fairly steep gradient and the extent of suitable habitat is small.

Other areas of local abundance are found at the mouths of the Kugaluk and Miner Rivers which empty into the lower Eskimo Lakes. These sites were heavily trapped at one time but during the past decade they have had an opportunity to rebuild their populations because trapping in them has been restricted.

Most of the tundra lakes bordering the lower delta, especially those connected with the delta by small streams, have signs of muskrat use. Viewed from the air there appear to be deep runways dug from muskrat dens in

the banks as a means of access to sources of food during winter. Because this region is exposed to the wind ice forms to great depths and the muskrats have a precarious existence. These lakes open late and freeze up early. The number of muskrats is restricted by the rigours of the climate and the very slow growth of vegetation. The amount of trapping is negligible.

There are very few muskrats in the lakes and streams bordering the Arctic Coast from the vicinity of Herschel Island on the west to at least Darnley Bay on the east. In the vicinity of the settlement of Paulatuk a 'rat lake' is one in which muskrats may be found, and which may yield to the Eskimo hunter five to ten pelts a year. Bearing in mind the character of the country we must wonder at any species being able to adapt itself and exist in it at all.

The vast hinterland from Fort Good Hope on the south to the delta of the Anderson River on the north, and westward to the Mackenzie River, shows evidence of muskrat activity. Concentrations that can be trapped profitably have been reported in some localities. At present this block of country is seldom visited by trappers, and the muskrats to be found there form a small but potentially valuable addition to the other, more valuable, species of fur animals.

The Mackenzie Delta has somewhat the same character as the delta of the Old Crow River in Yukon Territory. The latter area, known locally as 'Old Crow Flats', has a population of muskrats that is economically important and furnishes a means of subsistence to the people there. It shares, with the Mackenzie Delta, the distinction of having a high fur return per small unit

area - a unique occurrence in such northerly latitudes.

Procedures

Tagging

Tagging was carried on in order to have some check on the longevity,movements, and reproductive behaviour of the muskrats. Two types of tags were used: small fingerling tags such as are used in fish studies, and larger tags manufactured primarily for the banding of waterfowl. The small tags were clinched, through the ears of animals of all ages, with pliers provided for that purpose. The bands were put at the base of the tail on adult animals and were closed sufficiently to prevent slipping off. This type of band could be used only with fully grown animals. These were usually females, since the diameter of the tail of the mature male was often too great. The advantage of tail bands is that they can be observed under field conditions.

During 1947, and up to March, 1948, 303 muskrats were captured, tagged, and released. Of these, 217 were in the juvenile class. Animals tagged during the summer of 1948 are not dealt with in this report, because few of them were recovered before this part of the study ended. Only 10 of the 303 tags were recovered by trappers - a very small proportion. One animal had travelled four miles in the period between summer and spring. Another was taken a half-mile from where it was first trapped. The remainder did not appear to have moved any appreciable distance.

During studies on the three areas where most of the tagging was done, 89 previously tagged animals were taken. The interval between tagging

and recapture was in every case at least three months. The 89 recovered animals, together with the 10 animals taken by trappers, gave a return of about 30 per cent.

Each method of marking had its disadvantages. There seemed to be an unavoidable loss of tags which amounted to 2 per cent of the ear tags and 7 per cent of the tail bands. The loss was not large, but it could probably be reduced by employing different methods. A more satisfactory type of tag would be one larger than the ear tag but of the self-clinching type. Such a tag inserted in the hind leg of the animal about the tendon of Achilles would be easy to apply and less apt to be lost. The trapper who took the animal could easily see the tag when skinning the carcass which would be a further advantage from the standpoint of recoverability. The chief reason for failure of the ear tags was that the trappers did not see, or did not remember to look for, the tags hidden in the fur about the ears. If data on survival and population movements are to be valid, it is important to be able to identify every tagged animal as such when it is taken. The heel tagging method should provide assurance of this.

Trapping

Whenever possible trapping was done by means of wire cage traps (Figs. 1 and 2). These traps proved to be very effective and could be used both in summer and in winter with varying success. When, under adverse circumstances, it was not possible to use live traps, a limited amount of trapping was done with single spring steel traps, sizes 0 or 1. The latter had to be padded to prevent the jaws from breaking leg bones and the former were not always strong enough to hold a full-grown muskrat. The use of steel

traps was generally unsatisfactory. It required constant surveillance at the trap sites, yet in spite of this, bones were sometimes found broken.

In the spring when professional trappers were taking muskrats for fur, the traps most frequently used were size 1½. This size trap had the advantage, over smaller steel traps, of being heavy enough to drown a muskrat as soon as it was caught, thus cutting down losses from twisted-off legs and tails.

Throughout the period of open water, from June to mid-September, the live traps were placed in runways passing through marginal vegetation, or dug down to runways leading into bank dens and covered with vegetation. Both methods gave good results, especially after the young muskrats became active and more or less independent of the parents. It was found, however, that not all muskrats, and particularly not the young ones, could long resist exposure to cold and lack of food. In mid-September a young muskrat, that had spent the night in a trap without food and had been exposed to temperatures near freezing, was likely to be in rather sluggish condition in the morning. If recaptured and held a second night in the trap, it was likely to succumb. During trapping on Study Area No. 1, for the period September 12 to 18, a loss of 25 per cent of the young of the year was caused in this way.

For this reason live trapping was discontinued after September 18, but during the early winter - November to early December - it was possible by taking due precautions to resume it on an intensive scale. The method then used was relatively simple, though time-consuming, and gave satisfactory results.

By this time the muskrats had constructed and were using feeding stations on the ice, to which they came periodically. A feeding station

consists of a dome of vegetation large enough to accommodate one or two muskrats above the plunge hole in the ice. Such feeding stations are known locally as "pushups", a name which will be used hereafter in this report.

To set a live trap in a pushup it was necessary to cut away one side of the chamber, place the trap against the hole thus made, and cover the trap, and that side of the pushup, with burlap. A small tripod of willow twigs was built over the door of the trap so that weight from above would not interfere with its free action. A layer of snow was piled over trap and pushup to a depth of six to 12 inches. It is not known why the muskrats entered the traps; very probably curiosity impelled them. The snow kept them well insulated from cold and, even in temperatures as low as - 20° F., they survived 12 hours of captivity without any apparent ill effects. This method proved to be less efficient later in the winter. Colder weather decreased the activity of the muskrats and caused ice to close the plunge holes in many of the pushups. At the same time the insulating properties of the snow had become much reduced. Newly fallen snow crystals formed an ideal insulating medium, but by January there was considerable coalescence of crystals in the lower layers, resulting in granular snow that was almost ice. In November a difference of up to 19° F. between the upper and lower layers of 12 inches of snow was recorded. By mid-January this difference was as little as 3° F. and there was practically no insulating effect.

A small amount of trapping with steel traps was carried on during February, but with indifferent results. High winds, that swept away the protective snow cover, and low temperatures made it difficult to

open a pushup without having it freeze over and become useless to the muskrats.

All trapping by professional trappers during the open season in the Mackenzie Delta was done in pushups. Either the trap was set on the feeding ledge next to the plunge hole, or this ledge was chiselled away and the trap set below the water level. The latter was the better procedure during very cold weather.

Life History Studies

Size and Weight

The weights a large series of muskrats were recorded during the course of the investigation. The data obtained are fairly uniform but are rendered less valuable because the ages of most of the animals examined were not known. The tagging program provided some animals of known sex and age, and the measurement data obtained from them may be used in approximating the ages of other animals taken. The series is not as yet complete and more animals of known age are needed.

Only eight male muskrats, tagged as adults in 1947, were recovered in 1948. These animals were at least 20 to 24 months of age when weighed and measured. The average weight of these animals was 1,079.6 grams, with a range of 905 to 1,282 grams. Their measurements were: average total length, 539.6 mm., range 515 to 562 mm.; average tail length 237.1 mm., range 226 to 250 mm.; average hind foot length 78.1 mm., range 76 to 79 mm.

Ten adult females in the same age group were weighed and measured. Their average weight was 995 grams, range 703 to 1,195 grams. The measurements were: average total length 539.4 mm., range 519 to 556 mm.; average

tail length 235.6 mm., range 220 to 244 mm.; average hind foot length 74.6 mm., range 73 to 76 mm.

On the basis of post mortem examination of untagged animals, the ages of an additional number of each sex were determined. Weights and measurements for these, combined with data for the eight males and 10 females previously described, are given in Table 1.

It was realized that valuable information could be obtained on the structure of the muskrat population if young of the year could be distinguished readily from adults at the time of the spring harvest. Simple measurements, such as weight or total length, it was hoped, would be shown to be diagnostic.

During April, 1948, it was possible to take a fairly adequate series of young muskrats of known age. These had been tagged as juveniles during the previous summer and were not yet one year old. Table 2 gives the weights and measurements of these juveniles of both sexes.

Comparison of these data with data for adult animals (Table 1) revealed a significant difference in average sizes, but there was also an intergradation as some yearlings exceeded some adults in size. It would seem that there is no simple and reliable way to distinguish young animals from adults in April on the basis of measurement alone. More criteria are necessary.

Sex Ratios

It became apparent early in the study that trapping took more males than females. This was especially true of juveniles, of which 126 males and 96 females - a ratio of 131 males to 100 females - were tagged in 1947. Field observations suggested that the precocity of young males might

have had something to do with the unbalanced ratio. Accordingly trapping records were kept in the spring when there was less chance of taking one sex more often than the other, since the traps were below water line and both sexes fed from the pushups. In this case the count was 378 males to 334 females or a ratio of 113 males to 100 females.

During the period of hunting in open water a sample of 766 muskrats shot consisted of 507 males and 259 females - a ratio of 196 males to 100 females. The selectiveness of the harvest was partly the result of a conscious attempt on the part of the hunters to take males. It was found that the method of hunting included calling the males to the hunter by squeaking through compressed lips. In addition to this the females were more wary and secretive than the males at this time of the year, which is the height of the breeding season. Thus there was a disproportionately large number of males taken.

It could be postulated that the yearly drain on the male sex may decrease the breeding capacity of the muskrats. This would be quite possible if there was strict monogamy in breeding. It is hard to believe, however, that the male is so restrictive in his breeding behaviour that he would not breed with more than one female if the opportunity presented itself. The taking of large numbers of males during the breeding season may, however, delay the breeding of some females, particularly younger ones.

There was some indication that two adults were usually in attendance when the young were being reared. During June and July when the muskrats were most active and the young were still unable to live independently of the parents, it was usual to see the adult animals gathering green

vegetation from the shore and swimming with it to their dens. Observation of marked animals and collection of animals seen carrying food, revealed that they were usually males. The fact that the runways of the den systems were often plugged with quantities of food attested to the fidelity of the male to this part of his responsibilities in rearing the young. It seemed improbable that he collected the food for his own use since trapping revealed that the den he occupied was usually inhabited also by a female and young. The role of the adult male, therefore, seems to be an important one. It might be possible to test its importance by removing all the males from a lake as soon as the females are bred and by comparing the productivity of the lake with that of a control area having the usual complement of males. This was attempted on Study Area No. 3, but the necessary observations were not all completed, and the results were inconclusive.

During the time of the spring floods, which usually coincide with the breeding season, there is a certain amount of reshuffling of the population. The females seek out and occupy dens that are free from water, and seem to stay close by these dens. When there are more females than dens in a lake the surplus females must migrate to other lakes where dens are available. The results of trapping later in the summer showed that suitable habitats were usually occupied and that most dens had inhabitants.

Animals that travel along river channels, or overland between lakes, may be looked on as surplus produced in excess of what their native habitat will bear. They are of both sexes. Of 26 migrants collected during one evening, 14 were males and 12 were females. This was only a small sample taken in one area so it may not be representative. But it may be

expected, if only for reasons of space that there would be both males and females seeking new sites after being ousted from their winter quarters by older or stronger animals.

Local trappers asserted that the large males travel in the channels, but that the females stay in the lakes. A good hunter, they said, hunts his lakes lightly and puts greater effort into hunting the channels. Probably he is justified in doing this since he is saving his established breeding females and utilizing only those animals which might not become settled and so could be regarded as biological surplus.

Reproduction

Sexual Development

During the course of the winter the development of the sexual organs of the muskrats was checked periodically in order to find out how early in the year they became sexually mature. A series of testes was collected and measured for volume, and smears made from them were examined microscopically for spermatozoa.

Spermatozoa were first noted in the testes and epidymides on March 19. Testes had greatest volume at the height of the breeding season. After most females had been bred the volumes decreased rapidly until by mid-August they were reduced to half their June size. Undoubtedly the males were still fecund at that time but the amount of spermatozoa produced was decreasing rapidly. Breeding efficiency was probably much reduced as a consequence.

The musk glands, which are accessory sexual organs, undergo periodic enlargement and regression coincident with the increase and

decrease in size of the testes. In this case the surface area, a product of the length and width of one of the paired glands, was used as the criterion of development. Until the glands began to show enlargement from the quiescent state, they were not measured regularly. During March they had an average index of only 104 (8 by 13 mm.). By April the average index was 506, a four-fold increase. Greatest development took place in May and June when the average indices were 800 and 847, respectively. This was coincident with full development of other sex organs and highest reproduction levels. As with other sex organs, the regression of the musk glands during July and early August was rapid.

Number of Litters per Year

The information at hand regarding the number of litters per year is indicative but not complete. It has been demonstrated that the females may have two litters in one year, but it has yet to be determined how generally they do so.

Some of the larger females taken in August, and presumed to be second year animals, had uterine scars of two ages in the uterus. A female taken on July 22 had seven recent implantations and six uterine scars from a previous partus. A female taken on July 13 had seven uterine scars and six very early implantations. The actual role of uterine scars has not, however, been adequately studied, and it may be that the less distinct ones represent resorptions or even location of aborted foetuses. Until more information becomes available the assumption that there are two litters per year cannot be made on the evidence of uterine scars alone.

Some evidence to prove that there are two litters per year is

supplied by study of the grouping of weights of young September animals (Table 3). Of 40 males, 13, or 30 per cent, weighed over 500 grams. Only one was in the weight class 450 to 500 grams, but below that class the numbers were fairly evenly distributed in the weight classes. Twenty-four females taken at the same time followed the same general trend, although averaging about 50 grams less in weight. Consideration of these statistics and studies of the condition of the reproductive tracts of females of both yearling and older age groups led to the following inferences.

Females more than a year old become sexaually active earlier in the spring than do nulliparous females. They produce the litters born during the first two weeks in June. Females, just a year old, begin to have young about the middle of June. Litters continue to be born to this group until mid-July, with a peak during the last part of June. By the middle of July some of the multiparous females are having second litters. These litters continue to be born until the end of that month. It is improbable that many litters are born in August, although the very small animals (200 to 250 grams) taken in early September could be from such litters. The yearling females, then, have only one litter; the second year females may have two. There is a discontinuity in the series of births, about the time the older females have finished giving birth to their first litters and the younger females are beginning to give birth to theirs.

A check on the foregoing inferences could be provided by taking a continuous series of vaginal smears during the breeding season. This could be done without destroying the animals from which the smears are taken.

Population Studies

Tagging studies were aimed, in part, at ascertaining the carrying capacity of the muskrat environment and the seasonal shift of population in the environment. This was to determine if possible, how many animals might be reared on a unit area of habitat type, how many would survive to adulthood, and what, generally, the harvestable surplus was. These points were fairly well worked out for a limited area but they need to be determined on a more extensive basis.

One of the lakes on Study Area No. 3 was designated as Grassy Lake and more intensive investigations were carried on there than elsewhere. During the first part of August, 1947, an intensive tagging program was started on the lake. As many muskrats as possible were tagged and other related investigations were undertaken. Live trapping and tagging were continued in November and lasted throughout that month. In April, 1948, a program of controlled trapping with steel traps was carried on, and in June a few more muskrats were removed by shooting. A follow-up survey was made in July in order to check on breeding populations and the number of litters born. Tagging was also carried on at that time.

Grassy Lake was not typical of all the lakes of the Mackenzie Delta. It had been used as a source of breeding stock and so had been lightly harvested. This lake was, in fact, one of the most favourable habitats seen in the delta, and it had adequate amounts of both rearing and wintering sites. Its area was 28 acres, and it had, 1,650 yards of shoreline. It is connected with other lakes by two small creeks and eventually by these to Peel Channel.

In August, 1947, 45 muskrats were trapped and tagged in this lake. During November, 43 more were tagged and released. This made a total of 88 marked animals. Twenty-one of the original 45 were recaptured in November leaving 24 not accounted for. It was certain that there were 64 animals in the lake in November. There were probably more since it is unlikely that all were caught.

During the following April, K.H. Lang was kind enough to permit removal of the desired number of animals from the area. Forty muskrats were trapped in that month, 35 of which had been tagged previously. Using this proportion it was possible tc calculate that there had been a probable winter population of 73. Six muskrats, taken during the winter for examination, were added to this figure to give a total of 79. This was a density of nearly three muskrats per surface acre, or one for each 21 yards of shoreline. Comparison of these figures with those obtained at other lakes revealed that the population level of Grassy Lake was unusually high.

Six muskrats were removed from the lake during the winter, 40 were removed in April, and four in June. This made a total of 50, or nearly two per surface acre. It would appear that after April, 1948, there were 33 muskrats left and after June, 29. If the sex ratios obtained were correct, 40 per cent or 12 of these were females. These should have been able to find mates among the 17 males that remained.

To determine the effect of the removal of muskrats from the lake, all available breeding dens in the lake were checked during July, 1948. In 1947, eight such dens had been under investigation, and there were probably others. In 1948, eight dens and possibly nine, were occupied; three of them were new ones. Two of the den sites of 1947 were unoccupied. It seemed that

the number of animals taken during the hunting season had not decreased the productivity of the lake; if anything there was a little larger population in 1948 than in 1947.

A few muskrats tagged were not accounted for. The 24 muskrats tagged in the summer of 1947, and not recovered in the autumn of that year, may have succumbed to population depressants or may have migrated elsewhere. The lakes adjacent to Grassy Lake were trapped adequately in April, 1948, in the hope that some of the tags might be recovered, but none was. If the loss is to be attributed wholly to decimating factors there was a decrease of 56 per cent in autumn from summer, a serious condition if it existed.

It did not appear that the loss noted above was proportionally high for any particular age or sex group. Seven of the 14 adults tagged were recovered and of 32 juveniles, 14 were recovered. This would suggest that if population depressants were active they were not selective. No doubt the explanation lies between the extremes of predation and emigration. It is known that there is some movement of muskrats from one habitat to another in autumn. The data available indicated that the movement was usually a local and automatic adjustment in response to colder weather and lowering water levels. When the lush green of the Equisetum and sedge meadows is blighted by frost the animals leave the locations where they were reared and seek deeper water, where food in the form of submerged plants is abundant.

Depredation by animals that prey on muskrats was not thought to be great, at least not much sign of it was ever seen. The population level of predatory animals, especially of mink, was low because of trapping pressure. Red foxes were fairly common but not common enough to reduce greatly the number of muskrats. Raptorial birds were not abundant.

There is a possibility that some of the muskrats, found in

Grassy Lake during the summer of 1948, may have moved in from adjacent areas to occupy vacant den sites. About half the adults taken at nest dens at that time had not been tagged. There was no indication of where the untagged animals came from. They could have come from other lakes, but as the population pressure in nearby lakes was not high, they may have come directly from the river channel. These inferences are conjectural, but there seems to be a considerable redistribution of the muskrats in spring. Such movements can be ascribed to the flooding of dens, the search for food, and the excitement and unrest attendant upon breeding activities.

Winter Studies

Formation of Pushups

The feeding station or pushup is maintained even above several feet of ice. In autumn, small holes may be found in the ice after it is formed (Fig. 7). These do not close readily, as bubbles of gas rising to the surface seem to keep them open. If a hole does freeze, it forms a dome-shaped space filled with gas and the ice above it remains thin. Pushups are usually built at such locations. The gas apparently comes from the decomposition of organic matter. A considerable mound of vegetable debris - a by-product of feeding - accumulates below each pushup. The generally slow rate of decomposition in northern lakes produces a slow continuous release of gas, and in this way pushups are perpetuated year after year in the same location.

Muskrats may open holes in the ice in other ways. Pushups are often placed in a straight line between the den and feeding areas, but how the animals space their pushups at appropriate sites is not clear. It was observed that a muskrat could enlarge a hole in the ice if it could get its muzzle and upper incisors through the hole, but that it could not chew upward or downward

through solid ice.

Winter Carrying Capacity

Studies of winter carrying capacities revealed several important facts concerning muskrat activity during the winter season. In early November, 1947, 72 pushups were located and charted on Grassy Lake. Trapping was carried on in 14 of the largest of these. By early March only 35 pushups were in use; the rest were frozen shut and abandoned. When the muskrats were being harvested from the lake there were only 23 pushups in active use. It would appear that several animals used each feeding station, and that continuous usage helped to keep the plunge holes open.

This assumption was borne out by the autumn trapping. It was found that 37 per cent of the animals trapped in November were taken only once, 27 per cent twice, 23 per cent three times, and 13 per cent four times. Furthermore, 65 per cent were taken in only one pushup, 28 per cent in two pushups, and 7 per cent in three pushups. An average of six muskrats was taken at a pushup, with extremes of one and 13. The radius of activity was therefore fairly small, each animal restricting its movements to a few pushups in the vicinity of its den. The average distance between pushups was 40 yards.

The members of each group of animals were continually in contact, and the group evidently reacted as a discrete unit. They seldom come in contact with animals from other parts of the lake. This indicates that carrying capacity may depend not on a large unit such as a lake, but on smaller units within the lake. April trapping found the muskrats in the same general locations as in November which is evidence of the stability of winter associations.

The number of pushups in use in April was about 33 per cent of the total constructed on Grassy Lake. At a number of other lakes where pushups were tested, success was experienced at 47 per cent of a total of 760 pushups.

If 40 muskrats can be taken in April from a lake where there were 72 pushups in November, then it can be inferred that one muskrat for every two autumn pushups, or between one and two muskrats for each active spring pushup, could be harvested. This inference may be conservative since in small or narrow lakes the animals sometimes do most of their feeding from the banks and build few pushups. The amount of snowfall, the mean temperature, and the character of the lake are all variable factors in the success of pushups. More data for successive years are needed for comparison before truly valid statements can be made. In any case the individual trapper comes to know his lakes so well that, if he is willing, he can harvest only what they will allow.

The occupants of each den could not always have consisted of the members of only one family. There were family groups in summer but these broke up during autumn. As nearly as could be learned the inhabitants of a den were of both sexes and of several ages. They seemed to live on very amiable terms and, until the breeding season began, there was little evidence of intolerance among them. No doubt spatial relationships break down, however, when there is an absence of food, or where animals are sealed from their burrows as the ice layer thickens. The native trappers stated that when muskrats are frozen out of their shore dens they must try to live in the pushups and usually end by freezing or starving there. One Indian reported taking sixty dead muskrats from frozen pushups in a single lake.

Types of Lake Habitat

The extent to which ice thickness reduces the water area available to muskrats and restricts their movements, depends on the depth of the water and on the gradient of the bottom. In a lake with a shallow gradient and

only a small central area of deep water (Fig. 5) the accretion of an extra foot of ice greatly reduces the volume of the remaining water. A lake whose bottom drops sharply away from the shoreline to depths of three or four feet is not so greatly affected by an increase in ice thickness. As a general rule both types of gradient may be found in any lake, but the proportion of each varies in different lakes.

A series of soundings was made in winter on a number of lakes. Ice thickness and depth of water below the ice were measured both in the vicinity of muskrat pushups and in locations where there were no pushups. Late winter soundings made in March and April gave results somewhat different from what was expected. Ice, six to seven feet thick, had been reported, but no such ice thickness was observed.

It was found that snow depth varied from nil to 17 inches with an average of eight inches. Ice thickness which averaged 23 inches, and ranged from 17 to 33 inches, was directly correlated with snow depth. Snow formed effective insulation, and ice beneath it was always much thinner than in places where wind had removed the snow.

A disadvantage of snow cover, which is considerable in some years, is its weight. The weight of very deep snow can cause the ice to sink and force water to flow out through cracks in the ice and through the plunge holes of pushups. This water freezes quickly and, if enough of it escapes, the pushups are sealed by ice and thus are useless to the muskrats. Luckily the pressure is soon equalized, and it is seldom that all the pushups in a lake are sealed.

Water depths below the ice varied widely and ranged from nil to 145 inches. Each extreme was found on only one lake; generally the water depth was near the average of 48 inches. The average lake depth, therefore,

including ice thickness, was nearly six feet. It was found that at this depth there was adequate food in the form of submerged plants. Where greater lake depths of 10 to 14 feet were found there were very seldom any pushups, and there were no food plants. Water warms very slowly and the rays of the sun have a very feeble effect at these depths. From an aircraft it was possible in summer to pick out the very deep parts of a lake by the absence of plants. There were areas of great depth in most lakes, but they were often small in extent.

It would be safe to say that for the most part the lakes in the upper two-thirds of the delta are adequate habitat for muskrats, or can be made so. In the lower delta, north of latitude 68° 30' N., the situation is much less favourable. Because this area was so recently formed, there has not been so much deposition of silt, and as a consequence the banks of the channels are lower and the lake areas relatively larger than in the upper delta. There is also a decidedly greater fluctuation of water levels during the summer. Strong on-shore winds blowing over the broad estuary of the Mackenzie River causes the water to pile up. The current of the river may be reversed, and the water may rise so much that the effect is apparent as far as 90 miles inland. This rising water floods dens and must be harmful to the very young muskrats. The entrances of the dens are uncovered when the water recedes, leaving them more accessible to predator invasion. Siltation is also accelerated, since the lakes are flooded not only once each spring but also several times during summer.

At Study Area No. 5, which lies in this northern area, some muskrats were found to live in the creeks during the summer. This was the only habitat type where they were obliged to do so. The lakes were nearly all of relatively great area, and by August some of the larger ones were nothing but

broad meadows of sedge and grass. The four lakes in the study area varied in depth, but no soundings over six feet were made. One lake had hardly more than a foot of water over most of its area. The average water depth for the other three lakes was two feet. Deep water formed only about one-tenth of the total lake area. Plant food was abundant in the lakes and around them, giving them a habitat advantage over lakes farther upstream, but trapping returns showed that the production was only one-third to one-fifth of what might have been expected in the upper delta. Muskrat sign generally was scarce at this study area.

Harvesting Methods

Early Winter Trapping

A lack of timber in the lower delta allows the wind an almost unhindered sweep across the country. Many lakes are kept almost free from snow, and consequently the ice in them is much thicker. Lakes in this habitat normally freeze to the bottom, except in the small areas of deep water, and muskrats taken in them during very cold winters are apt to be small and to have thin and unprime pelts. This habitat is definitely submarginal, and the trappers who have trapping areas in this region must have very large areas in order to get an adequate income from muskrat fur.

Although the muskrats taken in the lower delta in early December are likely to be small and of inferior quality, they do, if trapped, provide the trapper with some financial return. Muskrats compelled by winter ice to inhabit a very restricted area in a lake do not grow appreciably after December, and may not survive until the opening of the spring trapping season. A lake that does not have at least four and a half feet of water over most of its area at the time it freezes, cannot be expected to winter a population of

muskrats adequately. Such lakes could be trapped profitably in December. This would give the native trapper a small source of income at a time of the year when the return from other fur, which is scarce in the delta, fails to supply even necessities. The same conditions exist, to a lesser degree, in other parts of the delta, and in these places, too, some loss during winter can be prevented by early winter trapping. The best time for this is during the first ten days or two weeks of December.

Trapping vs. Shooting

The practice of shooting muskrats with .22 calibre rifles is general in the Mackenzie Delta during the last few days of the open season, if there is open water at that time. It has been suggested that this practice should be abolished in order to lengthen the harvest period, and to produce a better average grade of fur. Cowan's report substantiates this view. It is not clear, however, that the harvest can be taken adequately by trapping alone. Some shooting at the end of the season may be necessary to harvest all the surplus of muskrats. At present some hunters take only a few muskrats by trapping, and most of their harvest by shooting.

Some trappers reported lakes in their trapping areas which could not be trapped adequately because water levels receded leaving an air space between ice and water where the animals were free to feed. No instance of this kind was noted in 1947 or 1948, nor is it likely that it occurs. It would be expected that the ice would bend and drop as the water receded. It surely did so in the river channels and should do so in any lakes except the smallest ones.

Information, concerning time spent in trapping and number of muskrats taken, was gathered (Table 4) from five trappers, most of whom were about average in trapping skill. The results were remarkably consistent.

The five trappers averaged one muskrat for about three trap-nights (.38 muskrats per trap-night) during a period of over a month.

A trapper is able to attend a maximum of about 40 traps per day. If he continued trapping during the two months of the open season, when trapping is possible, he would expend an effort equivalent to 2,400 trap-nights, and he should take about 900 muskrats. Few trappers, without assistance, actually take that many by trapping alone. This seems to show that trapping alone may not be adequate to take the harvestable surplus.

Most trappers can shoot in a night as many muskrats as they can trap in a week. About seven days of shooting after the breakup is usually sufficient for them to complete the harvest. Too prolonged shooting seriously infringes on the breeding season. The native trappers are in some cases aware of this, and stop shooting of their own volition when they begin to take too many females heavy with young.

Decimating Factors

It would be presumptive to attempt at this time to define the status of the several factors acting as depressants on the muskrat population of the delta. As indicated previously, there may be a substantial yearly decrease from natural causes, but the agencies involved are not yet clearly understood. They probably vary a great deal from year to year. Each type of habitat must have, at any given time, an optimum level of population, and it is logical to suppose that if that optimum level is exceeded some animals will be living in sub-optimal circumstances with lessened chances of survival. The carrying capacity of the habitat, and hence the optimum population level which it will support, varies in accordance with climatic conditions, changes in the water level, and the demands upon it by the resident animal population. There

will, therefore, be a tendency for the number of muskrats to be adjusted, by one factor or another, in varying degrees, towards that carrying capacity.

Climate

There were indications from past years that the principal cause of reduction in the number of muskrats may have been extreme climatic conditions. Reports, from the winters of 1945-6 and 1946-7, indicated that during both winters climatic conditions might have been the chief decimating influence. Authentic reports of "freezing out" of animals from shallow lakes, and of animals wandering from shallow lakes under winter conditions, leave little doubt of the importance of extreme winter conditions as a reduction factor.

Summer conditions, such as the amount of wind, rainfall, and warmth, are important in the rearing of the muskrats. Temperature and sunlight are the chief factors governing plant growth in the lakes and around them.

In 1948 water levels were exceptionally high. Deep snow hid the pushups from view and they were hard to locate. Cold March weather slowed up trapping. The weather did not moderate and melt the ice as soon as usual, and the break-up was late. These conditions greatly restricted the take of muskrats in that year. An epidemic of influenza among the natives during the late March and early April also reduced the trapping effort.

In estimating the population level of the muskrats, it is not always wise, therefore, to consider only the number of muskrats taken by the trappers. Trapping data may give a false impression. Although muskrats were probably more numerous in 1948 than in 1947, there was a decrease in take of over 16 per cent in 1948.

The mink, Mustela vison ingens, living in the same type of habitat as the muskrat is best able to prey on them when they are favourably situated. Only three mink were seen during the months spent in trapping. Mink was scarce in winter, especially in late winter, and few mink tracks were seen in the snow around muskrat habitations.

A favourite haunt of mink, after freeze-up, was beneath the ice along the edges of creeks in recesses left by receding water. It was not necessary for them to come out often, as food in the form of fish was abundant.

Mink was probably taking a toll of young muskrats in summer, but there were so few mink that the effect, although locally significant, must have been on the whole small.

Foxes

The red fox, Vulpes fulva, was more abundant in the delta than mink. Because of low prices for red fox pelts during the past few years it had received light trapping pressure and was increasing in numbers. Tracks were abundant throughout the region and were seen even at elevations of 2,000 feet along the Richardson Mountains, west of the delta. The fox showed little fear of human habitations and during the winter tracks were common around the settlement at Aklavik.

According to the trappers of the delta there was an epidemic among the foxes during the winters 1945-6 and 1946-7. Individuals affected were known locally as "crazy foxes". They lost their fear of man and were often belligerent. They were known to chase dog teams on the trail, bark outside the windows of houses, and exhibit extreme nervousness and activity. The epidemic slackened off during the second summer and foxes evidently increased. There

were, however, instances of the disease in 1947-8. One animal, killed by chained dogs at Aklavik, was sent to Edmonton for a check on the possibility of rabic infection. The analysis was negative and the condition not discussed. Foxes affected by the disease were reported by several trappers during the winter, and east of the delta hunters saw one chasing and barking at reindeer. Despite the epidemic, foxes were more numerous in the delta than any other species of 'fine' fur animal.

The nature of the country made it difficult to check the depredation of foxes on muskrats in summer. During the winter, when there was a good snow cover and the lakes were frozen, the foxes were much more in evidence. Trappers made use of their presence on the lakes to find buried pushups. A fox would locate, and visit, most of the pushups on any lake it came to, especially if the pushups were in active use. The trappers said that pushups visited and used by foxes, as scent stations or for voiding droppings, were invariably in active use by muskrats. This was generally the case.

There were two winter periods, of about a month each, when foxes had good success in taking muskrats. During October and early November, when the pushups were being built, the foxes were still able to dig into them. Later, when the pushups froze solidly, they were sealed against such attack. In late April, warmer weather again allowed foxes to dig into the pushups. They seemed to take full advantage of the opportunity, and even removed muskrats from traps. Muskrats were usually eaten near where they were captured, and parts of the skull and feet were left. At Study Area No. 3, foxes took eight muskrats from the traps in autumn and spring. One fox removed muskrats from a trap in the same pushup on three successive nights.

The combined loss from such depredations in the delta is, no doubt, greater than the value of the fox pelts taken. It is conceivable

that in some parts of the delta foxes may be more important as predators than as fur-bearers. This is not the case at present but if the light harvest of foxes continues they may become numerous enough to be a nuisance.

Northern Pike

The northern pike, Esox lucius, is common and widely distributed in the fresh waters of the delta. It is found in lakes where there is easy access from the channels. Spawning takes place in spring in the shallow, weedy type habitats much favoured by muskrats. The voracity of the pike is well known and it has been observed to take a toll of young water-birds, mice, and muskrats. The extent of its predation upon the various species of birds and mammals has never been demonstrated adequately.

Pike is abundant in some lakes in the Mackenzie Delta and specimens were collected at the Reindeer Station study area. In all, 50 pike were taken and examined. The results were far from conclusive. Thirty-four of the fish had nothing in their digestive tracts; 13 had fish; five had insects; one had a young muskrat. The fish averaged 4.5 pounds in weight. They were large enough to take juvenile muskrats, but they probably took less than was popularly supposed. The lakes at the Reindeer Depot had large populations of pike but, in spite of this, nearly normal numbers of young muskrats were produced in the lakes. Pike were never seen at Grassy Lake and so could have had no influence on the muskrat population there.

Raptorial Birds

The status of raptorial birds, in the biology of the muskrats of the delta, was not established, but the following were seen to take muskrats during the summer: great horned owl, goshawk, bald eagle, golden eagle, and gyrfalcon. The snowy owl, the great grey owl, and the American rough-leg are other birds in the delta that are capable, by their size, of capturing half-grown muskrats, but that did not seem to do so. As mentioned previously,

hawks and owls are not abundant locally in the delta during the summer. Great horned owls are perhaps the most numerous raptorial birds. The dense spruce cover and large amount of lake edge, with dead trees for nesting and hunting platforms, provide an ideal habitat for these birds. They seemed, however, to be most abundant along the sides of the delta within reach of higher ground. Snowy owls were seen only in open country near the river mouth.

Other Predators

The lynx, Lynx canadensis, was at a low population level during 1947 and 1948. The trappers reported that it was slowly increasing in numbers, but its chief food species, the snowshoe hare, Lepus americanus macfarlani, was not abundant. Signs of lynx were seen during the winter only in areas widely dispersed throughout the delta. Lynx was commonest in the upper delta, and around Arctic Red River. No instance of its preying on muskrats was noted or reported.

Both black and brown bears are found in the delta. Instances of black bears digging up muskrats dens were noted, but with what success is not known. The heavy hunting pressure on bears keeps their numbers low.

The wolf, Canis lupus, is very scarce in the delta proper but inhabits the hills and barrens along either side of it. It is not important as a predator on muskrats.

Disease and Parasites

Post mortem examinations of 479 muskrats were made during the course of the study. Few diseased animals were found. A record of the incidence of coenurus cysts of the tapeworm, Cladotaenia, in the livers and other organs was kept. The number of cysts, in animals infested, varied from one to many but was usually less than 10. Of 97 adult males, 15 or 15 per cent were infested with coenurus cysts; of 256 adult females, 26, or 10 per cent were in-

fested; of 14 juvenile males, one, or 7 per cent were infested, and of 12 juvenile females, none was infested.

Possibility of Habitat Improvement

Most lakes in the Mackenzie Delta are interconnected by small creeks, and have eventual communication with river channels. This allows them to fluctuate in depth as do the rivers. Drainage often progresses far enough to render lakes unsuitable for wintering muskrats.

On most areas investigated during the course of the study the drainage of a series of lakes was effected by a single small stream. One dam across such a stream might stabilize water levels in all the lakes above it. There would be an inflow at flood water over the dam in spring and subsequent outward drainage, so that the dam would have to be of sound construction, with a spillway or a broad top and a large slope ratio. Such a dam would be comparatively inexpensive to build since it would need to be only three to five feet high and usually less than 30 feet long.

Most trappers were planning improvement of their trapping areas and others have tried to effect improvements, but with little success. Few of them possessed the skill and knowledge to be able to build suitable dams, and they needed advice and assistance, perhaps only the former, in order to do so. Many lakes require little improvement.

Beaver

As mentioned in Cowan's report, there was evidence of beaver activity in the past in the Mackenzie Delta. Work done by beavers was seen; some of it was old, but much of it was recent. There had been more beavers in the delta than at the time of the investigation, but the extent of suitable

beaver habitat was much less than for muskrats. This would always limit the number of beavers that the delta could support.

It was not possible to visit all the beaver colonies reported by trappers, but observations were made at some of them and the findings were about the same in all cases.

Not more than one lodge was seen in any lake. All lodges were in the banks (Fig. 8) and were covered over with varying amounts of stripped sapling, evidently a by-product of feeding. The fact that there was only one lodge at each lake may have meant that the colonies were new, or that the habitat was restricted and the young beavers had been going elsewhere to establish themselves.

The generally shallow character of most lakes visited during the muskrat investigations made them unsuitable as habitat for beavers. Soundings made at sites of five beaver lodges revealed that the least depth at the lodge entrance was seven feet, the average was more than eight feet, and the maximum was 12 feet. The bank had to be at least five feet above mean water level to accommodate the den, and had to drop away sharply to the requisite depth. The lake could be any size if these conditions occurred, and if there was suitable food available.

The favoured food was willow, Salix spp. (Fig. 10). Alder was also utilized to a limited extent, but it was never noticed that conifers had been eaten. It took a good growth of willows along the lake edge to support a beaver colony because they seldom exceeded three inches in diameter at the base. A large amount of this type of food would have to be stored in autumn to keep a family group over the seven months period when the lakes

were closed by ice. The beavers may utilize available submerged aquatic plants such as pondweeds, Potamogeton spp., and milfoil, Myriophyllum exalbescens, or other food used by muskrats, but no information on this point was obtained.

The beaver seemed to prefer the more recently formed lakes which had not yet been subjected to too much silt and had shore areas with sub-climax growth and an adequate amount of willow. It would be safe to say that there are many trapping areas in the delta where such conditions are rare.

In some places the extent of suitable beaver habitat can be increased by raising the water level or by maintaining high water levels. The beaver do this to a certain extent; two short dams, built by two different colonies, were found (Fig. 9).

Lake improvements for beaver also provide suitable habitat for muskrats. In some cases transportation of food to the beavers is possible, if they require it, since there is no lack of willows.

The general opinion among trappers in the delta was that the beavers entered the delta from both sides, especially from the east, but did not survive long enough to establish themselves. Most beavers, they said, were shot for food. The registration of individual trapping areas, now in effect, may encourage trappers to protect beaver colonies on their areas and to establish new ones in suitable sites. At the time of the investigation breeding stock was not available, but this difficulty could be surmounted by transplanting pairs of beavers from areas of concentration. There is little doubt that beaver can be established in the delta in suitable areas which they do not at present inhabit, if they are adequately protected, and are, where necessary, given assistance by damming and by supplementing food supplies.

Summary

Preliminary studies of the mammalian fauna of the delta of the Mackenzie River were conducted during the period June, 1947, to September, 1948. The northern muskrat Ondatra zibethica spatulata Osgoode, received greatest attention because of its abundance and economic importance. Intensive investigations of muskrats were centred at five study areas. One of these was situated north of the region of forest cover.

All muskrats studied were living in dens in the banks of lakes and streams. Muskrats were captured in cage traps and marked for later identification before release. Methods of winter and summer trapping were developed so that information on movements and population pressures, during both seasons, could be obtained.

Tagging studies indicated that the age of muskrats during the spring hunting season could not be ascertained by simple measurements such as weight or total length. More refined methods are necessary.

Sex ratios were at all times found to be unbalanced in favour of the male muskrats. This disparity ranged from 113 males to 100 females, during the late winter period, to 131 males to 100 females among summer juveniles; and to 196 males to 100 females taken by hunters in the late spring shooting season.

The height of the breeding season was found to be about mid-June. Information available indicated that some females had two litters of young per year and others had only one. It appeared that the yearling females had only one litter during their first year because they matured later in spring than multiparous females.

Population studies were not conclusive because of the relatively low recovery of tagged animals. They indicated that during the course of a year there was a rather distinct change in the populations on the study

areas. This change may, no doubt, be ascribed to local movement of animals as well as to decimating factors. The greatest movement occurred in spring. During winter, the radius of movement of any animal beneath the lake ice was confined to a few pushups in the vicinity of the bank den.

Most lakes in the Mackenzie delta are shallow, and during winter have an average of 2 feet of ice and 4 feet of water. This total depth of about 6 feet was found to be nearly optimum for year-long survival of animals. Where depths were less, as in the lower delta area, there was danger of the lakes freezing solid in winter. In depths of 10 to 14 feet there were not sufficient submerged food plants to support a normal winter population of muskrats.

The severity of the climate is one of the chief factors restricting the density of muskrats in any given locality in the delta. It not only governs the amount and kind of plant growth available for food, but also causes freezing out in otherwise favourable habitats. The most important predators, other than man, are mink, foxes, hawks, owls, and northern pike.

There is a need for a program of habitat improvement in the Mackenzie delta, for both muskrats and beavers.

(Editor's Note: A program of habitat improvement in the Mackenzie Delta for both beaver and muskrats was undertaken on an experimental basis during the summer of 1952. This program will be carried on and further expanded during the 1953 open water season.)

Table 1 - Weights and Measurements of Adult Muskrats of Known Age
(Weights in grams; measurements in millimetres)

	MALE				FEMALE			
	Average	Range	S	N	Average	Range	S	N
Weight	1,114.8	935-1,420	124.0	27	1,010.8	703-1,395	149.1	33
Total Length	544.7	515-589	17.8	27	537.4	487-575	21.6	33
Tail Length	236.0	212-252	10.4	27	233.4	198-270	13.2	33
Hind Foot	77.0	72-80	2.1	27	75.1	71-79	2.9	33

S - Standard deviation N - Number in sample

Table 2 - Weights and Measurements of Juvenile Muskrats, April, 1948
(Weights in grams; measurements in millimetres)

	MALE				FEMALE			
	Average	Range	S	N	Average	Range	S	N
Weight	969.8	775-1,110	87.4	19	888.0	700-1,065	49.4	17
Total Length	528.6	487-564	19.2	18	511.5	478-534	17.7	16
Tail Length	230.1	210-245	10.2	18	223.5	204-242	11.3	16
Hind Foot	76.2	73-79	1.7	19	75.2	73-78	1.4	17

Table 3 - Frequence of Weights of 65 Young Muskrats in September
(Weight Classes in Grams)

	200-250	250-300	300-350	350-400	400-450	450-500	500-
Male	3	7	6	5	5	1	13
Female	2	1	5	3	3	6	4

Table 4 - Muskrats per Trap-Night for Five Trappers During Spring of 1948

	Total Trap-nights	Number of Muskrats	Muskrats per Trap-night
Trapper A	270	99	0.37
" B	533	208	0.39
" C	423	154	0.36
" D	294	142	0.48
" E	400	133	0.33
Totals	1,920	736	0.38

Fig. 1. Adult muskrat, Aldous holding cone, and National live trap.

Fig. 2. Young muskrats about one month old.

Fig. 3. Lake-edge habitat favoured by muskrats during summer.

Fig. 4. Lake edge deficient in food and choked by fallen timber and drift logs.

Fig. 5. This lake, though well supplied with food, had few muskrats because of its shallow depth.

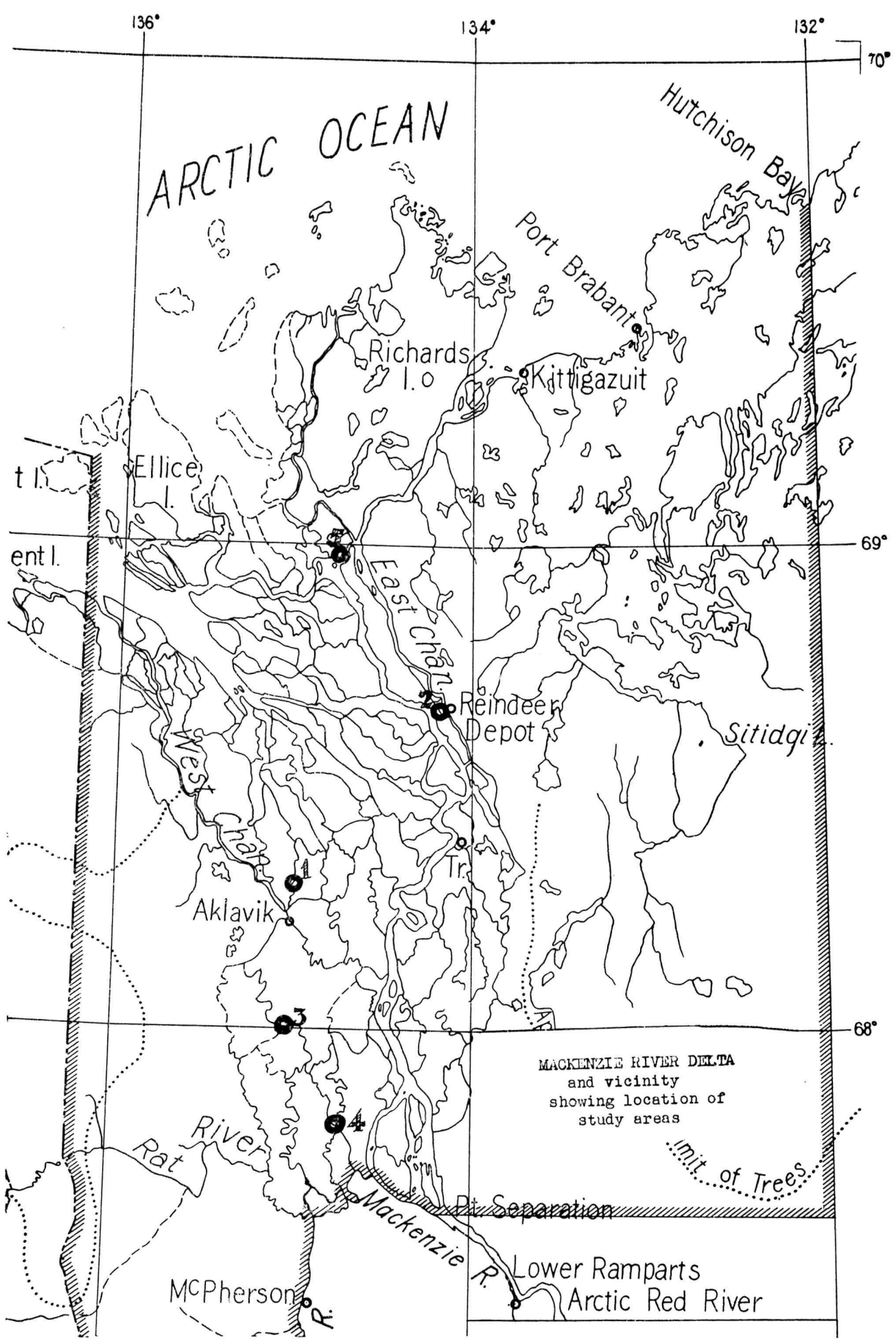
Fig. 6. Shoreline vegetation in vicinity of muskrat den showing heavily utilization as a food source.

Fig. 7. Hole in young ice kept open by the action of gas bubbles.

Fig. 8. Site of beaver bank lodge.

Fig. 9. Small dam constructed by beavers.

Fig. 10. Type of habitat favoured by beavers; deep water and abundant willow growth.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