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Biology of Canada geese (Branta canadensis moffitti) in the Flathead Valley of Montana

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BIOLOGY OF CANADA GEESE (*Branta canadensis moffitti*) IN THE FLATHEAD VALLEY OF MONTANA

By

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INTRODUCTION

The common Canada goose (Branta canadensis) is known throughout North America as one of the biggest, wariest, and most desirable of game birds. Wherever concentrations of geese occur during the waterfowl hunting season they are subjected to heavy shooting pressure. Proper management of such a popular game species requires a knowledge of the dynamics of goose populations including breeding biology, productivity levels, mortality factors, longevity, and response to human pressures.

Canada geese are migratory over most of their range in North America, and for this reason are difficult subjects for population and management studies. Hanson and Smith (1950) made an extensive survey of the Mississippi Flyway goose population (Branta canadensis interior) from the breeding grounds in the Hudson Bay Region to the wintering grounds in the lower Mississippi Valley. On the basis of band returns, data from Horseshoe Lake Refuge in Illinois, and other information these authors were able to estimate the average annual productivity and mortality of the population but not with the accuracy and confidence desirable for intensive management.

Except for small populations of Interior Canada Geese (Branta canadensis interior) of refuge origin in Michigan (Johnson, 1947) and in Illinois (Kossack, 1950), the Great Basin Canada Goose (Branta canadensis moffitti) is the only subspecies of the Canada goose that breeds within the continental United States. The breeding range of the Great Basin goose (Aldrich, 1946) includes the Great Plains and Great Basin regions west to eastern Oregon and Washington, east to the Dakotas, south to Great Salt Lake and northeastern California, and north to southern British Columbia and the southern prairie provinces of Canada.

Populations of Great Basin Geese breed in locally restricted areas within this range and may be resident in the vicinity of the breeding grounds during most of the year. They are therefore excellent subjects for productivity, population, and management studies, and many such studies have been made in the western United States. Studies of nesting and productivity have been made in Utah (Williams and Marshall, 1937, 1938), in California (Dow,1943; Naylor, 1953; Miller and Collins, 1953; Naylor and Hunt, 1954), and in Wyoming (Craighead and Craighead, 1949). Band returns have yielded some data on population turnover in Utah (Elder, 1947; Van den Akker and Wilson, 1949), and Jewett (1949) has estimated the breeding population of the Pacific Northwest. Yocom (1952) reported on the success of techniques used to increase goose nesting in eastern Washington, and Williams and Sooter (1940) reported on habitat requirements of geese on refuges in Utah and Oregon.

The Canada geese which breed in the Flathead Valley of Montana are usually year-round residents in the area. The present study was designed as an area study of this local population over a consecutive eighteen-month period. The major objectives of the study were:

1. To determine the status of the Flathead Valley Goose population through quantitative measurement of the population, productivity, and mortality.
2. To determine and evaluate those factors which control or affect productivity and mortality.
3. On the basis of this information, to make suggestions for effective management of the population.

The study was begun in February of 1953 and ended in June of 1954. The geese were thus followed during two breeding seasons, one hunting season and one winter. The investigator was in the field full time during the spring and fall of 1953 and part time during the summer of 1953 and the spring of 1954. Occasional censuses and observation were made during the winters of 1952-1953 and 1953-1954.

A variety of methods were used in carrying out the study. These will be discussed in relation to each phase of the study.

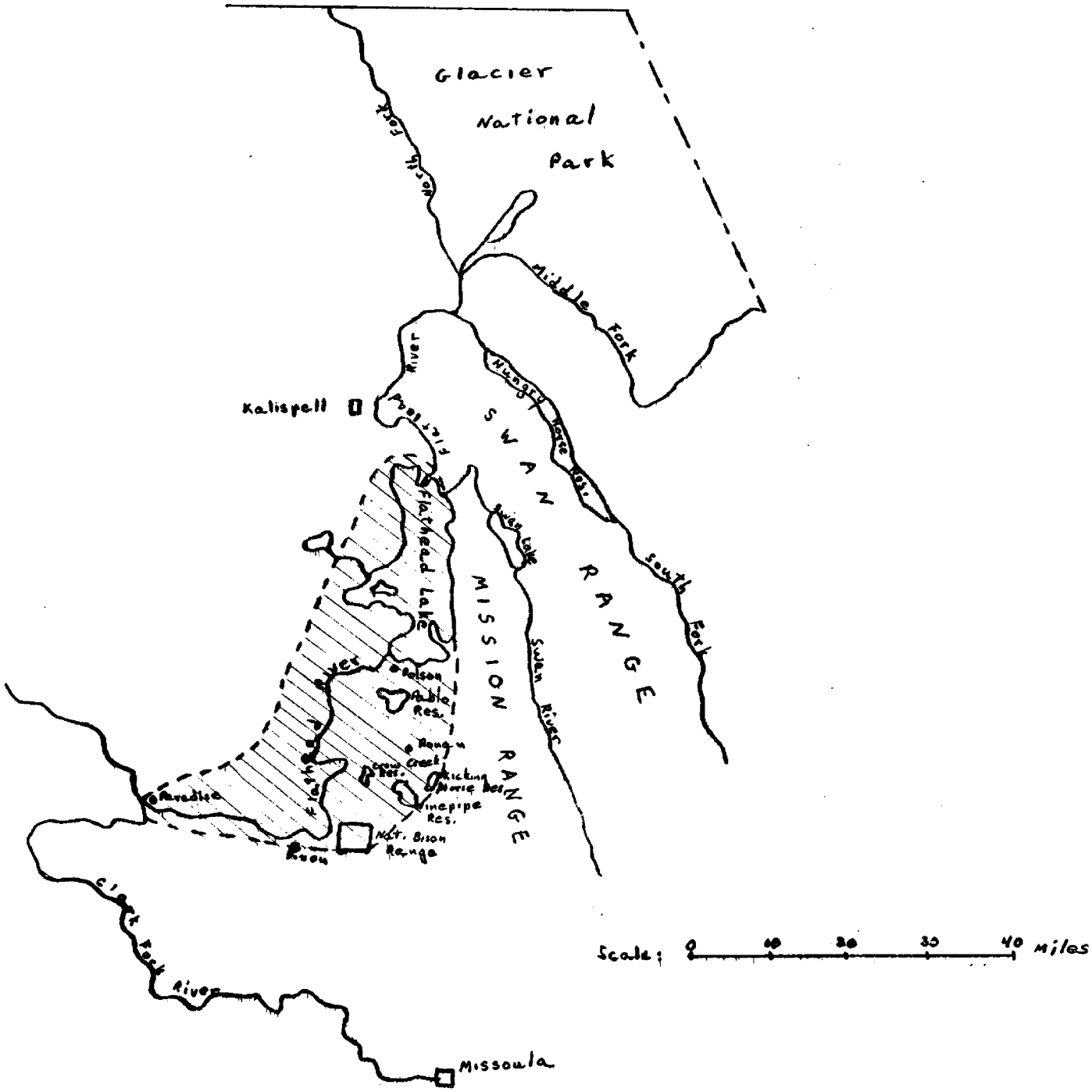
THE STUDY AREA

The study area included Flathead Lake, the lower Flathead Valley south of Flathead Lake, and The Flathead River from the point where it leaves the lake at Polson to the point where it joins the Clark Fork River at Paradise (Figure 1).

Flathead Lake is an oligotrophic lake of glacial origin. The lake is 28 miles long from north to south and averages about eight miles in width. The islands which occur in the south and west portions of the lake, as well as most of the east and west shores of the lake, are characterized by a rocky wooded shoreline. Polson Bay, an area of about twenty square miles at the south end of the lake, is more shallow than the main part of the lake, and much of the shoreline consists of marshy areas, mudflats and agricultural land. A similar shallow marshy area is located at the north end of the lake around the delta of the Flathead River where it enters the lake from the north. Open agricultural lands and shallow bays are also found around much of Big Arm Bay on the west side of the lake.

The level of Flathead Lake is controlled at Kerr Dam, a substation of the Montana Power Comapny, on the Flathead River two miles south of Polson. A maximum fluctuation of ten feet in level occurs between high water during mid-summer and low water in late winter and early spring. The change in water level is most noticeable in the shallow areas at the north and south ends of the lake where extensive areas of flats and marshes are dry during much of the year (October to May).

The lower Flathead Valley extends twenty-five miles south of Flathead Lake and is a broad glaciated valley bordered on the east by the



Area included in the study

Figure 1. Location of the Study Area.

Mission Range and on the west by the Flathead River and a series of foothills. The valley is intensively farmed and contains four irrigation reservoirs operated by the United States Bureau of Reclamation. Ninepipe and Pablo Reservoirs, with surrounding land areas, are maintained as U. S. Fish and Wildlife Service migratory bird refuges, Kicking Horse Reservoir and Crow Creek Reservoir are not refuge areas. The level of all these reservoirs is high in early summer, but becomes very low by fall and remains low until late spring.

The Flathead River, after leaving the lake at Polson, winds in a southerly direction for thirty miles. At Dixon the river turns west, and at Paradise, thirty miles west of Dixon, joins the Clark Fork of the Columbia. Along part of its course the river is bordered by rock cliffs and steep clay banks. In other areas the river broadens, forming numerous islands and channels. At Dixon an old oxbow of the river forms an extensive marsh, and in several places smaller oxbow sloughs and sink holes adjoin the river. Much of the bottomland bordering the river is utilized for agriculture. The river flow is controlled at Kerr Dam. Heavy releases of water from Flathead Lake occur during late May and early June and usually result in flooding of many of the islands and bottomland meadows.

A few local areas which neighbor the study area and which may be related to the Flathead Valley goose population were not included in the study because of the limitations of time and personnel. The Flathead River north of Flathead Lake and Swan Lake a few miles east of Flathead Lake are known to be used by breeding geese. Other small lakes to the north and west of Flathead Lake may be used to some extent as resting areas.

The economy of the Flathead Valley is based chiefly on agricul-

ture and on the recreation and tourist industries. The geese and other waterfowl are an important asset to the recreational interests in the area because of the large number of hunters which they attract to the region each fall. The geese sometimes cause damage to agriculture when large numbers of them concentrate to feed on pastures or winter wheat fields.

Human activities in the study area have affected the goose population adversely by encroaching on nesting areas and brood-rearing areas and creating unstable water levels. At the same time agriculture has greatly augmented the food supply of the geese, and the creation of artificial reservoirs and refuges has provided desirable resting and feeding areas. Quantitative information on the goose population and its interaction with human activities in the area should serve as a basis for sound management.

SPRING AND SUMMER PHASE-

THE BREEDING SEASON AND FACTORS AFFECTING PRODUCTIVITY

The Breeding Population

Determination of the breeding population in the study areas was made by a combination of aerial and ground census techniques.

On the lake, frequent counts were made from the land in the vicinity of the resting and feeding areas around Polson Bay, Big Arm Bay, and the north end of the lake.(Figure 2). In conjunction with the nesting studies counts were also made around the nesting islands from a boat and from the islands themselves. Knowledge of the behavior of the geese and of the number of nests in the area was necessary in order to determine the total number of geese and the proportion of these which were actually breeding.

The breeding population on the reservoirs was determined through ground counts combined with nesting censuses. The river was run by boat three times during the 1953 breeding season and four times during the 1954 breeding season. The breeding population was determined through nest counts and counts of pairs and other geese along the river.

Aerial counts of the entire study area were made three times during the 1953 breeding season and once during the 1954 breeding season. The aerial counts were useful in locating flocks of non-breeding birds, in checking ground counts of these flocks, and obtaining an overall picture of the distribution of the geese. Aerial counts in themselves did not give an accurate picture of the number of breeding geese in the study area. Counts of pairs on the nesting grounds during the period of territorial

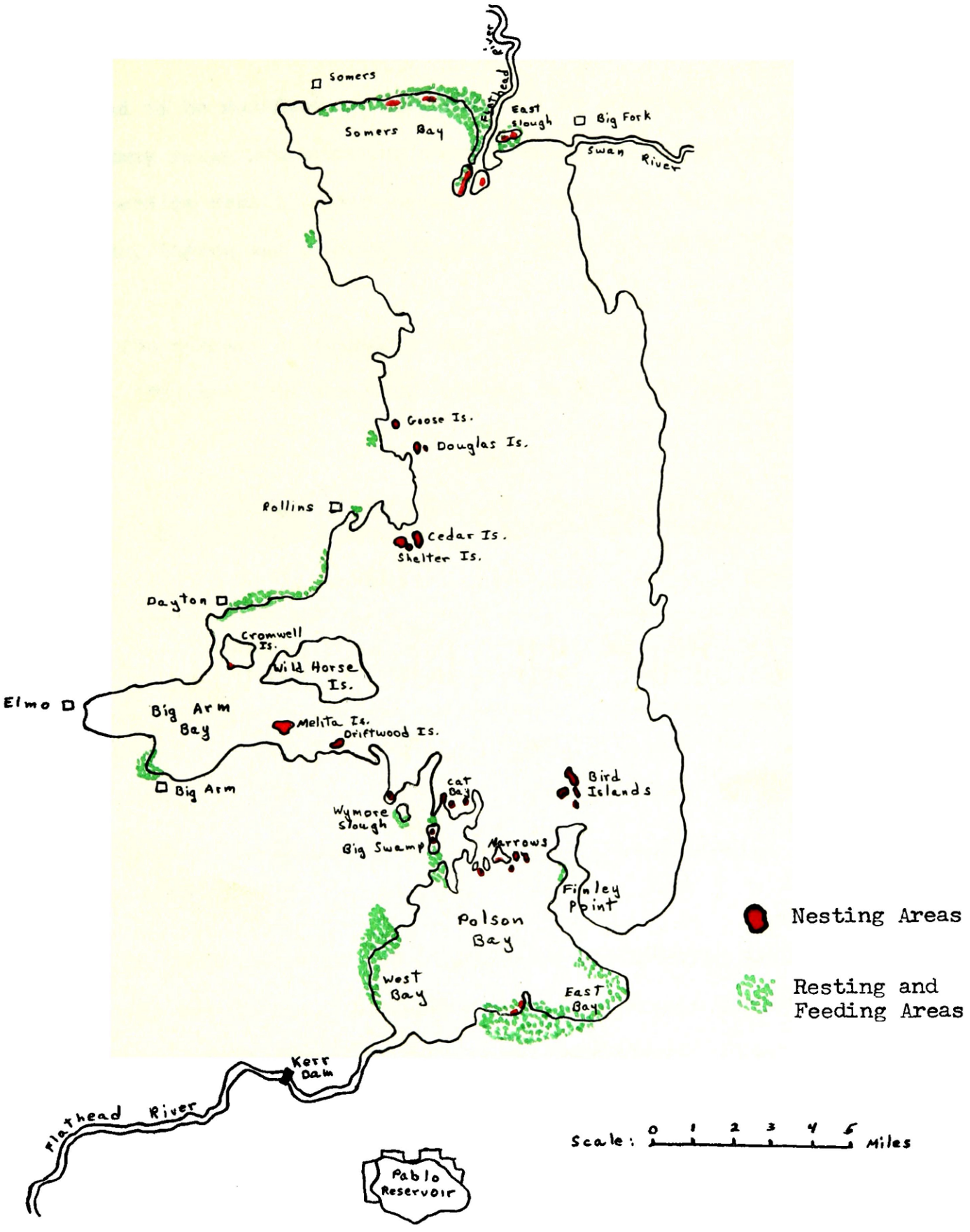


Figure 2. Flathead Lake, Showing Nesting Areas and Feeding Areas Used During the Nesting Season

defense had to be modified by knowledge of the numbers of nests in the area, as many young non-breeding pairs frequented the nesting areas during the breeding season. Because of the dense cover on most of the nesting islands, laying and incubating geese could not easily be located from the air.

The numbers of breeding and non-breeding geese in the study area during the 1953 and 1954 breeding seasons is shown in Table 1.

TABLE 1

NUMBER OF BREEDING AND NON-BREEDING GEESE
IN THE STUDY AREA DURING 1953 AND 1954 BREEDING SEASONS

Area	1953			1954		
	Breeding Geese	Non-breeding Geese	Total Geese	Breeding Geese	Non-breeding Geese	Total Geese
Flathead Lake	300	190	520	298	490	788
Flathead River	58	162	220	120	125	245
Ninepipe Refuge	12	48	60	14	30	44
Totals for Area	400	400	800	432	645	1077

In 1953 the ratio of breeding to non-breeding geese was approximately one to one. A proportion of 50 per cent breeding birds is believed to be unusually high for a goose population. Elder (1947) states that since most geese do not breed until their third year of life, not more than 25 per cent of the population can be expected to be biologically productive at any one time. The low ratio of young non-breeding birds in 1953 could be the result of low productivity in the previous two breeding seasons, of high mortality of young birds during the hunting

season, or of migration of young birds out of the study area. The latter possibility is strongly suggested by data obtained in 1954 from retraps of banded geese. There is also a possibility that more of the geese breed at two years of age than is generally supposed. Hanson and Smith (1950) state that "if the presence of an open oviduct is a sign of sexual maturity or an indication that eggs have been produced, data from Horseshoe Lake indicate that in the wild practically all females are productive at 2 years of age." In 1954 breeding birds made up about 40.2 per cent of the total population. The higher ratio of non-breeding geese in 1954 possibly reflects the high productivity in the 1953 breeding season and the presence of the previous year's young in the area.

Nesting Studies

Methods - During both years of the study as many nests as possible were located in the study area. Since most of the nests were concentrated on islands in the lake or river it was possible to locate practically all of them. Some nests were located early in the nesting cycle during territorial defense or during laying. A nest was not assigned a number until at least one egg was found in it, as pairs often scooped out several nesting hollows before settling on a final site. Hollows were also made by non-breeding pairs which went through the motions of territorial behavior and nest site selection but did not produce eggs. During laying, eggs were covered with the duff or vegetation in which the nest was built and were not easily seen. Most of the nests were located during incubation when females flushed from the nest at a short distance, and ample down made the nests conspicuous even when the eggs were covered and left. A few nests were not located until after the young had hatched or the nest had been destroyed or abandoned.

When nests with eggs were located, they were numbered and plotted on outline maps of the nesting areas. Detailed descriptions of nest sites were recorded to aid in relocating nests as well as to compile data on habitat preference. In 1953 nests were marked with oiled cardboard tags. In 1954 permanent numbered aluminum tags were placed at the nest sites.

Most of the nests were visited at least three times during the nesting season. In 1953 nests on the Bird Islands in the lake were visited six times. Where possible visits to nesting islands were made only in pleasant weather, and the time on the islands was kept at a minimum in order to disturb the birds as little as possible. Field data on behavior of adults, condition of nest, clutch size, predation, and hatch were recorded on the nest location maps and later were transferred to individual nest history forms.

In a few areas where nests were inaccessible, such as the north delta and the Dixon Marsh, the number of nests was determined through observations of the behavior of pairs in the area and aerial reconnaisance.

Nesting Dates. Early nesting activity began on the islands of the lake and river in February of both years. A few pairs of geese were seen on the islands in the lake as early as January. By the end of February many pairs were spending the night and part of each day on the islands, and some were defending territory and scooping out nesting hollows.

In 1953 the first eggs were laid about March 10th. Laying rose to a peak March 25-28 and dwindled to nothing by the last week in April. In 1954 the first eggs were laid about March 15, but laying was interrupted by a blizzard and period of very cold weather from March 27-30.

Probably because of this cold spell, there was no distinct peak of laying but rather a low peak before the March 27 blizzard and a slow rise and fall during the first two weeks of April. Some laying continued throughout April and into the first week of May.

The normal incubation period for wild Canada geese is about 28 days. In 1953 hatching dates extended from April 15 to May 25, with the peak of the hatch occurring April 24-27. The 1953 hatch followed a pattern similar to the laying, with a low peak during the last week of April and a slow rise and fall during the first two weeks of May. The first goslings hatched about April 20 in 1954 and the last about May 25.

The effect of the late March blizzard on the 1954 nesting dates and the observations cited below indicated that weather has a marked effect on nesting behavior. In 1954, nesting dates on the West Shore Islands averaged a week or two earlier than nesting dates on the Bird Islands, which are near the east shore and in the shadow of the Mission Mountains during part of each day in early spring. On the Bird Islands early nests were found on the south and west shores of the islands, while most of the nests on the north and east shores were a week or two later. Nesting activity on Ninepipe Refuge did not begin until late March after ice had melted from the reservoir.

Location and Construction of Nests. Table 2 indicates the distribution of nests in the major segments of the study area during the two years of the study. It will be noted that nesting on the lake decreased somewhat in 1954, while nesting on the river apparently increased by 100 per cent. Some of the increase on the river may be due to more thorough coverage in 1954, but most of it is believed to be a real increase in the

n this area.

TABLE 2

DISTRIBUTION OF NESTS IN STUDY AREA

Area	1953	1954
Bird Islands	78	65
Narrows-Cat Bay	35	32
West Shore Islands	59	65
North and South Ends	12	11
Total Nests on Lake	184	173
Total Nests on River	34	70
Total Nests on Refuge	7	11
Total Nests in Area	225	254

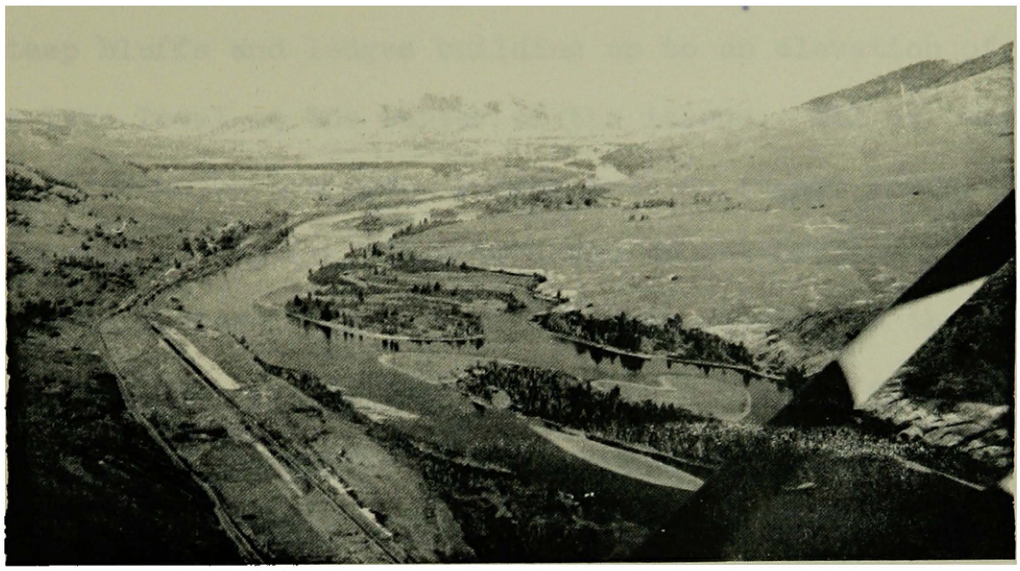
The distribution of the 479 nests located in the two years of the study according to habitat is shown in Table 3. Over 90 per cent of the nests were on islands, a habitat preference of nesting geese that is mentioned frequently in the literature. Nests on the mainland were all on isolated peninsulas, clay cliffs, or in trees. A few muskrat houses were used in the marsh areas, but this type of habitat is not important in the area.

TABLE 3

DISTRIBUTION OF NESTS BY HABITAT

	Islands	Osprey or Heron Nests	Cliffs or Peninsulas	Marshes Muskrat House	Total
Flathead Lake	338	12	3	4	357
Flathead River	80	12	5	7	104
Ninepipe Refuge	14	0	4	0	18
Totals	432	24	12	11	479

PLATE I



Nesting Islands, Flathead River

Nesting Islands, Flathead Lake

All of the nesting islands in the lake have rocky shorelines, often with steep bluffs and ledges building up to an elevation of 20 to 50 feet above lake level at the center of the island. All of these islands, except three which have been burned over in recent years, are heavily wooded with vegetation characteristic of the Douglas Fir-Ponderosa Pine zone in western Montana. Major plant species on the islands include Pinus ponderosa, Pseudotsuga taxifolia, Juniperus scopulorum, Populus tremuloides, Alnus tenuifolia, Elaeagnus canadensis, Salix sp., Prunus demissa, Amelanchier alnifolia, Symphoricarpos rivularis, Philadelphus lewisii, Holodiscus discolor, Physocarpus malvaceaus, Cornus stolonifera, Ribes lacustre, Ribes cereum, Rubus sp., Rosa sp., Berberis repens, Arctostaphylos uva-ursi, Lonicera utahensis, Clematis columbiana, Balsamorrhiza sagittata, Lomatium montanum, Erythronium grandiflorum, Agropyron spicatum, Bromus tectorum, Festuca scabrella, Festuca idahoensis, etc.

Vegetation on the burned over islands consists of the same species with the addition of Epilobium angustifolium, and with the shrubby genera (Ribes, Holodiscus, Rubus, etc.) predominating. The majority of the islands in the river are only 1 to 5 feet above water level and are covered with a dense river bottom vegetation consisting largely of Cornus stolonifera, Alnus tenuifolia, Juniperus scopulorum, Populus tremuloides, P. trichocarpa, and species of Rosa, Rubus, and Salix.

Nesting on some of the islands in the lake was almost colonial. Nesting density varied inversely with the size of the island as shown in Table 4. No data on acreage of the islands in the river was available, but the inverse relationship between size of island and nesting density

hat area.

TABLE 4

NESTING DENSITY AS RELATED TO SIZE OF ISLANDS ON FLATHEAD LAKE

Acreage Class of Island	Number of Islands	Total Acreage	Total Nests (Ave. of 2 yrs.)	Ave. No. of Nests per Acre
.5 - 2 acres	5	5.22	35	6.7
2 - 5.5 acres	4	18.12	50	2.77
20-30 acres	4	105.8	54	.51

The type of nesting cover chosen by the geese on the islands varied from open bluffs at the water's edge to dense woods more than 100 yards from water. The majority of nests were on open sites with some view of surrounding territory and easy access to the water. This is the type of site that is repeatedly mentioned in the literature as being preferred by nesting geese. No references are made in the literature to geese nesting in dense cover, but on the islands of the lake a surprising number of nests (approximately 25 per cent) were found situated in dense woods or under heavy brush cover. Most of these nests had no view of surrounding territory or of the water, and often an incubating goose could leave the nest only by struggling through brush, taking off straight up into the air, or walking several feet under the brush before taking flight. On the islands of the lake most of the nests were also within 30 feet of the water, but many were found 100 to 300 feet from the water's edge. Nest sites on the river were mostly within a few feet of the water and typically were situated under juniper, red ozier, or willow clumps. Very few nests were in dense cover.

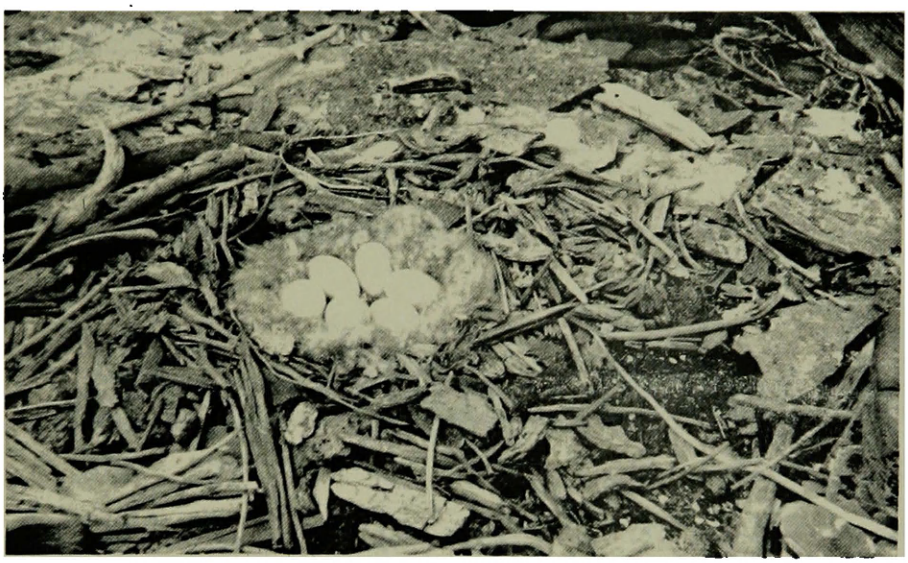
On Ninepipe Refuge water levels are low during winter and spring, increasing to a maximum in early summer. In 1953 the water level of the

reservoir was high enough during the nesting period so that some of the artificially constructed nesting islands were used. Vegetation on these islands consisted of grass, weeds, and a few small cottonwoods. Only those islands which were completely or almost completely surrounded by water were used. The water level was very low during the 1954 nesting season and the artificial islands were surrounded by dry flats. A few unsuccessful nesting attempts were made on these islands, but eventually all pairs deserted these sites to nest on exposed mud bars which were surrounded by water. The only vegetation on these bars was a mat of dead aquatic plants.

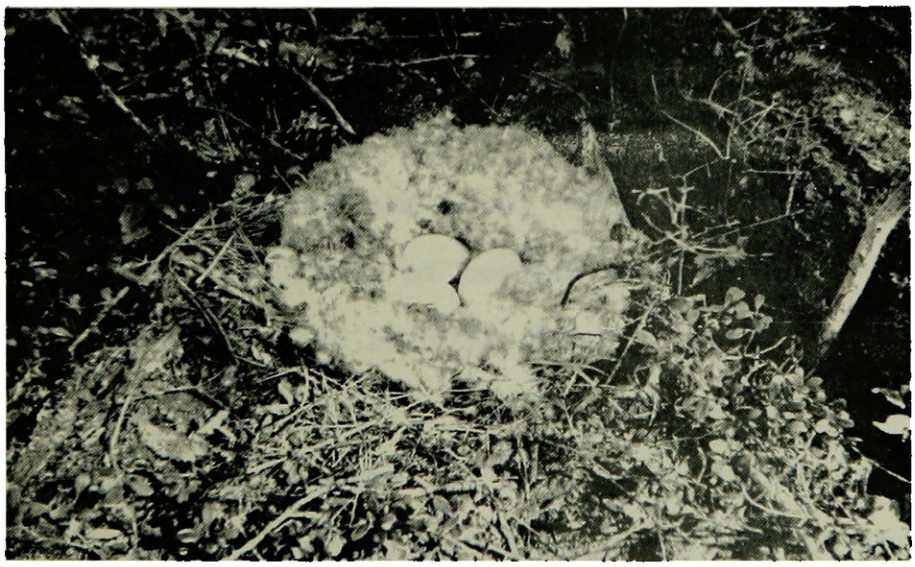
A large number of nest sites are reused in successive years. Data from the lake show that 48 of the nest sites used in 1954 were the exact sites used in 1953. An additional 30 of the nests were within 25 feet of the previous year's sites. Thus 78, or 45 per cent of the 1954 nests on the lake were on the same site or within 25 feet of the same sites used in 1953. Some sites have been used for a number of years, as indicated by the fact that the nest is built up with an accumulation of several inches of pulverized duff and old bits of egg shell. Some nests on the river were also at approximately the same sites as those of the previous year, but because many of these nests are flooded at the end of the breeding season each year, exact information on reuse of old nest sites was not obtained.

Materials used in nest construction were obtained from the immediate vicinity of the nest. Nests on islands in the lake were most commonly built up with twigs, pine needles, pine cones, and duff. Where the surrounding vegetation consisted of bearberry, grass, or weeds, geese made use of these materials. Down was usually added after incubation

PLATE II



Nest on Open Rocks with Scant Down



Nest in Woods with Ample Down

began. In some nests the down lining remained scanty throughout incubation, while in others a thick mat of down was added. (Plate II)

Nesting Success. The fate of nests during the two years of the study is shown in Table 5.

TABLE 5

FATE OF NESTS IN 1953 AND 1954

	Flathead Lake		Flathead River		Ninepipe Refuge		Totals for Area	
	1953	1954	1953	1954	1953	1954	1953	1954
Total Nests	184	173	34	70	7	11	225	254
Nests-Fate Unknown	23	11	3	19	0	0	26	30
Nests-Fate Known	161	162	31	51	7	11	199	224
Successful Nests	115	82	24	27	6	6	145	115
Unsuccessful Nests	46	80	7	24	1	5	54	109
% of Known-fate Nests Successful	71.5	50.7	77.5	52.9	85.6	54.6	73.0	51.0

In order to understand the lower nesting success in 1954 it is necessary to examine the causes of nesting failure.

Table 6 indicates that in 1953 about 42 per cent of the nesting failures were attributed positively to desertion, and in 1954 about 35 per cent were attributed to desertion. The number of nesting failures caused by desertion was probably higher than these figures indicate, as much of the predation occurred only after the nests had already been deserted. The apparently lower rate of desertion in 1954 is probably due

to the fact that many nests were visited less frequently than in 1953, and desertion was not detected before predation took place.

TABLE 6

CAUSES OF NESTING FAILURE

	Flathead Lake		Flathead River		Ninepipe Refuge		Totals for Area	
	1953	1954	1953	1954	1953	1954	1953	1954
No. of Unsuccessful Nests with Data	46	80	7	24	1	5	54	109
Nests Deserted-No Destruction	18	23	4	13	0	1	22	37
Nests Deserted-Partly Destroyed (Predation)	13	6	2	3	0	0	15	9
Nests Totally Destroyed (Predation)	15	51	1	7	1	4	17	62

In all cases the characteristics of the individual geese seemed to be the most important factor involved in desertion. Some geese were tolerant of a great deal of disturbance, while others deserted when there was very little disturbance by humans, predators, or other geese.

The presence of humans, especially over extended periods of time, brought about considerable desertion. The periodic visits of the investigators may have caused desertion in a few instances, but in the great majority of cases the geese returned to their nests if they were not kept off long enough to cause chilling of the eggs. Desertion was more likely to occur if the geese were disturbed before incubation had begun. Two cases of human disturbance over a period of time causing extensive desertion were

observed on islands in the lake. In 1953 two people were living in a cabin on Melita Island during the nesting season. Only two of eight nests on the island were successful that year, the other six being deserted. In 1954, when no one was living on the island, six out of nine nests were successful. In 1953 there were twelve nests on Driftwood Island, all successful. In 1954 a cabin on the island was being used on weekends, and in that year only two out of eight nests were successful. There are summer homes on many of the nesting islands in the lake, but ordinarily there is little human activity until after the geese are through nesting. A high rate of desertion and nesting failure on the islands in Flathead River near Dixon is attributed to their proximity to the town and their accessibility to residents of the area.

In a few instances desertion may have come about as a result of predation. Some geese continued to incubate even after one or more eggs had been destroyed by predators. Others apparently deserted if the nest was disturbed in this manner.

Miller and Collins (1953) attributed a high rate of desertion on refuge areas in northeast California to intraspecific strife due to crowding. There was little evidence that crowding was a cause of desertion in the study area. On one small island (two acres) in the lake there were nine nests in 1953. Five of these were deserted, and it is possible that crowding may have been a factor. On the other hand, three islands of less than an acre each in the West Shore area supported a nesting density of from six to twelve nests with a nesting success above the average for the area.

Weather, especially where it caused freezing or chilling of the eggs, may have been a major factor causing nesting failure in 1954. Many

of the deserted eggs apparently failed to develop because of chilling during the period of cold weather in late March and early April. The influence of weather on productivity of Canada geese has received little attention in the literature. Hanson and Smith (1950) mention inclement weather on the breeding grounds as a possible cause for years of low productivity in the Mississippi Valley goose population. Soper (1930), writing of blue geese, says: "Aside from man, possibly the most acute menace to the species is exceptionally cold, stormy weather at a critical time in the breeding period."

Considerable predation on nests was observed in both years of the study, although, as suggested above, probably much of the predation followed desertion. Over 90 per cent of the predation was attributed to crows or ravens. Predation by crows and ravens was indicated by the presence of these birds in the areas where predation occurred and by the sign found at destroyed nests (Rearden 1951). Egg shells were usually found within 50 feet of the nest, and often egg yolk was smeared on perches where eggs were eaten. Eggs were typically opened along one side leaving part of the shell intact, and often showed claw scratches and a small hole below the major opening where the lower mandible pierced the shell. Sometimes eggs were eaten in the nest, and shells and yolk were matted in the down. In a few instances crow predation was traced when crows ate eggs injected with dye for brood studies, and red or green droppings were observed under roosting trees. Wherever a crow or raven destroyed one nest there were likely to be several destroyed in the vicinity.

Magpies were observed on the Bird Islands in the lake and on several islands in the river. Goose nests on the river which were in close

proximity to magpie nests were not disturbed. Magpies apparently did not break into the goose eggs, although on one occasion they were seen cleaning up eggs which had already been broken by crows.

Little mammal predation was observed. Mink were present in both the lake and the river, but only five cases of nest predation were identified as mink. A fresh badger hole was found on a small island in the lake in 1954, and complete disappearance of the eggs from several nests on this island was attributed to this predator. Four nests on "dry" islands on Ninepipe Refuge in 1954 were probably destroyed by dogs. Dogs were seen roaming in the area, and the eggs showed evidence of being crushed by a large mammal.

Three cases of human predation were suspected on the lake. In these cases all down and eggs disappeared completely from the nests with no sign of shells or disturbance. It is believed that early picknickers or fishermen may have taken the eggs with the intention of hatching them.

Destruction by flooding was not listed in Table 6, because no complete data on the extent of such damage were available. There was no damage from flooding on the lake, as those few nests which were below high water level were hatched before the water level came up. Damage from flooding occurred on the river in both years, but it was insignificant in 1953. The 1954 data, though incomplete, are enough to estimate the amount of destruction. On April 24 or May 1 of 1954 all nests on the river were visited, and at that time 30 geese were still incubating. The nests were not checked again until May 20, and at that time 16 of the 30 nests were flooded with no way of determining whether or not they had hatched before flooding occurred. Information from Kerr Dam on the dates of increased water flow

and previous information on nesting activity in the submerged nests indicated that perhaps half of the 16 flooded nests hatched successfully.

Extent of Renesting. Kossack (1950) mentions one instance of renesting in Canada Geese, but otherwise there is no information in the literature on renesting in wild geese. Errington (1942) points out the desirability of considering renesting and other compensatory reproduction when analyzing productivity in higher vertebrates. He states that although little information is available on renesting in waterfowl, renesting undoubtedly compensates for some early nesting losses. Bennett (1938) found that about 36 out of 90 unsuccessful blue-winged teal renested, and Hochbaum (1944) found some evidence of renesting in the canvasback. Hickey (1952) estimated that only 57 per cent of mallards were successful on the first nesting attempt but that if one half to all of the unsuccessful pairs renested, between 73 and 81 per cent of nesting pairs would be successful during the season. It is the success of breeding pairs which is important in determining the productivity of the population.

Data on renests in the present study are not conclusive, as there was no way to distinguish individual geese. When a nest failed and a new nest appeared in the same territory, the second nest was designated a renest. A few nests which appeared rather late in the season were also believed to be renests, even though they were not in close proximity to an unsuccessful nest. The estimated extent of renesting is shown in Table 7. An average of about 30 per cent of unsuccessful pairs designated as renesters is probably not high. The apparently high rate of renesting on the river in 1953 may be a result of incomplete data on unsuccessful nests.

When nesting success is considered in terms of successful breeding pairs (Table 7), there was 82.5 per cent success in 1953 and 60.3 per cent success in 1954. When nesting success is considered in terms of successful nests (Table 5), there was 73 per cent success in 1953 and 51 per cent success in 1954.

TABLE 7

EXTENT OF RENESTING AND SUCCESS OF NESTING PAIRS

	Flathead Lake		Flathead River		Ninepipe Refuge		Totals for Area	
	1953	1954	1953	1954	1953	1954	1953	1954
Total No. of Nests in Area	184	173	34	70	7	11	225	254
No. of Unsuccessful Nests[1]	50	85	9	34	1	5	60	124
Number of Renests	19	24	5	10	1	4	25	38
No. of Nests Successful[1]	134	88	25	36	6	6	165	130
Number of Nesting Pairs	165	149	29	60	6	7	200	216
Per Cent of Nesting Pairs Successful	80.6	59.1	86.2	60.2	100.0	86.0	82.5	60.3
Per Cent of Unsuccessful Pairs Renesting	37.9	28.4	55.5	29.5	100.0	80.0	41.8	30.6

1 The total number of successful and unsuccessful nests was determined by using the percentage of known-fate nests successful (Table 5).

2 The per cent of unsuccessful pairs renesting was determined by dividing $\frac{\text{No. of Renests}}{\text{No. of Unsuccessful Nests}}$. Since some renests are included in the number of unsuccessful nests, this figure is approximate.

Clutch Size. The frequency of clutch sizes and the mean clutch in the two years of the study is shown in Table 8. Only nests with data on size of completed clutches were used in determining mean clutch size. Clutches were considered complete if the goose was incubating.

TABLE 8

CLUTCH SIZE AND FREQUENCY

Clutch Size	Clutch Frequency		
	1953	1954	Both Years
2	2	0	2
3	11	16	27
4	21	39	60
5	53	61	114
6	47	50	97
7	18	19	37
8	12	3	15
9	3	1	4
10	2	0	2
Total Nests	169	189	358
Mean Clutch Size	5.55	5.15	5.36

Mean clutch sizes cited in the literature range from 4.6, found by the Craigheads on the Snake River (1949), to 5.53, found in California by Naylor (1953).

Several factors were apparently correlated with clutch size. These were dates of laying, area, nesting success, and type of nesting cover used.

In 1953 a significant (95 per cent level) difference in clutch size in the first and second halves of the laying period was found on the lake. The mean size of 106 clutches completed in the period March 15 to April 5 was 5.75, and the mean size of 35 clutches completed in the period April 5-30 was 4.85. All but two clutches of 7 or more were completed before April 5. Data on laying dates were not sufficient to make such a

In 1954 the mean size of 51 completed clutches on the river was 5.8, and the mean size of 132 completed clutches on the lake was 4.9. This difference did not prove to be statistically significant.

On the lake a correlation was found between clutch size, the number of nests hidden in dense cover, and the number of successful nests. Table 9, which shows this relationship, includes data from nests in both years of the study.

TABLE 9

RELATION OF NESTING SUCCESS AND NESTING COVER TO CLUTCH SIZE

Clutch Size	Number of Nests	Percent of Nests in Dense Cover	Percent of Nests Successful
4 or less	82	19.5	39.2
5	88	26.2	74.0
6	76	32.9	76.5
7 or more	31	42.0	87.0
All Nests	277	27.7	65.5

Hanson and Smith (1950) indicate the possibility, suggested by game breeders and others experienced in raising geese, that the number of eggs laid may vary with the age of the bird, young geese laying four eggs in their first year, five in their second, and six or more thereafter. If this is true, the correlation of higher nesting success and increased use of cover with larger clutch size may indicate learned behavior on the part of the geese; the older and more experienced birds producing the larger clutches. It is also possible that the larger average clutch size in the early part of the nesting period and on the river might be the result of an age factor.

Average Hatch. The average number of goslings produced per nest in all nests with data and in successful nests only is shown in Table 10.

TABLE 10

AVERAGE HATCH PER NEST

	1953	1954	Both Years
No. of Nests with Data on Hatch	173	210	383
Average Hatch per Nest- All Nests with Data	3.53	2.22	2.85
Average Hatch per Nest- Successful Nests Only	5.14	4.64	4.94
Percent of Eggs Hatched in Successful Nests	92.5	90.2	92.1

Fate of Unhatched Eggs. It is seen in Table 10 that over ~~19~~ 90 per cent of the eggs in successful nests hatched in both years of the study. Data on 141 unhatched eggs in successful nests in both years of the study show that 56 per cent were infertile or frozen or otherwise killed at a very early stage of development; 18.4 per cent contained dead embryos at various stages of development; 14.2 per cent were destroyed by crows or other predators; and 11.4 per cent disappeared from the nest and their fate was unknown.

Total Eggs and Total Hatch. The total production of eggs and young in the area was determined by applying data on mean clutch size and mean hatch in known nests to nests from which no data on clutch and hatch were obtained. In determining the total number of eggs laid, a mean clutch size of 5.55 (169 nests) was used for 1953, and a mean clutch size of 5.15

(189 nests) was used for 1954. Figures on the total number of eggs produced (Table 11) include eggs laid in incomplete clutches. In determining the total number of goslings hatched, a mean hatch of 3.53 (173 nests) was used for 1953, and a mean hatch of 2.22 (210 nests) was used for 1954.

TABLE 11

TOTAL PRODUCTION OF EGGS AND YOUNG

Area	No. of Nests		Total Eggs		Total Young	
	1953	1954	1953	1954	1953	1954
Bird Islands	78	65	411	314	252	151
Narrows-Cat Bay	35	32	182	154	128	73
West Shore Islands	59	65	321	289	227	127
North & South Ends	12	11	67	57	42	24
Totals-Lake	184	173	981	814	649	375
Totals - River	34	70	203	406	114	186
Totals - Ninepipe	7	11	41	56	33	33
Totals - Area	225	254	1,225	1,276	796	594

Behavior of Adults During the Nesting Season. Data on the behavior of breeding birds during the nesting season were obtained mostly from observation of those birds nesting on the Bird Islands in the lake. Early in the nesting season, before laying began, nesting birds often spent the night and part of each day on the islands. Much of the morning and late afternoon were spent on the feeding and resting areas around the south end of the lake. The feeding grounds were at least six miles from the nesting islands in this area (see Figure 2, Page 9).

After laying began and during incubation, nesting pairs went to the feeding grounds early in the morning, and many, but not all, pairs

left the islands to feed again in late afternoon. During incubation, ganders sometimes flew to the feeding grounds alone. Nesting birds on the West Shore Islands flew to the north end of the lake or to the agricultural areas around Big Arm Bay to feed. Birds on the river apparently used pastures and grainfields in the vicinity of the nesting areas.

As mentioned previously, many non-breeding pairs frequented the nesting islands throughout the breeding season. These pairs flew off to feed with the nesting pairs in the early morning and late afternoon.

Many small flocks of unpaired birds also spent much of each day on the nesting islands. The numbers of these unpaired birds (Table 12) which were seen in the various feeding areas in 1954 suggested that they might be the previous year's goslings which had returned to the same areas in which they were reared.

TABLE 12

NUMBER OF GOSLINGS REARED IN AREAS IN 1953
COMPARED WITH NUMBER OF NON-BREEDING GEESE USING AREAS IN 1954

Area	Goslings Reared in Area in 1953	Non-breeding Geese Using Area in 1954
Polson Bay	255	225
Big Arm Bay	80	110
North End of Lake	160	165

Adult Mortality in the Nesting Season. Few instances of adult mortality during the nesting season were recorded. In 1953 a dying goose was found on the river, and the cause of death was believed to be lead poisoning. A dead goose found at the edge of Big Swamp near the lake in 1954 probably died of lead poisoning also. In 1954 a dead and an injured

goose were found at the same time on a small nesting island in the Narrows. The injured goose died of infection in a broken wing apparently suffered when she tried to fly through brush following some alarm. The carcass of the dead goose was within 25 feet of where the injured goose was found and had been completely eaten. Feathers were widely scattered, but the cause of death could not be determined.

Brood Studies

Brood studies were made in order to obtain data on brood movements, rearing grounds, food habits, and gosling mortality. The "brood period" extended from about April 15, when the first gosling hatched, to about July 20, when the last goslings attained flight. With the exception of a few observations on the river and refuge, all data on brood movements, rearing areas, and activities were obtained from the lake.

Brood Movements. Because no food supply is available on the nesting islands, broods leave the islands within 48 hours after hatching and travel to shallow sections of the lake where food is plentiful.

In order to follow brood movements and determine the relationship of the brood rearing areas to the nesting areas, broods were color-marked by injecting dye into the eggs before hatching. The injection technique described by Evans (1951) for ducks was used with some modifications.

Saturated solutions of water soluble food colors obtained from the Warner-Jenkinson Manufacturing Co., St. Louis, Mo., were used. Colors used were Ponceau SX (scarlet), Amaranth (cherry red), Fast Green FCF (bright green), Brilliant Blue FCF (light blue), and purple made by combining one part Amaranth with one part Brilliant Blue FCF. 1.5 cc. of the

Ponceau SX solution or 1 cc. of each of the other solutions was injected into each egg. A hole was punched in the small end of the egg with an egg drill made by embedding a dissecting needle in a rubber stopper with 1/8 " of the point projecting. The stopper-drill was used to cover a bottle of disinfectant solution consisting of one part mercuric chloride in 1000 parts of 50 per cent ethyl alcohol. The shell was cleaned with the disinfectant solution before the hole was punched. The drill and hypodermic needles were sterilized in the disinfectant solution after each injection. A 5 ml. hypodermic syringe with a 22 gauge needle was used to make the injections. Dyes were carried in 30 ml. serum bottles with soft rubber stoppers and were sterilized by processing for 20 minutes in a home pressure cooker at 10 lbs. of pressure. The point of the hypodermic needle was inserted just under the shell and the dye injected slowly to prevent overflow. The holes were sealed with collodion.

The best time for injection was determined to be 2 to 6 days before hatching. Eggs injected more than a week before hatching suffered a higher embryo mortality, and goslings from eggs injected only a day before hatching or after the eggs had pipped showed splotchy coloration.

Red proved to be the most satisfactory color for field observation. The two shades of red used could not be distinguished in the field with certainty. The red dye in the purple mixture apparently obscured the blue, and these goslings also appeared red. Red-dyed goslings could be distinguished from normal goslings from as great a distance as goslings could be seen with telescope or binocular, and the red down remained visible about the head and neck until the goslings began to get white cheek patches at 6 to 7 weeks of age. Traces of red down were found on

two goslings trapped for banding at about 10 weeks of age. The blue and green goslings were easily distinguished at close range during the first 3 or 4 weeks after hatching, but after that time could rarely be discerned.

In 1953 one nest on each of the islands in the lake was injected. Different colors were used in each nesting area, and different numbers of eggs were injected in nests where the same color was used so that broods might be distinguished by the number of colored goslings. In 1954, when it had been ascertained that the injection had very little effect on nesting success, a greater number of nests were injected in order to obtain more conclusive data on scattering of broods from the nesting islands.

The number of nests injected and the effects of the dye injection on nesting success and hatching success of eggs is shown in Table 13.

TABLE 13

NESTING SUCCESS AND HATCH IN DYE-INJECTED NESTS

	1953	1954
Number of nests injected	14	32
% of injected nests successful	64.3	59.4
Number of uninjected eggs in successful injected nests	19	42
% of uninjected eggs hatched in successful nests	79.0	92.8
Number of injected eggs in successful injected nests	31	65
% of injected eggs hatched in successful nests	68.0	75.5

Nesting success of injected nests was somewhat less than nesting success for all nests on the lake (71.5 per cent) in 1953 and somewhat greater than nesting success for all nests on the lake (50.7 per cent)

in 1954. The effect of the dye injection on nesting success was not significant. Hatching success of injected eggs in successful nests was lower than hatching success of uninjected eggs in the same nests. This difference was significant and suggests that the injection increased embryo mortality. Refinement of the injection technique should minimize this effect.

The color marking apparently had no effect on the attitude of the adult geese toward their young. One observation made in 1953 indicated that adults may have distinguished between colored and normal goslings. A visit to the Bird Islands was made on April 30, and two broods with colored young were found ready to leave the nest. One brood of three consisted of one red and two yellow goslings. The other brood of five had two red and three yellow goslings. A week later the three red goslings were seen together in one brood in the East Polson Bay rearing area. They remained together as one brood during the rest of the season.

Routes Traveled from Nesting Islands. The routes traveled by broods from the nesting islands to the major rearing areas are shown in Figure 3. Usually broods worked along the shorelines from the nesting islands, and colored broods were not ordinarily seen on the rearing grounds until several days after they hatched. One red brood from the Bird Islands was seen in the East Polson Bay area on the third day after hatching. Most of the traveling is apparently done on the water, but some broods from the Bird Islands are known to cross over Finley Point on their way to the East Polson Bay area. Broods are frequently seen crossing roads by residents of the Point, and one color-marked brood was seen crossing a farmer's field in this area.

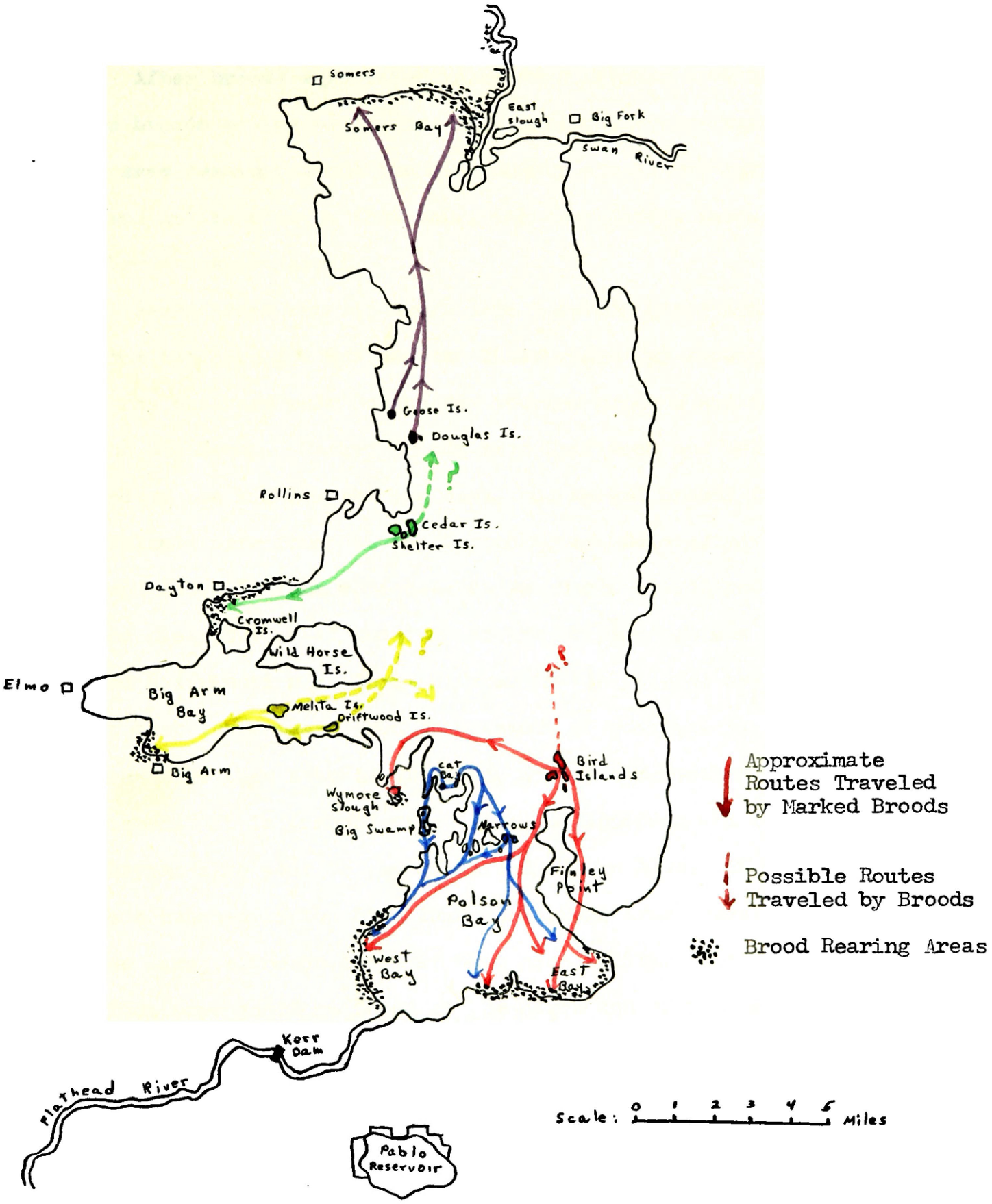


Figure 3. Flathead Lake, Showing Brood Rearing Areas and Routes Traveled by Marked Broods from Nesting Islands to Rearing Areas

After broods were established in a rearing area no instances of marked broods moving to another area were observed. Numbers of broods using an area remained about the same during the latter part of the brood season, and it is believed that there was very little movement of broods between brood-rearing areas.

Seven brood rearing areas were located on the lake (Figure 3). Broods from the Bird Islands and the Narrows-Cat Bay nesting areas were found on the east and west Polson Bay rearing grounds and in Wymore's Slough and Big Swamp. Marked broods from Driftwood and Melita Islands were found on the Big Arm rearing area, and marked broods from Cedar and Shelter Islands were found in the Dayton area. Colored goslings from Douglas and Goose Islands were seen at the north end of the lake. The number and distribution of goslings on the rearing grounds compared to the number and distribution of those hatched in the general areas (Table 14) indicates that there was a greater movement of goslings to the north end of Flathead Lake than hatching records, direct observation, or color marking indicated. It is probable that some goslings from the islands near Big Arm and Dayton also went to the north end of the lake. It is doubtful that broods hatched in the Bird Islands-Narrows area traveled to the north end of the lake, although there is that possibility. There is also a possibility that some goslings found at the north end of the lake may have come down the Flathead River from the north.

No color marking was attempted on the river, and thus movements of broods there were not definitely determined. Observations indicated that broods generally tended to move downstream from nesting areas and congregated where low grassy pastures were adjacent to the river.

TABLE 14

COMPARISON OF NUMBER AND DISTRIBUTION OF GOSLINGS HATCHED AND NUMBER AND DISTRIBUTION OF GOSLINGS ON REARING GROUNDS, FLATHEAD LAKE

Area	1953		1954	
	Hatched	Reared	Hatched	Reared
Bird Islands-Narrows-Cat Bay-Polson Bay	388	255	230	157
Driftwood-Melita-Big Arm	72	35	30	20
Cedar-Shelter-Dayton	89	45	51	26
Goose-Douglas North End	100	160	64	90
Totals-Lake	649	495	375	293

Description of Brood Rearing Areas. Rearing grounds on the lake are all in shallow areas that are adjacent to pastures or marsh areas where a food supply of grass or aquatic plants is plentiful.

The East Polson Bay area consists of about four miles of shoreline with extensive areas of cattails and brush-covered swamps. Five short stretches of pasture are close to the shore. Under conditions of low water, mud flats of about one fourth mile in width intervene between open water and the summer shore line. Early in the brood season, broods were scattered in this area and goslings fed largely on small aquatic plants in the marshy areas and around springs on the mud flats. As broods grew older they congregated on the grassy pasture areas.

The West Polson Bay area consists of two miles of shoreline and is built up with homes and farms. There are no extensive marshy areas

and a steeper shoreline exposes only a few yards of mud flats at low water. Five long stretches of pasture border the shore. Goslings in this area frequented feeding grounds close to human habitation and became relatively tame.

Big Swamp is a shallow marsh about one-half mile in length and 200 yards in width. It is bordered by rocky wooded shore on the east and west sides and open pasture on the north and south ends. A dense vegetation of soft-stemmed bulrush and other aquatics make ideal cover conditions for the few broods reared in this area. Wymore's slough is similar in size but lacks emergent vegetation and is surrounded on three sides by open pasture.

The Big Arm and Dayton rearing areas resemble the West Polson Bay area, with considerable human activity, no extensive areas of marsh or mud flats, and stretches of open pasture furnishing the feeding grounds.

The rearing area at the north end of the lake covers about five miles of shoreline and resembles the East Polson Bay area in having extensive marshes and mud flats at low water. One long stretch of pasture adjoins the shoreline at the east end. Goslings in the area feed largely in the marshes and sloughs during the early part of the brood period but congregate on the pasture and grassy dikes bordering the sloughs later in the season.

Brood Size and Brood Grouping. There was a tendency for broods congregated in crowded brood rearing areas to group and recombine, forming some broods of much larger than average size. Data on average brood size at time of hatching compared to average brood size at the end of the brood period is presented in Table 15.

TABLE 15

AVERAGE BROOD SIZE AT HATCHING COMPARED WITH AVERAGE BROOD SIZE AT END OF BROOD PERIOD

	Average Brood at Hatching		No. Young in Area End of Season		No. Broods in Area End of Season		Ave. Brood at End of Season	
	1953	1954	1953	1954	1953	1954	1953	1954
East Polson Bay	5.08	4.44	152	74	17	18	8.90	5.40
West Polson Bay	"	"	103	83	18	18	5.72	4.18
Big Arm and Dayton	"	"	80	46	12	11	6.67	4.64
North End of Lake	"	"	160	90	25	18	6.40	4.95
Flathead Lake	5.08	4.44	495	297	72	65	6.88	4.54
Flathead River	5.75	5.20	106	170	20	32	5.30	5.30
Ninepipe Refuge	5.50	5.50	33	33	6	6	5.50	5.50
Entire Study Area	5.14	4.64	634	496	98	103	6.46	4.81

Brood grouping in 1953 was pronounced on the lake, especially in the East Polson Bay area where the largest number of goslings was concentrated. In this area one brood of 40 was followed during most of the season, and several broods of 10 to 20 were frequently seen. A brood of four red goslings was first seen as part of a brood of twelve, a week later was observed several times alone, and during the last four weeks of the season appeared consistently as part of a brood of eight. In 1954, when there were fewer goslings using the brood areas, there was very little increase in average brood size and only two broods of ten or more were observed. In areas which were used by only a few broods, such as Wymore's Slough and Ninepipe Refuge, family groups remained intact. There was little brood combination on the river where broods were scattered over a 50-mile stretch. These observations indicate that the primary factor causing combination of broods is crowding on the rearing areas.

A similar increase in average brood size on the rearing grounds has been noted in the western United States by Williams and Marshall (1938), by Naylor (1953), and by Miller and Collins (1953). Elder (1949) stresses the permanence of family groups in goose flocks observed at Horseshoe Lake in Illinois, but Hanson and Smith (1950) point out that the more pronounced tendency for family groups to remain intact in the Mississippi Valley goose population is probably due to the widely scattered nature of nesting in the subarctic breeding grounds.

Gosling Counts. In order to determine the number of young and adults using the brood rearing areas, the average brood size, and gosling mortality, frequent counts of young and adults on the rearing grounds were made.

Complete counts were not always obtained in a brood area. Good counts were especially difficult to make early in the brood period when broods were scattered, and goslings were small and easily concealed. On the lake early brood counts were also hindered by the low lake level which often made it necessary for broods to cross 100 to 500 yards of open mud flats to get from feeding areas to open water. When the water was low or the lake was very rough goslings often took cover in cattails or brush. The best counts were made on calm days late in the brood season when the lake level was high and goslings took to open water if disturbed.

Table 16 shows the number of counts made in the different brood areas during the season and the best total count obtained in each area. The "best total count" is the maximum count made under good conditions near the end of the brood period, and in most cases is supported by two or more counts.

TABLE 16

GOSLING COUNTS ON BROOD REARING AREAS

Area	Number of Counts 1953	Number of Counts 1954	Best Total Count 1953	Best Total Count 1954
North End of Lake	4	4	160	90
Big Arm Bay	7	4	80	46
West Polson Bay	11	6	103	83
East Polson Bay	21	6	152	74
Flathead River	2	3	106	170
Ninepipe Refuge	5	4	33	33

To check on the reliability of the "best total count" in an area where all broods were seldom seen, counts were made 3 or 4 times weekly in the East Polson Bay area during the latter part of the 1953 brood season. The frequency of observation of two colored broods using the area was used as an index to the per cent of all goslings using the area which were being seen during an average count.

No. of times marked broods could have been seen = 2 broods x 16 counts = 32 times

Times red broods were seen = 18 times

Frequency of observation = $\frac{18}{32}$ = .56

Ave. no. of young seen in each of 16 counts = 79

Probable total no. of young in area = $\frac{79}{.56}$ = 142

The best total count of 152 was obtained twice and corresponds very closely to the figure (142) obtained by using the marked brood index explained above.

Two aerial counts were made during the brood period in 1953, but only a small portion of the goslings known to be present in the area were located. On May 4 only 22 goslings were located from the air where

343 goslings had been counted from the ground. On June 1, 152 young were counted from the air when over 600 were know to be present in the area.

Gosling Mortality. Because brood grouping masked any regression in brood size, decline in average brood size could not be used as an index to gosling mortality. Estimates of gosling mortality shown in Table 17 are based on comparison of the number of young at time of hatch with the number of young in the area at the end of the brood period (July 15).

TABLE 17

GOSLING MORTALITY IN STUDY AREA

	Flathead Lake		Flathead River		Ninepipe Refuge		Totals for Area	
	1953	1954	1953	1954	1953	1954	1953	1954
No. young hatched	648	375	115	186	33	33	796	594
No. young at end of brood period	495	293	106	170	33	33	634	496
No. young lost	153	82	9	16	0	0	162	98
Per cent lost	23.6	21.8	7.8	8.6	0.0	0.0	20.4	16.5

The relatively high gosling mortality on the lake is believed to be a real loss and not the result of incomplete gosling counts on the lake or failure to locate nests on the river or refuge. If conclusions about movements of young from the nesting islands to the brood rearing areas are correct, mortality at the south end of the lake is about 33 per cent and mortality of goslings from the west and north portions of the lake is about 7.5 per cent (Table 14). If some of the goslings at the north end of the lake came from the south end of the lake or from the river north of the lake, this picture of mortality on the lake would be changed.

There was little direct evidence of the causes of juvenile mortality on the lake, but most of the available evidence comes from Polson Bay where mortality was the highest. Many broods suffered losses while crossing by land over Finley Point from the Bird Islands to Polson Bay. Residents in that area report finding goslings stranded in cattle guards, deserted on roads, or killed by dogs and cats. Other losses undoubtedly occurred early in the brood period when the low lake level made it necessary for goslings to cross extensive mud flats to reach open water. One two-week-old brood, timed while making this crossing, traveled about 300 yards in 3½ minutes. Broods running for water or taking cover in cattails were vulnerable to predators. Coyotes, attracted to a section of the East Polson Bay rearing grounds by refuse in 1954, may have killed many young. No conclusive evidence was found, but many coyote tracks were seen on the mud flats, and a farmer in the area claims to have seen them chasing goslings. Dogs also roamed the area and may have caused some mortality. Eye-witness accounts by lake shore residents of domestic ducks and geese being killed by mink indicate that this is an important predator. Many mink tracks were seen on the flats, and one partially grown gosling was found on the marsh edge in 1953 with flesh eaten from the head and neck.

Goslings in the West Polson Bay, Big Arm, and Dayton areas suffered very little mortality. Probably the proximity of the feeding grounds to open water in these areas and the lack of cover for predators were the favorable factors. Human activity in these areas apparently had no ill effects on the goslings and may have decreased mortality by discouraging such predators as mink and coyote.

Most of the mortality of goslings from the west and north portions of the lake probably occurred on the north end rearing grounds, where conditions were similar to those in East Polson Bay. No sign of mink or coyote was found in this area, and lack of these predators may account for mortality being lower than in East Polson Bay. Neither did goslings using this area make an overland trek to reach the rearing grounds as did many of those using the East Polson Bay area.

The data on total hatch and number of young at the end of the brood period are less complete on the river, and therefore data on gosling mortality are less reliable. It is probable, however, as indicated in Table 17, that gosling mortality on the river is considerably lower because of its greater isolation and the protection afforded by numerous islands and channels, deep water, and swift currents.

Activities of Adults during the Brood Period. During the early part of the brood period non-breeding adults continued to frequent the nesting islands and feeding areas in pairs and small flocks. As the season progressed these flocks of non-breeding birds were apparently joined by non-breeding pairs and unsuccessful breeding pairs and combined to form larger flocks. In late May and early June flocks of 50 to 200 geese congregated on the feeding areas around the lake.

In 1953 most of the non-breeding adults and breeding adults that did not have young moved from the lake onto Pablo Reservoir by the time the molt began about June 15. Most of the surplus adults also disappeared from the river at this time and probably moved to Ninepipe or Pablo Reservoirs. This movement of surplus adults onto the refuges for the molt is suggested by the census figures in Table 18 which show approximately the same total

number (800) of adults in the area which were present during the nesting season (Table 1, page 10).

In 1954 a large part of the non-breeding adults which were present earlier in the breeding period apparently moved out of the study area before the molt began in mid-June. Table 18 shows 658 adults present in the study area at the end of June in 1954 as compared with 1075 present in the area during April and May (Table 1). During banding operations in the study area in June of 1954, twelve adults that had been banded in June of 1953 were recaptured, but none of the goslings that had been banded in 1953 were retrapped. These returns suggested that it was mostly the yearling birds that had moved out of the study area.

TABLE 18

NUMBER AND DISTRIBUTION OF GEESE IN THE STUDY AREA AT THE END OF THE BROOD PERIOD

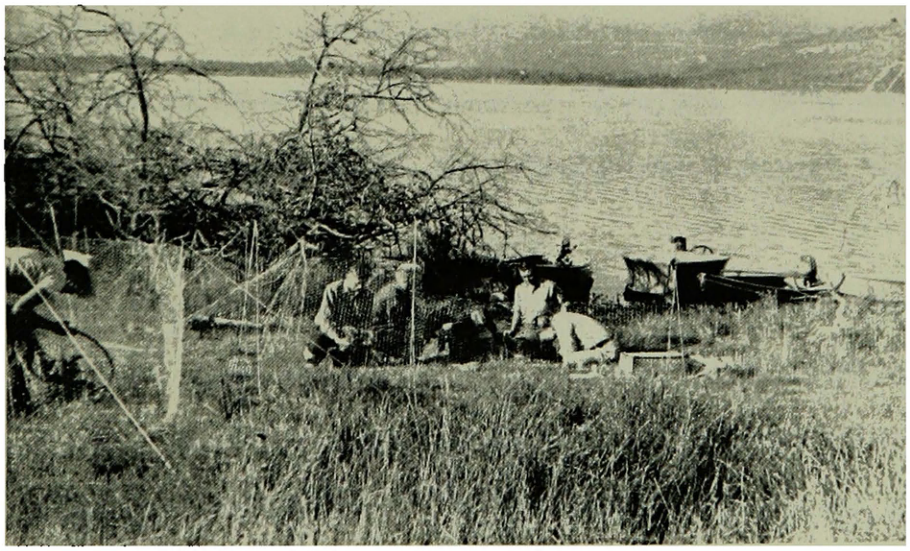
	1953			1954		
	No. Young	No. Adults	Total Geese	No. Young	No. Adults	Total Geese
East Polson Bay	152	34	186	74	36	110
West Polson Bay	103	37	140	83	37	120
Big Arm Bay	80	24	104	46	23	69
North End of Lake	160	50	210	90	36	126
Total-Lake	495	145	640	293	132	425
Pablo Reservoir	0	450	450	0	375	375
Ninepipe Reservoir	33	42	75	33	67	100
Flathead River	106	144	250	170	84	254
Total-Area	634	781	1415	496	658	1154

Adult pairs with young remained with the goslings on the brood grounds through the molt, which continued from about June 15 to July 20. Adults regained their powers of flight at the same time the young were attaining flight for the first time.

No evidence of adult mortality was found during the brood period.

PLATE III

Gosling Captured on East Polson Bay Rearing Area



Banding Operations, East Polson Bay

BANDING

In early July of 1953, when both young and adults were flightless, as many geese as possible were trapped and banded in the study area. The objectives of the banding were:

1. To furnish a means of analysis of the kill during the 1953 hunting season.
2. To aid in determining whether local birds migrate.
3. To aid in future studies of the population.

Methods

In east and west Polson Bay, young and adults were herded with four to six motor boats into wire wing traps placed on land in heavily used sections of the brood areas. Three drives were made in the East Polson Bay area on June 30 and July 1, and one drive was made in the West Polson Bay area on July 2. At this time some of the young managed to fly when pursued, and some of the adults had progressed far enough in the molt so that they could fly. Between fifteen and thirty geese, mostly young, were caught in each drive. All geese trapped were aged, sexed, banded, and yellow airplane dope was painted on the cheeks, throat, back, and tail. It was hoped that the airplane dope would mark the geese through the summer and into the hunting season.

On July 8 an attempt was made to herd molting adult geese on Pablo Reservoir. By that date over half of the 450 geese which molted on Pablo were able to fly, and those that could not fly could not be herded successfully. Of about 200 flightless geese headed toward the trap with four boats, only four were caught. On July 9, 10, and 11, flightless geese were run down individually and caught by hand with dip nets. Geese banded on Pablo were marked with red airplane dope.

On July 12, over twenty young geese were caught with dip nets at the north end of the lake. No attempt was made to herd geese in this area because of the large tracts of inundated timber and quantities of driftwood piled up on the shoreline.

On July 19 two young geese were caught with a dip net on Flathead River. Almost all geese in the study area could fly by that date and no further attempts were made to band flightless geese in 1953.

During September attempts were made to bait geese on the reservoirs and to trap them on the baited areas with a cannon-projected net trap. Only two geese were caught at that time. The cannon trap was tried again after the hunting season in December, and at that time twelve geese were caught and banded. This method would be most effective in winter when food is scarce and geese could easily be baited into the trap area.

In late June and early July of 1954, flightless geese were again trapped and banded in the study area. Over 400 young and adult geese were banded at this time. For purposes of the present study the 1954 banding was relevant only insofar as birds banded in 1953 were retrapped.

Results

Banding. Before the 1953 hunting season, 208 geese were banded in the study area. Table 19 summarizes the results of this banding program.

At the time most of the geese were banded (June 30 to July 19) there were approximately 1,415 geese present in the study area. Thus about 14.7 per cent of the local goose population was marked before the 1953 hunting season.

TABLE 19

GEESE BANDED IN THE STUDY AREA, 1953

Area Banded	East Polson Bay	West Polson Bay	North End of Lake	Pablo Reser-voir	Flat-head River	Ninepipe Reser-voir	Totals for Area
Juvenile Males	34	13	16	0	1	0	64
Juvenile Females	30	14	6	0	1	1	52
Total Juveniles	64	27	22	0	1	1	116
Adult Males	4	4	0	37	0	0	45
Adult Females	5	6	1	34	0	1	47
Total Adults	9	10	1	71	0	1	92
Total Geese	73	37	23	71	2	2	208

Color Marking. The use of red and yellow airplane dope to color mark banded geese did not prove successful under the conditions tried. The paint was applied on the soft feathers of cheeks, throat, and tail and apparently was preened off by the geese. Within two to three weeks after the paint was applied no color could be discerned on banded geese observed through binocular or telescope. Only one banded goose shot during the hunting season showed any sign of the paint applied during banding. The trace that remained was on the middle of the back. It is believed that the paint might have been more successful if applied on the primaries and retrices.

Band returns during the Hunting Season. During the 1953 hunting season 36 bands were recovered and returned by hunters. The distribution

of these returns and their relation to the kill will be discussed in the following section.

Retraps of Banded Birds in 1954. When banding of flightless geese was again undertaken in 1954, twelve of the birds banded in 1953 were retrapped. All retraps were adult birds banded on Polson Bay or Pablo Reservoir in 1953. None of the geese banded as goslings in 1953 were retrapped. Three geese banded outside of the study area were also retrapped at this time.

FALL AND WINTER PHASE--THE HUNTING SEASON, MIGRATION, AND WINTER, MORTALITY

The Pre-Hunting Season Period--July 15 to October 10

Population Numbers and Movements. In July of 1953, when young could fly and adults had regained flight after the molt, young and adult geese remaining on the lake and river joined the non-breeding birds on the refuge areas. This movement was indicated by census figures and by the presence of many banded geese on the refuges, some of them in small flocks which were evidently family groups from the lake. The geese remained on the reservoirs throughout August and early September. A drop in water levels on the refuges brought about favorable loafing and feeding conditions by exposing mud bars and extensive areas of semi-aquatic vegetation. The dwarf spikerush (Eleocharis acicularis) appeared to be the most important food plant on the refuge areas during late summer and fall. During this period, the geese spent most of the time on the refuges, leaving only for an hour or two just after sunrise each morning to feed on grain in fallow fields or stubble adjoining the refuge areas.

After the first of August, a steady increase in the numbers of geese using the reservoirs was noted. Some of this increase was due to the influx of local birds from the river and lake, but numbers beyond the total population of the study area on July first apparently represented a movement of geese in from more distant areas.

On September 17, a period of cold blustery weather began which was apparently the cause for some of the geese moving onto Polson Bay for the night and part of each day. This was the beginning of a daily

movement between lake and reservoir which continued throughout the hunting season. There was also a movement of a few geese onto the river at this time.

The distribution of geese in the study area during the pre-hunting season period is shown by the census figures presented in Table 20. These figures were compiled from both aerial and ground counts.

TABLE 20

POPULATION TRENDS DURING PRE-HUNTING SEASON PERIOD, 1953

Date	July 1	July 20	Aug. 5	Aug. 25	Sept. 5	Sept. 15	Sept. 25
Flathead Lake (north end)	210	200	65	25	25	00	549
Flathead Lake (south and west)	430	266	00	00	00	00	814
Flathead River	250	250	250	00	00	00	162
Pablo Refuge	450	520	875	1525	1725	1950	611
Ninepipe and Kicking Horse	75	150	225	150	275	375	567
Study Area	1415	1386	1415	1700	2025	2325	2703

The Hunting Season--October 10 to December 8

Methods. During the hunting season, the investigator was in the field full time and was assisted by a Fish and Game Department biologist assigned to the area. Other employees of the Fish and Game Department and the U. S. Fish and Wildlife Service also helped gather data on number of geese in the area, local and migratory movements of geese, hunting pressure, total kill, crippling losses, bag checks, and band returns.

In order to determine the number and distribution of geese in the study area, ground counts were made on Flathead Lake and on Ninepipe, Pablo, and Kicking Horse Reservoirs at least once a week, and an aerial census of the entire study area was made once every three weeks during the hunting season.

Field data were obtained nearly every day on movements of geese around the refuge areas and the south end of the lake. Frequent observations were also made of movements and feeding habits inside the refuges.

As many data as possible on hunter kill and crippling losses were obtained by direct observation in the field. Many geese were checked in hunters' bags for age and sex. Names and addresses of all hunters contacted in the field were obtained, whether or not they had bagged geese. Most of these hunters were interviewed again after the close of the season. Second-hand reports of geese killed were also followed up with personal interviews if possible. In interviews hunters were asked to furnish information on number of geese killed, date and place killed, time of day and activities of geese when killed, hunting methods, number of hunting days and hours, and estimated number of geese crippled.

All hunters were asked to return bands from bagged geese to employees of the Fish and Game Department and to supply information on date and place killed. It is believed that close to one hundred per cent of the bands recovered by hunters in the area were returned.

Results of Aerial Census. The number and distribution of geese in the study area during the hunting season is shown in Table 21 by a summary of the aerial counts made at three-week intervals. The census figures indicate that migration of northern birds into the area rose to a peak

early in November and leveled off to the pre-hunting season figure (Sept. 24) by December 8. Most of the geese were concentrated on Ninepipe and Pablo Refuges throughout the hunting season. There were few geese found on Polson Bay, Flathead River or Kicking Horse Reservoir after the hunting season began, and band returns indicated that these were probably local geese. Geese found at the north end of the lake were evidently both local and migrant geese. One of the young geese banded at the north end of the lake was shot in East Polson Bay on October 12, but three of the geese banded in that area were shot at the north end of the lake a few days after the hunting season began. One young goose banded at the south end of the lake was also shot at the north end.

TABLE 21

AERIAL COUNTS MADE DURING 1953 HUNTING SEASON

	Sept. 24	Oct. 7	Oct. 29	Nov. 17	Dec. 8
Pablo Reservoir	611	1415	2000	2395	1385
Ninepipe Reservoir	304	992	1023	1460	770
Kicking Horse Res.	260	00	00	00	90
South End of Lake	814	187	53	56	108
North End of Lake	549	746	294	00	391
Flathead River	162	00	00	00	17
Totals for Area	2703	3240	3370	3911	2761

Movements. The movements of the geese were of great importance in determining the number of geese available to hunters in the study area. Movements were of three kinds; migratory flights, local flights between water areas, and feeding flights. These movements are shown in Figure 4.

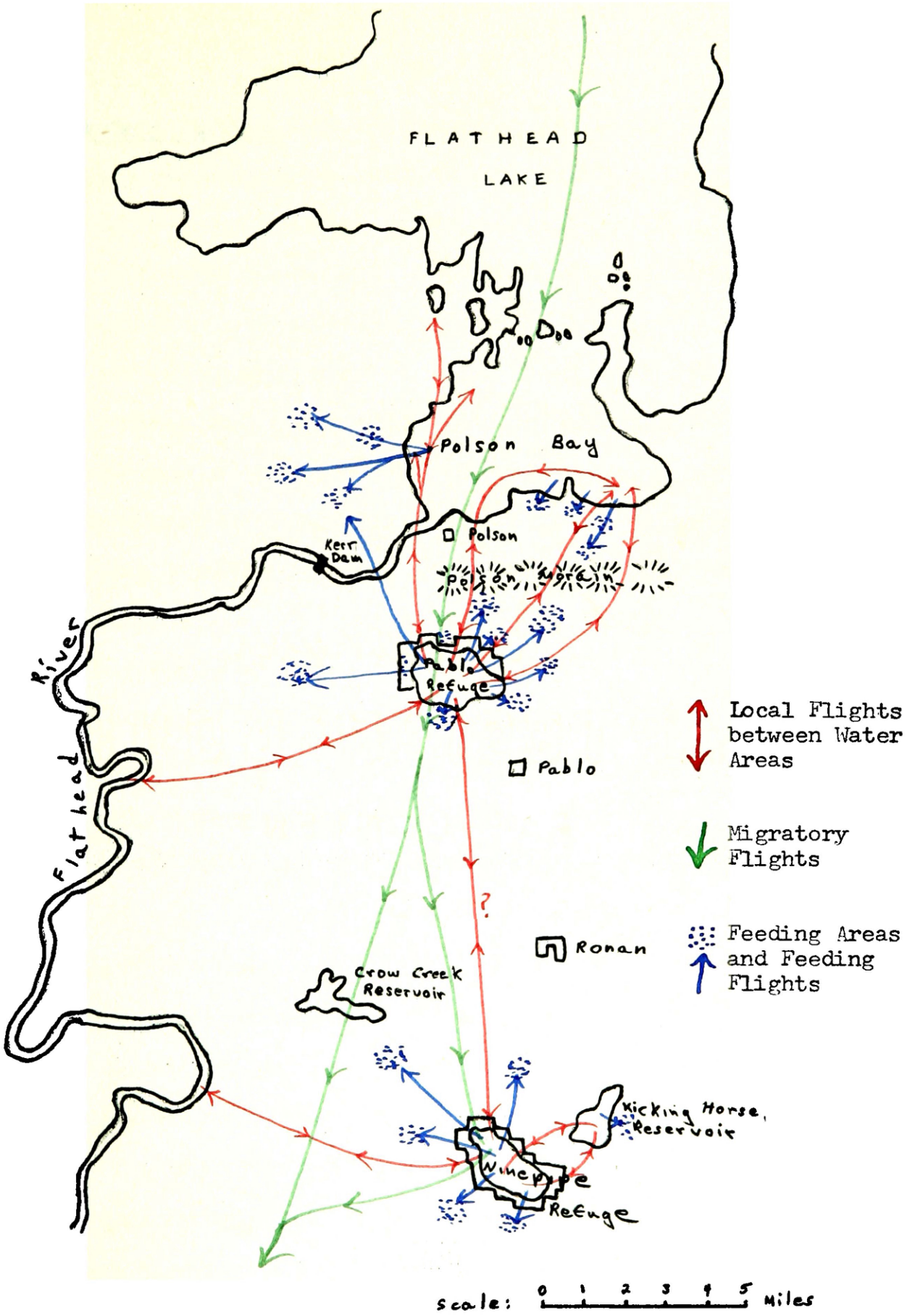


Figure 4. Lower Flathead Valley, Showing Movements of Geese during 1953 Hunting Season

Migratory Flights. As a rule there was no way of distinguishing migratory geese from the local birds. Hunters claimed that they could tell northern birds by their larger size and the reddish coloration of the breast, but these criteria were of no value. The reddish coloration was found on some of the banded local geese and was apparently a stain caused by an iron compound in some of the local shallow water areas. There was no way to compare weights of local and northern birds, but there was no significant variation in weights of birds of the same age and sex which were weighed from hunters' bags. Local geese could be distinguished to some extent by their habits, but all local geese did not take part in typical local movements, and there was no assurance that many northern geese did not join in these movements.

Some migratory flights were unmistakable, as when large flocks of geese came in high from the north in the early morning and settled on Pablo Refuge. Migratory flights out of Pablo Refuge left the refuge in the evening over the southwest corner and continued south above the foothills west of the valley. Large flocks of ducks and geese were often seen flying south past the study area in the evening over the western foothills.

Migratory flights contributed very little to the kill in 1953, but reports from hunters indicate that in some years such flights are the source of a large proportion of the kill.

Local Movements between Water Areas. The most consistent local flight pattern was established between Pablo Reservoir and East Polson Bay. Bands from geese shot from this flight indicated that basically the flight consisted of 50 to 200 geese which were family groups reared on Polson Bay in the spring of 1953. Almost all of the bands were from young geese band-

ed on the East Polson Bay rearing areas. Throughout the hunting season these geese flew from the refuge to the lake in the evening, spent the night on Polson Bay, and flew back to the refuge in the morning. Occasionally shooting pressure held them on the lake for all or most of the day. During periods of stormy (i.e. cold and windy) weather, the flight often numbered 400 to 600 geese which probably included most of the non-breeding geese which molted on Pablo during June and July. A "partial albino" goose served as a marker for this group of non-breeding adults. This goose had a completely white head and neck and was easily spotted in a group of birds whether in the water, on land, or in flight. The goose was seen around the nesting islands in the spring of 1953, was observed frequently on Pablo Refuge during the summer and fall, and was seen in Polson Bay and in the Pablo-Polson flight when the larger groups of birds were making this flight. This goose was shot while leaving Polson Bay on December 6, and proved to be a non-breeding female.

During the latter part of the season flights between Pablo Reservoir and West Polson Bay became regular. Banded geese shot from this flight had all been banded on the West Polson Bay rearing grounds.

Apparently these regular Pablo-Polson flights were the result of a strong attachment of the geese for the areas in which they were reared. The fact that the density of the flights increased during bad weather suggest that the geese found Polson Bay a more sheltered rest area than Pablo Reservoir. Most of the feeding took place on the refuge.

Geese that made the Polson flight regularly were subjected to heavier shooting pressure than any other segment of the population. In the morning they were shot at when they left Polson Bay, when they passed

over Polson Ridge, and when they came into the refuge. In the evening they were shot at only as they left the refuge. The relationship of the Polson flight to the hunter kill is demonstrated in detail in Table 22 and in Figure 5.

There were no other movements between water areas as consistent as the Pablo-Polson flight. A fairly regular flight existed between Ninepipe and Kicking Horse Reservoirs before the hunting season and was reestablished toward the end of the season. Geese were killed from this flight in the morning, either when leaving Kicking Horse or when coming into Ninepipe. There was very little movement observed between Pablo and Ninepipe Reservoirs or between the reservoirs and Flathead River, but interviews with hunters revealed that in some years these flights may be of considerable importance.

Feeding Flights. Movements out of the refuges for feeding purposes were regular and predictable before the hunting season opened, but after the first weekend of shooting, movements to feed became infrequent and irregular. During much of the season a large proportion of the daily movement out of the refuges as well as a large proportion of the daily kill was confined to the Polson flight (Table 22).

Apparently there was sufficient feed available inside the refuge areas to meet the needs of the geese during most of the hunting season. Observations of feeding activities and examination of scats indicated that the major part of the diet consisted of Eleocharis acicularis even after the extensive areas of this vegetation had become dry and brown following frost. Later in the season the geese were seen feeding more frequently in the weeds and dry-land vegetation on the borders of the refuges, and toward

TABLE 22

COMPARISON OF GOOSE MOVEMENT AND GOOSE KILL,
1953 HUNTING SEASON

	Entire Study Area*					Polson Area Only			
Week of Season	Total No. Geese Killed	Ave. No. Geese Present in Area	Ave. No. Geese Moving Each Day	Per Cent Geese Moving Each Day	Per Cent Geese in Area Killed	No. Geese Killed in Polson Flight	No. Geese Moving in Polson Flight	% Total Kill from Polson Flight	% Daily Movement Confined to Polson Flight
Oct. 10-16	69	2,500	425	17.0	2.4	10	100	16.4	23.6
Oct. 17-23	13	2,650	125	4.7	.5	11	100	84.5	80.0
Oct. 24-30	4	3,075	100	3.3	.1	4	85	100.0	85.0
Oct. 31 -Nov. 6	11	3,400	350	10.3	.3	8	250	72.7	71.5
Nov. 7-13	16	3,650	250	6.9	.4	14	200	87.6	80.0
Nov. 14-20	33	3,900	450	11.6	.8	22	250	66.6	55.6
Nov. 21-27	11	3,200	135	4.2	.3	7	75	63.6	55.6
Nov. 28 -Dec. 4	29	2,700	260	9.6	1.0	23	150	79.3	57.7
Dec. 5-8	49	2,350	500	21.3	2.1	43**	300	87.8	60.0
Date Unknown	80					33			
Total of average for season	315	3,080	275	8.9	10.2	175	160	55.5	58.0

*Exclusive of North End of Lane where little data on movement were obtained.

**Some of the geese shot while leaving the refuge late in the season may have been part of feeding flights rather than part of the regular Polson Flight.

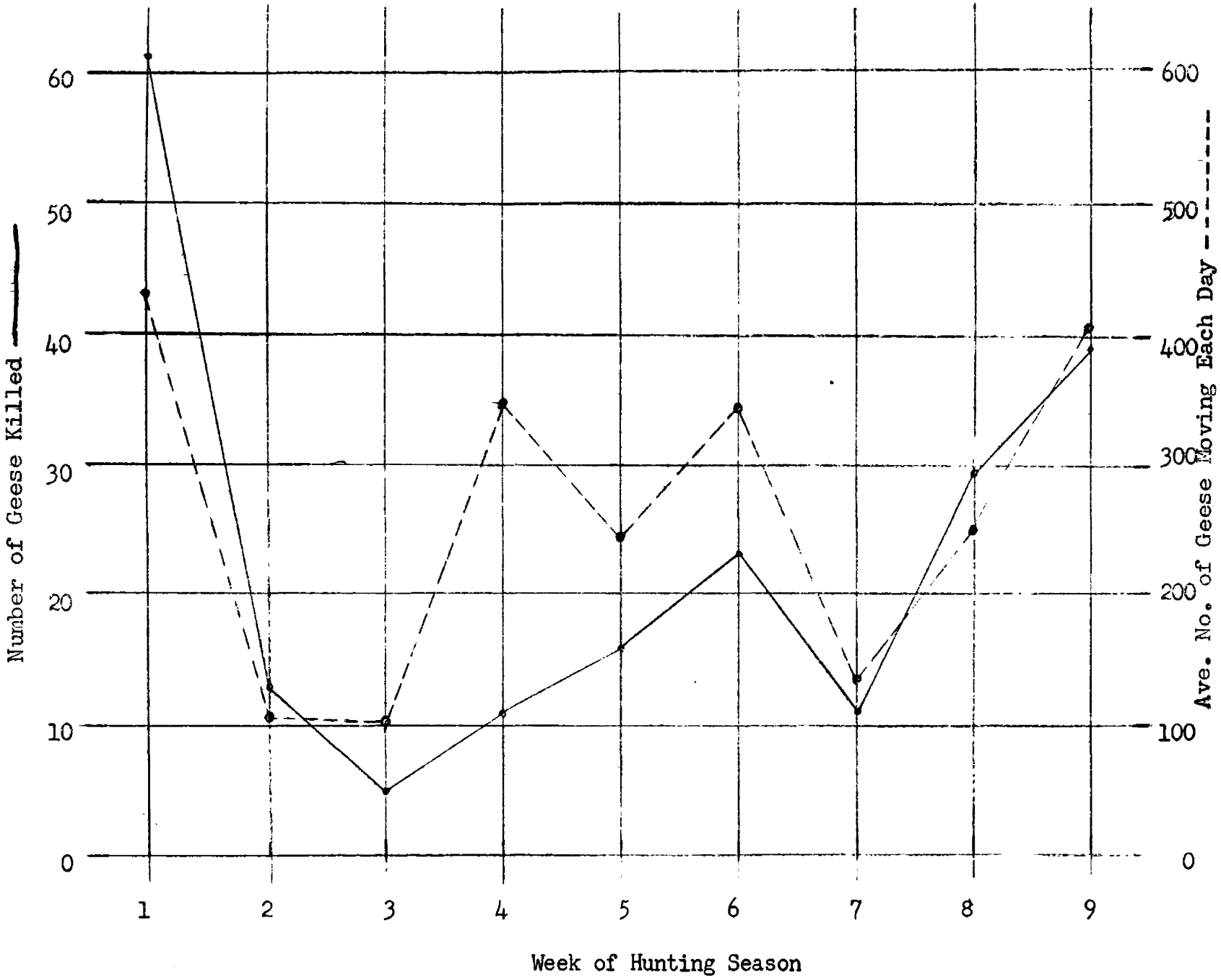


Figure 5. Relation of Goose Movement to Goose Kill.

the end of the season lack of feed inside the refuges brought about resumption of general feeding flights and a corresponding increase in the kill (Table 22). During the latter part of the season, when hunting pressure was intense and food supplies inside the refuge had become scarce, some flights were made out of Pablo Refuge at night. Flocks of geese left on these flights two or three hours after nightfall and returned an hour or two later. The numbers of birds making these flights and the destination of the flights could not be determined, but they were believed to be feeding flights.

Feeding areas outside the refuges were generally in grain fields. Early in the season wheat stubble was most commonly used, but oat and barley stubble seemed to be preferred when available. Later in the season green fields of young winter wheat became the most important source of food.

Hunting Methods and Distribution of Hunting Pressure. A break down of the 1953 kill by date and area in Table 23 indicates the distribution of hunter effort in the study area. As demonstrated in Table 22, hunter distribution and hunter pressure were controlled by the habits and movements of the geese. It might also be said that the habits and movements of the geese were controlled to a large extent by the hunter pressure.

About 45 per cent of the total kill was made around Pablo Refuge. Most of this kill was made by pass shooting from pits along the county roads on the north and east sides of the refuge. Hunters in this area made their best kills in late afternoon when geese left the refuge flying low over the dikes. Geese killed in this area were mostly from the Pablo-Polson flight, but evening feeding flights also left the refuge in this area, especially during the last two weeks of the season. Geese coming

TABLE 23

GOOSE KILL BY DATE AND AREA
1953 HUNTING SEASON

Week of Season	Ninepipe West and South	Ninepipe East and K. Horse	Pablo South and West	Pablo North and East	Lake South-east	Lake South-west	Lake North	River	Totals Each Week
Oct.10-16	38	2	14	2	8	0	7	6	68
Oct.17-23	1	1	0	8	3	0	0	0	13
Oct.24-30	0	0	0	1	3	0	0	0	4
Oct.31-Nov.6	2	0	1	6	2	0	0	0	11
Nov. 7-13	0	0	2	7	5	2	0	0	16
Nov.14-20	2	3	6	15	5	2	1	0	34
Nov.21-27	1	0	3	0	7	0	1	0	12
Nov.28-Dec.4	1	4	1	12	8	3	2	0	31
Dec. 5-8	4	1	1	19	16	8	3	0	52
Date Unknown	0	1	22	45	8	0	36	4	124
Totals for Each Area	48	12	50	115	65	15	50	10	365

into Pablo from the lake in the morning were usually flying high and well out of shooting range. Some kills were made by using decoys in grain fields north of Pablo. A leased stubble field on the northwest corner of the refuge was hunted intensively by one party and occasionally yielded good kills.

Geese killed on the south and west borders of Pablo Refuge were from feeding flights or migratory flights leaving the refuge. Feeding flights from this side of the refuge were regular before the hunting season but sporadic after the first few days of shooting. Shooting was done from pits on a public firing line and from two leased properties at the southeast and southwest corners of the refuge.

Most of the geese bagged on East Polson Bay were shot early in the morning as the Pablo-Polson flight left the lake. Hunters usually shot from blinds constructed on the mud flats or the edge of the marsh. Some shooting was done from a rise near the lake shore or from the glacial morain between Polson Bay and Pablo Reservoir. On mornings when low ceilings kept the geese flying low and a south wind slowed their flight heavy kills were made from this morain. Occasionally hunters using decoys in the grain fields just south of the lake were successful.

Geese bagged on the west shore of Polson Bay were shot late in the season when the geese reared in the area were spending part of each day on the lake and flying to grain fields west of the lake to feed. Geese were shot when leaving the lake or were decoyed into grain fields.

Most of the kill at the north end of the lake was made using decoys in grain fields. Some pass shooting was done from blinds on the mudflats and marshes in this area.

The large numbers of geese killed near Ninepipe Refuge early in the season were bagged in grain fields west of the refuge during the first three days of hunting. A few of the geese bagged at this time were shot from leased land on the south and west borders of the refuge as they flew out to feed. Most of the late season kill in the Ninepipe area was made by pass shooting from the flight between Ninepipe and Kicking Horse Reservoirs and from feeding flights leaving the refuge on the south and west.

Hunting Pressure and Hunter Success. An accurate measure of hunting pressure was difficult to obtain because of the size of the study area and the uncontrolled nature of the hunting. However, personal acquaintance with a large number of hunters and their habits as well as many casual field contacts, second-hand reports, and post-season interviews made it possible to tabulate hunter success and hunter hours per goose bagged as presented in Table 24. Hanson and Smith (1950) report 1.69 geese bagged per hunter-day at Horseshoe Lake in Illinois, a hunter success considerably higher than that found in the study area.

From these figures (Table 24) and field notes it is estimated that an average of about 50 hunters were in the field each day during the season. Heaviest hunting pressure was on weekends and in the early morning and late afternoon hours. At some times there were over 200 goose hunters in the field, and at other times there were probably fewer than 10. Since there were an average total of 3,080 geese in the area during the hunting season and an average of 50 hunters in the field each day, there were approximately 60 geese in the area each day for each hunter in the field. As an average of only about 275 of the 3,080 geese moved each day, there were only about 5.5 geese available to each hunter during an average

TABLE 24

HUNTER SUCCESS AND HUNTER HOURS

Hunter Classification[1]	No. of Hunters	No. Geese Bagged	No. Geese Bagged per Hunter	No. Successful[5] Hunters	% Successful Hunters	No. Field Hours per Hunter Per Season	Total Field Hours per Hunter Class per Season	Ave. No. Field Hours per Goose Bagged	Estimated Hunting Hours[6] per Goose Bagged
Intensive[2]	12	98	8.2	12	100.0	200	2,400	24.5	20-25
Regular[3]	60	149	2.5	45	75.0	100	6,000	40.2	30-40
Occasional[4]	250	128	.5	125	50.0	25	6,250	48.8	30-45
All Hunters	322	365	1.15	177	55.0	45	14,650	40.2	30-40

[1]Hunter classification is on basis of number of days spent in the field. Ave. number of days and hours spent in the field for each class is an estimate based on field observations and hunter interviews. All hunters classified as intensive or regular were contacted in the field and in post season interview. 197 occasional hunters were contacted. The figure of 250 occasional hunters is an approximation and may be low.

[2]Hunted 30-60 days of season, 1-10 hours per day. Averaged 40 days in field, 5 hours per day.

[3] " 10-30 " " " , 1-10 " " " . " 20 " " " , 5 " " " .

[4] " 1-10 " " " , 1-10 " " " . " 5 " " " , 5 " " " .

[5]Successful hunters are those who bagged at least one goose.

[6]An uncertain proportion of field hours were spent hunting other game, visiting, warming in cars and shacks, etc.

hunting day. An average of only 5.25 geese were bagged in the area each day by the combined effort of all the hunters in the field.

Total Hunter Bag and Crippling Losses. The total number of geese killed and crippled in the area during the 1953 hunting season is shown in Table 25. The final figures obtained are believed to be a very close approximation of the true hunter kill.

TABLE 25

GEESE KILLED AND CRIPPLED IN STUDY AREA, 1953 HUNTING SEASON

Huntin Area	Bagged Geese Checked or Reported	Cripples and Dead Geese not Retrieved	Total Geese Killed or Crippled
Ninepipe and Kicking Horse	60	30	90
Pablo Reservoir	165	60	225
South End of Lake	80	20	100
North End of Lake	50	10	60
Flathead River	10	0	10
Totals for Area	365	120	485

The estimated number of cripples and dead geese not retrieved by hunters is based on field observations and hunter interviews. Observations of goose flights in and out of the refuges during shooting hours indicated that for every two or three geese bagged another was crippled and dropped from the flight into the refuge. Counts of cripples and dead on the refuges substantiated these observations. Most of the hunters questioned estimated that they had crippled one goose for every three or four that they bagged. The figures obtained indicate a crippling loss of

about 33 per cent of the hunter bag. Using similar methods, Hanson and Smith (1950) estimated a 30 per cent crippling loss in the Horseshoe Lake flock.

In order to determine age and sex distribution of the kill, 118 geese were examined in hunters' bags. Aging and sexing techniques described by Elder (1946) and by Hanson (1949) were used. There was no significant difference in the numbers of males and females bagged, but the data do show a somewhat greater kill of juveniles than of adults(Table 26). The returns on banded geese (Table 27) show that 31.9 per cent of the locally banded juveniles were killed and only 6.5 per cent of the banded adults. This difference seems to be due largely to the habits and age distribution of the geese in the areas where they were banded rather than to a simple age differential in the kill. That is, the reason for the high kill of banded juveniles is due to the fact that most of the geese banded in the Polson Bay area were juveniles. The high kill of these juveniles was a result of their making the regular flight between Polson Bay and Pablo Reservoir rather than a result of their age. Since few of the breeding and non-breeding adults making the Pablo-Polson flight were banded, the high return rate from banded juveniles in the area is not indicative of the age distribution of the total kill in the Polson area.

Further analysis of the band returns shown in Table 27 emphasizes the disproportionately high kill of geese banded in the Polson Bay area. Using the proportion of band returns as an index, it is estimated that 43/208 times 1,415, or approximately 292 of the 1,415 geese present in the area in July were bagged during the hunting season. Therefore 292/365, or about 80 per cent of the total number of geese bagged

were from the local population. About 175/292, or approximately 60 per cent of the local geese bagged were from one segment of the local population that frequented the Pablo-Polson area.

TABLE 26

AGE AND SEX OF GEESE CHECKED IN HUNTERS' BAGS

Age Class	Males	Females	Totals	Per Cent of Totals
Juveniles	33	33	66	56.0
Non-breeding Adults	11	12	23	19.5
Breeding Adults	13	16	29	24.5
Totals	57	61	118	100.0
Per Cent of Totals	48.4	51.6	100.0	

TABLE 27

BAND RETURNS DURING THE 1953 HUNTING SEASON

	Polson Bay			North End of Lake		
	No. Geese in Area July 1	No. of Geese Banded	No. of Bands Returned	No. Geese in Area July 1	No. of Geese Banded	No. of Bands Returned
Juveniles	237	91	33	160	22	4
Adults	64	19	4	50	1	0
All Geese	301	110	37	210	23	4

	Pablo Refuge			Entire Study Area		
	No. Geese in Area July 1	No. of Geese Banded	No. of Bands Returned	No. Geese in Area July 1	No. of Geese Banded	No. of Bands Returned
Juveniles	0	0	0	630	116	37
Adults	450	71	2	785	92	6
All Geese	450	71	2	1,415	208	43

To arrive at a figure for the total number of geese lost from the local population during the hunting season a crippling loss of 96 geese, or 33 per cent of the local hunter bag of 292, was assumed. When the 96 cripples are added to the bag of 292, we arrive at a total loss of 388 geese. Thus 388/1,415 or approximately 27.4 per cent of the population present in the area in July was removed from the population during the hunting season. No bands were returned from areas outside of the study area, and it is believed that most of the hunter kill from the local population is included in this estimate.

The Winter Population

At the end of the hunting season on December 8, 1953, there were 2,760 geese present in the study area. A large number of these geese remained in the area until the middle of January when a period of blizzards and subzero temperatures caused many of the geese to leave the area. An aerial count was made on January 25, 1954, and only 656 geese were located. During this period the reservoirs and much of Polson Bay were frozen over, and many of the geese moved onto the Flathead River which remained open throughout the winter.

About 225 geese remained in the Pablo-Polson area during the worst part of the winter. These geese fed on windswept winter wheat fields and rested in sheltered hollows in these fields or on the lake or refuge. By March 1, 1954, over 500 geese were using this area and nesting activity on the islands had begun. During an aerial census on March 3, 1954, about 1,820 geese were located in the study area. Census data obtained during late March and early April showed a total of about 1,075 geese in the study area during most of the 1954 breeding season.

The facts that banded local geese were killed throughout the hunting season, that many of the birds which remained through the winter frequented the Pablo-Polson area following a behavior pattern typical of local birds, and that nesting activity began on islands in the lake as early as January, all suggest that the geese in the area during the winter were mostly from the local population. To determine the composition of the winter population with certainty, a winter banding program over a period of years would be necessary.

The winter of 1952-1953 was very mild, and a greater number of geese remained in the study area through the winter. During an aerial count on January 12, 1953, 1,275 geese were found in the area. On March first there were still about 1,275 geese in the area, but by the middle of March when the breeding season was well under way, only 800 geese remained. These constituted the adult population during the remainder of the breeding season.

It could not be determined how many local birds left the study area during the winter, or whether all those that left returned during the breeding season. The adults, especially the non-breeding adults, in the study area during the 1954 breeding season may not have included all the local birds that survived the winter and may have included birds from other areas. These possibilities are suggested by retraps of banded birds on Pablo Refuge and Polson Bay in June of 1954. At this time three non-breeding geese banded outside the study area and twelve geese banded in the study area as breeding or non-breeding adults in 1953 were retrapped. None of the geese banded as goslings in the study area were retrapped. These returns indicate that young birds may move out of the study

area during the winter or before the end of the breeding season and that young birds from other areas may drift into the Flathead Valley and remain there.

Because the composition of the adult population present in the study area during the breeding season was not clear, no definite conclusions about the extent of winter mortality in the local population could be drawn. If the estimated hunting season loss from the local population (388 geese) is subtracted from the total population in the study area at the end of the 1953 breeding season (1,415 geese), we conclude that about 1,027 geese were left in the local population at the end of the 1953 hunting season. During the 1954 breeding season 1,075 geese were censused in the study area. This figure is fairly close to the estimate of 1,027 geese left after the hunting season, but since figures are approximate and the composition of the population uncertain, no estimate of winter mortality in the local population is possible. It would appear, however, that winter mortality was rather low.

SUMMARY OF PRODUCTIVITY AND MORTALITY-
STATUS OF THE POPULATION

In a short term study such as the present one, no clear picture of population trends could be established. Data on productivity of the breeding population in the two years of the study and on the nature and extent of mortality factors during the period have been obtained. The role of population shifts in determining the number of breeding and non-breeding birds in the area, and the degree to which present productivity of the local population contributes to its future productivity can only be determined through long term banding and nesting studies.

Productivity

From the view point of management, productivity of the population must be evaluated in terms of the number of harvestable geese produced each year. In the present study the number of young geese reaching the flight stage in July was used as a measure of annual productivity of the Flathead Valley goose population.

In both years of the study the potential productivity of the population was considerably higher than the actual productivity. In 1953 there were 200 nesting pairs in the area. If each nesting pair had hatched an average clutch of 5.5 eggs and raised them to the flying age, a total of 1,100 young would have been produced. Actual productivity at the end of the breeding season was 630 young or about 57 per cent of the potential. About 300 of the potential 1,100 goslings were lost in the nest through destruction or desertion of eggs, and about 170 were lost

between hatching and attainment of flight. Each breeding pair produced an average of 3.16 harvestable young.

In 1954, 216 nesting pairs produced a total of 500 young at the end of the breeding season, or 42 per cent of a potential production of 1,190 young. Of these potential young, 590 were lost before hatching and 100 after hatching. In 1954, each nesting pair produced an average of of 2.32 harvestable young.

Craighead and Craighead (1949) found productivity on the Snake River in Wyoming to be 1.2 young per nesting pair. Kossack (1950) reports 3.5 and 4.6 goslings produced per nest under refuge conditions in Illinois. Williams and Marshall (1938) found 3.9 young produced per nest. These authors obtained no data on the number of young reaching the flight stage, but all believed gosling mortality to be negligible. Hanson and Smith (1950) estimate that the average annual production per pair of Mississippi Valley geese averages 2.48 to 2.84 goslings or about 50 per cent of the eggs produced. Productivity in the Flathead Valley (3.16 young per pair in 1953 and 2.32 young per pair in 1954) closely approaches this estimate.

The most important factors limiting productivity appeared to be nesting failure due to desertion, predation, or adverse weather conditions. Flooding and possibly crowding were less important factors, but flooding has potentialities of being considerably greater in other years. Lack of preferred nesting habitat may limit productivity indirectly by reducing the number of breeding birds using the area. Gosling mortality was of importance as a factor limiting productivity only in a few areas, notably the East Polson Bay area.

Mortality

Apart from the mortality of eggs and goslings during the breeding season, the only significant mortality in the population occurred during the hunting season. Only five instances of adult mortality were found during the spring and summer. It is probable that adult mortality during that period was less than one per cent.

Band returns indicated that approximately 27½ per cent of the local population or 388 geese were killed or crippled during the 1953 hunting season. This left about 1,025 geese in the local population at the end of the hunting season.

No accurate estimate of winter mortality could be made, but losses during this period appeared to be very low.

The total annual mortality in the Flathead Valley Goose population during the period of the study was probably between 25 and 30 per cent. Hanson and Smith (1950) estimated the average annual mortality in the Horseshoe Lake flock in 1943-1946 to be about 40 per cent due to hunting losses alone. Mortality due to hunting in the entire Mississippi flyway population they estimated to be about 23 per cent. These authors found that the heavy hunting losses combined with a high differential kill of juvenile birds and other mortality factors was more than the population could bear. Data indicating a marked decrease in the flyway population in the years 1939-1944 caused authorities to close the flyway to hunting in 1946.

In spite of what appeared to be an excessive mortality due to hunting in the Mississippi flyway population, band recovery rates from geese banded at Horseshoe Lake were only about 10 per cent. Other workers have found that band recovery rates of 15 to 25 per cent in populations of Great Basin Canada Geese may not indicate excessive mortality.

Elder (1947) reports that the band recovery rate over a five year period from a non-migratory population banded in Utah was 26 per cent. Hanson and Smith (1950) cite unpublished data from C.S.Williams of the U.S. Fish and Wildlife Service which indicated that the Utah population could show a first-year recovery rate of 16 per cent and an overall recovery rate of 25 per cent and still increase. These authors also quote Moffitt (1935) as being concerned over the future of a California breeding flock when he obtained a first-year recovery rate of 11.5 per cent. The first-year recovery rate of all geese banded in the Flathead Valley in 1953 was 20.6 per cent. The first-year recovery rate from geese banded in the Polson Bay segment of the Flathead Valley population was 33.6 per cent. The number of geese banded in the study area in 1953 was not sufficient to lend strong statistical reliability to figures estimated from band returns, but on the basis of first-year recovery rates it appears that hunting season mortality approaches the maximum allowable if the population is to be maintained or increased.

Status of the Population

Data from one year of study in the Flathead Valley indicate that a surplus of geese was produced in the area following a heavy hunting season harvest. In 1953 a population of 800 geese, consisting of 400 breeding adults and 400 non-breeding birds, produced about 630 harvestable young. This production represented an increase of 79 per cent over the original population. After estimated hunting losses and other mortality losses were deducted there were still 1,000 or more geese remaining in the local population. These figures indicate that between the 1953 breeding season and the 1954 breeding season there was an overall increase

in the population of more than 200 birds or an increase of 25 per cent or more over the original population of 800 birds.

These figures do not take into account the possiblity that the 800 original birds may not have included the entire resident population that survived after the 1952 hunting season. It is possible that many of the young that hatched in the area in 1952 and survived the 1952 hunting season had left the area early in the 1953 breeding season. If this were true the per cent of increase in the population during 1953 might be much smaller than the data indicate.

Even if the apparent increase during the period was real, there are indications that 1953 might not be a typical sample of annual productivity and mortality. Comparison of productivity in the study area in 1953 with productivity in 1954 and with productivity cited in other areas, suggests that 1953 may have been an exceptionally productive year and that such high productivity levels cannot be expected every year. There are also indications that hunting season mortality may have been unusually low in 1953. Practically all hunters interviewed felt that they had not had a successful hunting season in the fall of 1953. The poor hunter success was attributed to the mild fall, the lack of movement of geese out of the refuge areas to feed, and the scarcity of migrant geese moving in and out of the area. In years of higher kill most of the increase may be in kill of migrant birds, but it is probable that in falls when food conditions are less favorable inside the refuges that there is also a higher kill of local birds.

The 1954 breeding population (216 pairs) shows a slight increase over the 1953 breeding population (200 pairs). Most of this

increase was on the Flathead River where the number of breeding geese apparently increased by 100 per cent. There was a decrease of about ten per cent in the breeding population on the lake in 1954. Most of the decrease occurred in Polson Bay area in the nesting population using the Bird Islands and the Narrows Islands. It is not certain at present whether there is any movement of the local breeding population between nesting areas or whether any significant proportion of the local breeding population is recruited from geese moving into the Flathead Valley from other areas. If the nesting population in the entire study area and in the different segments of the study area is derived largely from young birds which were reared in the same area, then the decreased breeding population in the Polson Bay area may be a result of the heavy hunting pressure on that segment of the population.

SUGGESTIONS FOR MANAGEMENT

An accurate picture of population trends in the Flathead Valley goose population will be obtained only be studies of productivity, mortality, and band returns over a period of years. Present data indicate that the population is holding its own and perhaps increasing slightly but that seasons of low productivity or heavy hunting pressure might change this picture significantly.

Hunting season mortality approaching the desirable maximum of locally reared birds, especially in the Pablo-Polson area, indicates that it would be desirable to maintain productivity at the highest possible levels and to manage hunting pressure so as to distribute the harvest more evenly over the different area-segments of the local population and between resident and non-resident geese. Some increase in the harvest of local birds might be allowable if future studies indicate that the population continues to gain in numbers.

Measures for Increasing Productivity. Productivity might be increased by increasing the nesting population, by reducing nesting failures, and by reducing gosling mortality.

In order to maintain the present nesting population, nesting habitat which is presently available and preferred must be preserved. If the nesting population is to be increased to any extent more desirable nesting locations should be provided. In 1953 the State Fish and Game Department purchased the largest of the Bird Islands in Flathead Lake and at present is considering the purchase of other islands in the lake. Protection of these islands from human disturbance during the nesting period and from loss of their natural cover is essential if the breeding population in that area is to be maintained. Data presented in Table 4

(Page 17) indicate that the smaller islands are the most valuable as nesting sanctuaries.

New nest sites might be provided in the form of artificial islands, tree platforms, or muskrat-marsh habitat. Artificial islands would not be feasible in the study area, as those locations where the water is shallow enough to make construction of such islands possible are dry during most of the breeding season. This is the situation which exists with the nesting islands constructed on Ninepipe Refuge.

Nesting platforms in trees were tried during the 1954 breeding season, and observations indicate that they may be of considerable value. Observation of osprey and heron nests used by nesting geese in the study area were a help in placing artificial platforms in desirable sites. These nests were all located from 15 to 60 feet high in trees, had good visibility of the surrounding area, were no more than a few yards from water, and were rather isolated from human activity.

Possibilities for development of marsh habitat such as that widely used by nesting geese in Utah and Oregon (Williams and Sooter, 1937) are limited in the study area. Such marshes are of greatest value to nesting geese when muskrat lodges are available as nest bases. In the study area marsh areas at Dixon, Big Swamp, and the slough east of the delta at the north end of the lake are used by nesting geese and should be preserved. It is possible that desirable marsh habitat might be developed at the north end of the lake by impounding the backwater sloughs at high water.

Low productivity brought about by seasons of unusually severe weather could not be controlled, but reduction of nesting failure might be accomplished through reduction of desertion and predation due to other

causes and in some years of flooding. Desertion caused by human disturbance could be minimized by purchasing nesting islands and by posting heavily used nesting areas against trespassing and fishing during the breeding season. Control of crows on heavily infested nesting islands might reduce nesting failures due to predation. Whether losses due to crow predation are great enough to make intensive control desirable is questionable, but experimental control in some of the nesting areas would aid in evaluating the importance of this predator.

Gosling mortality appears to be of great importance only in the East Polson Bay rearing area. Mortality in this area was attributed to the overland trek of many broods across Finley Point and to low water levels on the brood grounds accompanied by increased vulnerability to mammal predators. There is probably no way to control the movement of broods over Finley Point, but if it were possible to bring the lake levels up to near maximum in early May instead of in June greater protection would be afforded young broods and gosling mortality in the East Polson Bay area and in other brood areas on the lake would probably be reduced. Control of mink and coyote in the Polson Bay area might be of some value in reducing gosling mortality. Coyotes were attracted to the vicinity of the rearing grounds in 1954 by refuse dumped in the area by a butcher shop. This situation could easily be remedied.

Long term management plans should consider the preservation of brood rearing areas on the lake. Continued building and development along the lake shore may eventually destroy the value of these areas as essential feeding grounds for broods unless measures are taken to preserve them. Development of some of these areas for brood-rearing purposes might be desirable.

Flooding of nests on the Flathead River could be prevented if heavy releases of water at Kerr Dam were held off until after May 25. Delaying releases of water from the lake would be beneficial in raising water levels on the brood grounds at an earlier date as well as preventing the flooding of late nests on the river.

Measures to Increase the Efficiency of the Harvest. Management during the hunting season should be aimed at more even distribution of the kill rather than at an overall increase of the harvest. It would be desirable to reduce the hunting pressure on birds in the Pablo-Polson flight. It is doubtful that the habits of this segment of the population could be changed, but hunter pressure might be diverted from this area by encouraging more general movements of geese out of the refuges in other areas.

Such movements might be brought about by limiting the food supply inside the refuge and providing food sources outside the refuge areas. Control of food supply inside the refuge areas could best be accomplished by manipulating water levels to cover the large areas of dwarf spikerush on which the geese feed so extensively. Because of the drain on water supplies for irrigation during late summer and early fall, maintenance of high water levels in the reservoirs during the hunting season might not be practicable. Some water is pumped from the Flathead River into Pablo Reservoir in the fall, when demands for irrigation are over, in order to create better water conditions for migrating waterfowl. A further rise in fall water levels by this method might bring about the desired results.

If food supplies are limited inside the refuge areas, food sources outside the refuges must be assured in order to hold the geese in

the area. In order to prevent damage to agricultural crops, especially winter wheat in the late fall, purchase and management of feeding areas near the refuges by the Fish and Game Department might be desirable. Such a program of land purchase and development has been begun around Ninepipe Refuge and should bring results in the 1954 hunting season.

If encouragement of movement of geese by these methods should cause a marked increase in the kill of local birds or cause geese to move out of the area altogether during the hunting season, measures would have to be taken to control hunting pressure. This might be done by restricting hunting areas, by regulating hunting hours, or reducing bag limits.

SUMMARY

1. An area study of a local population of Canada Geese was carried on in the Flathead Valley of Montana between January, 1953 and July, 1954. The study area included Flathead Lake, the Flathead Valley for a distance of twenty miles south of the lake, and the Flathead River between Polson where the river leaves the lake, and Paradise, fifty miles southwest of the lake. The objectives of the study were to determine the status of the population through quantitative measurement of productivity and mortality, to determine what factors control productivity and mortality, and to determine what practices might be desirable in management of the population.

2. The breeding population was determined through aerial counts and counts from the ground or from a boat. In 1953 there were 800 adult geese in the study area during the breeding season, and 400 of these were breeding birds. In 1954 there were 1,075 adult geese in the area during the breeding season, 432 of which were breeding birds.

3. Nesting activity in the study area began early in February. The first eggs were laid about March 10 and the last about April 25. Hatching dates extended from April 15 to May 25.

4. In 1953, 225 nests were located in the study area. In 1954, 254 nests were located. There was a marked increase in nesting on the river in 1954 but a slight decrease in nesting on the lake.

5. Over 90 per cent of all the nests were on islands in the lake, river, or Ninepipe Reservoir. Nests on the mainland were in heron or osprey nests, on cliffs or peninsulas, or on muskrat houses in marshes. Small islands had a much greater nesting density per acre than did large islands.

6. Nests were most commonly built within 30 feet from water in open cover with a view of surrounding territory, but many nests on the islands in the lake were found over 100 feet from water or in dense cover.

7. In 1953, 73 per cent of the 225 nests were successful, and in 1954, 51 per cent of the 254 nests were successful. The chief cause of nesting failure was desertion due to inclement weather, human disturbance, or unknown factors. Predation by crows was also an important factor causing failure of nests. The relatively lower nesting success in 1954 was probably due largely to inclement weather in the early part of the nesting season.

8. It is estimated that about 30 per cent of unsuccessful pairs renested. If nesting success is measured in terms of successful breeding pairs rather than in terms of successful nests, nesting success was 82.5 per cent in 1953 and 60.3 per cent in 1954.

9. The mean clutch size determined from 169 nests was 5.55 eggs per nest in 1953 and 5.15 eggs per nest determined from 189 nests in 1954. Completed clutches varied from 2 eggs to 10 eggs. A relationship was found between clutch size and date of laying, nesting area, type of nesting cover used, and nesting success. This relationship may express an age factor.

10. In both years of the study over 90 per cent of the eggs in successful nests hatched. Average hatch in 119 successful nests in 1953 was 5.14 young per nest. In 1954 the average hatch in 101 successful nests was 4.64 young per nest. Average hatch in all nests was 3.53 young per nest in 1953 and 2.22 young per nest in 1954. In 1953 a total of about 796 goslings were hatched in the study area, and in 1954 a total of about 594 young were hatched.

11. In order to follow brood movements after hatching, eggs in many nests on the lake were injected with dye which color-marked the young. The dye injection had no significant effect on nesting success but did cause a slight increase in embryo mortality.

12. On the lake, broods left the nest about 48 hours after hatching and traveled 2 to 10 miles to reach brood rearing areas in shallow parts of the lake where aquatic vegetation or pasture grass was available for food.

13. There was a tendency for broods to combine on crowded brood rearing areas, and in some of these areas average brood size increased by as much as 75 per cent during the brood period.

14. Gosling mortality was determined by comparing number of young hatched with number of young reaching the flight stage. Gosling mortality on the lake was between 20 and 25 per cent in both years of the study. On the river mortality was less than 10 per cent, and there was no detectable mortality on Ninepipe Refuge. Most of the mortality on the lake occurred in East Polson Bay and was ascribed to low water levels making broods vulnerable to mink and coyote predation, and to the habit of many geese of leading their broods across Finley Point to reach the rearing grounds. In 1953, 634 young reached the flight stage in July, and 1954, 496 young reached the flight stage.

15. In the summer of 1953, 208 geese were trapped and banded in the study area. Of those geese trapped, 116 were young that could not yet fly and 92 were adult geese undergoing the annual molt.

16. After the molt and before the hunting season, practically all of the local geese were concentrated on Ninepipe and Pablo Refuges. An

increase in the population in the area during that period indicated movement of geese into the study area from other regions.

17. The 1953 hunting season extended from October 10 to December 8. Aerial censuses made at three week intervals showed that an average of 3,080 geese were present in the study area during that period.

18. The hunter kill was closely related to the number of birds moving off the refuge areas each day. Movements consisted of feeding flights, flights between local water areas, and migratory flights. A group of local birds which moved regularly between Pablo Refuge and Polson Bay suffered heavier hunting losses than any other segment of the population.

19. The distribution of hunting pressure was controlled to a large extent by the daily movements of the geese. The movements of the geese were in turn influenced by hunting pressure. On weekends when the geese were moving there were sometimes over 200 hunters in the field.

20. An average of about 1.15 geese were bagged by each of 322 hunters during the season. Intensive hunters bagged more geese per hunter and spent fewer hours per goose bagged than did occasional hunters.

21. A total of 365 geese were bagged by hunters in the study area, and a crippling loss of about 33 per cent of the hunter bag was estimated. A total of 485 geese were killed or crippled in the area during the hunting season. Band returns indicated that about 388 of these or 80 per cent were from the local population.

22. Checks of 118 geese in hunters' bags indicated that about 56 per cent of the geese bagged were juveniles and about 44 per cent were breeding or non-breeding adults.

23. The first year recovery rate of bands from the local population was 20.6 per cent. There was a 33.6 per cent recovery rate from geese banded in the Polson Bay area. These high recovery rates indicate that the kill of local geese, especially in the Polson area, may be close to a desirable maximum.

24. Many of the local geese apparently remained in the study area during the winter. The number of local and foreign birds in the winter population and in the spring breeding population was not definitely determined, and winter losses from the local population could not therefore be accurately ascertained. Winter losses appeared to be low, however.

25. The data obtained indicate that the Flathead Valley goose population is holding its own or increasing slightly. The true status of the population can be determined only by studies of productivity, mortality, and band returns over a period of years. In the meantime management should be aimed at keeping productivity at the highest possible levels and bringing about a more even distribution of the kill during the hunting season.

26. Specific management recommendations for the study area were made.

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