BIOLOGY OF MANITOBA GIANT CANADA GEESE

(ANNUAL JOB PROGRESS REPORT - APRIL 1969)

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Investigator: Dennis G. Raveling

INTRODUCTION

The rediscovery of the existence of the giant Canada goose (Branta canadensis maxima) by Hanson (1965) increased the impetus for re-establishment of Canada geese in the prairies and parkland areas of midwestern Canada and the U.S. A nucleus of giant Canada geese existed in the Interlake region of southern Manitoba. This population has expanded in recent years concurrent with the development of a winter refuge area in Rochester, Minnesota (cf. Gulden and Johnson, 1968) and a successful nesting population in Manitoba at Marshy Point (near Oak Point) Goose Sanctuary. This breeding population was established by the Delta Waterfowl Research Station and private landowners.

This flock represents unique research opportunities with respect to studying the same marked individuals and families of geese on a year-around basis. They are for the most part readily observable and relatively tame both in summer and winter. Previous studies were able to document behavior of marked individuals in the summer (eg. Balham, 1954; Martin, 1964; Sherwood, 1966a) or winter (Raveling, 1967) but not all year.

Understanding the distribution, breeding success, mortality, and behavior of these geese has direct application to management measures that could be undertaken in the rest of the Interlake as well as offering an opportunity to study life history aspects that are at present poorly understood.

Specific objectives include the documentation of the variability in the social structure of the flock (eg. family integrity; % orphan immatures;

prevalence of brood-mixing; % yearlings in families, pairs, and as singles) as related to the distribution, mortality and breeding biology of these geese (eg. time and mechanism of family breakup; nesting success; pairing of age classes and dispersal of geese nesting for the first time). Results of the relationships of age structure and social classes hopefully will provide data needed for interpretation of counts of landing geese (Raveling, 1969a). Analysis of mortality as related to social status and behavior should enable insight to be gained on the evolutionary significance of the structure of goose populations that could not be gained from analysis of leg-band recoveries. Marked geese may also enable population structure and mortality calculations to be made which are independent of hunter reported recoveries, age ratios from shot birds, and trapping ratios, all of which are replete with biases and difficulties (cf. Hanson and Smith, 1950:168; Sherwood, 1966a; Raveling, 1966; Martinson and McCann, 1966). Specific information on mortality of this flock is necessary to evaluating measures necessary to insure expanding numbers of these geese; a major concern in the creation of the goose biologist's position in Manitoba.

METHODS

Approximately 500 geese are to be marked each summer with individually coded, colored neck-bands described by Sherwood, 1966b. Some geese are trapped during the flightless period, but late in the molt so that the neck-bands will stay on and not injure goslings. Other geese are trapped after they have reached the flying stage, but before migrants from other subspecies nesting further north have appeared. All geese are marked at the Marshy Point Goose Sanctuary on the SE shore of Lake Manitoba. In subsequent seasons some geese nesting at other Interlake locations may also be neck-banded to determine if they concentrate at Marshy Point before their final fall migration and to have

comparable treatments for mortality calculations of refuge vs. non-refuge raised geese.

Every goose captured was weighed. Measurements of culmen, toe, and tarsus were taken from a few specimens. Weight data are to be analyzed as an indicator of hatching date and related to subsequent survival of goslings. Each neck-band has an individual letter or number code. In 1968 yellow neck-bands with either red or black markings were used.

Once the geese are marked the procedure is simply to observe as many neck-bands as possible at Marshy Point, and determine their social and familial relationships based on a knowledge of behavior (see Raveling, 1967). Frequent trips are made to Rochester, Minnesota, to document presence and relationships of these geese during the winter. Letters soliciting information on observations of neck-banded geese in other locations were mailed to the U.S. Fish & Wildlife Service and various state conservation agencies in the mid-west.

Starting with this spring (1969) nest sites, clutch sizes and hatching success of marked and unmarked birds at Marshy Point will be recorded. This will be accomplished primarily by James Cooper (University of Massachusetts) as part of his Ph.D. study coordinated through Delta.

RESULTS AND DISCUSSION

BANDING

Neck-bands were placed on 446 giant Canadas captured between July 7 and September 19, 1968 (Table 1). Geese banded in July were flightless and captured by driving them into a pen. Frequent rains throughout August delayed cannon-net trapping. Geese were captured in August in a drop-gate, walk-in trap. Geese banded in September were captured with a cannon-net.

During July and August there were extremely few adult geese that were not leading or associated with young. Flightless geese trapped in July represent

those birds which probably nested very near the East Meadows Ranch buildings which stayed in a flock near these dwellings and would come to bait if no one were around. About 250 to 300 geese were near the buildings during the molt although they were wary and not easily approached. About 450 to 500 geese stayed out in the marsh near the beach line of Lake Manitoba during the molt. These geese were very wary. Within one to three weeks after the geese had reached flight stage, however, all the geese at East Meadows responded to artificial feeding near the buildings and were quite tame and easily trapped.

The population at Marshy Point increased from 700-800 during the flightless stage to 1,100 in mid-August to 2,000+ by September 6 (Raveling, 1969b). Geese nesting in scattered locations in other marshes near the Marshy Point apparently concentrated at the refuge after flight had been attained. On September 3 and thereafter the percentage of adult geese that were singles or pairs and definitely not associated with young increased noticeably. These geese represent the yearlings and failed nesters which probably had molted on the Thelon River in the Northwest Territories (Sterling and Dzubin, 1967). The non-nesting geese had left Marshy Point on June 10. The trapping results (Table 1) indicate this return of non-breeding geese even though cannon-netting can produce many biases in age-ratio data (Raveling, 1966).

In summary, neck-bands were placed on a large percentage of the Marshy Point giant Canada goose population (perhaps 25%+), except for 1968 yearlings. Several geese were marked which probably nested away from Marshy Point, but which concentrate there. It seems likely that these geese may have originally been produced at Marshy Point and are now dispersing to other locations to nest. Future observations of neck-banded geese nesting for the first time should establish the degree to which such dispersal may be occurring. The reason for this belief is the apparent high reproductive success of the geese

at Marshy Point, the low hunting mortality (see below), and high nesting density. Numbers of pairs in 1968 and previous years are unknown but the population has been increasing. Many geese are nesting in artificial nest sites (fish crate platforms raised 2-3 feet above the water on posts). In 1968, at least 66 of 102 available boxes were used (L. King, personal communication).

DISTRIBUTION

Migration

Previous banding at Marshy Point by Delta (see Hanson, 1965:83) and at Rochester, Minnesota (Gulden and Johnson, 1968) established that Rochester, Minnesota was a primary wintering area for Marshy Point geese and particularly for giant Canadas throughout the Interlake.

The first migrant giant Canadas arrived at Rochester about October 1. On October 5, I observed 6 neck-banded geese at Rochester among 1,600 geese present and examined. On October 16, Minnesota personnel reported 11 neck-bands and by mid-November there were many more.

The last geese to migrate from Manitoba did so on November 19. Observations at Rochester demonstrated that the early migrants contained few geese from Marshy Point. For two seasons now aerial surveys have suggested that the goose concentrations at Dog Lake and Hecla Island - Riverton left these areas in early October (see Raveling, 1968, 1969b). Although the numbers of geese increased at Marshy Point it seems that geese from these more northern Interlake areas make up the bulk of early migrants to Rochester.

Further support for the above conclusion is provided by the ratio of neck-bands observed at Marshy Point in the fall (Table 2). These data represent days when it appeared that the great majority of the geese at the refuge were concentrated near the buildings and thus offered a good opportunity to

record neck-bands. Noticeable drops in the numbers and ratios of neck-banded geese observable occurred late in the season, ie. the last week of October and later. Also notice that the ratio of August and September banded geese observed (Table 2) indicates that more of these birds, which probably contained many individuals that nested away from Marshy Point and the returning non-nesting geese, dispersed or migrated earlier than the Marshy Point nesting population (July bands).

Some autumn dispersal from Marshy Point to other Manitoba areas occurred. Two neck-bands were observed at Delta, four were observed 2 miles south of Warren (40 miles southeast of banding site), one each was shot at East Shoal Lake, Big Grass Marsh, and Harwill, Manitoba. These locations are, respectively, 30 miles southeast, 32 miles west-southwest, and 55 miles northeast of Marshy Point. A neck-banded goose was reported from Alf Hole Sanctuary, 122 miles southeast of Marshy Point, but there is some doubt as to the validity of this observation.

The different patterns of migration are of significance to hunting and recreational opportunity in Manitoba. The majority of migrant Canada geese pass over Manitoba without stopping in the autumn or they do not stay for long, (Raveling, 1969b). Giant Canadas which do not migrate until freeze-up are therefore available for longer periods of time and are the most important population in the Interlake (away from Shoal Lakes) with regard to harvest by hunters (Raveling, 1969b).

Why do certain segments of Interlake giant Canadas migrate early and others very late? Analysis of Minnesota bandings suggested a too-high mortality rate and demonstrated that most the kill occurred between Dog Lake and Riverton (Gulden and Johnson, 1968 and personal communications). Does hunting pressure and

harassment induce earlier migration? If so, why did September and even August banded geese from Marshy Point leave the refuge before the resident (July banded) geese even though there was abundant food and low kill of geese? This fact suggests there is a traditional "subflock" character to differential migration. Or, perhaps other giant Canada geese congregating at Marshy Point in the autumn are at a disadvantage in obtaining food supplied artificially, or otherwise, because of their wariness, lack of familiarity or experience, or dominance relations to geese on their natal area?

This latter suggestion is perhaps supported by the fact that most August banded geese were, I believe, residents of the outer marsh at the refuge which concentrated at the feeding sites near the buildings after flight was attained. These feeding sites might be considered the "home range" of the July banded geese. Perhaps associations of certain neck-band groups during winter will reveal further information on the subflock nature of geese as suggested in Raveling (1969c). This will be difficult, however, because of the small size of the Rochester winter refuge.

Winter

The distribution of neck-bands observed during winter is illustrated in Figure 1. Of the 446 neck-banded geese, 28 were known to be killed by hunters, one died of unknown causes at Marshy Point and one had a bad wing and was over-wintered at Marshy Point. Of the 416 remaining, the following distribution was observed:

274 (65.9%) - Rochester, Minnesota
95 (22.8%) - Kirwin, Kansas
11 (2.6%) - Missouri - (10 at Swan Lake NWR and 1 at Squaw Creek NWR)
1 (0.2%) - Rock County, Wisconsin
1 (0.2%) - Gambill Refuge, Texas
34 (8.2%) - Unaccounted for

Of the 446 birds in the original sample, 92.6% were accounted for in the

kill or at their winter quarters. The remaining 34 could easily be made up of geese which had lost their neck-bands or which had been shot and not reported by hunters (see mortality section).

Six (2.2%) of the 274 marked geese at Rochester had lost their neck-bands. Their identity was obtained by reading leg band numbers with a spotting scope of geese associating with neck-banded birds. This figure is obviously a minimum and thus one can expect at least 5 additional neck-bands were lost from the 171+ geese that were not at Rochester. Summer trapping will yield a more accurate estimate of the percentage of geese which lost neck-bands. Band returns may also not be complete at this writing.

The distribution of geese from Marshy Point to both Minnesota and Kansas has several implications. Banding at Rochester has demonstrated that the great majority of these geese are from the Interlake of Manitoba (Gulden and Johnson, 1968). Giant Canada geese banded at Delta, however, migrate through the Central Flyway with recoveries occurring in the Dakotas, Missouri, Nebraska, Kansas and Texas (see Hanson, 1965:84). The breeding population of geese at Marshy Point was started with a transplant from Delta. The history of what and how many geese were transplanted and what treatment was afforded these geese is yet somewhat vague but it appears that some geese at Marshy Point maintained the tradition of the Delta geese. Most, however, have formed a migratory pattern with the other Interlake geese which go to Rochester.

Supporting the suggestions above that many September banded geese represented birds congregating at Marshy Point from other Interlake locations and that these migrated earlier and predominantly to Minnesota are the proportions of neck-bands observed at different winter locations (Figure 1 and Table 3). A much higher proportion of September banded geese were observed at Rochester as compared to the combined July and August banded birds ($X^2 = 46.10$;

1 d.f.; $p < 0.001$).

Proportions of July and August banded geese in Kansas and the numbers of unaccounted for individuals are biased. This is because Kansas observers had difficulty in correctly identifying numbers on the July neck-bands because these numbers were scratching off. Because I had observed many of these neck-bands through the summer, I was able to distinguish individuals by number at Rochester that no one else could positively accomplish. Furthermore, I could approach the birds much more closely at Rochester than observers could in Kansas; thus numbers were easier to read. The problem existed mostly with July banded geese because after I discovered that some letters were sloughing off, all other bands were wrapped with a plastic covering over the numbers.

From this analysis, the result is that a high proportion of geese nesting and being raised at Marshy Point are migrating in the tradition of Delta geese from which many of them are progeny. Mortality rates between the Minnesota and Kansas segments will be of interest in comparing the effects of different kinds of sanctuary and management programs on the success of re-establishing populations of giant Canadas. It is of great significance that the 382 marked geese observed of the 416 available (91.8%) were all on refuges. This demonstrates once again the response of Canada geese to refuges and the importance of refuges which when properly managed can control kill to a refined degree.

Minnesota

The history and description of the Rochester refuge and populations is available in Gulden and Johnson (1968). The usual situation is a population decline in January of approximately 1/3 the peak population. This happened again in 1968-69. I estimated that 10,500 geese were present at Rochester in mid-December and 8,500 in early February. One-third fewer neck-bands were recorded in February than I had observed in November or December (90 neck-bands

gone). Fourteen of these marked geese were subsequently observed in Missouri (11 at the Mark Twain Unit of the Upper Mississippi National Wildlife Refuge and these same geese - all one family - were then seen at the Busch Refuge in Missouri near the Mark Twain Unit; 3 were observed at Mingo National Wildlife Refuge in southeast Missouri). It had earlier been suspected that Rochester geese go to the Busch area based on surveys of numbers but it was unproved because the move occurred after hunting and no band recoveries had been received (R. Jessen, personal communication).

Kansas

I have not visited Kirwin National Wildlife Refuge, but information was passed on to me by their staff. It is a 10,778 acre refuge with a 5,000 acre reservoir, 2,000 acres of cultivated lands and 3,778 acres of grassland. The autumn peak population of Canada geese is about 10,000, and about 7,000+ remain through the winter. About 15,000 are present at the peak during spring migration. The refuge has started its own local flock of giant Canadas originating primarily from the J. Clark Salyer NWR. I retrapped two of their banded giants at Marshy Point. Kill of geese in the area is believed to be small, ie. approximately 300-400.

Many neck-bands remained at Kirwin through the winter but some probably moved on. Observations further south were not reported.

Missouri

As reported above, the neck-banded geese observed on and close to the Mississippi River were birds which moved south after having been in Rochester, Minnesota for approximately 2 months. Ten others were observed at the Swan Lake NWR (see Vaught and Kirsch, 1966) where over 100,000 geese winter (Eastern Prairie Population). It is likely that some of the unaccounted for neck-bands

were at Swan Lake because it would be lucky indeed to record all neck-bands in so large a flock. Two neck-banded geese (in addition to those observed) were shot at Swan Lake. Giant Canadas are a regular occurrence in the harvest at this intensively managed and hunting area (personal observations).

The other Missouri record of a neck-band was at Squaw Creek NWR which winters about 5,000 Canada geese, many of them giants which are from western Manitoba (The Pas) (H. Burgess, personal communication).

Other Areas

One neck-banded goose was observed at the Gambill Goose Refuge in Lamar County, Texas. This refuge is not far from the Hagerman Refuge from which Sterling and Dzubin (1967) retrapped molting giants on the Thelon River, Northwest Territories, that had been originally banded in Texas.

One neck-banded goose was observed in Rock County, Wisconsin. This is the wintering location of about 3,000 giant Canadas which presumably originate mostly from southeast Manitoba (Raveling, 1969b).

MORTALITY

Observation of such a high percentage of available neck-bands offers unique opportunities to study total and hunting mortality rates, band reporting rates, and population structure.

Distribution of Kill and Reporting Rates

It is a well known phenomenon that interest and cooperation by hunters in reporting bands has lessened and this makes analysis of distribution and kill rates difficult or impossible, especially in the numerous instances where only small banded samples are possible to attain such as in this study of giant Canadas. Of 446 neck-banded geese, hunters reported only 14 but I have learned of 14 others which were killed and not reported. I learned of these because of the neck-bands and the greater interest on the part of the hunter in this type

of band but I am convinced that most of these 14 would not have been reported to the banding office in any case. Curiously, most of the unreported bands I know of are from the U.S. where I had no influence on reporting. I actively advertised and solicited in Manitoba.

The distribution of the known kill is presented in Table 4. Four of the 11 bands reported from Manitoba were sent in by Provincial Conservation Officers who had killed the geese or were with the successful hunter. In both cases, however, they were with private individuals who are known to be co-operative as evidenced by their display of previous band return cards. Of the seven killed in Manitoba but not reported, five were learned of through local gossip. In contacting these persons to learn the band numbers and whether or not the hunter knew the bird had a neck-band before he shot, the following came to light.

(A) No need to send band in because bird was banded in Washington so it must be an old one (it was an immature).

(B) Had killed many banded geese in last 5 years but was afraid refuge boundary would be extended around his property.

(C) Didn't know what to do with band but thought the Manager of East Meadows Ranch might be interested (3 cases).

The other two unreported Manitoba bands were accounted for as follows:

(A) Picked up on road block - hunter not a local so no information was given him and I told him if he wanted any information he would have to send in the band. This person was an obvious neophyte and in fact had been knowingly trespassing where he shot the bird.

(B) Hunter gave the neck-band to the local C.O. but he lost the leg-band and C.O. lost the neck-band!

The two unreported bands from Missouri I learned of at the winter Technical

Section meeting of the Mississippi Flyway Council (good reason for going!). In this particular outstanding case, the two geese were killed by Conservation Dept. personnel (not Vaught), one of whom was present at the meeting and informed me of this kill after I had been asked to give a resume of my work at the meeting. Subsequently, this person could find only one of the bands.

The one unreported kill from Minnesota was learned about in correspondence with a hunter who had reported a band and wrote the U.S. banding office for more information about the yellow collar. As it turned out, he had killed two out of the same flock but apparently as the band numbers were close together (11 numbers apart; X6 and X8 on the neck-band) he thought reporting one was sufficient.

The four unreported bands from Kansas were related via the Kirwin Refuge staff. They were told of the kill in casual, second-hand conversation and have been able to obtain only one leg-band number so far.

I detail these records only to once again demonstrate the profusion of complexities surrounding persons' attitudes and actions with regard to bird bands. We have all thought that novelties such as neck-bands created a higher reporting rate than just leg-bands. Indeed, if that is true and reflected in the 14 bands which were sent in, then these small samples give further testimony to the sad state of affairs. It is extremely unlikely that these 28 records represent the entire retrieved kill of neck-banded geese. Therefore, it can be concluded that reporting rate is lower than 50%. If it is as low as 25-33%, then an estimate of kill ranges from 42 to 56. It cannot be more because of the numbers of bands accounted for in winter (Table 5). Subsequent observations and trapping neck-banded geese and geese which lost their neck-bands and were unaccounted for during the winter 1968-69 should probably refine this estimate to a precise degree.

The effects of reporting variances obviously affect conclusions on the distribution of kill in this flock and with small samples. Although previous leg-banding of the geese at Marshy Point was accomplished by Delta, the various treatments of the birds (overwintered, transplanted, etc.), difficulties in the records, and small yearly samples prohibit many meaningful comparisons and conclusions. The only usable sample is 145 geese banded in 1962. There was only one direct recovery (from near Rochester). This again reflects the lack of band reporting by the persons adjacent to the Marshy Point refuge (12 of the 18 neck-banded geese killed in Manitoba were shot adjacent to the refuge, but only five of the 12 were reported and four of these 5 were killed by persons from Winnipeg and other locations). Not one recovery of Rochester banded geese has been reported from the Marshy Point vicinity, yet I retrapped nine birds banded at Rochester.

Of a total of 28 recoveries to date from the 1962 banding at Marshy Point, only 8 (28.6%) come from Manitoba (7 from localities other than the refuge vicinity); 6 were from Minnesota and 1 was from Kansas. Fifty percent (14) of the recoveries were scattered, but 17 recaptures were obtained at Rochester. Clearly, in this case, as the neck-bands demonstrated, reports of geese killed are very misleading as to the distribution of the flock and of mortality.

Neck-bands apparently do not lead to higher mortality because of focusing the attention of the hunter on these particular birds. Follow-up contact was made on the fate of 16 neck-banded geese killed by hunters. Thirteen of these were shot by hunters who did not know the goose was wearing a neck-band until they picked up the bird. The three geese killed in which the hunters knew of the neck-bands were all killed by Conservation Department officials. One of the birds actually landed in decoys and the other two were coming into decoys at close range and were singled out of a group of five. They killed four of the five so it did not make much difference.

Vulnerability of Age Classes

Because the identity of two of the unreported birds known dead needs to be verified, only 26 shot birds can be used for this calculation. Five of the 21 were adults so 3.86% were known to be shot (129 banded) or 3.40% if yearlings are included (147 total banding) which they should be as they are usually unidentified or unidentifiable in kill age ratios. The number of immatures killed was 21 out of 299 banded or 7.02%. Therefore, immatures were 2.06 times as vulnerable to the gun as adults $(\frac{7.02}{3.40})$.

The sample of known dead birds is very small. A more meaningful figure is probably that available from the age classes of neck-banded birds which were not accounted for, ie. 95 geese. This figure includes the 28 geese known to be dead and those unaccounted for because of lost neck-bands, not observed, death, and inability to discern band numbers of individuals in Kansas (the latter being the only possible source of error). These results reveal 16.28% of adults were missing, 5.56% of yearlings, and 24.41% of immatures. Therefore, immature vulnerability to disappearance (including natural death, hunter-kill, and crippling loss) was 1.63 times greater than the combined yearling and adult classes or 1.50 times greater than adults and 4.39 times more vulnerable than yearlings. Vastly increased yearling samples in subsequent years will refine these ratios. For the present, the most useful figure is probably the one that immatures were 1.63 times more vulnerable than all other age classes combined.

Minimum Mortality Rates

Thirty geese are known to be dead (28 shot, 1 died of natural causes, and 1 cripple overwintered which could not fly and would have died). Data presented reveal that the band reporting rate was in all probability lower than 50% but higher than 25%. A reasonable figure to use would seem to be 33.3% which is very close to what Martinson and McCann (1966) calculated as the over-

all reporting of goose bands. Thus the total mortality was 44 (42 shot, 1 died, 1 would have died). I consider this minimal as it does not account for any crippling loss except one bird, or any natural mortality except for one bird. Two neck-banded geese at Rochester appeared to have been wounded as they were limping badly.

Thus total mortality of 44 equals 9.9% (44 ÷ 446). The age structure of the mortality would be in the ratio of the known dead, ie. 6 adults: 23 immatures, or therefore 9 adults and 35 immatures total. Thus the adult mortality was 6.1% (9 ÷ 147) and the immature mortality was 11.7% (35 ÷ 299).

Maximum Mortality Rates

The maximum possible mortality can be calculated by assuming that all 29 geese unaccounted for (Table 5) are dead in addition to the 30 dead birds known of for a total of 59 or 13.2% (50 ÷ 446). This can be subdivided into age classes by using the figure of immatures being 1.63 times more vulnerable than adults obtained from unaccounted for individual neck-bands. Thus 62% of the 59 dead geese should be immatures or 37 which yields an immature mortality rate of 12.4% (37 ÷ 299). Adult mortality rate would therefore equal 15% (22 ÷ 147).

Discussion of Mortality Rates

The maximum figures would mean that every live neck-banded bird was observed. This indeed may have occurred in Minnesota and Kansas but it would be unexpected in larger refuges and allows for no geese to be in inaccessible locations.

In any case the range of variation between maximum and minimum possible mortality is very narrow (6.1 to 15% for adults - average 10.5%; 11.7 to 13.2% for immatures - average 12.5%). The minimum figures essentially account for just mortality caused by hunting. The maximum rate allows for additional

natural mortality above that suspected to be possible through hunting. The difference in these ranges is perhaps revealing of a significant aspect of goose mortality. The large bulk of the immature mortality is caused by the gun whereas it appears that about one-half plus of the adult mortality in this flock could be natural on a combination of natural and increased vulnerability to crippling.

Regardless of which rate is most accurate, the range is narrow and essentially irrefutable. It proves that this flock should be expanding at a significant rate (which it is see below).

Population Structure

Immatures were 2.06 times as vulnerable as adults to being shot and 1.63 times as vulnerable to death from all causes combined. This figure may be biased because of the small number of banded birds shot or it may eventually confirm the suggested higher vulnerability of adults to natural death and crippling. For the present calculation of population structure, both figures will be used.

I examined a sample of 60 giant Canada geese killed in the Interlake in 1968. The ratio was 35 adults (58.3%) and 25 immatures (41.7%) or 0.71:1 immature per adult. Therefore, the population was 0.44:1 immature per adult (0.71 ÷ 1.63 vulnerability factor) or 30.6% immature (0.44 ÷ 1.44); or 25.4% immature if the 2.06 vulnerability factor is used.

These results at first glance do not suggest as good a reproductive season as seemed evident last summer (I haven't had time to analyze family size and success ratios of neck-banded geese yet). However, yearling mortality is low and if immature mortality is very low, the yearling, non-breeding component of the population would be very large. This would depress relatively the percent immatures even though reproductive success may have been excellent.

Hypothetical Population - Since two figures of percent immatures are available I shall use the average of about 28% for this calculation. The population structure before and after hunting is presented in Table 6 obtained by using an adult mortality rate of 10.5% and an immature mortality rate of 12.5% (averages of the minimum and maximum rates).

Population Growth Potential - The pre-hunting season population structure reveals a final successful reproduction of 0.39 immatures per adult (which includes yearlings) (280 ÷ 720). If this figure represents an average then the 849 geese returning (or slightly fewer to account for late winter and early spring mortality) would raise 347 young. Thus the total population would approach 1,236 next autumn for a growth rate of 23.6%. A figure of 20% is probably more reasonable so as to account for some spring and summer mortality of adults.

APPLICATION TO ACTUAL POPULATIONS

Population Size - The peak population at Rochester was 10,500. Banding in Minnesota demonstrates that the great majority of these birds must be nesting in Manitoba, primarily the Interlake (Gulden & Johnson, 1968). However, all of the Marshy Point population obviously does not go to Minnesota. Of the neck-bands observed, 71.7% were in Minnesota. This suggests the total population of giants sampled by this banding may be as high as 14,600. I believe, however, that it is primarily, if not only, the Marshy Point population in the Interlake which splits in so great a degree. Thus, if 2,000 represents the Marshy Point population (and near vicinity) then something on the order of 700 plus geese are going to locations other than Rochester. Additional banding will clarify this. For the present it would seem that about 11,000 to 12,000 geese should be returning to Manitoba in the spring of 1969. With a 20% increment in the flock we could have about 14,000-15,000 geese next fall and Rochester should increase to 12,000-13,000. Growth of estimated peak numbers at Rochester since 1960 has been on the average of almost 13%

(Table 7). The difference between the calculated growth presented here and that observed at Rochester can be accounted for by many factors such as the high success of the nesting geese at Marshy Point; what was the distribution of bands of refuge vs. non-refuge geese; has there been a break of original flight to Rochester after severe winters forced geese into other locations; how accurate are the census figures; was 1968-69 a better than average reproductive season for these geese, and so on.

BEHAVIOR

Observations of neck-banded geese by myself at Marshy Point from July through November 19 and at Rochester, Minnesota, in November, December, February, and March resulted in thousands of records of specific individuals. Locations, apparent and definite family relationships and behavioral data were gathered for a high proportion of the neck-banded birds.

Individual histories of each bird must be extracted from field notes. I simply have not had time to even begin this enormously time-consuming task. When accomplished, distribution, mortality, reproductive success, migration pattern, etc., as per the objectives outlined in the original project proposal will be analyzed in relation to social status.

Some intriguing suggestions were revealed (impressions and memory only - needs verification from actual data).

(A) Geese that left Rochester in mid-winter were predominantly families. This would coincide nicely with LeFebvre's and Raveling's (1967) analysis of heat loss and the influence of immatures in determining winter distribution.

(B) Copulation began over one month before egg laying was to start but it seemed to be mostly among pairs without families. Families were intact in March. Does this influence which geese will nest first or be most successful?

(C) Families were basically intact all winter. However, greater variation

was encountered than in my previous study of families in winter (Raveling, 1967). Some families split apart repeatedly but always rejoined. Three causes seem apparent.

(1) Bonds may not be as strong in gang broods (ie. families larger than clutch size caused by absorption of one or more broods into a large unit by one pair) depending upon the age of the goslings at the time of gang brood formation.

(2) Some ganders are not aggressive. It seemed that families associated with these adult males were not closely knit. This may, however, still be a reflection of loose bonds in gang broods.

(3) My method of trapping in my previous study captured only highly aggressive ganders and their families. Thus I may not have sampled the variation present in the population with regard to family integrity and aggressiveness. This suggestion is also supported by a less rigid dominance pattern observed with this flock depending on family size than was recorded in my previous study.

(D) Some yearlings and single adults became paired during February. However, I still believe they knew each other from the summer breeding ground experience. (Several yearlings have formed pairs this April and have territories - I suspect these will break up and not be recognizable during winter 1969-70 but should come together in late winter 1970 and probably nest in their old territory as 2-year-olds - How's that for anticipating results! - More neck-bands and observations should clarify this whole subject).

(E) Traditional use of the same shoreline areas for roosting in winter was observed as previously reported (Raveling, 1969c).

(F) If anything, families were more closely knit in March than in December and February. It appears that severe cold weather (which prevailed at each of my winter trips) acted to inhibit close following of one another

within the goose families.

(G) Neck-bands did not bother the geese and no ice formed on the bands even though I observed geese at temperatures as low as -18°F. The Minnesota Game Warden reported no icing even when temperatures were -25°F.

(H) Flight patterns and inactivi ty during cold weather conformed to the pattern reported in LeFebvre and Raveling (1967).

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Table 1. Numbers of giant Canada geese neck-banded with yellow collars in 1968 at Marshy Point Goose Sanctuary

Date	Adult Male	Adult Female	Yearling Male	Yearling Female	Imm. Male	Imm. Female	Total
July (flightless geese)	9	9	0	0	44	33*	95
August	12	14	0	0	61	54*	141
September	48	37	8	10	65	42**	210
TOTALS	69	60	8	10	170	129*	446

* - Non significant deviation from 50:50; $X^2 = 2.92$ (July); $X^2 = 0.42$ (August); Total $X^2 = 3.12$

** - Significant deviation from 50:50; $X^2 = 4.94$ (0.05 level 1 d.f.)

Table 2. Proportion of neck-banded Canada geese observed at Marshy Point Goose Sanctuary during autumn, 1968.

Date(s)	% of July Bands	% of August Bands	% of September Bands	Total %
Sept. 27-30	51.6	48.9	45.9	48.0
Oct. 27	50.5	54.2	42.6	48.0
Nov. 11	31.6	22.5	17.2	22.0

All gone by November 19

Table 3. Proportion of neck-bands observed at different winter locations in relation to month of banding.

Date of banding and no. banded	No. killed* and subtracted from no. banded for calculation of %	% Observed at Rochester, Minnesota	% Observed at Kirwin, Kansas	% Observed Elsewhere	% Unaccounted for
July - 95	9	59.3	17.4**	1.2	22.1**
August - 141	8	50.4	23.3**	6.8	19.5**
September - 210	9	77.6	8.0	1.5	12.9

* - Not equal total kill known of because records not finally verified as yet.

** - % at Kirwin lower than actual and % unaccounted for higher than actual because not all numbers and letters were correctly identified because of scratching off and unfamiliarity of observers with band codes. 95 different neck-bands at Kirwin, but only 62 were correctly identified as to the coded individual.

Table 4. Distribution of the hunter-kill of neck-banded Canada geese reported and not reported to the banding office.

Location	Number Reported	No. known dead but not reported	Total
Manitoba	11 (78.6%)	7	18 (64.3%)
Minnesota	2 (14.3%)	1	3 (10.7%)
South Dakota	1 (7.1%)	0	1 (3.6%)
Kansas	0 (0%)	4	4 (14.3%)
Missouri	0 (0%)	2	2 (7.1%)
	14 (100%)		28 (100%)

Table 5. Fate of 446 neck-banded Canada geese during autumn and winter, 1968-69 and estimates of additional hunter-kill, crippling loss and natural mortality.

Fate			Number
Observed at Rochester, Minnesota			274
Observed at Kirwin, Kansas			95
Observed at other locations			13
Cripple - overwintered in Manitoba			1
Died - unknown causes - Manitoba			1
Shot and reported to Banding Office			14
Shot and not reported to Banding Office			14
Estimate of minimal neck-band loss in addition to that known of			5
	Total		417
Therefore, No. unaccounted for = 29			
Additional hunter-kill if reporting rate = 33% or 25%	14 or 28		
Crippling loss (15% of retrieved kill) if reporting rate is 33% or 25%	6 or 8* (can't be- equals more than can be dead)		
Additional natural mortality, neck-band loss, and unobserved birds if reporting rate = 33% or 25%	9	1	
	29	29	

Table 6. Hypothetical population structure derived from vulnerability and mortality data of neck-banded Canada geese.

	No. adults & Yearlings	Number Immatures	Population Size
Before hunting	720	280	1,000
Mid to late winter	644	245	889
Mortality rates	10.5%	12.5%	11.1%

Table 7. Growth of the estimated peak numbers of geese at Rochester, Minnesota.

Year	Population	Increase over last year
1961-62	4,500*	12.5%
1962-63	5,200*	15.6%
1963-64	6,000*	15.4%
1964-65	6,000*	0.0%
1965-66	7,400*	23.3%
1966-67	8,650*	16.9%
1967-68	9,500**	9.8%
1968-69	10,500***	9.5%
Average		12.9%
	Average (excluding 1964-65)	14.7%

* - From Gulden and Johnson (1968)
** - R. Jessen (personal communication)
*** - My count

⊠ - Banding Site - Marshy Point, Manitoba
274 - Rochester, Minnesota
95 - Kirwin, Kansas

Figure 1. Distribution of neck-banded Canada geese observed during winter 1968-69.