AN INVESTIGATION OF SOME PROBLEMS OF ECOLOGY OF THE BEAVER *Castor canadensis canadensis* Kuhl, IN NORTHERN MANITOBA

A THESIS

PRESENTED TO

THE FACULTY OF GRADUATE STUDIES

THE UNIVERSITY OF MANITOBA

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF SCIENCE

---

by

John Blake Nash

April 1951

Much of the work reported in this thesis was done while the writer was in the employ of the Game and Fisheries Branch, the Department of Mines and Natural Resources of the Province of Manitoba and grateful acknowledgement is made of permission to use the material and data obtained during that employment.

To Dr. A. Savage, Faculty of Agriculture, the University of Manitoba, for assistance and advice in problems of pathology and to Mr. Fred Zeiler, Department of Mathematics, University of Manitoba for aid in the mathematical problems of population studies, the writer offers his sincere thanks.

TABLE OF CONTENTS

INTRODUCTION

During the last decade there has been a five fold increase in the numbers of beaver in the province of Manitoba. The ecological status of the beaver, the factors which brought about this population increase and the attendant game management problems form the subjects of the investigations reported in this thesis.

Ecologically the beaver is a native of the aspen park and mixed wood areas of the province. Driven from this natural habitat by unregulated trapping and by the habitat reduction attendant upon the advances of agriculture, the species now exists, except for a few scattered colonies, in the northern coniferous forest which occupies most of the territory between the 54th and 57th parallels of latitude and which also extends southward on the east side of Lake Winnipeg to the Lake of the Woods.

In this unfavorable district the beaver existed in small numbers until 1942 when, under the combined effects of habitat modification and a particularly well chosen plan of controlled trapping, the population began to increase sharply and within seven years rose to a number more than five times that shown by the 1942 census. The population now appears to be relatively stable under the influence of systematic trapping and it is the hope of the authorities concerned to maintain this level in the areas now in production and to increase the total by introducing the beaver to areas not presently occupied. The subsequent pages deal with the problems involved in achieving this aim.

Systematic position of the beaver.

The beaver is a rodent belonging to the family Castoridae. Miller (1923) lists three species of beaver in North America, Castor canadensis Kuhl, C . caecator Bangs, and C. subauratus Taylor. These species are recognized by Anthony (1928) but Pratt (1929) reduces subauratus to subspecies rank and this classification is now commonly recognized. Twelve subspecies of *C. canadensis* are now recognized, *Castor canadensis canadensis* Kuhl, being the only one found in Manitoba.

Review of the literature.

Most of the available literature is contained in the published papers of American ecologists in the employ of various state and federal agencies. Each author appears to have concentrated on some specific phase of the problem so these only will be reviewed.

Bailey (1922) surveys the general habits of beaver and concentrates on the problems of damage by beaver and on the possibilities of farming the animal. He describes the live trap which he designed and which has been of great value in the majority of subsequent work.

Rasmussen (1940) states the effect upon trout of beaver activities in trout waters.

Tappe (1942) describes the current status of beaver in California and gives detailed accounts of the histories of individual colonies introduced in recent years.

Couch (1942) reviews briefly the damage and benefit activities of beaver in the United States and gives detailed instructions in the techniques and skills of live trapping and transplanting beaver.

Rasmussen and West (1943) describe transplanting operations in Utah with special reference to the identification tagging of beaver.

Erickson (1944) lists the parasites of beaver.

Grasse and Putnam (1950) discuss the food preferences and requirements of beaver and give much valuable information regarding the relationship of beaver to other wild life.

Deficiencies in the Literature.

Very little information was found regarding the effect of food supply upon distribution and abundance of the beaver. No information upon the growth of population or upon population coaction was found.

The Ecological Factors Involved.

For any species, ecology is reduced to a question of the ability of Biotic Potential of the species to oppose the forces of the Environmental Resistance encountered in the specific habitat.

The Manitoba beaver appear to be exposed to the following factors of environmental resistance:

Climate	Predators
Coverage	Parasites
Water Supply	Disease
Food Supply	Population Coaction.

These factors will be discussed separately and with each will be included the factors of Biotic Potential by which the beaver resists them.

The most important factors appear to be those of food supply and population coaction and it is upon these that this investigation has been concentrated.

Beaver Morphology.

Certain morphological characteristics of the beaver though not readily assignable to any particular phase of the investigation are of general importance to a n understanding of the ecology and are therefore presented.

The Game Management Problem.

The task of a game manager is to discover the ecological factors of the species involved and by exploiting these to obtain the maximum desired effect. This effect varies with species and depends upon their relative position in regard to the other species of the area. For instance, wolves are in general detrimental to the rest of the game population and minimum wolf populations are therefore desirable. On the other hand beaver produce desirable fur and the problem becomes one of so manipulating the controllable elements of the ecological equation as to produce the maximum sustained yield of pelts.

The common pitfall of game management has been an unwillingness to reduce populations when necessary. This is an understandable result of the struggle on the part of the authorities to prevent the extinction of some badly maltreated species but has been shown in several instances to be quite as disastrous as overcropping. It will be shown that this may constitute a real threat to the beaver population of Manitoba.

The general problem of trapping comes under the heading of predation and is dealt with in that section.

CHAPTER I

MORPHOLOGY

Morphological adaptations and data.

Certain morphological adaptations of the beaver to an aquatic existence are of ecological importance. The animal possesses nostril and ear valves which close upon submersion. The lips may be closed behind the incisors, allowing the use of these teeth for underwater cutting. The fore limbs are reduced in size and increased in dexterity and are used as hands in many building operations. The hind feet are elongated and webbed and the shape and musculature of the hind legs are modified for powerful swimming. The tail is broadened by dorso-ventral flattening and serves as a most efficient rudder particularly during the many towing tasks which the beaver undertakes. The adaptations of the limbs, while of undoubted value in the water, render the beaver slow and awkward when on land.

Attempts have been made to determine the age of beaver from morphological measurements, particularly of weight. The works of various authors are shown in Table I. The general findings are that average weights may be attributed to each age group but that the inter-group gradient is so gradual as to prevent definite classification of many individuals.

TABLE I.

SUMMARY OF THE FINDINGS OF VARIOUS AUTHORS

ON AGE - WEIGHT RELATIONS OF BEAVER.

AUTHOR	AVERAGE WEIGHT IN POUNDS OF BEAVER OF KNOWN AGES.					
	Kit	1 year	2 year	3 year	adult (mature)	max.
BAILEY (1922)	2	25--30	40--45	50	60--70	100--110
SHAW (1948)	---	17	33	---	40	---
MOORE (1949)	---	--	--	---	40	65
Swank (1949)	1--12	18--25	--	---	--	56
GRASSE (1950)	9	24	29	---	41	---
COOK (1948	---	20	25-33	---	35	

Table II lists morphological measurements made by the writer from a sample of beaver livetrapped along the right of way of the Hudson Bay Railway in the vicinity of Thicket Portage Manitoba. These data were obtained during the months of July and August. Also included are the data on two captive beaver held at the University of Manitoba and measured in December, ages of which are known to be ten years.

It will be noted that there is a division into five fairly definite groups about the 8, 18, 26, 33 and 45 pound levels which probably represent the mean weights of kit, 1 year, two year, mature and old beaver respectively.

The tail breadth measurements fall into five groups of the following means: 3, $3\frac{1}{2}$, $4\frac{1}{2}$, 5 and 6 inches and appear to be related to the last four of the weight groups.

Neither the tail length nor the ratio of the tail proportions appear to show any orderly arrangement in groups nor any correlation with the other measurements.

There is no apparent sexual dimorphism shown.

From the foregoing the writer concludes that the mean weights and tail breadths for age groups of beaver are as shown in Table III. It is also concluded that, due to the lack of any clear cut divisions between the groups, the larger specimens of one group may easily be confused with the smaller specimens of the next larger group and that hence many individuals could not accurately be classified. However, since the bulk of the members of each group appear to be close to the group mean it appears that sufficiently accurate information as to the age composition of a population could be obtained to be of ecological significance.

TABLE II

MORPHOLOGICAL DATA OF A SAMPLE OF MANITOBA BEAVER
TAKEN AT THICKET PORTAGE, MANITOBA. 1950.

Tag No.	Sex	Weight (lb.)	Tail Size (in.)	Tail Ratio Length/Breadth	Body Length	Body Girth
----	?	7¼	---	----	---	---
---	?	8¼	-6⅛	----	16½	---
1611	F	12½	8 x 3	2.65	19	21½
1624	M	15	10 x 3¼	3.08	22	23
1625	F	18	9½ x 3¼	2.92	23½	22½
1626	?	18½	9 x 3½	2.57	25	22
1615	M	21	10 x 3-3/4	2.65	24	23
1604	F	21½	9¼ x 3½	2.64	23	23
1612	M	24	10½ x 4	2.66	24	27½
1620	M	25	10 x 4-3/4	2.10	25½	26½
1627	?	25	10½ x 4	2.57	28	25
1704	F	25	10 x 4¼	2.35	27¼	25
1616	M	26	10 x 4	2.50	24	23
1701	F	26	11 x 3-3/4	2.92	25½	23½
1602	M	26	9½ x 3½	2.76	26	24
1703	F	26	9½ x 4½	2.23	24	27
1628	?	26½	11 x 4¼	2.58	24	23
1622	M	27½	11 x 4½	2.44	24	27
1607	M	28	11½ x 4	2.90	26½	23
1633	M	29	11 x 5	2.20	30	26½
1702	M	30½	12½ x 4-3/4	2.63	24	24
1606	F	30¼	12¼ x 5½	2.23	23½	26
1614	F	32	12 x 4-3/4	2.53	25	28
1617	M	32	10½ x 4½	2.44	23½	30
1629	M	32	11 x 5	2.20	30	27½
1636	F	32	11 x 5	2.20	31	26
1623	F	32½	12 x 5	2.40	29	30
1634	?	32½	12 x 4½	2.65	31½	27
1637	F	33	11¼ x 5¼	2.65	32	27
1610	M	34½	12 x 4½	2.66	26	29½
1619	M	34½	11 x 5	2.20	27½	30
1618	M	36	11 x 5	2.20	27½	30
1621	F	46¼	12½ x 5-3/4	2.18	32	30
Lab.1	M	44	11 x 6	1.81	32	28
Lab. 2	F	46½	9 x 6	1.50	30	29

TABLE III

MEAN WEIGHTS AND TAIL BREADTHS OF MANITOBA BEAVER

	PROBABLE AGE GROUP				
	Kit	1 yr.	2 yr.	Adult	Old
Weight (lb.)	8	18	26	33	45
Tail Breadth (in.)	--	3	3½	4½ - 5	6.

CHAPTER II

CLIMATE

This factor operates chiefly through its effect upon the food supply of the beaver which is considered separately.

The only sub-factor of climate which operates directly is temperature which is effectively countered by the protective instincts detailed hereafter.

Bailey (1922) gives the range of the beaver as "most of the continent of North America from the mouths of the Rio Grande and Colorado Rivers and Northern Florida north to Labrador, Alaska and the mouth of the MacKenzie River, well within the Arctic Circle." This indicates survival of the species through a temperature range from -60 degrees F. to 100 degrees F. or occasionally even more.

This temperature forces the beaver to construct shelters and further deprives him of access to much of his food supply by effectively sealing over the waters in which the animal has taken refuge.

The beaver's protective instinct leads him to build "houses" or "lodges" having underwater entrances. These shelters are built in the water or upon the bank and are solidly constructed of poles and branches set firmly in the ground and solidly plastered with mud to form a thickwalled structure which when frozen is windproof and will retain the body heat of the occupants. Ventilation is afforded by an unplastered area at the top and entrance is effected by one or more "plunge holes" or tunnels the entrance of which is under water. Channels are dug to ensure sufficient water depths at the tunnel entrances and the mud so obtained is used in construction of the house.

The Manitoba beaver almost uniformly build houses although each colony has associated with it a number of extensive bank burrows, also with underwater entrances, which provide alternative shelters and may be used as rest and breathing places during the beaver's water travel under the ice. Young beaver are reported often to use bank burrows during their first winter away from the parental house but it has been the writer's experience that this is more the exception than the rule.

Beaver colonies along the Hudson Bay Railway grade are systematically live trapped to extinction each summer to prevent damage to the grade and are quite as systematically re-colonized the following spring, presumably by young beaver leaving the parental colony. No signs of bank colonies were observed and in many instances the immigrants ignored the existing house and built a new one.

The beaver of the Deer River (Mile 442, The Hudson Bay Railway) live in bank burrows during the summer months but retire to houses in the surrounding muskeg creeks for the winter. This practise is due to the regular flooding and ice action experienced on this River each spring.

The size and shape of beaver houses varies considerably from tall hemispherical structures well offshore to low, long, roundtopped structures often set well up on the bank. All are characterized by wall from 18 inches to 2 feet thick.

The building material varies with the habitat. Willow and alder with peeled poplar is most common but birch, tamarack, spruce and any shrubs will be used if available. In marshland, large quantities of reeds are utilized. Figures 1. and 2. show houses typical of the habitat. The house in Fig. 1. is located in the marshes of the Saskatchewan delta and considerable quantities of marsh vegetation were utilized in its construction. This house was 22 feet in diameter and 7 feet high. The house in figure 2. is representative of the bank type of house, and measured 30 feet long, 12 feet broad and 3½ feet high. Located in the forested district north of Flin Flon, Manitoba, it was constructed of willow, alder, balsam poplar and aspen poplar.

When the water is frozen over the beaver is unable to forage ashore for his usual food. He meets this effect of low temperature by storing food under water where it is accessible throughout the winter. In the foreground of Fig. 2. may be seen a typical feed pile which extends from the top to the bottom.

By way of contrast, it is reported from California (Tappe, 1942) that the three local subspecies (shastensis, subauratus and repentinus) normally prefer to live in bank burrows, building houses only when the rocky banks preclude successful burrowing.

Fig. 1. Beaver House in a Marsh Habitat

Fig. 2. Beaver house in a Forest Habitat.

CHAPTER III

COVERAGE

The problem of coverage is almost entirely related to the factors of water supply and food supply, so far as the beaver is concerned. If water and deciduous trees are available the animal is able to find coverage. If these two factors are not present the beaver will not be found and the problem of coverage will not exist. This is a departure from the ecological pattern in the case of most animals for usually the question of coverage for protection from the elements and from predators is a separate one.

CHAPTER IV

WATER SUPPLY

This factor is an essential. The beaver's adaptations to an aquatic mode of life render him awkward, slow and relatively inefficient on land where he falls an easy prey to any of the larger predators. Without water he can survive neither the cold of winter nor the heat of summer and without water his young become the victims of the many predators which surround him.

Where lakes or ponds exist, the beaver readily establishes his house, choosing sheltered bays or stream mouths where protection from wave and wind-driven ice action are found, usually building his house on the bank. The most remarkable of the beaver's protective instincts is that of dam building whereby he utilizes any small, steady supply of water to produce a pond and thereby create his own local protection from weather and predators.

The dam in figure 3. is located on Racher's Creek about seventy miles southeast of The Pas, Manitoba. Below the dam water depths rarely exceed 18 inches but above the dam a four mile long pond from 3 to 6 feet deep is found. Habitat is thus provided for four active colonies. This dam is 250 feet long by 4½ feet high and is constructed of willows cemented with mud and reinforced with pieces of limestone weighing up to five pounds.

The longest dam observed by the writer was located on a muskeg creek entering the southwest corner of Landing Lake, Manitoba. This dam was 87 yards long with an average height of 30 inches and impounded a body of water about two miles long with an average width of 100 yards, in which three separate beaver colonies were located.

The highest dam noted was about 30 yards long and 6½ feet high, impounding a relatively small pond about 50 yards by 200 yards.

Fig. 3. Dam on Rancher's Creek.

Grasse and Putnam (1950) report two large dams in Wyoming, the first 30 feet long by 18 feet high and the second over 1000 feet long and from 2 to 12 feet high.

The Manitoba beaver appear to show considerable tolerance to variations in the nature of the water. They thrive in the slightly alkaline waters of the Saskatchewan Delta and do equally well in the slightly acid waters of the northern muskegs. They settle readily in the clear, cold water of northern lakes but also colonize the muddy, sewage-polluted waters of the Red River at Winnipeg. The writer recalls having seen, about 1930, a beaver pond where the receding water level during the summer months left an "alkali" precipitate indicative of high salinity.

Tappe (1942) quotes Parvin (MS, 1939) to the effect that beaver in Colorado dislike water containing excess acid, sulphur or other chemicals.

Streams and rivers provide adequate sites for beaver colonies if the banks are suitable for building and if the current is not prohibitively swift. The relatively sluggish reaches of the Saskatchewan Delta provide favorable sites and beaver colonies have been successfully located in its banks, whereas the swift and rocky Nelson renders no such service. The turbulent Deer River regularly overflows its banks each spring and carries large masses of ice which preclude the survival of a beaver house from one season to the next.

Hensley (1946) reports that no beaver inhabit the north coast streams of California, a fact which John Work, of the Hudson's Bay Company, in 1832 attributed to the fact that these streams are apt to run dry during the dry season.

From the foregoing it is established that the presence of water is essential to the beaver's existence particularly by protecting from the climate the variety of houses and burrows which he constructs, and that water supply thus forms a limiting factor to the distribution of beaver populations.

The proportions of the beaver dam are usually related to the surrounding terrain. Dams on channels in marshes are frequently very long for every inch rise of the water level causes considerable lateral extension of the pond . Conversely, dams on rapidly falling streams must be high in order to raise the pond level to that of the water a few yards upstream. Further to these needs the beaver frequently exploit high, firm banks to create a large, deep pond by building a high dam. Rancher's Creek (Fig. 3) flows through a plain and has banks about four feet high. The beaver, by closing the stream bed completely, utilized all the available water.

CHAPTER V

FOOD SUPPLY

The type and quantity of food available to the beaver form the greatest single factor in determining his abundance. The beaver of Western Canada survived the steadily increasing pressure of trapping over a period of two hundred years but were almost exterminated within half a century when the encroachments of agriculture destroyed their food supply.

The beavers food consists of the bark, leaves and twigs of deciduous trees and shrubs with the corms, rhizomes and stems of many aquatic plants. In addition to these the animal will eat grains and root crops from fields close to his pond and in captivity will eat apples and bread.

The beaver is completely vegetarian and no record has been found to indicate even occasional carnivorous lapses despite the fact that intraspecific fighting and killing have been observed by the writer among captive beaver in the holding pens at Thicket Portage, Manitoba.

In this question of food supply, the writer proposes to establish six points which are presented, each with its supporting evidence, immediately following.

A. Poplar (Populus spp) and willows (Salix spp) are the preferred food of beaver.

The list of foods commonly used by the beaver is long and varies from one part of the country to another.

Bailey (1922) states, "Poplars and cottonwoods, all species of the genus Populus, are the favorite food of the beaver and few other trees are cut where these are to be had. Willows, birches, pin cherry, alders and the bush maples come next. Many small bushes, hazel, witchopple, cornel, service berry and raspberry are cut for food and under stress of necessity such hardwoods as birch, maple, ash, cherry and even oak are felled both for food and for building material. Such conifers as hemlock, spruce, balsam and tamarack are rarely cut and then only for building purposes, not for food."

Rasmussen (1940) finds that "much of the tract (in Utah) was unsuitable for beaver because of .... lack of a sufficient quantity of their preferred and almost sole foods, aspen (Populus tremuloides) and several species of willows (Salix spp.)."

Barkalow (1940) states that in Alabama corn fields located within 25 yards of a creek are likely to be damaged. Sweet gum, black gum, willow and water ash are their favorite foods.

The beaver of California use the poplars most commonly but also utilize a great deal of willow, alder and tules (Scirpus acutus). In the absence of poplars, willow appears to be the main food plant. Considerable wastage of poplars is noted where food is plentiful. (Tappe, 1942.)

Instructions issued in a U.S. federal bulletin urge that in transplanting beaver, areas of adequate food supply be chosen for the new sites and advise that "in the North and far West, willows, mountain maples, alders, aspens and cottonwoods are preferred." (Couch 1942)

In Michigan, Bradt (1942) found that the beaver would eat nearly all plants within reach of the pond, but that aspens, maples and willows were the main foods and that aquatic plants formed an important part of the diet.

Prospective beaver farmers in Wisconsin are advised that the main requirement for the farm site is the presence of aspen, cottonwood or poplar upon which the beaver depend. (Grange, 1947).

Shaw (1949) places aspens, maples and willows as first choice foods of the beaver of Massachussets.

Detailed examinations of a number of beaver sites in northern Manitoba revealed that in almost all cases the colonies were sited with access to supplies of aspen poplar and that this tree, with the willow formed the principal source of tree food. The willow was the principal material for dam and house building though occasional unpeeled and numerous peeled poplar sticks were so used. Alders, birch (Betula papyrifera) and, rarely, conifers were used as building material. In one instance, at a point near Hudson's Bay, in the total absence of any species of poplar, black spruce (Picea mariana) was cut and peeled and a few cuttings were included in the willow feed pile.

The writer examined ninety four beaver colonies and found:

All were using willow for food and building material;
Eighty-six were using aspen poplar in large amounts;
Very small quantities of alder, birch and spruce were used for food in isolated cases and slightly larger amounts were used for building material;
In those areas where poplar was not used it was not available.
IN GENERAL poplar and willow, when available, are used to the near exclusion of other foods.

Feeding pen tests were conducted at Thicket Portage with five captive beaver. The specimens were given, twice daily, mixtures of aspen poplar, black poplar, willow, alder and birch. Unused portions were removed at each subsequent feeding and the relative amounts of each type utilized were noted.

It was observed that the animals showed a distinct preference for aspen poplar, the leaves, twigs and bark being the parts eaten.

The findings are tabulated in Table IV.

TABLE IV.

FOOD PREFERENCES SHOWN BY CAPTIVE BEAVER

Thicket Portage, Manitoba, Aug/Sep. 1947

Date	Relative quantities used of types offered				
	Aspen	B. Poplar	Willow	Alder	Birch
28	Large	None	Sample	None	None
29	"	1 sample	Large	1 sample	"
30	"	None	Variable	None	"
31	"	"	Large	"	"
1	"	"	Medium	"	1 sample
2	"	"	"	2 samples	"
3	"	"	"	None	"
4	"	"	"	"	"

Food Supply (cont'd)

B. There is a definite relationship between the presence of aspen poplar and the abundance of beaver.

In the ninety-four cases previously referred to, those where poplar was used occurred in the better trapping areas. The presence of poplar was noted in all colonies found in the Thicketonei Group which presents markedly better trapping.

Poplar was found in those parts of the Saskatchewan Delta where the beaver colonies are most numerous, i.e. the lower reaches about the junction of the Saskatchewan and Summerberry Rivers.

Poplar was found in some instances in the Flin Flon and Cold Lake Areas where the trapping is, on the whole, mediocre.

Poplar was not found in the Churchill area, the Shamattawa area, the Ilford Area, or the marshy areas of the Saskatchewan Delta. In all of these the trapping is poor or, in the case of the Saskatchewan Delta, the population is too low to allow of trapping as yet.

From the census records of beaver colonies taken by The Game and Fisheries Branch, Department of Mines and Natural Resources, Province of Manitoba, in 1950, the density of beaver colonies was computed and entered in the appropriate areas of the map shown in Figure 4. The broken line indicates the northern limits of poplar as defined by Harrison, (1934).

It is noted that the concentrations of beaver decline as the limits of the poplar are approached and passed, and that the best areas are those near the Hudson Bay Railway.

C. The poplar is a recently acquired feature of the habitat, the result of fires.

This is a matter of easy substantiation for the fires involved occurred in many cases within the memory of men still living in the affected area. For example, a trader at Thicket Portage will point out where the water tank stood before the fire of 1920 and will state that "from there clear down to the Forestry Dock was solid spruce that big." At the moment the place indicated is occupied by poplar predominantly thirty years old. Or again a veteran section man will show one where the big fire jumped Armstrong Lake and ran for twenty miles before the rain put it out. Again a check of the age of the resultant poplar crop tallies with the date indicated for the fire.

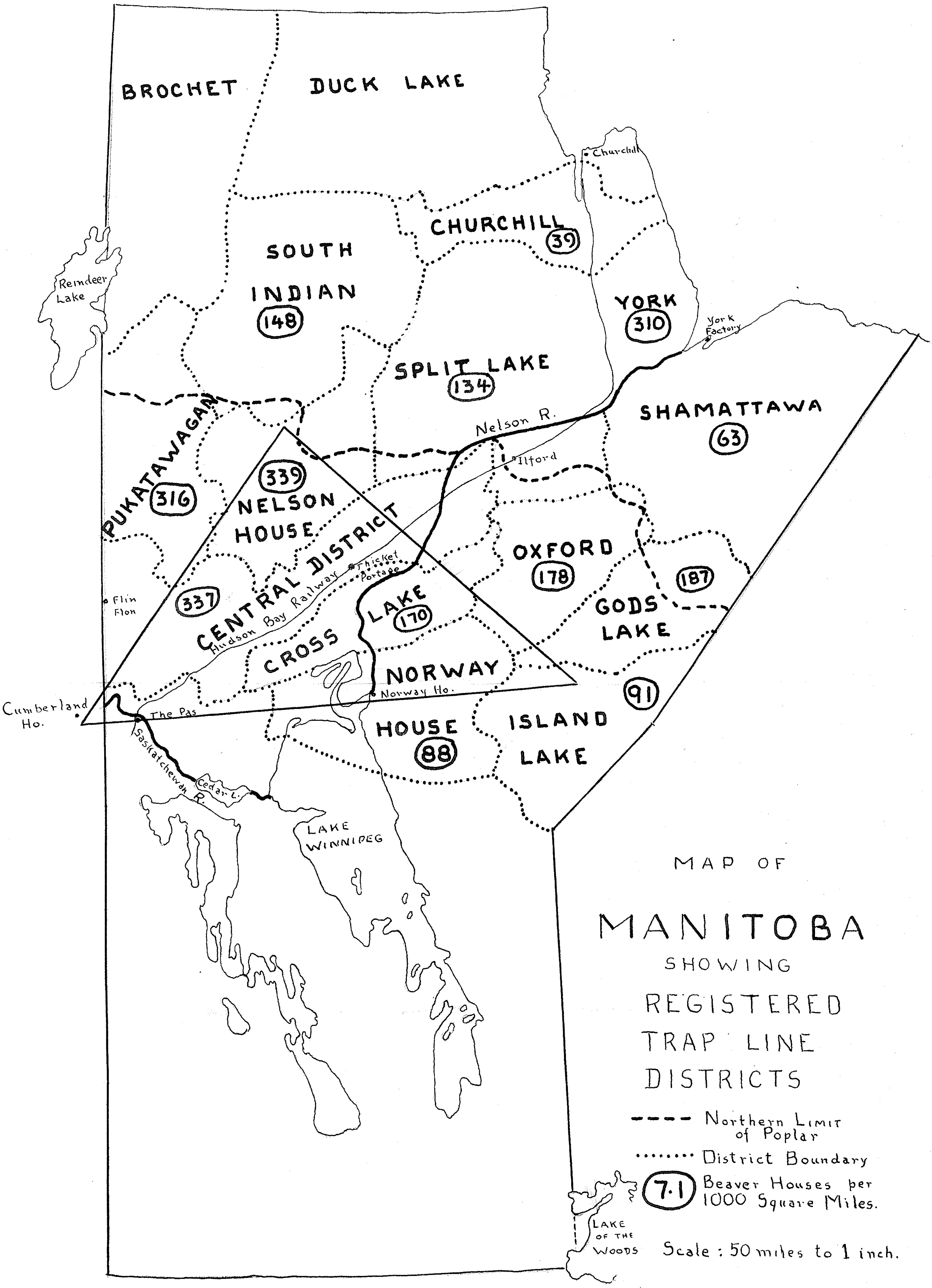

BROCHET
DUCK LAKE
Churchill
CHURCHILL
39
SOUTH INDIAN
148
Reindeer Lake
YORK
310
York Factory
SPLIT LAKE
134
SHAMATTAWA
63
Nelson R.
Ilford
PUKATAWAGAN
316
339
NELSON HOUSE
CENTRAL DISTRICT
Thicket Portage
Hudson Bay Railway
OXFORD
178
187
GODS LAKE
337
Flin Flon
LAKE
170
CROSS
NORWAY
Norway Ho.
91
Cumberland Ho.
The Pas
HOUSE
88
ISLAND LAKE
Saskatchewan R.
Cedar L.
LAKE WINNIPEG
MAP OF
MANITOBA
SHOWING
REGISTERED
TRAP LINE
DISTRICTS
Northern Limit of Poplar
District Boundary
7.1
Beaver Houses per 1000 Square Miles.
LAKE OF THE WOODS
Scale : 50 miles to 1 inch.

Fig. 4.

Examination of the areas now showing poplar reveals, in most cases, the remains of charred and fallen spruce or fire killed specimens of spruce left standing in the dense new growths of poplar. Fig. 5 shows an example of the latter condition.

Fig. 5. Fire killed spruce amoung replacement poplar

The area south of Island Lake has been notoriously poor trapping ground for some time, but of recent years has shown considerable improvement. Investigation shows that fire swept a large area there in 1934 and that a dense growth of small poplar is now to be found where once was spruce.

The occurrence of many of these fires is reported to coincide with the building of the Hudson Bay Railway by which the country was opened to relatively inexpert woodsmen and whose locomotives were a notorious cause of fires.

It is also to be noted that Thicket Portage lies at the crossing of the railway and the old water route from the Nelson to the Churchill Rivers and has therefore been the centre of much travel with its necessary and often careless fire-building. Thicket Portage is the centre of the best beaver country in the north.

A particularly fine example of poplar succession after fire was noted at Angling Lake, northeast of Island Lake, Manitoba, where a fire had occurred at some unrecorded date. The writer cut several of the largest trees in each of four areas and noted their ages. The fire date was definitely set at 1910 and the succession was predominantly poplar. The data are shown in Table V.

TABLE V

AGES OF TREES IN SITE OF FIRE AT ANGLING LAKE

Location	Sample	Age	Date of Seeding
North Bay, SW corner.	Aspen	38	1911
	Aspen	39	1910
	Aspen	35	1914
West Shore	Aspen	39	1910
	Spruce	68	1881 (survivor)
Bay at NW corner	Aspen	39	1910
	Aspen	39	1910
	Aspen	37	1912
N. Shore	Spruce	72	1877 (Fire scarred in 33rd year i.e. in 1910)
	Aspen	39	1910
	Aspen	39	1910
	Aspen	36	1913

There is evidence to show that most of this has been of low fur producing quality for some time, a condition not to be reconciled with the present growths of poplar. The following excerpts, presented by permission of the Governor and Committee of the Hudson's Bay Company, bear out this contention.

Report on Jack River District...James Sutherland..June 1st, 1815

"....the original inhabitants of this place seem to have all emigrated to the westward and within this few years back several families have left this place and gone to Swan River and Cumberland House, the poverty of the country for animals induces them to leave their native soil."

Report on Norway House District

Chief Trader Joseph McGillivray. Dated Norway House 1st June 1823. A list of the hunting grounds of the district. "....North Side Lake, Limestone Lake, Cross Lake, Jack Lake, Little Winnipeg, Deers Lake, Thunder Lake, Winnipeg, Jack Head, Sandy Point Lake, Bad Lake."

Report on Norway District, 1825 Chief Factor Colin Robertson. "Norway House District....(is) of the least importance attached to the northern department....the Indians having removed to other districts more abundant in the larger species of animals."

Gov. George Simpson to the Gov. and Committee, H.B.C., London dated Norway House, 25 July 1827. "....the country is miserably poor....the few natives that belong to it are frequently compelled to go in quest of a livelihood to other districts." 1828..."....this establishment does very little in the way of Indian trade....the surrounding country is very poor in large and furbearing animals."

1829...." the Indian trade of this place is not worthy of notice.

1830....".....the country being so much exhausted that the natives instead of giving their time and attention to the chase as heretofore, now employ themselves as labourers......"

1831...."The Indians attached to this place are now reduced to four or five families."

1832...."This district comprehends...Island Lake, Nelson River, Cumberland, Swan River and Winnipeg Districts; but for many years past its returns have been small..."

On the map shown in Fig..4..the above area is enclosed by the heavy line. Note that it includes much of the presently trapped areas.

Food Supply (Cont'd)

D. Poplar growth is favored by southern exposure. The writer first noticed this phenomenon on the shores of bays at the north end of Manistikwan (Big Island) Lake near Flin Flon Manitoba. Here in an area where fire had destroyed the spruce on all sides of a bay, the north side of the bay showed good growths of poplar and willow but the south side of the bay bore chiefly birch and alder.

On the Minago River, west of Cross Lake, Manitoba, a point of land between the river and a bay, offered a multiple example of this type of distribution. The north side of the bay showed dense growth of poplar while the south side showed heavy spruce. The north side of the river showed a fine stand of climax poplar with no evidence that spruce had been there within the last century but on the south side of the river a few poplars struggled for life among the spruce trees. Figure 6. shows the south side of the bay in the foreground with the north side visible in the distance. In Figure 7. the fine stand of poplar on the north side of the river is displayed. Thus a single point of land where no factor except the exposure varied is found to show radically different growths on its north-facing and south-facing sides.

This difference in growth was also observed on the Grassy River near its confluence with the Nelson, on Bays of Landing Lake and on Angling Lake.

Rocky ridges and points exposed to the wind appear to favor the growth of birch rather than poplar following a fire while at Ilford where considerable areas of sandy soil is found, the Jack Pine (*Pinus banksiana*) flourishes.

Fig. 6. Northern Exposure Favors Spruce.

Fig. 7 Southern Exposure Favors Poplar.

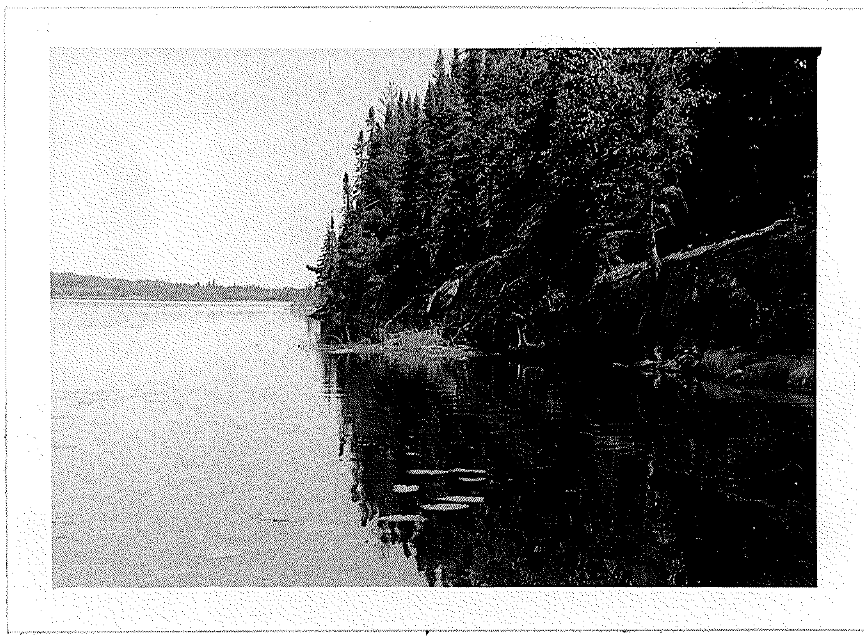


Fig. 6. Northern Exposure Favors Spruce.

Fig. 7 Southern Exposure Favors Poplar.

The writer concludes that following fire which removes the climax spruce (Picea mariana), certain deciduous seres are usually found with poplar flourishing in the areas of best soil and shelter and greatest insolation while rocky areas of lower insolation favor the production of birch. Alder seems more likely to accompany the birch but the relative distributions of willow and alder are not as clearly marked as is the case with birch, willow and spruce. Insolation appears to be the critical factor.

Food Supply (Cont'd)

E. The poplar growth following fire is a temporary or sub-climax sere and does not perpetuate itself.

During the summers of 1947, 1948, 1949 and 1950 the writer had occasion to examine several hundred areas of poplar from points on Kissinew Lake near the Saskatchewan border to Shamattawa in the eastern part of the province and from the Minago River to Split Lake. In all cases except one, on the Minago, these poplar growths were interspersed with numbers of small spruce and occasionally with large spruce, survivors of the fire. In the older poplar stands, sizable spruce indicated the ability of the latter to survive among the poplar.

Among the poplar of younger stands, where the spruce seedlings were quite tiny, there were a few poplar seedlings but in the stands of older poplar where the spruce were well established, it was rare indeed to find a small poplar.

On the other hand, well established stands of spruce presented such a combination of root and shade competition coupled with the acid soil typical of spruce occupation that the poplar was never observed to invade. Frequently such areas were observed to come under heavy attack by airborne poplar seed which were apparently unable to establish themselves.

Where the beaver establish themselves they perform selective destruction in the mixed stands of poplar and spruce, taking the poplar and leaving the spruce. In the small clearings so produced, of which more than one hundred were observed, only one case of poplar replacement was noted. On McLaren Creek, west of Thicket Portage considerable replacement of poplar was noted and the encroachment by the spruce was negligible.

Figure 8. shows such an effect where cuttings of mature poplar may be seen. Spruce of various ages are to be observed but no poplar seedlings are visible .

Fig. 8.

Food Supply (Cont'd)

F. The present poplar supply is not inexhaustible. Despite the fact that fires have produced large areas of poplar growth, the aquatic habits of the beaver, by restricting his habitat to the margin of streams and lakes, deny him the use of any but a small fraction of this poplar. This is further aggravated by the fact that frequently this marginal poplar is reduced by a fringe of willow or conifers which better tolerate the wet ground and force the poplar back from the shoreline.

Bradt (1947) cites other workers to the effect that beaver rarely cut trees more than 400 feet from the water's edge but also states that he has observed cuttings 650 feet from the water and has seen quite extensive cuttings up to 500 feet from the shore.

The writer observed one site on Landing Lake where poplar was cut in quantity 360 feet from the shoreline, but considers this to be exceptional. Manitoba beaver rarely cut more than 100 feet from the water and most colonies obtain their food from even closer sources.

The possibility exists that when the poplar becomes considerably reduced these beaver will be compelled to go further inland for food. It is anticipated that predation will increase sharply under such conditions for the main enemies of the beaver, bears and wolves, are reported to make most of the kills while the victims are engaged in food gathering.

By the damming of small streams the beaver in enabled greatly to extend the areas safely accessible to him, but in northern Manitoba this has two major drawbacks from the point of view of food supply. In the first place many of the available streams originate in and run through muskeg where the vegetation, even following fire, is predominantly willow and conifers. Secondly, where the streams do flow through poplar areas, the pond created by damming frequently destroys, by drowning, more poplar than the colony uses for food, thus greatly accelerating the destruction of the habitat.

The digging of canals, at which the beaver is expert, also permits him to extend the safe range of cutting and also aids considerably in the movement of the trees which he wishes to transport to the main pond. To provide safety for the beaver the canal must be at least two feet deep and two feet wide. To construct such a canal on any but soft ground of very gentle slope would be a task beyond even the beaver's talents. The use of canals is therefore quite limited.

Of the small fraction of poplar available to the beaver much is lost due to lodging of trees during felling which thus remain beyond the animals reach and much more is wasted by the critical appetite which the animal displays in the presence of plenty. When ample poplar is available the beaver fells many trees, using only the leaves and smaller branches and leaving the main trunk and larger branches to dry and become useless. Thus a great part of any habitat may be reduced to uselessness in a fairly short time.

Bradt (1947) made widely quoted estimates of the beaver's food requirements and of the amounts of poplar available to a colony. He found that, on the average, one beaver cuts 216 trees per year, and that poplar trees of an average diameter of 2.1 inches number from 1500 to 3,000 per acre. He thus concludes that an average colony of five beaver will be supported for from 1 to 2.5 years by an acre of poplar under the conditions found in Michigan.

The findings of the writer for both cuttings and densities of poplar in northern Manitoba are widely at variance with the foregoing. Counts of stumps and calculations of tree densities in the surrounding areas show an average annual cutting per <u>colony</u> of 130 poplars and an average density of 994 stems per acre. From these an average expected life of 8.7 years per colony per acre may be deduced.

The data on which the above averages are based are presented in Table VI.

TABLE VI

SUMMARY OF TREE CUTTINGS AND DENSITIES OF POPLAR IN BEAVER SITES AT THICKET PORTAGE, MANITOBA

Age of Colony (Years)	Total Poplars Cut	Average Annual Cuttings.	Average Poplars Per 1000 sq. yds.	Average Poplars per acre.	Colony years per acre of Poplar
10	1653	165	219.0	1060	6.4
5	244	49	190.7	916	18.7*
2	289	145	240.0	1152	7.9
2	261	130	221.7	1064	8.2
3	297	99	249.0	1195	12.0
2	580	290	243.0	1166	2.0
2	234	117	232.0	1113	9.5
3	300	100	73.0	350	3.5
4	438	109	172.0	826	7.6
3	280	93	228.0	1094	11.7
Mean	130			994	8.7

* This colony was sited in a willow swamp about ½ mile from its poplar supply. Cuttings of poplar were widely dispersed and the data obtained are probably low.

It will be seen from the table that the average annual cuttings range from 49 to 290, the average densities from 350 to 1195 stems per acre and the average predicted colony-years per acre from 2.0 to 18.7. It is apparent that mathematical means derived from such data could be very misleading.

Mathematically, a strip of poplar 33 yards wide extending for 440 yards along the water front constitutes an acre of poplar. Practically, such distribution is extremely rare in Northern Manitoba and rarer still in conjunction with the other requirements of a beaver colony.

In the writer's opinion there is, from the beaver's point of view, no such thing as an acre of poplar. Beaver frequently by-pass poplars standing within easy reach of the water and cut and with great labor drag to the water, a tree double the distance away; beaver will, for no apparent reason, leave many poplar standing in a cutting area and abandon the site only to build a new house half a mile away; beaver will girdle a tree and leave it to die: beaver will fell a tree and leave it untouched; beaver will assiduously hunt out poplar from among the encroaching spruce and ignore a fine dense stand of poplar a few yards distant; in short beaver take poplar where they please with little or no apparent regard for plan, pattern or the ecologist's convenience.

There seems to be no better unit of carrying capacity than the "site", which, judging by those which the beaver occupies, should include a supply of calm water, soft banks for easy burrowing, willows or alders for building material, aquatic vegetation, a supply of aspen poplar and no close neighbors.

It appears to the writer that a good method of determining the carrying capacity is to make detailed reconnaissances of the area concerned in order to determine the number of such sites and to express the results in terms of colonies for that area. Attempts to calculate from such data as that shown in Table VI could lead only to confusion.

It is equally apparent that in northern Manitoba, where the square miles per trapper are many and the territories per Conservation Officer enormous, detailed examinations will require considerable time and that an interim method of determining carrying capacities is needed. One feasible method is shown in the chapter on population studies.

The writer is of the opinion that three factors are largely responsible for the observed differences in poplar consumption between Manitoba and Michigan. First, the wastage in Michigan, which has approximately double the poplar density, will be appreciably greater. Second, the Michigan studies appear to have been conducted in areas of relatively distinct boundaries, whereas those in Manitoba were conducted on large, intricately connected waterways which allowed the beaver to indulge in summer wanderings and thus spread his cutting activities over such large areas that positive counts of the whole year's efforts became virtually impossible. Third, it is probable that in the presence of smaller supplies of poplar the Manitoba beaver depend more upon aquatic vegetation than do the Michigan beaver. It is certain that some willow is eaten but due both to the inaccessible habitat of much of the poplar and the fact that much of the willow cut is used in building, no accurate estimate of the relative importance of this food plant could be made.

Food Supply (Cont'd)

G. Aquatic plants form a large part of the beaver's diet.

It has been noted by Bradt (1947) that the beaver of Michigan eat a variety of aquatic plants including eel grass (Potamogeton), duck potato (Sagittaria), duckweed (Lemma), water weed (Elodea), white water lily roots (Nymphaea), and yellow water lily roots (Nymphozanthus). Bradt "is inclined to think that the use of such plants is more extensive than has been heretofore recognized."

In California beaver are found to employ tules (Scirpus acutus) as food wherever they are available. Poplars are scarce or unobtainable but are cut heavily wherever they are found. Willow seems to form the principal food of these beaver. Listed also as foods of significance are the common cattail (Typha latifolia), and the pond lily (Nymphaea polysepala) (Tappe, 1942.)

In West Virginia the roots of cattail and bur-reed (Sparganium) are used by beaver as are also young growths of sedges (Carex spp.) and bullrush (Scirpus spp.) (Swank, 1949).

From Wyoming it is reported (Grasse and Putnam, 1950) that the beaver live through the summer on "aquatic plants, grasses, rushes, sedges etc......he does very little tree or shrub cutting...."

Limited feeding experiments by the writer showed that over a period of three days a kit beaver weighing 8½ pounds ate a daily average of 18½ ounces of water lily rhizome (Nuphar advenum) and that a large adult of unknown weight ate a daily average of 63.3 ounces over the same period, as compared with average daily consumptions of poplar bark of 11.6

and 47.8 ounces respectively, also over a three day period. These beaver had been confined for a period of several weeks on a diet of poplar and when offered the rhizomes with poplar they displayed a marked, though temporary preference for the rhizomes and during the three day test period ate little or no poplar. During the two succeeding days, however, they ignored the rhizomes completely and finally settled down to a variably mixed diet of which no quantitative records were kept.

Attempts at quantitative feeding experiments using small aquatic plants failed due to the difficulties of recovering the unused food from the beaver's bedding. A variety of plants were offered and the following observations made:

Typha latifolia	(Common cattail)	Rhizomes and stem bases eaten.
Scirpus validus	(Softstem bullrush)	Stems and roots eaten.
Valisneria sp.	(Water Celery)	Leaves eaten.
Carex sp.	Sedge	Probably not eaten.
Acorus calamus	(Sweet flag)	Stem bases.
Calla palustris	(Water arum)	Consistently refused.

The inclusion in feed piles of quantities of lily rhizomes was common and beaver were frequently observed carrying the rhizomes from lily beds to the house. At a beaver house close to the writer's headquarters at Thicket Portage, adult and kit beaver were frequently observed to obtain and eat the lily rhizome.

In the marshy areas of the Saskatchewan Delta feed piles consisting almost entirely of lily rhizome were observed. (See fig. 8.)

The lily produces the largest rhizomes of the aquatic plants (see Fig. 9) and is almost universally distributed where fairly quiet water from two to six feet deep is found. It is very frequently found to establish itself in the beaver ponds where it provides a source of food available throughout the winter. It is therefore thought to be a major source of beaver food.

Although it appears to be very probable that the aquatic plants form a significant part of the beaver's diet, the habits of both the plants and the animals make quantitative evaluations impossible. Furthermore, due to the wide distribution of such plants, wherever the essential requirements of the beaver are found, the writer believes that they do not constitute a limiting factor to beaver distribution. Their importance probably varies inversely as the quantities of poplar available. Lily Rhizome, because of its large size and high palatability is probably the most important of the aquatic plants in northern Manitoba.

Fig. 9. A Feedpile of Lily Rhizomes. (Nuphar advenum)

Fig. 10. A Portion of a Lily Rhizome.

Food Supply (Cont'd) SUMMARY

Briefly to summarize the problem of food supply, the writer believes that the following points have been made:

Beaver will be found where water, willows and aquatic plants are available to them.

The limiting factor to beaver densities is the abundance of aspen poplar (Populus tremuloides)

The supplies of poplar in northern Manitoba are largely due to fires.

The supply is not inexhaustible and replacement will not be poplar.

Aquatic plants play a significant though indefinite part in the problem of food supply.

CHAPTER VI

PREDATION.

Predation of beaver falls into two classes, that committed by man in the form of trapping and that committed by other predators.

A. Trapping

For many years prior to 1942 beaver trapping was illegal in Manitoba except for that done by treaty Indians exercising their privilege of taking animals for food. Naturally, a pelt so taken should not be wasted and equally naturally there were traders to relieve the Indian of his encumbrance. With the door left thus ajar a fairly steady trade in illegal beaver skins was conducted, the methods of which kept the beaver population at a low level despite the steadily improving habitat.

Trappers have informed the writer that in those days every effort was made to keep secret from other trappers the location of a beaver house until the fur was prime at which time the colony was trapped to extinction. This was done in most cases with a knowledge of the poor conservation involved but with a cynical attitude of realism, knowing that it was not a question of whether or not the beaver survived but merely one of who enjoyed the spoils.

Institution of the Registered Trapline System in 1942 did much to stop this malpractise. The trapper's rights to an area were secured, poaching was largely stopped and the vicious competition terminated. Quotas of one beaver for every colony in excess of seven were allowed and an immediate increase in the numbers of beaver became apparent.

The quota was based upon two assumptions supported by findings in the United States, first that the average litter was four and second that the survival rate was about fifty percent. Bailey (1922) sets the average litter at four, Bradt (1947) at 4.18 and Grasse and Putnam (1950) at 3.8. Survival rate is based on the fact that colonies known to contain adults and two litters of succeeding years show an average of 5.1 in Michigan (Bradt, 1947) whereas one would expect to find 10 had all survived. In Manitoba, the findings of trappers were accepted until better evidence should be found and the quota was accordingly set to allow half of the annual increase for propagation and half for trapping.

Records of census returns, submitted by trappers and subject to spot checks by Conservation Officers, have been kept for the Central District and are presented in Table VII with the corresponding data on pelts taken. It is noted that under this form of controlled predation the population levels have risen from 820 colonies in 1942 to 4,648 in 1950 with a peak of 4684 in 1948. 504 pelts were taken, legally, in 1943, 4,145 in 1949 and the peak year of 1948 produced a spring crop of 4866 in 1949.

The above figures do not tell the whole story. The surrounding areas, which were previously almost devoid of beaver have shown large increases and beaver livetrapped from the Central District have formed the nuclei of apparently thriving populations in several other districts.

As the population increased the intensity of trapping was also increased and a sliding scale quota was applied to allow the trapper of the densely populated line to control his population. The present quota allows of slightly less than two beaver per house in the better areas, a figure designed to remove the bulk of the annual increase.

This form of predation may be adjusted to the ability of the prey to withstand it and, particularly in this case, has the beneficial effect of keeping the population within the limits of the carrying capacity of the range.

Leopold (1933, p.231) gives first of five factors influencing predation, the density of the prey population. In this respect the impact of other predators on the beaver must be materially reduced by human predation in the form of trapping.

Intermediate between the predation of regulated trappers and the predation of carnivores is that caused by poachers. Such unregulated and unrecorded trapping is disproportionately damaging to the population, being indiscriminate, frequently wasteful (taking of unprime skins) and, by causing errors in the data, productive of management error. The control of such persons constitutes a major problem of management and causes the waste of many man-hours which could be better employed in the variety of routine investigations essential to good game management.

Predation (cont'd)

B. Predation proper.

The animals of northern Manitoba capable of predation on the beaver include the bear, wolf, coyote, fox, wolverine, otter, lynx, and possibly the mink, marten, fisher and eagle.

Leopold (1933, p.231) lists five variables as influencing the mortality from predation of a given species in a given range. They are:

1. The density of the prey population.
2. The density of the predator population.
3. The predilection of the predator, that is, its natural food preferences.
4. The physical condition of the game and the escape facilities available to it.
5. The abundance of buffers or alternative foods for the predators.

The above noted predators will be considered in terms of Leopold's variables.

The question of the density of the prey population has already been mentioned in this respect and the effect of trapping in reducing other predation noted. The opportunities for predators have undoubtedly increased with the increase in population but the systematic trapping program should do much to minimize the total predation from other causes.

Bears are not sufficiently numerous to constitute a major hazard to the beaver and because of their depredations on the camps and equipment of the trappers they are assiduously destroyed whenever they constitute a real nuisance. Locally they may constitute a problem. For instance in the marshes of the Saskatchewan Delta, the writer observed considerable bear damage to beaver workings and one bear was observed by a colleague to capture a muskrat by a technique which could be and quite probably was applied to beaver. The bear opened the house and waited until the 'rat, which was apparently unaware of the impending danger, emerged from his flooded runway whereupon he was promptly seized.

This technique was successfully employed by the writer and a colleague in the Netley marsh at the mouth of the Red River and several 'rats were captured with no more equipment than a pair of stout leather gloves.

In the Saskatchewan Delta two instances were observed where a bear had opened the top of a beaver house but no definite proof of a predation was seen.

Foxes, though numerically strong, do not appear to constitute a threat to the beaver. Their predilection appears to be elsewhere and the trappers assert that foxes never molest beaver. The writer observed only one fox and no other sign at a beaver site and concludes that they are not significant in beaver predation.

The wolverine is too rare in Manitoba to be other than a very occasional slayer of beaver. Of about one hundred trappers questioned in the Central District, only one had seen a wolverine. This trapper caught two, having seen none previously and has seen none nor their sign since.

The lynx fails to qualify as a predator of beaver on the grounds of small numbers and a predilection for rabbits. It is probable that as the rabbit population declines the lynx will turn to any available food in order to stave off starvation but the lynx decline follows that of the rabbit so shortly that his numbers are soon reduced to the point where he fails to be of importance. These rabbit-lynx relationships have been thoroughly established and are reported by Allee <u>et al</u> (1949) pp 86 and 324.

The <u>otter</u> occupies a debatable position in regard to the beaver. Certainly his aquatic habits give him greater opportunity for predation and almost completely remove the advantage which the beaver has over other predators. Bailey (1922) states that otter probably enter the beaver house and kill the young. Bradt (1947) considers the total effect of predation on beaver in Michigan negligible. The otter in Manitoba is not numerous and therefore while possibly of some local importance may be disregarded. The writer saw only one otter, on the Hargrave River west of Cross Lake and only one sign elsewhere.

The <u>smaller mustelids</u> are also negligible on the grounds of other predilections and also because of their inability to cope with other than a very small beaver. Swank (1949) records three instances of mink predation on beaver, all very young.

The case of the <u>wolf</u> is different. Both timber wolves and coyotes are numerous in northern Manitoba and show every sign of criminal intent toward the beaver. The writer observed numerous instances of wolf interest in beaver activities and the only live wolves seen were engaged in stalking beaver in a cutting area on the outskirts of the Thicket Portage settlement. The trapper on whose line this was seen informed the writer that the wolves had so harassed the beaver during the previous fall that he had felt compelled to fell trees into the water in order to ensure the survival of the colony.

The writer observed on three occasions, wolf faeces containing beaver hair and was shown a sample from which a small strip of beaver pelt was obtained.

At the trapper's meeting at Wabowden Manitoba in the spring of 1949 one trapper supported his statement of wolf predation by producing a bushel sack of wolf faeces in which considerable beaver hair was observable.

The wolf attacks adults largely in the cutting areas and this form of predation would undoubtedly increase sharply as supplies of poplar close to the water were exhausted and the beaver compelled to venture farther inland.

Another form of wolf attack on beaver was observed in three widely separated areas by the writer. Oval holes, approximately 14 inches by 10 inches were found in the sides of beaver bank houses, in all cases having been made in the latter part of May, the time being established by the date of the trappers last previous observation of the undamaged house. The sticks were chewed as by wolves and the shape and size of the holes and the method of dirt distribution tallied with that found in wolf dens. Wolf tracks were evident in the surrounding soil and in one case faeces containing beaver hair were noted.

Swank (1949) suggests that the crying of small beaver, which the writer has noted to be clearly audible, probably attracts the predators and encourages the digging attack. While small the beaver is apparently unable to dive and thus is easily caught. It is possible that the hole digging attack is coupled with the waiting technique employed by bears.

The Manitoba wolf depends upon the caribou for winter food and when these animals leave the beaver regions in the spring the beaver appears to form the wolf's predilection.

During the past winter a large scale attack has been made on the

the Manitoba wolf, using a tested technique of considerable success. It should do much to increase the survival rate of beaver.

The ability of the adult beaver to escape and to defend himself is great. His aquatic habits are his main protection but he is no mean fighter when aroused and is sufficiently compact and powerful to give pause to all except the larger predators. The writer observed three instances of the potentialities of the beaver in this direction. Young beaver were killed in the holding pens at Thicket Portage by beaver bites which sheared through ribs quite cleanly. A broom employed in pen cleaning was cut off cleanly in one snap by an aggravated beaver. The writer was attacked by a beaver which missed his bite but struck with the nose and closed teeth on the victims foot. The effect was comparable to that of a kick with a heavy boot and considerable swelling and bruising followed.

The writer concludes that beaver predation is committed largely by bears and wolves in Manitoba, the latter being the major offenders.

CHAPTER VII
PARASITES

The parasites of beaver are of no apparent significance. Erickson (1944) lists the following as the recorded internal parasites of C. Canadensis. The trematodes Stichorchis subtriquetrus, Stephanoproraoides lawi and Renifer ellipticus; the nematodes Travossosius americanus, Castorstrongylus castoris, Capillaria hepatica, Filaria sp., Gongylonema sp. and Oxyuris sp.

Erickson considers the effect of these parasites to be virtually negligible.

The writer recovered no parasites in the course of 18 routine postmortem examinations of which at least nine were conducted in the presence of a competent parasitologist.

Unidentified fluke ova have been recovered from the faeces of two ten year old beaver at present alive in captivity.

Ectoparasites recorded include one louse specimen, one tick specimen and three cases of screw worm larvae in addition to the frequent reports of the parasitic beetle, Platypsylla castoris. (Erickson, 1944)

The writer combed fifty live beaver in unsuccessful attempts to recover the beetle but obtained them from three freshly dead specimens during skinning. The trappers report that these so-called "beaver lice" are sometimes found on most pelts and in other years on none.

Two cases were reported to the writer of apparent pathogenicity of the beaver beetle. Mr. Norman Patterson, Conservation Officer at Ox/ford House stated that he livetrapped a small kit at a house from which he had removed the other beaver several days earlier. The kit was heavily infested and in a weakened condition. The skin showed considerable irritation and damage. The beetles were removed by the use of an insect repellant, approximately a cupfull being collected, and the kit recovered.

Mr. Hugh Conn, Department of Indian Affairs, stated that he had occasion to examine two kit beaver which he found to be heavily infested with beetles. The skin was considerably scarified and infected and the kits soon died.

The writer concludes that the parasites of beaver are in general negligible but that some mortality of kits may be caused by the beetle, P. Castoris.

CHAPTER VIII

DISEASE

Excepting tularemia which has been reported on several occasions in beaver (Bradt, 1947) (Morgan, 1949) no cases of disease have been reported in beaver prior to 1948. The animal seems to be singularly free from epizootics such as are found in the case of muskrats and rabbits.

In the spring of 1949 reports were received from the York Factory and Shamattawa areas that numbers of dead beaver had been found and that disease was suspected. Investigation by a party, which included the writer, received reports of 33 carcasses found, the descriptions of which (no carcasses being available) were noted and found to be suggestive of tularemia, subcutaneous lesions being the best established of these. In all areas concerned, the quotas were taken.

In the summer of 1950, reports of extensive deaths on the Nelson River, on the lower Grass River and in the Saskatchewan Delta were received and investigations conducted by the writer. 21 dead beaver were reported from the first two districts and about thirty "dead" houses. In one case the trapper failed to take his quota by a considerable margin, only 24 beaver being taken from 38 houses.

A trip through the affected area revealed a minimum of beaver movement and indicated a considerable drop in beaver population. Subsequent census reports show a decrease of 25% for the affected area as compared to a drop of 9% for the whole Central District, of which this area is a part.

28 samples of blood, obtained by cardiac puncture from live

beaver were submitted for pathological examination. All samples were reported negative for tularemia.

Two carcasses of beaver found dead have been received and submitted to complete examination, the autopsy and culture work having been carried out at the Veterinary Pathology Laboratory of the Manitoba Dept. of Agric. and the histological examinations having been made by the writer.

The first carcass was found in the vicinity of Ilford, Manitoba and was submitted frozen on October 24th, 1949.

The autopsy findings revealed blood stained exudate in the peritoneal cavity, innumerable small areas of necrosis in the liver and spleen and enlargement and caseation of the lymph glands.

Incubation of smears from these organs on Bacto "Cystine Heart Agar with Haemoglobin" produced growths from which the most Tulari-like colonies were fished and recultured. A rabbit was injected with these organisms but failed to show any typical symptoms or lesions.

The liver and spleen were too decomposed to yield any information. The lymph node was recognizable and showed definite hyperplasia of the connective tissue structures, evidence of a chronic condition.

The pathologist reported, "Tularemia not proven. Because of the typical lesions found in the beaver carcass, it is still suspected as the cause of death."

The second carcase was submitted October 13th, 1950 having been found dead in the Saskatchewan River.

The pathologist reported typical lesions of Tularemia.

Cultures on cystine produced mixed growths from which the colonies most suggestive of tularemia were recultured and the resultant material injected into a guinea pig, which died in exactly four days.

Post mortem examination of the guinea pig showed lobular pneumonia and caseous foci in the liver and spleen, with enlargement of the sub lumbar lymph glands of one side.

Cultures from these organs produced a practically pure growth of small, bipolar gram negative rods, showing neither motility nor spore formation.

Injection of this into another guinea pig caused death in exactly four days but produced no typical lesions of Tularemia.

A culture forwarded to the Hull Laboratory, 18th November failed to prove viable on arrival.

It is concluded from the foregoing that the beaver deaths were in both cases caused by a disease resembling Tularemia, but that substantiation by identification of the organism was not made.

Generally speaking the problem of disease among the beaver of Manitoba has not yet proved to be of any great moment. The deaths reported above all occurred in the poor areas. The numbers of beaver involved are not significantly large.

CHAPTER IX

POPULATION STUDIES

The difficulties encountered in attempting to determine the carrying capacities of various areas of northern Manitoba for beaver led the writer to undertake a study of the growth patterns displayed by the beaver populations in groups of various sizes.

The theories advanced by Raymond Pearl, (1930) assert that in all cases examined, plant and animal populations display a typical pattern of growth, the data of which may be plotted graphically to a curve of consistent shape. This curve is commonly referred to as the Pearl Curve, the sigmoid curve or the logistic curve.

An example of such a curve is reproduced from Pearl in Figure 11 as a basis of comparison with the curves derived by the writer.

According to this theory, populations show a slow initial increase which is followed by a rapid rise, and finally a levelling off as a static state is attained. This levelling is supposed to be due to realization of the carrying capacity of the habitat concerned and may therefore be considered a measure of carrying capacity. The level at which the population becomes stabilized is known as the upper asymptote.

The number of cases in which Pearl accurately predicted the performance of a population from data yielding only a part of the curve so impressed this writer that it was decided to attempt application of these principles to the problem of beaver populations and carrying capacities.

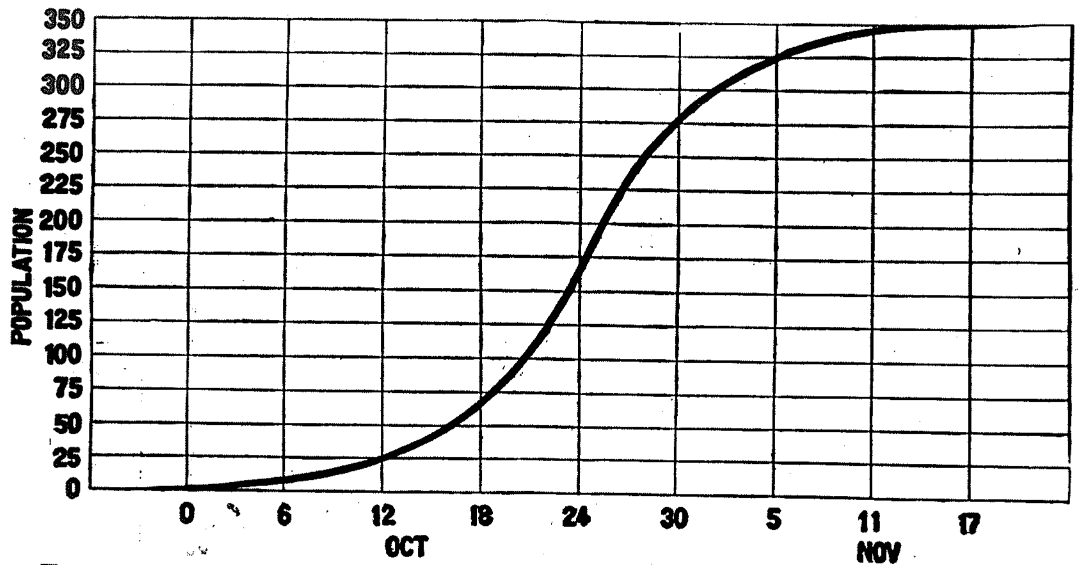


Fig. 150.—Increase in population of vinegar flies in a "universe" of limited size. A few flies were placed in a pint milk bottle with suitable food and allowed to reproduce. A census was taken every few days. The curve shows that the population increased slowly at first, rapidly afterwards, more slowly again, and finally became stationary. (*Modified from Pearl.*)

Fig 11 A Typical Population Growth Curve.

The data at the writer's disposal were compiled by the Game and Fisheries Branch, Department of Mines and Natural Resources of the Province of Manitoba from census records taken by trappers and catch figures as checked and submitted by Conservation Officers of the same branch.

In general the returns submitted by trappers are subject to a modicum of suspicion since the quota and hence the trapper's income from beaver pelts is determined by the population statement. However, the majority of trappers are honest and the minority is restrained by the threat of punishment for making false returns and the knowledge that these returns are subject to complete investigation without warning by Conservation Officers. It may therefore be assumed that the reports are, on the whole, as accurate as the trapper can make them. The returns are a statement of the number of "live" beaver houses seen by the trapper during his early winter rounds of the trapline and their accuracy depends upon the industry and vigor of the trapper and upon the degree of accessibility of all parts of his trapline. A change from an old to a young trapper on a certain line is frequently seen to produce an increase in the house count for the young man inherits from his predecessor a knowledge of the location of previously reported houses and also brings to the line greater capacity for travel and a new pattern of travel, the last two factors usually operating to discover previously overlooked houses. In one case a trapper discovered an additional number of houses by the expedient of hiring an aircraft to fly him over an area of particularly dense growth which had previously been avoided because of its lack of winter trails.

Information thus obtained is probably subject to a certain amount of error, but the system of checks previously mentioned and the exercise of discretion based upon personal knowledge of the trapper enable the authorities to form a fairly accurate opinion of the actual population levels. The actual data submitted are presented in Table VII.

From the data in Table VII. the population growth for the Central District was graphed and the curve so obtained was examined. It was found to yield a formula of

$$P \text{ equals } \frac{4.5}{1 \text{ plus } 4.6e^{-0.7t}}$$

Where P is the population
t is the age of the population
e is a constant.

TABLE VII

BEAVER CENSUS AND HARVEST

CENTRAL TRAPLINE DISTRICT

1942 - 1950

Trapline Group	Numbers of Beaver Houses Found Occupied.							
	1942	1943	1944	1945	1946	1947	1948	1949
Cormorant Lake	28	65	79	99	135	96	115	99
Herb Lake	110	357	516	672	802	778	658	729
Wabowden	113	249	406	489	565	462	811	617
Thicketonei	387	879	1284	1529	1808	1918	1979	2193
Ilford	21	73	78	83	129	157	176	163
Cranberry	96	209	256	301	388	396	472	533
Sherridon	47	170	215	247	323	342	355	438
Flin Flon	18	52	54	72	106	107	108	134
Total houses Central District	820	2054	2888	3492	4256	4256	4684	4006
Total harvest Central District	Nil	504	1738	2560	3372	3462	4138	4866

Total Houses Central District 1950 -- 4648 (Group returns not available)

Total Harvest Central District 1950 - 4145

Note: the above census figures were obtained in the fall of the year noted, the harvest being taken in the spring.

Extrapolation, in 1948, produced the logistic curve shown in Figure 12, with an upper asymptote of approximately 4,500 houses. Subsequent additions of datum points for the years 1948, 1949 and 1950 were found to fit satisfactorily.

Allee et al, (1949, p 326) show that population stability is rarely a static effect but rather an oscillation about a mean represented by the upper asymptote.

It will be observed that the beaver population of the Central District appears to be conforming to this rule.

Curves were similarly plotted for the three central groups of the district and for one at either end in order to compare the population growth in the better districts with that in the poorer marginal areas. It will be noted that in each case, despite the considerable differences in total population achieved, the patterns of growth were similar and that a fair approximation of the Pearl curve was obtained for each area. Figures 13, 14, 15, 16 and 17 represent the population growths for Thicketonei, Wabowden, Herb Lake, Ilford and Flin Flon groups respectively.

It will also be observed that, due presumably to the absence of early data on the population life of the groups, the initial, slow growth phase is not clearly marked in all cases.

The study was then carried to the level of individual traplines and curves were plotted for the data of one hundred and fifty lines in five groups. All lines for which data had been kept completely or nearly so were included in this study. In some cases, due to such accidents as the death or illness of the trapper, reports for a year were missing from

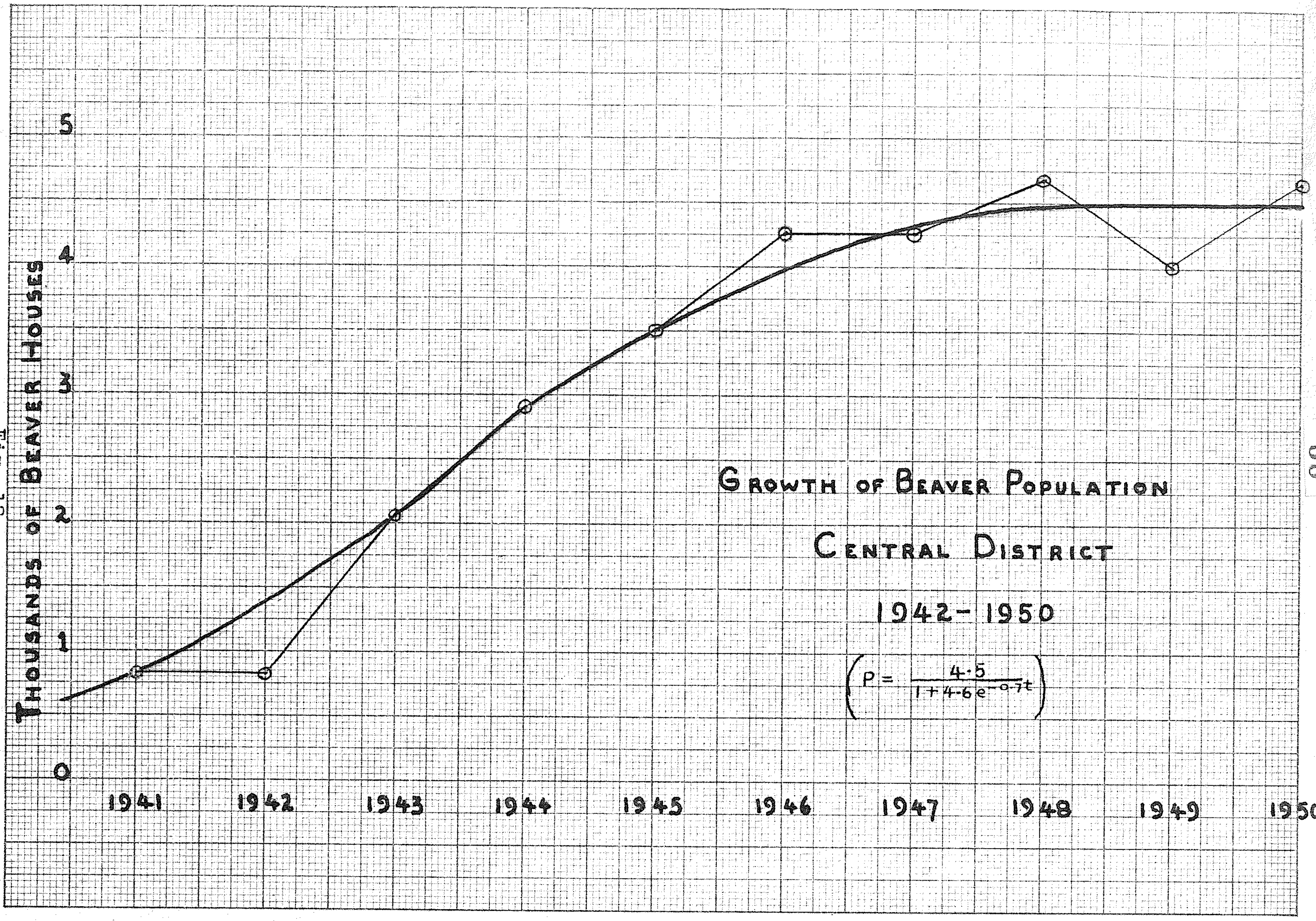
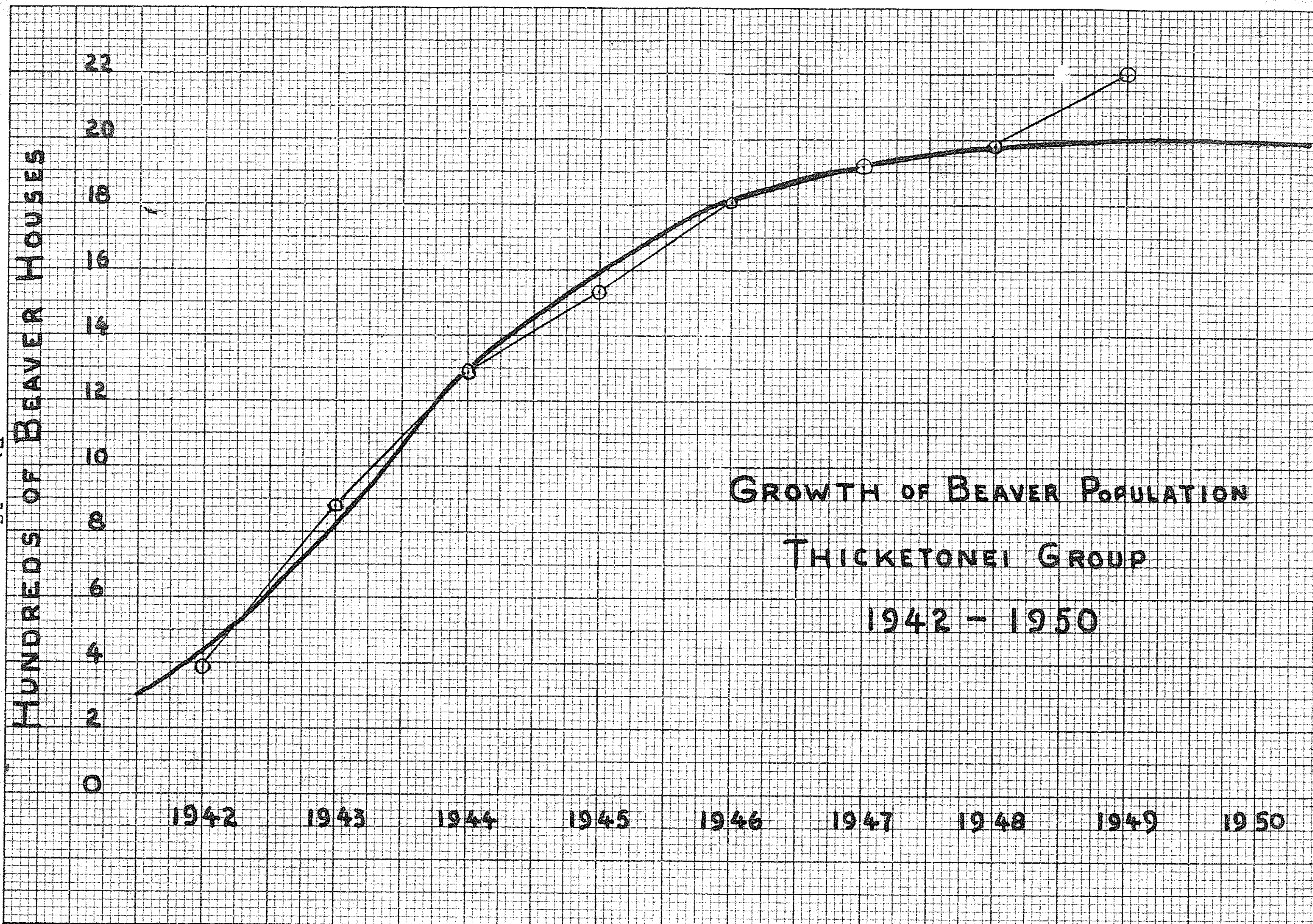

Thousands of Beaver Houses
0
1
2
3
4
5
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
Growth of Beaver Population
Central District
1942-1950
$\left(P = \frac{4 \cdot 5}{1 + 4 \cdot 6 e^{-0 \cdot 7t}}\right)$

Fig. 12



GROWTH OF BEAVER POPULATION
THICKETONEI GROUP
1942 - 1950
HUNDREDS OF BEAVER HOUSES
0
2
4
6
8
10
12
14
16
18
20
22
1942
1943
1944
1945
1946
1947
1948
1949
1950

Fig. 13

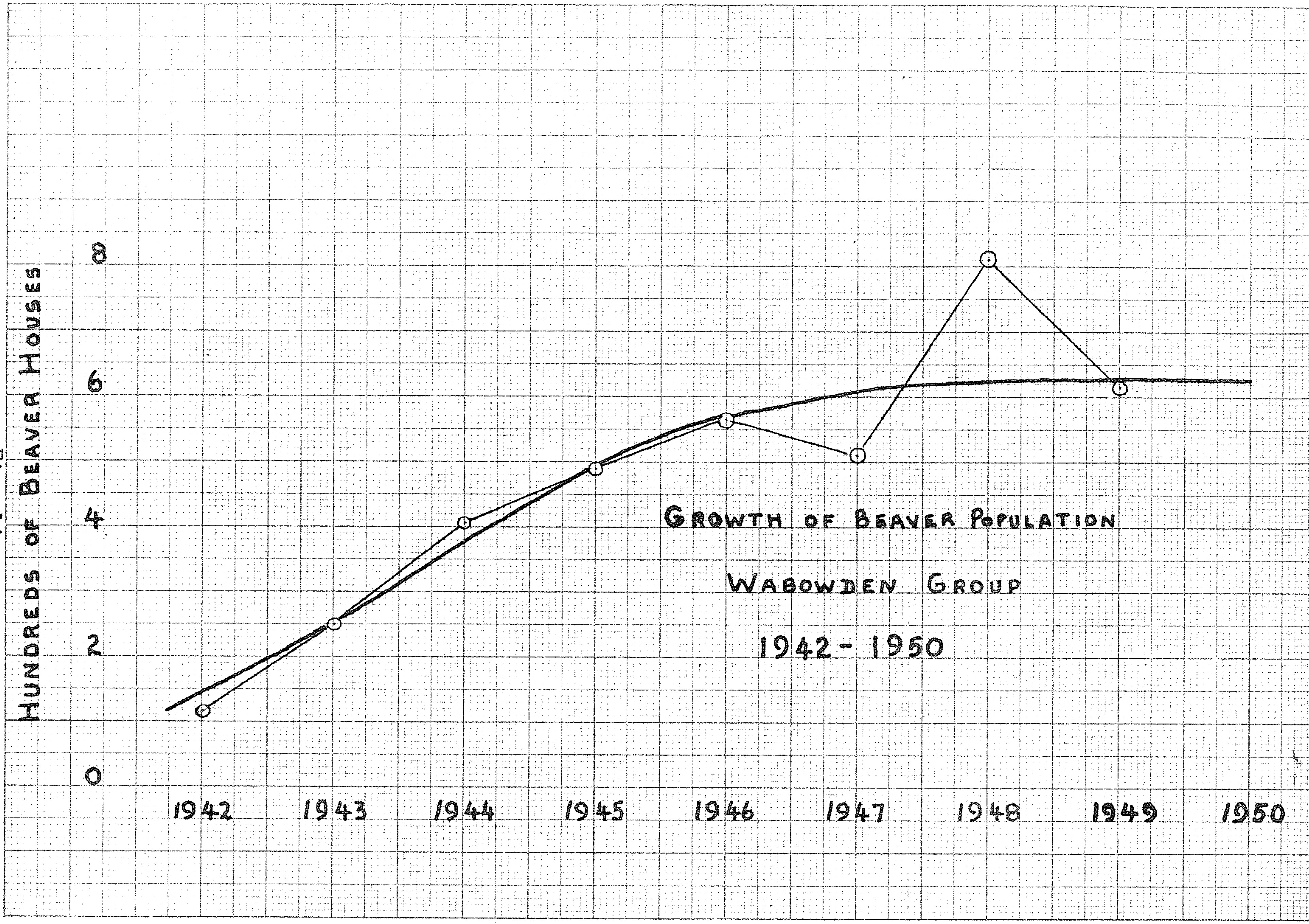

GROWTH OF BEAVER POPULATION
WABOWDEN GROUP
1942 - 1950
HUNDREDS OF BEAVER HOUSES
0
2
4
6
8
1942
1943
1944
1945
1946
1947
1948
1949
1950

Fig. 14

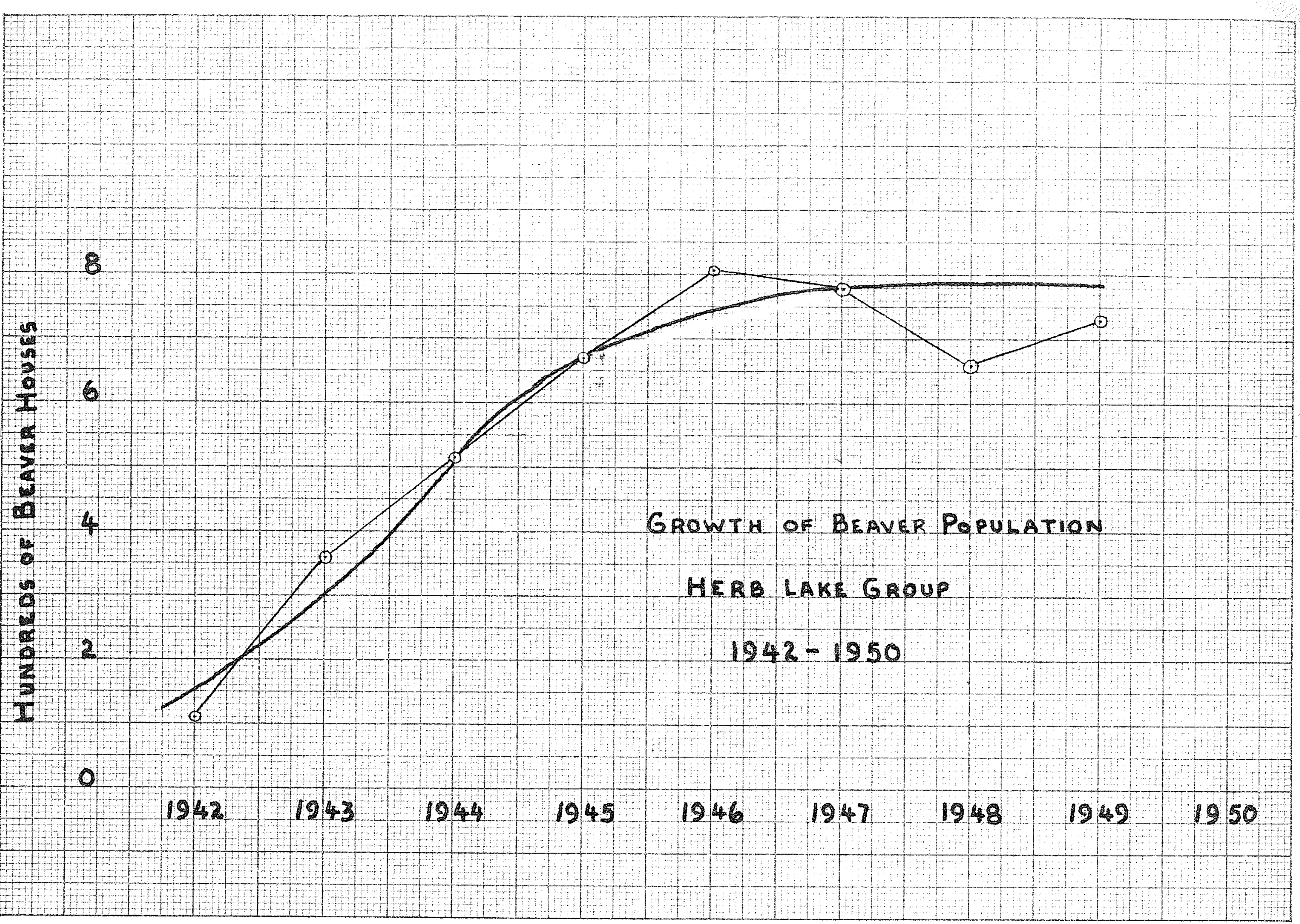
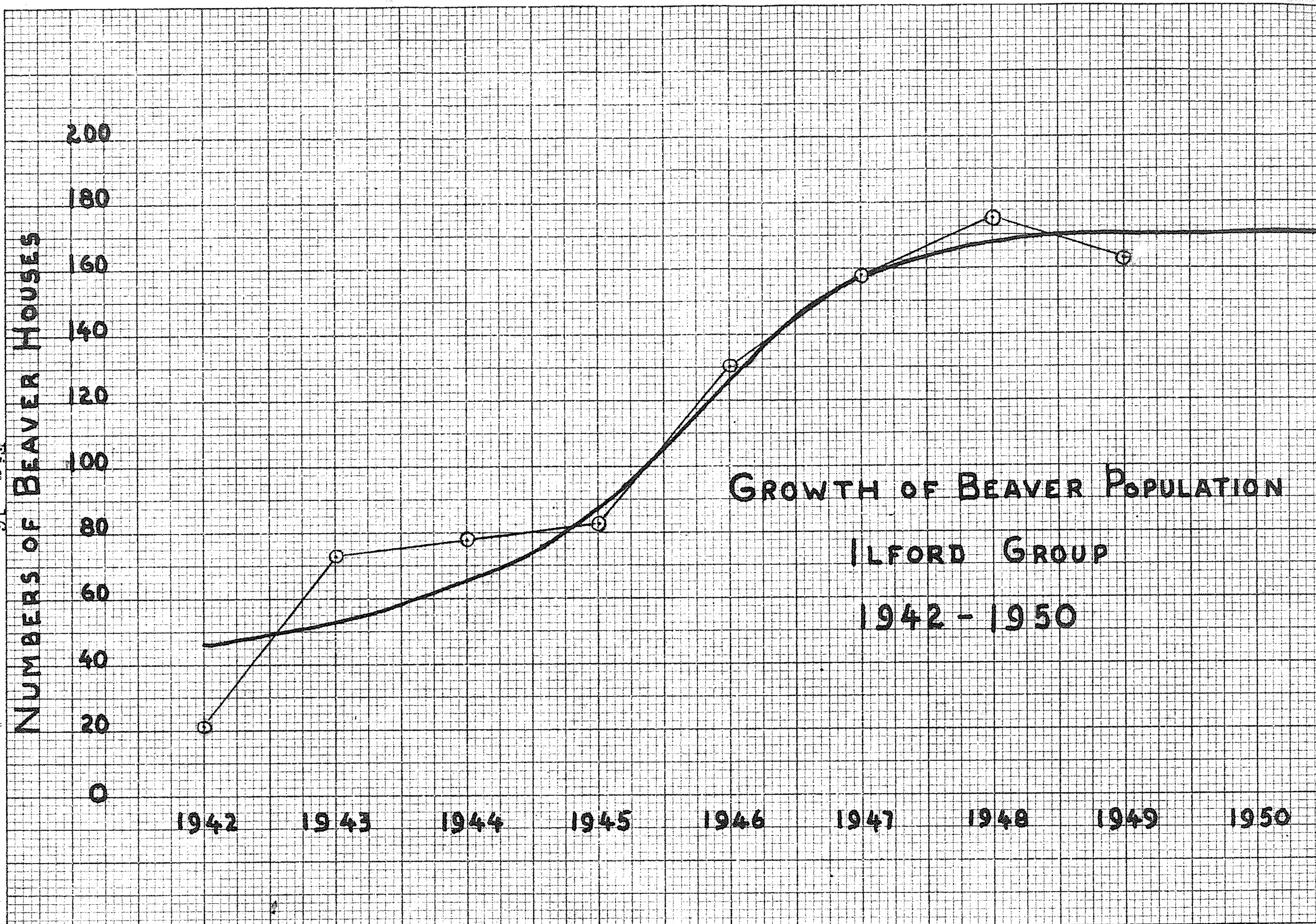
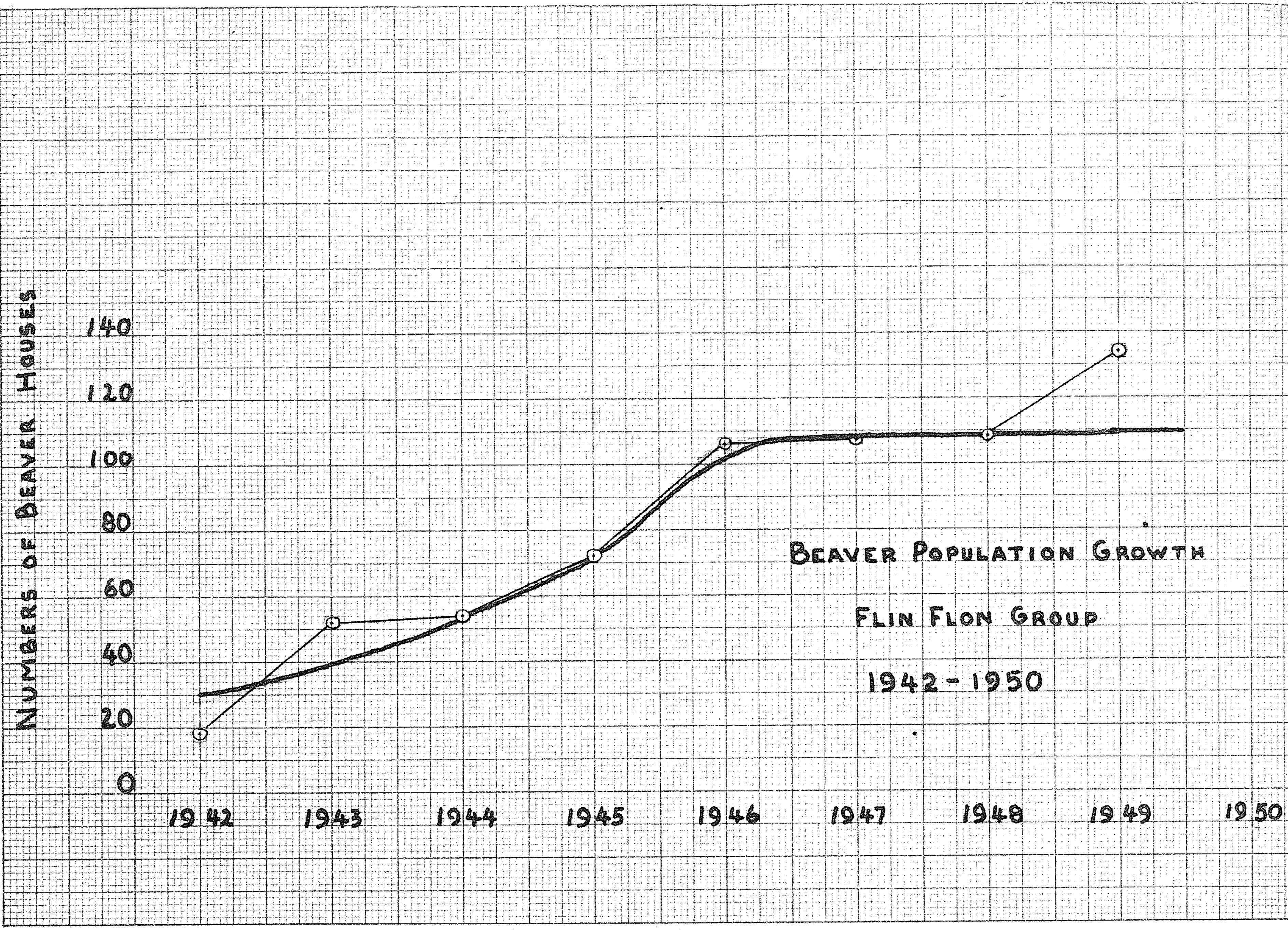

GROWTH OF BEAVER POPULATION
HERB LAKE GROUP
1942 - 1950
HUNDREDS OF BEAVER HOUSES
0
2
4
6
8
1942
1943
1944
1945
1946
1947
1948
1949
1950

Fig. 15



Growth of Beaver Population
Ilford Group
1942 - 1950
Numbers of Beaver Houses
200
180
160
140
120
100
80
60
40
20
0
1942
1943
1944
1945
1946
1947
1948
1949
1950

FIG. 17


Numbers of Beaver Houses
140
120
100
80
60
40
20
0
1942
1943
1944
1945
1946
1947
1948
1949
1950
Beaver Population Growth
Flin Flon Group
1942 - 1950

the record, but usually this gap could be bridged successfully.

The curves so obtained were examined and the lines classified according to their degree of conformation to the typical Pearl curve. The criteria applied were these:

Excellent--those lines whose data produced typical Pearl curves and showed no marked deviation of datum points from the curve.

Good--those lines whose data produced typical Pearl curves but which showed one or two deviations of the datum points from the curve.

Fair--those lines whose data produced typical Pearl curves but which showed wide distribution of the datum points about the curve.

Poor--those lines whose data failed to conform to the Pearl curve.

Among the latter group the writer was able to identify several lines where the physical condition of the trapper was below par, others where there had been frequent changes of trappers and still others where the trapper was a man of doubtful industry or integrity.

Table VIII shows the distribution of traplines in the defined groups.

The degree of conformation of the data to the Pearl curve is significantly high. It is noted that only 21% of the lines failed to show conformation and that 15% showed excellent conformation. The impressive total of 79% which conformed, more or less, to the Pearlcurve would appear to show that the pattern of growth is well marked, even down to the individual trap line.

Inclusion of all the curves plotted would make this paper unjustifiably bulky. Two examples of the curves for individual lines are shown in figures 18 and 19 for lines number 58 and 15 respectively in the Ticketonei Group.

Number 58 yielded an almost perfect example of the Pearl curve through all its phases and gives a valuable picture of the population history and status for that line.

Number 15, on the other hand is an example of failure to conform to the Pearl curve. The history of this line is known to the writer and provides an explanation of the irregularity of pattern shown.

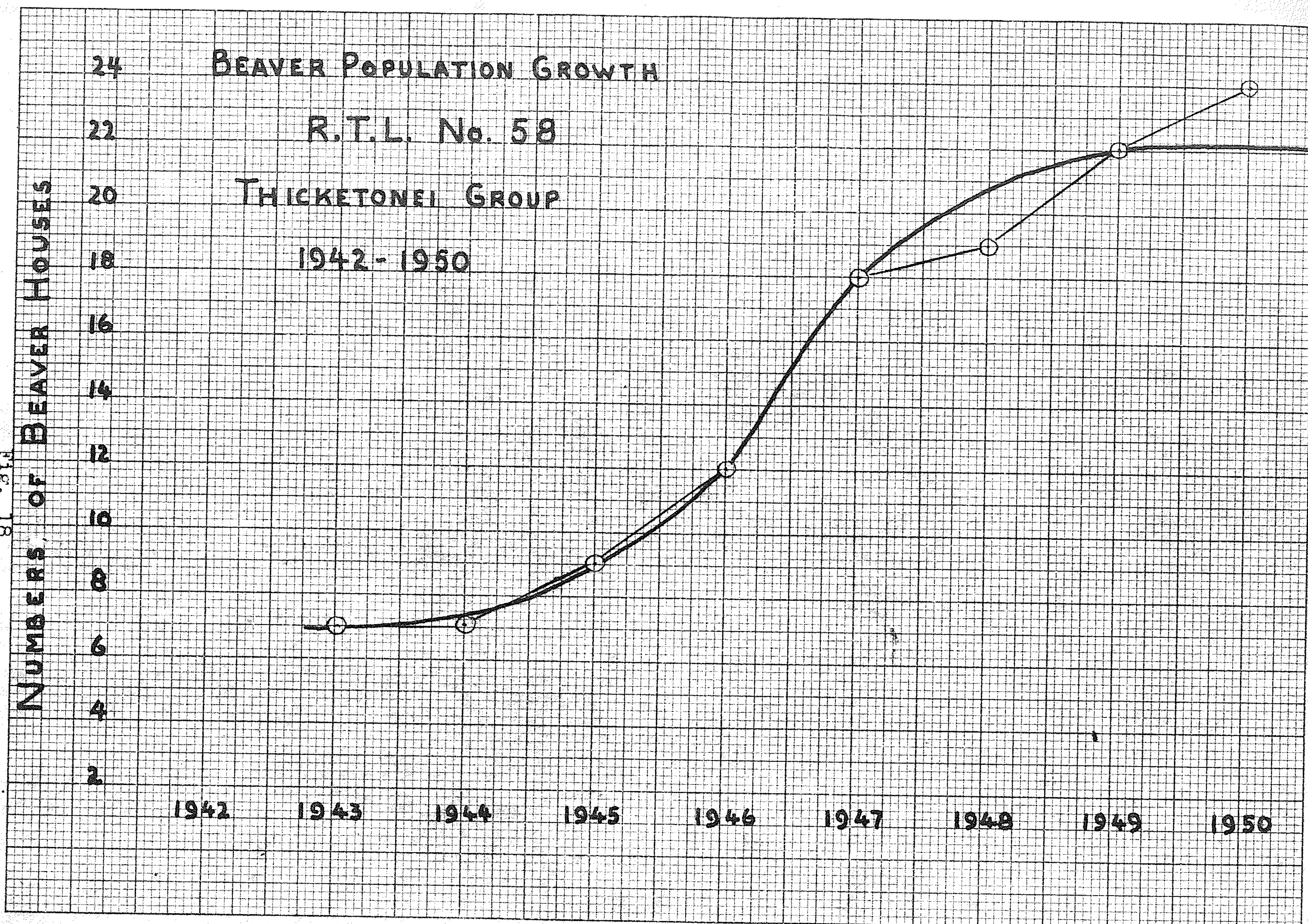

BEAVER POPULATION GROWTH
R.T.L. No. 58
THICKETONEI GROUP
1942 - 1950
NUMBERS OF BEAVER HOUSES
24
22
20
18
16
14
12
10
8
6
4
2
1942
1943
1944
1945
1946
1947
1948
1949
1950

Fig. 18

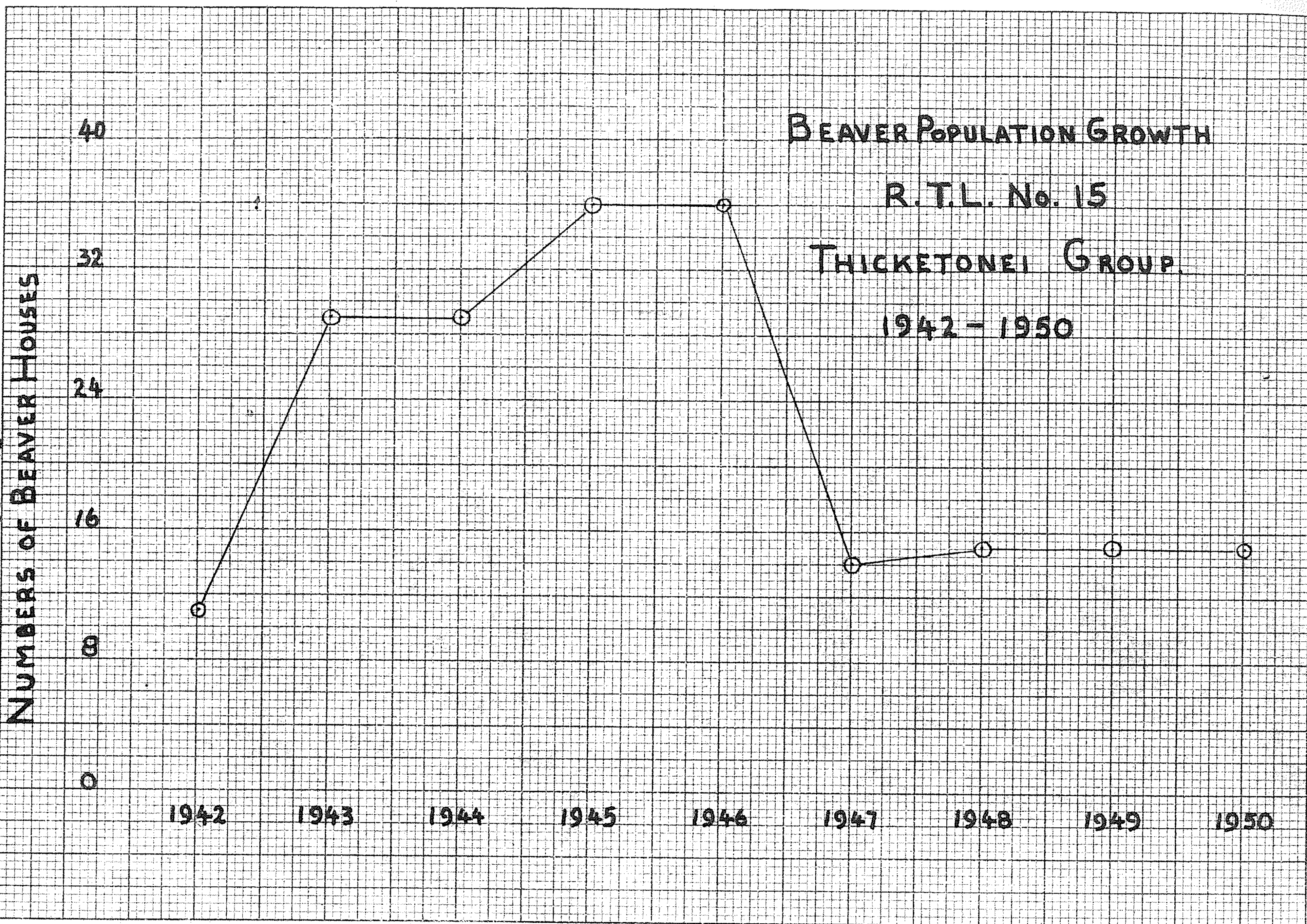

BEAVER POPULATION GROWTH
R.T.L. No. 15
THICKETONEI GROUP
1942 - 1950
NUMBERS OF BEAVER HOUSES
40
32
24
16
8
0
1942
1943
1944
1945
1946
1947
1948
1949
1950

Fig. 15

The trapper to whom this line was leased from 1942 until 1947 was also engaged in trading in the local settlement. Acting upon information of irregularities in the operation of the line, the authorities conducted a check of occupied houses and discovered evidence of gross misrepresentation of fact and exaggeration of the number of houses present. As a result the trapper was removed from the line and it was left untrapped for one season. Since that time a small quota has been allowed to an elderly Indian whose infirmities do not allow him to make the efforts necessary for proper census taking. The graph shows the point at which the original trapper was removed and also shows the unlikely repetition of the same house count for four successive years, probably attributable to the Indian's relative inability to travel and his submission, year after year, of the figure established by the official check.

The data from which Figures 18 and 19 were prepared are presented in Table IX.

TABLE IX.

CENSUS DATA FOR TRAPLINES NO. 15 and 58

THICKETONEI GROUP

1942-1950

Trapline No.	Number of Occupied Beaver Houses								
	1942	1943	1944	1945	1946	1947	1948	1949	1950
15	11	29	29	36	36	14	15	15	15
58	--	7	7	9	12	18	19	22	24

TABLE VIII

CONFORMATION OF GROWTH RATES OF TRAPLINE POPULATIONS

OF THE CENTRAL DISTRICT

TO THE TYPICAL PEARL CURVE

GROUP	CLASS	REGISTERED TRAPLINE NUMBER	% OF GROUP IN CLASS
Thicetonei	Excellent	3, 13, 33, 42, 44, 49, 53, 56, 58,	16%
	Good	9, 11, 22, 25, 29, 31, 39, 40, 41, 43, 47, 50, 54, 59, 63,68.	28%
	Fair	8, 10, 14, 16, 20, 26, 27, 30, 32, 34, 35, 36, 37, 48, 52, 60, 66, 67	31%
	Poor	4, 7, 12, 15, 19, 21, 23, 24, 28, 38, 46, 55, 57, 64, 65	25%
Wabowden	Excellent	17, 19,	10%
	Good	10, 12, 13, 15, 16, 18,	30%
	Fair	1, 2, 3, 6, 7, 8, 9, 20	40%
	Poor	4b, 11, 14, 21	20%
Herb Lake	Excellent	7, 19, 25, 30.	14%
	Good	1, 8, 10, 11, 13, 18, 21, 31,	26%
	Fair	2, 3, 4, 5, 9, 12, 14, 17, 22, 23, 26.	36%
	Poor	6, 15, 16, 20, 28, 29, 32,	24%
Cranberry	Excellent	8, 14, 17, 23	19%
	Good	9, 12, 19, 20, 21, 25, 26, 27.	38%
	Fair	10, 20, 22, 24, 28.	24%
	Poor	2, 18, 31, 35.	19%
Sherridon	Excellent	2, 10, 17,	14%
	Good	4a, 5, 6, 7, 12, 13, 20, 23, 24, 25.	48%
	Fair	1, 18, 19, 21, 22, 26.	29%
	Poor	16, 27.	9%
District Totals	Excellent	22	15%
	Good	48	32%
	Fair	48	32%
	Poor	32	21%

The fact appears to be established that the beaver populations of northern Manitoba increase according to a pattern best expressed by the Pearl curve. This being the case, the carrying capacity of any line, group or district may be determined by consideration of the stage of development of the appropriate graph. This method is of considerable value under the conditions of large, heterogeneous range and small staff which are found in the beaver producing parts of the Province. One disadvantage of the system lies in its <u>post facto</u> nature for the population must have been established for some time in order to provide sufficient data for curve plotting. Thus it could not be used to determine the suitability of an area for beaver transplanting.

The principal application of this system is in the determination of trapping quotas. It is imperative that overstocking be prevented and a consideration of the graph of any line should enable the game manager to decide whether such overpopulation was likely and to take measures to correct such a tendency.

CHAPTER IX

CONCLUSIONS.

The writer has presented various data and observations in connection with the beaver population of northern Manitoba. These have been discussed in the body of the thesis and the conclusions reached have been appended to the chapters concerned. It is considered worthwhile, hoever, to repeat, for the sake of emphasis, certain statements made earlier and briefly to review the salient points of the discussion.

The beaver, a native of the deciduous forest, is now found in considerable numbers in areas of which the climax vegetation is black spruce.

This invasion by a practically exogenous species has been made possible by the appearance of quantities of aspen poplar in the spruce habitat and the densities of beaver population are directly related to the distribution and abundance of aspen poplar.

The poplar is largely the result of fires which have destroyed the spruce and initiated a succession which includes a poplar sere.

This poplar is not a permanent factor of the habitat and yields to spruce, the process being accelerated by the destruction of poplar by feeding beaver. The poplar will not perpetuate itself and when utilized is lost to the beaver unless some steps are taken to destroy the replacing spruce and reinstitute the normal succession.

The greatest threat to the beaver is the beaver himself. Overpopulation will cause destruction of the habitat and bring about a decline in population.

The growth of the beaver population has been greatly accelerated by the controlled trapping found under the Registered Trapline System and it now so remains to control as to produce the maximum sustained yield of pelts.

Predation of the beaver appears to amount to about fifty percent of each years increase, the bear and wolf being largely responsible. Wolf control programs are currently in operation to reduce one source of predation to the minimum.

Parasites of beaver appear to be negligible, except in rare cases of immature animals.

Disease has caused some local losses but the beaver appears to be free from sweeping epizootics such as are found among muskrats.

A major problem of management is the determination of the carrying capacity of the habitat. Two methods have been suggested, determination of the number of unoccupied potential sites and consideration of the pattern of population growth which appear to follow the plan described by Pearl.

LITERATURE CITED

Alle, W. C. et al, 1949, Principles of Animal Ecology. Philadelphia: W.B. Saunders Co.

Anthony, H.E., 1928, Field Book of N.A. Mammals. New York: Putnams.

Bailey, Vernon, 1922, Beaver Habits, Beaver Control and Possibilities in Beaver Farming. U.S. Dept. of Agric., Bull. No. 1078: Washington Govt. Printing Office.

Barkalow, F.S., 1940, Industrious Beaver is Returning to This State: Alabama Game and Fish News, pp. 5-9.

Bradt, G.W., 1947, Michigan Beaver Management, Game Div. Michigan Dept. of Conservation.

Couch, Leo K., 1942, Trapping and Transplanting Live Beaver. U.S. Fish and Wildlife Service, Conservation Bull. 30: U.S. Govt. Printing Office, Washington.

Erickson, Arnold B., 1944, Parasites of Beavers. The American Midland Naturalist, 31)3): 625-630.

Grange, Wallace, 1947, Practical Beaver and Muskrat Farming. The Sandhill Press. Babcock Wisconsin.

Grasse, J.E. and Putnam, E.F., Beaver Management and Ecology in Wyoming. Bull. No.6, Wyoming Game and Fish Commission, Cheyenne, Wyoming.

Harrison--J.B.D., 1934, The Forests of Manitoba. Dept. of the Interior Canada., Forest Service--Bull 85. Ottawa: The King's Printer.

Hensley, A. L., 1946, A Progress Report on Beaver in California. Calif. Fish and Game, 32(2):pp. 87-99.

--------, and Fox, B.C., 1948, Experiments on the Management of Colorado River Beaver. Calif. Fish and Game, 34 (3): pp 115-131.

Leopold, Aldo, 1933, Game Management. New York: Scribner's

Miller, G.S., 1923, List of N.A. Recent Mammals. Washington Govt. Printing Office.

Pearl, Raymond, 1930, The Biology of Population Growth, New York Knopf.

Pratt, H.S., 1929, Manual of the Vertebrates of the U.S. New York: Blakiston's.

Moore, G.S. and Martin E.C., 1949, Status of Beaver in Alabama Ala. Dept. of Conservation.

Rasmussen, D.I., 1940, Beaver-Trout Relationships in the Rocky Mountain Region. Trans. of the Fifth N. Am. Wildlife Conference: 257-263.

------, and West, Nolan, 1943, Experimental Beaver Transplanting in Utah. Trans. of Eighth N.Am. Wildlife Conference: 311-318.

Shaw, S.P., 1948, The Beaver in Massachussets. Fed. Aid in Wildlife Restoration, Project No. 5-R

Swank, W. G., 1949, Beaver Ecology and Management. Conservation Committee of W.Fa.: Charleston,W.V.

Tappe, D.T., 1942, The Status of Beavers in California. State of Calif., Dept. of Natural Resources Division of Fish and Game.

Morgan, B.B., 1949, Tularemia (Rabbit Fever) in Wisconsin. Wisconsin Medical Journal, June, 1949.