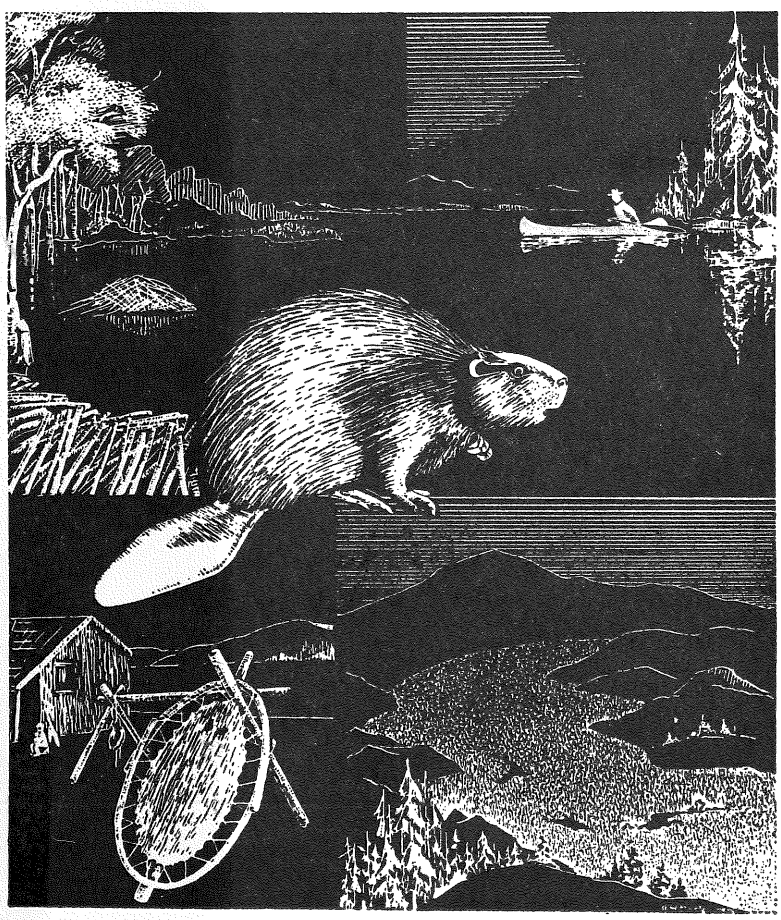
THE Beaver in Minnesota



MINNESOTA DEPARTMENT OF CONSERVATION
Division of Game and Fish

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Beaver in Minnesota

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INTRODUCTION

The beaver is among the most interesting of Minnesota mammals and one that was of great importance in the early history and economy of the State. Today beaver pelts are still a valuable natural resource and beaver management is an important aspect of wildlife conservation. Because of its habits, the beaver must often be considered in plans for land and water use and in the over-all management of fish and wildlife. There is a long history of beaver management in Minnesota, and much investigative work has been done on this semi-aquatic animal. The present bulletin attempts to summarize this information, much of which has previously appeared only in mimeographed Minnesota Pittman-Robertson Quarterly Reports, and to relate the findings about the beaver in Minnesota to those that have been made elsewhere.

The authors are indebted to the late Dr. Arnold B. Erickson, Supervisor of Game Research in Minnesota for many years, who made the initial plans and outline for this bulletin, and to many persons who supplied information for it. They include game biologists who have studied the beaver, game wardens who have gathered information on beaver populations and who have coped with many beaver complaints, conservation administrators who have struggled with the ever-recurring "beaver problem", and even fisheries workers, who sometimes have found beavers troublesome in trout streams.

Several very useful bulletins on beaver have been published by other states. With the permission of the authors and their organizations, pertinent portions of two of these have been used in the present bulletin. Appendix II (pages 65 to 77) entitled "A Guide to Beaver Trapping and Pelting" is, for the most part, by Keith G. Hay and William H. Rutherford of the Colorado Department of Game and Fish. Appendix III (pages 78 to 80), entitled "Grading of Beaver Pelts and Manufacture of Fur Coats", is from Technical Bulletin No. 1 of the West Virginia Conservation Commission and is used with the permission of the author, Wendell G. Swank.

As a bit of zoological background, the Minnesota beaver is, of course, the well-known and widely distributed American beaver *(Castor canadensis)*. It is closely related to and possibly the same species as the European beaver *(Castor fiber)*. The beaver is a rodent or gnawer (Order Rodentia; Sub-order Sciurineae; Superfamily Castoroidea; and Family Castoridae) and is one of the largest of the rodents, the body of an adult being about 30 inches long and the flat tail an additional 12 to 16 inches. Its common name is but slightly modified from the Anglo-Saxon "beofor", and the Latin generic name, "Castor", refers to one of the twin sons of Zeus, Castor and Pollux, who were, according to classical mythology, the guardians of sailors in ancient Greece.

Several other kinds of beavers, long extinct, are known as fossils. In America, fossil beaver of the genus *Eucastor* were about half the size of our beaver. There was also a giant beaver *(Castoroides ohioensis)* which was as large as a black bear. The left half of a lower jaw of one of these animals was found by excavators in Minneapolis in 1879, and in 1937 much of a skeleton of an immature animal was found at Hidden Falls in St. Paul. The restored skeleton can be seen at the St. Paul Science Museum, and details concerning it are given in the paper of B. R. Erickson.[16] Other fossil beaver include *Trogonotherium* of India and *Steneofiber* and *Chalicomys* both found in Europe.[28]

But it is the living and lively American beaver with which we are concerned. In many ways it is a most remarkable animal and one, which like the bison, played an important role in the early history of America. The beaver has been the subject of much natural history as well as a considerable amount of unnatural history, fancy and folklore. For an example of the latter, the reader is referred to the account of beaver and its habits by the early Minnesota explorer, Count Giacomo Beltrami which was reprinted in the June 1941 issue of the Conservation Volunteer. It is hoped that the following pages will help set the record straight and, more important, provide a sound basis for the management of this valuable furbearer.

The Fur Trade

Paul Bunyan was not the first legendary figure to stalk across the Minnesota wilderness. Before him came the paddling voyageur: the French fur trader, hunter, and trapper. He travelled the waterways by canoe, often accompanied by Indians. It was the voyageur who founded the Beaver Trade.

The Beaver Trade, often called the Fur Trade, began on the east coast around 1600; especially in New England and French Canada. Jean Nicolet, in 1634, paddled westward through the Great Lakes to the Sault Sainte Marie, and became the first white man to explore Wisconsin. He was an agent of the French proprietors of Wisconsin for the promotion of the Fur Trade. The Trade reached Minnesota when Pierre Esprit Radisson, along with Medard Chouard des Groselliers, came from Quebec in 1655 and travelled by canoe through the rivers and lakes. He returned with $100,000 worth of furs—then a fantastic amount. As a result of the efforts of Radisson the Hudson's Bay Company was founded in 1670.

Daniel Greysolon Duluth journeyed to the head of Lake Superior in 1678 to explore the western wilderness. He endeavored to ally the Assiniboine and the Sioux with the French for fur trading. During the course of his travels, in 1680, he liberated Father Hennepin and two companions from captivity by the Sioux Indians at Lake Mille Lacs.

In 1688 Jacques de Noyon was the first to traverse the chain of lakes that lie along Minnesota's northern boundary and which soon became an important fur-trading route. De Noyon set out from Lake Superior and, under the guidance of Assiniboine Indians, passed through Rainy Lake (then called Lake of the Crees) and wintered on its outflowing river called the Takamaniouen (evidently the Koochiching or Rainy River).

In 1731 Pierre Gaultier de Varennes, better known as Sieur de la Verendrye, arrived at the Pigeon River and the Grand Portage. He travelled up the border lakes and across Lake of the Woods to build Fort St. Charles at the tip of the Northwest Angle. Verendrye has been called the founder of the Fur Trade in northern Minnesota, Manitoba and Saskatchewan. The trading posts he established extended the Fur Trade from the Pigeon River and Rainy Lake to the Saskatchewan and Missouri rivers.

The outpouring of furs from this untapped central region caused the New England Fur Trade to decline by 1764. At this time, beaver and other fur-bearers were becoming scarce in the East, and traders there could not compete with the high quality and lower-priced furs of the Hudson's Bay Company.

The Fur Trade in the Minnesota region boomed in 1775, when nine fur-trading applications were authorized. It was a fur-trader, Alexander Henry, who named Gooseberry Falls in this year. The famous fort at Grand Portage was built in 1783 by the Northwest Fur Company, and this firm operated it until 1803. At Fort Charlotte, four miles to the east, the XY Company also had a post. The Northwest Company established posts at Fond du Lac, 12 miles east of Duluth, in 1792 and at Big Sandy Lake two years later.

By the early 1800's there were signs that beaver were diminishing in numbers. Disease, forest fires, and even wolverines were blamed for the decline,[43] but the unrestricted harvest fostered by strenuously competing companies received little consideration. Along the Red River, scarcity of beavers was mentioned in 1805 in the journals of Alexander Henry. Between 1801 and 1808 the taking of beavers was extended westward and Indian bands under Henry's direction brought in about 7,000 pelts from the Red River and its tributaries in what is now North Dakota.[5] G. N. Rysgaard says, "In the reports of the Hudson's Bay Company for the region of Lac La Pluie (Rainy Lake), it is found that a beaver population crisis existed in what is now known as the Rainy Lake region as far back as the early 1800's".[52]

The Lac La Pluie reports for the years 1822-26, which have been published by Rysgaard with the permission of the Governor and the Committee of the Hudson's Bay Company, state: "Beaver . . . has been diminishing for these several years past, especially on the south side of Rainy Lake . . . Rainy Lake River and Lake of the Woods. . . . The sudden decrease of beaver (now nearly extinct) which took place in the beginning of the present century (is attributed to) . . . the great fires during the two dry summers of 1803-04 when the whole country almost from one extremity to the other was in a continual blaze and stopped only by the snows of autumn."

According to Rysgaard, "Undoubtedly the first concerted effort to protect and conserve the beaver population in lands now included in the Minnesota boundary, were those efforts by the Hudson's Bay Company officials who attempted to convince the Indians at this time that it was an "absolute necessity" to refrain from killing beaver for a few years. The Lac La Pluie report for 1826-27 mentions that the Rainy Lake Indians began to follow their advice but the Sturgeon Lake Indians came into the region and took beaver from "resting lodges".

By 1820 the heyday of the French Voyageurs and Couriers de Bois was near an end in Minnesota, and the fur brigades began to descend upon the west coast. The first parties of trappers arrived in California in 1827.[69] Fur brigades of as many as 200 men from Fort Vancouver were sent into California by the Hudson's Bay Company each year from 1828 to 1845 and in

1850 a party was said to have taken 1800 beaver from one valley. The "mountain men" who led the way west across the great plains were mostly beaver trappers.

Although we speak of trappers and trapping in connection with the Fur Trade, it should be realized that steel traps were almost non-existent before 1800. Indians, who supplied most of the fur for the trade, used many methods for taking beaver: pitfalls, deadfalls, nets, snares, arrows, and bullets. Early white trappers also used these Indian methods. The modern steel trap, invented by Newhouse in 1823, was not generally available until after 1850.

After the war of 1812 the American Fur Company took over the posts established by the Canadian Companies, and this company amassed the fortunes of the John Jacob Astor family. In our region the Fur Trade came to a halt with the demise of The American Fur Company in 1842. In Minnesota, beaver were recovering by 1850, probably as a result of the declining fur industry and growth of aspen stimulated by fires.[67]

The contribution of the beaver to the early development of the United States is well summarized by Helenette Silver in her history of New Hampshire game and furbearers:[60]

> The beaver stands high as a figure of importance in history and should perhaps share with George Washington the title Father of His Country. The beaver built Colonial America and Canada; in recognition, a beaver has been used as the emblem of the Dominion, but the millions of beavers who gave their lives for the United States are heroes unsung.
>
> All through the pattern of international intrigue and almost continuous warfare between nations and tribes, which made up the first half of the period of white man's occupation of America, is woven the pelt of this little Empire Builder.
>
> There were able historians among the Pilgrim Fathers who have gradually led us to believe that the basic reason for colonization was the search for religious freedom. The Pilgrims were a rather special case, but, even the Plymouth Colony did not hesitate to exploit its natural resources. Trade with the Indians commenced at the very first meeting with Samoset, and before 1636 the beaver trade had paid all the debts of the colony.
>
> By far the greater majority of colonists were motivated by hope of material gain. This was particularly true in New Hampshire, whose proprietors were opponents of Puritanism and supporters of the King, receiving their grants as a reward for their loyalty. The great objective of colonization was clear, simple, and uncomplicated by any moral principles: it was the acquisition of wealth, and the colonists were in a hurry to get it. They expected treasure—gold, gems, and furs. In New Hampshire, at least, they spent a good deal longer looking for them than they should have before they finally buckled down and started ploughing.
>
> In all of the colonies, most of the dreams gradually faded; there was neither gold nor jewels, but there was fur. The greatest single reason for exploration of the continent was the search for it. From East to West, from South to North, and far beyond the present boundaries, the trappers found beavers by the millions. There were estimated to be 60,000,000 in North America before the coming of the Europeans.
>
> With so many of them it was inevitable that beaver should exert a profound influence on their surroundings. There are few phases of life from conservation to high society with which the beaver was not concerned. Without it the American language would not now know the symbolic "Mrs. Astor", which stands for every-

thing correct, formal, a little snobbish, and above all—rich. Founding of the Astor millions and other fabulous fortunes are among the lesser items in the credit account of the beaver.

Trappers moved in ahead of the pioneers and sometimes the beaver were already gone before the towns were settled. On the foundation of the fur trade was built the richest continent in the modern world, and supreme among the furbearers was the beaver. So important were they that the whole peltry trade assumed their name, to go down in history as the Beaver Trade."

In our time beaver pelts have been of greatest value for women's fur coats. But it was the felt hat made from beaver fur that stimulated exploration of North America. In England, Charles I decreed in 1638 that only beaver fur could be used for manufacture of felt hats. Hat felt was made from inferior pelts and from underfur combed from better pelts.[3] The better pelts, with guard hairs intact, were made into stoles. A cape of beaver fur was a mark of distinction among the gentlemen, nobility, and clergy of Europe. So great was the demand that around 1800 about 200,000 beaver pelts a year were sent from America to Europe.

There were several causes for the decline of the Beaver Trade after 1800. About 1825 French silk hats began to replace beaver hats as the fashionable head gear. Then too, the cheaper fur of the coypu (nutria) came into use as a substitute for beaver fur. Pelts of millions of these large South American rodents were shipped to Europe from the La Plata region where they were taken by hunting with dogs. As a result the demand for beaver fur declined.

Figures compiled by Henderson and Craig[27] indicate the early growth, subsequent decline, and the recent recovery of trade in beaver pelts. In 1624, 400 beaver pelts were shipped from New York; in 1635, 15,000 and in 1671, 80,000. By 1800, when the trade was at its peak, between 100,000 and 500,000 pelts a year were shipped to Europe, mostly via "the St. Lawrence and Hudson's Bay". Take of beaver pelts continued at a fairly high level for more than fifty years, but most of the pelts came from increasingly remote regions. Between 1853 and 1857 Hudson's Bay Company sold, on the average, 118,000 pelts a year in London, but by the turn of the century, when protection of the beaver had become general, this company sold fewer than 40,000 annually.

By the 1920's beaver populations had come back, and in 1923-24 it was estimated that the annual catch in North America was about 200,000 pelts; mostly from Canada.[27] During recent years the harvest of beaver pelts from the United States has been between 175,000 and 200,000 each year (data compiled by the U. S. Fish and Wildlife Service). It appears, therefore, that the harvest of beaver pelts in North America (Canada and United States combined) is now as great as it was at the height of the early fur trade—about 400,000 to 500,000 a year.

There is a difference, however, for the present pelt harvest comes from a total beaver population that is undoubtedly smaller than it was under primitive conditions. The present take of pelts represents an annual harvest from managed and protected beaver populations. Under such management we can expect beaver populations to remain relatively stable for years to come. The trapping-out and moving-on of the early days has been replaced by population management and a reasonable annual harvest of fur.

It should be emphasized that the early extirpation of beaver from area after area, progressing westward across the country, was caused by year-round killing of the animals. There were no limits and no restrictions as to trapping seasons. When the fur was used mainly for felt, there was no need for pelts to be prime. The bulk of beaver pelts were taken in summer, and the more industrious trappers took as many as 400 beavers a year. In contrast, the present limit per trapping license in Minnesota is now 10 per year.

Famous Minnesota Fur Traders

There are nine fur traders after whom Minnesota counties have been named—Aitkin, Faribault, Morrison, Olmsted, Renville, Rice, Sibley, McLeod, and Brown. Other fur traders played important roles in Minnesota history.

William Alexander Aitkin came to the northwest about 1802 and married into an influential Indian family. In 1831 he took charge of the Fond du Lac Department of the American Fur Company which had headquarters at Sandy Lake. Later, 1842-1851, he established his own trading post in Morrison County at the mouth of the Swan River.

William Morrison entered the service of the XY Fur Company in 1802, coming to Grand Portage, Leech Lake, and the headquarters of the Crow Wing River. From 1805 to 1816 he was engaged at these trading posts for the XY and Northwest Companies, a coalition. Later he established a series of trading posts for the American Fur Company extending from Grand Portage westward to Lake of the Woods. He visited the Mississippi headwaters and Lake Itasca, then called Lac la Biche (Elk Lake), in 1803 and 1804. During his journeys as a fur trader he explored a large region of northern Minnesota. His younger brother, Allan, joined him in the fur trade and had charge of posts at Sandy Lake, Leech Lake, Red Lake and Lake Mille Lacs. At Crow Wing he was the first trader.

Jean Baptiste Faribault came to the northwest in 1798 and took charge of a Northwest Company post in Michigan. In 1803 he came from a post in Iowa to one at Little Rapids on the Minnesota River near the present towns

of Chaska and Carver. Later he moved to Prairie du Chien, Wisconsin, where he established his own fur business and still later moved to Pike Island near Fort Snelling. After 1826 Faribault traded for many years at Little Rapids. His son, *Alexander Faribault,* founded a trading post in Rice County near the city named after him. He traded with Indians on the Cannon River in 1826 and established posts at Waterville, Morristown and at a Sioux village on Cannon Lake.

Joseph Renville, who was of French and Indian descent, established a stockade on the east bank of the Minnesota River at Lac Qui Parle Lake in 1826. Previously he had operated a fur business which he sold to the American Fur Company.

David Olmsted established a trading post at Long Prairie in 1848 when the Winnebago Indians were transferred there by the Army. He became the first mayor of St. Paul in 1854.

Henry Mower Rice was an agent of the Chouteau Fur Company and came to Fort Snelling in 1839.

Henry Hastings Sibley, after whom Sibley County and the town of Hastings are named, was a partner in the American Fur Company. He arrived at Mendota in 1834, taking charge of a division of the company in which were 300 traders. He was elected Congressman of the Minnesota Territory in 1848 and became the first Governor of the State.

Martin McLeod was employed at the Fort Snelling Post in 1838, at a St. Croix Valley post the following year, at Big Stone Lake in 1843, and at Lac Qui Parle in 1846. He became a member of the first Legislature.

Joseph R. Brown was also a member of the first Legislature. He was licensed to operate a fur trading post "near Fort Snelling" in 1830-31. He traded at Lake Traverse during the years around 1837.

There were others in the fur trade whose names are commemorated in Minnesota geographic names and history. James "Bully" Wells was a trader at Little Rapids and later, in 1836, established a post at Okaman, a former village in Waseca County. In 1837 he moved to Lake Pepin where he traded for 16 years. He also founded a post at Wells Lake near Faribault. He was a member of the Territorial Legislature. Another, Joe Rollette, was employed at the Pembina post of the American Fur Company in 1840. He established the route of the Red River Carts from Pembina to St. Paul. His fame rests mostly in the legislative trick perpetrated by him whereby St. Paul and not St. Peter became Minnesota's capital.

The Beaver and Minnesota Geographic Names

Many Minnesota geographic names show the early general distribution of the beaver and its value to the pioneer economy.[72] In Cook County there are two Beaver Lakes, and there are two in Lake County. In Lake County the Beaver River runs through Beaver Bay Township (which is as large as eight ordinary townships) to enter Lake Superior at the town of Beaver Bay. The famous Kawishiwi River is said to mean "river full of beaver houses" in Ojibway. In St. Louis County there is a Beaver Lake, a Seven Beaver Lake, a Beaver Creek, and two Beaver Rivers, the one emptying into Bear Island Lake and the other running from Wild Rice Lake to the Cloquet River. In Koochiching County, Beaver Brook runs through Beaver Township into the Little Fork River.

Lake of the Woods County has a Beaver Dam Township, and there are Beaver townships in Roseau and Aitkin Counties. There are four Beaver Lakes in Itasca, and one each in Stearns, Ramsey, and Steele Counties. Itasca County has a Beavertail Lake and an Amik Lake (amik is the Chippewa word for beaver). Of other Beaver Creeks, one runs from Cass County through Wadena County into the Crow Wing River; one called Chapah or Chapali (beaver) Creek by the Sioux Indians in Renville County runs through Beaver Falls Township, past the town of that name, into the Minnesota River; a third, in Murray County, is tributary to the Des Moines River; a fourth, in Rock County, runs through Beaver Creek Township past the town of the same name and into the Big Sioux River in South Dakota. Fillmore, Houston, and Winona Counties also each have a Beaver Creek; tributaries respectively, to the Iowa, Root, and Whitewater rivers. In Winona County there is the vanishing town of Beaver which was plotted in 1856 by the first white settlers where a beaver dam obstructed the creek. Wright County once had a Beaver Dam Lake which is now dry.

Some geographical units that were once named after this animal are now called by other names. In Sherburne County, the numerous islands in the Mississippi were named the Beaver Islands by Zebulon Pike in 1805. Buffalo Lake and the Buffalo River in Clay and Becker Counties were originally named after the beaver by the Indians. The Lac Qui Parle River, although named after the "Lake which Speaks" by Indians and this name later translated into French, was called Beaver Creek by early fur traders.

In all, there are at least 40 Minnesota geographical entities named after this singular animal: including 4 towns, 7 townships, 16 lakes, 4 rivers and 9 smaller streams.

Many Indian names of natural features were adopted by the whites. Some of the names were left in the Indian languages while others were translated

into English. This has often been the fate of natural features named after the beaver. Indian names for the beaver varied among the tribes, but some of the variation is probably due to uncertainties of transliteration. The Ojibway or Chippewa word for beaver has been spelled "amik" or "ahmik" and the Cree word "ahmisk." The Minnesota Sioux or Dakota Indians called the beaver "chapah"; the Dakota Sioux "capa"; and the related Omaha tribe called it "zhaba".[5]

Beaver Values—Past and Present

The earliest traders found that an Indian would trade a beaver pelt for a knife, but later, as the Indians acquired a sharper sense of values, a pelt bought as many as five knives. Also it has been stated that to the bartering primitive Indian a musket was worth a pile of beaver pelts extending from the butt to the tip of the barrel.[3]

Fur prices have always varied with the whims of fashion and with economic trends. In recent years beaver furs, as well as furs of most other kinds, have had low value. Competition with garments made from synthetic fibers and changes in living habits have been important in the decline of fur prices. Synthetic furs need little care and are cheap to produce. And there is not too much practical need for a heavy fur coat in a world of air conditioning and heated automobiles.

During the present century prices of beaver pelts were highest in prosperous times following World War I, around 1920, and after World War II, in 1945. Pelts then brought as much as "$1.00 an inch". It should be explained that the "inch" used as a pelt measure is peculiar to the fur trade. The size of the pelt is determined by adding two pelt measurements in inches; from side to side and nose to tail. In 1920 a large pelt was worth as much as $65.00 and a small pelt, nearly $30.00. The average pelt price in New York was $40.70 in February, 1920, but the price dropped sharply in April and in the following year the average price was only $12.03.[27]

Payments for beaver pelts to Minnesota trappers, as reported by several fur buyers for the years 1939 through 1962, are listed in Table 7. During these years the value of the beaver peltry has ranged from about $56,000 to $337,000 with a total of $3,973,000 for the 24 years: an appreciable item in the State's economy.

Beavers have also been used for food. Indians ate beaver meat, and many early explorers and settlers enjoyed it. It is reported that Indians cooked the beaver in its skin. According to Vernon Bailey "The liver is large and almost as tender and sweet as that of a chicken or goose. The body meat has a rather gamy flavor but, if properly cared for, is excellent when cooked and was gen-

erally preferred by trappers to any other game, even in the early days when buffalo, elk, and deer were abundant."[4] The tail was an especial delicacy. C. E. Johnson who studied beaver in the Adirondacks wrote, "Personally, I have always made it a practice to eat the flesh of any beaver that I have taken and have, without exception, found it pleasant to the taste. My own preference with beaver, as with meat of other wild game, is to place the meat in a pan and fry it or broil it."[35] As late as 1918, 600 beaver carcasses were shipped to Toronto, Ontario, presumably for food.[27]

The castor or scent glands also have value. From the time of the ancient Greeks until quite recently castoreum, the reddish-brown oily content of the castor glands, has been used in medicine and perfumery. This liquid is also used in the making of scents or lures for trapping many kinds of animals: including beavers. Castoreum was valued at $10 to $20 per pound in 1915 and between 1858 and 1884 the Hudson's Bay Company sold 25,000 pounds.[27] Properly dried castor glands in recent years have been worth $6 to $7 a pound or $1.00 to $1.50 for the pair of glands from a mature beaver.[21]

Beaver in Itasca State Park

The story of beaver in Itasca State Park is of special historical interest to Minnesotans. Dr. T. S. Roberts, Minnesota's famous ornithologist, tells the story of their reintroduction into the Park.[48] Apparently there had been no beavers here for many years before the Park was established in 1891. Judge Wallace B. Douglas, after whom Douglas Lodge is named, learned in the summer of 1900, that the Superintendent of Algonquin Park in lower Canada had written Minnesota Governor John Lind offering to donate four beavers to the State. Judge Douglas, who was Attorney General and also in charge of the Park, requested they be accepted. In July, 1901, one live male and two live females arrived from Canada and were liberated on Schoolcraft Island. One male did not survive the trip. Apparently, publicity on this introduction was withheld, for in 1902, Dr. Roberts was greatly surprised to find two beaver dams on Nicollet Creek.

W. T. Cox, then State Forester, kept the beavers under close observation for the next 22 years and according to him, "By 1912 there were 50 houses, and beavers estimated to number 250 in Itasca Park, in spite of some poaching. A careful count in 1914 showed 92 inhabited houses, indicating about 460 beavers. In 1916 the count showed 127 used houses, and the beaver population was estimated at 635 or more. Trapping under permit was begun in the spring of 1917, but the increase was not all taken, as is shown by the estimates of 750 beavers in 1918 and 1,000 in 1921. The trapping, under careful supervision, was done when the lakes began to open up around the

edges early in spring, and by setting the traps at long distances from the houses mainly old male beavers were caught. The few adult females taken contained usually four embryos that apparently would have been born about the 1st of May, while some yearling females would have given birth to smaller families about the 1st of July. By this discrepancy in breeding time of old and young females, Mr. Cox correctly accounts for the fact that both large and small young are taken in fall, which trappers commonly explain by the theory that two litters of young are raised in a season by one female."[61]

Figure 1. Edge of active beaver dam above Squaw Lake, Itasca Park.

According to Laurence Hiner who studied the beaver here in the 1930's "During the fall and winter of 1934-35, W. S. Feeney . . . , Game Technician of this area for the National Park Service, reported 123 used and abandoned lodges and 750 individual beavers within the park area. In summarizing his survey, Feeney emphasized that there was an over-abundance of beaver. The population is so great that many animals are forced into shallow lakes and ponds in order to obtain aspen for food. Investigations during the summer of 1935 at the Forestry and Biological Station at Itasca Park verified the work of Feeney. The beaver were, ecologically speaking, eating themselves out of their environment".[30] Further details on the history of beaver in Itasca Park can be found in *The Itasca Story* by John Dobie.[13a]

As a result of this over-population and replacement of available aspen by evergreens and other trees less suitable for beaver food, beaver populations in the Park have not regained the levels of earlier years. Aerial censuses con-

ducted by the Game and Fish Division show that in 1947 there were 18 colonies and 90 beavers; in 1949, 47 colonies and 235 beavers; in 1950, 37 colonies and 185 beavers; in 1952, 31 colonies and 155 beavers; and in 1953, 54 colonies and 270 beavers.

Beaver on the North Shore of Lake Superior

Beavers, according to early reports, were scarce on the streams of the North Shore of Lake Superior during the era of the Fur Trade. The forest was then largely coniferous. However, lumbering and fires in the early years of this century produced extensive stands of aspen, and the area then became suitable for beaver. Here, in 1922, Thaddeus Surber, early Minnesota biologist, found beavers "widely, but rather sparingly distributed".[64] In the 1930's there were many beavers along the North Shore in St. Louis, Lake, and Cook Counties, and these counties were opened to trapping in 1939 along with the rest of the State. However, since then, except for 1943, all or part of the North Shore watershed has been closed to trapping. In 10 of the 20 years since 1943, the entire watershed has been closed; in nine years the Cook County portion of the watershed has been closed; and in two years that portion of the watershed in Cook and Lake Counties. With this protection beavers have become very abundant on some of the North Shore streams. This is illustrated by colony counts for Cascade River and adjacent areas in Tables 8, 9, and 10 (T. 62 N, R. 2W, in Table 8). Here counts of beaver colonies have ranged from 6 to 50 per township in 1941-1956, and from 59 to 155 per 100 miles of stream in 1946-1959.

The Beaver as an Aquatic Animal

Although the beaver is a land animal, it is amphibious and admirably adapted for semi-aquatic life. It has valves by which it can close its nose and ears when underwater and, like the muskrat, its lips close behind the chisel-like incisor teeth, permitting gnawing underwater. The short hind legs with large webbed feet are powerful propellers. The front feet are not webbed and are not used in swimming. They serve to carry mud, dig burrows, and hold food while the animal eats sitting up like a squirrel.

One of the best general descriptions of the beaver is that by Vernon Bailey[4]:

> Beavers are compact, heavy-bodied, . . . animals with powerfully developed bones and muscular systems, broadly flattened naked tails, and dense coats of fine, soft, waterproof underfur, hidden by coarse . . . guard hairs, generally of some shade of dull or rusty brown . . . The eyes are small, with very limited range of vision; the ears are short, fur-lined . . . and very keen of hearing; the nostrils are small . . . with large and complex nasal cavities lying back of the openings, and have an unusually keen sense of smell . . . The stomach and intestines are very large to accommodate the large quantity of coarse food consumed.

Beavers weighing 40 to 50 pounds are not uncommon. The two largest recorded in Minnesota weighed 74 pounds each. Both were females and one contained a litter of young. Schorger recorded weights of 78.5, 80.5 and 87 pounds from Wisconsin,[53] and Bailey says that there are records of very fat beavers weighing 100 and 110 pounds.[4]

The usual color of the fur in Minnesota is a dark brown, but some pelts appear almost black and some quite rusty. Across the country the darkest forms occur in the east and the lightest in the west. The golden beaver of California is of a very light color, ranging from "hazel" to "clay". Pelt prices also vary according to color, and the darkest pelts are the most valuable. Albino beavers are found occasionally, and one was reported by Game Warden Joe Roseman in 1942 from the Stuart River 22 miles northwest of Ely.[50]

The beaver's broad, flat and scaly tail is used as a rudder for steering when swimming and the beaver has also been seen using its tail as a scull.[31] But it is not used as a trowel or hod for carrying mud as sometimes has been written. The tail is also useful as a prop when the beaver is cutting a tree. Several observers have seen a beaver sit on its tail while eating. The loud splash made by a beaver's tail when the animal dives suddenly may serve as a warning to other beavers, or it may frighten or confuse animals of other kinds. It is not known whether a beaver can make a "crash dive" without making a loud splash, and there are no recorded instances of a beaver thumping

the water with its tail without diving. Once while standing motionless beside a stream the senior author watched a beaver from a distance of 10 to 15 feet. Finally sensing human presence it dove three times in quick succession, each time with a loud slap of the tail. Then it dove quietly without the tail splash and disappeared under water. At another time a beaver was observed diving in deep water (about 15 feet deep, according to the lake sounding map). Apparently it was feeding upon submerged vegetation, and at each dive its tail smacked the water; yet there was no apparent reason for giving a warning. Possibly release of energy necessary for a deep dive and the sudden arching of the body causes the tail to hit the water sharply. Or just as likely, the sudden downward thrust of the tail may act as a lever-like baffle against water thrust upward by the hind feet. It has also been suggested that the flattened tail aids the beaver in keeping it head depressed when submerged and nuzzling about in the mud for food.[32]

On each hind food there are two inner claws that are specialized for grooming the fur.[54] The innermost toe has a double-edged claw which clamps over a soft lobe to form a coarse comb. The claw of the second toe has a finely serrated edge (see Figure 2). Oil from the two abdominal oil glands is spread over the fur with the double claws and in this way the fur is kept unmatted, water repellent and effective as insulation. These oil glands should not be confused with the much larger castors which are scent glands (see Figure 17).

Many diving mammals have adaptations which permit them to stay submerged for long periods. Respiratory control in the brain of diving mammals is less sensitive to carbon dioxide in the blood than it is in land mammals. When diving, heart beat slows and blood pressure decreases in the small arteries. The small blood vessels in the mesenteries (membranes of the intestinal region) constrict and allow less blood to flow through them. Diving mammals do not have larger lungs, proportionately, than land mammals; rather, they renew the air in the lungs more completely. For instance, 90 percent of the lung capacity is renewed at each inhalation by whales but only 15 to 20 percent by man. Beavers and some seals can submerge for perhaps 15 minutes, muskrats nearly as long, and whales up to two hours. Land mammals can generally stay submerged for less than four or five minutes.[9]

The beaver has several anatomical peculiarities. There is the cloaca, a chamber in which are the urogenital and rectal openings. The male beaver also has a strange rudimentary, and highly variable structure, called the *uterus masculinus*. This is a non-functional organ that resembles the female uterus but is quite imperfect. It is largest in the European beaver where there may be an opening from it into the urethra. The American beaver has no such opening, and the organ itself is sometimes absent.[13]

Beavers, as well as koalas and wombats of Australia, possess a peculiar large glandular structure on the stomach called the "cardiac gland". In beaver this gland is 6-7 cm x 4 cm x 2 cm (about 2.5 x 1.6 x 0.8 inches) and is shaped like a flattened football.[42] It has been suggested that the cardiac gland aids in digestion of cellulose, such as is found in wood. However, no evidence

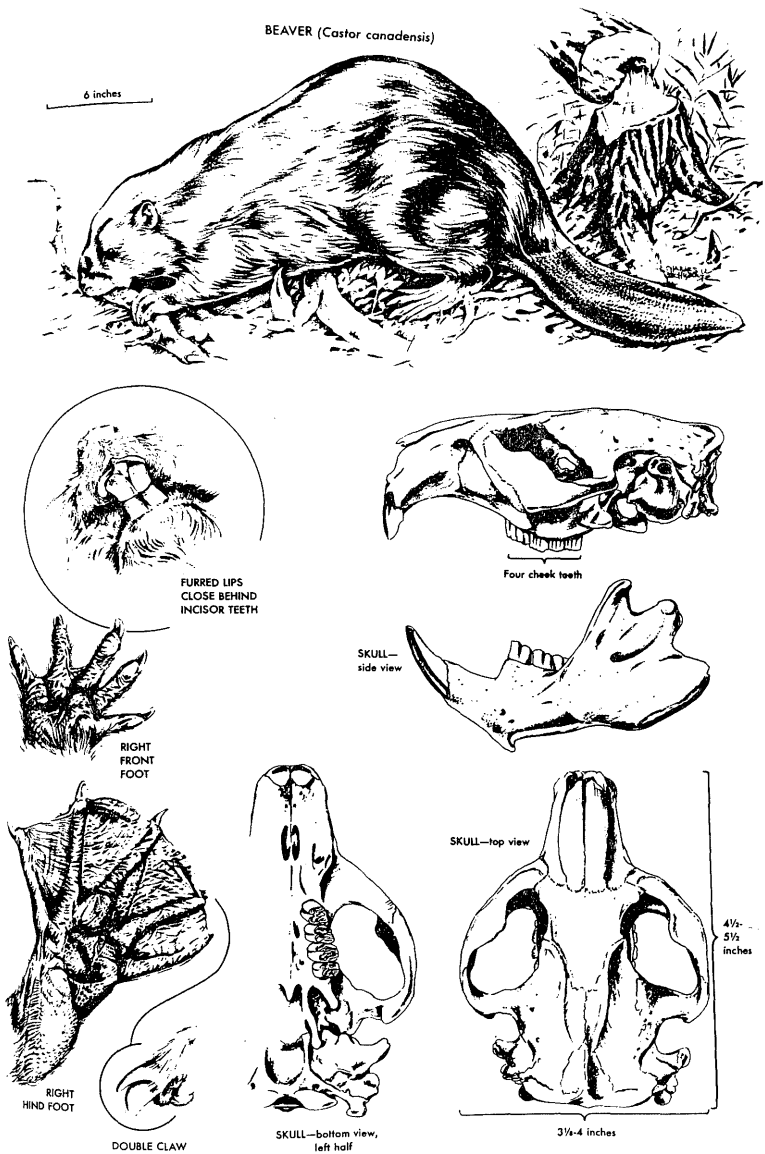

Figure 2. Some structural features of the beaver. Note chisel-like incisor teeth behind which the lips can close. Hind foot is webbed and has a double claw for combing hair.

has been found that gastric digestion of beavers differs from that of the dog or man. Some cellulose, however, may be digested by bacteria in the beaver's intestines.[35, 42]

The large front gnawing teeth (incisors) are covered with very hard orange enamel. They grow throughout the life of the animal and are worn away as the beaver gnaws. The soft interior and thinner back enamel of the tooth wear away faster than the front enamel, giving the incisors a chisel-sharp edge.

Beaver Colonies and Works

The social life of beavers has been studied by complete trapping of colonies and by live-trapping, marking, and releasing animals and then observing them later.[7, 10, 25, 71] A colony is essentially a family unit. Following is a generalized account of the structure of a colony and variations that may be expected on the shallow streams and rivers, such as make up most of our beaver habitat.

The colony site is chosen by a mature female, usually in late summer, and once having established a colony, the female may remain here year after year. Kits that have been born earlier in the same year, prior to choice of the new site, will be with the female. An adult male may be present or may join the group later. If the female had a litter the previous year, some or all of these young (now yearlings) may form part of the new colony. It is likely that two-year old offspring are also sometimes present for as many as three adult-sized beavers of each sex have been found in a colony. Such "extra" adults are either earlier offspring of the colony-founding female or transients. Colonies in untrapped areas often contain 8 or 9 beavers, while in trapped areas there are usually 5 or 6. The largest colonies that have been reported contained 13 beavers.

In Minnesota the family remains together from about September until April and all members except the kits take part in gathering and storage of food and work on the structures. Throughout the winter the family usually headquarters in one main lodge where mutual body heat keeps them warm. Beavers remain active under the ice, feeding and exploring the bounds of their domain and sometimes digging burrows or tunnels. The breeding season begins in late January when it is likely that mature yearlings pair off with siblings (brothers or sisters). Late maturing two-year olds may also find mates among siblings.

The number of beavers in a colony is limited by the number of offspring produced by the female and the age of maturity of the offspring. But the

area occupied by a colony is determined by the habitat, the beaver population level, and, probably, aggressiveness of individuals.

In early spring the beavers disperse from their colonies, leaving the old female to occupy the home lodge or burrow. Evidently, a pregnant female develops a territoriality which excludes other adult beavers. Some of her young settle nearby while others wander away. The old male also may wander. During spring and summer these dispersing animals often occupy habitat that is unsuitable for winter use and they may perish if they attempt to winter here. When populations are high, young females, who establish their first colony in the fall, may be hard-pressed to find a suitable location.

Trapping studies indicate the importance of the maternal female in holding colonies together. After her death, the colony is apt to be abandoned. On the other hand, if the adult male is lost, a new male is readily accepted by the female.

The remarkable structures built by beavers and the seemingly human habits, activities, and attributes of this animal attracted much attention from early American travellers and naturalists. Among the Indians the beaver was revered and respected and one of the 21 totems or clans of the Chippewas was the Amik or Beaver Totem. However, despite the well-known and generally similar works of dam and lodge building, the habits of beavers are really quite variable. They can and often do exist without dams or lodges and without winter food-storage piles. The instinct to build is not displayed by all beavers and in Western Europe it has been thought, that because of centuries of persecution, beavers living near human population centers have lost the proclivity for building dams and lodges which might betray their presence. In general, it appears that beavers build those structures that are necessary to make habitation of an area possible and are limited only by the wide range of their instinctive abilities.

In cold climates beavers build dams only in shallow flowing waters. Lodges are built mostly where banks suitable for burrows are absent. They dig canals where food cannot be gathered easily without them. Food storage piles are apt to be lacking where vegetation is available throughout the year—as it is in warmer parts of the country, such as Louisiana and parts of California. Tree cutting is also less where the climate is warm.

A typical dam is three to six feet high although at least one is recorded at 18 feet. The length depends mostly upon the topography of site and age and size of the colony. Dams several hundred feet long are not uncommon, and the longest on record is over 2,000 feet. Quite often a series of several dams is built by a colony. In Minnesota studies, made in 1942 and 1947, one colony was found which had built 10 dams and 7 colonies were noted which had

not built any. Out of 69 colonies observed the average was 3 dams per colony. Possibly a dam built downstream from the original dam serves to strengthen the main dam by backing water up against it, but this is not proven. More likely, secondary dams are built to provide additional deep water for feeding and transporting food.

Figure 3. An old and unusually large beaver dam on a drainage ditch.

Most new dams are built in late summer by young beaver that have left their natal colony and settled down at new sites. Displaced adults or those moving from deteriorated habitat may also build at this time. Abandoned dams are often taken over and repaired. Established colonies carry on repair work throughout the year but, according to Townsend, major repair and new construction in Montana are concentrated in late August and early September.[71]

The choice of a site for a dam has often been a source of wonderment. Yet the placement of dams is not always advantageous, and beavers may waste much energy at unsuitable sites, or they may add materials that increase the size of a dam unnecessarily. Often the outlet of a large deep lake is dammed without apparent benefit, or dams are constructed which flood and

kill vegetation that could have provided more food. Tevis is of the opinion that the building and repair of dams is compulsive and stems from an inherent urge or perhaps "physiological need" to obstruct flowing water.[70] Probably the first consideration in choosing the site for a dam is food availability. When food is found, the dam is usually built at the first downstream location where a constriction in the banks, a shallows, or where a culvert causes a riffle or eddy. The dam is begun by first lodging sticks in the bottom and these are then covered with mud or other bottom materials. Layer on layer the dam rises and is gradually extended as water flows around the ends. The inner face of the dam is plastered with mud and the downstream side reinforced with large sticks.

Stones as large as footballs may be incorporated in the dam. During the summer of 1963 several dams were observed in the upper Snake River in Kanabec County in which hundreds of boulders ranging in diameter from 3 to 10 inches were incorporated. Boulders are readily available here on the stream bottom. In southeastern Minnesota where creeks flow over beds of limestone rock, beavers sometimes try to make dams of the flat limestone slabs. The remnants of such an unsuccessful attempt are like a causeway built by boys for walking across the stream — a layer or two of flat rocks weighing as much as four or five pounds each.

Lodges (beaver houses) vary in size, the size depending upon the number of beavers and the age of the colony. They are built of mud and peeled sticks piled on top of a sunken islet or placed over a bank burrow. Lodges may have one or several underwater entrances and one or more living chambers. The chamber is commonly about one-and-a-half feet wide, two feet high, and three or four feet long. But it may be larger, and Warren describes a lodge in Yellowstone Park with eight entrances and a chamber six feet long and four feet wide.[74] A bank lodge is essentially a roofed-over burrow and where the soil permits, lodges surrounded by water are also built over burrows.

Apparently, ancestral beavers were burrowing animals that in the course of evolution came to cover their burrows with sticks and mud, giving them greater safety from cave-ins. Lodge building habits are similar for the European beaver and B. T. Semyonoff states that in Russia burrows are made where conditions are suitable and lodges built only where river banks are low and subject to flooding. The value of covering burrows is implied in notations by Russian game workers that elk (our moose) sometimes collapse burrows and that bears sometimes dig young beavers from burrows.[56]

Lodges range from 6 to nearly 40 feet in diameter and often extend 4 to 8 feet out of the water. Such a structure is impervious to large wild animals except aquatic mammals such as otter which can enter underwater.

Often there is an opening that is a few inches in diameter in the top of the lodge. This provides ventilation in winter. Water vapor coming from it has led trappers to call it the "smoke hole".

Most colonies have only one lodge. Of 31 Minnesota colonies investigated in 1942, 26 had one lodge, two colonies had two lodges, and three colonies no lodge at all. There is a record of three lodges built by one colony on a lake.

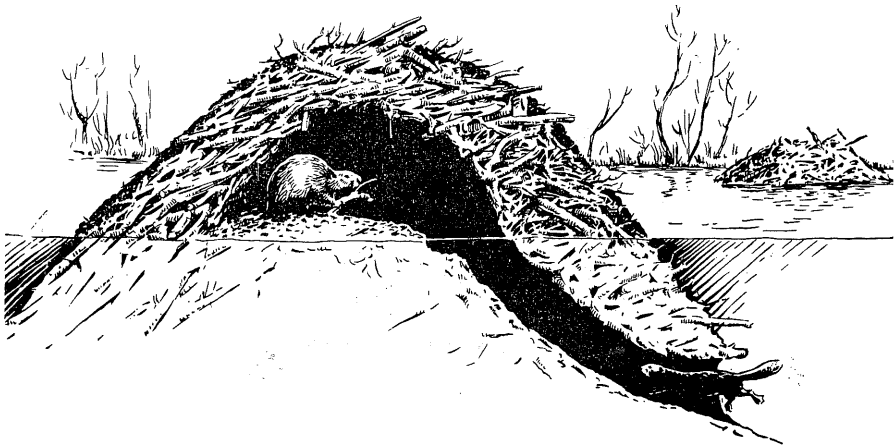

Figure 4. Cross-section of beaver lodge. Usually there is one lodge per colony.

Burrows of many types are made by beavers. Some are small and used temporarily during floods. Others serve as a lodge and have several entrances and more than one chamber. Some colonies which have lodges also use burrows. Although burrows generally have their openings under water, A. P. Zhdanoff claims that in Russia beaver burrows are sometimes not connected with water.[77] However, captive American beavers kept by Vernon Bailey would not dig on dry land. Another type of burrow is used only as a sort of a dining room or resting place. Long burrows, much like canals, may be made along the pond or stream bottom during winter, if the water when covered with ice is too shallow for travel.

Canals and paths (runways) on land are made by beavers, and along them branches are hauled. Paths are cleared through vegetation, both on land and in flooded areas, by cutting and hauling away interfering brush or trees. Some observers, however, are of the opinion that paths are not made purposely but are fortuitous developments, somewhat like deer trails, and develop through continued but unplanned use. Where the land slopes upward from the water's edge, a path, when much used, becomes wet and slippery from the beaver's wet fur. This wetness makes dragging of food to the pond easier and early observers thought, erroneously, that the animals purposely carried water to the path. In flat areas a beaver path becomes a canal. In

addition to being cleared of vegetation, the canal is dug to a depth of a foot or more to float branches. Canals as long as 745 feet have been found. Small dams may be built on canals to maintain suitable water levels.

Figure 5. Beaver canal and path. Beaver may transport food for several hundred feet along paths and canals.

According to Townsend, who worked in Montana, in summer (beginning in late June) adult beavers make small mounds of mud near the water, and on these they deposit scent from their castor glands.[71] He found some mounds higher than two feet which were the result of more than two years of activity. H. U. Green mentioned that such heaps are made in Manitoba in May and June and he describes them as "characteristic beaver sign heaps of wet mud about nine inches high and three inches across, beside the water".[22] It is believed that these scented mounds attract mates or warn away intruding beavers. To quote Grass and Putnam, "Males, at least, are definitely on the fight at the first smell of beaver scent. The hair on their backs raises, and they hiss and blow in a grand show of beaver anger".[21]

Food storage piles are accumulated mainly during October in cold climates. Branches are dragged and towed to within a few feet of the house and piled together in the water until the whole mass, which rests on the bottom, protrudes two or three feet above the surface.

Whenever possible, foods other than those stored in the food pile are used. Beavers continue to leave their pond for feeding as long as there are openings in the ice, and they may feed on underwater vegetation throughout the winter. According to Semyonoff, activities of Russian beaver decrease markedly on land when the temperature falls to about zero.[57] Cutting of trees after the ice cover has become general has sometimes been interpreted as indicating food shortage in the pond. However, such winter cutting may indicate only that a beaver has found opportunity to leave the ice-covered pond for a freshly-cut meal.

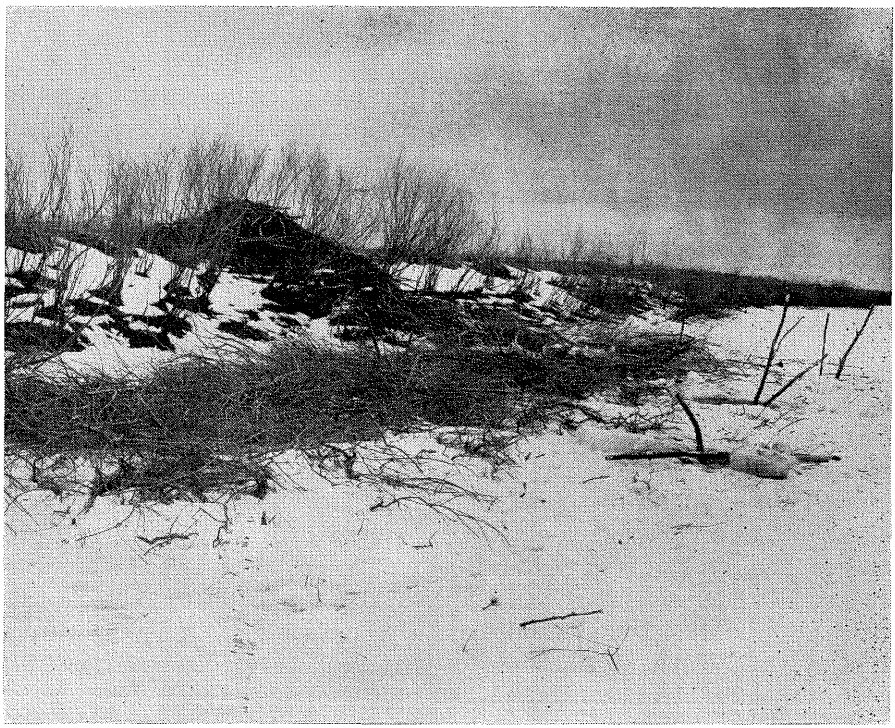

Figure 6. Beaver lodge with a food storage pile in foreground. Stakes mark the location of traps.

Beavers are among the few animals which exert a major influence on their habitat. Their dams can transform a small creek into a series of ponds, and these may benefit many other kinds of wildlife. Waterfowl are raised on such ponds.[33a] Cutting of aspen stands by beaver sometimes fosters production of a great variety and increased quantity of wildlife food and cover plants and may hasten the development of timber trees of greater commercial value than the aspen destroyed. In some places beaver ponds have filled with silt, become wet sedgy meadows, and eventually valuable farm land. In this way

broad alluvial plains have been formed in valleys having only small brooks.[47, 51] Such a beaver-modified valley is shown on the cover. Colonists settled where their cattle could feed on meadows made by beavers, and mills were sometimes operated from the power furnished by water from beaver impoundments.[60] Beaver ponds, however, that are filled with saturated peaty soil and become wet sedgy meadows are not readily invaded by upland trees. Attempts to plant such with trees on the North Shore have failed, and analyses of the soil water show it to be high in ferrous iron and nearly devoid of oxygen — both conditions inhibitory to the growth of upland plants.[39a]

Age, Sex and Weights

Age and Aging — Determination of the age of animals is important in both game research and game management. To know the rate of population increase, we must know the age at which animals reproduce, how long they live, and how many young are produced by females of different ages. In the case of a fairly long-lived animal, such as the beaver, the effect of food supply upon rates of increase cannot be assessed without knowledge of the age and fecundity of breeding females.

When Minnesota biologists began to investigate beaver populations and problems in the early 1940's, there was little information on the ages of beavers in the trapping catch. During the springs of 1941 and 1942, 252 beavers that had been taken by trappers were weighed and the weights grouped and plotted on a graph. From this work, it appeared that skinned carcasses of young beaver, about ten months old, weighed up to 16 pounds; that carcasses of 22 month-old beaver ranged in weight from 16 to 28 pounds; and that carcasses of beaver 34 months or older weighed more than 28 pounds. For unpelted animals this would mean that 10 month-old kits weighed up to 18.4 pounds, and those a year older ranged in weight from 18.4 to 32.2 pounds. On the basis of weight, all beaver heavier than 32.2 pounds could be classified only as adults of unknown age (see Table 1).

Table 1—Carcass weights[1] of Minnesota beaver collected by spring trapping in 1941, 1942, and 1947

Weight in pounds	Number	Percent	Weight in pounds	Number	Percent
9-12	29	9.3	37-40	16	5.1
13-16	51	16.3	41-44	9	2.9
17-20	62	19.8	45-48	13	4.2
21-24	24	7.7	49-52	7	2.2
25-28	29	9.3	53-56	4	1.3
29-32	22	7.0	57-60	3	1.0
33-36	44	14.0			
			Total	313	100.1

[1]Weight of carcass less pelt, Live weight is about 15 percent more.

A fourth age class was determined later by work of Patric and Webb in New York State. They used weights, tail dimensions, and skull measurements.[46] With this approach, beaver taken in April were classified as kits, yearlings, two year-olds, and adults. Their method was verified by marking young beavers and recapturing them in later years. Table 2 shows the measurements and weights at approximate ages for New York beavers. In general, the weight ranges are similar to those cited for Minnesota animals. It should be noted that sometimes old beavers lose weight, and this will cause error in age determinations based on weight alone. Tail measurements are handy for aging beaver. In using tail measurements the greatest width and length of the scaly portion of the tail are multiplied together and the result, expressed in square inches, is called the "product of tail dimensions". As an index of age, tail measurements are as useful as weights and much more easily obtained. But tail measurements also produce erroneous results for some animals. Probably the best single indication of age is the measurement across the cheekbones (width of the zygomatic arches). Accurate use of a good caliper is necessary on either cleaned skulls or complete heads. Most accurate aging combines the three methods. The maximum age reported for a beaver is 19 years for a female.[60a]

Table 2—Approximate ranges of weights, products of tail dimensions, and zygomatic breadths of four age groups of spring-caught beavers from New York State[46]

Age Group (age in months)		Weight (pounds)	Product of tail dimensions (sq. inches)	Zygomatic breadth (inches)
March-April kits (10-11)	Range	12-17	16-28	2.50-3.00
	Mean	14	25	2.70
March-April yearlings (22-23)	Range	20-26	34-42	3.20-3.40
	Mean	22	38	3.30
March-April two-year olds (34-35)	Range	28-34	43-45	3.50-3.60
	Mean	30	44	3.55
March-April adults (47 or more)	Range	35+	46+	3.65+

Sex determination—It is quite difficult to distinguish male from female beavers. Sex organs of the male are within the body cavity, and there is no scrotum. The castor glands should not be mistaken for testes. Mammary glands are not evident on animals of either sex except for lactating females or those advanced in pregnancy. On such females the four pectoral mammae are prominent.

According to Osborn, the sex of male beaver kits and yearlings can be quite easily determined by palpating (feeling) for the small penis which is in a median position on the abdomen.[45] Very young males have small castor glands that do not conceal the penis. On older males the penis can sometimes be felt to one side of the castor glands unless it lies close to or under them. Testes on older beaver can be palpated with practice. Sexing by palpation is most reliable when the beaver is held in an upright position.

A dead beaver is best sexed by dissection whereby the body cavity is cut open and the sex organs exposed. If this is not possible, the cloaca can be examined. In females the urogenital opening in the cloaca is large, and the space between this opening and the anus is narrow. The opposite is true for males. It should be noted that in young females the hymen membrane may obscure the genital opening.

Sex ratio among Minnesota beavers is nearly even. For 750 beaver carcasses that were examined over seven years, the sex ratio was 105 females per 100 males. Sex and age data for beaver examined in each of these years are shown in Table 3. The Handbook of Biological Data[60a] gives an average sex ratio for beavers of 52 males per 100 animals.

Table 3—Sex and age[1] ratios of Minnesota beavers taken by trappers, 1941-1951

Year	Total beavers examined	Male	Female	Females per male	Adult	Juvenile[2]	Juveniles per adult
1941	183	86	97	1.13	71	112	1.58
1942	124	58	66	1.14	37	55	1.49
1946	74	30	44	1.47	36	44	1.22
1947	74	42	32	0.76	27	47	1.74
1948	146	77	69	0.90	51	95	1.86
1950	101	55	46	0.84	62	39	0.62
1951	48	17	31	1.82	39	9	0.23
Totals	750	365	385	1.06	323	401	1.24

[1]Ages are based on weights.
[2]A juvenile is a kit or yearling.

Reproduction and Fecundity of Beaver

Apparently male beavers are capable of breeding at 22 months. Bond found that males with carcass weights of 15 to 19 pounds and which had a baculum (penis bone) size of 3.9 x 24 mm were mature.[8] Many female beavers mature later, and Osborn states that in Wyoming 21 percent bred when 22 months old and the remainder at 34 months.[44]

Young and very old females produce smaller litters than middle-aged females. Minnesota game biologists who visited Tillden's beaver farm at Hill City, Minnesota, in 1941 were told by the proprietor that two-year olds produced only two or three young while middle-aged females produced four to seven. One 12-year-old had a litter of three.

Of 176 females examined in spring by Minnesota game biologists between 1941 and 1951, 110 (about two-thirds) were pregnant. In these, the average number of fetuses was 5.29. This average is considerably higher than similar figures reported in 12 studies from other states. In none of these was the average greater than 4.2 young per pregnant female. In Michigan, Bradt

found 3.72 for 65 pregnant females.[11] In Maine, Hodgdon and Hunt reported 3.6 for 152 cases.[31] Even lower productivity was found in California, in New Mexico, and in Wyoming,[23, 33, 44] and averages in these states were, respectively, 2.7 for 14 females, 2.7 for 22 females, and 2.9 for 36 females.

The Minnesota sample contained five cases of 8 embryos and two of 9 embryos. A few females had only two fetuses, and none had only one. However, a Minnesota beaver examined by S. E. Aldous in 1938 contained a single embryo (U. S. Fish and Wildlife Service files, University of Minnesota). The distribution of embryo counts for 37 pregnant females examined in 1951 by Minnesota biologists was: 4 females each contained 3 young; 8 contained 4; 12 contained 5; 9 contained 6; 2 contained 7; and 2 contained 9. In 1941, two cases of twins were recorded: that is, two embryos in one embryonic sac. The large number of embryos in the Minnesota beavers and the high productivity indicated may be due either to food quality or to age of the females examined (see Table 4). It seems likely that much of the high productivity reflects good food supplies, especially aspen. However, the percentage of older females may also have been quite high, for it is likely that the females examined came from lightly harvested populations, from which there was some selection of larger beavers by trappers.

A relationship between kind of foods and productivity was found by Huey in New Mexico. Here, there was an average of 2.06 young per female

Figure 7. Eight beaver fetuses from a single female in late pregnancy, April 19, 1947. Average fetus weight was 230 grams. Hair was developing on head and shoulders.

where willow was the principal food, 2.75 in cottonwood areas, and 4.20 in aspen areas.[33]

Because resorption of early embryos is known for beaver, one might expect larger numbers of embryos in females taken in the early stages of pregnancy. However this factor probably had little influence on the high average cited for Minnesota. Except in 1941, most of the beaver examined were taken after mid-April: fairly late in pregnancy.

There are late litters, and these suggest that young females may come into breeding condition later in the season than do older females. There is no information recorded on the duration of estrus or possibility of recurrent estrus periods. Gestation has been estimated at about 100 days.[31]

Table 4—Reproductive data for female beavers taken by spring trapping in Minnesota, 1941-1951

	Adult females			Embryos and fetuses			
		Bred females		Numbers		Sex of fetuses	
Year	Total females	N.	Percent	Total	Mean	Female	Male
1941	46	31	67	171	5.5	17	16
1942	42	27	64	149	5.5	—	—
1947	11	8	73	42	5.3	19	16
1950	29	19	66	126	5.3	42	32
1951	48	25	52	*190	5.1	11	18
Totals	176	110	63	678	5.3	89	82

*Includes young from 12 females from trappers whose total catch was not examined.

Beavers at birth weigh about a pound or slightly more. They are beautiful, precocious, and miniature replicas of the full grown animals. Their brown eyes are wide open, their incisor teeth emerging, and they have little flat tails and fluffy brown fur. Bailey relates that one born in semi-captivity went into the water when only 4 days old.[6] It could swim but was unable to dive because of the dense, woolly fur. Weaning begins when the young are about six weeks old.

Foods and Feeding Habits

Tree-cutting by beavers is so noticeable that it might be thought erroneously that other foods are little used. It is true that the branches of woody plants stockpiled in late summer and fall may be the only foods for nearly six months in Minnesota, and even longer farther north. But in the best habitats water plants are important foods, even in winter. During the warm months the main foods are water plants, sprouts from trees and shrubs, and terrestrial herbaceous vegetation. Aquatic plants eaten include water-lilies, sedges, reeds, cattails, bur-reeds, arrow-heads, pondweeds, and grasses. The roots, rhizomes, and tubers are most used.

The list of plants used by beaver is long, but the poplars of several species, including cottonwood, are the most preferred and most important. Poplars are fast-growing, resprout readily from stumps, and reproduce rapidly from root-suckers. They therefore afford a more constant supply of food than do other trees. They also pioneer open areas adjacent to water and, as a group, are abundant over most of the North American beaver range. Trembling aspen, large-tooth aspen, and balsam poplar all are common in the northern forested portions of Minnesota, and trembling aspen and cottonwood also occur on the prairies. Willows of many kinds are highly acceptable, and have many of the characteristics and qualities of the poplars. Willows have even been planted for beaver food in Russia.[18] In northern Minnesota, alder is also extensively eaten. Many other trees and shrubs have been found in beaver food piles. In 1947, D. B. Vesall and L. J. McCann examined 27 food piles in 8 northern Minnesota counties (Table 5). Aspens were found in 85 percent of the piles, willow in 78 percent and alder in 56 percent. Usually food piles contained woody plants of about three species.

Beaver colonies in Minnesota ordinarily accumulate only one winter food pile. However Semyonoff notes that in Russia "beavers as a rule have several underwater stores in various secluded places".[57] He also mentions that large piles contained 3-3½ cubic meters (about 100 cubic feet) of twigs. In Minnesota the size of the food pile varies greatly and seems to be only remotely related to the number of beavers in the colony and is probably more dependent upon the amount of available food.

Entire twigs up to about ½ inch in diameter are eaten, but only the bark and cambium are consumed from the branches or trunks which are between twig size and about four inches in diameter. Very little is eaten from larger branches and tree trunks, although sometimes very large trees are girdled. Along the Whitewater River in southeastern Minnesota many cottonwoods two to three feet in diameter have been barked as high as a beaver could reach. The exposed roots were also barked. The amount of food obtained by barking large trees is not great, but such girdled trees soon die, and a variety of new beaver foods spring up.

Beavers usually work alone, although several may work together on a felled tree. Pieces just big enough to be dragged easily to the water are cut from branches of large trees. If a beaver has misjudged and the section is too heavy, he will cut it smaller. Branches three or four inches in diameter will be cut into pieces about three or four feet long. A small tree or branch that is an inch or so in diameter will be dragged away in its entirety. Grasping the end of the piece with his teeth, the beaver walks to the water and then continues to tow the piece as he swims.

Table 5—Occurrence of different kinds of woody plants in 27 Minnesota beaver food piles, 1947

Food Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Occurrence
Aspen	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23
Willow		x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x		x	x	20
Alder			x		x						x	x	x	x	x	x	x	x	x		x		x	x		x		15
White birch																x	x	x		x			x	x				6
Red-osier dogwood																				x	x		x	x				4
Hazel					x																	x			x		x	4
Cherries																						x			x	x	x	4
Ash					x																x					x		3
Bur oak																						x			x		x	3
Juneberry																									x		x	2
Mt. maple																											x	1
Balsam poplar																			x									1
Smooth sumac																										x		1
Totals	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	6	7	

Figure 8. Beaver cutting on 24- to 30-inch cottonwoods. In farming country beaver seldom fell such large trees but may eat the bark.

Despite popular belief, a beaver, as he cuts around the trunk, does not predetermine the direction in which a tree will fall. One has only to observe beaver cuttings on flat land to be convinced of this. Trees are felled in all directions, and a good share of them fall against other trees where they become lodged and cannot be used. Occasionally beavers are killed or injured by the tree they fell, and it is surprising that the accident rate among these fur-coated loggers is not higher.

Aldous found that 64 percent of the food on felled aspen was not utilized.[1] For trees 4- to 6-inches in diameter the waste was high because often such trees were too light to crash to the ground in heavy forest. Larger trees were even less utilized and, when felled, only the tops were eaten. Small trees, up to three inches in diameter are preferred for cutting, and until these become scarce, large trees are seldom taken. Stegeman calculated that trees one inch in diameter provided two to three times more food per acre than do those of larger sizes.[62]

Beavers usually go no further than about 300 feet from water to cut trees, and colonies are apt to be abandoned when all aspen are removed that far from the water's edge. Hiner concluded that beaver colonies in Itasca State Park, Minnesota, were able to survive longer where the aspen grew on an incline than where the land was level. He found that the longest hauls, up to 450 feet, were made on fairly steep slopes—those with gradient greater than 15 percent—but very steep slopes were avoided. In ponds and streams

beavers travel as far as 1,200 feet to bring back food for storage piles, but they may tow food even greater distances on lakes.[30]

The future of a colony can be predicted when the average amount of aspen a beaver consumes each day is known and this figure used along with a forestry estimate of the amount of aspen available to the colony. Growth rate of the trees and their re-sprouting capability must also be taken into account. It has been estimated in Colorado that the average consumption of green aspen is about a ton per beaver per year.[75] Stegeman arrived at a somewhat lower figure. He found from four studies that the average amount of aspen eaten per beaver per day was 4.5 pounds and concluded that 1,500 pounds of aspen per beaver per year was a realistic allowance, considering that there were four months when other foods were important. He also found that an acre of aspen of 1-inch d.b.h. produced, on a sustained yield basis, 1,347 pounds of aspen per acre per year, and an acre of mixed size classes, 505 pounds per year. Using this method for his 85-acre study area, Stegeman calculated that between 9 and 25 beavers could be harvested each year.[62] It is apparent that forestry practices which maintain stands of small aspen will support the most beavers.

Several species of conifers have been recorded as occasional beaver foods, but conifers are seldom eaten in cold climates. Chabreck found in Louisiana that the main beaver food was loblolly pine, although sweet gum, sweet bay,

Figure 9. Typical beaver cutting of large aspen. The trees are felled in all directions.

and spruce pine were preferred.[12] Here food is not stored for winter, and more trees were barked standing than were felled. In farming country of the Middlewest, field corn is often eaten by beavers, and frequently in Minnesota a wandering beaver will settle in summer on a stream or ditch where there is little food except a few willows and an adjoining cornfield.

Diseases and Parasites

At times disease sharply reduces beaver populations over much of their range. The most recent widespread die-off was caused by tularemia. It was first reported in February, 1949, as a die-off of muskrats and beavers in northwestern Ontario. This epizootic spread from northern Ontario through Manitoba to Minnesota, Wisconsin, and Michigan. The organism causing tularemia, *Pasteurella tularensis,* was found in Ontario beavers in 1950. This disease is transmissible to man, and in this same year blood tests of Indians in northern Ontario and Manitoba, many of whom are trappers, revealed that 12 percent had been exposed to it.[19] In April, 1950, two sick beavers were picked up by personnel of the Whitewater State Game Refuge in Winona County, Minnesota. Mr. Matt Saari and the senior author delivered these to the Mayo Institute in Rochester where Dr. Luther Thompson isolated the tularemia organism from the carcasses. In the spring of 1952 many thousands of beavers must have perished in northern Minnesota, for many reports of dead beavers and abandoned colonies with unused food piles were received from trappers and others. Often these reports did not specify numbers of dead beavers found, but the total from reports that were complete was 407. Several trappers contracted tularemia in the fall of 1951; presumably from muskrats.[63].

A study that included live-trapping and tagging of beaver at St. Croix State Park in Pine County was brought to an end by this die-off during the spring and summer of 1952.[7] Dr. James Beer of the University of Minnesota who made a thorough examination of the 11 colonies during September of that year found only an occasional beaver track, three cut trees, and no repair work on any of the dams. The die-off occurred in Alberta and Wisconsin during 1952-53 and in Michigan during 1953-54.[38] Prior to this well-documented epizootic, there were die-offs from tularemia in Montana and Wyoming in 1939 and 1940.[34, 55] In 1946 there was a die-off of beaver on the Red Lake Game Refuge in northern Minnesota and although this was not investigated until the following year, tularemia was considered to be a good possibility.[17] One of the investigators later autopsied a beaver from nearby Becker County and contracted the disease.

The great die-off of about 1800, mentioned by Grace Lee Nute, and previously noted in this publication, may well have been caused by tularemia.[43]

John Tanner wrote in 1830: ". . . some kind of distemper was prevailing among these animals, which destroyed them in vast numbers . . . Many of them which I opened, were red and bloody about the heart. Those in large rivers and running water suffered less; almost all of those that lived in ponds and stagnant water, died. Since that year the beaver have never been so plentiful in the country of Red River and Hudson's Bay as they used formerly to be." [68]

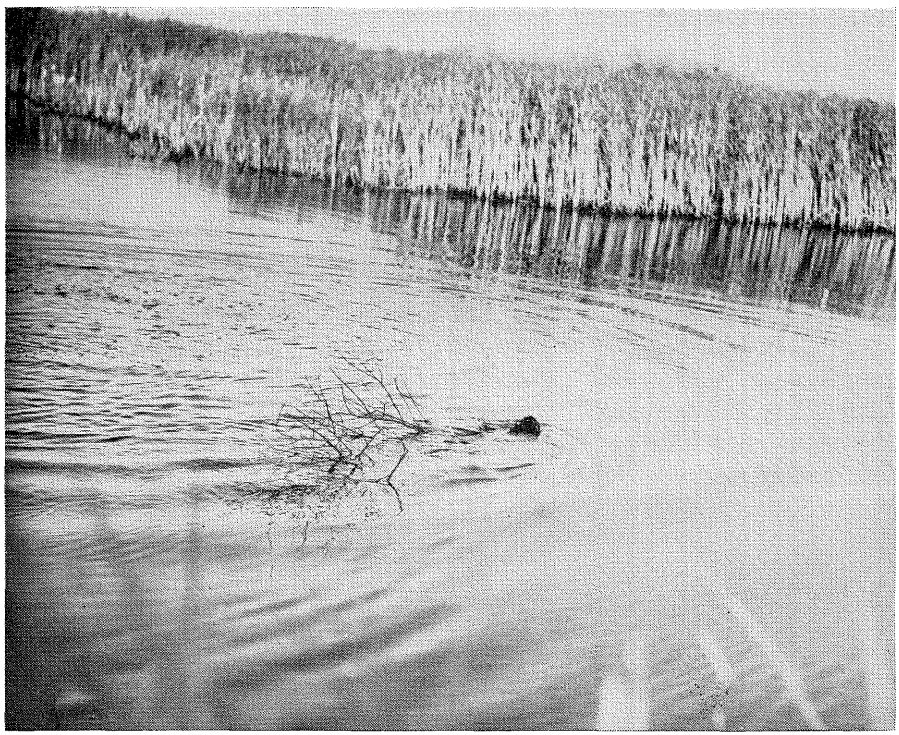

Figure 10. A swimming beaver hauling brush to food storage pile.

For many years tularemia was thought to be spread mainly by ticks and biting flies. However, most human cases have been contracted by handling infected animals, especially muskrats and rabbits. It is believed that infected animals, or carcasses can spread the disease by contaminating the water, and that serious outbreaks usually occur during population explosions of smaller rodents, such as meadow mice. At such times a great variety of rodents, game mammals, and birds may be infected. Outbreaks among beavers apparently are related to low water levels and high beaver populations. Jellison and co-workers found that the tularemia organism remained viable in the mud and water of streams for as long as 33 days.[34]

Although the cause of some die-offs cannot be determined positively, tularemia is always the prime suspect, for few other diseases have been isolated from beavers. Two cases of rabies are recorded and one case each of infection with the bacteria *Salmonella* and *Pasteurella pseudotuberculosis.*[38] Dr. Arnold B. Erickson found a fungus infection, *Haplosporangium parvum,* in the lungs of a trapped beaver.[15]

Beavers have surprisingly few kinds of parasites. Only two parasitic worms have been found in any number in Minnesota beavers. Erickson, who examined 140 beaver carcasses for parasites, found stomach worms *(Travassosius americanus)* in 89 percent of the animals. The average number of worms on those infected was 142 and the maximum 1,197. The cecal fluke *(Stichorchis subtriquetus)* was found in 79 percent, and the average number was 29 per infected animal with a maximum of 263. These parasites appeared not to injure their hosts even though 70 percent of the beavers examined had both kinds.[14]

Eggs of the stomach worm are probably ingested with water and develop directly. The cecal fluke, however, has a complicated life history. Eggs of this fluke pass out of the beaver in body wastes. After hatching, the young flukes (called miracidia) penetrate the body of snails where they develop for 35 days before leaving the snail as immature worms or cercariae. These probably attach themselves to underwater vegetation, become encysted, and remain on the vegetation until it is eaten by a beaver. In the digestive tract the cercariae emerge from their cysts and attach themselves to the lining of the cecum where they develop into mature worms.

Small numbers of two other parasitic worms were found by Erickson in a few beavers: the strongyle *(Castorstrongylus castoris)* in 10, and the intestinal fluke *(Stephanoproraoides lawi)* in two. There are also a few records of other parasites from other states.

External parasites are rarely found on beavers. There may be an occasional louse, tick, or flea but never an infestation. The most common external parasites are two species of tiny beetles which live in the fur. One of these, *Leptinillus validus,* has not been recorded for Minnesota and the other, *Platypsyllus castoris,* has been found three times in this state. This beetle is about an eighth of an inch long and has neither wings nor eyes.

Predation

Popular writings of the last century, based on stories or reported adventures of Indians and trappers, fostered the idea that beavers live in constant jeopardy from attacks of wild predators. In such stories a lynx lies waiting for

several days for a beaver to venture away from the water; a bear or wolverine tears away at the lodge or digs a beaver out of a burrow; or an otter is sure death for any beaver he might discover.

Actually predators probably were of little consequence to early beaver populations; judging from the number of beavers taken by early trappers. And at that time predators were probably more numerous than they are now. No studies made in this century disclose serious predation, and high survival of young beavers seems to be the rule.

However, when beavers are abundant and the good habitat is occupied to overflowing, increased losses from several sources, including predation, can be expected. Spring dispersal of family groups forces two-year-olds and perhaps yearlings away from their winter home. These young may find no suitable habitat unoccupied, and they will be harassed by resident beavers until they move on. Sometimes the only place they can find to settle will be insecure habitat, such as shallow streams without suitable banks for burrowing. The young may even be forced to strike off across country several miles to find water. Drought, of course, compounds such difficulties.

During this dispersal period, and especially when populations are high, some losses to predators can be expected. However, authenticated cases of predation are few. Killing of two beavers by a bear "in a burrow underneath two fallen hemlocks" is mentioned in "The Beaver in Pennsylvania".[2] Murie found some beaver fur in droppings of wolves in Alaska and of coyotes at Yellowstone.[40, 41] Semyonoff in Russia mentions a beaver burrow broken open by a bear and another incident where a bear had probably caught a beaver in a burrow.[56] He also reports a case of a fox having eaten a young beaver and states that beaver fur was found in lynx droppings. He found that otter avoid beaver colonies, and records an instance where beavers drove off an otter. Semyonoff also quotes another Russian who recorded two instances of young beavers killed by otter. Seton reported beavers driving off an otter.[58]

It should be noted that finding of fur in droppings of predators is, at best, poor circumstantial evidence of predation: few predators refuse carrion. Stenlund noticed foxes, wolves, and bears scavenging on beavers apparently killed by disease.[63] Bears, especially, are attracted to beaver colonies during epidemics.

Trapping Regulations and Their Effects

History of Trapping Regulations in Minnesota — By the middle of the 19th Century Minnesota was being settled at a rapid rate and, despite the demise of the fur trade, beavers continued to be harassed and taken. In recognition of this the legislature, in 1875, passed a law prohibiting trapping between May 1 and November 1. But beaver populations still declined. The story was similar in other states. By 1900 beaver were exterminated in agricultural regions of the eastern half of United States and all but extirpated elsewhere. In 1909 the Minnesota legislature prohibited taking of beavers at any time. The Iowa legislature had passed a similar law in 1872, Colorado in 1886, New Mexico in 1897 and Wyoming in 1899. Protection began in California in 1911 and in Michigan in 1920.

In Minnesota there was no legal trapping of beaver for 10 years after 1909, and beaver populations increased. In 1914 the Biennial Report of the Minnesota Board of Game and Fish Commissioners noted: "There are quite a few colonies of beaver in this state; one in Itasca Park, some in Beltrami County, and some in the Superior game preserve. This industrious little animal is increasing quite rapidly, and in the course of a few more years, we may be able to resume trapping for them." They continued increasing quite rapidly, and in 1919 the Legislature gave the Commissioner of Conservation authority to issue special permits to take nuisance beavers. To insure against abuses, each permittee was required to post a $500 bond, and each pelt was required to have a $3.00 tag or seal affixed.

At this time many beaver nuisance complaints came from the huge bog areas of northern Minnesota where drainage ditches reached their greatest extension about 1917, and where prior to ditching, the animal had been practically unknown. Here beavers moved in and began to plug up the ditches. In 1919, 361 beavers were taken here on permits. In 1921, 3,533 were removed; mostly from the ditches in Koochiching County. During the 5-year period 1919-1923, more than 7,000 were taken by permit trapping (see Table 6). At this time, Carlos Avery, then Conservation Commissioner, commented that beaver had become "a mixed blessing", and many shared his feelings.

A few years later drouth put an end to the "orgy of ditch building"—to quote an early Conservation Department document—and the agricultural boom on the northern peat lands began to decline. By the early 1930's some 1,700,000 acres of peat lands including part of the present Red Lake Game Refuge, had been removed from agriculture. An additional 1,000,000 acres in other northern counties, for which there were once high agricultural hopes, had also been found unsuitable for farming.

Drainage of peat lands created a tremendous fire hazard in dry years and led to many disastrous forest fires. To alleviate this fire hazard some dams were built in the ditches by governmental agencies in the early 1930's, and beavers were welcomed back. They made use of man-made dams and added

Table 6—Beaver trapping under permits and special licenses that were first issued in 1919. The figures have been compiled from several sources and should be regarded as only approximate since some of the records are incomplete. Dash (—) indicates no data

Fiscal year ending in	Beaver permits issued	Number of beavers taken under permits[2]	Length of beaver trapping season in days[1]
1919	—	361	closed
1920	375	1,230	closed
1921	84	3,533	closed
1922	250	1,529	closed
1923	204	289	closed
1924	52	287	closed
1925	—	—	closed
1926	70	412	closed
1927	76	284	closed
1928	92	240	closed
1929	31	135	closed
1930	—	—	closed
1931	—	—	closed
1932	—	115	closed
1933	31	40	closed
1934	14	—	closed
1935	11	70	closed
1936	11	772	closed
1937	44*	1,080	closed
1938	32*	730	closed
1939	51*	358	8
1940	81*	247	closed
1941	—	270	13
1942	232*	250	15
1943	108*	178	15
1944	142*	1,302	closed
1945	547*	1,666	15
1946	490*	1,495	10
1947	721*	2,153	closed except in NW
1948	387*	—	11
1949	295	—	8
1950	411	—	23
1951	200	—	16
1952	208	—	31
1953	—	—	15
1954	—	—	30
1955	—	—	22
1956	—	—	15
1957	—	—	23
1958	209	—	**45N, 38S
1959	61	—	**30N, 23S
1960	169	—	**36N, 23S
1961	187	—	**37N, 16E, 30S
1962	175	—	**37N, 30S

*Computed from income from permits at $2.50 per permit.
**In the years 1958-1962 Minnesota had 2 or 3 beaver trapping zones. See maps in Appendix IV.
[1]See Appendix IV for trapping dates and zones.
[2]Prior to 1947 a special seal was issued for beavers trapped under permit; beginning with 1948 no distinction was made in seal sales between beaver trapped under permit and those taken during the regular season.

many of their own. Within the decade, however, the drought ended, and forestry became an important use of these lands. Again beavers were found to be interfering with human values. And there were many of them; for their increase was aided by wet years and regrowth of food plants. Rigid protection continued, and game wardens found enforcement of the beaver law a major problem. Thaddeus Surber in 1932 described their difficulties: "notwithstanding (that) stringent laws for the preservation of this animal exist on our statute books, their enforcement is extremely difficult owing to the ease with which the animals can be taken and the pelts "bootlegged" and I have no hesitancy in saying that enforcement of this law has given the game and fish commissioner more sleepless nights and entailed more expense than any other law affecting our game or fur-bearing animals."[65] As early as 1934, Charles McFarlane, Deputy Director of the Division of Game and Fish, recommended, in a report on fur buying and trapping, that a general beaver trapping season should replace the permit system. In 1935, H. E. Statler wrote in the Minnesota Conservationist: "There is hardly a stream or river in Pine County, Carlton County, lower St. Louis or Lake County where there is not at least one live beaver colony, as many as eight on some." He recommended an open season "to allow legal trappers a chance."[61] In 1935 beaver were noticed on Bear Creek three miles from Rochester after an absence of 55 years. In that year six dams were built on this stream ten miles east of town. To prevent erosion of the road the county constructed a 300-foot dike which diverted the water back to the main stream channel. About 200 cars were present on a Sunday, so interested were people in the newly-returned beavers and their work.[49]

As fur values rose, both illegal trapping and permit trapping increased until the Legislature in 1939 finally gave the Commissioner of Conservation authority for an open season. A season was declared as soon as possible after this authority was granted and between May 2 and May 9, 1939, more than 11,000 beavers were harvested from an open area of about 28,000 square miles in northern Minnesota (see map in Appendix IV). This was about one-third of the State's land area and on it was about 85 percent of the beaver population.

By 1940 there were colonies in 66 counties and, within a few years, beavers had spread to all 87 counties. The beaver spread along the water courses, and from a questionnaire sent to trappers it was learned that 78 percent of the 1941 harvest had been taken from rivers, 19 percent from lakes, and 3 percent from ditches.

In the 1940's the present approach to management was developed. Since then beavers have generally been considered undesirable in the agricultural areas, and management of them aims to control their numbers here by annual

trapping seasons. However, until 1952 it was thought necessary to provide beavers with special protection from overharvesting in the southern part of the state, but recent decline in pelt prices and trapper interest has made such concern unnecessary. In the heavily forested regions of the north, management is designed to maintain a highly productive beaver population from which a harvest of pelts can be taken each year. It is in the counties that fringe the northern forested area, where forest and farm lands are interspersed, that nuisance beavers are major problems of game wardens.

Factors to be Considered in Trapping Regulations — An understanding of factors which affect trapping success and the number of beavers harvested is essential for sound management. Trapping regulations should permit a planned, reasonable harvest each year; should keep beaver damage at a minimum; and should conserve beaver colonies that have other recreational values. As a matter of background for those not familiar with trapping regulations in Minnesota, the taking of beaver requires both a trapping license that presently costs $2.50 and seals which must be attached to each pelt. Present price of a seal is 25 cents.

Table 7—Size and value of the Minnesota beaver harvest, 1939-1962, together with data on number of trappers, season limits and trapping success

Year	Number licenses sold	Number beaver taken	Mean take per license	Number taken per license per day of open season	Season limit per trapper	Average pelt price	Calculated value to trappers
1939	2,697	11,048	4.09	0.51	8	$11.00	$121,319
1940	Closed	247*	—	—	—	—	—
1941	2,676	7,669	2.87	0.22	8	26.50	203,228
1942	2,947	4,259	1.45	0.10	8	23.50	110,110
1943	4,077	10,207	2.50	0.17	4	33.36	304,505
1944	Closed	1,302*					
1945	4,307	7,791	1.81	0.12	6	48.00	296,058
1946	4,169	8,283	1.99	0.20	5	21.00	172,935
1947	1,056	4,112	3.89	—	5	30.00	123,360
1948	4,530	10,274	2.27	0.21	4	19.00	194,693
1949	6,004	10,895	1.81	0.23	10	17.00	185,215
1950	5,902	19,565	3.31	0.14	10	18.00	337,150
1951	2,884	13,387	4.64	0.29	10	23.00	307,907
1952	2,913	14,205	4.88	0.16	10	—	—
1953	1,673	6,996	4.18	0.28	10	8.00	55,968
1954	2,086	15,594	7.48	0.25	10	12.00	187,128
1955	3,848	24,157	6.28	0.29	10	12.00	289,884
1956	2,667	13,016	4.88	0.33	10	8.00	104,128
1957	2,066	14,806	7.17	0.33	10	8.00	118,300
1958	3,308	26,578	8.03	0.19†	10	9.20	226,228
1959	3,066	19,408	6.33	0.24†	10	7.80	151,300
1960	3,246	21,496	6.62	0.21†	10	9.10	214,960
1961	3,569	22,108	6.19	0.24†	10	8.00	176,864
1962	1,830	11,481	6.27	0.19†	10	8.00	91,848

*Taken under permits only.
†Calculated using average length of season for all open zones.

Figures for numbers of beavers taken each year since 1939 (Table 7) show a fairly stable harvest of pelts since 1950 — usually between 10,000 and 20,000 with an average of about 18,000 a year. The catch figures for any year are influenced by many factors: These include number of trappers, season dates, season length, size and location of areas open to taking beavers, and limit of beaver allowed per license. Weather and trapping conditions, price of pelts, and activity or availability of more experienced trappers are also important.

In Minnesota small trapping harvests have sometimes been caused by bad weather, particularly in 1942 and in the spring of 1950. Long seasons lessen the short-term adverse effects of bad weather. The catch in 1947 and 1962 was limited both by smaller numbers of trappers and restriction of areas open for trapping. Several factors contributed to the low total harvest in 1953. An outbreak of tularemia reduced the number of beavers available for trapping. Several trappers contracted the disease, and fear of contracting it was probably an important factor in the decline of nearly 40 percent in trapping license sales. Also, in 1953, pelt prices dropped sharply and trapping conditions were poor during the December season. There were large harvests in 1955, because of good weather and increased numbers of trappers, and again in 1958 because of an extra long season (45 days in the north and 38 days in the south).

Comparison of catches for the several years shown in Table 7 with information on length of seasons in Table 6 gives no indication that longer seasons in recent years (since 1957) have had an adverse effect on beaver populations. The catch has stayed up, year after year, and at a higher level than when the seasons were shorter. The trapping catch during the 5 fiscal years 1958-1962 has averaged 20,214 animals; for the preceding 5 years 14,914 animals. The number of nuisance permits has been fairly constant since 1951, generally being between 170 and 210 each year.

The distribution of the 1961 harvest, the third largest on record, is shown in Figure 11. It is based on the number of beaver sealed by county. For the whole state, the average harvest of beavers was about 27 per 100 square miles; the catch ranging from 80 to 100 per 100 square miles in the northeast to 0 to 10 in the southwest. This map reflects, in a general way, population levels in recent years. Beaver are most abundant in the northeast and decrease in numbers southwestward across the state.

Average take of pelts per trapper per day of open season has varied little since 1939, being 0.22 for the years 1939-49 when open seasons ranged from 8 to 15 days; 0.25 for 1950-1957 when season length was 15 to 31 days and 0.21 from 1958-1962 when season length in the north ranged from 37 to 45 days. It appears that the increased take per license during the last 10 years

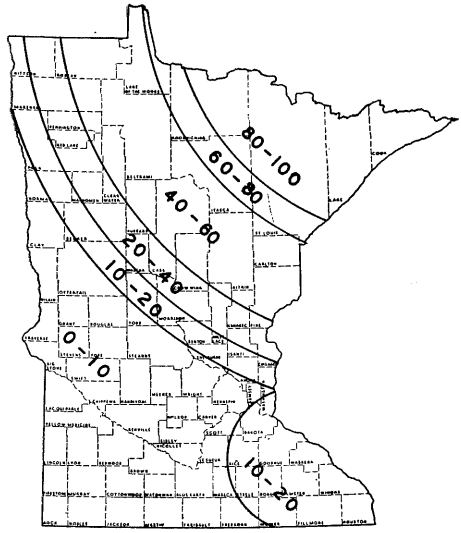

Figure 11. Beaver harvested per 100 square miles in 1961.

reflects mostly increased season length. Small limits per license in the early years may have restricted the total catch. Low pelt prices have resulted in fewer trappers in recent years than there were in the 1940's, but the harvest has continued at a high level probably because of longer seasons.

If trapping success is judged by the take of beavers per day of open season, trappers have generally been equally successful in December and spring seasons.

The total area opened to beaver trapping has varied greatly over the years (see maps in Appendix IV). Even within general open areas the amount of refuge closed or open each year has been subject to large changes. It was the policy in the early years to keep all game refuges closed to beaver trapping. Thus in 1939, about 3 million acres, or 15 percent of the open zone, was refuge in which no trapping was allowed. During the next open season, in 1941, about 2 million acres or 12 percent of the open area was refuge. Most of this sanctuary for beavers was in the Red Lake Game Refuge (more than 430,000 acres), the Superior National Forest refuges (more than 1,250,000 acres), the McGrath Game Refuge (more than 180,000 acres) and more than 100,000 acres in refuges in Koochiching County.

In 1944 the Superior refuge area was reduced to 700,000 acres. The Koochiching County refuges were opened from 1945 to 1947 and in 1949. Most of the Superior National Forest Refuges were open to beaver trapping from 1952 to 1958, and the McGrath Refuge was opened from 1954 to 1956. During the 1950's, the Federal waterfowl refuges were opened for several

years, and since 1956 the refuge managers have controlled the harvest by permit trapping. State statutory game refuges were opened 1956 through 1960, and those in the southern zone through 1962. State-owned game refuges generally have been kept closed, but nuisance beavers have been controlled by permit trapping or by refuge personnel. The trend in recent years has been toward controlling beaver numbers on refuges by trapping rather than giving them complete protection as in the past.

Spring vs. Fall Trapping — Often beavers are trapped in spring. This is an exception to the general rule that wildlife crops should be harvested in late summer or fall. There are three principal reasons for spring beaver trapping: (1) Beaver pelts are prime in early spring, the fur being fullest and the hide most free from discoloration; (2) winter losses are usually small; and (3) trapping after the February breeding season allows most surviving females to bear litters. To clarify the last point, if all adult males are taken from a colony in fall, the remaining females will not be bred and cannot bear young the following spring; but if males are taken by spring trapping, the productivity of remaining females will be unaffected.

Sometimes nature enthusiasts protest that spring trapping is excessively cruel, both because pregnant females are taken and because young born the previous year may be left without a mother. However, since beaver litters are born in May or June, fall trapping of females leaves even younger (six-month-old) juveniles motherless throughout the winter, and these same juveniles would be ten months old in the spring and more self-sufficient. Taking of pregnant females during spring trapping season cannot be avoided, but the resultant effect on next year's production of young is about the same as if they had been taken the preceding fall. Opposition to spring trapping is mostly a matter of sentiment; not of basic biology or game management.

Taking of Small Beavers — When pelt prices are low, there is a tendency for trappers to keep large beavers and discard kits or yearlings that have been taken. This tendency is probably fostered both by limitations on the number of beavers that can be taken per license and by the cost of pelt seals. In 1957, one fur company bought 1,200 pelts and of these only 7 or 8 graded less than 42 inches. Only a few kits were pelted and sold by trappers yet often 20 percent of the trapping take is of such small animals. It also appears from these records that trappers brought in most of the small skins during the first few days of the season, probably to determine the price. Later, it is likely they discarded animals too small to pelt profitably.

Prices of beaver pelts in 1957 were: 65 inches and up, $13-15; 60-65 inches, $10; 55-60 inches, $7; 50-55 inches, $5; 46-50 inches, $3; 40-46 inches, $1.50 to $2.00. At this time the price of each beaver pelt seal was

$1.00 and it is most unlikely that the trapper would buy a $1.00 seal for a $2.00 pelt. Because of this the cost of a seal was reduced to 25 cents in 1959 with the hope that trappers would skin and market more pelts of small beavers. Even with this reduced fee a trapper who could fill out his license limit with larger animals would quite naturally hesitate to bother pelting the small ones.

Generally the larger beavers in a colony are captured first, and certain trapping methods are designed to take the larger ones. However, by any beaver trapping method some kits are taken and often these are drowned or severely hurt, making it impossible to release them alive. It is suggested, therefore, that when fur prices are low, consideration be given to allowing several kits per license beyond the usual limit for pelts.

Beaver Farming

Beaver farming, whereby beavers are raised in enclosures, began in the 1920's. Beavers were kept in small artificial pens or in fenced-in marshes or ponds. Beaver farming, along with fox and muskrat farming, declined in the 1930's. In 1931 there were 1,088 beavers being raised on permits in the state but by 1936 there were only 538 and by 1941 only 51 animals. There were 41 beavers on beaver farms in 1945. At present (in 1963) there are no beaver farms in Minnesota.

The Tillden Beaver Farm at Hill City was visited by game biologists in 1941. The report on beaver farming, as then carried on here, states:

> "The farm has been operating about fifteen years on a small scale, chiefly as an avocation. The beaver are held in individual pens in a 90-foot dimly lighted shed, which has a capacity of about 100 beavers. The pens have concrete floors with pools ranging in size from 4′ x 3′ to 3′ x 10′ approximately one foot deep. Each pool is continuously supplied with spring water. A large nesting box in each pen is made of wood. A sloping runway connects the nesting box with the pool. It is essential to keep the runway covered with water to prevent the beaver from developing sore feet. The floor of the nesting box is a few inches above the water level. The beaver construct the nest of shredded sticks. It is periodically cleaned out and replaced with fresh material by the animals.
>
> During the summer, small sizes of mixed hardwood consisting of aspen, white birch, and chokecherry are fed. Aspen is the chief food of the mixture. When fed mostly on aspen, the animals seem to prefer the bark of other hardwoods such as white birch and the cherries. In the winter, stove-sized wood is fed. After the beaver have barked this wood, it is piled, dried, and sold for firewood. The diet is supplemented with carrots, potatoes and oats. Beavers are very fond of oats and bread."

Censusing Beaver

The question "How many of this or that kind of animal are there in the state?" is often asked but has no reasonably simple answer. There is no easy and completely satisfactory way to obtain an exact count of most wild animals. The numbers of animals in any population is changing continually because of losses and gains from day to day. At certain times the size of the population may increase rapidly from reproduction over a few weeks or months.

In game management it is not too important to know exact population figures unless the population can be intensively managed and the size of the population and harvest of animals from it closely controlled. For such intensive management we should know how many individuals are present and how many can be taken from each unit of area to increase, decrease, or maintain the population. Such intensive management is possible only on certain refuges and management areas, but it is not feasible for the state as a whole. It is more important for the game manager to know whether or not the living space or habitat can accommodate more animals without endangering the habitat and the future welfare of the population.

An exact population count for widely occurring animals such as beavers would cost more than it would justify. A population estimate obtained by sampling methods is a more feasible approach. Such an estimate can provide an indication (or index) of the size of the population and of population trends from year to year. Total counts are also of value on certain areas such as refuges. The greatest value of census information is for evaluation of effects of management; in the case of beaver, the trapping seasons.

A total census of all beaver colonies in Minnesota was attempted in 1940. Game wardens, CCC camp personnel, wildlife biologists, and others all took part. According to the census plan every colony in Minnesota was to be plotted on maps. The job was quite easy in about two-thirds of the state because of good roads and few beaver colonies. But in the northern wilderness the task was immense, and even with the aid of aerial photographs less than 50 percent of the state was inventoried before the next trapping season. On the basis of this incomplete census it was estimated, with reasonable accuracy, that there were at least 10,000 colonies in the state and at least 50,000 beavers.[29]

The next year, 1941, a sampling method was devised by biologists David B. Vesall and Lester McCann. Sixty-four townships in the northern beaver range were selected on the basis of amount and type of surface water, intensity of agriculture, topography, and accessibility. Again the census was conducted mainly by auto, boat, and walking, but two townships in the Superior National Forest were censused from airplanes of the U. S. Forest Service. In all, seven

percent of the 32,000 square miles of optimum beaver range was so censused. A population of 40,000 beavers and 8,000 colonies was computed by expanding the sample.

Ground checks showed the airplane counts of colonies were somewhat inaccurate, but it was clear that improvements in technique could make beaver census from the air efficient and economical. Since 1946 all beaver censuses have been made from airplanes. Until 1956 all houses were counted on sample townships. In addition, certain areas of special interest were censused; especially Itasca State Park, the Cascade River on the North Shore, and Koochiching County. However so few townships have been covered each year (usually 20) that this aerial census could provide only a general indication of the state-wide population. The beaver colony counts by townships for the years 1941-1956 are shown in Table 8.

In censusing the townships, much of the flying was over upland habitat unsuitable for beavers. It was decided, therefore, that a stream system or ditch system was a more logical census unit, and since 1957 censuses have been made by flying predetermined routes in certain watersheds. Colony counts made this way and expressed as number of colonies per 100 miles of stream are shown in Tables 9 and 10. Maps of each route are on file in the Game and Fish Division.

Aerial counts of colonies can be made in much less time than ground counts. Censusing a township by air takes 30 to 45 minutes but requires four days by ground travel. The aerial counting method, however, has limitations. The census cannot begin in autumn until the leaves have fallen and cannot continue after snow cover is heavy. In some years there have been only a few days of suitable flying weather. Experienced observers are essential.

By aerial census only active colonies are counted as determined by presence of fresh food piles, and the average number of beavers per colony must be estimated. Although the average colony usually contains five animals, larger groups can be expected in older established situations, and smaller groups in areas recently colonized.

Trends in counts from year to year can have several meanings: Trapping may have varied in intensity; disease may have occurred; or food supplies improved or deteriorated. If over-trapping has caused a decrease, the answer is obvious, but if disease or lack of food is at fault, curtailment of trapping may not be the answer. Aerial census must, therefore, be interpreted in the light of information gathered on the ground.

Counts of beaver colonies by the several methods discussed are shown in Tables 8, 9, and 10. Counts per township for the years 1941-1956 ranged from 0 to 47, with an average of 9.6. Highest counts for these years were

Table 8—Active beaver colonies[1] per township in Minnesota, 1941-1956. Dash (—) indicate townships not counted this year

Township (N) and Range (W)	County	1941	1942	1943	1945	1946	1947	1949	1950	1951	1952	1953	1955	1956
138-31	Cass	5	—	—	—	2	0	4	5	5	4	9	10	9
139-31	"	3	1	—	—	5	1	8	8	1	6	11	13	7
141-25	"	3	4	4	6	8	9	15	8	2	—	8	16	8
141-26 & 27	"	9	—	—	—	5	2	12	7	9	—	13	11	1
62-2	Cook	10	13	6	—	16	20	50	36	—	—	44	32	—
142-34	Hubbard	18	23	7	6	4	12	30	—	—	9	28	31	24
53-25	Itasca	—	—	3	4	—	3	—	2	—	—	4	4	1
59-24	"	14	—	—	—	13	3	7	8	15	11	6	7	3
60-24	"	14	—	—	—	11	4	7	17	18	24	16	14	7
62-22	"	3	—	—	—	6	2	5	3	3	—	2	3	2
63-22	Koochiching	7	—	—	—	3	—	1	2	1	—	1	1	9
59-9	Lake	2	—	—	—	—	2	5	8	—	—	5	—	—
42-17	Pine	30	26	1	—	6	9	47	37	—	23	—	—	—
53-20	St. Louis	5	—	—	—	3	2	—	1	—	—	4	—	—
55-21	" "	—	—	4	—	3	0	—	3	—	—	1	—	—
57-13	" "	1	—	—	—	—	0	—	—	—	—	1	—	—
60-12	" "	1	—	—	—	0	0	12	6	—	—	1	—	—
64-12	" "	17	16	15	—	0	10	—	—	—	—	27	18	—
65-19	" "	—	2	3	—	5	2	—	—	—	—	—	—	—
66-17	" "	—	2	—	—	12	16	—	—	—	—	23	—	—

[1] Ground counts from 1941 to 1946, aerial counts thereafter.

Figure 12. Food storage pile in front of lodge. Usually there is one such storage pile per colony. Such partly-submerged piles of winter food often contain several kinds of woody plants.

from T. 61, R. 2 in Cook County (this township contains the Cascade River); T. 142, R. 34 in Hubbard County (above Mantrap Lake); T. 59, R. 24 and T. 60, R. 24 in Itasca County (east and south of Scenic State Park) and T. 42, R. 17, in Pine County (Wilma Township, containing Village of Duxbury and several streams).

The counts from the air of colonies along selected water routes, which are shown in Table 9 for the years 1957 through 1962, range from 9 to 155 colonies per 100 miles of stream with an average, for the 13 routes, of 35.6 colonies per 100 miles. This average is considerably influenced by two very high counts (140 and 155) from the Cascade River-Kimball Creek route on the North Shore in 1957 and 1959. The median figure of 26 colonies per 100 miles is more representative. This is equivalent to about 1 colony for four miles of stream in the principal beaver range.

Colony counts made between 1946 and 1956 along streams in three beaver problem areas — Koochiching County ditches, Red Lake Game Refuge ditches, and the Cascade River on the North Shore were higher (Table 10)

Table 9—Aerial count of beaver colonies along selected waterways in Minnesota, 1957-1962. Dash (—) indicates census not made

Area	Route Miles[1]	Colonies per 100 miles					
		1957	1958	1959	1960	1961	1962
Kawishiwi River	60	—	71	58	23	20	—
Koochiching Co.	200	58	55	45	48	50	—
Itasca Co.	160	36	31	32	34	15	16
Southern St. Louis Co.	470	11	17	18	—	22	23
Carlton-Pine Co.	140	41	18	19	26	35	49
Cass-Crow Wing Co.	176	20	20	19	53	42	—
Beltrami-Cass-Hubbard Co.	202	27	25	14	9	14	21
Clearwater-Beltrami Co.	222	50	54	20	26	26	37
Lake of the Woods Co.	89	55	25	—	—	—	—
Hubbard-Becker Co.	192	20	10	—	—	—	—
Ely-Finger Lakes Area	80	—	—	—	—	32	—
Cascade River-Kimball Creek	92	155	—	140	—	—	—
Hays Creek-Kelliher	138	—	—	—	—	36	33

[1]Approximate, not completed in all years for some routes.

and averaged 53.8 colonies per 100 miles of waterway flown (median 49) or about one colony per two miles of stream. On the Cascade River this population level has been associated with injury to the stream as a trout water.

During the past 20 years there seems to be little trend either up or down in the house counts for the northern beaver range, and it appears that beaver populations here are fairly well stabilized. Beaver, however, remain a constant cause of complaints in the agricultural areas. It seems likely, on the basis of past and recent censuses and trends in the trapping harvest, that the Minnesota beaver population is at least 50 to 60 thousand animals. The population has maintained itself, and spread, despite an average trapping harvest during the past 10 years of about 18,000 animals a year and longer trapping seasons since 1957.

Table 10—Aerial counts of beaver colonies along Minnesota waterways having especially high populations, 1946-1949. Dash (—) indicates census not made

Area	Colonies per 100 miles							
	1946	1947	1949	1950	1952	1953	1955	1956
Koochiching Co. ditches	76	21	67	—	25	77	21	38
Red Lake Game Refuge ditches	22	21	28	—	28	52	32	—
Cascade River	—	59	122	65	—	122	92	—

BEAVER VALUES — PLUS AND MINUS — AS RELATED TO MANAGEMENT

Beavers cause many changes in the areas they inhabit, and such changes may be either beneficial or detrimental to man. Beavers are Minnesota's original water conservationists but if in the wrong place or in excessive numbers can be a real nuisance and cause much damage.

In mountainous areas beavers often are highly beneficial. Grasse and Putnam state that "On the headwaters of Wyoming streams . . . there can be no logical debate as to whether beaver are beneficial or detrimental. They are beneficial and usually make contributions far out of proportion to the credit they receive."[21] However, these authors also note that dams farther downstream, in areas where land use is intensive, are quite detrimental to man's interest. They point to an example of a large dam on a headwater stream which so stabilizes the stream that long periods of drouth, heavy rainfall, or snow melt run-off make little difference in the flow below the dam. Water may percolate through such beaver dams and the surrounding soil and reappear downstream. Such dams improve trout fishing in mountainous areas and reduce erosion by slowing run-off. In the Rocky Mountain region it has been found that beavers must be adequately harvested to prevent damage to trout streams, and that on shale soils and where stream gradients exceed about 15 percent, all beavers should be removed. In such situations soil-binding vegetation is of greater benefit than are the activities of beaver in preventing soil erosion.[76]

In Minnesota there are many benefits from beavers. Their pelts are a valuable natural resource; they aid in water conservation, and by their impoundments benefit other kinds of wildlife. Their dams and works, in some places, are a recreational asset as tourist attractions. But, as elsewhere, there are both credits and deficits on the beavers' biological balance sheet in Minnesota. If in the wrong place or too numerous, beavers can be a real nuisance and damage roads, forests, farm lands and trout streams. Often it is difficult to get unanimous agreement as to when and where beavers are undesirable. If a beaver dam floods a public road or beaver burrows cause a road to wash out, the need for eliminating the nuisance colony is obvious, and the same is true when beavers flood a farm field or interfere with field drainage.

Other complaints are more controversial, particularly where beaver flooding is in public forests or other areas removed from civilization. On flat timber land, dams which cause harmful flooding in wet years may provide needed ground moisture in dry years. A study of beaver-forest relationships was made in 1946 on the flat swamp-type coniferous forest along drainage ditches in

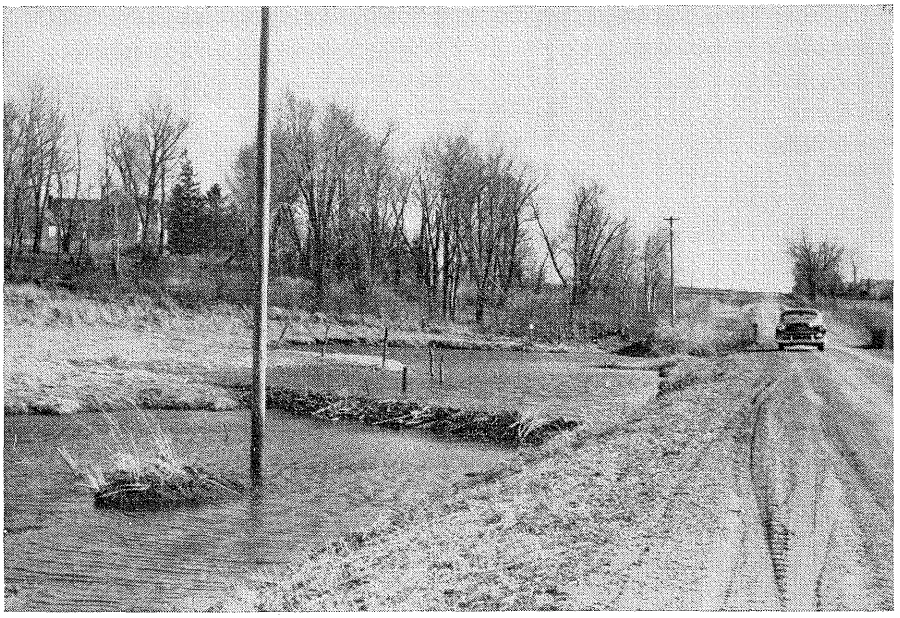

Figure 13. A beaver problem. The dam in the roadside ditch and bank burrows caused the road shoulder to wash out.

Koochiching County, Minnesota. During the wet years when the study was made, beaver populations were high, and beaver dams were flooding timber, forest-protection roads, logging roads, and highways. Here, because of the flatness of the terrain, the value of timber killed by flooding was greater than the fur value of beavers.[73] But in other places and on other sites, such as in the Adirondack region of New York, the annual value of beaver fur has been found to be greater than that of the aspen or hardwoods that they might destroy. Beaver activities here also increased other kinds of wildlife; animals of economic values equal to or greater than that of the beaver itself. Time required to produce a wild crop must be considered: timber requires 50 years or more to produce a crop and even longer after an area has burned; production of a crop of beavers requires only a few years.[62]

Protection of beaver has had undesirable effects on some North Shore streams and trout populations. There is, however, considerable difference of opinion, and especially among fishermen, as to the effects of beaver upon trout streams. Trout fishing above new impoundments is often good for a few years but usually becomes progressively poorer behind old dams. Impoundments may decrease flow of water in the stream below, and beaver eliminate trees that shade and cool the streams, causing them to become too warm for trout. Accumulation of silt in ponds and deposition of the silt downstream when dams break are harmful to trout foods and spawning redds. On the

credit side there can be seepage springs below beaver ponds that cool tl water in the stream and supply a more constant flow.

A study of the effects of beavers on several Minnesota North Shore trou streams has been made by John G. Hale.[24] He found that beaver activit caused gravel and riffle bottoms to be covered with silt and detritus and tha near beaver dams, water velocity was slowed and the water warmed. Ther was an effect both on fish and fishermen. As for the fish, the stream becam more suited to warm water species and less to trout. As for the fishermen about two-thirds of those contacted preferred to fish in the flowing stream rather than in beaver ponds. Beaver dams were barriers to trout migratin upstream to spawn, and in impounded areas the invertebrate life was of type less desirable for trout food than in the stream itself.

On our North Shore streams beavers should be managed, probably by permit trapping, to prevent their overabundance. If beavers are allowed to maintain high populations, they not only damage the streams but also eliminate their own food supply. This has already happened along some of the streams, such as portions of the Cascade River. Large numbers of beavers so reduce their food supply that in a few years the population declines to levels lower than could be maintained by judicious population control through limited trapping. However, in recreational areas along the North Shore, maintenance of some beaver colonies at the sites where they can be seen by the tourists is a real economic asset.

On the waterways in the canoe country of the Superior National Forest Roadless Area, beavers perform a special service. Their dams make navigable shallow streams and in some places save canoeists long portages. For this reason the waters of several canoe routes have been closed to beaver trapping since 1956.

In some sites a beaver impoundment may have little effect on a trout stream, as is shown by a study by Shetter and Whalls in Michigan.[59] A beaver pond, probably 5 years old, supplied good brook trout fishing in 1939 and 1940. The dam then began to deteriorate and became ineffective by 1943. In 1949 the dam was rebuilt by the Michigan Conservation Department. Data on water temperatures and fishing in the stream below were compared for three years before and three years after the dam was restored. After the dam was restored, average water temperatures at a station 1.5 miles downstream rose about 10° F. in June, 9° in July, and 5.6° in August and 1° to 3° in winter. Streamflow was little affected in summer but decreased about 10 percent in winter. But because cold springs flowed into the impoundment, the increased temperature did not, in this case, adversely affect brook trout fishing in the stream. Neither did stream fishing improve after the dam was repaired.

G. J. Knudsen has presented a picture of the values of beaver in Wisconsin based upon a study of 353 ponds.[37] A special beaver-trout-forestry committee of the Wisconsin Conservation Department made recommendations for beaver management that provides for maximum control of beaver in watersheds of special value for trout and production of valuable lowland timber. State-wide harvesting by general trapping seasons was also recommended. This committee suggested that forest management may be able to exclude beavers from problem sites by developing unfavorable habitat for them. Such an approach might be elimination of aspen.

Figure 14. Beaver lodge on poor site. Food, building materials and water supply are all inadequate.

Control of beavers causing damage has been carried out in several ways in Minnesota. Live-trapping and transportation of beavers to other areas was done by game wardens in the early years. After beavers became abundant, this procedure became impractical both because of the cost and because available unused beaver habitat was scarce. Permits to trap and pelt offending beavers have been issued since 1919. Such permits are obtained by trappers from a game warden. The permittee is required to take beavers from areas of the complaint. Department employees have used traps and guns to remove beavers, and dams have been dynamited or otherwise destroyed. Several thousand dollars worth of dynamite have been used in some years. The number of beaver complaints handled by game wardens in recent years has usually been between 170 and 210 each year.

The Dakotas also have beaver troubles. The South Dakota Division of Game, Fish and Parks has controlled beavers by shooting. Lee describes float trips down the Cheyenne River during which all beavers seen were shot and the pelts sold by the state.[39] There is at present no closed season on beavers in South Dakota. North Dakota had a six month season for several years followed by two years of no protection ending in 1961. In 1962 the six-month season was re-established.

There are situations where beaver damage can be prevented or controlled without killing the animals or destroying the dams. Damage to ornamental trees can be prevented by wrapping the trunk with wire cloth to a height of three feet. Occasionally a beaver dam can be tolerated at a certain level but becomes a nuisance if raised higher. Bailey presents a method whereby a desired level of water can be maintained by pipes through the dam (Fig. 15). The pipes must be securely laid and fastened down and intakes screened. One or more pipes of sufficient size to carry the normal water flow should be laid through the dam with the outlet at the height of the desired water level. The intake should be screened and covered with stones and the outlet project far enough beyond the dam so beavers cannot plug it. Three or more logs may be used instead of a pipe.[4] They are laid upon a board or encased in sheet metal. Minnesota Game Warden Joseph Brickner once constructed a similar drain of four 10-foot planks. He placed a basket of chicken wire over the upstream end to keep out debris.

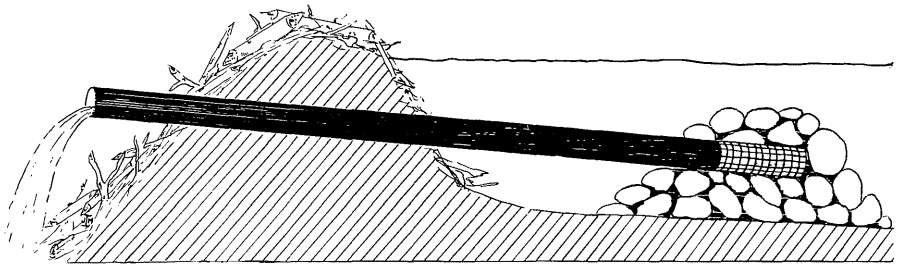

Figure 15. Use of pipe for controlling water level behind beaver dams. (Redrawn from Bailey, 1922)

SUMMARY AND CONCLUSIONS

The beaver, because of its considerable past and present values, has a well documented history of about 200 years in Minnesota and even longer in more eastern North America. This lengthy history is unprecedented in the annals of our wildlife and from it several conclusions are obvious concerning relationships between wild animals and man, and between wild animals and their habitat. The history of the beaver presents a unique demonstration of the principles of wildlife management and ecology at work.

1. The early depletion and near extinction of beavers amply demonstrates that wild animals of considerable value to man, *particularly species that concentrate in special habitats,* are apt to be exterminated if not given adequate legal protection.

2. The recovery of beaver populations after near extinction was first slow and then rapid, demonstrating the resilience and the geometric (first slow and then rapid) rate of increase of wildlife populations.

3. The damage done to human values by beavers, when too numerous, and the destruction of their habitat when and where there has been little population control shows the tendency of wild animals to become overly abundant if protected too completely.

4. The fairly stable beaver population in Minnesota in recent years, as indicated by trapping take, shows the value of planned and well enforced regulations by which part of the population is taken and used each year. Under this management the habitat for beaver in the principal northern range has been preserved. For North America, as a whole, the present annual harvest of beaver pelts, mostly from the same areas each year, equals the peak take during the early fur trade. Management for sustained yield has replaced the trapping-out and moving-on of the early years.

5. The history of disease in beaver points out the ever-present danger of epidemics that may suddenly appear and decimate wild animal populations. Such catastrophes are usually beyond human control but the possibility of their occurrence can be minimized by keeping wild animal populations at a moderate level.

6. The complex interrelationships between beaver, their habitat, other wildlife and man demonstrate that information concerning such relationships is indispensable for proper management, and that such knowledge must be kept current so management can be adjusted to changing conditions.

Management of beavers in Minnesota has generally been quite satisfactory in recent years, but in planning future management the following points should be considered:

1. Every effort should be made to have a trapping season each year. This maintains trapping interest and assures that there will be skilled trappers available; trappers who are necessary for proper beaver management. Closing of large areas should be avoided except under unusual circumstances where the beaver population requires special protection.
2. Some principles to be considered in habitat management for beaver and in setting trapping seasons are:
   a) Overabundance of beaver results in depleted food supplies and abandonment of formerly productive areas;
   b) poor food supplies cause a lowered reproductive rate;
   c) in the absence of beaver, fires, or lumbering, aspen stands will be replaced by vegetation that cannot support a sizeable beaver population.
3. With present forest management trends it can be expected that in the future there will be fewer beaver in northern Minnesota. As coniferous forest replaces aspen and other beaver food plants that are characteristic of the immature forest, a decline in the numbers of beaver can be expected. Maintenance of future beaver populations depends as much on providing proper habitat, as on the control of population size through regulation of the harvest.
4. There is need for more flexibility within the legal framework for trapping regulations. The present legal limit of 10 beaver per trapper may not always be satisfactory on all trapping areas. It should be possible to adjust trapping regulations more completely to fit current beaver population trends and local habitat conditions.

Properly planned and well enforced trapping regulations are of little value unless there are skilled trappers to take the excess beaver. For this reason detailed information on trapping, skinning, stretching, and grading of pelts is included in the Appendix. It is hoped that this will be useful to experienced trappers and, especially to beginners, of whom there are too few. If beaver management is to be successful, trapping must not become a lost art.

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APPENDIX I

Scientific Names of Plants Mentioned in Text[20]

Alder	*Alnus rugosa*
Ash, black	*Fraxinus nigra*
Arrowhead	*Sagittaria* spp.
Aspen, large-toothed	*Populus grandidentata*
Aspen, trembling (popple)	*P. tremuloides*
Bay, sweet	*Magnolia virginiana*
Birch, white	*Betula papyrifera*
Bur-reed	*Sparganium* spp.
Cattail	*Typha spp.*
Chokecherry	*Prunus virginiana*
Cottonwood	*Populus deltoides*
Dogwood, red-osier	*Cornus stolonifera*
Gum, sweet	*Liquidambar styraciflua*
Hazel	*Corylus americana, C. cornuta*
Juneberry	*Amelanchier* spp.
Maple, mountain	*Acer spicatum*
Oak, bur	*Quercus macrocarpa*
Oak, red	*Q. borealis*
Pine, loblolly	*Pinus taeda*
Pine, spruce	*P. glabra*
Pondweed	*Potamogeton* spp.
Poplar, balsam	*Populus balsamifera*
Reed	*Scirpus* spp.
Sedge	*Carex* spp.
Sumac, smooth	*Rhus glabra*
Waterlily	*Nuphar* spp., *Nymphaea* spp.
Willow	*Salix* spp.

APPENDIX II

A Guide to Beaver Trapping and Pelting

by

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Colorado Department of Game and Fish

TRAPPING

GENERAL COMMENTS

Compared with some other furbearers the beaver is easy to trap, especially in areas where the animals have not been previously disturbed by trappers. A great deal of our public land falls in this category. However, the more an area is worked by trappers, the more "trap shy" beavers become. Amateurish or improper trapping techniques can make beavers "trap shy" in a hurry, especially if the trapper is getting a high proportion of feet and not many beavers. A three-legged beaver is infinitely wiser than a four-legged one!

This does not mean that beaver trapping is easy. On the contrary, beaver trapping requires real physical labor as well as a thorough and intimate knowledge of the habits of the animals. Trapping skill is acquired slowly, even when attention is given to past mistakes. This is also true in acquiring the skill necessary to good pelt preparation, as the beaver is one of the most difficult furbearers to skin and flesh. Special techniques for skinning as well as stretching the pelt must be learned. Men who have trapped for years say that ". . . after you have fought with the first 100 beavers, you start to learn how to skin on the second hundred, and by the time you have 'shucked out' 300, you've got a pretty fair idea what you're doing." The authors' purpose, therefore, is not to try to make skilled trappers overnight, but rather to attempt to outline techniques that should serve as a basic guide.

EQUIPMENT NEEDED

Equipment falls in two general classifications: (1) that used in capturing the animal, and (2) that used in preparing the pelt for market. A display of both types of equipment is found in Figure 16.

Traps. The trap, of course, is the basic item. It should be large enough to catch a beaver high on the leg and to provide considerable weight to hold the beaver down in the water, thus decreasing the chances of "wring-offs," Number 14 or 48 is the smallest trap that should be used; a Number 4½ is ideal. It is a good idea to weight the smaller traps (No. 14 or 48) to insure rapid drowning and reduce the chance of escape. This is easily done by affixing a weight (rock, metal, etc., approximately 15 pounds) about six inches

above the trap chain swivel. Beavers have been caught and held in Number 3 or 4 coyote traps, but the chances of misses or wring-offs are so great with these traps that it does not pay to use them. Traps should have about 4 feet of chain and 6 or 8 feet of heavy, but not stiff, wire attached. New traps can be purchased from mail order houses or jobbers in trapping supplies. Occasionally, bargains in used traps can be found at second hand stores or junk yards.

Scent. The judicious use of scent can be of great advantage to a beaver trapper. The basic ingredients are ground castor, oil from the beaver's oil glands and mineral oil to thin the mixture. Additional ingredients may be used; these comprise the secret formulas of many old-time trappers, and their use is strictly up to the individual. Oil of anise and other pungent spicy oils are generally included in these formulas. Figure 17 shows the location of a beaver's castors and oil glands, cut away from the body cavity in which they lie.

Miscellaneous Trapping Equipment. In addition to traps and scent, the field equipment of a beaver trapper consists of an axe for cutting and driving stakes, rubber gloves, hip boots, a .22 pistol and a strap or rope which can be fastened to the beaver's legs so that the animal can be carried over the shoulder. Additional equipment for trapping through the ice includes a crowbar and a shovel or pair of long-handled tongs.

Pelting Equipment. Beavers can be skinned almost anywhere, *e.g.,* on the ground, on the tailgate of a pickup truck or any other such surface. In fact, if a beaver is caught a considerable distance from a road, it is usually easiest to skin the animal on the spot. If the beaver is brought in, however, the work of skinning can be greatly lessened if a trough of comfortable height is constructed. Such a trough will hold a beaver firmly in any position. The trough may also be adjusted in width, for animals of different sizes, by lengthening or shortening the chains on the legs. The legs are bolted loosely together to permit movement.

Most trappers use a minimum of three knives in pelting beavers. These should consist of a heavy-bladed knife for cutting off feet and trimming the stretched pelt; a small, narrow-bladed knife for splitting the skin along the belly; and a thin, finely-ground skinning knife. A can of oil, a fine carborundum stone, a sharpening steel and a razor strop are aids for keeping the knives dressed. Many trappers use the beaver's tail as a strop with very good results. The importance of keeping the skinning knife very sharp cannot be overemphasized. A fine-edged skinning knife should never be used for cutting off feet or trimming pelts; use other knives for these purposes. A new skinning knife will have a blade which is too thick, and which has too great an angle of bevel on the edge. No amount of working on steel or strop

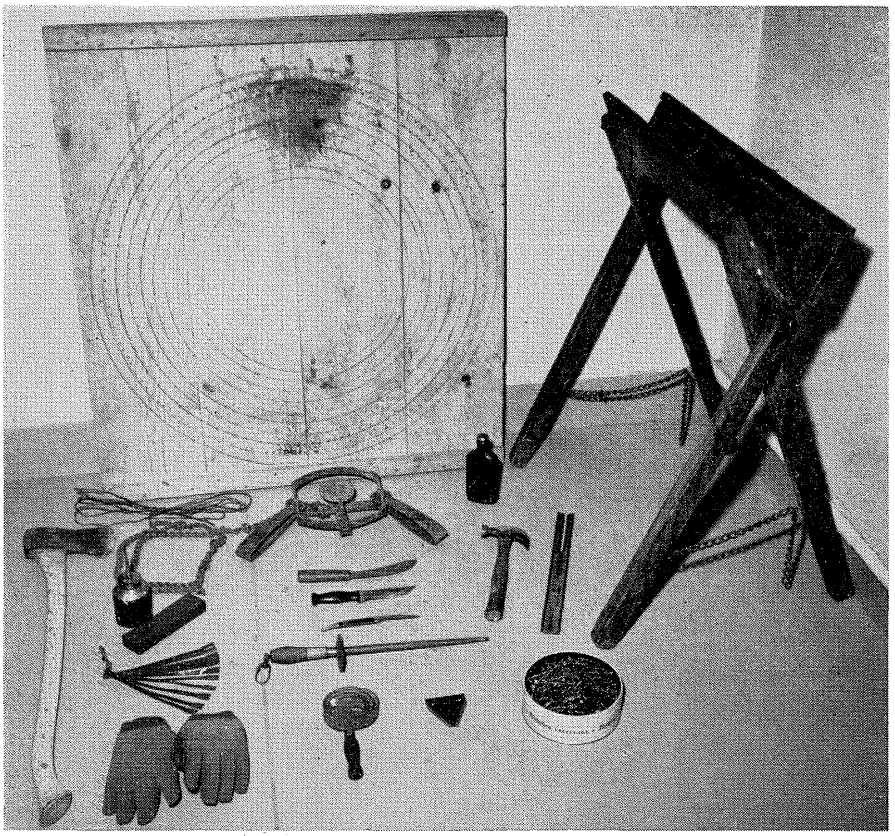


Figure 16. Equipment for beaver trapping and pelting. Shown are: (1) stretching board, (2) skinning trough, (3) can of nails, (4) scraper, (5) curry comb, (6) rubber gloves, (7) axe, (8) trap site seals, (9) carborundum stone and oil can, (10) trap and its chain and wire, (11) skinning knife, (12) heavy-bladed knife for cutting off feet, (13) splitting knife for stomach, (14) steel, (15) hammer, (16 nail remover bar, (17) scent bottle. Trap site seals are not used in Minnesota.

will make such a knife satisfactory unless the excess metal has first been removed with a file. The blade should have a straight taper from back to edge.

Boards for stretching the skins should be constructed of lumber which is relatively knot free, and should be 38 to 40 inches square. Concentric rings, of alternate colors, inscribed about an inch apart on the board serve as guides for stretching the pelt in a circular shape. A claw hammer, a supply of 6d or 8d box nails and an instrument for scraping (or fleshing) the stretched hide complete the list of equipment. A section from the sickle bar of a mower makes a very satisfactory scraper, although any straight-edged piece of steel will do. A strip of steel, about ¼ inch thick and 1½ inches wide, with a 6-inch slit down one end, makes an excellent tool for removing nails from the dried pelt.

SELECTION OF TRAP SITES

Figure 18 shows a beaver lodge and surroundings with arrows marking likely spots for sets. On many occasions trappers find spots used by beavers, but with water too shallow to insure drowning the catch, while a few feet away the water is deep enough for drowning purposes, but no beaver sign is present. In such instances the use of scent is a "must", for it attracts beavers to the better trap site. Don't, however, expect the scent to compensate for carelessness in making the set. In order to take advantage of the best possible sites, a trapping area should always be thoroughly examined before a trap is ever set. Two or three very carefully placed traps will catch as many or more beavers than a dozen scattered about haphazardly, with the added advantage that the beavers will not become "spooked" as quickly.

MAKING TRAP SETS

The first rule in placing a trap is to do everything possible to insure that the animal will be drowned quickly. Many people object to the harvest of animals by steel trap as inhumane, even when—as in the case of beavers—steel-trapping is the only efficient means of accomplishing the harvest. Under

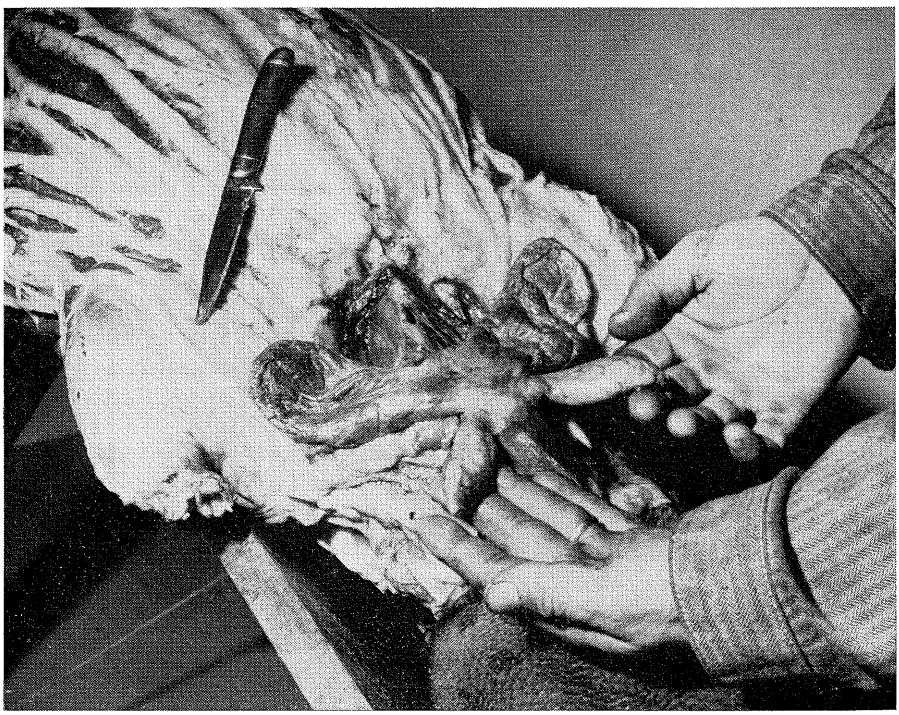


Figure 17. The source of beaver scent. The larger pair of glands are the castors which are the source of the scent, the smaller pair are the oil sacs.

Figure 18. A beaver lodge and surroundings. Arrows mark likely spots for setting traps: (A) food paths, (B) runways, (C) scent mounds, (D) shoreline feeding areas.

these circumstances the beaver trapper is more or less obligated to do his trapping in as humane a manner as possible.

Many different ways of setting beaver traps are employed, each having certain merits. The authors have chosen to explain the two most common and well-proven methods after studying various techniques of beaver trapping, equipment needed and simplicity of operation.

The first type of set requires the use of a drowning stake, and necessitates relatively deep water (3 feet or more). The second type does not involve the use of a stake and may be set in shallower water, *e.g.*, stream or river.

Using the drowning stake method, a pole is first selected approximately 3 to 4 inches in diameter—the length depending upon the depth of water. The stake is driven securely out into the pond or stream a short distance (depending upon length of chain) from the proposed trap set. After the trap is in place, the chain is looped once, completely around the base of the stake, and the wire attached to a solid object on the bank. With this method traps may be placed for either front or hind foot catches. The hind foot catch is generally more effective than front foot catches, as the hind legs are much larger and stronger, thus making wring-offs less likely to occur. The trap is placed with the jaws parallel to the line of travel and with the pan 4 or 5

inches below the water surface. The springs or "ears" of the trap are placed at an angle to the jaws as shown in Figure 19. The trap should also be off center of the line of travel and far enough back from the scent daub so that the beaver will swim over the trap with the front feet and hit the pan with the hind foot as it places its feet on the bank.

Figure 19. Setting a beaver trap. Drowning stake around which trap chain is wrapped is shown to left of trapper. Note the use of guide sticks and logs placed on either side of trap.

As soon as the animal is caught, it usually dives for the deep water, and in most cases the weight of the trap pulls the beaver under and he is quickly drowned. The stake is used to aid this operation especially when large animals are involved. The chain is shortened and entangled by the animal's movement around the stake, thereby limiting its actions and chance of escape. In shallow water where the trapped animal can readily reach the surface, the stake can act as a solid support and may enhance wring-offs. For this reason deep water is a "must" when using a stake set. Figure 19 shows a trap being placed with the drowning stake in position. Figure 20 illustrates a cross-sectional view of the stake method.

In making a set without the drowning stake the objective is definitely to make a hind foot catch to insure holding the animal if he is not drowned.

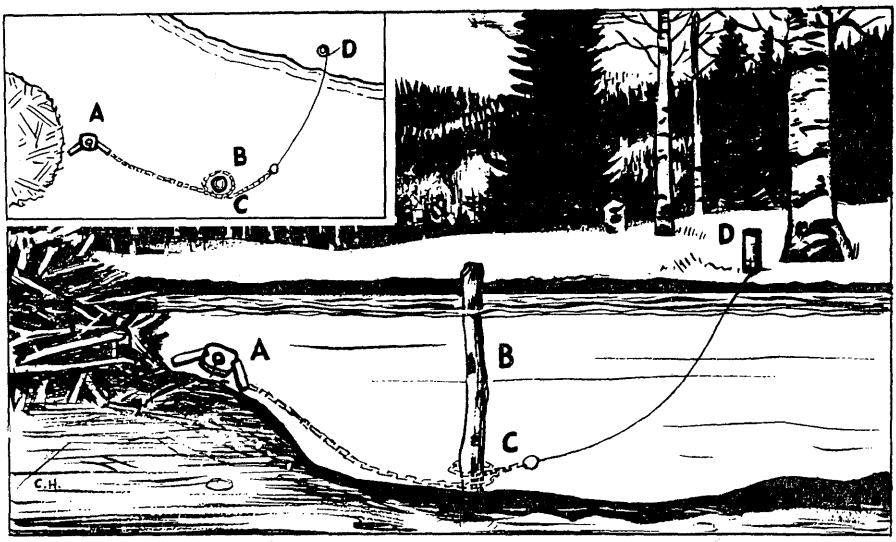


Figure 20. Underwater view showing (A) location of trap near beaver lodge; (B) drowning stake; (C) position of chain; and (D) wire attached to stake on bank. The inset shows the view from above. Trap chain should be forced as far as possible into bottom with the foot.

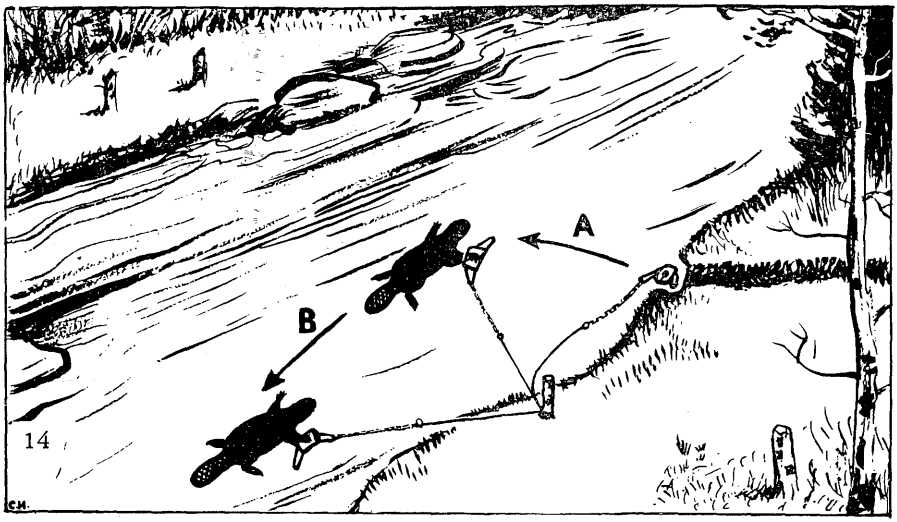


Figure 21. Trap set on stream, without drowning stake, showing movement of beaver into deeper water (A) and final position of drowned animal (B).

Again, every effort should be made to drown the animal by setting in deep water and weighting the lighter traps. The trap itself is set in the same manner as the stake method. The wire, however, is securely fastened down-stream to a solid object on the bank (Figure 21). Here, the weight of the trap alone is responsible for drowning the animal. On a river the dead beaver is usually found downstream as shown in Figure 21. Care must be taken in placing the wire so that nothing obstructs the movement of the animal to deeper water.

(Editorial note: A taut wire with one end anchored on the shore and the other in deep water is commonly used to insure quick drowning of trapped beaver. The trap-ring will slide down the wire to a catch which prevents the beaver from returning to the surface. An "L" shaped piece of steel which slides only in one direction serves the same purpose and may be more satisfactory, as shown in Figure 22.)

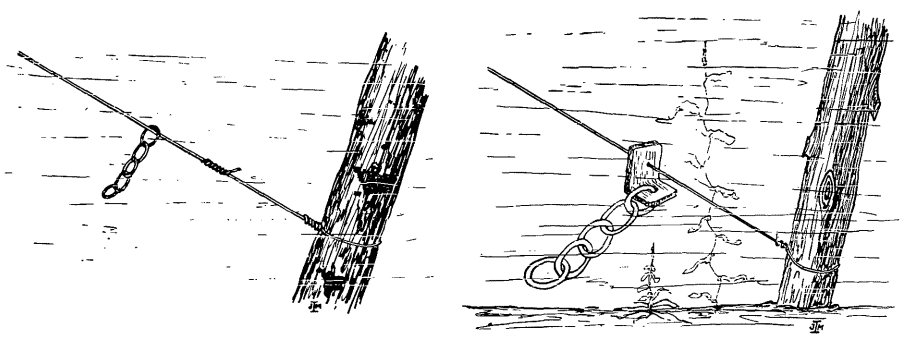


Figure 22. Stakes in deep water with device to prevent traps being pulled back to shallows.

Site conditions and depth of water dictate which of the above methods is best to use. With either type of set it is a good idea to stomp a small shelf in the mud of desired depth for the trap to rest upon. This provides a firm base for the trap and helps prevent "misses".

It is often difficult to set a Number 4½ trap by compressing both springs at once. If such difficulty is encountered, one spring can be compressed and held in place by a nail pushed under the jaw post. The other spring can be compressed, the trap set and the nail removed. To insure easy removal of the nail, place it under the "free" jaw as the other jaw will be secured by the pan catch or "dog", and make removal difficult.

The use of scent may be employed with both of the above described methods. In making a scent set, the use of a mud daub on the bank in front of the trap adds to its effectiveness. Sprinkle only a few drops of scent on the daub with a small stick. The scent arouses the beaver's curiosity; but too much of it will make him suspicious, and become a disadvantage. If there is a possibility that a beaver can approach the scent from some direction other than directly over the trap, poke some small sticks and/or small logs into the

mud on either side of the trap to help in guiding the animal to the desired spot (note guide sticks and logs in Figure 19). Often a "blind set" (trap placed without using scent) can be used to advantage, especially if beavers have become scent shy. Blind sets are placed in runways, lodge entrances, approaches to feeding spots and other places where beavers will naturally travel.

ICE TRAPPING

During the winter months when the beaver's pelt is at peak primeness (and highest value) the rivers and ponds are often covered with a thick layer of ice.

The first step in catching beavers under these conditions is to chop a hole through the ice about a foot and a half in diameter, and preferably between the lodge and the food cache. Next, select a green aspen pole similar in size to a drowning stake. It should be driven into the bottom as straight as possible. The trap or traps—and usually two are used—are lowered into position at the base of the pole (Figure 23). This may be accomplished by holding the trap chain in one hand and lowering the trap on a shovel with the other hand. Tongs as shown in Figure 24 are also used for this operation. The trap wire is then tied to another pole lying on top of the ice. Some trappers chop an additional hole and run the trap wire under the ice, through the hole, and attach it to a small pole as shown in Figure 23.

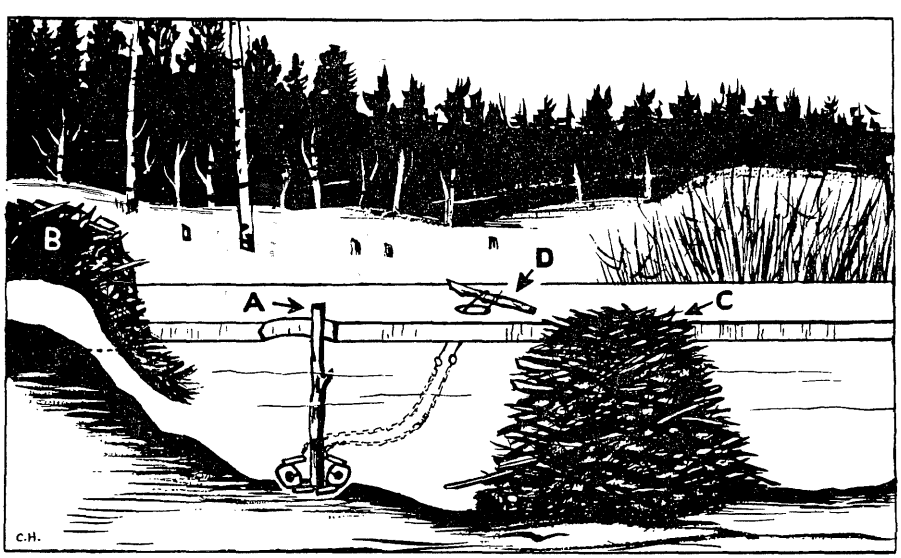


Figure 23. Making a set under the ice. Note position of traps (springs pointing inward) at base of aspen pole (A), between lodge (B) and food cache (C), and trap wire tied through additional hole (D). More than one such set is usually employed.

The beaver, in the process of feeding on the freshly cut aspen, steps in one or both of the traps and is readily drowned. More than one of these sets are commonly made around the food cache.

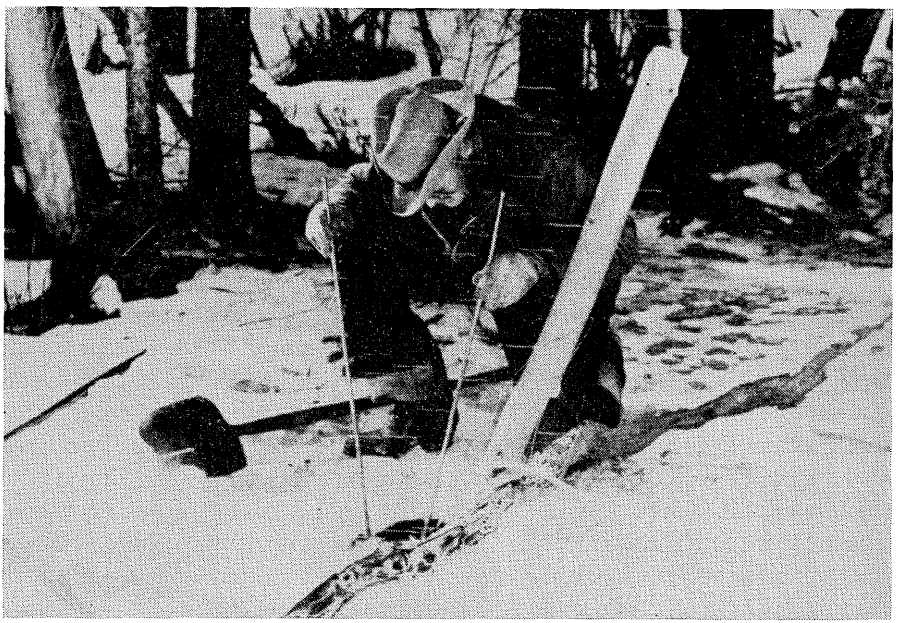


Figure 24. Lowering the trap into position by use of tongs. The green aspen pole is used for bait; the dead limb to attach the trap wire. Pole should be erect.

REMOVING ANIMAL

Occasionally, in spite of all preventive measures, a trapped beaver will stay alive in the trap. A shot with a .22 pistol in the ear or the top of the head will quickly dispatch the animal with a minimum of damage to the pelt.

When removing a beaver from a trap the springs should be quickly compressed, while at the same time the beaver is lifted free of the jaws. This will prevent damage to the fur.

SKINNING

The beaver is considered to be the most difficult of the furbearers to skin. This is mainly due to a layer of tough, stringy fat between the skin and the flesh, which firmly adheres to both. Only a skilled beaver skinner can leave this fat on the carcass instead of on the pelt. The hide cannot be pulled off; every square inch of surface must be separated from the carcass with a knife. Unskilled individuals will leave fat or flesh on the skin in places. Such pelts will inevitably be graded down by the fur buyer.

The beaver is skinned "open" rather than "cased" as with most other furbearers, *i.e.,* muskrat, mink, marten, etc. The first step is to cut off all 4 feet (at the first joint), cut around the base of the tail and make a longitudinal incision from the base of the tail, along the abdomen to the mouth (Figure 25). The process of "shaving" the skin from the carcass then begins. The left hand actually does most of the work, as the pelt must be constantly gripped and pulled taut while the knife is being applied. The most difficult places are around the legs, eyes and ears. In skinning the head, particular attention should be paid to cutting away all of the gristle around the ears. The beaver is skinned to the middle of the back, then turned over and started from the other side (Figure 26). When the skin is finally free from the carcass, any fat or flesh remaining at the point of separation should be taken off.

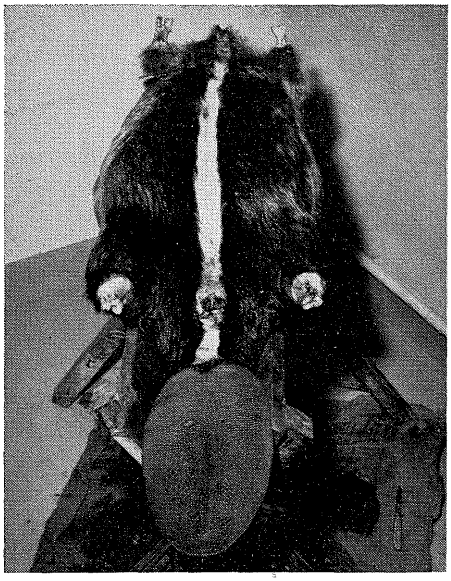


Figure 25. Beginning the skinning process. The legs are cut off at the first joint, a cut is made around the base of the tail, and the pelt is then split up abdomen to the mouth.

Figure 26. Freeing skin to mid-line of the back.

STRETCHING

Experience alone will tell the skinner how large the stretched pelt should be. Grasp the pelt on both sides, midway between the legs, and pull out as far as it will go. Then come back one or two rings on the board, depending on the pelt size, and note the colored ring which is to be used. Then peg the nose and tail areas and the two sides on this ring (Figure 27). The next step is to peg out the edges as shown in Figure 28. Then the nose, lips and the

flaps around the tail are pegged out beyond the ring, and the final nailing of the skin then takes place (Figure 29). A pelt stretched drum-head-tight is too tight, as this will make it appear to be lightly furred. A pelt which is flabby and moves around on the board is too loose. If either of these conditions are encountered it is best to pull the nails and reset them in or out, as the case may be. The final nailing should have the nails about an inch apart. After the pelt is stretched, the hind leg holes are nailed shut, the nose, lips and tail flaps which were pegged out are trimmed off, and the pelt is scraped to remove any remaining fat or flesh. The completed pelt—stretched, trimmed and scraped is shown in Figure 30.

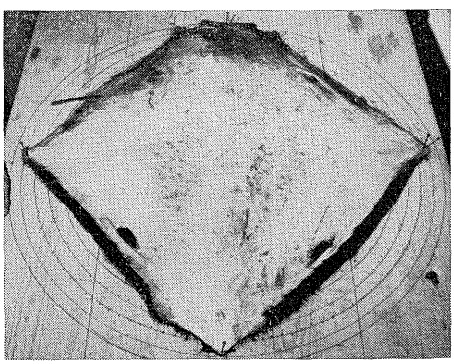


Figure 27. The initial nailing of a pelt. After the size of the stretched skin has been determined, start nails as shown.

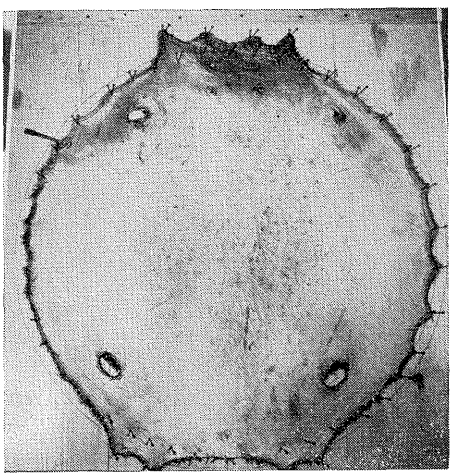


Figure 29. The third step. Excess skin around the nose, lips and base of tail is pulled out beyond the ring and nailed.

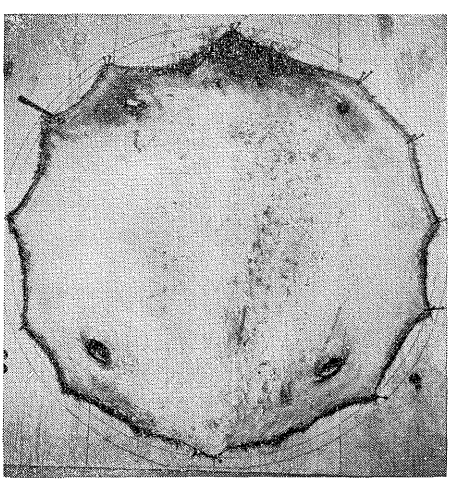


Figure 28. The second step in stretching. Nails are placed about six inches apart around entire skin on the selected ring.

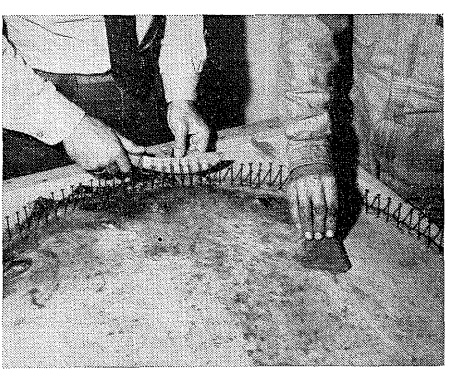


Figure 30. Finished stretched pelt. Nails are placed approximately an inch apart. The hind leg holes have been nailed shut.

An empty 50-gallon oil drum makes an excellent support for the stretching board. The drum stands waist high, and allows pelts to be stretched on both sides of the board.

CARE AND SALE OF PELTS

Stretched pelts should be stored for drying in a dry, shady place with plenty of air circulation. Pelts should never be dried in the sun. When the areas around the legs and ears feel dry and hard to the touch, the pelt can be removed from the board. The fur should be brushed to remove dirt and loose fur. When pelts are stored after being removed from the boards it is a good idea to lay a stretching board on top of the stack to prevent the edges of the hides from curling.

APPENDIX III

Grading of Beaver Pelts and Manufacture of Fur Coats

by

Wendall G. Swank[66]
West Virginia Conservation Commission

GRADING OF BEAVER PELTS

The first consideration in grading beaver pelts is the size, since this determines how many pelts it will take to make a coat. The pelts are measured from the tip of the nose to center point where the tail is attached and at right angles to this measurement halfway between front and hind legs, that is, across the center of the belly and back. When speaking of sizes these two measurements are added together. The standard trade name for sizes are as follows:

65 inches or over—super blankets; 63-65 inches—blankets;

60-63 inches—extra large; 55-60 inches—large;

50-55 inches—large-medium; 40-49 inches—medium;

below 40 inches—small and cubs (kits).

Unprimeness is indicated by blue or dark streaks on the flesh side of the pelt. If a pelt is unprime it will usually show across the front shoulders more than any other place. A pelt showing slight unprimeness on the flesh side is turned over and examined on the fur side for length of guard hairs or sparseness of underfur is graded down. A point considered very important in grading beaver is the removal of all fat and flesh. Beaver pelts "burn" very quickly if excess flesh or fat is left on them. This causes the hair to fall out when the pelts are processed. Excess dry flesh on the pelts also causes them to break if accidentally folded.

Cuts, even though they are small, detract from the value of the pelts, for in processing each of these cuts must be sewed together, and in the manufacture of the final garment smooth cuts are made by the manufacturer to eliminate ragged edged cuts made by the trapper. Both of these operations are time consuming and some material is wasted. A cut around the edge, or on the belly is just as bad as one on the back, for all fur except the head is used in making a beaver coat. The belly fur contrasts in color with fur from the back to produce the strip effect . . . color is also of prime importance in grading beaver pelts. The darkest are the best pelts and are obtained from Quebec, Eastern and Western Canada, and McKenzie River. The next darkest come from Maine and Labrador, then Michigan, Wisconsin and

Pennsylvania. West Virginia beaver fall in the latter class. The inferior colors, that is the lightest, come from the Dakotas, Wyoming, and other mid-western and southwestern states. Some of these pelts are a light tan.

PROCESSING OF BEAVER PELTS

Briefly, the steps in commercial processing of a beaver pelt are as follows:

1. The pelt is soaked in water, the length of time depending upon the thickness of the pelt.
2. It is then placed in a revolving drum with sawdust made from hard maple. This sawdust acts as an abrasive and cleaning agent on the hair and leather. It also takes up any excess moisture.
3. The leather side of each skin is then brushed with a soaking solution, the pelt is folded lengthwise and leather side in, and hung on racks to dry. The exposed hair becomes dry, but the leather remains soft and moist.
4. At the right time the pelts are taken from the drying room to the plucking room. Here the hair side is dusted with fine calcium carbonate powder. The pelt is then placed across a round log-like beam. While holding the pelt in place with his leg an operator pushes a large draw knife across the pelt. This draws out the guard hairs and their roots. The fine underfur is not marred.
5. After the plucking operation the chalk is removed from the skin by placing it in a rotating screened drum.
6. The skin is again soaked until soft and pliable, then removed from the vat and the thickness of the leather is reduced. This is done by drawing the leather side of the pelt over a circular shaving knife.
7. The pelt is now placed in a tanning solution for three to twelve hours, depending upon the time required for the solution to penetrate through the leather to the fur side. The tanning solution is made principally of salt, alum and water.
8. After coming out of the tanning solution the pelt is stretched and dried.
9. The skin is then run through a large staking wheel which takes out all wrinkles.
10. The skin is again cut down in thickness.
11. The skin is now oiled on the leather side and put into a mechanical kicker, which literally beats the oil into the skin, making it soft and pliable.

12. When sufficiently beaten the skins are removed and placed in a rotating sawdust drum to remove the excess oil, then a rotating wire cage to remove the sawdust.

13. The leather is now shaved down again and the whole process of oiling, kicking, and cleaning is repeated.

14. The last shaving of the leather is done after soaking the skin overnight in a chemical which puffs up the leather. This enables the operator to cut the skin right down almost to the roots of the hair, making the pelts lighter in weight.

15. The skin is then put through a series of seven drummings with sawdust and a cleaning between each.

16. The pelt is now ready for shearing. This operation is done by running the pelt up, over, and down a triangle. At the apex of the triangle a thin line of fur stands upright, and is clipped off. The skin is then drummed vigorously, brushed, run through an exhaust blower, and clipped again.

17. The final process is running the skins through a powerful vacuum to remove any loose hair. The skins are then packed for shipment.

THE MANUFACTURE OF BEAVER COATS

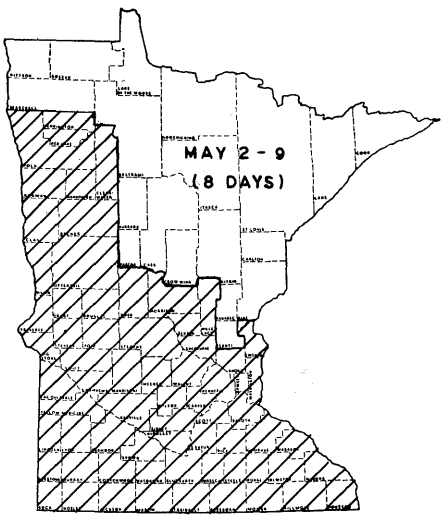
When the coat manufacturer gets a shipment of beaver skins, they are all laid out and matched in coat lots. Eighteen skins in the kit size are required to make a coat, while only seven super-blanket size skins are required. The skins chosen depends upon the weight of the coat and number of stripes desired. Large skins make heavier coats. Five stripes are produced in a coat from large skins, while eleven stripes appear in a coat made from the kit size. The stripe effect is produced by matching light colored belly fur with dark fur from the back. This color contrast is accentuated by shearing the belly fur closer than that from the back. The skins are cut into strips about ¼ inch wide, matched, then sewed together again.

The wholesale cost of a good quality beaver coat at the present time is around $1,000. Beaver is among the most durable of furs, and will stand more abuse than many of the other furs. Inferior quality pelts and those parts of the pelt cut off in the manufacture of coats are used for trimming hats and other small items.

APPENDIX IV

Minnesota beaver trapping areas, zones, and seasons, 1939-1962

Closed areas are indicated by diagonal hatching



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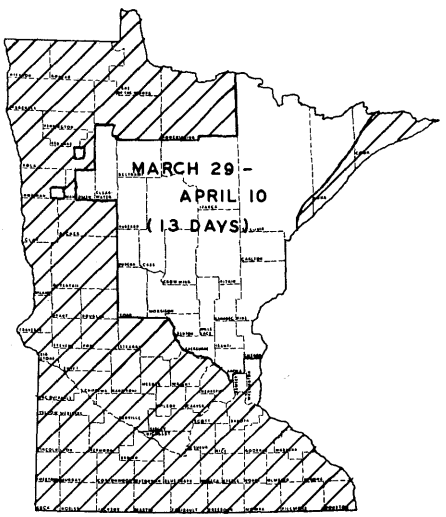

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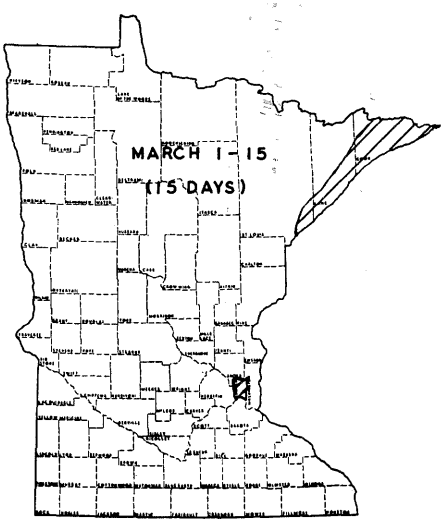

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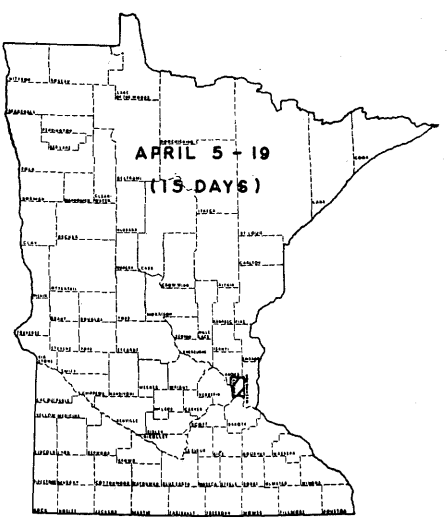

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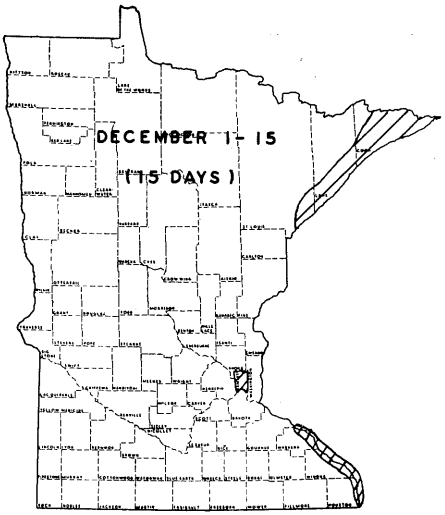

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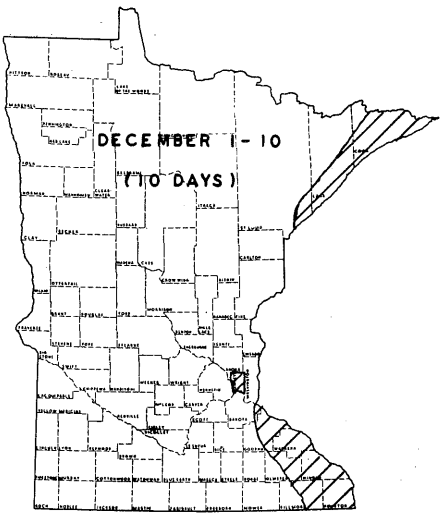

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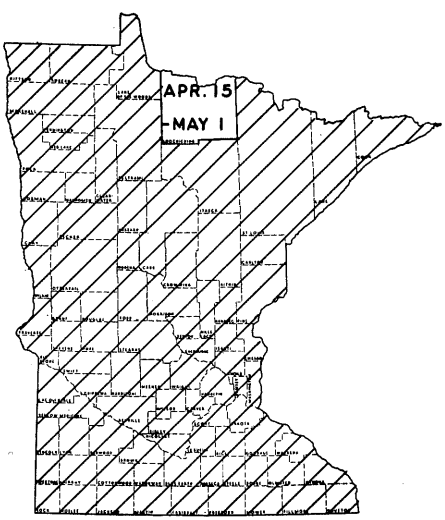

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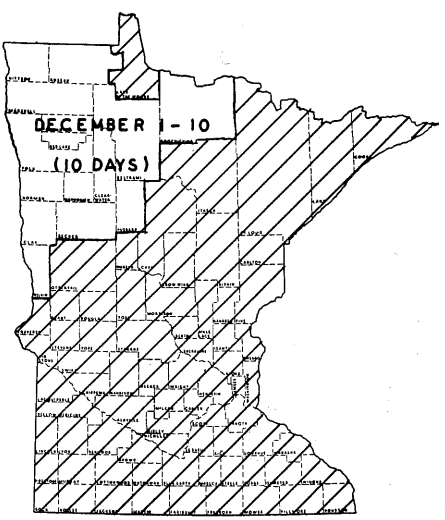

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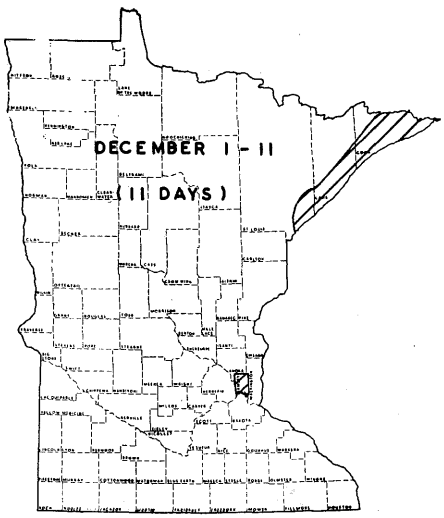

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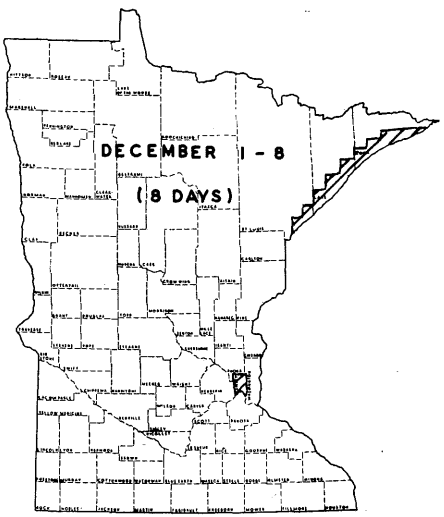

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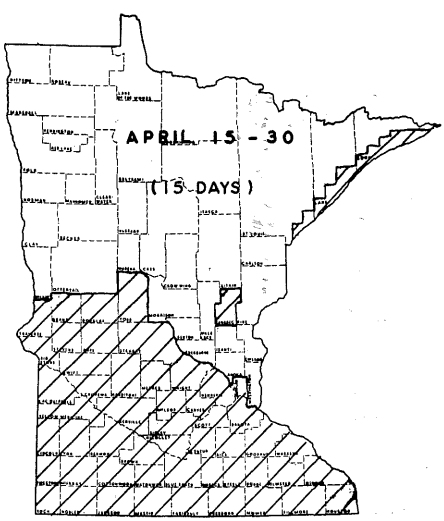

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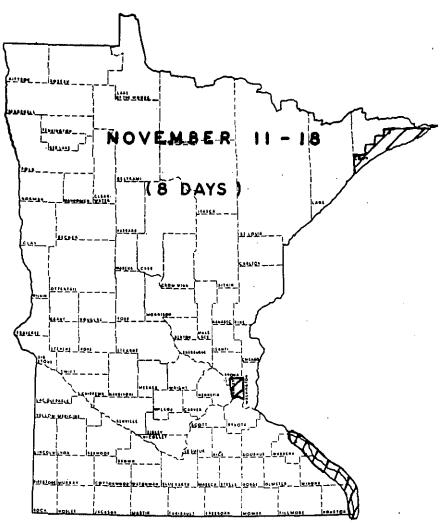

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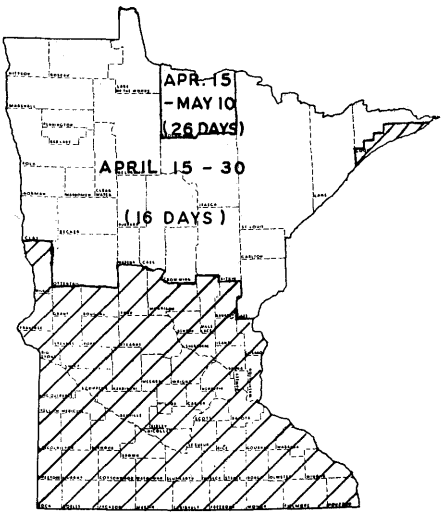

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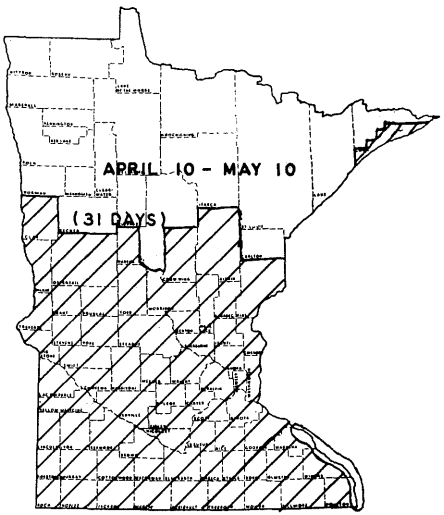

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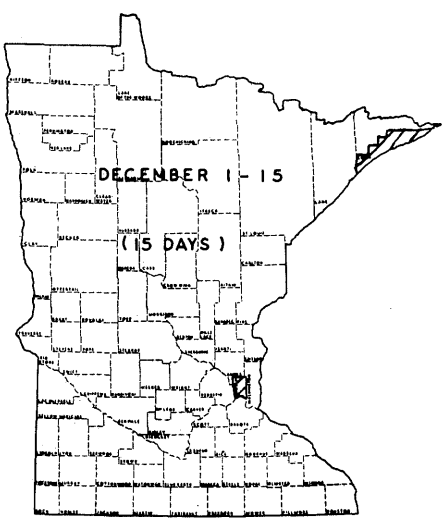

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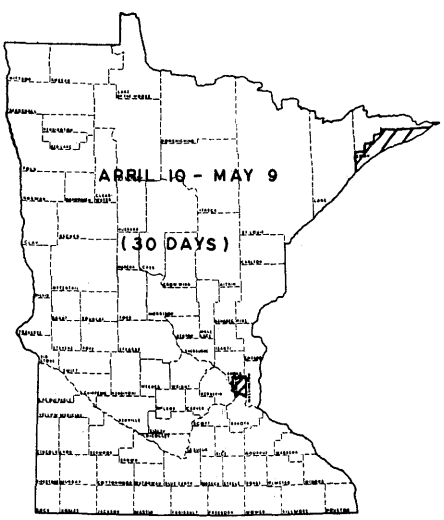

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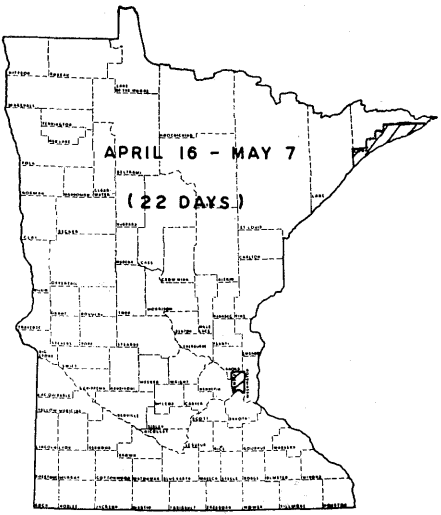

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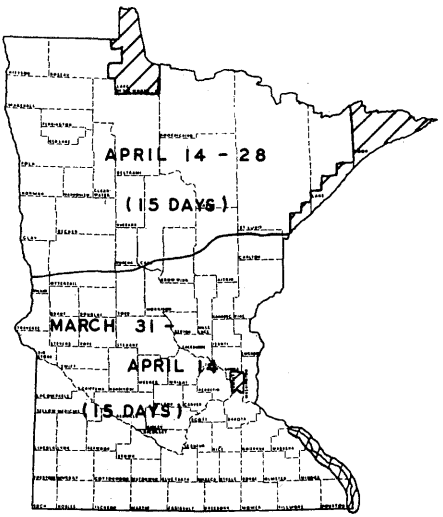

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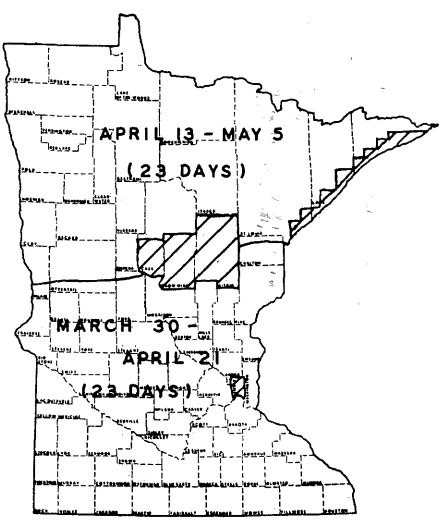

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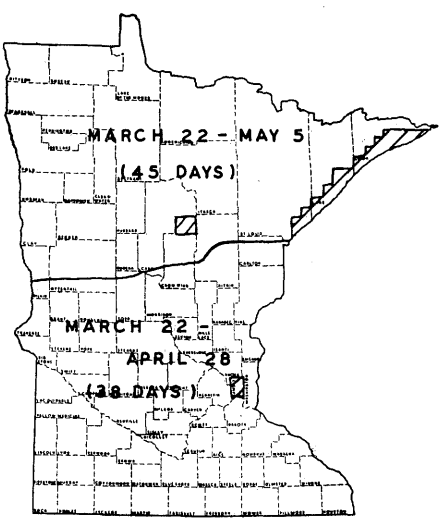

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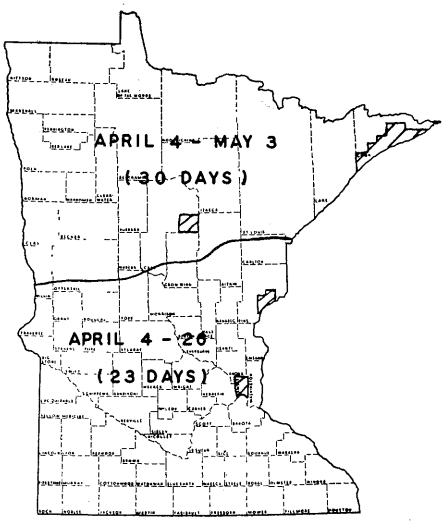

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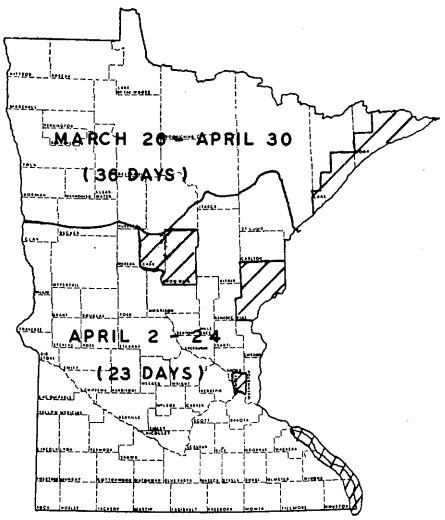

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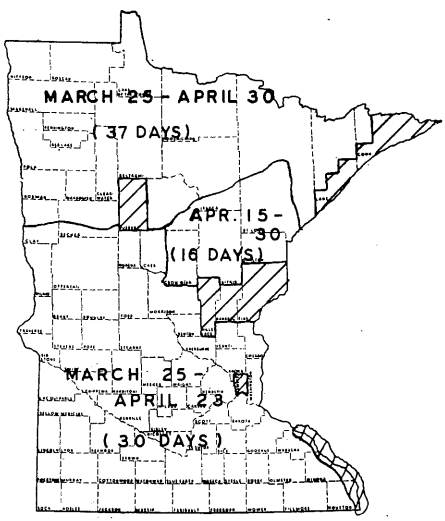

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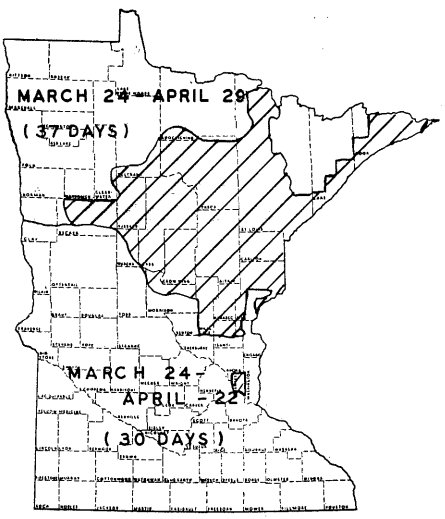

1962

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