Ecology of Canada geese (Branta canadensis) at Medicine Lake National Wildlife Refuge
by Harry Scott Denson

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
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A thesis submitted in partial fulfillment
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APPROVAL

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Harry Scott Denson

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

This study was initiated because of two concerns over the Canada goose (Branta canadensis) population at Medicine Lake National Wildlife Refuge (MLNWR): 1) the population appeared to have stagnated growth, and 2) the early fall departures from the area prior to hunting season. Production, seasonal activity, and migration chronology were studied during 1985 and 1986. A total of 299 and 307 Canada goose nests were located on the study area in 1985 and 1986, respectively, and distributions were plotted. Physical parameters were measured at all nest locations. Average clutch size for 1985 and 1986 were 5.1 and 5.7, respectively. Nest success for 1985 and 1986 was 63.5 and 72.3 %, respectively. Canada geese left the study area in September both years. Sixty-two band recoveries from geese banded on MLNWR showed a high return (72 %) from the North Platte River valley near Lisco, Nebraska. This study indicated that MLNWR supported a stable, self-sustaining population with the potential for increased growth. The Central Flyway Waterfowl Technical Committee established a goal of 1000 breeding pairs of Canada geese for northeastern Montana. Management recommendation are discussed to assist MLNWR to meet this goal.

INTRODUCTION

Seven Great Basin Canada geese (Branta canadensis) were live trapped at Bowdoin Refuge in 1939 in an attempt to re-establish a nesting population on Medicine Lake National Wildlife Refuge (MLNWR). These efforts were directed at maintaining a captive breeding flock and luring wild migrants into the area to nest. The captive breeding program at MLNWR was terminated in 1966, and the remaining 22 pinioned geese were transferred to Charles M. Russell National Game Refuge. The 54 nesting pairs on MLNWR in 1966 have since increased to approximately 300 pairs.

Two concerns over the Canada goose population at MLNWR have recently surfaced which precipitated this study. The first was an apparent stagnation in population growth which seemingly caused available breeding habitat to go unoccupied. A second concern, which is a recent phenomenon, was an early departure of geese from the area in the fall before the opening of the hunting season.

Past banding analyses have indicated that many of the geese from MLNWR migrate through, or winter along, the North Platte River between Scottsbluff and Lewellen near Lisco, Nebraska. The natural springs along the river in

this area maintain open water through the most severe winters which seems to attract and hold these geese (Hunt 1986).

The objectives of this study were to: 1) determine the annual productivity of Canada geese breeding at MLNWR, 2) evaluate movements of family groups and aggregations of families during the summer, 3) determine the fall movements, migration, and mortality of MLNWR geese, and 4) evaluate early spring movements, and establishment and defense of breeding territories.

Field work was conducted from late March through December, 1985 and from middle March through December, 1986.

DESCRIPTION OF STUDY AREA

Medicine Lake National Wildlife Refuge (MLNWR) is located in extreme northeast Montana within Sheridan and Roosevelt Counties between Plentywood and Culbertson (Figure 1). The landscape is gently rolling to flat terrain with elevations ranging from 590 (1,935) to 617 meters (m) (2,025 feet (ft). Three intermittent streams, Sand Creek, Cottonwood Creek and Lake Creek, drain into the management units and eventually into Medicine Lake. Two other intermittent streams, Lost Creek and Sheep Creek drain into Homestead Lake. Muddy Creek drains the entire area and is classified as a permanent stream.

Medicine Lake is located north of the ancestral Missouri River channel which originally flowed north to Hudson Bay. The last glacial activity forced it to turn its course to the east as the glacial sheet moved down from Canada. When the massive sheet of ice receded, it left a blanket of glacial till resulting in rocky rolling hills with numerous wetlands and marshes. These heavily glaciated rolling plains are located in the mixed grass and short grass prairie transition zone.

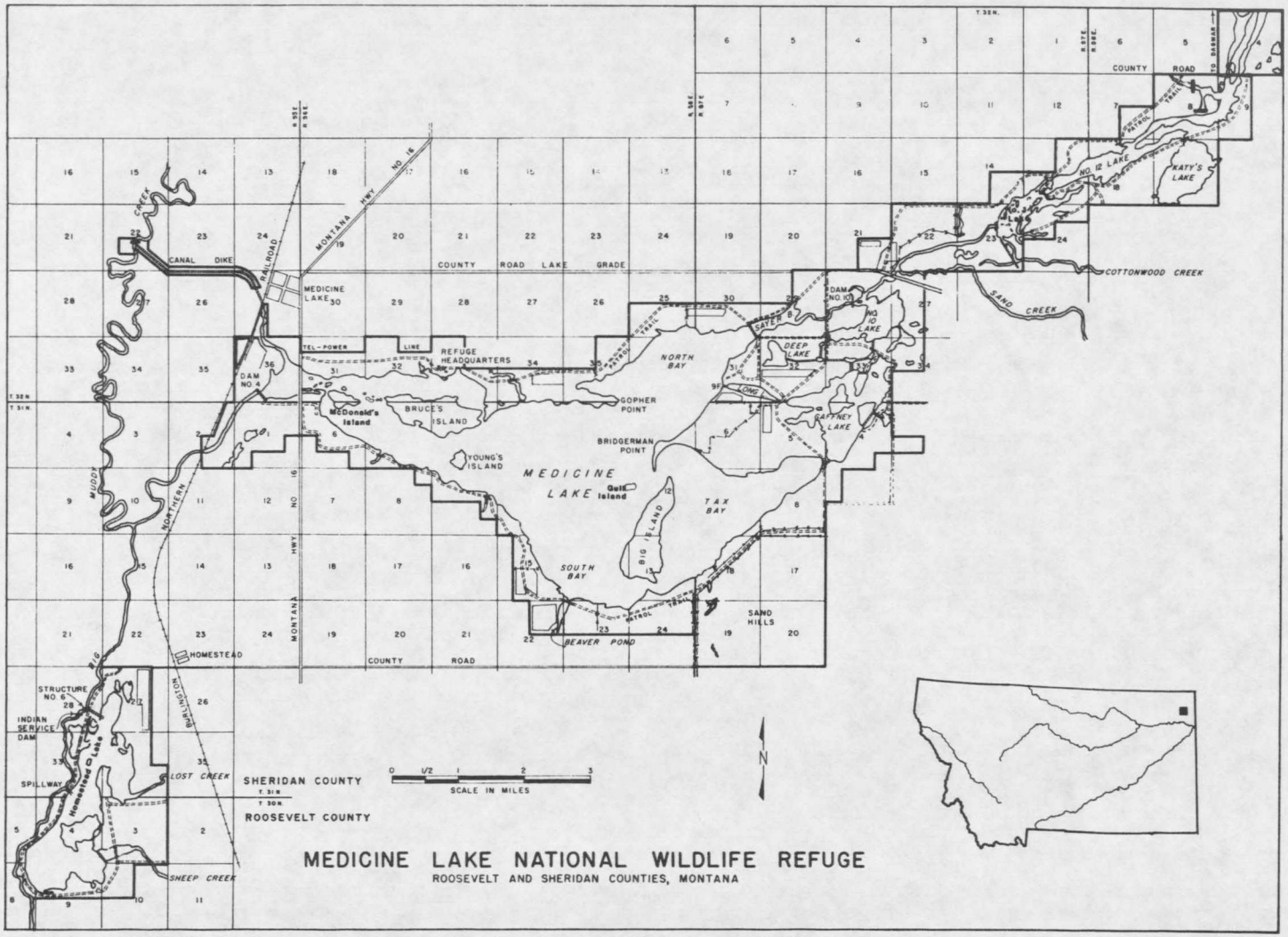

Figure 1. Medicine Lake National Wildlife Refuge showing units within the study area.

The refuge, established in 1935 by Presidential Executive Order No. 7148, set aside 9591 hectares (ha) (23,700 acres (a)) for wildlife conservation. Subsequent acquisition increased the size to 12730 ha (31,457 a) of water, marsh, and uplands. Its primary designation is to provide waterfowl production and migrational habitat.

The Medicine Lake Wilderness Area was established by congress in 1976. It is Montana's smallest wilderness, a 4,597 ha (11,360 a) enclave encompassing the main portion of the lake which includes McDonald's, Bruce's, Young's Islands and Big Island. Also included is the 939 ha (320 a) Sandhills Unit with its unique rolling hills, native grass, and clumps of chokecherry (Prunus virginiana), buffaloberry (Shepherdia argentea), and snowberry (Symphoricarpos occidentalis).

Three soil types of the eastern glaciated plains are present on the study area. They are: 1) silty range, 2) saline lowland range and 3) sand or sandy range (U. S. Dept. of Agriculture).

The dominant plant species identified in order of occurrence within each major cover type at the nesting sites are listed in Appendix, Table 8. The vegetation around the marsh cover type including the wetlands and management units occurred in three zones: 1) submerged, 2) emerged and, 3) riparian (Miller 1980).

The refuge consists of two separate areas comprising

12,730 ha (31,457 a) which includes 5,482 hectares (13,546 acres) of open water and marsh, 5,809 ha (14,354 a) of grasslands, and 1,440 ha (3,557 a) of cultivated lands or former croplands. Surrounding private land is intensively farmed for small grains. The north area contains the 3,521 ha (8,700 a) Medicine Lake as well as 8 other small lakes or management units. The Homestead Unit consists of the 518 ha (1,280 a) Homestead Lake and adjacent uplands. The study area contained ninety-four man-made and eighteen natural islands.

The refuge lies within the Williston Basin oilfield which has been one of the most active oilfields in the contiguous 48 states. Oil exploration and development is widespread on surrounding private lands and was initiated on the refuge in 1986 with the drilling of two wells within 150 m (0.25 miles (mi)) of Lake # 11.

Both avian and mammalian predators were found on the study area. In both 1985 and 1986 the MLNWR management plan had predator control operating to improve nest success. The plan called for the removal of striped skunks (Mephitis mephitis), raccoon (Procyon lotor) and red fox (Vulpes fulva). In 1985, 63 skunks, 18 raccoons, and 1 fox were removed using various trapping techniques. Increased trapping efforts produced only 42 skunks and 18 raccoons in 1986. Other animals trapped included 5 mink

(Mustela vision), 2 long-tailed weasels (Mustela frenata), 1 badger (Taxidea taxus), 1 feral cat (Felis sp.), 1 Richardson's ground squirrel (Citellus richardsoni) and four black-billed magpies (Pica pica) (Martin 1986).

The climate is typical of the northern great plains, with cold winters and warm summers having extreme temperatures of -49 (-57) to 47 Celsius (C) (117 Fahrenheit (F)) respectively. Average precipitation is 30.5 (12) to 38 centimeters (cm) (15 inches (in)) with summer hailstorms and violent electrical storms common. Spring is generally the most windy period with the velocity of 32 kilometers per hour (kph) (20 miles per hour (mph)) occurring 15 % of the time. Medicine Lake becomes ice-free in mid-April and freezes up in early November.

Average date of the last freeze is May 27 and the average date of the first freeze is September 10 giving an average frost-free season of 110 days (Caprio 1965).

METHODS

Geese were observed, with the aid of binoculars, a 15 to 60X Bushnell spotting scope, and a Questar scope with a 28mm objective (79X). Observations were grouped into 1 of 5 seasonal activity periods: (1) prenesting, (2) nesting, (3) brooding/molting, (4) post-molt, and (5) wintering periods.

Prenesting Period

The prenesting period began with the arrival of geese at MLNWR which occurred from early to mid-March. Territorial geese were observed and locations plotted to aid in locating nesting sites. These observations included date/time, location/activity, group size/number of banded geese, neck collar numbers, and any comments pertinent to the sighting.

Nesting Period

The prenesting period ended and nesting period began with the laying of the first egg. To minimize disturbances during the critical egg laying and early incubation periods, nest searches were not conducted until incubation was well underway in late April. Extensive nest

searches were conducted on foot, 3 or 4 wheeled vehicles, and by canoe. To coincide with the annual goose production survey flight administered by the refuge staff and as an orientation flight, one aerial flight was made on 8 May, 1985.

The refuge was divided into 15 islands and management units to facilitate data recording. These units were as follows; Highway Islands, McDonald's Island, McDonald's Islands, Bruce's Island, Young's Island, Big Island, Bridgeman Point, Main Shore of Medicine Lake, Gaffney Lake, Lake # 10, Lake # 11, Lake # 12 including Katy's Lake, Homestead Lake, Gull Island and Deep Lake.

During the nesting survey all islands were visited and searched thoroughly for nests. Areas on the mainland and in the marsh where pairs were observed were also searched. Nests were located in all phases of the nesting cycle but were most often found during incubation when females were flushed. Each nest site was visited twice to determine nest success. The initial nest search commenced on 23 April in 1985 and on 17 April in 1986. Nest locations were plotted on topographical maps and nest sites were marked with blue and red surveying flags for 1985 and 1986, respectively. Each flag was placed 5 m (16.4 ft) north (N) of the nest site to lessen its attraction to the nest by avian predators. Photographs were taken of representative nests in each major cover

type. These photos served as a permanent record for conditions representing nest site selection.

Physical and biological factors associated with goose nests were recorded. During the initial search, the following information was recorded at each site: location, nest number, date, site description, vegetational type, description of surrounding water, soil type, nest materials, reuse of site, numbers of eggs in the clutch and approximate laying and hatching dates.

The location of each nest was plotted on the back of a separate inventory card and each nest was assigned a consecutive number corresponding to the area in which it was found. The date and time were recorded along with current weather conditions. Nest site descriptions included structural characteristics such as location relative to main shore, natural or man-made island, pennisula blocked by an electric predator fence, overwater, or haybale. The physical characteristics of each nest site were evaluated at the time of the search or at a later date with the aid of aerial photos.

Vegetative type for each nest site was determined to be one of the following; bare ground and rocks, marsh, grass, forbs, brush including western snowberry, and prairie rose (Rosa setigera), shrubs including buffaloberry and chokecherry, and trees. Individual

species were identified at the nest site when possible from the available litter.

The position of each nest was described with respect to the ground and was recorded as ground, haybale, artificial nesting structure, or bulrush. The depth of the surrounding water was measured on the side of the island nearest to the mainshore at its deepest point and ranked as 0, 1, 2, 3, or 4 for the following corresponding depths of water in meters: (0), (0-0.3), (0.4 -0.6), (0.7-0.9), and (>0.9), respectively. The soil type at each nest site was evaluated and recorded as sand, gravel, boulders, clay loam, sandy loam or not applicable. The materials used in the nest construction were recorded as sticks, grass, combination of sticks and grass, bulrush, or hay.

The laying and hatching dates were determined by candling eggs with a 15 cm (6 in) piece of 6 cm (2 3/8 in) flexible radiator hose (Weller 1956). Using the air space to evaluate the number of days incubated, laying and hatching dates could be determined using an average incubation period of 28 days and a laying rate of 1.5 days per egg (Hinz 1977). There were several instances where visual observations confirmed the calculated laying and hatching dates. Nest searches were avoided in extreme weather and the time at each nest was kept short to minimize the disturbance during the incubation period.

The eggs were covered by the investigator with the nest lining to lessen the chance of predation and embryonic death (Higgins and Kantrud 1973). Clutch sizes were determined by flushing the hen and counting the eggs or by examining the nest after hatching and when possible counting the number of embryonic sacs and unhatched eggs in the nest. The eggs remaining in the nest were examined in the field for cause of failure (Kossack 1950).

Average brood size at the time of hatching was determined by observations of broods or by counting the number of eggs hatched in the successful nests. Embryonic sacs were used to calculate nesting and hatching success. Nests where at least one egg hatched were recorded as successful. Hatching success was recorded as the percentage of eggs that hatched in successful nests. Locations of many nests were noted before the search owing to their conspicuous locations on haybales, small islands and in nesting structures.

The second search commenced on 22 May, 1985 and 18 May, 1986 when most nests were believed to have hatched. During the second search, determining nest success was the major objective. Other information gathered at this time included elevation above water, determined with a graduated PVC pipe and a hand level, distance to water with an Edscop 15.2 cm (6 in) field range finder and

with an Edscop 15.2 cm (6 in) field range finder and vegetative densities with a Robel pole (Robel 1970). Modifications to the procedure discussed by Robel were that four readings were taken at each cardinal point around a spot 0.3 m (1 ft) north of each nest bowl. These visual obstruction measurements were taken from a height of 1 m (3.1 ft) and at a distance of 4 m (12.4 ft) away from the Robel pole. The Robel pole or height-density pole was 1.5 m x 3.8 cm square (4 ft 11 in x 1.5 in square) graduated in decimeters (dm) and one-half decimeters on all 4 sides. The pole was painted white with graduations and numerals for each decimeter in black. The sight pole was 1 m (3.1 ft) in length with a cord 4 m (12.4 ft) long connected by a swivel at the top of the height-density pole to maintain the sighting distance. The graduation totally obscured to the nearest one-half a decimeter was recorded on each cardinal point. Species composition of vegetation was recorded at the nest site with the assistance of refuge personnel or unknown specimens were taken to the refuge headquarters for comparison with specimens in the refuge herbarium.

Egg and gosling losses during the nesting period were recorded and classified as follows: infertile eggs, embryonic death, avian or mammalian predation, eggs found floating in the water near nest or found outside the nest, natural nest destruction as in flooding and island bank

predation were carefully examined in addition to the surrounding area to determine the nest predator (Sooter 1946 and Reardon 1951).

The height of the nest above water was measured by sighting a hand level to the base of the nest and recording the height from a surveyor's rod. When a nest was located in an area where a direct reading was impossible, a number of known heights were taken and totaled for the elevation above water.

The distance from each nest to the water was measured by using a 30.5 m (100 ft) range finder. For greater accuracy on nests further than 15.2 m (50 ft) from the water's edge, a series of shorter distances were measured and totaled.

Vegetative cover was mapped from aerial photos and later "ground truthed" for each of the major nesting islands to determine % cover. The 5 major cover types used were marsh, grass, brush, shrub, and trees. Other features identified were wetlands, rockpiles and old feeding structures. Each cover type was estimated by using the Linear Measuring Set (LMS) and precents were calculated from the totals. These estimates of vegetative cover from the major nesting islands were made from spatial features mapped from aerial photos and transferred to transparencies. The procedure included digitizing each

transparency followed by processing each image and scaling each to 79.2 m/cm (660 ft/in) (Harrison 1984). For individual islands, areas were totaled and vegetative cover types were divided by the total areas for % of cover.

Brooding/molting Period

During the brooding/molting period goose broods were observed to determine when most averaged 7 weeks of age, the optimal age for banding. Special attention was given to record areas of high use. These major brooding areas were plotted on topographical maps to assist refuge personnel in future management. Banding occurred in July of both years employing one of two methods. The first method included a modified funnel trap constructed of 5 rolls of plastic coated poultry netting (3-45.7 m (150 ft) X 1.2 m (4 ft), 2-45.7 m (150 ft) X 0.9 m (3 ft)). One roll each of the 1.2 m and 0.9 m were used to construct 2-91.4 m (300 ft) lead wings running 6.1 (20) to 9.1 m (30 ft) into the water, which then paralleled the shore forming a modified V-shaped funnel. At the throat of the funnel which was approximately 15.2 m (50 ft) up on the bank, a catch-pen was constructed of 1 roll of 1.2 m (4 ft) poultry netting in the shape of a modified figure 8. This shape allowed splitting the pen into two segments to minimize injury and stress on captured geese by reducing

minimize injury and stress on captured geese by reducing the instances of crowding and trampling (Szymczak et al. 1981). The sides and wings of the trap were supported with 1.8 (6) and 2.1 m (7 ft) fence posts and 0.6 cm (0.25 in) aluminum rods at approximately 3 (10) to 4.5 m (15 ft) intervals. The second trapping method used was the free-banding technique as described by Hanson and Eberhardt (1971). Modifications of this technique were discussed by Hinz (1977).

Goslings which were determined to be less than 7 weeks of age, or subadult males, were banded with standard aluminum leg bands only. Captured female birds 7 weeks of age or older, and adult male birds determined to be part of the breeding population, were banded with standard aluminum leg bands and also with Vinyline plastic yellow neck collars, 7 cm in height, having a black alpha numeric code (MF-00, MK-00, MR-00). This color combination greatly increased observability (Hamilton, 1978). The sex and age of each goose was determined through cloacal examination and feather characteristics as described by Hanson (1967) and Yocom and Harris (1965).

Post-molting Period

The post-molt period started when the geese started to fly. Observations contained the same information as

dates of neck collared geese from MLNWR. The reformation of the flock was observed as well as the return of the nonbreeders and yearling birds from their molt migration.

Wintering Period

In both years during the wintering period information was collected by Nebraska Department of Game and Parks personnel. Sightings of neck-collared birds supplemented the band return information from hunter harvested birds. The form for reporting observations of neck collared Canada geese on the North Platte River included date, neck collar number, status code, observation description and observer. Status codes were: 1) feeding, 2) roosting, 3) flying, and 4) dead. Descriptive information included location of the observation or harvest, type of vegetation or crop being used general condition of the birds, cause of death, location with respect to refuge or no hunting areas and the length of time birds used specific areas or sites. Lastly, the observer was identified as a member of the Nebraska Game and Parks Commission or a hunter or concerned sportsman.

The objectives of the study, as related to Nebraska Game and Parks, were to: 1) verify the flock's migration chronology, 2) identify their geographical distribution, 3) check hunters' bags to determine harvest and general condition of geese, 4) identify feeding activity by

identifying food used and food availability.

The data analysis was conducted at the completion of the second field season using the MSUSTAT statistical package with appropriate comparisons made between years and locations. These data were tabulated and summarized at the end of the study.

Adult mortality throughout 1985 and 1986 was recorded when observed. Five carcasses of geese suspected of botulism or lead poisoning were sent to the U.S. Fish and Wildlife Service National Wildlife Health Laboratory in Madison, Wisconsin for diagnosis. During the 2 years, all geese found dead were given preliminary examinations in the field which included date, location, position of body and condition. Birds found sick were taken to the refuge headquarters for observation and rehabilatation. At death all birds were subject to internal examination to determine cause if possible.

RESULTS AND DISCUSSION

Prenesting Period

Geese arrived at MLNWR in 1985 and 1986 in early March (Brock 1985) with monthly average temperatures of 1.1 (34) and 4.9 (41) degrees C (F), respectively. Both temperatures were above the 1951-1980 mean temperature of -3.6 (25.5) degrees C (F). In 1986 the first collared goose was observed at the refuge on 9 March (Martin 1986). Medicine Lake was ice covered both years when geese returned to MLNWR and the ice remained until 15 April in 1985 and 29 March in 1986. Soon after the arrival of geese, mated pairs were observed on all management units traditionally used by nesting geese. Pairs and groups of geese were well dispersed on the refuge by the middle of March in both years.

Nesting activities soon commenced and territories were established and defended before the ice was entirely off the lakes and ponds. Adverse weather conditions can delay the start of the breeding season (Collias and Jahn 1959). Beginning nest initiation dates in 1985 and 1986 were 29 and 17 March respectively. With the higher mean temperatures in 1986, the median date of nest initiation

was 7 days earlier than 1985 (Fig. 2).

Naylor (1953), in California, and Atwater (1959), in Montana, noted that most geese appeared paired on arrival. Kossack (1950), Hanson (1953) and Naylor (1953) reported that pair formation takes place on the wintering grounds and the results of my study provided no information to the contrary. Most observations of territorial chases and breeding behavior at MLNWR involved established pairs. On several occasions pairs which included collared juvenile females were observed defending territories with only unlined bowls or scrapes present.

Behaviorial data collected on pairs and family groups verified observations reported by others. Females selected the nest site as reported by Collias and Jahn (1959), Brakhage (1965) and Moser (1973). Before nesting the male and female defended their territory together, but after nesting started, the male defended alone. Kossack (1950), Weigand et al. (1968) and Moser (1973) reported similar behavior. Family breakup was observed when a collared juvenile was driven away and later observed with a group of collared nonbreeding geese. On Lake # 11 several islands were used by subadult birds which seemed to be tolerated by territorial pairs. The second largest island on Lake # 11 was used simultaneously by nesting and non-breeding geese.

Nesting Period

The nesting period started 29 March in 1985 and 17 March in 1986 with the seasonal pattern of nest initiation shown in Figure 2. Nesting activities lasted 81 days in 1985 and 86 in 1986. Median hatching dates were 14 May 1985 and 8 May 1986.

The nesting periods for the 2 years were long when compared with Brakhage (1965), who reported a range of 64-79 days in Clinton County, Missouri. The long nesting period may have been the result of renesting efforts or later nesting by less dominant pairs, neither of which was documented.

Eighteen collared geese were associated with fifteen nesting sites in 1986. One collared bird, MK-35, nested on a small island at Big Slough WPA. Her nesting effort was unsuccessful and later she was observed molting on Gaffney Lake. This bird was harvested in Boulder, Colorado on 11 December, 1986. This nesting effort may be indicative of pioneering by MLNWR geese into the WPA's.

There was an indication that fishing activities adversely affected goose nesting. In 1985 four pairs were observed defending territories on the pennisula east of Bruce's Island where fishing pressure may have discouraged nesting. No nests were found. In 1986 two pairs were observed defending territories, one nest was found which

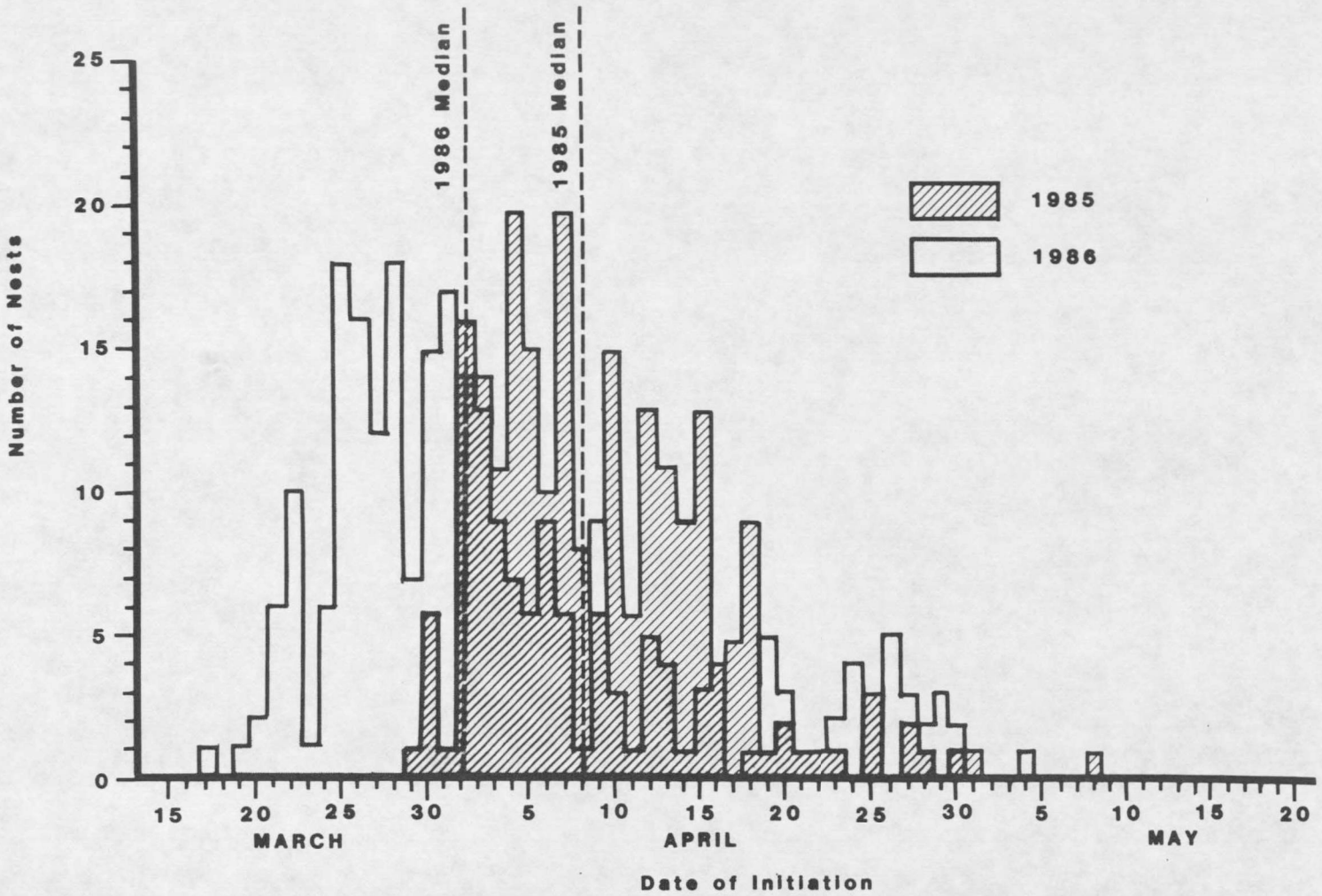

Figure 2. Dates of initation of 228 and 262 Canada goose nests in 1985 and 1986, respectively, on MLNWR.

later had the eggs removed. On the Highway Islands in 1986 one group of anglers disturbed nesting geese on all 4 islands and kept incubating hens from their nests for 6 to 8 hours. This disturbance was reflected in the differences in nest success between the 2 years, 70.6 % in 1985 and 57.1 % in 1986.

Two pairs were located in 1986 in which both the male and female were collared. MK-60 and MF-02 nested on the south end of Big Island and further observations were non-existent. MK-01 and MK-29 nested on a small island on Lake # 11. The pair actively defended their island and eventually nested. Both members fed on vegetation on the island and nearby on aquatic plants and invertebrates. The hen laid six eggs, all of which hatched. No observations were made of this hen with her brood. The male, MK-29, was observed with a group field feeding in spring wheat stubble 2.4 km (1.5 miles (mi)) northwest (NW) of Lake # 11 on 8 April 1986, while the hen was incubating.

The number of nesting pairs at MLNWR from 1980 to 1985, determined from production flights, were 239, 225, 213, 236, 132, and 169, respectively. The apparent drop in numbers in 1984 and 1985 may have been the result of an inexperienced observer (Brock 1985). Nest searches for 1985 and 1986 showed stability in nesting pairs with 299 and 307 nests, respectively.

A summary of nest site data including location, position, soil type, depth of surrounding water, and nest materials for 1985 and 1986 is contained in Appendix, Table 9. In 1985, 64 nest sites (21.4 %) were classified as reused sites compared to 111 (36.2 %) in 1986. Artificial nest sites (i.e. manmade islands, artificial nest structures and haybales) represented 31.8 % and 29 % for 1985 and 1986, respectively (Appendix, Table 9).

Clay and sandy loam were the represented soil types at 81.6 and 82.7 % of the nest sites for 1985 and 1986, respectively. Nests were composed of the nearest available materials, usually sticks, grass, bulrush or hay. Sticks were the predominent nest material used in both years making up 56.5 % and 61.6 % of nests in 1985 and 1986, respectively. Depth of surrounding water 0.9 m (3 ft) or greater occurred 59.5 % and 74.9 % for 1985 and 1986, respectively.

Nesting on MLNWR is concentrated in several areas. Island nests constituted 92 and 91.5 % of all nests in the 2 years. Several researchers have documented the preference geese show for nesting on islands; Naylor (1954) on the Susan River in Lassen County, California; Geis (1956) on the Flathead River of Montana; Hook (1973) at Freezeout Lake, Montana; and Hinz (1974) on the Lower Yellowstone Valley in Montana.

Miller and Collins 1953, Naylor 1953, Geis 1956, and Hammond and Mann 1956 have noted that vegetation cover seemed less important in nest site selection than good visibility from the nest. Most nests found during this study would support these findings. However, geese nesting in areas where security is high but with high nesting densities may seek visual barriers to avoid intraspecific interference. In the marsh cover type, nesting platforms over the water were constructed within bulrush. On Big Island, clumps of snowberry were used by nesting geese throughout the island. In both of these situations visibility was poor but the security level from predators was high.

On Big Island, two-thirds of the nesting occurred on the northern one-third of the island (Figure 3). This distribution may be due to the apparent security of the north end. The distance to the mainshore at this end was 0.4 to 0.8 km (0.25 to 0.5 mi) compared to 0.2 km (0.12 mi) at the south end. Secondly, white pelican (Pelecanus erythrorhynchos), California gull (Larus californicus), ring-billed gull (Larus delawarenis), great blue heron (Ardea herodias) and double-crested cormorant (Phalacrocorax auritus) rookeries are located at the northern end of the island and tradition between nesting geese and colonial nesters may play a part in this nest distribution (Vermeer 1968). Lastly, the major reason for

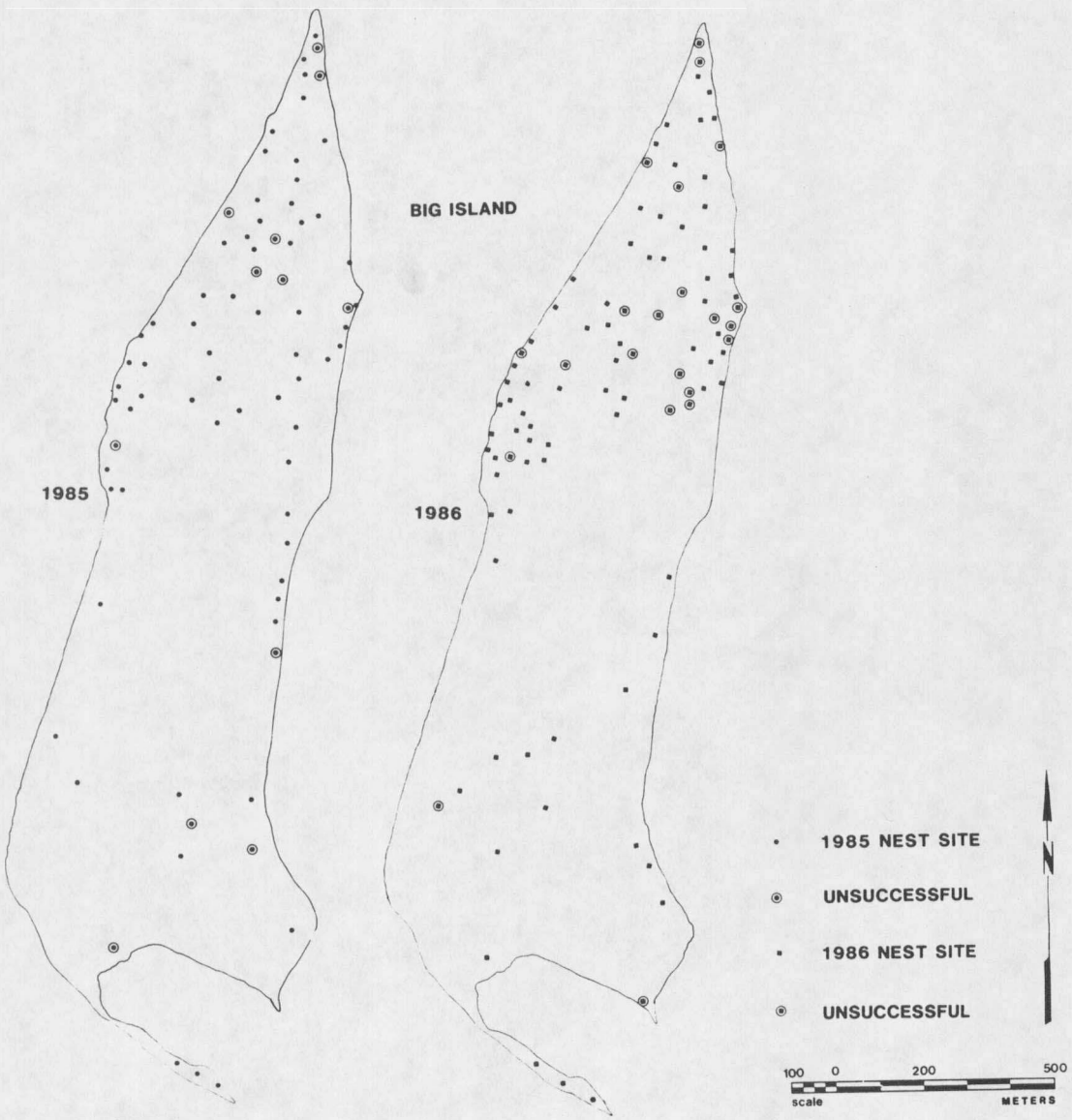

Figure 3. Nest distribution of Canada geese on Big Island, MLNWR, for 1985 and 1986.

this distribution may be related to the greater and more diverse amount of edge perimeter of snowberry patches at the northern end compared to the southern end (Figure 4). Similar findings were reported by Hanson and Eberhardt (1971) on the Columbia River in Washington where "edge effect" was created by a drift log or similar object in an otherwise homogeneous island environment. Ewaschuk and Boag (1972) reported the preference for snowberry by nesting geese.

Overall nesting densities on Big Island were 0.83 (0.34) and 1.0 (0.41) nests per hectare (per acre) for 1985 and 1986, respectively. On the northern one-third of the island, nesting densities were 2.3 (0.92) and 1.6 (0.7) nests per hectare (per acre) for 1985 and 1986, respectively, compared to the southern end with densities of 0.3 (0.1) nests per hectare (per acre) for both years of the study. Johnson (1947) and Brakhage (1965) felt that 2.45 (1.0) nests per hectare (per acre) was a desirable figure for nest density.

Nest site data are highly variable and dependent on island location and origin. Vegetation was compared between nest sites and major vegetation cover types present on the large nesting islands with summaries shown in Figures 4 to 6 and Table 1. Nest site selection was made prior to any significant new plant growth so residual vegetation from the previous year provided the

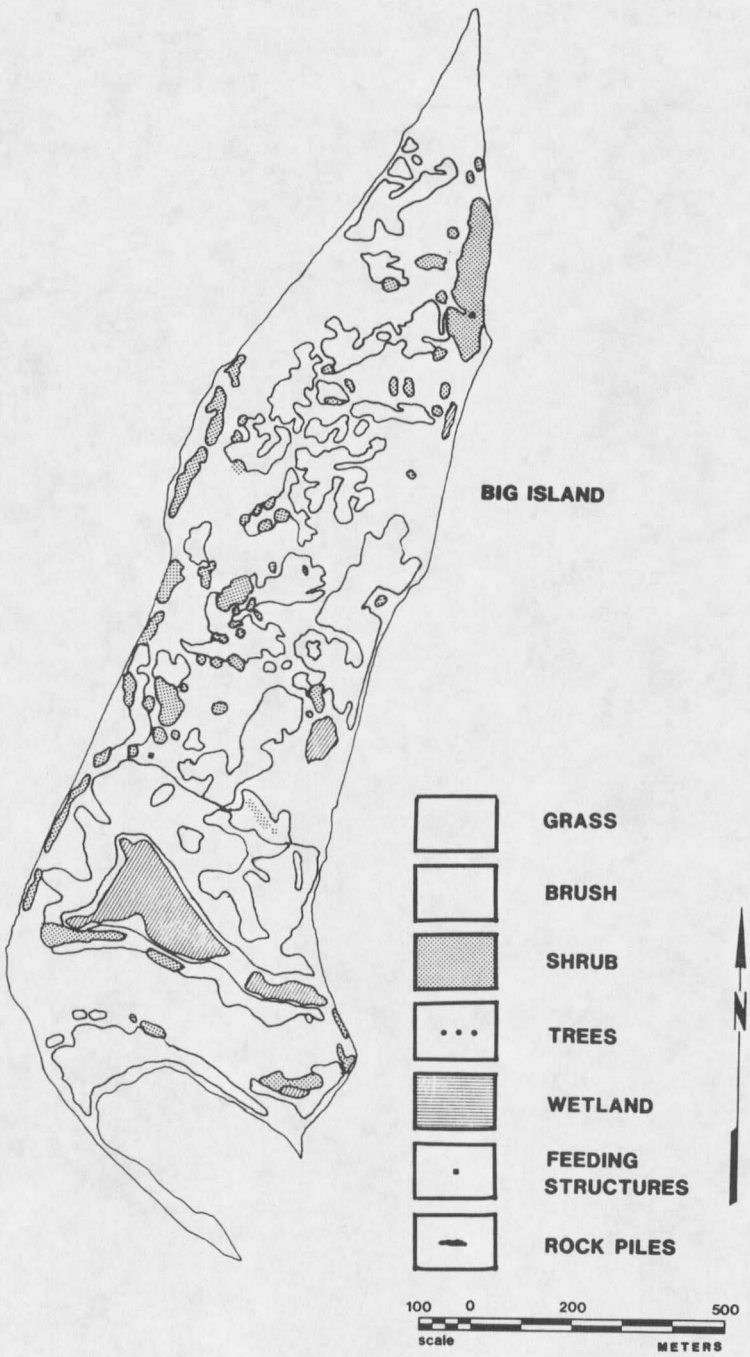

Figure 4. Major cover types present on Big Island, MLNWR, 1986.

Figure 5. Major cover types present on Bruce's, Island, MLNWR, 1986.

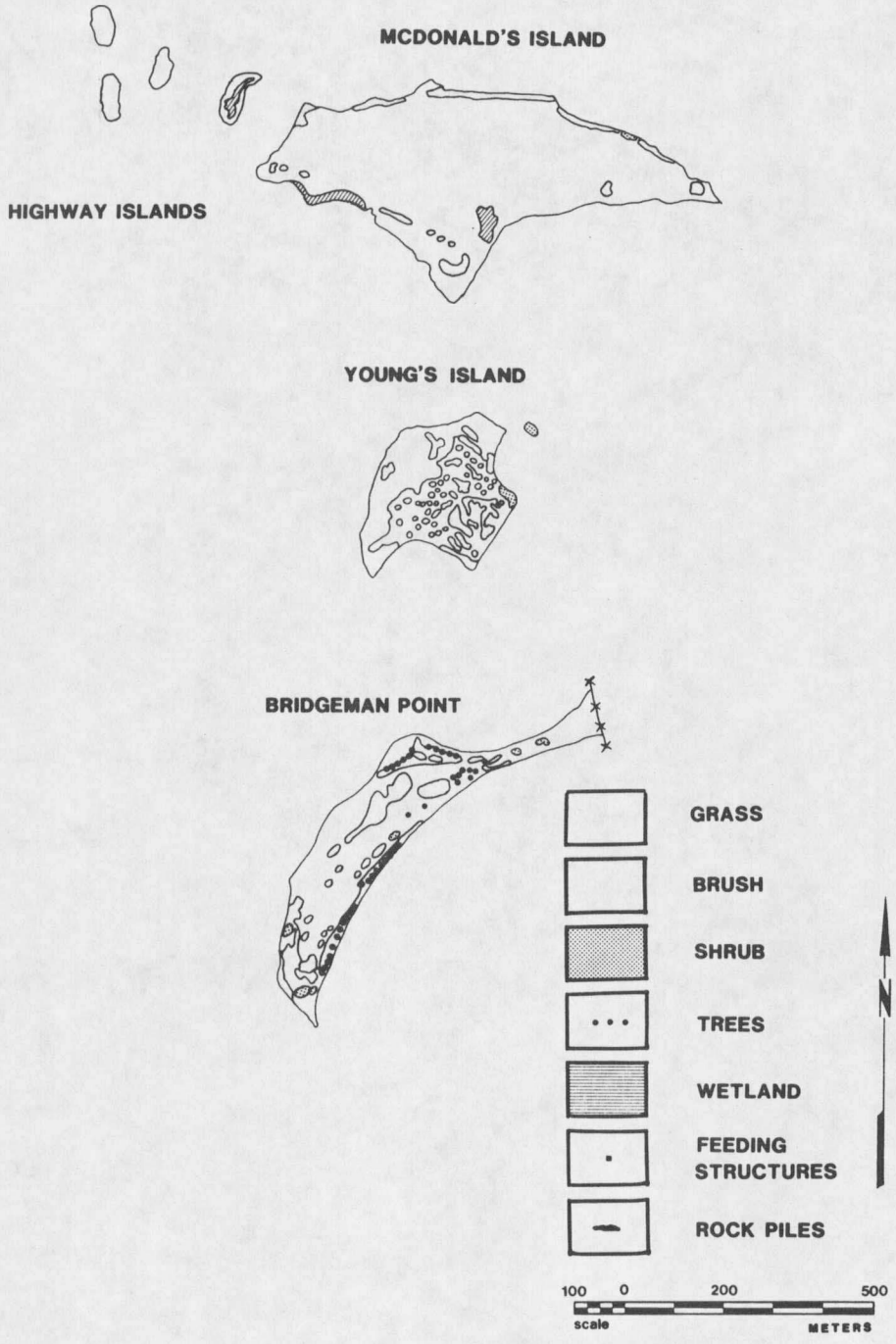

Figure 6. Major cover types present on Highway, McDonald's and Young's Islands and Bridgeman Point, MLNWR, 1986.

Table 1. Summary of major cover types present on the large islands on MLNWR, 1986.

Cover Type (%)	Grass	Brush	Shrub	Tree	Wetland	Total
Management area						
Highway Islands	88.6	11.4	0	0	0	100
McDonald Island	90.7	6.6	0.2	0.2	2.3	100
McDonald's Islands	64.6	31.6	0	0	3.8	100
Bruce's Island	93.4	0.1	0	0.1	6.4	100
Young's Island	47.8	50.2	2	0	0	100
Big Island	55.3	30.6	7.7	0.1	6.3	100
Brigeman Point	67.4	28.5	1.4	2.7	0	100
Two large Islands on Lake # 11	62.2	37.8	0	0	0	100

only effective cover. In general, this study supports Hook's (1973) findings that the nature of the island vegetation appeared to have no appreciable effect on selection of islands for nest sites and that the island itself, particularly in the case of smaller islands seems to be the dominant feature. Geis 1956, Klopman 1958, Sherwood 1967, and Vermeer 1970 also have reported similar findings. Firmbase, good visibility from the nest and nearness to water are qualities important in nest site selection as reported by Williams and Marshall (1937), Miller and Collins (1953), MacInnes (1962), and Brakhage (1965).

Sherwood (1965) found that the close spacing of islands prevented the use of some as nest sites and recommended a minimum of 46 m (150 ft) between islands. On Lake # 11 several islands were not occupied and it is believed that intraspecific interaction was the major reason. Visual barriers may aid in reducing competition and increasing production in this area. This will be discussed further in the recommendation section.

Distance to and height above water averages for 1985 and 1986 are shown in Table 2. The average height above water ranged from 0.5 (1.6) to 2.4 m (7.8 ft) in 1985 and 0.3 (1.0) to 2.3 m (7.6 ft) in 1986. The distances to water on which Table 2 averages were computed ranged from 0.15 (0.5) to greater than 122 m (400 ft) in both years.

Table 2. Average elevation and distance to water for Canada goose nests at MLNWR by management unit for 1985 and 1986.

Management unit	Elevation above water meters (feet)		Distance to water meters (feet)	
	1985	1986	1985	1986
Highway Island	0.7(2.4)	0.4(1.2)	3.9(12.8)	1.2(4.0)
McDonald Island	2.3(7.6)	1.9(6.1)	33.9(111)	22.2(73)
McDonald Islands	1.0(3.2)	0.6(1.8)	9.3(30.4)	5.5(18)
Bruce's Island	1.6(5.4)	0.5(1.5)	40.7(134)	5.5(18)
Young's Island	2.0(6.7)	1.8(5.9)	23.4(77)	18.4(60)
Big Island	2.4(7.8)	2.1(6.9)	49.0(161)	34.1(112)
Bridgeman Point	1.2(4.1)	1.2(4.0)	16.0(52)	12.5(41)
Gaffney Lake	1.7(5.6)	0.8(2.8)	16.0(52)	7.0(23)
Main Shoreline	2.4(7.8)	2.3(7.6)	29.0(95)	21.0(68)
Lake # 10	0.5(1.6)	0.3(1.0)	2.1(6.8)	1.1(3.7)
Lake # 11	0.9(3.0)	0.6(2.5)	4.3(14)	3.0(10)
Lake # 12 w/ Katy's	2.2(7.1)	1.2(4.1)	16.6(55)	8.9(29)
Homestead	1.0(3.3)	0.7(2.4)	20.8(68)	3.6(12)
Gull Island	0.6(1.8)	0.5(1.6)	8.5(28)	5.2(17)
Deep Lake	1.1(3.6)		1.8(6)	
MLNWR Average	1.6(5.2)	1.4(4.5)	24.1(79)	16.8(55)

Flooding was not a major problem on MLNWR although in 1986 Lake # 10 had a rise in water level and caused 5 nests to be flooded and abandoned. Distance to and height above water are not considered important in nest site selection and nest success in areas of managed water levels. In this study the values were more related to the size and height of the islands. On most small islands, nests were located on or near the crest.

Average clutch sizes for the years 1985 and 1986 were 5.1 and 5.7, respectively. The difference between the 2 years was not statistically significant ($P > 0.05$). Clutch sizes ranged from 1 to 9 in 1985 and from 1 to 14 in 1986 (Figure 7). The mode for both years was 6. These values are quite comparable to the results in studies by Geis (1956), 5.55 and 5.15 in the Flathead River Valley, Montana; Hook (1973), 5.44 at Freezeout Lake, Montana; and Hinz (1977), 5.45 for the Yellowstone River Basin, Montana; and Hamilton (1978), 5.53 in southeastern Montana.

Summary of nest success data for MLNWR by management unit is listed in Table 3. In 1985, 945 of 1295 eggs hatched for a 73 % hatching success. In 1986, 1146 Of 1640 eggs hatched for a 70 % hatching success. A summary of nests with egg failure is presented in Table 4. Predation accounted for 67.4 % and 31.2 % of all losses in 1985 and 1986, respectively. The average number of eggs

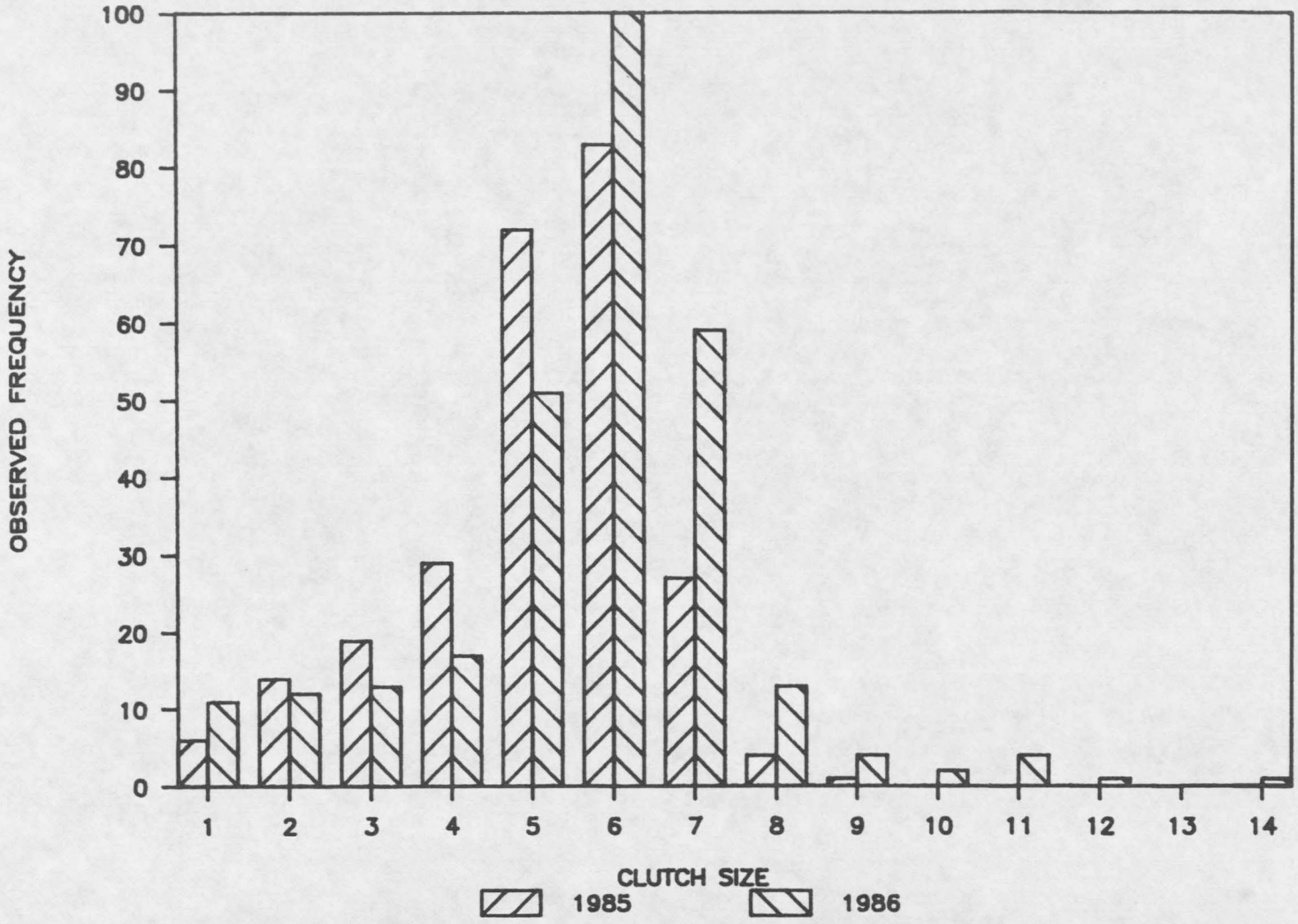

Figure 7. Frequency distribution of clutch size from Canada goose nests in 1985 (N=255) and 1986 (N=288) on MLNWR, Montana.

Table 3. Summary of Canada goose nest success by management unit for 1985 and 1986 on MLNWR, Montana.

Management unit	# Nests		# Successful		# Unknown		% Successful	
	1985	1986	1985	1986	1985	1986	1985	1986
Highway Islands	17	14	12	8	0	4	70.6	57.1
McDonald Island	11	14	10	10	0	0	90.6	71.4
McDonald Islands	13	12	10	10	0	0	76.9	83.3
Bruce's Island	2	1	0	1	0	0	0	100
Young's Island	43	40	30	31	0	0	69.8	77.5
Big Island	83	100	67	77	0	1	80.7	77.0
Bridgeman Point	11	9	7	7	0	0	63.6	77.8
Gaffney Lake	5	4	1	2	0	0	20.0	50.0
Main Shoreline	1	2	0	1	0	0	0	50.0
Lake # 10	16	17	8	6	2	0	50.0	35.3
Lake # 11	47	43	29	33	0	0	61.7	76.7
Lake # 12 w/Katy's	10	5	2	3	0	0	20.0	60.0
Homestead	38	45	13	32	0	0	34.2	71.1
Gull Island	1	1	1	1	0	0	100	100
Deep Lake	1	0	0	0	0	0	0	0
Total	299	307	190	222	2	5	63.5	72.3

Table 4. Summary of Canada goose nests with egg failures in both successful and unsuccessful nests in 1985 and 1986 on MLNWR, Montana.

Reason	1985		1986	
	Number	%	Number	%
Destroyed				
Avian	32	23.7	36	23.4
Mammalian	59	43.7	12	7.8
Dead Embryo	19	14.1	29	18.8
Deserted/ Infertile	23	17.1	71	46.1
Broken	1	0.8	1	0.6
Erosion	1	0.8	0	0
Flooded	0	0	5	3.2
Total	135	100	154	99.9

hatching per nest was 5.0 in 1985 and 5.2 in 1986.

Nest success for 1985 and 1986 averaged 67.9 % which compares favorably with other studies which ranged from 57.5 to 80 % (Rienecker and Anderson 1960, Moser 1973, Hinz 1977). The nest success in 1985 was 63.5 % compared with 72.3 % in 1986. This difference was primarily due to low water levels in 1985 especially at Homestead Lake which had 34.2 % success that year compared with 71.1 % in 1986 when water levels were more optimum.

The water levels were sufficiently high in late March of 1985 for nesting geese to select islands but as the water level dropped, most nest sites became accessible to striped skunks, raccoons, and coyotes (Canis latrans). Kalmbach (1939) stated that for managed areas a 70 % nest success was a reasonable standard for Canada geese.

Coyotes and raccoons were the most important predators on goose nests during this study. Tracks, scats, canine marks on the eggs, and observations of animals in particular areas provided evidence of their activities. Only one incubating hen was known to have been killed. It occurred in 1985 on a small island in Lake 11, 50 m (164 ft) from shore. The hen was eaten by a coyote (identified by a scat) 5 m (16.4 ft) from the nest. A raccoon later destroyed the remaining eggs. Humans were observed at one nest and are believed to have removed the eggs. Humans were responsible for the desertion of several others on the Highway Islands.

Avian predation was recorded when found but may have resulted after nest desertion. Magpies and common crows (Corvus brachyrhynchos) were potential avian predators on the area. Numerous geese in this study nested on the edge of gull colonies and observations support Hanson and Eberhardt's (1971) findings that gulls may provide some protection by harassing mammalian predators. The general

belief that gull predation occurs after waterfowl nests have hatched was supported by two observations of gull predation on 1 to 2 day old goslings.

Nest locations relative to major cover types are presented in Table 5. In 1985, 69.4 % were located in brush and forbs. In 1986, the comparable figure was 71.6 %. In 1985, one set of Robel readings were taken. The average for all units was 2.1 while unit area averages ranged from 1.0 to 3.6. In 1986, two sets of Robel readings were taken at about a 1 month interval to compare differences in vegetation growth between searches, Table 6. The averages for the 1986 reading were 1.0 for the

Table 5. Summary of cover type selected by nesting Canada geese for 1985 and 1986 on MLNWR.

Cover Type	1985		1986	
	Number	%	Number	%
Bareground/ Rocks	3	1	3	1
Marsh	41	13.7	36	11.7
Grass	42	14	36	11.7
Forbs	60	20.2	59	19.2
Brush	147	49.2	161	52.4
Shrub	3	1	11	3.6
Tree	3	1	1	0.3
Total	299	100	307	100

Table 6. Average of height-density reading at Canada goose nesting sites at MLNWR for 1985 and 1986.

Height-density readings (Robel 1970)	1985		1986	
Management unit	Number	Average reading	Number	Average reading
Highway Island	17	1.0	14	0.7
McDonald Island	11	1.2	14	1.1
McDonald Islands	13	1.6	12	3.6
Bruce Island	2	1.4	1	0.5
Young's Island	43	3.6	40	2.8
Big Island	82	2.7	100	2.2
Bridgeman Point	11	3.5	9	2.9
Gaffney Lake	5	2.0	4	1.6
Main Shoreline	1	1.5	2	1.4
Lake # 10	16	1.1	17	1.8
Lake # 11	46	1.4	43	0.7
Lake # 12 w/ Katy's	10	2.0	5	2.4
Homestead	38	1.4	45	0.4
Gull Island	1	1.2	1	0
Deep Lake	1	0	0	0
MLNWR Average	297	2.2	307	1.6
*Initial Robel reading in 1986 before vegetation green up.			303	1.0

first and 1.6 for the second. Nest locations for 1985 and 1986 for all management units (except Big Island, Fig. 3) are shown in Appendix, Figures 10 through 18.

Brooding/molting Period

The brooding/molting period commenced on 17 May in 1985 and 10 June in 1986. The molt in breeding Canada geese takes place 20-30 days after the young have hatched (Brakhage 1965) and lasts for approximately 6 weeks (Williams 1967). The period between hatching and fledging is approximately 65 to 70 days (Yocom and Harris 1965). Using these figures the molt for most adult geese at MLNWR should occur on about the first week in June. Flight feathers were first observed in early June in both 1985 and 1986. During trapping operations in both years during late June and early July some geese could fly. Hanson (1965) believed flight was possible before growth of the primaries was completed.

Moser (1973) describes the molt as a very secretive event and at MLNWR it is no different. The birds are exceptionally secretive during molting and brood rearing periods. As the young birds reached 4 to 5 weeks of age and large groups of molting geese started feeding together, observations became more numerous. Adult birds molting on Big Island were not observed until late June in both years.

Many collared geese were observed in March and April in 1986 with no further observations until early August. Groups of geese were observed during March, April and May of both years. Molt migrations have been reported by Hanson (1965), Naylor and Hunt (1954), Hamilton (1978) and Hinz (1977). Molt migrations, primarily involving nonbreeding geese, usually occur in April and May just prior to the post-nuptial molt (Krohn and Bizeau 1979). The molt migration of MLNWR geese has not been described and the molting site is unknown.

In late May of 1985 and 1986 large groups of geese were observed using winter wheat stubble 3.2 km (2 mi) south (S) of Big Island on the main lake. These groups are believed to eventually have molted on Big Island. The destination of the molt migration is usually a large body of water which offers security and a food source during the flightless period, requirements which Medicine Lake appears to provide. Some source areas for geese using MLNWR to molt based on band returns are local Waterfowl Production Areas (WPA's), nearby management units including Lake # 11 and Homestead Lake, northwestern North Dakota, Yellowstone River Basin (Hinz 1987) and Hiline areas.

During July of 1985 and 1986, banding operations were conducted on MLNWR. In 1985, 418 Canada Geese were leg

banded, 176 of which were also neck collared. In 1986, 186 were leg banded of which 93 were neck collared.

During my study, collar retention was believed to be high. Hinz (1977) and Hamilton (1976) reported retention problems owing to poor adhesives. This was corrected by securing the collars with rivets. Several individual geese were observed to work repeatedly at removing the collars.

Brood movements were observed in both 1985 and 1986 on MLNWR. Some movements on the main Medicine Lake in 1986 were a direct result of human disturbance. Human use of fishing access points on Bridgeman Point and the pennisula east of Bruce's Island was the most notable. Movements of broods around Lake # 11 seemed to be related to feeding opportunities. Geis (1956) reported that brood movements led to feeding grounds while Williams (1967) and Hanson and Eberhardt (1971) believed they led to areas where feeding plus security were offered. Movements at MLNWR are believed to be in search of secure disturbance free areas with an adequate food base.

Brood rearing movements on Homestead Lake in 1985 may have been in response to low water. Brooding geese followed the retreating water to an area north of Tom Horn point. Observations showed broods grazing in alfalfa (Medicago sativa) and dense nesting cover grasses next to the Lost Creek Arm. In 1986 when water levels were higher

than 1985, brooding geese at Homestead Lake showed similar but less dramatic patterns.

Several major areas on Medicine Lake were used by goose broods in 1985. The first was near Dam # 4, west of Highway # 16 where they fed primarily on alkali bulrush (Scirpus paludosus) and riparian grasses. Later in July and early August geese were observed feeding in spring wheat stubble on the refuge northwest of Dam # 4. In 1986 a modified pattern was noted when the birds shifted to an area east of Highway # 16, north of the Highway islands and were observed feeding on foxtail barley (Hordeum jubatum) and riparian grasses along the edge of the main lake. By early August 1986,just prior to attaining flight, geese had shifted to the west side of Highway 16. A second area used by goose broods on Medicine Lake was the south side of Bruce's Island. Several observations were made of goose broods using the wetlands on the southside and feeding throughout the island. Many observations were made of broods using the north mainshore by the headquarters for resting and feeding.

Goose broods used Big Island extensively in both 1985 and 1986. In 1985 observations were made of broods feeding northeast of Bridgeman Point, Gopher Point, and on Big Island. Several broods in 1985 used a grove of trees on the southside of Tax Bay, resting on the main shore and

feeding in the pasture south of the grove. In 1986 brood locations were similar until the end of June when human disturbances on the Main Lake caused movements from Big Island to Gaffney Lake, Beaver Pond, and a few small groups toward North Bay. The broods which moved to Gaffney Lake and Beaver Pond remained in these areas and were observed feeding on the edge of the water on alkali bulrush and riparian grasses. No other observations were made of the other small groups and they were believed to have returned to Big Island.

On Lake # 11, goose broods were observed on several occasions moving through Lake Grade Flats and in the meadows east of the lake where alkali bulrush showed signs of heavy grazing.

Brood habitat is difficult to define and disturbances may cause some habitat to go unoccupied. Forced movements to new grazing areas may expose broods to increased mortality from predation. During the early brood rearing period, disturbed adult pairs may abandon goslings that can not keep up. During windy periods on Medicine Lake, goslings were observed stranded on the beach in heavy wave action, unable to swim in the rough water. Thus, it is important that major brooding areas receive a minimum of disturbance.

Gosling mortality was difficult to record with any certainty due to minimal individual brood identity. Also,

in addition to being difficult to locate, broods frequently move significant distances in short periods of time and the tendency for the formation of "gang" broods made recording of brood "shrinkage" impossible.

The number of dead juvenile and adult geese seen was recorded. Most authorities reported losses occurring in the first 3 weeks of life. At MLNWR losses suspected to be due to Botulism Type C occurred at all ages.

In both years of this study, mortality of geese on Medicine Lake from Botulism Type C was identified. In 1985, 27 geese were found dead bewteen 8 July and 16 August. Of these 27 geese, 21 were banded and distributed on the shores of the following areas: 14 on Big Island, 4 on Tax Bay, 2 on North Bay, 1 on Gopher Point, and 1 on southside of Bruce's Island. One goose, MK-50, was found sick and later released alive after rehabilitation. It was observed several times near Lake # 11 and walked with a crippled leg. On 1 October 1985 it was found dead on Nelson's reservoir located 4.8 km (3 mi) north of North Bay. Local farmers reported that the bird had been on the pond for several weeks and they suspected it had been poached.

In 1985, one goose was sent to Madison, Wisconsin for analysis and the results were positive for Clostridum botulinum Type C. On 20 September 1985, one juvenile

goose was found sick on Lake # 12. After death, an autopsy was performed to determine cause of death. The examination showed an impacted gizzard and thick keratinous deposits suggesting lead poisoning.

In 1986, 21 geese, 10 of which were banded, were found dead between 27 June 1986 to 29 July 1986. Geese were found on the shores of the following areas: 3 on the southside of Bruce's Island, 14 on Big Island, 2 on Bridgeman Point, and 2 on Tax Bay.

Most dead geese found diplayed similar symptoms. They included paralysis of the nictitans and the neck muscles, green stained and dirty vents, and most birds in 1986 had reduced breast muscles. Most geese were found with heads tucked under their wings or head stuck in the sand at the water's edge.

In 1986, 4 geese were sent to Madison, Wisconsin for analysis of lead (Pb) and botulism. One goose was listed positive and the other three suspected for botulism Type C. Tests for Pb were negative. In all 4 specimens the pectoral muscles were reduced and in one goose a number 4 lead pellet was found in the subcutaneous tissues. Since the distribution of botulism mortalities were similar for both years, these areas are suspected as "hot spots" for botulism.

Postmolting Period

Individual neck collar observations totaled 426 and 750 in 1985 and 1986, respectively. In 1985 and 1986, 17 and 14 birds respectively were not re-observed after banding. It is believed that these birds were molting geese from outside MLNWR.

Field feeding geese were first observed on 28 July in 1985 and 18 July in 1986. Summer fallowed strips and alfalfa fields were first used by field-feeding geese followed by winter wheat (Triticum aestivum) fields. The small grain harvest started with winter wheat both years on or about 1 August making winter wheat stubble the first small grain crop available to field-feeding geese. Fields used first were those that were combined first. Hinz (1977) found similar results along the Yellowstone River. Summer fallowed strips were used by geese grazing on young volunteer plants and other green vegetation. In most observations geese would land in the fallowed strips and move into the edge of the stubble. As the harvest progressed throughout the month of August the use of small grain fields increased.

Drought conditions in 1985 caused poor crop conditions. Many farmers elected to leave grain standing because harvesting would not be cost effective. Fields that were harvested by combines showed heavy use by geese.

Above average precipitation in 1986 improved crop conditions and provided much needed water for surrounding wetlands. Many more fields became available to field-feeding geese in 1986 and was reflected by geese spending more time off the refuge.

Observations in the first week of August showed nonbreeders which had molted elsewhere returning to the refuge with the majority arriving around 21 August.

In both 1985 and 1986 as various groups of geese completed the molt, use of distinct portions of the refuge were noted. In 1985 these areas included Homestead Lake, Bruce's Island and Lake # 11.

Geese at Homestead Lake used the north end of the Twin Lakes for resting periods and fed in barley (Hordeum vulgare) and spring wheat fields 2.4 to 3.2 km (1.5 to 2 mi) northeast. The geese on Bruce's Island used the wetlands on the southside of the island or the southside of the main shore to rest and fed in spring wheat fields 3.2 to 4 km (2.0 to 2.5 mi) southwest. Together these two groups of geese accounted for 2/3 of the total number of geese being observed at that time. From 11 to 17 September both groups departed. Harmon Ranch personnel reported that yellow collared birds may have spent time during this period south of Bainville, Montana but the report was not verified.

Geese using Lake # 11 rested on the shores of Katy's

Lake and on the islands in Lake # 11. Feeding flights to spring and durum (Triticum durum) wheat fields were made 4.8 to 9.6 km (3 to 6 mi) to the northwest. A neck-collared pair, MK-01 and MK-29, were consistently sighted together within these large groups. Two observations were made of MK-29 on Medicine Lake and on the southside feeding, a distance of 19.2 km (12 mi) from Lake # 11. This suggests some mixing between flocks.

Mk-01, an adult female, and MK-29, an adult male, were banded on Bridgeman Point on 1 July 1985. The pair were observed numerous times in 1985 resting at a duck trapping site on east side of Katy's Lake. Small grains used to bait ducks attacted geese to this location. After the grain in the adjacent fields was harvested, geese started to feed in them. Late in September 1985 patterns were very routine, resting on the shores of Katy's Lake and feeding in a spring wheat field 9.6 km (6 mi) west.

Precipitation was greater in 1986 than 1985 and resulted in a higher % of crops being harvested. This fact, coupled with a wet fall, made movements of geese less predictable than in 1985. Homestead Lake geese were first observed field feeding on 4 August 1986. Resting on Sheep Creek and Breezer dams, they fed in winter wheat 1.6 km (1 mi) to the east. During August a botulism outbreak occurred at Homestead Lake. Owing to the disturbances

from pick-up crews, geese moved to Anderson's wetland 6.4 km (4 mi) southwest (SW) of Homestead Lake for resting periods. Movements of geese in response to disturbances has been discussed by Szymczak et al. (1981). These geese returned several times to Sheep Creek and Breezer dams during the fall. In September 1986 they routinely rested on Anderson's wetlands 6.4 km (4 mi) SW and fed in barley fields 4 km (2.5 mi) SW of Homestead Lake.

On Medicine Lake in 1986, geese were observed in two groups located on Dam # 4 and slightly to the SW of Big Island. The geese on Dam # 4 in early August started feeding in spring wheat fields 0.4 km (0.25 mi) south of the town of Medicine Lake. Later these geese spent much of their time off the refuge resting along Big Muddy Creek and feeding in spring wheat fields 6.4 to 8 km (4 to 5 mi) north of town. Geese around Big Island rested on the south shore and utilized winter wheat fields 1.6 to 2.4 km (1 to 1.5 mi) to the south.

Movements of these geese to Portra's Reservoir, 19.2 km (12 mi) southeast (SE) were observed. In the area surrounding Portra's Reservoir, geese were observed feeding in spring wheat fields. The Portra Ranch reported that geese had been using harvested oat (Avena sativa) fields but no observations were made to verify this report.

In 1986, geese on Lake # 11 used spring wheat fields

0.8 km (0.5 mi) northeast (NE) and 0.4 km (0.25 mi) west (W) of Lake # 11. Observations were made as far as 5.6 km (3.5 mi) NE in spring wheat. Movements to Portra's Reservoir were also observed among these geese eventually returning to Lake # 11. On 9 September 1986, a group of geese marked at MLNWR returned to Lake # 11 from their molt. They were observed with neck collared goose, code 92-CY in yellow/black, which was marked elsewhere. This group stayed separated from the others, rested on Lake # 12 and fed in adjacent spring wheat fields. They remained in the area and later migrated with the resident birds. Goose 92-CY was again reported 6.4 km (4 mi) from Scottsbluff, Nebraska on a sandpit.

Wintering Period

In 1985 a noticeable decrease in goose numbers on MLNWR was observed during the week of 11 to 17 September. No collared geese were observed after 2 October 1985. This coincided with the first collared goose observation from Nebraska on 25 September 1985. This report also indicated that these geese had been in the Lisco, Nebraska area for about 2 weeks. Geese on the North Platte near Lisco fed in picked corn (Zea mays) fields and spent resting periods on sand bars and backwaters along the river (Lyman 1985).

In 1986, collar sightings in the MLNWR vicinity showed a sharp decrease during the week of 1-7 October 1986. One goose, harvested on the refuge on 13 October 1986, had been observed several times in September and was apparently sick on all previous sightings. Neck collared geese were first observed near Lisco on 16 September. Observations which I made during 13-16 October 1986 further supported the report of an early migration from MLNWR to the North Platte River. Before arriving in Nebraska, an early fall snow storm had dropped 9 cm (6 in) of snow in western Nebraska. The moisture delayed harvest of the corn crop and with only a few fields available to field-feeding geese, it was possible to make a large number of collar observations in a relatively short period of time. All observations made in 1986 supported information provided in 1985, that geese fed in picked corn fields and used the North Platte for roosting. Hayed meadows and alfalfa fields were also used for feeding and roosting.

The area immediately adjacent to the North Platte River between Lisco and Oshgosh, Nebraska was classified as to agricultural crop types. Of the 6216 hectares (15,360 acres) classified, 81 % was grassland, 10 % corn, 5 % alfalfa, and 4 % wheat. Land use practices included grazing, haying, and irrigated farming.

Unreported hunter harvest from geese shot in Nebraska

(Atwood and Geis 1960) may lessen the potential band returns by approximately one-half. Based on conversations with local sportsman and farmers from the Lisco area, concerns over harvest cutbacks and bag reductions may be factors in band reporting suppression. In the North Platte River area goose hunting is highly commercialized and of considerable economic interest to a wide range of people.

Band returns of Canada geese banded on MLNWR from 1979 to 1984 show returns from 12 states with Nebraska and Montana accounting for 61.5 and 13.9 % respectively. A summary of band recoveries by state is presented in Table 7 (Brock 1984).

The goose season in Montana opened on 28 September, 1985 and 4 October in 1986. Nebraska's Canada goose season for the Panhandle region opened on 10 November in both 1985 and 1986. The distribution of band recoveries for 1985 are illustrated in Figure 8. Harvest returns for 1986 are incomplete but show similar results. The 1985 returns showed 72 % of MLNWR Canada geese harvested at or near Lisco, Nebraska. In 1986 5 returns were from the Lisco area, 1 from MLNWR, 1 from Springer Reservoir, Wyoming and 2 from Boulder, Colorado.

Neck collar sightings made in both, 1985 and 1986, supported the belief that the Lisco area is important for

Table 7. Band recovery locations of Canada geese banded at MLNWR from 1979 and 1984 (Brock 1984).

Location	1979	1980	1981	1982	1983	1984	Total
Montana	1	0	4	6	6	0	17
Nebraska	3	17	25	10	14	6	75
Colorado	0	0	3	3	0	1	7
Wyoming	0	2	2	0	1	0	5
North Dakota	0	1	3	0	2	0	6
Saskatchewan	1	1	1	1	0	0	4
Kansas	0	0	1	1	0	0	2
Texas	1	0	0	0	0	0	1
South Dakota	0	0	0	1	0	1	2
Alabama	0	1	0	0	0	0	1
Mississippi	0	0	1	0	0	0	1
Oregon	1	0	0	0	0	0	1
Total Recoveries	7	22	40	22	23	8	122
Total Geese Banded	10	132	196	46	45	14	443

* 1984 band returns incomplete at time of summary.

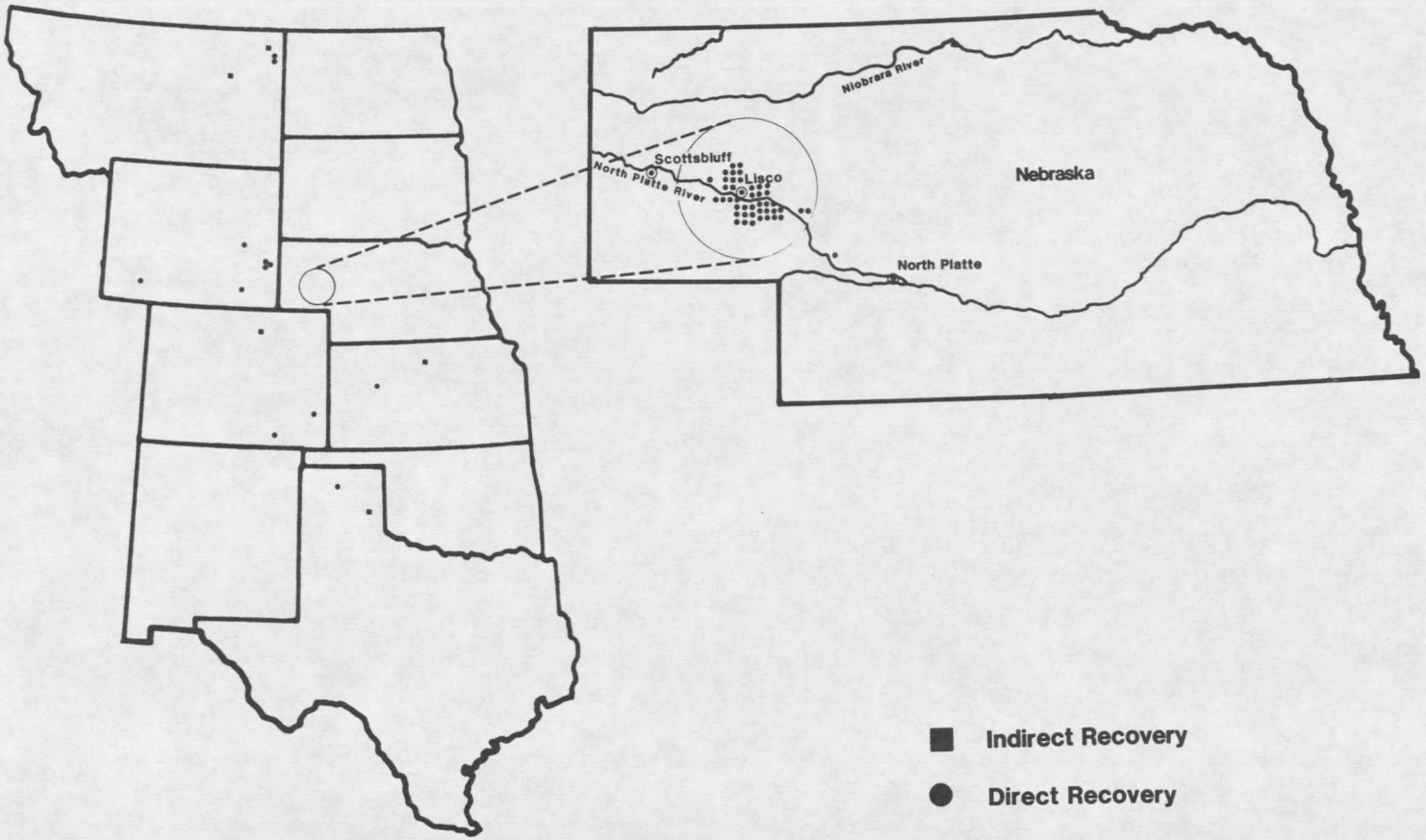

Figure 8. Distribution of band recoveries of Canada geese banded at MLNWR for 1985.

wintering MLNWR Canada geese. Population estimates made from an air boat in October 1986 between Broadwater and Lewellen, Nebraska were 1400 to 1600 geese. In December of 1986 the population within this section of the North Platte River was estimated at 10,000-15,000 geese (Hunt 1986).

In the Lisco, Nebraska area, geese used 4 or 5 principal roosting sites along the North Platte River. Local sportman reported that during the hunting season, geese have a tendency to move to areas of closure or leave the area. Szymczak et al. (1981) found that birds left their home roosting sites primarily in response to disturbances in the fall and established roosting sites inside hunting closure areas. They attempted to return to their home roosting sites periodically throughout the year. Some birds, particularly local males, established new home roosts and pioneered to other nesting areas in subsequent years.

The median harvest date falls within the week of 21 to 27 November 1985 and is shown in Figure 9 with location by state.

Freeze up on all refuge management units on MLNWR occurred on 14 November in 1985 and on 9 November in 1986.

Geese wintering on the North Platte River may depart the area in extreme weather or if hunting pressure is too great. In late December if the river freezes over, many

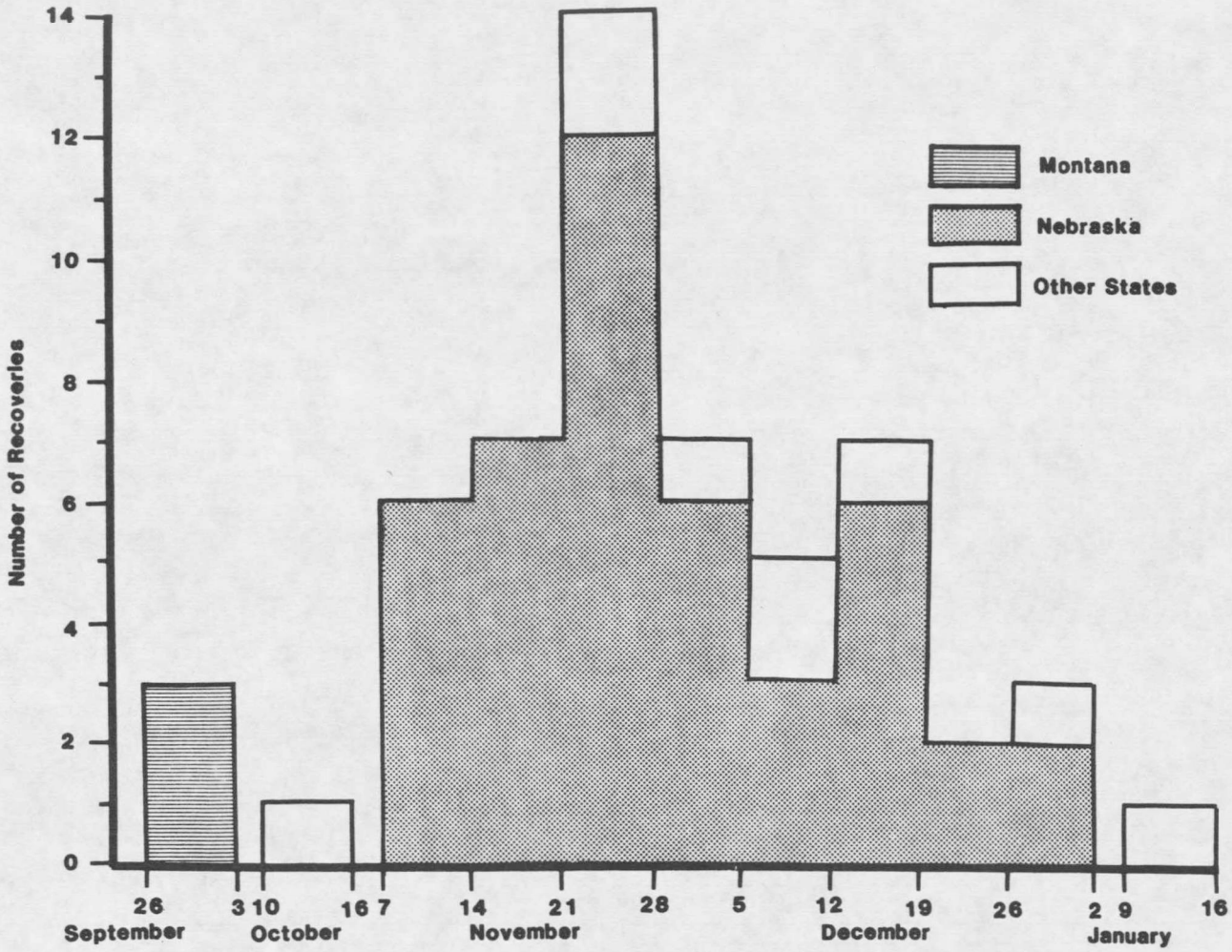

Figure 9. Frequency distribution of band recoveries in 1985 by date and location.

birds leave the area but some stay through the winter (Hunt 1986). Observations of geese from MLNWR have been reported as far south as Texas and Oklahoma. A local female, MK-06, banded at MLNWR on 1 July 1985, was observed at Checotah, Oklahoma, 53.6 km (21 mi) south of Muskogee. Another observation was made of a pair defending a territory near Clayton, New Mexico from 21 May to 19 July 1986. One member of this pair was an adult male, MK-89, banded on MLNWR on 1 July 1985. An adult male, MK-30, banded on Bridgeman Point on 1 July 1985 was observed numerous times while wintering in Washington Park, Denver, Colorado. Both MK-89 and MK-30 are believed to have been nonresident molters on Medicine Lake at the time of their banding.

In 1985, 418 geese were banded and 84 returns were recovered for a known minimum mortality of 20 %. Of these recoveries, 62 were harvested, 21 were from suspected botulism losses, and 1 was reported as unknown. The actual mortality may be much higher due to hunters failing to report bands or birds being preyed upon while sick and consequently not recovered. The data for 1986 are incomplete. Thus far 9 geese were reported harvested, 8 were found dead suspected of botulism and 3 were found dead from unknown reasons.

CONCLUSION

This study has shown that MLNWR supports a self-sustaining stable population of Canada geese which has the potential for an increased number of breeding pairs on the refuge and surrounding waterfowl production areas. Geese appeared to be occupying all optimal breeding habitat. However, management techniques which could convert unused areas into productive breeding and brood rearing sites could be implemented which would allow expansion of the population.

This study showed that nest success, nesting densities and nest site selection was quite comparable to results from similiar studies of other goose populations. Several areas of heavy brood use indicated potential problems with interactions between humans and geese, a situation easily eliminated by limiting access during critical periods.

Field-feeding sites were not considered to be limiting although in 1985, harvested fields were less available than in 1986. Hunting pressure in Montana both years was considered light.

During this study, arrival and departure dates were closely monitored. Departure dates from MLNWR were early

in the fall both years and showed a direct route to the Lisco, Nebraska area. Departure of many of the geese from MLNWR before opening of the Montana hunting season, explained the disproportionate harvest recoveries focused along the North Platte River near Lisco. The Lisco area is an important wintering area for this population of geese. This wintering area potentially could play two major roles relative to the welfare of this population. In addition to being the major harvest area, the habitat conditions during severe winters could adversely affect the condition of birds returning to breed at MLNWR.

MANAGEMENT RECOMMENDATIONS

The draft guidelines contained in the Management Plan for large Canada geese of the Central Flyway currently being written by the Central Flyway Waterfowl Technical Committee call for a breeding population objective of 1000 breeding pairs in Northeastern Montana. Management efforts should thus be aimed at building the MLNWR flock to the maximum size that the area can sustain. Management practices aimed at reaching this goal are discussed below.

The goose nest aerial survey should be modified to make it a more accurate measure of goose production. This survey should be flown over the entire refuge with ground searches conducted twice for success information on Big Island, Young's Island, Homestead Lake islands and Lake # 11 islands. Such ground truths could provide observability indices in addition to nest success data.

The following survey flight techniques are recommended to provide more year to year continuity: 1) use of a slow, tandem seat monoplane with 80-104 kph (50-65 mph) airspeed (i.e. supercub), 2) use of the same pilot and observer from year to year when possible, 3) conduct inventories on calm sunny days between 9-11 am or 2-5 pm, 4) take inventories in late April or early May

toward the end of the incubation period, but before the hatch has commenced 5) fly at an elevation of 60 m (200 ft) or less, 6) record geese as pairs, singles and groups, 7) calculate a correction index for observability from 3 years of ground and flight information.

Complete searches of marginal nesting habitat should be conducted at least once every 3 years to check success of habitat improvement projects and to document pioneering as it occurs.

Major nesting islands should be visited after ice out but before nest initiation each year to remove mammalian predators. Hanson and Eberhardt (1971) reported that islands with coyotes before nesting season had little or no nesting. Brock (1985) reported that in some years at MLNWR, coyotes on Big Island greatly reduced the nesting pair counts.

Nesting platforms properly distributed is one way of increasing nesting density (Rienecker 1971). In nesting habitats which were marginal because of water fluctuations as on Lake # 10, 10 to 15 artificial nesting structures could improve nest success.

Waterfowl Production Areas (WPAs) should be individually evaluated for goose nesting potential. In suitable areas, artificial nesting structures and/or islands should be constructed to encourage goose nesting.

Transplanting of young geese may speed this pioneering effort (Surrendi 1969).

Artificial nesting structures should be placed in such a way as to increase production for a long term. Single pole structures should be placed 3 m (10 ft) within emergent cover to provide protection from ice movement. The structure should be over water at least 1 m above the high water mark and placed to provide good visibility to the open water. Four pole structures are more durable for areas where ice is a problem.

Haybale structures have been successfully used at MLNWR in the past but the practice was discontinued in 1984. Those remaining are in need of replacement. Since geese readily nested on haybales, additional structures should be installed in areas of stable water levels to prevent flooding. Haybales should be tightly wrapped with snowfence or chicken wire to increase their lifespan. Areas that could benefit from additional haybales are Lake # 10, Lake Grade Flats, Lake # 12 including Katy's Lake, Gaffney Lake, Homestead Lake, and selected WPAs.

Construction of nesting islands in Lake # 10, Lake # 12, Katy's Lake, Homestead Lake and certain WPA's is recommended. Pennisulas should either be considered for cut-off or for erection of electric predator-excluding fences. One example is at Ferguson WPA where a pennisula