THE NESTING OF THE CANADA GOOSE AT DOG LAKE, MANITOBA

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THE purpose of this paper is to describe the nesting chronology, nest-site characteristics, density relationships and productivity of an isolated population of Canada Geese (*Branta canadensis interior*) in central Manitoba. Several studies of wild Canada Geese have dealt with the nesting period and have evaluated breeding success in the United States (Dow, 1943; Craighead and Craighead, 1949; Miller and Collins, 1953; Naylor, 1953; Naylor and Hunt, 1954; Geis, 1956; Steel *et al.*, 1957; and others); but, up to the present time, the nesting ecology of the Canada Goose has not been studied intensively in Canada.

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AREA AND METHODS

The Study Area.—During 1954 and 1955, I examined the ecological requirements and general behavior of this species at Dog Lake, Manitoba, from spring arrival to the completion of the nesting season. This lake, located in the west-central section of Manitoba's Interlake District, lies within the forest ecotone known as aspen parkland (Bird, 1930). It is over 125 square miles in area and is surrounded by gently rolling country which, prior to 1900, was almost entirely covered by either brûlée or dense aspen growth. Considerable portions of forest have now been leveled to provide farm land and pasture.

The shape of Dog Lake is roughly circular, but two prominent bays project, one to the north and another to the southeast. Maximum depth varied from seven to 10¾ feet during the study years, and was estimated to have been approximately five feet during the dry summer of 1953. Shoreline slope was very gentle both on the mainland and on the islands. In 1954, nine distinct islands were present; and, although rising water the following year covered the smallest island, at the same time a new one was created by the cutting off of a peninsula from the mainland. Indeed, water level changes have had a striking effect upon the animal life of these islands. In the early part of this century when water extended to what has been termed the "surveyed" lake bank (1900 shoreline delineation, Survey Branch map, Manitoba Dept. of Mines and Natural Resources, 1948), only two large wooded islands and a rock outcropping on another island protruded on this lake. According to the Otto family (pers. comm.), residents in the region since 1910, a ditch constructed in 1914 drained a great quantity of water from Dog Lake to nearby Lake Manitoba. Although Survey Branch records do not confirm this history, the lake level dropped to such an extent at that time that new, small islands became visible. It was apparently during the summer of the following year that Canada Geese were first heard calling in this region. The emergence of these flat islands and of vast reaches of former lake bed thus appears to have coincided with the start of breeding by Canada Geese at Dog Lake. Today this sort of island appears to be the preferred nesting area, whereas the former lake bed surrounding the lake was judged essential during the brooding period.

Methods.—I carried out my field work from March 22 to August 30, 1954, and from March 25 to September 20, 1955. About 10 days after the birds arrived in spring, a crew of three men assisted me in searching likely nesting areas which surround the lake. Nests were usually located by first finding the waiting gander. The team then narrowed its scope of searching in order to find the female and her nest. Undoubtedly some shoreline nests were overlooked because the pairs "sneaked" away from the site. Some pairs showed a proclivity for such behavior, but this mattered little on the islands where all ground could be covered thoroughly. As soon as the ice left the lake, this nest searching was extended to the islands. Trips to the nests were sometimes made as often as every other day. Such frequency seemed necessary in order to determine accurately the dates for the beginning of each nest and its hatching time.

Nesting Chronology

The Start of Nesting.—Geese arrived at Dog Lake on April 8 in 1954 and were estimated to have begun nesting about April 26. In the following year, they arrived on April 1 and evidently started nesting as early as April 9.

The start of the nesting season was arbitrarily designated as that estimated time at which the first egg was laid. I assumed that the date of laying of the first egg could be estimated if clutch size, the rate of laying, incubation period, and the hatching date were known. If the clutch was incomplete, the first-egg date was computed by dating back from the day the final egg was laid, allowing 1.5 days for the laying of each egg (Kossack, 1950). If

TABLE 1
ESTIMATED DATES FOR THE START OF NESTING

Location	Date	Year	Total Nests	Reference
California	February 24	1951	360	Naylor, 1953
California	March 15	1952	201	Miller and Collins, 1953
Manitoba	April 9	1955	44	This study
Manitoba	April 26	1954	60	This study

the clutch was complete, first-egg dates were reckoned by dating back from the hatching day (hatching dates were accurate to within one day). The estimated laying period plus an assumed average incubation period of 26 days (Kossack, 1950) was then set as the interim between the first egg and hatching.

The average date for first eggs in this two-year Manitoba study was 43 days later than the mean for the two studies in northeastern California (Table 1). According to Hopkins' "bioclimatic law" (Chapman, 1931:223), a difference of four days should result for every degree difference in latitude, and the expected difference in this case would be 40 days. However, in view of the small samples available for comparison, the degree of conformity to this rule should be regarded as merely indicative.

Length of Season.—In comparing length of nesting season as determined in various Canada Goose studies, I found two with a significant deviation from the mean of 64 days for all studies. The shortest period reported was 53 days in this study, and the longest, 83 days in California (Table 2).

The direct factors which serve importantly to lengthen the season are the destruction of early nests and late renesting. At Dog Lake, early nests are

TABLE 2
LENGTH OF THE NESTING SEASON

Location	Number of days	Total Nests	Year	References
Manitoba	53	44	1954	This study
California	60[1]	360	1951	Naylor, 1953
Manitoba	61	60	1955	This study
Illinois	61	24	1945	Kossack, 1950
Utah	61	84	1937	Williams and Marshall, 1937
California	65	249	1940	Dow, 1943
Illinois	69	28	1946	Kossack, 1950
California	83	201	1952	Miller and Collins, 1953

[1] Excluding two presumed renesting attempts, one of which involved infertile eggs and embryos dead in an early stage of development.

particularly vulnerable to predation by foxes (*Vulpes fulva*) and coyotes (*Canis latrans*) because at this time the ice still permits ready access from the mainland. Therefore, in theory, the sooner the ice breakup occurs after the start of nesting, the less probability that this sort of nest destruction will result. Also, as mentioned later, some early nests are destroyed by flows of ice moving overland. In both instances the pairs concerned were thought to have renested, for new nests were found very close to the old. Peter Ward (pers. comm.) finds that full-winged, color-banded geese on the Delta marshes, Manitoba, renest after the initial nest has been ruined.

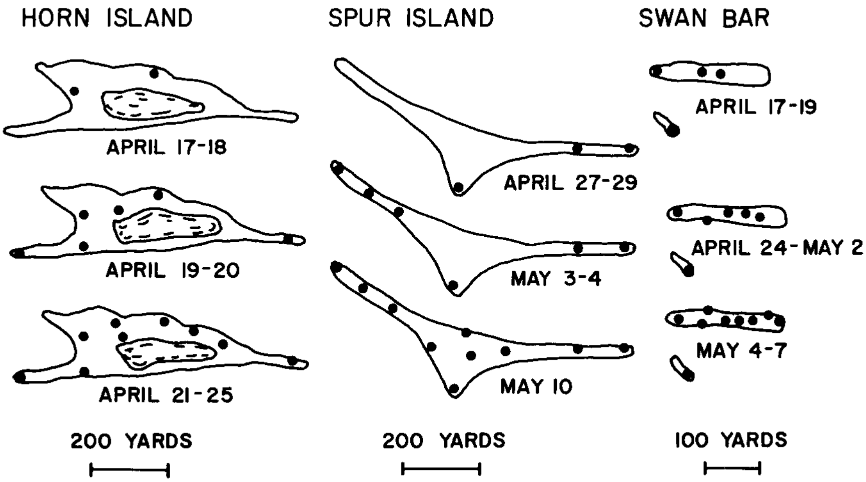

FIG. 1. The number and location of Canada Goose nests on certain islands of Dog Lake at various time intervals (Spur Island, 1954; Horn Island, 1955, and Swan Bar, 1955).

What mainly accounted for the shorter nesting season at Dog Lake in 1954 was the absence of late renesting. In other words, the peak hatch came around June 13 and the last nest hatched five days later (Figure 2). In California, however, Naylor (1953) found a new nest nine weeks after nesting had begun. Figure 2 suggests, nonetheless, that late renesting may occur rarely at 51° north latitude when first nesting begins relatively late.

In addition, my observations in this region suggest that a goose, already incubating for 10 days or more, may no longer be capable of renesting. Certainly this aspect of reproductive potential in geese deserves further study.

Characteristics of the Nesting Site

Nest Sites.—Except for a few nests, nesting at Dog Lake was restricted to the islands. In 1955 there was a marked shrinkage in island size because of rising water levels, and with it an increase in the number of nesting pairs.

TABLE 3

NUMBER OF NESTS PER ACRE ON ISLANDS

	Acreage 0.25–1 1954	0.25–1 1955	1–1.5 1954	1–1.5 1955	Above 10 1954	Above 10 1955
With forest						
Sugarbush Id.					0	0
Little Sugarbush Id.					2(0)[1]	4(1)
Gull Rock Id.					3(0)	4(0)
Without forest						
Long Bar	4(4)	3(0)				
Swan Bar		15(4)	5(5)			
Horn Id.			4(2)	11(8)		
Pelican Id.			7(5)	12(0)		
Rocky Bar	5(1)[2]					
Spur Id.			12(8)	5(2)		

[1] The number of nests successfully hatched is given in parentheses.
[2] Covered with water in 1955.

In spite of this, the number of nests on the mainland remained constant. When islands are present, a definite preference for them has been found (Geis, 1956; Naylor, 1953), provided they embody the essentials of a good breeding ground as outlined by Williams and Sooter (1940). Wild geese at Dog Lake showed a preference within island types: they preferred islands which supported no mass of tall tree growth. The three largest islands had dense stands of box elder (*Acer negundo*), elm (*Ulmus americana*) and aspen (*Populus tremuloides*), particularly at the edge of the old lake bank. These large islands were rimmed, in addition, by an extensive border of exposed former lake bed, from 50 to approximately 200 yards in width, an area which appeared to offer a suitable nesting situation for geese. Nevertheless, nests per unit area on forested islands were far fewer than on the treeless ones (Table 3). It is also possible that when geese are given a choice, small islands are preferred (Geis, 1956).

Visibility at the nest site has been stressed by many investigators (Williams and Marshall, 1937; Williams and Sooter, 1940; Dow, 1943; Kossack, 1950; Miller and Collins, 1953; Naylor, 1953; and Steel *et al.*, 1957). At Dog Lake, because of the uniformly flat terrain, this site character was difficult to evaluate. It can be stated, however, that no nests were built there in dense stands of vegetation and that none was found within 100 yards of forest cover.

In some regions, islands are utilized to a great degree even though visibility on them is limited. At Holkam Hall, Norfolk, England, Canada Geese (*B. c. canadensis*) nest in high concentration on islands covered with heavy

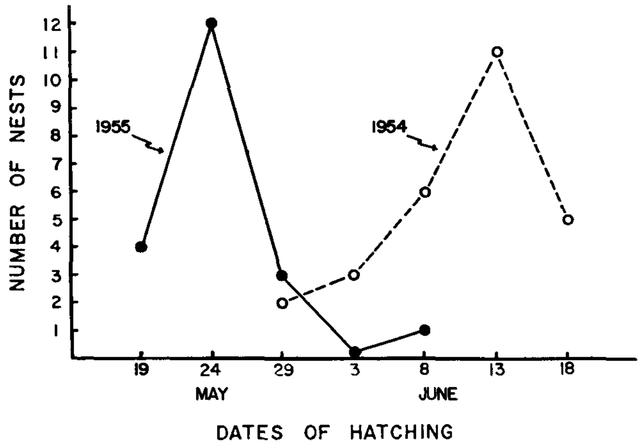

FIG. 2. The distribution and pattern of establishment of successful nests, Dog Lake. Data for 1954 and 1955 are combined. Sample size: 27 nests in 1954; 20 nests in 1955.

shrub and tree growth (Klopman, in prep.). On Flathead Lake, Montana, 25 per cent of all island nests were located in woods or under thick shrub cover (Geis, 1956). Possibly a hierarchy of preferences operates so that, in a given area, islands *per se* provide a stronger stimulus to nest than do other localities regardless of the visibility characteristics. Once the pair begins nest-site searching on an island, other stimuli, such as optimum visibility, nearness of other nesting pairs, etc., then function to determine the exact location of the nest. In marsh habitats a different arrangement undoubtedly exists, for in many instances marsh islands do not provide dry and substantial ground nor are they at times surrounded by enough water to prevent intrusion by predatory mammals.

Time of nest construction in relation to the available sites may prove important in determining the location of a particular nest. At Holkam Hall, England, for instance, only nests begun relatively late were found in the interior of islands where, in my judgment, visibility was poor.

At Dog Lake, 12 of 104 nests were located more than 40 yards from water. The farthest nest, in fact, was 300 yards from water. On the tree-covered islands, all 13 nests were found within 20 yards of open water. Birds on the smaller islands were prevented from nesting, in most cases, on the gravel midrib because of an absence there of nesting material. Sites to one side of the rib were naturally closer to water. In 1955, when island size was reduced, nests were of necessity nearer the water. In short, whereas nests on the large, forested islands demonstrated a "selection" for sites near the water, those on the smaller islands provided inconclusive evidence in this regard because all available nesting terrain was situated so near the water. Other workers, however, (Williams and Marshall, 1937; Williams and Sooter, 1940; and Miller and Collins, 1953) have shown more clearly a relationship between site location and proximity of water.

In most instances, nest sites near water offer better visibility for gander and incubating goose than do sites situated elsewhere. They also provide the young, particularly, with quick escape from mammalian predators, and afford immediate access to a food source (in some areas) and to bathing.

On six occasions, I moved nests of wild geese at Dog Lake from three to 12 feet from their original site and reconstructed them. In all but one case, the new nest site was accepted. In this single instance, the initial site was nearly surrounded by water. I shifted the nest and rebuilt it 12 feet away. Upon my return the following day, I found that all four eggs and nest material had been reassembled in the original scrape.

At Dog Lake no nest sites were re-used the second year. This may be explained in part by the annual alteration in island size and shape, and to some degree by the gross uniformity of the terrain utilized for nesting. Geis (1956) found many nest sites re-used in successive years.

Nesting Materials.—Goose nests are built with the material found no farther than a few feet from the scrape. As is the case with many early-nesting species, the goose's breeding habitat provides only last season's dead growth for nest material. The types of plant matter available were quite limited at this time on Dog Lake. Prairie grasses were most abundant, and *Phragmites* was second in availability. Nonetheless, only 15 per cent of the nests that I studied were constructed completely of grasses, whereas 55 per cent of them were made of dead *Phragmites* (Table 4). This decided preference may indicate that harder, more woody vegetation provided a stronger stimulus to the nesting goose than did the less ligneous grasses. At the same time, preference may be based on relative diameter rather than on structural quality. Nest material ranged in diameter from that of grass to that of dead poplar branches (2 to 7 mm.). Most of the substances utilized were approximately 5 mm. in diameter. Some nests were composed of two different materials and, if they were both about the same thickness, they were found mixed. If there was a considerable difference in diameter, the thinner plant growth, for example a grass, was normally used to line the cup.

Density Relationships

Nesting Density.—Breeding-pair density at Dog Lake was much higher than is usually reported for wild populations of the subspecies *B. c. interior* or *B. c. canadensis.* For instance, in 1955, Swan Bar (approximately one-sixth of an acre) was settled by at least 10 different pairs and was the site for 15 nests. Two nests on this island, estimated to have been started the same day, were but nine yards apart.

Although they do not give comparative figures, Hanson and Smith (1950) state repeatedly that within production centers around Hudson and James bays breeding pairs of these subspecies were scattered with seldom more than one pair to a particular lake. J. J. Tuck (pers. comm.) observed an average of only one pair to the square mile of muskeg in Newfoundland. On the basis of 10 years' experience in Michigan, Johnson (1947) recommended "no more than one nesting pair to each half acre or acre" in a management program.

TABLE 4
NESTING MATERIAL UTILIZED BY CANADA GEESE

Plant Species	No. Nests	Per cent
Reed (*Phragmites communis*)	47	55
Pigweed (*Chenopodium*)	13	15
Grasses (Gramineae)	12	14
Goldenrod (*Solidago* spp.)	5	6
Rush (*Juncus* spp.)	3	4
Wild rose (*Rosa* sp.)	2	2
Sweet clover (*Melilotus alba*)	1	1
Wild aster (*Chryopsis* sp.)	1	1
Cocklebur (*Xanthium canadense*)	1	1
Poplar seedling (*Populus tremuloides*)	1	1
Total		100

More nearly comparable to density conditions at Dog Lake are those cited for certain breeding concentrations of *B. c. moffitti* in western United States. For instance, Jensen and Nelson (1948) reported an island-nesting unit in southeastern Idaho with a density equivalent to 54 to 66 nests per acre. Naylor (1953) mentioned an island at Honey Lake, California, which supported 31 nests on one-half an acre. In the Blitzen Valley, Oregon, C. S. Williams (pers. comm.) found 11 nests on a single haystack.

In other breeding concentrations of this western subspecies, however, Jensen and Nelson (*op. cit.*) noted only one pair per acre, and 74 per cent of all nests located by Geis (1956) involved densities between 2.7 and 0.5 per acre. Breeding densities in certain parts of Oregon ranged from 9.7 to 6.0 pairs per square mile (Morse, 1952).

Williams (pers. comm.) and Hochbaum (pers. comm.) suggest that each breeding unit may evolve a pair distance that is specific to the colony. This view, however, precludes any year-to-year density variation within a colony. Such changes are known to have occurred at Dog Lake. It seems more reason-

TABLE 5
COMPARATIVE MEAN NEAREST-NEIGHBOR DISTANCES
TAKEN FROM MAPS AND EXPRESSED IN MAP-MILLIMETERS

Islands	1954	No. Nests	1955	No. Nests
Spur Island	7.9	10	7.0	5
Swan Bar	9.0	5	3.1	15
Horn Island	11.5	4	6.1	9
Pelican Island	8.7	7	8.0	12
Long Bar	14.0	4	11.6	3
Mean of all bars and islands	9.4		6.4	

able to assume that these differences, barring differences in breeding-population size, may be a function of habitat. That is, each habitat offers a different number and distribution of nesting niches.

The insular and annual density changes that occurred at Dog Lake were expressed at nearest-neighbor distances (Clark and Evans, 1954). These measurements, taken from nest locations plotted on maps, showed that the distance between nests on five selected islands was about 32 per cent less in 1955 than in 1954 (Table 5). Reasons for the increased density in 1955 were (1) the persistence of island-nesting, (2) the rising water levels that reduced the size of islands, and (3) an increase in the number of breeding pairs.

The Chronology of Nest Establishment and its Significance.—The time of building and the location of successive nests on an island are, in my opinion, important to a better understanding of how nest densities develop.

In the examples selected for study below are those islands that afforded the largest numbers of nests with complete nest histories. Some nests on the islands cited could not be included because of insufficient information concerning their start. The time of nest establishment was computed by a method mentioned earlier.

One difficulty with this method of analysis is that on a given island one cannot be sure of the length of time that nest sites were defended prior to building the nest. To assume that this was nearly constant from pair to pair or that it is of short duration (less than one week) may be presumptuous. If, for instance, all pairs that eventually nested on a given island are present and defending areas from the onset of nesting, then Figure 2 may only represent differences in timing of the nest-building urge.

However, from observations of these areas in early spring I found that, while some of the pairs that finally nest are present from the beginning of nesting, there is a definite succession in the formation of defended areas. This may, to some extent, be reflected in the differences in nest-building dates. Those birds that have not begun site-searching usually rest on the water and ice adjacent to the island and often continue feeding flights to the mainland. A week after their arrival, it is common to find many pairs collected around an island, and later to locate only a few nests there.

Figure 1 represents the number and location of nests on certain islands at various arbitrarily selected time intervals.

The time between the establishment of the first and last nests on an island varied from eight to 20 days. In the latter case, renesting was thought to have accounted for the three latest nests. Within a given year and with one exception, first nests were begun on each island on about the same date. In 1954 and 1955 nesting began six to seven days later on Pelican Island than on other islands. This island was the only regular nesting site in this region for large colonies of Ring-billed Gulls (*Larus delawarensis*) and White Pelicans (*Pelecanus erythrorhynchos*).

One might have assumed that the initial pairs to settle an island represent the older birds and thus the ones most apt to be the least tolerant of their neighbors. However, some of the earliest nesters had the lowest average nearest-neighbor distance.

Unlike colonial nesting in many other birds, the pattern of nesting among these geese does not expand outward from an initial focal point, i.e., in the geese the nearest-neighbor distance decreases as the number of nests increases. One might think that, if this were a process of constantly filling the spaces between, the first two or three nests established on an island would be the maximum possible distance apart. This was not the case. In the absence of any apparent site tradition (Hochbaum, 1956), these nest sites may be, for some reason, "better" than other sites available at the time.

In general, the nearest-neighbor distances on a given island were fairly constant and indicated an even spacing of nests over the available nesting ground. With a density arrangement and development of this kind, it is apparent that nests already present on an island greatly influence the location of those that follow. Thus site "selection" in this instance may be largely determined by social interactions among pairs.

Productivity

Nesting Success

Those nests located in which eggs hatched are termed the successful nests in this paper. Nest success was 61 per cent in 1954 and 35 per cent in 1955 (Table 6). Many factors operate to reduce the number of successful Canada Goose nests. At Dog Lake the most important of these were flooding, predation and desertion.

Flooding.—In 1954 eight nests were lost to flooding, and in 1955, 16 nests. In general, above-average precipitation was recorded at the nearest weather

TABLE 6
CAUSES OF NEST FAILURE IN PER CENT FOR SEVERAL GOOSE NESTING STUDIES

Location of area	Total nests	Per cent success	Predation	Flooding	Desertion	All others	Reference
Manitoba	44	61	21	18	0	0	This study, 1954
Manitoba	60	35	8	27	18	12	This study, 1955
Two years combined	104	46	13	23	11	7	
California	169	53	27	1	7	12	Dow, 1943
California	249	15	15	14	7	4	Dow, 1943
California	360	68	4	2	24	2	Naylor, 1953
California	115	72	17	0	11	0	Naylor and Hunt, 1954
California	201	79	3	5	11	2	Miller and Collins, 1953

station during the spring in both years studied (Table 7). Having no outlet today, Dog Lake accumulates considerable agricultural-drainage water in the spring and summer of wet years. Drainage runs from east to west, and three main ditches bring water from approximately 15 miles east of the lake. Farm land is drained either into the ditches or directly into the lake. In wet years Lake Manitoba may also overflow into Dog Lake. The gross accumulation of water from May, 1954, to May, 1955, amounted to approximately three and three-quarters feet.

Due to the increase in lake water after ice breakup, almost half of all nests both years were begun during periods of rising water. Exposed lake-bed perimeters of all islands were so remarkably flat that minute rises in water levels would inundate wide stretches of shore. After the ice breakup in 1955, islands were found drastically reduced in size as compared to the previous year. Some had shrunk to one-twentieth of their former area. One island was completely covered by water, and a mainland peninsula used by nesting geese had vanished. Another point of land was cut off at its base, and was

TABLE 7
PRECIPITATION (IN INCHES) IN THE SPRING OF 1954 AND 1955 AS COMPARED TO NORMAL PRECIPITATION

Manitoba Station	April	May	June
Gimli			
1954	1.67	1.94	5.08
1955	1.00	2.88	2.79
10-year mean	0.87	1.80	3.55
Dauphin			
1954	1.70	1.65	5.51
1955	2.22	1.99	4.63
30-year mean	0.73	1.70	2.70

hence termed an "island" in 1955. Cattle fences needed in the dry year of 1953 were found up to 500 yards out into the lake; and many of these were later covered from sight.

In 1954 only those nests within about 15 feet of water were vulnerable to flooding. In the following year, islands were generally so small that few sites were high and dry. Goose nests on the flat bars or islands at Dog Lake were spaced, not clumped in distribution, so that in 1955 most nests were dangerously close to the water.

TABLE 8
CAUSES OF NEST FAILURE, DOG LAKE, 1954–1955

Causes of Failure	Number of Nests 1954	1955	Total
Flooding	8	16	24
Desertion	0	11	11
Due to pelican nesting	0	6	
Due to gull nesting	0	1	
Unknown causes	0	4	
Observer disturbance	0	5[1]	5
Human exploitation	6	0	6
Fox predation	3	3	6
Herring Gull predation	0	2	2
Ice movements	0	2	2
Total	17	39	56

[1] Due to the use of blinds.

Storm winds provide the driving power to carry water to the nest. In 1954, four nests were lost on June 8, a day marked by rain and southwest winds of 35 miles per hour. Again on May 23, when three nests were destroyed by water, winds swept northeast at 30 miles per hour. The only remaining nest flooded that year was built one foot from water. Of the 16 nests inundated in 1955, six were torn apart as a result of a storm on May 5.

Predation.—Nest failures due to predation totaled 21 per cent of all nests in 1954 and eight per cent in 1955 (Table 8). The principal predators were foxes, gulls and man.

In both years, foxes became stranded on one of the forested islands after the ice melted. Once on an island, they seemed to have no difficulty in dstroying goose nests, as evidenced by the destruction of all but one nest in both years on Gull Rock Island. Except that broken egg shells were never found near the nests, the destroyed nests resembled those which Dow (1943) and Sooter (1946) described as destroyed by coyotes. The nest down always smelled strongly of fox urine, and usually a scat could be found near the nest.

Conclusive evidence showed that foxes at Dog Lake will swim from one wooded island to another. However, no fox sign was found after ice breakup on the treeless islands, so that these animals are possibly attracted only to islands with dense tree and shrub cover. If this is so, they would normally miss the bulk of the breeding geese.

In 1954 one nest, built before the lake ice broke, was disrupted by a fox.

Predation attributable to Herring Gulls (*Larus argentatus*) accounted for two of 104 nests and occurred only in 1955.

A quarter of a mile of water separates Horn Island from the Dog Creek Indian Reservation. While on a routine inspection trip in mid-May, 1954, I noticed that two seemingly undisturbed nests on this island contained no eggs. Another nest like this was discovered a few minutes later on nearby Little Sugarbush Island. After close scrutiny on the latter island, I located two campfires surrounded by the remains of many boiled duck eggs. Hand-made oars had been used as kindling. The goose eggs had apparently been taken elsewhere for eating or incubation under hens. A week later all eggs from three goose nests on Spur Island were missing. Both cases seem to have been the result of human predation.

Prior to the 1955 nesting season, both the Bureau of Indian Affairs, Winnipeg, and the local authorities were informed of these activities. That year no such disturbance was detected. It is quite possible, however, that egging has been and will continue to be a tradition for some people at Dog Lake.

It is quite significant that two well-known predators of waterfowl nests, the skunk (*Mephitis mephitis*) and the Common Crow (*Corvus brachyrhynchos*), occurred in considerable numbers in this region but did no damage during the study years. In fact in 1954, after the ice had left the lake, a skunk was stranded on one of the smaller islands. Judging from the scats at its bed, it had probably been there four days or more before I found it. Three goose nests were nearby and intact. Crows, although numerous on the mainland, were rarely seen on the islands during spring and summer.

Desertion.—This cause of nest failure was strangely absent in 1954, but rose to 18 per cent in 1955 (Table 8). It is significant that with a sharp increase in density during the second year, no desertion could be directly attributed to the crowding of nesting pairs of Canada Geese. Six goose nests were abandoned when White Pelicans colonized around them. Another incubating goose deserted apparently because a Herring Gull nested a few feet away. The cause of desertion of four nests was unknown.

Other causes of nest failure.—In 1955, when I attempted observation of nests from blinds, five nests were abandoned as a result. Two of these nests were in the first week of incubation, the others in the second week.

As the ice is breaking up, wave action sometimes pushes large sections of ice overland. In this manner, two nests were destroyed in 1955.

Nest Failure as Compared to Other Goose Studies

It can be seen from the two-year aggregate of the Dog Lake data (Table 6) that flooding accounted for more than one-half of all nest destruction. Roughly two-fifths of the total failure can be assigned to predation and desertion. Only 48, or 46 per cent of the 104 nests, were successful. This figure is much lower than the nesting success of four out of five of the other studies available for comparison.

In northeastern California, desertion and predation were the primary forces that lowered nesting success (Table 6). There most desertion was caused by intraspecific conflict in contrast to the interspecific strife which accounted for nearly all desertion at Dog Lake. Predation varied from over 50 per cent of the total nest failure in one study to but 15 per cent in another. No particular form of predation was common to all studies of this species. Flooding, a factor which proved so important at Dog Lake, contributed little to nest failure in most of the California studies. Very possibly, as Naylor (1953) found, nesting there begins after the maximum run-off period.

Hatching.—The hatching period extended from May 28 to June 17 in 1954, and from May 15 to June 8 in 1955. The actual difference in the length of the hatching period was only four days between years. However, the last four nests hatched over a 16-day period in 1955, whereas the final four nests hatched in three days the previous year. The distribution of successful (hatched) nests for the two years, when grouped in five-day intervals, appears somewhat similar (Figure 2). One might suspect, however, that the spacing of the final four nests in 1955 indicates that these may have been renests. But how can we be certain that some early renesting did not occur in 1954? From the distribution of hatched nests alone it is difficult, if not impossible, to differentiate between the span of valid first nestings and dispersed increment of renests.

Production.—Young per successful nest averaged 4.8 in 1954 and 5.5 in 1955. The total number of young believed to have left the nest was 129 in the first year and 115 in the second. Because of the vastness of the region and the shyness of the birds, only a few broods could be seen on a given day, so that no estimate of gosling mortality can be offered in the present paper. Mixing of broods was not apparent, although family groups did flock during the molt.

Mean clutch size for 40 nests in 1954 was 5.0 ± 2.5 eggs and in 1955 it was 5.2 ± 2.5 eggs for 53 nests. One nest of 11 eggs was excluded from the 1955 data because some of the eggs were found outside the nest, and it seemed doubtful that all eggs were the product of one nesting.

Hatchability of Canada Goose eggs in the wild usually approaches 90 per cent. At Dog Lake in 1954, 95 per cent of the eggs in successful nests hatched;

in 1955, 97 per cent hatched. Infertile eggs amounted to five, or four per cent, in 1954, and one, or one per cent, in 1955. Only one instance (one per cent) of embryonic mortality was identified both years. In each year one chick (one per cent each year) was found dead soon after hatching.

Summary

In 1954 and 1955, Canada Geese at Dog Lake, Manitoba, began nesting with all lake water frozen. Compared to two published studies for northeastern California, the start of nesting was about 43 days later, and the season normally shorter in this study. Of the 104 nests, 94 per cent were found on islands, most of which were small and without forest cover.

Breeding densities at Dog Lake exceeded those reported for wild populations of the subspecies, *Branta canadensis interior.* Maximum density was expressed as 10 different pairs or 15 nests on one-sixth of an acre. The minimum distance between active nests was nine yards. Area differences in density were thought to be the result of habitat peculiarities. Annual insular densities at Dog Lake showed a 32 per cent increase from 1954 to 1955. Earliest nests on islands were not the maximum possible distance apart, and nearest-neighbor distance decreased as the number of nests increased. Site "selection" appeared to be influenced by social interactions between pairs.

Nest success was 61 per cent in 1954 and 35 per cent in 1955. For the two-year aggregate, flooding accounted for more than 50 per cent of total nest failure, and predation and desertion together, about 40 per cent. The principal predators were foxes, gulls and man. Desertion was caused mainly by interspecific friction.

The hatching period extended from May 28 to June 17 in 1954, and from May 15 to June 8 in 1955. Mean clutch size was 5.0 ± 2.5 eggs in 1954, and 5.2 ± 2.5 eggs in 1955. Despite the increase in young per successful nest from 4.8 to 5.5, the number of young believed to have left the nest was 129 the first year and 115 the second.

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