

A BIOLOGICAL STUDY OF THE MUSKRAT, (ONDATRA ZIBETHICA ALBA,
(SABINE) MILLER, 1912) IN MANITOBA

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by
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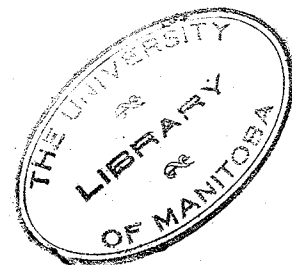


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Figure I --- A litter of ten muskrats which were photographed on June 30th, at Pruden Bay Station, Netley Marsh. Their average total body length was approximately 135 mm. which placed them at six days of age. The animals have been tagged for experimental purposes.



FOREWORD

The early fur trade furnished the stimulus for exploration and the subsequent colonization of the North American continent.

"Probably the oldest industry in the world was the taking of furs for clothing; aborigines the world over have been dependent upon fur animals for ages. The early invaders of North America pushed into the West for furs. If one reviews the history of North America, he soon learns that not gold, agricultural lands, or timber attracted the hardy adventurers, but rather the claims of the fur trade." (Hamilton, 1939)

The fur trade of Canada plays an important role in the economic status of this country. A large population of Northern Canada is primarily dependent upon the fur bearing animals. Approximately 60,000 Eskimos and 20,000 Indians are supported largely by the fur industry. These natives cannot subsist on agriculture due to the unsuitability of the soil and also because of their nomadic nature. Since there exists a sufficient native population in Canada to secure all the furs that can be marketed, certain restrictions have been placed on the number of white trappers.

With the increasing demand for furs, many of the fur - bearing species have been trapped very heavily resulting in a serious decrease in their numbers. If the conditions of the habitat became severe, the outcome would have been extermination if conservation measures were not brought into function. The purpose of management and regulation is to permanently maintain the fur supply on a sustained - yield basis.

INTRODUCTION

Total Canadian Fur Production

The twenty two fur-bearing animals of Canada are mostly carnivorous mammals but also included are two rodents of great importance. The latter are the beaver and the muskrat. The total Canadian fur production during the season 1947/48 ending June 30th, is shown in Table I. This crop was worth over 32 million dollars. Therefore the Canadian fur industry is of considerable value.

Muskrat Fur Production

The "banner of the fur trade" as formerly held by the beaver, has long since been replaced by the muskrat. Its broad distribution and enormous numbers as well as its great versatility which has enabled it to withstand prolonged heavy trapping and the severe fluctuations of its habitat have made this animal one of the most important species of the fur trade. It is trapped in Alaska, Canada, and in 47 states. Louisiana is by far the greatest producer and supplies approximately six million pelts yearly. The total North American production exceeds 10 million muskrat pelts annually.

Canadian production of these pelts amounted to over 3.5 million during the season 1947/48 ending June 30th. Table I states that their worth exceeded 9.5 million dollars. This same table also shows that the muskrat is the most abundant and the most valuable fur bearer in comparison to any of the

other species which are obtained from the wild. It constitutes approximately 30% of the total value of all the Canadian fur revenue.

Table II, has all the territories of Canada arranged in their order of importance with respect to her muskrat fur production. Manitoba, in the season 1947/48 ending June 30th, surpassed all the other regions in her yield of muskrat furs.

The number of raw pelts taken in Manitoba from the season 1942/43 to the season 1948/49 ending March 31st is shown in table III. The total amount of pelts cropped in this province during the season 1948/49 was approximately 1.67 million. The muskrat furnished over 930,000 of these pelts or slightly less than 56% of the total catch. These furs produced a revenue exceeding 1.25 million dollars. The total value of the furs for the season 1948/49 ending March 31st, as shown by table IV, was over 2.5 million dollars. Therefore the muskrat constitutes almost 50% of the total Canadian fur catch revenue. The muskrat formed not only the majority of the pelts taken from the wild in Manitoba but also the greatest return for any one species.

The abundance and the pelt value of the muskrat do not remain stationary. Tables V and VI show these fluctuations. During the past season, the muskrat population has reached almost another all time high in Manitoba. The

TABLE I
TOTAL CANADIAN FUR PRODUCTION
Season 1947/48

Kind	No. of Pelts		Total Value of Pelts	Average Value per Pelt
	Wild Life	Ranch raised		
<u>CANADA</u>				
Badger -----	1,034	-	\$ 1,380	\$ 1.33
Bear, white -----	246	-	6,530	26.54
Bear, not specified	827	-	2,257	2.73
Beaver -----	135,629	-	4,382,241	32.31
Cat, domestic -----	-	31	16	0.52
Coyote or prairie wolf -----	21,728	-	64,787	2.98
Ermine (weasel) ---	528,029	-	1,201,271	2.27
Fisher -----	2,788	35	102,230	36.21
Fitch -----	-	231	739	3.20
Fox, blue -----	606	1,579	34,775	15.92
Fox, cross -----	5,771	785	36,716	5.60
Fox, platinum -----	-	30,433	660,147	21.69
Fox, red -----	46,124	370	120,854	2.60
Fox, silver -----	1,085	127,300	1,583,006	12.33
Fox, white-marked -	-	19,789	254,119	12.84
Fox, white -----	55,354	69	616,210	11.12
Fox, not specified	109	20	438	3.40
Lynx -----	6,582	-	128,188	19.48
Marten -----	15,051	39	415,898	27.56
Mink, mutation ---	-	32,903	658,507	20.01
Mink, standard ---	92,191	529,412	110,426,077	16.77
Muskrat -----	3,569,157	-	9,518,064	2.67
Nutria -----	-	8	10	1.25
Otter -----	11,974	-	296,410	24.75
Rabbit -----	124,801	-	57,320	0.46
Raccoon -----	24,192	22	63,062	2.60
Skunk -----	19,096	-	12,770	0.67
Squirrel -----	2,543,798	-	1,577,887	0.62
Wild Cat -----	1,265	-	3,480	2.75
Wolf -----	1,231	-	3,539	2.87
Wolverine -----	452	-	4,064	8.99
TOTAL -----	7,209,120	743,026	32,232,992	-

(Figures obtained from the
Dominion Bureau of Statistics)

TABLE II
 CANADIAN MUSKRAT FUR PRODUCTION
 Season 1947/48.

Territory	Number of Pelts (Wild)	Value	
		Total	Average per Pelt
Manitoba -----	1,004,762	\$2,712,857	\$2.70
Ontario -----	862,490	2,587,470	3.00
Saskatchewan -----	510,730	1,368,756	2.68
Alberta -----	463,193	1,097,767	2.37
North West Territories	395,992	864,782	2.30
Quebec -----	161,101	434,973	2.70
British Columbia ----	67,191	161,258	2.40
Nova Scotia -----	50,600	149,270	2.95
Yukon Territories ---	30,686	73,646	2.40
New Brunswick -----	21,299	63,897	3.00
Prince Edward Island	1,113	3,388	3.04

(Figures obtained from the Dominion
 Bureau of Statistics)

TABLE III

RAW PELTS TAKEN FROM THE WILD IN MANITOBA, 1942/43 TO 1948/49

Species	1942/43	1943/44	1944/45	1945/46	1946/47	1947/48	1948/49
Weasel -----	113,080	155,567	124,815	109,613	103,656	91,600	99,705
Squirrel -----	326,203	228,803	445,214	300,847	399,658	224,677	580,707
Muskrat -----	280,838	581,862	855,724	958,099	808,692	822,998	930,330
Mink -----	18,356	21,067	15,338	12,801	15,850	18,778	22,932
Skunk -----	22,839	42,235	26,981	14,747	12,026	1,494	653
Badger -----	725	1,040	513	432	239	90	34
Wolf, Coyote ----	4,054	7,745	5,295	3,801	2,132	2,268	1,725
Wolf, Timber ----	-	-	565	511	403	247	255
Fox, Silver -----	955	859	523	433	258	201	165
Fox, Blue -----	14	9	4	6	23	2	8
Fox, Cross -----	6,072	5,027	3,042	2,107	1,430	826	828
Fox, White -----	470	363	311	297	1,449	89	47
Fox, Red -----	24,043	24,717	14,533	10,241	6,271	3,173	2,836
Wolverine -----	12	12	9	12	24	14	16
Beaver -----	Closed	13,248	5,399	9,057	7,878	12,443	14,099
Otter -----	1,772	1,816	2,277	1,804	1,850	2,093	2,103
Fisher -----	317	490	418	315	24	50	11
Marten -----	347	269	234	213	15	97	18
Bear -----	101	193	87	71	37	38	44
Lynx -----	596	525	311	149	27	20	74
Jack Rabbit -----	-	-	14,886	14,824	9,728	7,998	5,760
Raccoon -----	-	-	-	-	-	28	56

(Manitoba Government Annual Report 1948/49)

TABLE IV

ESTIMATED VALUATION OF FURS TAKEN FROM THE WILD, 1947/48 AND 1948/49

Species	Season 1947/48 Quantity	Estimated Valuation 1947/48	Season 1948/49 Quantity	Estimated Valuation 1948/49
Weasel -----	91,600	\$ 215,260.00	99,705	\$ 154,542.75
Squirrel -----	224,677	146,040.05	580,707	133,562.61
Muskrat -----	822,998	2,222,094.60	930,330	1,274,552.10
Mink -----	18,778	694,786.00	22,932	619,164.00
Skunk -----	1,494	1,120.50	653	326.50
Badger -----	90	135.00	34	44.20
Wolf, Coyote -----	2,268	6,804.00	1,725	4,312.50
Wolf, Timber -----	247	988.00	255	1,147.50
Fox, Silver -----	201	1,005.00	165	660.00
Fox, Blue -----	2	20.00	8	48.00
Fox, Cross -----	826	3,717.00	828	2,484.00
Fox, White -----	89	1,246.00	47	470.00
Fox, Red -----	3,173	9,519.00	2,836	5,672.00
Wolverine -----	14	140.00	16	128.00
Beaver -----	12,443	423,062.00	14,099	310,178.00
Otter -----	2,093	58,604.00	2,103	42,060.00
Fisher -----	50	1,500.00	11	275.00
Marten -----	97	2,910.00	18	360.00
Bear -----	38	76.00	44	88.00
Lynx -----	20	420.00	74	888.00
Jack Rabbit -----	7,998	5,198.70	5,760	1,728.00
Raccoon -----	28	56.00	56	112.00
		<u>\$3,794,701.85</u>		<u>\$2,552,803.16</u>
			Decrease - 33%	

TABLE V

FUR PRODUCTION FROM THE WILD, SHOWING HIGH, LOW AND AVERAGE PRODUCTION,
1924/25 TO 1948/49

Species	Highest Production Number	Season	Lowest Production Number	Season	Average Production	Production Season 1948/49
Weasel -----	155,567	1943/44	56,187	1935/36	101,442	99,705
Squirrel (7 years) -----	580,707	1948/49	224,677	1947/48	358,015	580,707
Muskrat -----	958,099	1945/46	213,866	1927/28	468,702	930,330
Mink -----	28,888	1933/34	9,833	1927/28	16,900	22,932
Skunk -----	42,235	1943/44	653	1948/49	13,669	653
Badger -----	1,476	1927/28	Closed	Seasons	476	34
Wolf, Coyote -----	13,056	1927/28	1,725	1948/49	4,403	1,725
Wolf, Timber (5 years) ---	565	1944/45	247	1947/48	396	255
Fox, Silver -----	985	1933/34	86	1928/29	426	165
Fox, Blue -----	23	1946/47	-	1931/32	6	8
Fox, Cross -----	6,072	1942/43	795	1928/29	2,678	828
Fox, White -----	8,397	1924/25	47	1948/49	1,284	47
Fox, Red -----	24,717	1943/44	2,413	1928/29	9,940	2,836
Wolverine -----	88	1931/32	9	1944/45	27	16
Beaver -----	14,099	1948/49	Closed	Seasons	6,323	14,099
Otter -----	2,277	1944/45	714	1931/32	1,537	2,103
Fisher -----	953	1925/26	Closed	Seasons	362	11
Marten -----	2,191	1925/26	Closed	Seasons	542	18
Bear -----	598	1928/29	37	1946/47	194	44
Lynx -----	2,394	1925/26	Closed	Seasons	842	74
Jack Rabbit (5 years) ---	14,886	1944/45	5,760	1948/49	10,639	5,760
Raccoon (2 years) -----	56	1948/49	28	1947/48	42	56

TABLE VI

HIGHEST, LOWEST AND PRESENT AVERAGE VALUE OF PELTS TAKEN FROM THE WILD,
1928/29 TO 1948/49

Species	Highest	Season	Lowest	Season	1948/49
Weasel -----	3.05	1945/46	.46	1932/33	1.55
Squirrel (7 years) -----	.80	1945/46	.23	1948/49	.23
Muskrat -----	3.50	1945/46	.44	1931/32	1.37
Mink -----	40.00	1945/46	4.96	1931/32	27.00
Skunk -----	3.95	1943/44	.50	1948/49	.50
Badger -----	30.00	1928/29	1.30	1948/49	1.30
Wolf, Coyote -----	20.00	1928/29	2.50	1948/49	2.50
Wolf, Timber (5 years) -----	10.00	1944/45	4.00	1947/48	4.50
Fox, Silver -----	113.50	1928/29	4.00	1948/49	4.00
Fox, Blue -----	51.00	1928/29	6.00	1948/49	6.00
Fox, Cross -----	71.25	1928/29	3.00	1948/49	3.00
Fox, White -----	51.00	1928/29	10.00	1948/49	10.00
Fox, Red -----	31.25	1928/29	2.00	1948/49	2.00
Wolverine -----	17.00	1945/46	3.80	1932/33	8.00
Beaver -----	47.00	1945/46	7.50	1934/35	22.00
Otter -----	31.75	1928/29	9.60	1931/32	20.00
Fisher -----	68.00	1943/44	25.00	1948/49	25.00
Marten -----	55.00	1945/46	11.30	1931/32	20.00
Bear -----	6.25	1928/29	.85	1931/32	2.00
Lynx -----	46.00	1943/44	11.42	1931/32	12.00
Jack Rabbit (5 years) -----	.85	1945/46	.30	1948/49	.30
Raccoon (2 years) -----	-	-	-	-	2.00

TABLE VII
 CANADIAN PRODUCTION OF MUSKRAT RAW FURS
 Seasons 1928/29 to 1947/48

SEASON	NUMBER	TOTAL VALUE	AVERAGE VALUE
1928/29	2,785,994	3,924,949	1.41
1929/30	2,109,232	1,781,651	0.84
1930/31	2,639,086	2,143,148	0.81
1931/32	2,632,984	1,403,993	0.53
1932/33	2,731,490	1,581,606	0.58
1933/34	2,538,565	1,863,322	0.73
1934/35	1,983,747	1,784,252	0.90
1935/36	1,630,231	2,148,605	1.32
1936/37	1,607,897	2,250,971	1.40
1937/38	1,748,239	1,320,509	0.76
1938/39	2,295,550	2,011,469	0.88
1939/40	3,241,089	3,829,318	1.18
1940/41	2,795,218	4,990,762	1.79
1941/42	2,408,436	4,954,504	2.06
1942/43	2,068,468	5,671,910	2.74
1943/44	2,038,868	4,654,641	2.28
1944/45	2,377,629	6,299,411	2.65
1945/46	3,420,496	11,159,502	3.26
1946/47	2,795,687	5,431,833	1.94
1947/48	3,569,157	9,518,064	2.67

(Figures obtained from
 Dominion Bureau of Statistics)

numerical increase is however offset by a drop in the pelt value. Table VII illustrates the fluctuations in abundance and value of the total Canadian Muskrat raw fur production. The last recorded season of 1947/48 ending June 30th, had the greatest muskrat catch for a period of 19 years. Over 3.5 million muskrat pelts have been marketed during that season yielding over 9.5 million dollars. This statistical survey shows the importance of muskrat fur production in Canada as well as in Manitoba alone.

Rehabilitation Projects

In order to maintain the Canadian fur industry at a high constant level, various government departments have proceeded with the development of marsh lands for the purpose of fur production and rehabilitation of the fur - bearing species. Various measures were put into practice as an attempt to counteract the tendency of these animals to decline. The first method which resulted in success for some of the fur - bearing species was a reconstructive one. Fur farms were brought into large scale productivity with respect to such animals as the fox and the mink. A more recent development resulted in fur rehabilitation programs, where especially the beaver and the muskrat are actively assisted to increase their numbers in their natural environment.

The first step in this direction was undertaken at The Pas, Manitoba, in connection with the rehabilitation of

the muskrat.

"In 1932 --- 54,000 acres of land were leased from the government of that province by private interests with the object of increasing the muskrat population by the control of water levels on the marshes they once inhabited."

In 1931 only 125 rats had been trapped from this area while in 1937 approximately 60,000 pelts were taken. This project proved that the muskrat population could be restored by water control measures.

In 1934 the Manitoba Government, assisted by the Dominion Government started a similar fur rehabilitation scheme on a area of 135,000 acres formerly known as the Summerberry Game Preserve. Since that time.....

"Administration and maintenance costs have been fully met from production and the capital cost has been offset by the fact that 1,800 families previously on relief have been restored to a self - sustaining basis."

A few years later, two areas totalling 680,000 acres have been added to the original Summerberry project. Saskatchewan also has over 1,520,000 acres under similar control. Fur rehabilitation programs have met with some degree of success but

various factors which cause severe declines in the animal populations during certain periods of time have not as yet been eradicated. These factors particularly affect the muskrat numbers.

Former Management Programs

In the past, management programs had concentrated on the following controls:

- (a) Manipulation of water levels as a means of creating and maintaining a suitable habitat.
- (b) Regulation of trapping in order to retain a suitable breeding stock each year.

These original programs were found to be inadequate in their attempt at maintaining muskrat production on the highest possible quantitative and qualitative sustained basis.

Biological Survey Project

In the spring of 1947, the provincial government of Manitoba broadened its management program by initiating a Biological Survey Party which was placed under the direction of Dr. J. A. McLEOD. This project has been in function every summer since its introduction.

The Problem

In order to ascertain the problems of major importance which affect the muskrat population, a detailed biological study of this animal and its habitat was undertaken.

The observations have been integrated in two large sets of complex, dynamically opposed factors. These two groups of factors, depending on their relative magnitudes, are responsible for the density of the muskrat population.

Those factors which tend to increase the population form its biotic potential. Opposing the latter is a group of factors which tends to decrease this same population. These factors form the animal's environmental resistance. When both of the groups are equal, the population, remains stationary. If the biotic potential exceeds the environmental resistance, the population increases. But when the environmental resistance is greater than the biotic potential, the muskrat population will decrease until that resistance is reduced or otherwise the animals will be under a threat of complete extermination.

The work of the past few summers has enabled a detailed observation of certain trends which seriously influence the muskrat population. Methods of controlling unfavorable chains of events are discussed. These methods may be of immediate and future use for management techniques when the muskrat and its habitat are subjected to still more intense rehabilitation projects.

Derivation of Common Name

The muskrat has strongly developed perineal glands

which discharge during the period of sexual excitement producing a strong musk odor. This characteristic has furnished the musk prefix of its name.

Originally this animal was called the Musquash by the Cree Indians. This name still persists in the London fur markets.

"The first published description of the muskrat is to be found in "A map of Virginia, with a Description of the Country, the Commodities, People, Government and Religion Written by Captaine Smith, sometimes Governour of the Country." The author was none other than Captain John Smith whose name is so dramatically associated in early American history with that of the Indian maiden Pocohontas." (Arthur, 1928)

The captain wrote in 1612 and compared the animal to the water rat in its form and nature but with an exceedingly strong smell of musk.

The name "Musk Rat" has been traced back as far as 1635. Apparently this Christening was performed by a Jesuit father in Quebec. Father LeJeune's diary contained the French term Rat musque which in English free translation implies the name by which the animal is commonly called today. This same man wrote the following in 1656:

"There are found in these regions of America animals to which the French have given the name of Musk Rats, because in truth they resemble the rats of France -- except that they are much larger -- and smell of musk in the Spring. The French are very fond of this odor; the Savages dislike it as if it were a stench."

(Jesuit Relations, 1897 - 1901)

Taxonomy of the Muskrat

The muskrat is a mammal belonging to the rodent family. Its scientific name has undergone many changes since its first introduction by Linnaeus.

Castor zibethicus Linnaeus, 1766.

Ondatra zibethicus Link, 1795.

Fiber zibethicus True, 1885.

Ondatra zibethica Miller, 1912.

There are fifteen subspecies. Seven occur in Canada and the remaining eight are only found in the United States.

Distribution

No animal can survive all the different environmental conditions which exist in the world. Some animals are more versatile than others and consequently they occupy greater areas which usually are geographically far apart. The muskrat is one of these animals. However, the muskrat is

specialized for a semi-aquatic habitat. It depends on certain semi-aquatic plants and their root systems for food and housing. In order to secure these lower plant systems efficiently the substratum must be soft and wet allowing easy burrowing. Therefore the muskrat is limited in its distribution to marshy areas bearing the needed plants in a soft, wet substratum.

The muskrat has a very wide distribution in North America, occurring all the way from the northern tree limit in the Arctic regions south to the Mexican border. It is absent from the dry areas occurring in the western plains and the alpine tundras of high mountain ranges. Manitoba has three subspecies of muskrats but only Ondatra zibethica alba, (Sabine) Miller, 1912 is of great importance because of its abundance and wide distribution. The subspecies is commonly referred to as the Hudson Bay Muskrat. It occurs in the Hudson Bay drainage system of Manitoba and extends as far north as the initial boundary of the Barren Grounds.

THE HABITAT

General

The muskrat is primarily dependent upon certain plants for its subsistence. The type of soil and the climatic conditions determine the amount and the variety of vegetation produced. In order to arrive at a thorough understanding of the habitat which is so fundamental from the standpoint of muskrat production, something must be known about the soils and their developmental history. The soils are the result of the actions of climate and organic organisms upon geological deposits.

The Geological Histories Of The Major Areas Studied

1. Saskatchewan River Delta

Silurian limestone (Ellis, 1938) comprises the parental geological base of this area. This formation is in the shape of a "spear-head". The point originates in the region between the southern shores of Lakes Winnipeg and Manitoba. The main body extends in a northwesterly direction in the Inter-lake area. At the northern extremities of Lakes Winnipegosis and Winnipeg, the rock formation broadens very sharply towards the east and west.

Due to the ice movements of the glacial and post-glacial periods, this fairly flat Silurian base was covered with a thin, flat layer of boulder till. The deposit was composed chiefly of limestone. Following the recession of the glaciers and the formation of Lake Agassiz, clay and coarse

gravel was added over the boulder till.

The Saskatchewan River, draining a large portion of the territory east of the Rocky Mountain watershed, emptied into Lake Agassiz. The sediments, accumulated by this river from the southern portions of Alberta and Saskatchewan, were deposited at its mouth. This resulted in a large, flat floodplain which subsequently formed a delta. This delta is interlaced with numerous channels which are continuously being silted in and new ones are formed again.

Due to the fairly flat nature of the delta and because of the absence of a valley in the immediate neighborhood, the river periodically overflows its banks. This results in a further deposition of silt and the filling of the existing depressions with water (Fig. 2). Since the silt deposits consist of much impervious clay and because of the close proximity of the limestone base, this water and also the water of precipitation are retained.

The water-filled depressions are generally fairly broad, shallow areas in which the water depth does not usually exceed ten feet (McLeod, 1948). These areas together with the unflooded portions of the territory, have various plants of the different stages of hydrosere succession. These have produced layers of organic matter which are periodically covered over by silt deposits following the heavy floods.

Figure 2.--- Aerial view of portion of
flood plain showing channels and sloughs.

(After McLeod, 1947)



This process has been repeated many times as can be seen in a cross section of the substratum (Fig. 3).

2. Netley Marsh

This area is situated at the southern end of Lake Winnipeg. This whole region was once the bottom of the great Lake Agassiz. The parental geological base is composed of Ordovician limestone. The great former ice movements have covered this stone formation with a deposit of boulder till and gravel. Following the break-through of drainage rivers into the Hudson Bay, the lake gradually receded. In so doing, it threw up a series of temporary shorelines by means of joint action of ice and water.

Such temporary shores effectively separated a number of regions which once were parts of the bottom of the glacial lake. The higher elevations remained as dry land while the depressions retained some of the water and became small lakes or marshes. Netley Marsh was the result of such similar action.

Lake Winnipeg has been a fairly stable body of water for quite a long number of years. Water action has produced a sandy ridge at its southern end. This has separated a large portion of former lake bottom from the open lake. The area has remained as a series of small lakes and marsh sloughs which are suitable for muskrat production (Map I).

Figure 3.--- Side of pit dug near river
channel showing stratification of silt and clay.

(After McLeod, 1947)

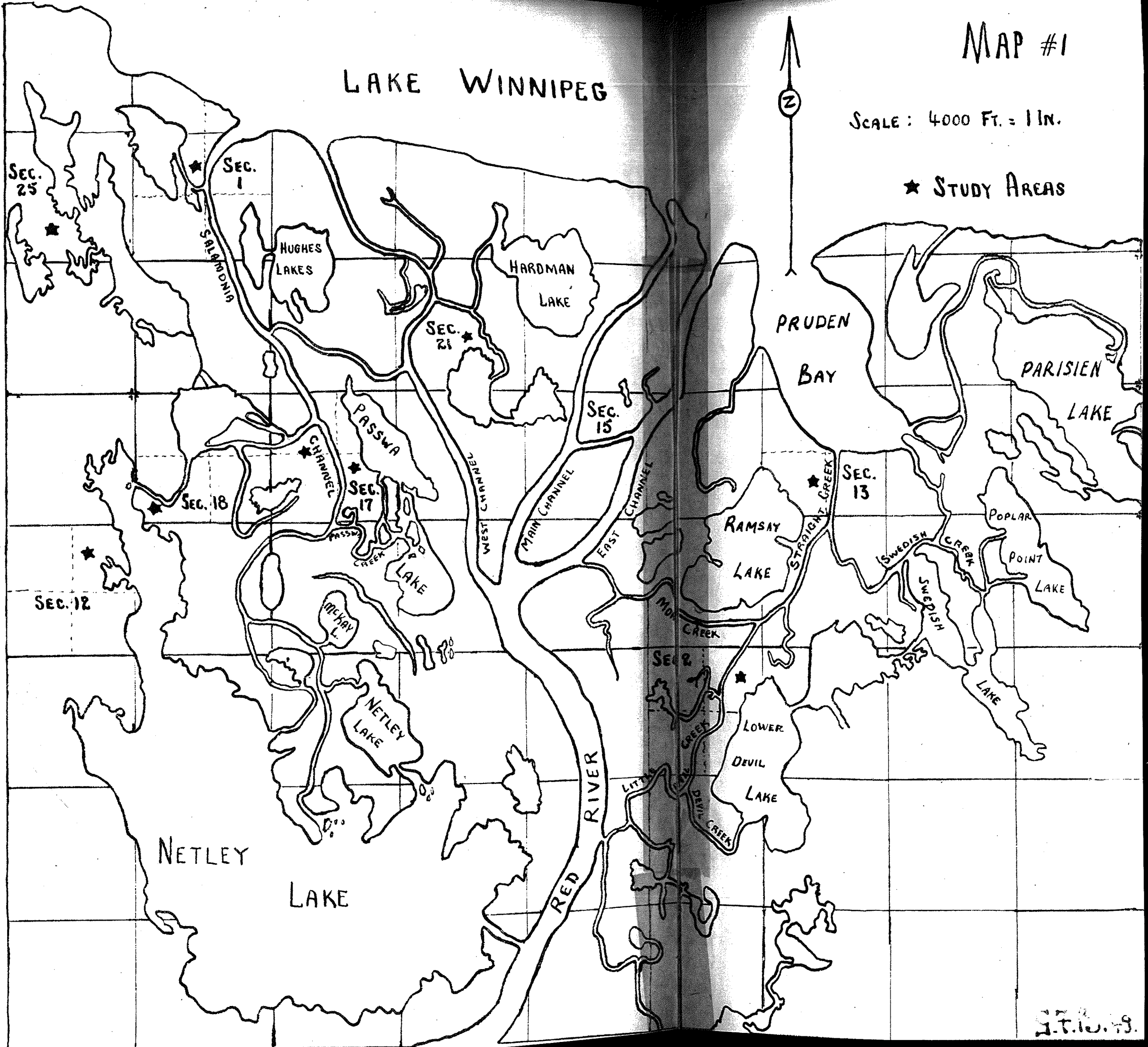


LAKE WINNIPEG

MAP #1

SCALE: 4000 FT. = 1 IN.

★ STUDY AREAS



S.T.O. 49.

The territory has undergone heavy sedimentation because of the reduction in the water movements and because of the abundant sediment brought in by the Red River. Netley Marsh communicates with Lake Winnipeg through a series of deep channels (Map I).

Any serious water depth fluctuation at the southern end of the lake causes a readjustment of the marsh waters so as to create an equilibrium between the two levels. Strong north winds often produce a change of 24 inches in the water level of the marsh in a period of 24 hours. Because of these fluctuations in the marsh water level, the habitat which is suitable for the muskrat is relatively unstable as compared to some of the other muskrat producing territories. These fluctuations seriously affect the plant growth on which the muskrat is dependent.

3. Delta Marsh

Delta Marsh is situated at the southern end of Lake Manitoba. Its formation history is quite similar to that of Netley Marsh. However there is one striking difference. There are no large channels connecting the marsh with the lake. Two small communications have been effectively dammed off by artificial means. Also no large rivers carry in sediments as is the case in Netley Marsh. As a result, the muskrat suitable habitat is quite stable because there are no serious fluctuations in the marsh water levels.

4. Oak Lake

Oak Lake with a maximum area of approximately 10 square miles (McLeod, 1948) is situated in the south-western corner of Manitoba. The parental geological deposit consists of Cretaceous shales. This lake occupies a shallow basin which formerly was part of the bottom of Lake Souris. In the past, prolonged water action produced a light sandy substratum of alluvial and lacustrine origin. The maximum water depth varies between 12 to 15 feet (McLeod, 1948).

Two streams, Bell and Pipestone Creeks, serve as a source of inflow of spring waters from the higher regions to the west during periods of heavy run-off. During the rest of the year, precipitation furnishes the only water-replenishing source. Following such heavy spring floods, the excess waters are removed from the lake southward by means of Plum Lake, Plum Creek and by this route reach the Souris River.

The contours of this lake do not have a suitable gradation from the shore towards the deeper waters. Therefore a satisfactory flooded substratum for growth of such plants as *Typha* does not exist under average conditions. The only valuable vegetation for muskrats consists of *Scirpus validus*. During periods of lowered water depths, this plant furnishes satisfactory food and shelter for the animal throughout the year. During high water levels, the only possible lodge location areas consist of narrow shorelines on which sedge plants

predominate. Such areas are unsatisfactory from the view point of overwintering the muskrat population.

5. Whitewater Lake

Whitewater Lake occupies an area of approximately seven square miles (McLeod, 1948). Its geological history and location are quite similar to that of Oak Lake. This body of water has no permanent inflowing or outflowing streams. It is really a large catch basin which collects spring flood waters from the higher neighboring lands. Also water seeps up through the substratum bringing with it many soluble compounds which are toxic to most plants. This seepage is made possible because of the very high water table of this region during the average years.

The contours of this lake are ideal from the standpoint of muskrat suitable habitat. The substratum has a very gentle slope and consequently supports a luxuriant growth of Typha vegetation. The average water depth varies from 6 to 18 inches (McLeod, 1948). Therefore cover, food, and water levels are ideal during all seasons of the year for the support of muskrats.

The Stages of Hydrosere Succession

During the survey of muskrat producing areas, the following hydrosere stages were encountered:

1. Submerged Stage (water depth 8 to 20 feet)
2. Floating Stage (water depth 6 to 8 feet)
3. Reed-swamp Stage (water depth 1 to 6 feet)
4. Sedge-meadow Stage (water less than 1 foot)
5. Woodland Stage

The Reed-swamp Stage was found to be the only sere which is suitable for sustained muskrat production.

The Reed-swamp Stage

Since this sere was determined to be necessary for muskrat production, a detailed study of its character, occurrence and maintenance was undertaken. Where the water levels have remained quite stationary over a period of several years, this successional stage is present wherever a suitable flooded bottom occurs. Generally soil with a water depth from 1 to 4 feet supports the plants of this sere. The depth may be increased to as much as 6 feet depending upon the nature of the substratum and the strength of the water currents.

There is a definite zonation of marsh plants from the deep to the shallow waters as follows:

1. Scirpus validus zone.

2. Scirpus fluviatilis zone
3. Typha zone
4. Phragmites zone.

The above mentioned plants are the dominants of the reed-swamp stage of the hydrosere. They possess a well developed rhizome system which provides a firm anchorage to the flooded substratum as well as a means of vegetative reproduction. This type of asexual reproduction is usually the only means of migration and plant regeneration in flooded areas because seedling reproduction is impossible due to the abundance of surface water.

All of these plants are not only satisfactory but also essential for optimum food and shelter materials. Throughout the summer months, all portions of the vegetation are utilized. The rhizome systems provide the main means of subsistence during the critical winter months.

The Influence of Water Levels on the Reed-Swamp Stage

Unusually high or low water levels generally produce a deleterious effect on the vegetation of the reed-swamp stage. Floods of sufficient duration or of great magnitude destroy the emergent vegetation. Scirpus validus vegetation was removed without leaving a trace in many of the severely flooded Summerberry regions. Remnants of luxuriant growths of Phragmites and Typha were seen in the form of dead stalks and floating divots. (Figs. 4, 5, 8, and 9.)

Figure 4. --- Regression of succession produced by prolonged raising of the water level. The reed-swamp sere has undergone almost complete destruction and is being replaced by the floating stage (Summerberry Marsh, 1949).

Figure 5. --- The drowned remains of Phragmites and Typha vegetation following recent flooding. The muskrat suitable habitat has been destroyed. No muskrat lodges could be found in the immediate vicinity (Summerberry Marsh, 1949).

Figure 6. --- Absence of emergent vegetation in lake due to the excessively high water levels. Muskrats were absent in such areas (Summerberry Marsh, 1949).



Because of high banks and the absence of drainage outlets, many of the Summerberry lakes retained a considerable amount of the recent flood waters. In many cases this resulted in open lakes with no emergent or floating vegetation except the willows on the unflooded banks (Fig. 6). In other areas which retained less water, the reed-swamp sere was replaced by water lilies which represent the floating stage (Fig. 4). Such retrogressive succession was common in many of the Summerberry lakes.

Following the destruction of the reed-swamp sere, the existing muskrat populations sought temporary shelter on the banks in the willows which are the components of the woodland sere. The population of the heavily flooded lakes dropped to almost zero. The decrease was due to migration in some cases but mainly to mortality following the severities of winter because of the lack of an adequate supply of nourishing, palatable food and suitable shelter.

In some of the Summerberry lakes and especially in Netley Marsh, the high water receded partially or completely. Partial water lowering enabled the re-establishment of the still living Phragmites vegetation and the introduction of Equisetum limosum (Figs. 6 and 7). Typha and Scirpus validus which were the most seriously affected by high water levels and in the majority of cases totally destroyed, could not re-establish themselves in many of the still partially flooded areas.

Figure 7. --- Establishment of a marginal fringe of Equisetum vegetation following the recession of flood waters. In the background, uprooted willows offer proof as to the severity of the recent flood (Summerberry Marsh, 1949).

Figure 8. --- The results of a recent flood and its partial recession. A zone of Phragmites stands in the foreground. Drowned out Typha stalks can be seen in the middle. In the left background, the dark zone illustrates the recent growth of Equisetum (Summerberry, 1949).

Figure 9. --- Photograph of the same area as in Fig. 8 showing the former broad zone of Typha vegetation. Only a few muskrat lodges could be located.



Regeneration of the Reed-Swamp Sere

Some of the marsh areas, however, drained to such an extent that many of the flooded portions were exposed as water-soaked soils bearing the remains of drowned basal stocks and roots of former vegetation (Fig. 14). Such moisture saturated soils, now devoid of surface water, furnished an excellent medium for the germination of various reed-swamp seedlings. Young Typha plants were the first to make their appearance (Figs. 10 and 11). Following the further recession of water, more seedlings became established (Figs. 12 to 17). Scirpus validus seedlings were next in making their appearance in dominant proportions (Fig. 15). Various secondary species of the reed-swamp sere such as Acorus, Sagittaria, and Sparganium also made their introduction (Fig. 13).

By October 8th, 1949 the Scirpus validus and Typha seedlings had reached an average height of approximately 4 feet (Fig. 17). The rhizome systems of both types of vegetation had undergone extensive growth and vegetative reproduction was being carried out. Generally, Typha seedlings occupied a broad zone which was situated on the drier soil bordered by old Carex and Phragmites vegetation. A zone of Scirpus validus and Typha dominants followed (Fig. 16). The most recently exposed soil contained a broad band of vegetation with Scirpus validus as the dominant plant (Figs. 15 and 17).

Figure 10. ---- Recession of water from an area in Netley Marsh. A new zone of soil was drained free of surface waters between the Phragmites - Carex vegetation and the soil which still was covered with water.

(Transect, July 22/49).

Figure 11. ---- Establishment of Typha seedlings on the drained soil zone of the preceding figure.

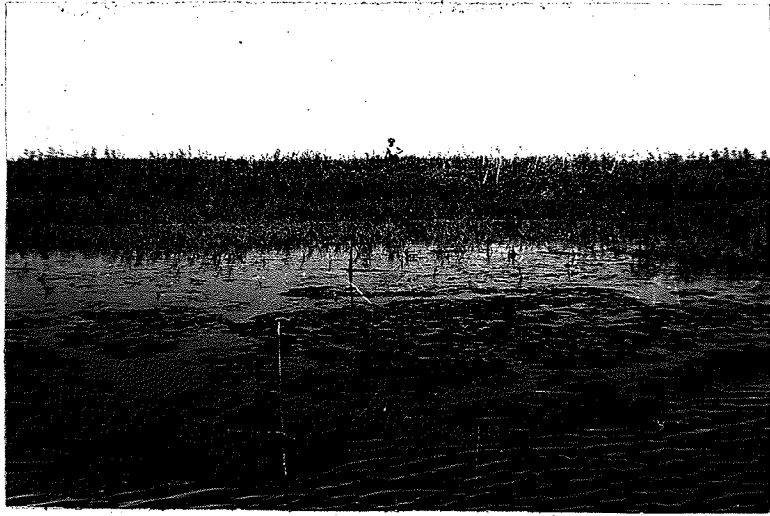


Figure 12. --- The same area as in Figs. 10 and 11 but photographed on August 5/49. The Typha seedlings have grown rapidly and have extended the width of the zone.

Figure 13. --- Composition of Transect Area:

- (Left to Right):
1. Typha seedling
 2. Sagittaria
 3. Acorus
 4. Carex
 5. Scirpus validus

(Netley Marsh, August 5/49)

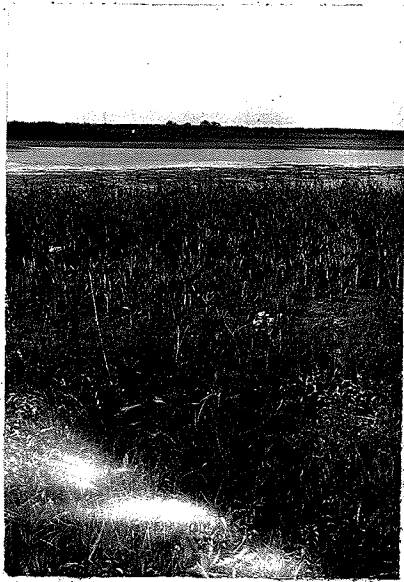


Figure 14. --- Transect Area at August 27, 1949.

Note the further recession of water leaving more exposed mud bottom which formerly possessed Scirpus fluviatilis vegetation.

Figure 15. --- Transect Area at August 27, 1949.

Scirpus validus vegetation occupies that portion of the drained zone which borders the free water.

Figure 16. --- Transect Area at August 27, 1949.

Mixed vegetation of Scirpus fluviatilis and Typha.

Both of these plants are dominants of the reed-swamp sere.

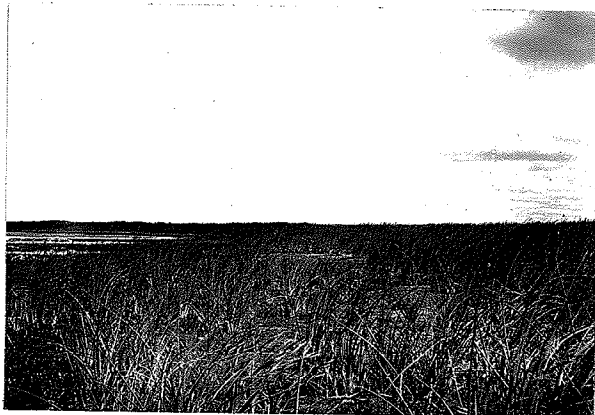
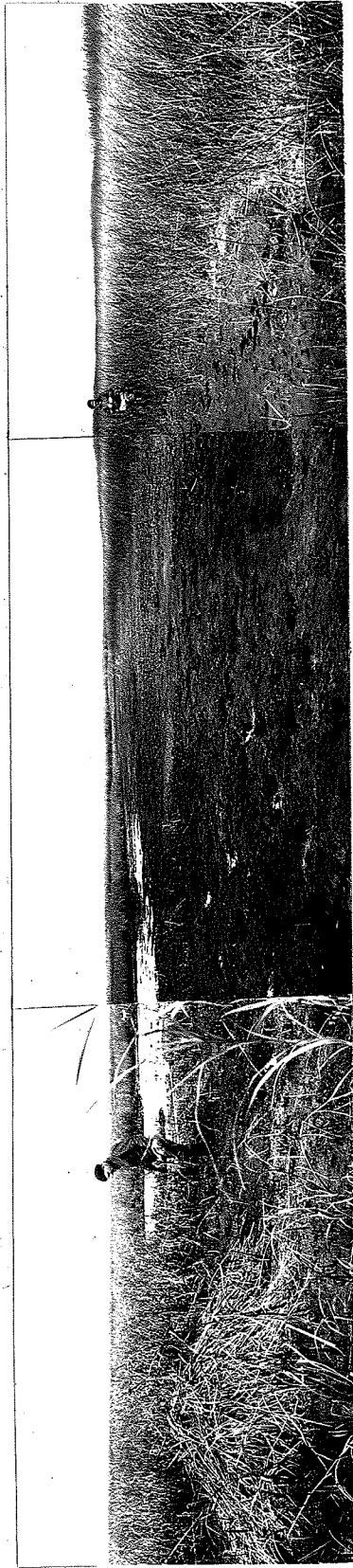


Figure 17 --- Panoramic view of Transect Area on September 8, 1949. On the right can be seen the marginal strip of Phragmites which is growing on the bank. Next comes the zone of sexual reproduction bearing Scirpus validus and Typha seedlings. In the middle is the exposed soil. On the left stands a muskrat lodge in Scirpus fluviatilis vegetation which borders soil which is covered with water. This area should be ideal as a muskrat habitat if the water level is raised before the end of the fall in 1950.



A considerable portion of the marsh areas showed such favorable habitat regeneration by means of sexual reproduction. In Netley Marsh, the following observational areas had seedlings introduced in abundant quantities:

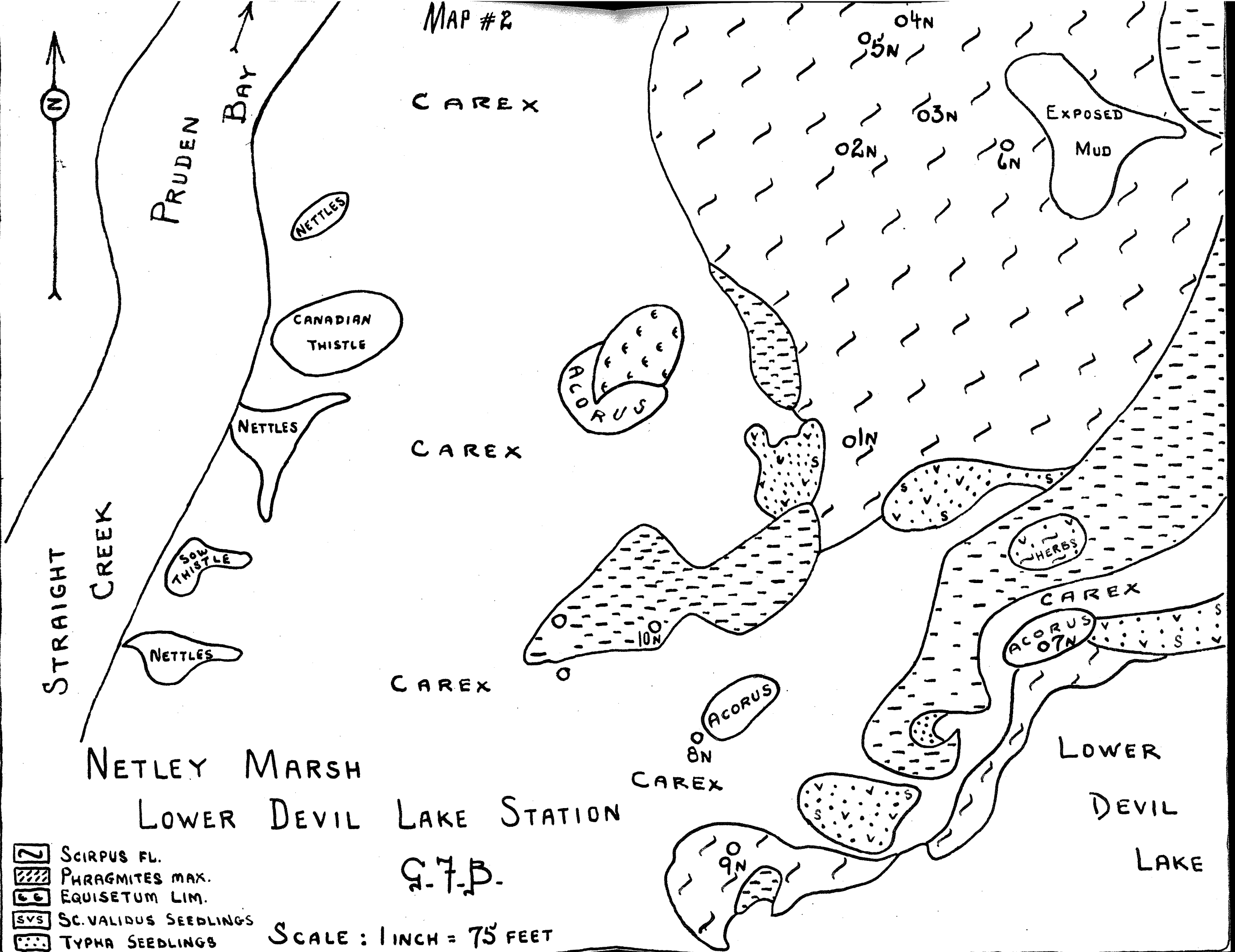
1. Lower Devil Lake Station (Map II, Figs. 18 and 19).
2. Passwa Lake Station (Map III).
3. Pruden Bay Station (Map IV).

Many portions of this reed-swamp seedling vegetation were originated after the drawing of the maps and consequently are not recorded. Only a few areas in the Summerberry Marsh showed suitable, sexual reed-swamp regeneration (Fig. 20).

Mud Flat Succession

Sedimentation is important in bringing about new areas which are suitable for the growth of reed-swamp plants. This process is quite common, especially in Netley Marsh, due to the gradual deposition of sediments which are being brought in by the constant movement of water. When such sedimentation flats lose their surface water, seed germination is initiated (Figs. 21 to 25). If this process begins in the spring, a dense stand of mixed vegetation will result in the fall (Fig. 26). Reed-swamp vegetation predominates in such areas. In time, provided the water level is slightly raised, such plants as Scirpus and Typha will assume full dominance of the mud flat. In such a manner, new areas which are very suitable as a muskrat habitat, are being constantly formed.

MAP #2



CAREX

CAREX

CAREX

CAREX






CAREX

NETLEY MARSH

LOWER DEVIL LAKE STATION

LOWER DEVIL LAKE

LAKE

-  SCIRPUS FL.
-  PHRAGMITES MAX.
-  EQUISETUM LIM.
-  SC. VALIDUS SEEDLINGS
-  TYPHA SEEDLINGS

SCALE : 1 INCH = 75 FEET

G. F. B.

NETLEY MARSH

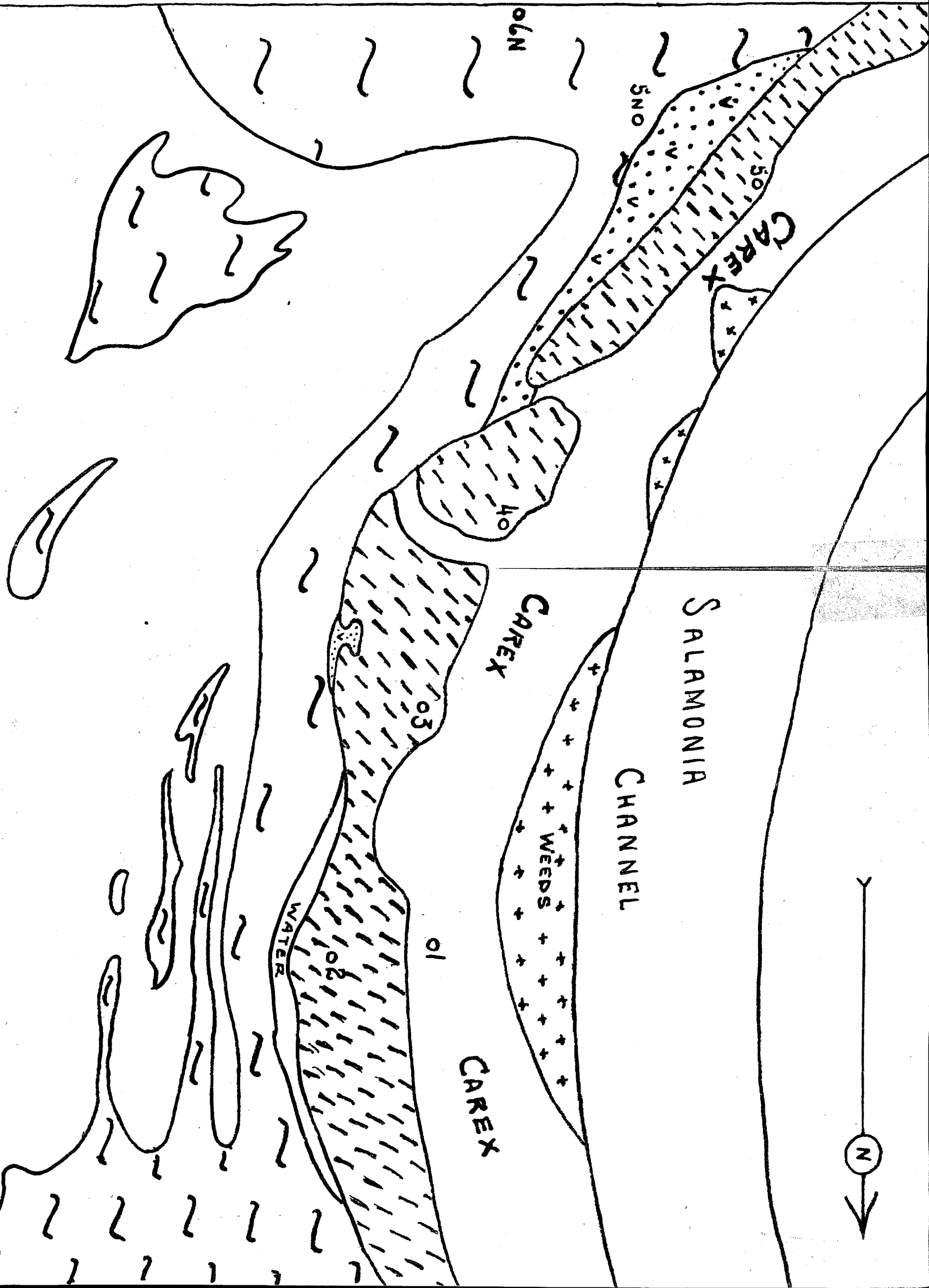
PASSWA LAKE STATION

MAP #3.

JULY-27-1949

G-7-B.

PASSWA LAKE



7N

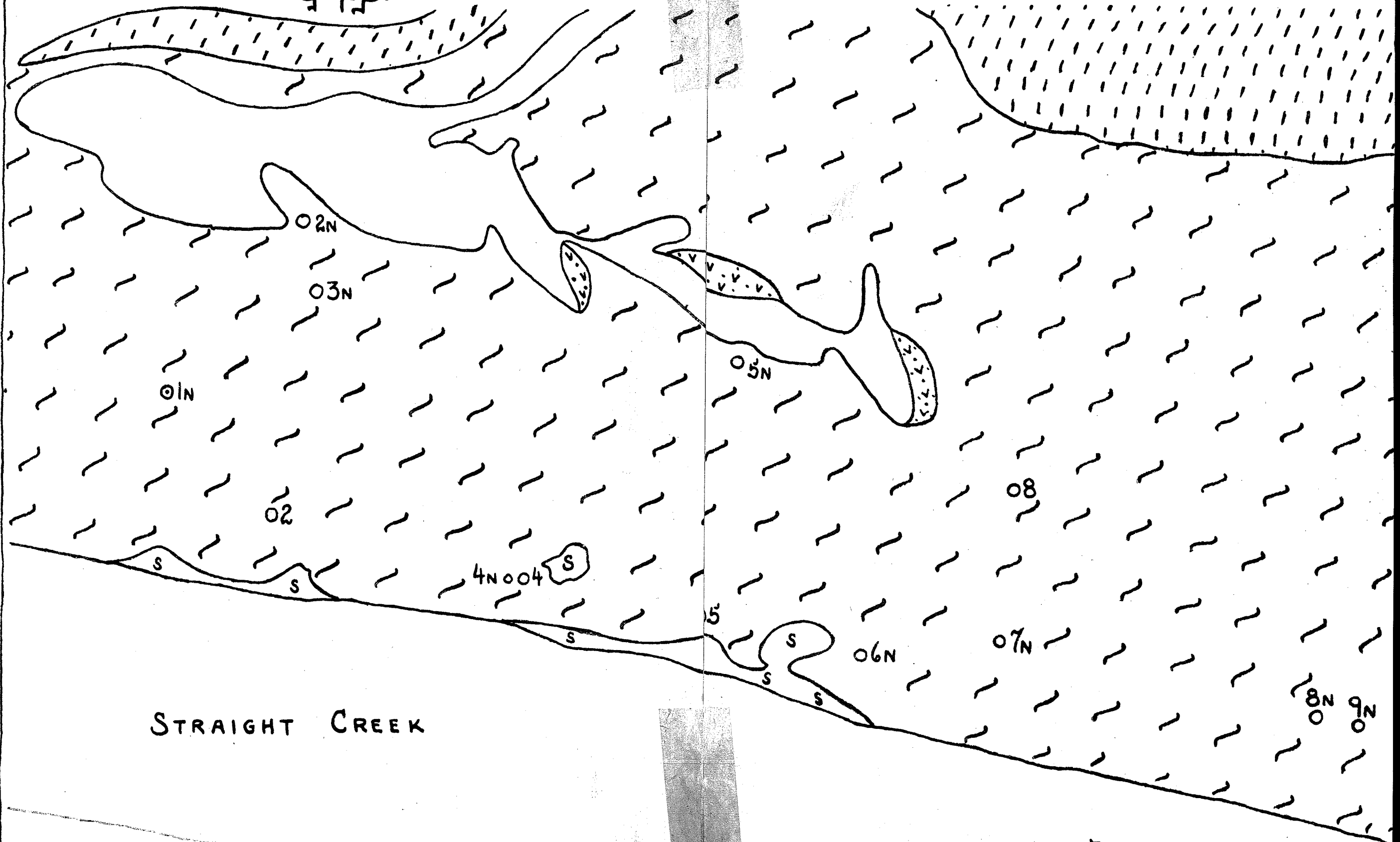
NETLEY MARSH

PRUDEN BAY STATION

AUG.-3-49 G-7-B.

MAP #4

SCALE: 1 INCH = 75 FEET



STRAIGHT CREEK

PRUDEN BAY (300 YDS.)

Figure 18. --- Typha seedlings developed on recently drained soil at Lower Devil Lake Station (Netley - August, 1949).

Figure 19. --- A recently constructed lodge in Acorus calamus seedling vegetation at Lower Devil Lake Station (Netley - August, 1949).

Figure 20. --- A broad zone of recently drained soil, situated between the willows and open water, bearing the following seedlings:

Acorus,

Scirpus validus,

Sparganium,

Typha,

and various annuals.

This area was devoid of any emergent vegetation in the early part of the summer (Summerberry - August, 1949).

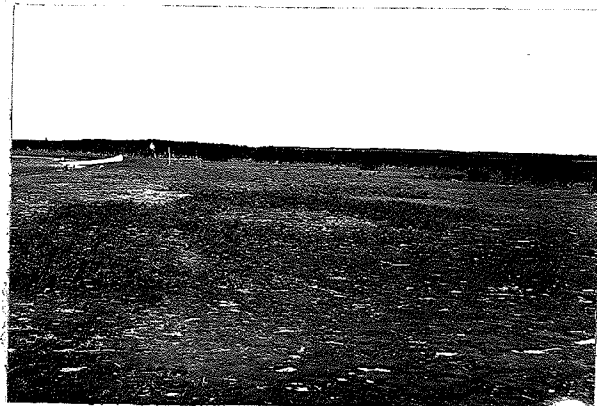
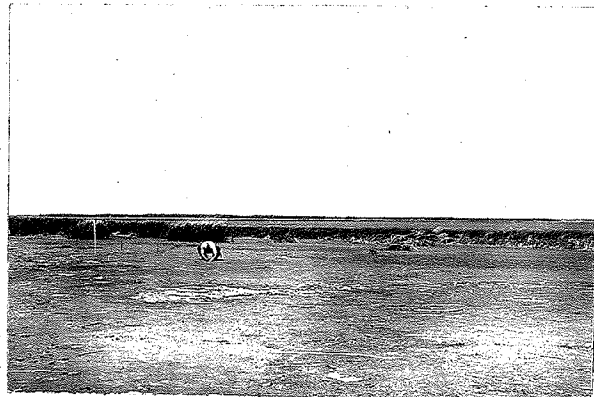


Colonization of a mud flat which was produced by the deposition of sediments and exposed by the recession of high water levels (Netley Marsh, 1949).

Figure 21. --- Nude appearance (May 24th).

Figure 22. --- Beginning of seed germination (June 30th).

Figure 23. --- Miscellaneous assortment of seedlings (June 30th). Seed germination progressing.



Progressing Colonization of the Same Mud Flat (Netley Marsh, 1949).

Figure 24. --- Seedlings increasing in density and size (July 11th).

Figure 25. --- Scirpus validus and Typha seedlings making their first appearance (July 22nd).

Figure 26. --- Complete colonization of the mud flat (August 26th). The predominating plants are of the following families:

Cyperaceae,
Graminaceae,
Leguminosae,
Typhaceae.

The vegetation is over 4 feet in height.



THE MUSKRAT

Morphology and Physiology

The muskrat is a small, sturdily constructed animal with a distinctly constricted neck (Fig. 27). The average adult has a head and body length of approximately 12 inches and a tail length of 10 inches. Such an animal weighs about two pounds. The body form has certain peculiarities which are also characteristic of other rodents possessing the burrowing habit. The head is quite large and rounded. The eyes are relatively small but the sense of hearing, smell and touch (vibrissae) are well developed. Such a relative development of sense organs is indicative of animals which possess a nocturnal habit. The incisors are quite large and strong which makes it possible for the animal to utilize plants of large size and firm texture.

The limbs are quite short and exhibit a marked difference in size between the fore and hind members. The fore legs are relatively small bearing four clawed digits. They are very prehensile enabling dexterous manipulation of short stalks when feeding. Being buttressed against, a rugged pectoral girdle by a well developed musculature, the fore limbs are very efficient for burrowing in a soft, wet substratum. The hind legs are larger and possess five, clawed digits. The presence of stiff hairs and partial webbing on these appendages make them a valuable aid in swimming.

Figure 27.--- A muskrat kit of approximately
six months growth.



The tail is characteristically flattened laterally, scaled, and almost devoid of hairs. It is used as an organ of support when the animal feeds in an erect position. The tail also acts as a rudder when the animal is swimming.

The fur of the muskrat, besides its great commercial value, offers the necessary protection from the severities of the environment. It is very warm because of its density, softness, and water resistance (wax). The pelage is composed of two types of hairs:

- (1) dense, soft under fur of uniform distribution
- (2) less dense, unevenly distributed, firm, glossy,
long guard hairs.

The guard hairs bear most of the darker pigment and consequently produce the darker coloration on the dorsal and lateral surfaces of the pelt.

The animal can dive with great dexterity and remain submerged for a long period which may extend for 15 minutes. Because of its small lungs and rapid respiration rate, the animal undergoes an anaerobic existence while under water. ? The oxygen required for metabolism is probably derived from the degradation of carbohydrates. The cessation of breathing while under water is referred to as submergence apnea (Koppanyi and Dooley, 1929) (Irving, 1939).

Consequently the muskrat is a highly specialized animal which is well adapted for a semi-aquatic form of life. However, these specializations limit the animal in its versatility to efficiently cope with any other type of habitat. In order to realize its maximum potentialities, the habitat must be of the type previously described.

Biotic Potential

The sum total of the factors tending to increase muskrat abundance constitute what is referred to ecologically as the animal's biotic potential. These factors are more or less dependent on the inherent qualities of the animal itself. The biotic potential is discussed under the following four headings:

I Reproductive Potential

II Nutritive Potential

III Protective Potential

IV Survival Potential

I Reproductive Potential

Reproduction In General

Reproduction in animals accomplishes two important functions:

- (a) "to increase the number of individuals and
- (b) to produce individuals that have combinations of characteristics that differ from those of their parents and that may enable them better to survive in the particular

environment in which they are produced".

(Pearse, 1926).

Reproduction stimuli are produced by the increased intensity of light together with rising temperatures especially in the Temperate Zone. In Manitoba the sexual activities of the muskrat commence in the early spring and continue during the summer until their cessation in the late fall. This period of time determines the maximum number of litters that this animal can produce annually.

The Manner of Mating.

The muskrat is a polygamous animal. While the monogamous type of mating is efficient for all types of population conditions, the polygamous animals are inefficient when the breeding stock is sparse. The possibility of fertilization being affected in all the females of a thin population is extremely small due to the short oestrus period at which time the male may be absent.

Oestrus Period

The oestrus period in small mammals of the rodent family is very short. This phenomenon occurs in the female when the ova are mature and ready to accept the male sperms. At this time, the female is in a great state of excitement. The temperature and metabolic activities are greatly accelerated by the stimulation produced through a complex interaction

of hormones secreted by the animal's endocrine glands. The oestrus period of the muskrat lasts only a few hours and recurs for a few days (McLeod, 1948). If the female is not fertilized during the oestrus period, the ova will perish and consequently no litter will be produced during that month. } This is due to the fact that the succeeding ova will reach maturity in approximately one month following the last oestrus period.

Gestation Period

There has been no definite experimental evidence for the exact period of time of gestation. However most workers agree from close observations of the muskrat's breeding habits that the interval extends from 23 to 30 days. Here in Manitoba, field data support the 25 day period of gestation.

Condition of the Young at Birth

Musk rats when born are helpless and require an average period of about three weeks of parental care before they are able to look after themselves. This attention assures a greater survival rate. At birth the young are blind and naked (Fig. 28). They require nutrition and shelter. Their locomotion is almost completely limited to the search for a teat on which to feed. The young are nourished from milk glands on the ventral surface of the parental female by means of mammae. The maximum number of mammae in a fully matured female are six pectoral and four inguinal pairs. The young develop a coat of hair shortly after a week's growth. ~~These~~

Figure 28.--- A litter of seven young muskrats
which are two days of age (Netley Marsh, 4/8/49).



Their eyes are completely opened by the fifteenth day under average conditions. They become quite active after the opening of their eyes. Their powers of endurance are greatly increased. Now they are able to leave the nest and dive down the plunge hole and swim for quite a long distance. The young at twenty days are able to stay submerged for nearly two minutes at their first dive. They are able to stay under water for a few more periods after this but the time of submergence decreases rapidly. At thirty days they are well able to look after themselves except in the matter of housing.

Number of Litters Per Breeding Season

The average time required for the production of a subsequent litter is approximately 30 days. This interval is derived as follows:

2 days lapse following parturition
3 days of recurrent oestrus periods
25 day period of gestation

TOTAL: 30 days for the delivery of the litter.

These conclusions are supported by the field data on the following pages as represented in Graph I. Taking the peaks of the corrected curves into consideration, it is evident that the maximum number of first litters was produced in the interval of May 20th -- 24th. The next crest occurs in the period of June 23rd -- 27th and represents the largest number of second litters. Evidence for the assumption that the same female

produced a second litter after 30 days was derived as follows:

- (a) The last litter was produced in the same house as the first young. This deduction was made possible by selecting permanent areas for study. The houses were all located, mapped, and numbered by means of marked stakes (Maps 2 to 4).
- (b) Members of the first litter were captured in the near vicinity and plunge holes of the same house.

By similar reasoning, the third litter was produced in the interval of July 23rd -- 27th. Thus it is practically possible to assume that the time between subsequent litters is a period of approximately 30 days. Such conclusions cannot be derived from the peak which occurs from August 22nd -- 26th because of the smallness of last year's sample and the absence of data for it this summer.

1949 MUSKRAT LITTER DATA

- (?) - incomplete
litter
- ∅ - eyes closed
- 0 - eyes opened

Date	Location	Date of birth	No. in litter	No. of litter	Total length (cms.)	Weight (ozs.)	Age in days	Sex Ratio M. to F.	Condition of eyes	Where collected	Remarks as to Nest and Young Muskrats
May 13	Whitewater Lake	May 11 or 12	5	1	9.6	.8	1-2	2:3	∅	In nest	Nest closed, dry lined, condition good, no mites.
May 13	Whitewater Lake	May 11 or 12	5	1	9.7	.8	1-2	4:1	∅	Open Nest	Nest exposed to weather, condition good, no mites.
May 24	N.E. Lower Devil Lake	May 21	5	1	11.1	1.0	3	2:3	∅	In Nest	Condition good, no mites.
May 24	N.E. Lower Devil Lake	May 19	6	1	12.7	1.3	5	5:1	∅	Near Nest	Condition very good, quite active no mites.
May 24	N.E. Lower Devil Lake	May 18	5	1	13.4	1.6	6	2:3	∅	Near Nest	Condition excellent quite active, no mites.
May 25	S.W. $\frac{1}{4}$ Sec. 18 Netley	May 23	8	1	11.0	.9	2	7:1	∅	In Nest	Condition good, no mites.
May 25	S.W. $\frac{1}{4}$ Sec. 18	May 23	5	1	10.9	.9	2	2:3	∅	In Nest	Litter cold and wet, no mites.
May 25	S.W. $\frac{1}{4}$ Sec. 18	May 21	3 (?)	1	12.1	1.2	4	1:2	∅	Near Nest	Animals active, no mites.
May 25	S. W. $\frac{1}{4}$ Sec. 18	May 22	8	1	11.3	1.0	3	5:3	∅	In Nest	Quite active, no mites.
May 25	S. W. $\frac{1}{4}$ Sec. 18	May 25	6	1	9.2	.7	0	4:2	∅	In Nest	Condition dry and warm, no mites.
May 25	S.W. $\frac{1}{4}$ Sec. 18	May 22	3 (?)	1	11.4	1.1	3	1:2	∅	Plunge hole	Very active, wet no mites.
May 25	S. W. $\frac{1}{4}$ Sec. 18	May 24	7	1	9.6	.7	1	4:3	∅	In Nest	Condition very good, few mites.
May 27	Pruden Bay	May 18	6	1	15.8	2.4	9	3:3	∅	In Nest	Condition excellent, no mites, good fur
May 27	Pruden Bay	May 20	1 (?)	1	14.0	1.6	7	1:0	∅	Plunge hole	Very active, wet, no mites.

<u>Date</u>	<u>Location</u>	<u>Date of birth</u>	<u>No. in litter</u>	<u>No. of litter</u>	<u>Total length (cms.)</u>	<u>Weight (ozs.)</u>	<u>Age in days</u>	<u>Sex Ratio M. to F.</u>	<u>Condition of eyes</u>	<u>Where collected</u>	<u>Remarks as to Nest and Young Muskrats</u>
May 27	Pruden Bay	May 21	3 (?)	1	13.8	1.7	6	3:0	∅	Plunge hole	Quite active, some escaped, no mites.
May 27	Pruden Bay	May 23	9	1	12.1	1.1	4	5:4	∅	In Nest	Condition very good, no mites.
May 27	Pruden Bay	May 23	8	1	12.4	1.2	4	6:2	∅	In Nest	Condition excellent, no mites.
May 27	E. Pruden Bay	May 20	6	1	14.2	1.5	7	2:4	∅	In Nest	Condition good dry and warm, no mites.
May 31	Lake Francis	May 19	7	1	11.0	1.0	2	4:3	∅	In Nest	Condition good few mites.
May 31	Lake Francis	May 28	10	1	11.6	1.0	3	5:5	∅	In Nest	Condition very good, no mites.
June 2	Cadham Bay	May 25	3 (?)	1	15.1	1.7	8	3:0	∅	Plunge hole	Very active, no mites.
June 2	Cadham Bay	May 20	9	1	18.2	3.0	13	7:2	0	In Nest	Very active, no mites.
June 2	Cadham Bay	May 19	4 (?)	1	19.7	3.5	14	4:0	0	Plunge hole	Very active, wet, no mites.
June 2	Cadham Bay	May 20	8	1	18.9	3.2	13	2:6	∅	In Nest	Condition good, no mites.
June 2	Cadham Bay	May 25	8	1	15.0	2.0	8	3:5	∅	In Nest	Quite active, few mites.
June 2	Cadham Bay	June 1	2 (?)	1	9.7	.8	1	0:2	∅	Plunge hole	Condition fair.
June 2	Cadham Bay	May 18	7	1	20.3	3.2	15	5:2	0	Near Nest	Condition good no mites.
June 3	N.E. Simpson Bay	May 27	7	1	14.1	1.7	7	4:3	∅	In Nest	Warm and dry, no mites.
June 3	Simpson (Delta)	June 1	2 (?)	1	10.7	1.0	2	1:1	∅	Near Nest	Very active, no mites.

Date	Location	Date of birth	No. in litter	No. of litter	Total length (cms.)	Weight (ozs.)	Age in days	Sex Ratio M. to F.	Condition of eyes	Where collected	Remarks as to Nest and Young Muskrats
June 3	Simpson	May 23	6	1	17.2	2.6	11	5:1	Ø	Near nest	Condition good, no mites.
June 3	Division Bay	May 24	6	1	16.5	2.3	10	4:2	Ø	In nest	Warm and dry, no mites.
June 3	Belle Point	May 23	3 (?)	1	17.3	2.5	11	1:2	Ø	Near nest	Condition good, no mites.
June 3	Blackfox Lake	May 15	10	1	23.0	3.7	19	10:0	0	In nest	Warm and dry, no mites.
June 3	Blackfox Lake	May 23	4 (?)	1	17.5	2.6	11	2:2	Ø	Plunge hole	Quite active, no mites.
June 3	Wilson Lake	-	1 (?)	1	-	-	-	0:1	Ø	Plunge hole	Able to swim well.
June 3	Wilson Lake	June 2	5	1	9.5	.7	1	2:3	Ø	In nest	Good condition, no mites.
June 3	Clair Lake	May 23	9	1	17.1	2.3	11	6:3	Ø	In nest	Warm and dry, no mites.
June 9	Pruden Bay	May 15	4 (?)	1	26.4	5.6	25	3:1	0	Plunge hole	Quite active crawlers and swimmers.
June 9	Pruden Bay	May 21	9	1	23.6	4.2	19	6:3	0	Near nest	Condition excellent.
June 9	Pruden Bay	May 24	7	1	20.5	3.1	16	7:0	0	Near nest	Condition excellent.
June 9	Pruden Bay	May 24	5	1	20.7	3.6	16	1:4	0	Near nest	Condition excellent.
June 9	Pruden Bay	June 6	6	2	11.8	1.0	3	2:4	Ø	In nest	Condition good, umbilicus healed, no mites.
June 9	N.E. Lower Devil Lake	June 2	7	1-2	14.6	1.7	7	5:2	Ø	Near nest	Condition fair, no mites.
June 9	N.E. Lower Devil Lake	May 23	6	1	21.2	1.3	17	6:0	0	Near nest	Condition sluggish, mites.

Date	Location	Date of birth	No. in litter	No. of litter	Total length (cms.)	Weight (ozs.)	Age in days	Sex Ratio M. to F.	Condition of eyes	Where collected	Remarks as to Nest and Young Muskrats
June 9	N.E. Lower Devil Lake	May 21	6	1	23.0	4.2	19	5:1	0	Near nest	Condition sluggish, mites.
June 10	S.W. $\frac{1}{4}$ Sec. 18 Netley	June 8	5	1-2	10.7	.9	2	0:5	∅	In nest	Condition fair.
June 10	S. W. $\frac{1}{4}$ Sec. 18	June 1	10	1-2	15.9	1.9	9	1:9	∅	In nest	Condition good, very few mites.
June 10	S. W. $\frac{1}{4}$ Sec. 18	May 26	5	1	19.0	3.2	14	5:0	0	Near nest	Condition good, few mites.
June 10	N. W. $\frac{1}{4}$ Sec. 30	May 30	5	1	17.2	2.3	11	4:1	∅	Near nest	Condition good, few mites.
June 16	N. W. $\frac{1}{4}$ Sec. 30	May 29	6	1	23.4	3.6	19	5:1	0	Plunge hole	Very active, condition good.
June 22	Pakow Lake 9	June 21	6	2	10.5	.8	1	2:4	∅	In nest	Condition fair, some mites.
June 22	Pakow Lake 8	June 19	5	2	11.7	1.1	3	4:1	∅	In nest	Condition poor, white with mites.
June 22	Pakow Lake 8	May 31	4 (?)	1	25.0	4.3	22	3:1	0	Plunge hole	Able to swim well.
June 23	Baptizing Lake 8	June 17	4 (?)	2	13.4	1.5	6	1:3	∅	Plunge hole	Condition fair, few mites.
June 24	Richard Zone Lake 34	June 21	3	2	11.3	1.1	3	2:1	∅	Near nest	Condition fair, few mites.
June 24	Richard Lake 34	June 22	7	2	11.0	.9	2	4:3	∅	In nest	Condition good, few mites.
June 24	Richard Lake 34	June 6	3 (?)	1-2	22.5	3.9	18	3:0	0	Plunge hole	Very active.
June 24	Richard Lake 36	June 6	4 (?)	1-2	22.6	3.8	18	3:1	0	Plunge hole	Very active.
June 24	Richard Lake 36	June 19	9	2	12.8	1.2	5	3:6	∅	in nest	Condition fair, many mites.