

## A STUDY OF MIGRATING ROSS GEESE IN WESTERN SASKATCHEWAN

By ALEX DZUBIN

The Ross Goose (*Chen rossii*) was, until recently, considered a very rare and endangered species throughout much of western North America. Its limited breeding ground in the Perry River district, Northwest Territories, Canada, its narrow but traditional migration lane from Lake Athabasca, through Alberta and along the Rockies to Montana, and its restricted wintering area in the Central Valley of California made it a unique species of particular concern to conservationists. Although a protected bird from 1931 to 1963, small numbers of Ross Geese were taken inadvertently by hunters, both on the Canadian prairies and on the Californian wintering grounds. The total population prior to 1955 was estimated at only 6,000 (Morse, 1963). Within the last decade the indicated status of this species has been much improved (Jahn *et al.*, 1963). Some apparent shifts in migration lanes have occurred, and a general increase in numbers has been noted east of the traditional migration route in Canada. The purpose of this paper is to document the transposition of one of the major migration pathways into western Saskatchewan, evaluate the birds' present status, and describe the recent reproductive success of the population.

## ACKNOWLEDGMENTS

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## METHODS

Many of the data reported here were gathered in the spring and autumn congregating area of the Ross Goose which straddles the border of the provinces of Alberta and Saskatchewan. That area lies between latitude 51° and 53° N and longitude 108° to 113° W (fig. 1). It is situated on the northern edge of the grassland, near the southern border of the park land (Coupland, 1950). Depressions associated with rough and rolling topography fill with runoff snow water, forming shallow lakes which have become saline. The lakes vary in size from a hundred acres to well over several square miles. In the autumn, migrating geese utilize the large, less saline lakes for resting purposes, and they fly out twice daily into the surrounding wheat and barley stubble fields to feed on waste grain. In spring, geese utilize the smaller runoff ponds for resting areas, as the larger and deeper lakes are invariably frozen until early May.

Irregular aerial and ground censuses of lakes, ponds, and water bodies had been carried out each April, September, and October since 1956, but they were intensified after 1960. All species of geese were recorded. Most surveys of the Ross Goose were conducted from the ground with the aid of a 40-power telescope necessary to separate accurately this small species from the larger Snow Goose (*Chen hyperborea*). The smaller size of the Ross Goose and its shorter neck and bill, higher-pitched call, pink coloration of immature mandibles, and general whiteness of young were the major criteria utilized in separating species. However, in autumn counts, prior to October 5, the number of Snow Geese in flocks of white geese rarely exceeded 10 per cent. That species was always a later migrant into the district than the Ross Goose and it also left for the south later. A vehicle driven to within 150 yards of loafing geese was utilized as a blind to obtain counts of brood sizes, family groups, and age ratios after methods proposed by Lynch and Singleton (1963). Data on brood sizes were taken before the opening of the hunting season and include only broods seen with two adults. Each year two or three apparent broods were recorded without the second adult. Age ratios are from trapped samples taken during the hunting season. Such ratios were tentatively utilized for yearly productivity comparisons, although there is now some question of the preciseness of sex and age ratios taken from cannon-netted geese (Nass, 1964).

White geese could also be enumerated as they left the lakes in small flocks during the morning or late afternoon feeding flights. A similar count could be obtained when geese returned from feeding, but invariably flocks were larger and more difficult to enumerate at that time. A percentage composition of Ross Geese obtained from the census of loafing birds could be applied to average figures obtained in the above counts to give a verifiable population of Ross Geese.

During September and October of 1956 to 1959, an intensive Mallard (*Anas platyrhynchos*) banding program was carried out in the district, especially on Teo Lake. Incidental to this project, species of geese were checked on various lakes. No large concentration of Ross Geese was recorded. The recent influx reported here is, therefore, not a matter of relatively recent ornithological activity in the area.

From 1961 to 1964, 2000 Ross Geese were banded on loafing areas with the aid of cannon-net traps. Small numbers of geese were also dyed red, green, and yellow after the method proposed by Kozlik, Miller, and Rienecker (1959). Neckbanding of immatures has continued each year, utilizing the jesse-knot plastic neckband of Craighead and Stockstad (1956).

In order to ascertain illegal kill and to obtain specimens, checks of hunters' bags were carried out with the help of the Kindersley and Kerrobert Detachments of the Royal Canadian Mounted Police and the Saskatchewan Department of Natural Resources Conservation Officers.

I have followed the nomenclature of the A.O.U. Check-list (1957). There have been some differences of opinion regarding the status of *Chen*, with an increasing number of waterfowl biologists including that genus in *Anser*, after Delacour (1954) and Scott (1957b).

#### AGING TECHNIQUE

A crude aging technique utilizing upper mandible color and general body condition was tried during each trapping season to determine whether young birds had been hatched late or early in the breeding season. I had noted that most young examined prior to September 20, had predominately black or gray bills with only a slight

TABLE 1

## COMPARISON OF PRIMARY AND SECONDARY BILL COLORS OF IMMATURE ROSS GEESSE

Date	Upper mandible color	Black	Black Gray	Black Pink	Pink Black	Gray Black	Gray	Gray Pink	Pink Gray	Pink	Total sample size	Approx. age in weeks
Sept. 20, 1963	Immature ♂ ♂	2	3	1	-	3	3	12	3	1	28	10-12
	Immature ♀ ♀	6	8	2	-	3	11	8	3	-	41	
	Total			28			34		7		69	(average hatch)
	Per cent of total			40.6			49.3		10.1			
Oct. 14, 1963	Immature ♂ ♂	-	1	5	-	1	-	9	17	11	44	13-15
	Immature ♀ ♀	-	-	5	1	-	-	12	12	6	36	
	Total			13			21		46		80	(average hatch)
	Per cent of total			16.3			26.2		57.5			
Oct. 10-17, 1962	Immature ♂ ♂	-	-	12	2	-	-	16	44	15	89	
	Immature ♀ ♀	2	-	30	7	-	-	19	28	13	99	12-15
	Total			53			35		100		188	(later hatch)
	Per cent of total			28.2			18.6		53.2			

wash of pink, whereas the bills of the same banded individuals caught three weeks later showed increased amounts of pink coloration, especially dorsally and forward from the nares and back of the bill nail. With increasing age the color of the bill progresses from a general black through a black-gray to a pearl-gray and further to various shades of pink. Ventrolaterally, bills remain gray or dark, and much of the color comparison (table 1) is based on the top half of the mandible. Young with all black or gray black bills are considered to have hatched two to three weeks later than birds with pink or pink-gray bills.

Blaauw (1905) mentions that the legs of aviary-hatched Ross Geese begin to turn pink at 10 weeks while the bill assumes its double coloration of a greenish base and pink tip. The first pink color in the bill of wild young appears slightly later than 10 weeks. Also, most bills have a black or gray base. However, I have examined few young of known age and in this 10-week age estimate, have used average hatching dates of July 5 to 15 which are within dates described by Ryder (1964).

Colors of bills were compared to the color chart of Palmer (1962) and assigned one primary color if over 80 per cent of the area of the upper mandible was of one color, and a primary and secondary color if one color made up approximately 60 per cent and the other the remainder. A few were assigned even a third color, for example, pink-gray-black, if the third color made up more than 10 per cent of the upper surface of the mandible. Only the first and second colors are given in table 1. Most grays vary in intensity, but a pale gray, pearly gray, and light gray are most common. Pinks are predominately a bright, dark pink, but again much variation exists.

If during the first two weeks of October more than 25 per cent of the immatures examined showed bills with some black coloration, the hatching season for that year was considered to be late. If more than 25 per cent of the immatures showed predominately pink bills by the last week of September and most of the remainder were shades of gray, it was considered to have been an early hatch (table 1). Males tend to show pinkness earlier than females, and a greater proportion of males are therefore assigned a pink or pink-gray classification for any one period.

I noted that bills of immature Snow Geese caught at the same time as immature Ross Geese are predominately black-gray in color, and young of the two species can

usually be separated successfully by this means in the hand and in the field from mid-September until the third week of October. In this interval most immature Ross Geese have some tinge of pink on their bills, whereas few young Snow Geese do.

#### MIGRATION

*Traditional migration pathway.*—Most of the migration records for Ross Geese in Canada are from the province of Alberta. A review of the literature on the migration of geese for Alberta and Saskatchewan indicates that the Ross Goose had not been recorded as a migrant in Saskatchewan by many authors (Cooke, 1906; Bent, 1925; Phillips and Lincoln, 1930; Soper, MS; Kortright, 1957; Morse, 1963). The American Ornithologists' Union Check-list (1957) showed the species as occurring regularly in migration at the western end of Lake Athabasca, Alberta, and occasionally in Ontario, Manitoba, and Alberta. Delacour (1954) described a distribution pattern similar to that of the Check-list, but his map (p. 135) of the nonbreeding range of the species encompassed much of Saskatchewan. Hanson, Queneau, and Scott (1956) discussed migration patterns, but did not refer to Alberta or Saskatchewan. However, Hellmayr and Conover (1948) describe the species as migrating through Alberta and also record two specimens from Tofield, Alberta (near Beaverhill Lake, southeast of Edmonton). Salt and Wilk (1958) mentioned that the species migrates through Alberta and the other prairie provinces each year. Much earlier, Farley (1932) considered this species a rare migrant in the Camrose area of Alberta prior to the date of his publication, while Taverner (1949) noted that it comes down through the more western prairies.

J. Dewey Soper, former Dominion Wildlife Officer, in an unpublished report gives the following complete description of the range of the Ross Goose in Alberta to 1951 (see fig. 1 for place names): "As visualized now, the northern Alberta flyway is a comparatively narrow one between Athabasca Delta and the southern prairies. The flight seems to be aimed at about Beaverhill Lake, but from somewhere in the central region the birds obviously fan out to cover a broader band of territory to the south. Thus the bulk of known occurrences in the Alberta prairie region fall within a strip approximately bounded on the west by Edmonton-Calgary longitudes and, on the east, by those passing through Hardisty, Coronation and Bow Island. This north-south band is about 100 miles wide and 330 miles long. . . . The way matters appear at present, it seems possible that the main line of migration passes through Beaverhill, Sullivan, Dowling, and McGregor lakes. Evidently Sullivan Lake is the best of these as a focal point of greatest regularity. The limited information at hand apparently points to a movement of secondary importance through a chain of areas embracing Ministik, Hay, Dried Meat, Red Deer, and Buffalo lakes. So far, nothing substantiates the presence of any marked numbers along this route, but merely widely-spaced records of small groups distributed erratically in time and space."

*Saskatchewan records to 1959.*—Reports of Ross Geese in Saskatchewan were uncommon prior to 1959. Snyder (1957:69), however, had described the main migration routes to and from the Arctic stating that it "is west of the mountains of the United States, crosses the mountains apparently in western Montana, and passes north and south through eastern Alberta and western Saskatchewan." No specimens from Saskatchewan were available to him. Similarly, Taverner (1940) described the main flight line as being through eastern Alberta and western Saskatchewan. He found Ross Geese irregular and somewhat uncommon and usually in sporadic flocks, sometimes of considerable size, but never in total commensurate with the known numbers.

Mitchell (1924) had stated earlier that the Ross Goose was rare in the south, one only having been taken one and one-half miles southwest of Caron, Saskatchewan, on October 9, 1905. Mr. Earl Godfrey, Curator of Ornithology, National Museum of Canada, has furnished the following information on previous records for western Saskatchewan: "Two specimens in the private collection of Hoyes Lloyd which were taken with one rifle shot from a flock estimated by Lloyd to contain some 250 Ross geese at Baliol, Saskatchewan (near Kerrobert), on September 29, 1922. The two specimens were collected by Lloyd's assistant at the time, Herman Battersby."

Data on five specimens in the Saskatchewan Museum of Natural History provided by Mr. Ralph Carson, Museum Assistant, are as follows: Imperial Beach, October 1, 1935, male; Outlook, October 28, 1953, juvenal male; Coleville, September 28, 1955, male; Regina, September 12, 1955 (6 miles from city; see Belcher, 1961); Saskatoon, October 5, 1956, male.

Nero (1963:43) states that one specimen collected by Francis Harper at the mouth of the Charlot River, Lake Athabasca Region, on June 26, 1914, had a "right radius previously broken but healed, bird able to fly."

Sight records and verified specimens are available from field diaries of members of the Canadian Wildlife Service who worked in the Kindersley area of Saskatchewan (51° N latitude, 100° W longitude) from 1953 to 1959. At least two to ten Ross Geese were examined yearly in hunters' bags in September and October. A number of these are in the collection of the Canadian Wildlife Service, University of Saskatchewan, Saskatoon. Sight records usually included small flocks of fewer than 20 birds which were mixed with flocks of Lesser Snow and White-fronted geese (*Anser albifrons*), either feeding in wheat and barley fields or resting on lakes. Some of these latter records formed the basis for including the Ross Goose in the Fourth Edition of the Field Check-list of Saskatchewan Birds (Houston, Bard, and Nero, 1959). Prior to 1959 the species was an uncommon autumnal migrant through western Saskatchewan and a rare bird in the remainder of the province.

*Saskatchewan records after 1960.*—In the year 1960, for the first time, spectacularly large numbers of Ross Geese occurred in the Kindersley district. Aerial surveys of the area conducted between September 16 and 18 of each year had shown the following percentage composition of white geese: 1957, 2.9 per cent of a total of 9000 geese; 1958, 1.1 per cent of 15,000; and 1959, 0.05 per cent of 11,000. However, in 1960 an aerial survey made on September 18 indicated an estimated population of white geese of 5240 in a total goose population of 45,066, or 11.6 per cent, an abnormally high percentage. A ground check conducted between September 18 and 21 on ten lakes indicated a total population of 400 Lesser Snow and 5600 Ross Geese, of which 5200 were on four lakes—Teo, Dewar, Buffalo Coulee, and Cutbank (fig. 1). During September and October, 1960, checks of hunters' bags in the field, at locker plants, and at check stations produced a total of 53 hand-identified records of Ross Geese taken at eight different lakes. A number of the specimens are in the National Museum of Canada at Ottawa, and two are at the Royal Ontario Museum at Toronto.

Robert Webb, game biologist, Alberta Fish and Wildlife Division, censused a number of lakes in central Alberta at the same time that the population peaked in Saskatchewan. He recorded over 4000 Ross Geese, mostly in the vicinity of Sullivan Lake (Webb, *in litt.*).

Following the initial peak of 5200 Ross Geese in 1960, a peak population of only 1200 was counted in 1961 (table 2). The number of young birds seen in 1961 was exceptionally low. In 1962 and 1963 another large influx of Ross Geese occurred, with

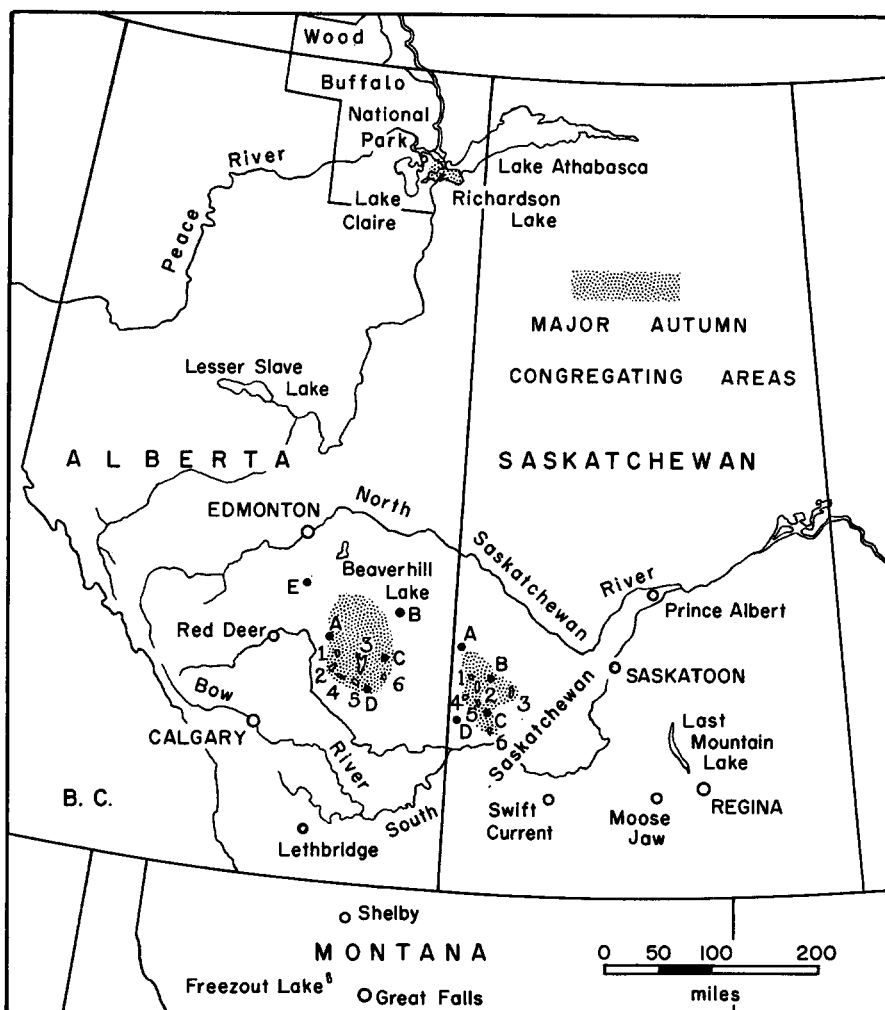


Fig. 1. Major congregating areas of Ross Geese in autumn in Alberta and Saskatchewan.

Localities.—ALBERTA, Lakes: 1 Shooting, 2 Gough, 3 Sullivan, 4 Farrell-Chain, 5 Dowling, 6 Kirkpatrick. Towns: A Stettler, B Hardisty, C Cornation, D Hanna, E Camrose. SASKATCHEWAN, Lakes: 1 Steele's, 2 Buffalo Coulee, 3 Opuntia, 4 Dewar, 5 Teo, 6 Cutbank. Towns: A Macklin, B Kerrobert, C Kindersley, D Alsask.

11,000 and 10,270 being recorded, respectively. A peak population of 21,700 was observed in 1964, mostly on Buffalo Coulee and Teo lakes. The species, therefore, has become a regular autumnal migrant through western Saskatchewan.

Other verified records of Ross Geese inadvertently killed by hunters away from the Kindersley district are as follows: 1 immature male, Goose Lake, south of Tessier, Saskatchewan, October 4, 1960; 3—2 adult? and 1 immature?, Last Mountain Lake, Imperial, Saskatchewan, September 28, 1960; 1 immature female, South Saskatchewan River, south of Lacadena, Saskatchewan, October 17, 1960.

TABLE 2  
 CHRONOLOGY OF MIGRATION AND PEAK POPULATION NUMBERS OF ROSS GEESE  
 IN CONGREGATING AREAS NEAR KINDERSLEY, SASKATCHEWAN, 1960-1963

Season	Date first Ross Goose seen	Dates* when local population increases	Peak** population numbers	Date of peak	Dates* when local population decreases	Date last Ross Goose recorded	Approximate dates when most lakes frozen
1960	Sept. 10	Sept. 14-16	5200	Sept. 18	Oct. 2-3 9-10	Oct. 30	Nov. 8-10
1961	Sept. 4	Sept. 4-5 10-11 17-18 29-30	1200	Oct. 3	Sept. 27-28 Oct. 7	Oct. 19	Oct. 20-22
1962	Sept. 5	Sept. 17-18 23-24 Oct. 6-7	11,000	Oct. 25-26	Sept. 28-29 Oct. 28-29 Nov. 7-8	Nov. 13	Nov. 12-Dec. 6
1963	Sept. 12	Sept. 11-12 15-16 18-19 27-28	10,270	Sept. 28	Sept. 23-24 Oct. 3-4 Oct. 16-18	Nov. 9	Nov. 10-17
1964	Sept. 10	Sept. 9-10 13-14 17-18 22-23 25-26	21,700	Oct. 1	Oct. 3-4 16-17 20-21 26-27 Nov. 10-11	Nov. 14	Nov. 11-20

\* Possible migration dates into and out of district.

\*\* On Teo, Dewar, Cutbank, and Buffalo Coulee lakes only. (Dewar Lake was dry in 1961 and 1964, and also after October 5, 1962.) Other lakes rarely held more than 100 Ross Geese.

Chopping (1961) records 24 Ross Geese on Last Mountain Lake, 9 miles west of Hatfield, Saskatchewan, on September 13, 1961. Ledingham (*in* Chopping, *loc. cit.*) mentions two other records of Ross Geese, identified by F. W. Lahrman of the Provincial Museum of Natural History: one on Wascana Lake from September 29 to October 11, and three on Buck Lake, 20 miles south of Regina on October 8.

*Staging areas in central Alberta.*—The major autumnal congregation areas in Alberta for the Ross Goose for the last decade are centered on a series of shallow lakes between the towns of Camrose, Hardisty, Coronation, Hanna, and Stettler (fig. 1). The main area lies between the Red Deer and North Saskatchewan rivers and is some 100 miles by 75 miles in extent. Although small flocks of Ross Geese have been known to utilize infrequently a large number of the small lakes and sloughs in the district, a few lakes are used consistently in the autumn. Sullivan Lake, as well as the associated small sloughs and dugouts within five miles of the main lake, is by far the most important staging area. Other major lakes used by migrating Ross Geese in autumn include Dowling, Farrell, Chain, Lanes, Spiers, Shooting, and Kirkpatrick. Small flocks are regularly found on Beaverhill Lake, southeast of Edmonton, both in spring and autumn (Salt and Wilk, 1958). Farley (1936) examined two Ross Geese which were shot on the shoreline of Bittern Lake, west of Camrose, Alberta, on October 17, 1935. During the past three years small flocks of Ross Geese have been censused on artificial dams and impoundments, beyond the confines of natural lakes. The total number of water areas on which the species has been recorded has increased. Yet the location of the major staging area in Alberta has not changed materially since Soper (MS) described it earlier.

Spring flocks of Ross Geese are much smaller and more scattered than autumn groupings. Some use is made of the flooded grain stubble lands. However, the species has been recorded from most of the aforementioned lakes from April 18 to April 29, 1963 (Sugden, *in litt.*). Ross Geese have been noted in central Alberta as late as May 17. Randall (1946) described the Ross Goose as not rare in spring, but he stated that it is a later migrant than the Snow Goose in the Brooks area, south of the Red Deer River. The species was rarely seen during autumn migration.

To the south of Alberta the species is recorded in the Great Falls area of Montana in late April and early May (D. Witt, *in litt.*; United States Fish and Wildlife Service, 1957). An early report by R. S. Williams (1886) describes the sighting of several thousand Ross Geese on a bar in the Missouri River at Great Falls on April 17, 1885. They remained in the vicinity until April 26.

*Staging areas in Saskatchewan.*—The major autumn congregating area in Saskatchewan is more restricted in extent than that in Alberta, being some 50 by 50 miles. It lies between the towns of Macklin on the north and Kerrobert and Kindersley on the south and extends westward to Alsask on the Alberta border (fig. 1). The two districts in each province are separated by an intervening area along the border which contains two lakes, Grassy Island and Sounding, which do not attract Ross Geese. In Saskatchewan, the town of Kindersley lies at the southeastern edge of the area over which Ross Geese have spread. Dewar, Buffalo Coulee, and Teo lakes, all within 10 miles of each other, have been the major water bodies used as resting areas by the geese over the five-year period. The two latter lakes are by far the most heavily utilized, as they lie in pasture-game preserves and are protected from disturbance by hunters. Buffalo Coulee regularly has double the number of Ross Geese found on Teo Lake. Small numbers of Ross Geese have also been observed for varying periods at the following: Opuntia Lake, 40 miles east of Kerrobert; Steele's Lake, 15 miles west of Kerrobert; Cutbank Lake, 14 miles south of Kindersley; and Eyre Lake, 6 miles southeast of Alsask. The first mentioned lake is a Migratory Bird Sanctuary whereas the last three lakes are provincially protected areas. However, at no time have populations of Ross Geese exceeded 400 individuals on those water bodies. In 1963, heavy summer rains filled many of the depressions to the north of the Kindersley area and small flocks of up to 300 Ross Geese were found in lakes east of Macklin and north of Kerrobert in the Wilkie-Unity district. A similar change in habitat conditions in Alberta resulted in more small flocks of Ross Geese being reported north and east of Coronation.

By October 1, 1964, heavy fall rains temporarily filled many previously dry depressions in central Saskatchewan. Between Kerrobert and Macklin, approximately 3000 Ross Geese were found on five small lakes: Shallow, Heartshill, Cactus, Walz, and Denzil. Another 4500 Ross Geese were recorded north and east of Kerrobert on Ear, Muddy, End, and Grassy lakes. A further 1700 Ross Geese were utilizing three small saline sloughs to the north and east of Alsask. Generally, there has been an ever-increasing number of mid-Saskatchewan lakes utilized by Ross Geese. The species was recorded from eight lakes in 1960 and from nearly twenty lakes in 1964.

In 1963 and 1964, temporary puddles, 10 to 150 acres in size, containing mats of spikerush (*Eleocharis* sp.) and sedges (*Carex* spp.), were used heavily by small flocks of Ross Geese for feeding and resting areas, especially by birds that had just arrived from the north. Subsequent activity by hunters forced flocks to move onto larger lakes located in game preserves. From here the geese flew twice daily into the surrounding fields to feed on the waste upland grains, chiefly wheat and barley.



Small flocks of Ross Geese have been reported in the Kindersley district in spring. Sixteen Ross Geese were observed on Teo Lake on May 9, 1964, and another 25 on Buffalo Coulee on the same date. A lack of extensive field activity in the district in spring precludes any discussion of the spring status and movements of the species through Saskatchewan. The Ross Goose appears to be an uncommon migrant, utilizing the more western route in Alberta for its return flight northward.

Soper (1957) noted large migrations of Ross Geese through the Slave River delta, Northwest Territories, in late May and early June, while Höhn and Robinson (1951) collected a male on May 22, 1949, in the same area. Kozlik, Miller, and Rienecker (1959) reported a sighting of eight dyed Ross Geese at Hay River near Great Slave Lake on June 7, 1955. Ryder (1964) and Aleksiuik (1964) first observed the species on the breeding grounds at Perry River, Northwest Territories, on June 5 and 6, 1963. Most spring migrants therefore move northward through Alberta and to the southern edge of the Northwest Territories during the month of May. The little information that is available about the flight northeastward across the tundra to the breeding grounds is summarized by Clarke (1940).

*Autumn migration dates.*—In 1960, Barry (*in litt.*) observed flocks of several hundred Ross Geese in at least three areas of the Perry River lowlands as early as August 16. However, all arctic-breeding geese appeared to have an exceptionally early nesting year. A flock of Ross Geese was reported on September 6, 1949, in the Peace-Athabasca delta, but few flocks reach the area before September 10 to 15 (Soper, 1952). In the Slave River delta, Ross Geese migrated through the last two or three weeks of September but returned northward roughly through late May and early June (Soper, 1957). Cooke (1906) reports returning flocks of Ross Geese at Great Slave Lake, Northwest Territories, as early as September 1 in 1893. However, for the same area Soper (1957) recorded that the period of fall migration of these geese was during the last two or three weeks of September. The Ross Goose was reported to be the last of the geese to arrive in spring, but it was among the first to return in autumn at Fort Chipewyan, Northwest Territories (MacFarlane, 1891).

A few migrant Ross Geese reach central Alberta by the second and third weeks of September, but the principle migration period is early October (Soper, MS). Personal communications from various biologists and conservation officers of the Alberta Department of Lands and Forests and Canadian Wildlife Service indicate infrequent observations of small flocks of Ross Geese as early as the first week of September, but the major movement through is during the third week of the month.

Prior to the shift of part of the population of Ross Geese eastward in 1960, the earliest record for western Saskatchewan I made was of a lone bird on September 1, 1959. The most recent records of first arrivals are between September 4 and 12 (table 2). Major influxes of geese generally occurred between September 15 and 20. While visual observations of major departures southward are rare, population numbers generally decrease after the first week of October. In warm, open autumns, for example, the autumn of 1962, large flocks of geese remained until late October (table 2). Generally, only a few small flocks of 20 to 200 birds are found on two or three unfrozen lakes after October 15. As far as can be ascertained the chronology of autumn migration in central Alberta and Saskatchewan is the same; Ross Geese arrive during mid-September and most leave by mid-October.

Ross Geese have been reported as early as September 1, 1917, in Montana (Saunders, 1921), but Cooke (1906) gives October 15 as the average arrival date at Columbia Falls and October 28 as the latest arrival date. D. Witt (*in litt.*) reports

that the most important staging area in Montana is in the vicinity of Freezeout Lake near Great Falls. Here, the species appears about the first week of October, but it reaches a peak in numbers during the last week of the month and first week of November, about the same time as the Snow Geese. In 1963, small flocks of Ross Geese remained as late as November 20. White geese, which include Ross Geese, are also found on Tiber Reservoir, Bynum Reservoir, Alkali Lake, and Lake Francis during the months of October and November until freeze-up.

After crossing the continental divide Ross Geese arrive in California as early as October 6 (Grinnell, Bryant, and Storer, 1918). Marshall (1957:130) gives a concise resume of the chronology of migration and wintering areas utilized: "This goose appears in the Klamath Basin of northeastern California in mid-October, and a month later begins a gradual southward movement of about 200 miles into the Sacramento Valley. By mid-December, most of the Ross goose population moves another 200 miles farther south into a grassland area of the northern San Joaquin Valley, where they remain until February and March before returning north. In the Klamath Basin, Ross geese associate closely with snow geese, both as individuals and in flocks. In the San Joaquin Valley this species becomes somewhat detached from flocks of snow geese, so that censusing can be reasonably accurate. An aerial survey taken in February of 1957 disclosed about 8,000 Ross' geese. Utilizing aerial photographs, it is felt the survey brought reliable results. In November of 1955, over 5,000 Ross' geese were counted from the ground in one flock in the Sacramento Valley." Marshall (*in litt.*) noted that Ross Geese associate mainly with Cackling Geese (*Branta canadensis minima*) in the San Joaquin and southern Sacramento valleys and feed primarily on green feed, whereas the Snow and White-fronted geese frequent rice fields and other cereal croplands. Frank Kozlik (*in litt.*) stated that: "Usually Ross' geese arrive at Tule Lake about October 15-20 and normally they will stay there until November 15. About that time bad weather occurs and the birds depart for the wintering grounds of the Central Valley. Naturally, these dates vary with weather conditions. In 1955, the year that we color marked Ross', the birds arrived late and they remained at Tule Lake into December. In 1958 the birds arrived early and by November 1 most of the birds had departed from Tule Lake. This last fall (1962) the migration coincided with your information. . . . The geese arrived at Tule Lake about November 10 and there were very few birds present. It seems that most of the Ross' bypassed Tule Lake and came directly to the wintering grounds."

Based on numerous observations of dyed birds, the extent of the wintering grounds and the spring migration route in California and Oregon have been clearly delineated by Kozlik, Miller, and Rienecker (1959). On spring migration Ross Geese utilize flooded hay meadows and shallow lakes in the Harney Valley, located south of Burns in southeast Oregon. They are also found in the Pitt River area of northeastern California during their migration between the Sacramento Valley and the Klamath Basin (Marshall, *in litt.*).

*Distribution and banding.*—A number of records of Ross Geese in the Mississippi Valley, one as early as 1910, have been reported by Smart (1960) from Illinois south to Louisiana and Texas. Rusch (1961) reported one specimen from Wisconsin, and Moyle (1964) records a sight record for Minnesota in 1962. Niles (1963) further described an immature female shot by a hunter in the Rio Grande Valley of New Mexico in December, 1956, while Behle, Bushman, and White (1963) described one specimen and several sight records for Utah in 1961. The apparent increase of records over the midcontinent also parallels a general widening of the known Arctic

breeding range (Ryder, 1964; Barry, 1964). MacInnes and Cooch (1963) have made the most recent summary of other records of Ross Geese from South Dakota, Oklahoma, and Texas, all seen by MacInnes during the autumn of 1961. They further speculate that such eastern records probably involve small breeding colonies on Southampton Island, Northwest Territories, and possibly the Koukdjuak River area of western Baffin Island. In view of the fact that in Saskatchewan, Ross Geese regularly mix with flocks of White-fronted Geese, which in turn migrate through both the Central and Mississippi flyways, some of the eastern records certainly could have originated from the Perry River population migrating through Saskatchewan. A small number of recoveries of the Ross Geese banded at Kindersley are from Texas, and one from Nebraska, east of the continental divide, lending credence to this belief. Two others are from the intermountain region, one in Nevada and another in Arizona.

A single recovery at Regina, Saskatchewan, 200 miles southeast of the banding site (Wade and Wade, 1963) supports the view that some Ross Geese do move south-eastward. On the other hand, six red-colored Ross Geese dyed at Kindersley were reported by Mr. Hugo Nelson at Benton Lake Refuge near Great Falls, Montana, indicating a flight south-southwestward from the Kindersley district to the traditional congregating area northwest of Great Falls, Montana.

Although data on recovery of banded Ross Geese are incomplete, most of the reports are from Saskatchewan, California, Alberta, and Montana, with a few from México. Apparently there is a free interchange between Ross Geese migrating through Saskatchewan and Alberta. Ross Geese banded in Saskatchewan in 1961 and 1962 have been recovered or seen in central Alberta during subsequent years, especially during the autumn. A purple neckbanded Ross Goose banded at Kindersley in the autumn of 1962 was seen April 22, 1963, at Sullivan Lake, Alberta (Sugden, *in litt.*).

At Kindersley, I also have numerous sightings and six hand identifications of neckbanded Ross Geese by C. MacInnes at the mouth of the Perry River in 1961, and five hand-verified sightings of Ross Geese neckbanded by J. Ryder at the same place in 1963. Five Ross Geese previously banded at Perry River were captured by banding crews at Kindersley in 1964. Four individuals with blue neckbands were also recorded. All these sightings and recoveries suggest strongly that both subpopulations of Ross Geese migrating through Alberta and Saskatchewan originate in the Perry River district, Northwest Territories.

I predict that sightings, reports, and recoveries of Ross Geese through most states of the Central and Mississippi flyway will become more numerous over the next several years. The increased numbers, which have shifted eastward, now mix with populations of White-fronted and Canada geese (*B. c. parvipes*). These groups continue southward along flyways east of the continental divide. It is almost certain that more wandering Ross Geese will be reported east of the traditional migration route.

#### HABITAT CHANGES

A number of factors could be weighed in considering the eastward shift of a portion of the population of Ross Geese. Since changes in weather and habitat are the most apparent and affect all species of waterfowl, they are considered here. An investigation of conditions in the two major autumn staging areas prior to and after the first influx of Ross Geese in 1960 revealed some major modifications, especially in habitat conditions. In the north, flooding had inundated feeding marshes, while in the southern prairies continuing drought had dried or altered lakes formerly used as resting areas.

TABLE 3  
WATER ELEVATIONS, IN FEET, OF LAKE ATHABASCA AT FORT CHIPEWYAN, NORTHWEST TERRITORIES\*

Year	Instantaneous lake elevations				Elevations Sept. 15	Sept. 15 Elevation from 694 feet	Elevations Sept. 30
	May minimum	Date	Summer maximum	Date			
1959**	689.99	May 6	695.41	July 15	693.30	-0.70	694.00
1960	691.65	11	699.74	14	696.39	+2.39	696.85
1961	(no May readings)		697.33	June 27	694.32	+0.32	693.37
1962	693.46	May 17	699.81	July 18	697.81	+3.81	696.97
1963	693.78	17	698.54	8	695.64	+1.64	694.65
1964	691.46	3	699.73	August 25	697.91	+3.91	697.32

\* Water Resources Branch, Department of Northern Affairs and National Resources.

\*\* Calculated from elevations taken at Crackingstone Point.

*Northern Alberta and Northwest Territories.*—The Peace-Athabasca delta region is one of the three most important stopping places for Ross Geese in Canada. Favored lakes in this region include the southern part of the Lake Mamawi, Galoot Lake, Richardson Lake, Limon Lake and Frezie Lake (Soper, 1951). Apparently all species of geese utilize the extensive mud flats associated with the delta as resting places and feed in the surrounding marshy lowlands (Novakowski, personal communication). Geese also utilize certain exposed points for gravel. Silt discharged into the delta by the rivers has formed a vast lowland, which varies in height from a few inches to a few feet above normal lake levels (Soper, *loc. cit.*). Droughts, such as occurred in 1945, expose miles of mud flats, while occasional spring flooding in May and June has thwarted nesting by ducks. A rise in water levels of two to three feet can cover hundreds of acres of marsh area. Mr. E. D. Fowler (personal communication) of the Water Resources Branch of the Department of Northern Affairs and National Resources, commented that: "Flooding in the delta area of the Athabasca and Peace rivers complex at the west end of Athabasca Lake is a direct result of high Athabasca Lake levels, and delta water levels are closely comparable to the lake. Inordinately high lake levels are reached following heavy runoff over the open water season in both the Peace and Athabasca rivers, the Peace River acting as a natural hydraulic dam to effect greater storage in the lake, together with increments of storage from the Peace itself during exceptionally high river stages before Athabasca Lake has reached maximum stage. We therefore believe records of Athabasca Lake elevations will provide a better appreciation of how the delta area is affected as a feeding and resting ground for migratory waterfowl. . . . From our own experience it was noted that relatively few geese tarried in the Athabasca delta in the fall season of 1960 and 1962 and we had assumed this was due to the high water levels making feed inaccessible."

Water elevations at Lake Athabasca show seasonal fluctuations of from five to eight feet from May minima to summer maxima (table 3). Such lake elevations reflect rainfall and runoff above the entire basins of the Peace and Athabasca rivers. Elevations for September 15 and September 30 are shown, as this period would approximate the time of migration of Ross Geese through the Peace-Athabasca delta region. A mean level of 694 feet represents a relatively low marsh condition with no flooding. Major positive fluctuations of lake levels occurred, in decreasing levels, in 1964, 1962, 1960, and 1963, the same four years that peak populations of Ross Geese occurred in Saskatchewan.

An aerial census of the Athabasca delta and Lake Claire marshes, conducted on October 1, 1959, indicated 3095 Canada Geese, 3877 White-fronted Geese, and 20,284

"white" geese, whereas a year later on October 4, 1960, a comparable count showed 672 Canada Geese, 283 White-fronted Geese, and 7531 Snow Geese (Barry, *in litt.*). The number of geese utilizing the marshes and open lakes had dropped markedly from 1959 to 1960. Most feeding marshes were inundated in 1960, and only the tops of willows were exposed. Fuller (1962) further stressed the effect of severe flooding on populations of bison (*Bison bison*) along the shoreline of Lake Claire during the autumn and winter of 1960. The data on water levels suggest that flooding of the traditional feeding marshes in 1960 forced Ross Geese to move southward quickly and not prolong their regular stay on the Athabasca delta. A similar flooding and lack of suitable feeding areas in 1962, 1963, and 1964, probably induced geese to become mere transients and move southward soon after their arrival from the northern breeding grounds.

*Southern Alberta and Saskatchewan.*—There has been a continual drying of surface waters on the Canadian prairies since 1955. This drying has been associated with lower snowfall in winter, generally low rainfall in spring and summer warm autumns, and higher temperatures which increased evaporation rates. Much of the prairie area of Canada is semiarid and subject to wide yearly fluctuations in precipitation and surface water areas (Kendall and Thomas, 1956; Lynch, Evans, and Conover, 1963). G. D. V. Williams (1962) has discussed the effect of the drought on plant crops in 1960 and 1961 and the general precipitation picture which led to the drying trend.

In the Kindersley district of Saskatchewan 6 out of 16 shallow lakes which contained water in 1958 were dry in September, 1959. The number of water areas remained the same into 1960, but low water levels in the form of extended mud flats and large white, saline lake bottoms were evident. The effect of increasing salinity on water utilization is not clear, although I have observed that some saline lakes are rarely used for drinking purposes by waterfowl. In Alberta a similar drying situation existed. I noted wide mud flats on many lakes in the vicinity of Sullivan Lake on an aerial survey into central Alberta on September 26, 1960. Few natural depressions contained water; however, water levels were not yet critical, with some 23,000 white geese enumerated on and in the vicinity of Sullivan Lake. By April 18, 1961, another aerial survey showed Sullivan Lake to be reduced to several hundred acres of shallow muddy water in the center of an extensive mud flat. The extended drought, although not completely desiccating all the traditional lakes used by Ross Geese in central Alberta, had removed and dried a number of them. Improvements in surface water did not occur until the summer of 1963, while during each autumn from 1960 to 1962 part of the population of Ross Geese apparently shifted eastward to utilize the few remaining lakes in western Saskatchewan. There was another hot, dry summer in central Alberta in 1964. By September 11, Sullivan, Gough, Farrell, and Marion lakes were dry or nearly so. Rains falling between September 24 and October 1 added several inches of water to each lake and some Ross Geese were subsequently censused on these lakes. However, the main mass of migrating Ross Geese appeared in Saskatchewan between September 20 and 25 at about the time when water conditions were poorest in Alberta. The highest number of Ross Geese yet recorded near Kindersley, Saskatchewan (21,700), and to the north of Kindersley (9200), was made after the traditional stop-off area of Sullivan Lake was dry. The Alberta staging areas held only a total of 3400 Ross Geese at this time. Whether the flocks left the Athabasca delta *en masse* and flew directly to Saskatchewan, or whether they first migrated to central Alberta and then wandered eastward in search of suitable water areas, is unknown.

Although lake levels did rise in central Alberta in 1963, Ross Geese continued to migrate to and utilize the lakes in western Saskatchewan. Late September rains in 1964 also added water to lakes in central Alberta but available water was either not suitable or too saline to hold many Ross Geese. Thus they were forced to move elsewhere. There is then an indicated break in the tradition of utilizing the Alberta staging area by part of the population of Ross Geese and the adoption of a new flight lane through western Saskatchewan. In the light of Lloyd's collection of two Ross Geese out of a flock of 250 in the Kerrobert area in 1922, it is evident that such population shifts may have occurred in the past and may be a periodic phenomenon associated with changing habitat conditions. A predisposition to a quick change in flight lanes or a movement out of a traditionally used area to take advantage of superior resting, water, and food conditions would help ensure the survival of a species.

Regular re-use of travel lanes, homing, and recurring utilization of certain lakes by waterfowl are well-known phenomena (Hochbaum, 1955). However, traditions can change and pioneering is practiced by most waterfowl species. In England, Boyd (1955) had noted that the use of traditional areas by wintering Pink-footed Geese (*A. jabalis brachyrhynchus*) can easily be altered, especially by a scattering of two-year-old birds and their return to these new areas in subsequent years. Many examples and reasons for changes in use of traditional wintering grounds by most species of European geese (*Anser*) are discussed by Wynne-Edwards (1962). Habitat alterations are important but so are the gradual modifications of traditions of utilization. In the case of the initial large scale shift of Ross Geese eastward in 1960, deterioration of habitat, weather factors and their effect on migration, or a chance movement all must be considered as valid reasons for the shift. Thereafter the patterned homing qualities of geese, that is, the effect of tradition and of young following their parents to new areas, could have affected subsequent utilization of the new fall congregating area in Saskatchewan.

I have no way of weighing the effect of increased population size and presence of many young on the spread eastward. Increased numbers and lack of suitable food and resting areas for such numbers could induce the shifts. Ground weather-pattern records of the several weeks before and following the initial move in 1960 showed no particular aberrancies. Certainly groups of a migrating species could be blown eastward by high altitude winds, and I cannot exclude this possibility for the 1960 influx. However, any movements of Ross Geese after 1960 should be associated with some other phenomenon besides a temporary shift owing to weather disturbances. Changed habitat conditions in the Athabasca delta and central Alberta are the most plausible explanations. Whether or not a direct or interdependent (flooding—drought—shifting) causal relationship exists will be resolved when one of the staging areas returns to a pre-1960 condition.

*Eastward movement of Snow Geese.*—The shift of a portion of the population of Ross Geese into Saskatchewan had been preceded by an extension of the flight path of the Snow Goose from central Alberta eastward. Central Alberta had been a traditional fall and spring congregating area for this species (Taverner, 1949), with only small numbers reported in west-central Saskatchewan, where the first major influx of Snow Geese was recorded during the springs of 1954 and 1955 (Lamont, *in litt.*). Thereafter, each spring and autumn I have censused flocks of Snow Geese from several hundred to over 10,000 on various lakes in the district. In late October, 1960, to October of 1964, peak populations of up to 25,000 Snow Geese utilized most of the same lakes on which Ross Geese were found in late September. The spread of Snow

TABLE 4

## LATE WINTER POPULATION ESTIMATES OF ROSS GEESE

Year of count**	Population
1955	6000
1956	11,000
1957	7925
1958	12,800
1959	15,600
1960	18,000
1961	23,050
1962	27,920
1963	25,250
1964	32,450
1965	31,880

\* Partly after Chattin; *in* Glover and Smith (1963).

\*\* February or March.

Geese eastward is chiefly associated with an increased population, as it antedated any major changes of habitat in central Alberta.

A possible breeding colony of Ross Geese has been found on Banks Island, Northwest Territories (Barry, 1964). This area is also the breeding grounds for most of the Snow Geese migrating through Alberta and Saskatchewan (McEwen, 1958; Cooch, 1964). Further banding work should indicate whether any of the Ross Geese found in Saskatchewan are breeding on Banks Island and whether they are accompanying Snow Geese through that province.

## POPULATION STATUS

*Wintering population.*—Estimates of the total population of Ross Geese on the wintering grounds have been difficult to undertake because the species mixes readily with Snow Geese. Published census figures taken prior to 1955 are therefore only crude estimates and subject to close scrutiny (Morse, 1963; Marshall, *in litt.*). As the Ross Goose is a later spring migrant than the Snow Goose, a better total population estimate has been arrived at by a late February and early March count. At this time Snow Geese have started to move northward and most remaining white geese are Ross Geese (Chattin *in* Glover and Smith, 1963). Since 1951, personnel of the Region I office of the United States Bureau of Sport Fisheries and Wildlife, including Eugene Kridler and Dave Marshall, have conducted these counts. Continuity for the population estimates has been provided by the participation of pilot-biologist Ray Glahn of the Portland office. Census data taken literally show that the Ross Goose population has increased fourfold from 1955 to 1963 (table 4). Data for February, 1964, indicate that there was a 25 per cent increase in the wintering population of the Ross Goose over that of 1963; 32,450 Ross Geese were recorded in the San Joaquin and Sacramento valleys (Chattin, *in litt.*).

The aerial census of 1965 did not materially differ from the 1964 count with 31,880 Ross Geese recorded (Glahn, *in litt.*). Nine hundred Ross Geese were found as far south as the Imperial Valley.

Recently, Marshall (*in litt.*) has indicated that the population figure of 6000 Ross Geese obtained by him in 1955 is not comparable to subsequent estimates, because all wintering habitat utilized by Ross Geese was not found that year. Recent

coverage is more complete. He has suggested also that for years prior to 1955, field reports indicated that numbers of Ross Geese were higher than those published. However, the bird had been considered a rare and endangered species for so long that reports of large or increasing numbers were immediately discounted. Because of a lack of adequate and simultaneous coverage, the early status of the species is obscure and is subject to question. As early as 1932 (Soper, 1934, 1942) discredited the reported rarity of the species. He noted that a local warden at the Athabasca delta was of the opinion that Ross Geese were much more numerous than was generally supposed. "Many hundreds" occurred regularly in spring and fall migration at the delta and the southern part of Lake Mamawi.

More recently, MacInnes (1964) has examined the wintering status of the Ross Goose and has concluded that at least part of the increment of the past years is due to an increase in field activity by ornithologists and an expansion of wintering areas covered by census takers. Field workers are becoming more cognizant of rare species, readily seeking them out and identifying them more easily than in the past.

Short term population fluctuations of Ross Geese are probably due to a number of the same factors which control production in other arctic breeding geese, but their effects are more intense because of the restricted breeding range. Severe arctic weather, especially in late springs, is a major factor governing nesting and production of this species (Hanson, Queneau, and Scott, 1956; Ryder, 1964), and also of Blue (*Chen caerulescens caerulescens*) and Lesser Snow geese (*C. hyberborea hyberborea*) (Cooch, 1961, 1964). Barry (1962) has shown further that late snow cover reduces food supply and the number of nesting sites available for the American Brant (*Branta bernicla hrota*). If real, the recent rise in the wintering population of the Ross Goose (table 4) may be associated with a long-term amelioration of climate in the eastern Arctic (Cooch, 1961, 1963; Baum and Havens, 1956) or it may be associated with a short series of favorable breeding years for the Ross Goose with excellent production and survival of young.

*Autumn population.*—Estimates of total numbers of fall-migrating Ross Geese in Canada are almost nonexistent. Comprehensive aerial and ground surveys have only recently been undertaken. A partial count of Ross Geese known to be present in Saskatchewan and Alberta (Webb, *in litt.*) during the third week of September, 1960, approached 9200. Broad aerial estimates of all potential migration habitat in the two provinces show only numbers of "white" geese. Complementary ground counts are necessary to determine percentage of Ross and Snow geese on most lakes. Estimates varying from 8000 to 25,000 Ross Geese have been made for periods in 1961, 1962, and 1963. In late September, 1964, aerial and ground surveys showed at least 13,500 "white" geese in central Alberta and another 32,800 in western Saskatchewan. From the best available data it was estimated that 6 per cent of the white geese found in Saskatchewan and 75 per cent of those found in Alberta were Snow Geese. The remainder, some 34,300, were Ross Geese. Approximately nine times more Ross Geese were found in Saskatchewan in 1964 than in Alberta, 30,900 versus 3,400.

The estimate of 34,300 Ross Geese during the fall of 1964 closely approximates the 1963-1964 winter survey figure of 32,450 and the 31,880 censused in 1965 (table 4). However, if we assume a five per cent spring and summer mortality of the birds in the last figure and add summer production of young (approximately 30 per cent of the population were made up of young in the fall of 1964), we arrive at a calculated continental population of some 44,000 birds. The autumn count does not en-



compass all of the known migration areas, although few Ross Geese are found in Montana in late September (Witt, *in litt.*). The difference of 10,000 birds between the estimated and calculated population can be attributed to the biases inherent in the minimal aerial and ground censuses now carried on. A much expanded effort is required. I conclude that the continental population of Ross Geese, prior to October 1, 1964, was no lower than 34,300, and perhaps it was as high as 44,000.

*Population controls.*—Some of the most evident factors which can affect yearly numbers of Ross Geese are arctic weather, killing by natives, loss due to predators, poisoning, and killing by hunters. As previously mentioned, yearly production of eggs and young should depend primarily on favorable spring arctic weather. Killing of geese by Eskimos and loss of eggs and young to predators appear to be low (Hanson, Queneau, and Scott, 1956; Ryder, 1964; Barry, 1964). Cottam (1960) described a loss of 396 Ross Geese plus several thousand other geese on farm land adjacent to the Tule-Lower Klamath Lake Refuge of Oregon and northern California as a direct result of spreading zinc phosphate- and 1080-treated grains in the control of an eruption of the meadow mouse (*Microtus montanus*). Few such large scale losses occur.

The yearly take of Ross Geese by hunters had been thought to be one of the major reasons for the continuing low numbers; yet no verifiable estimate of the loss due to hunting has ever been made. In the United States the Ross Goose was found commonly in the markets of San Francisco, Sacramento, Stockton, and Los Angeles (Grinnell, Bryant, and Storer, 1918). Special protection was extended to the species in 1931. Later the accidental and illegal killing of Ross Geese after they had mixed with Snow Geese was felt to be a serious menace to the species (Cahalane, Cottam, Finley, and Leopold, 1941). The population of the species then was estimated to be between five and six thousand individuals. The authors felt that all white geese in the Sacramento Valley should be protected to save the Ross Goose. Scott (1957a) mentioned that an estimated "several thousand" Ross Geese are known to be shot annually in error for Lesser Snow Geese in California. In Canada, Ross Geese were apparently regular migrants through the Calgary district of Alberta at the turn of the century, because every autumn a few were killed by local sportsmen who called them "little wavey" (Macoun and Macoun, 1909). However, Farley (1936) mentions that there were few Alberta records of Ross Geese probably owing to the fact that "wavies" were not popular and were seldom killed by hunters. He noted that only at rare intervals during the previous 40 years did he receive kill records of small, white geese. Such aversion to the taking of white geese still remains on the Canadian prairies, possibly because of the poor plucking and flesh qualities of white geese when compared to the Canada and White-fronted geese. Soper (MS) recorded the results of an extensive autumn bag check by officers of the Royal Canadian Mounted Police in 1951 throughout southern Alberta. He shows only 19 Ross Geese checked out of an unknown number of other geese. He felt that the figures were much too low, but he determined that most Ross Geese were shot accidentally in the south-central part of the province in the vicinity of Sullivan Lake. Soper (MS) stressed that Ross Geese fly lower, are more curious, and appear less suspicious and shy than other species of geese. They are therefore much more vulnerable to shooting pressure than are Lesser Snow Geese. At Fort Chipewyan, Northwest Territories, Taverner (1940) noted that many "galoots" were killed and salted for the winter food supply. The practice has now been discontinued. In the vicinity of Richardson Lake Bird Sanctuary, at the delta of the Athabasca River, Northwest Territories, a small number of Ross Geese

are taken each spring and autumn by natives (Hanson, Queneau, and Scott, 1956). The larger species of geese are preferred by these people, however, because of their greater availability and weight (Novakowski, *in litt.*).

During the goose hunting seasons from 1958 to 1964, infrequent bag checks made by Bob Webb in Alberta and by various federal and provincial personnel in Saskatchewan showed the per cent of Ross Geese in goose hunters' daily bags to vary between 3 and 33 per cent of the total number of geese taken. Bag checks, made through the hunting season in areas where Ross Geese migrate, show that this species usually makes up less than 10 per cent of the total number of all goose species shot. I have crudely extrapolated any available yearly bag check data to the estimated annual goose kill of the central portions of Saskatchewan and Alberta. From the best available data on geese shot by hunters and with the addition of a 20 per cent yearly loss by crippling, it appears that the take of Ross Geese in Canada prior to 1963 could have been as low as 500 birds per year and as high as 2235. The last mentioned figure is based on very meager data. The figures suggest that the take fluctuated between years, but it was always low, probably fewer than 1200 birds per year.

Any Ross Geese shifting from Alberta eastward were subjected to high concentrations of hunters from Saskatchewan during late September, 1960, 1961, and 1962. Local losses were high, especially on the opening day of goose hunting, which until 1963 had been about mid-September. An estimated 150 Ross Geese were killed around Buffalo Coulee Lake, Saskatchewan, in three days in 1960. In Alberta, Wishart and Sugden (1963) give examples of localized bag checks which show over 20 per cent of daily bags to be composed of Ross Geese. Yet, prior to 1963, no concerted checking was attempted throughout the hunting season nor throughout the entire migration range of Ross Geese. The apparent magnitude of the autumn take can easily be distorted upward by poor and nonrandom statistics, when in actual fact localized large harvests of geese are rare indeed.

In 1963, in cooperation with game departments of the Province of Saskatchewan and Alberta, a closed season was initiated on the shooting of all white geese until the end of the first week in October (October 7). After that date Ross Geese could be taken legally. In 1964, the opening date for hunting was October 5. Previously collected aerial and ground data had indicated that Ross Geese start to move south early (table 2) and that Snow Geese moving into the area would tend to "dilute" the white goose population. Also, increasing numbers of the preferred Lesser Canada Goose (*B. c. parvipes*) would draw hunters away from concentrations of Ross Geese. Maximum estimates of the number of Ross Geese killed in Canada during the first open season vary between 1135 and 1360. These figures are about the same as estimates of Ross Geese inadvertently shot in years prior to 1963, in spite of a record harvest of white geese. The estimates for 1964 are incomplete but appear lower than those for 1963, some 900 to 1150 geese being killed.

In the United States in 1963 and 1964, one Ross Goose was allowed in the hunter's bag and no apparent or measurable rise in the kill resulted (Chattin, *in litt.*). Sampling of data on kills by hunters would have to be much expanded in California to give statistically sound and accurate estimates of the kill in the United States. The lack of such data precludes any meaningful estimate at the present time. Similarly, sufficient band recoveries are not yet available to estimate total kill by hunters. In all, the illegal, and now legal, hunting take has had little apparent effect on depressing the "indicated" rise of the Ross Goose population over the past six years (table 4).

TABLE 5

## BROOD SIZES AND PERCENTAGES OF YOUNG IN TRAPPED SAMPLES OF MIGRATING ROSS GEESE, 1960-1963

Season	Number of broods	Frequency of brood sizes						Average brood size	Time* of hatch	Cannon-net trap samples	
		1	2	3	4	5	6			Number trapped	Per cent of young
1960	108	22	26	35	14	10	1	2.70	Early	80**	51.3
1961	19	4	8	5	2	—	—	2.26	(?Late)	242	3.3
1962	111	24	46	34	7	—	—	2.22	Late	732	(66.0)***
1963	124	12	50	36	18	6	2	2.77	Average	289	47.4
1964	188	23	55	74	26	7	3	2.72	Average	755	46.1

\* Based on time of arrival, color of immature mandibles and general body condition.

\*\* Sample trapped by Jack Grieb, Colorado Fish and Game Department, on Kirkpatrick Lake and Sullivan Lake, Alberta.

\*\*\* Distorted by large catches of young late in season.

The census in late February, even though crude, should provide adequate checks to determine yearly status of the bird. The gathering of data on broods and productivity (Lynch and Singleton, 1964) on the fall migration areas and wintering grounds would further supplement the census. Restrictive legislation concerned with shooting of all white geese, and special area closures can directly affect the take of this species and ensure that the Ross Goose does not reach the precarious levels of the 1940's. The relatively restricted autumn migration range in Canada makes the species most amenable to controlled manipulations in lengths of hunting seasons and areas open to hunting.

*Productivity.*—Average brood sizes and per cent composition of young in trapped samples can easily be obtained and related to annual productivity. However, random age-ratio information and numbers of successful breeding adults with young cannot be gathered accurately without a much expanded sampling effort. The meager data presented here may not, therefore, reflect the true population productivity.

Clutch sizes on the breeding grounds vary from two to six eggs. In 1940, the most common number was four (Gavin, 1947). In 1949 of ten nests checked the average clutch size was three eggs per nest (Hanson, Queneau, and Scott, 1956), while the average size of 71 broods, all one week or less in age, was 2.9. A group of broods of two- to three-week-old goslings also averaged 2.9 young per brood. Ryder (1964) gives a clutch size of 3.67 before predation and 3.47 after predation, prior to hatching. The nesting success, that is, a nest in which at least one egg hatched, was 96.7 per cent, while 93.5 per cent of all eggs hatched. Average brood sizes of Ross Geese observed before the Saskatchewan hunting season showed slight variation between years from a low of 2.22 young per brood in 1962 to a high of 2.77 in 1963 (table 5). Utilizing the 1963 clutch size from Ryder (*op. cit.*), the loss from hatching to the ten- to twelve-week-old flying broods on the mid-Saskatchewan staging area averages nearly 0.5 young per brood. Whether the loss occurs on the breeding grounds prior to fledging or during the migration period to Saskatchewan is unknown.

Average brood sizes in 1961, the year when productivity of young was low, and 1962, when productivity was high but the season was late, were about the same, although the number of adults with young varied. This indicates that average brood size is not necessarily indicative of reproductive success. Data on population size and proportion of productive adults with young are also needed to supplement information on size of broods in the construction of meaningful yearly appraisal (Lynch and Singleton, 1964). All samples were small, and sampling of every population segment

across the migration range is required. Broods with five and six young were observed in 1960, 1963, and 1964, years of excellent production of young, with an average or early hatch (table 5). Lower brood sizes of 1961 and 1962 may simply reflect smaller clutch sizes in cold or late-nesting years (Hanson *et al.*, 1956; Ryder, 1964; Cooch, 1961, 1964).

On the basis of dark color of the mandibles (table 1), and body weights, hatching in 1962 was considered late, even though the number of young recorded in the migrating population approached 50 per cent. The 66.0 per cent of young geese shown in the trapped samples was heavily distorted by two large catches in late October containing predominately immature birds. From October 20 to 28, 1962, I observed five swimming groups of Ross Geese, varying in size between 42 and 117 individuals and containing over 80 per cent young. Each group consisted of several apparent families and large numbers of unattached young. I can only speculate as to the possible reasons for rafts of predominately young Ross Geese. Perhaps brood adoption occurs readily in this species, as family bonds are not as strong as in other species of *Anser* and *Chen* (Elder and Elder, 1949; Cooch, 1961). Alternatively, hunters may disrupt family groups and cause wandering of unattached young. In late years, young may be physiologically delayed and be incapable of migrating. Some adults may fly south without their brood. As groups of young were noted only in the late 1962 season, the main reason for the distorted age ratios may center around the physiological condition of the young. In a year when most lakes freeze in late October such young could be entrapped in the ice, as has been described for late-hatched cygnets of the Trumpeter Swan (*Olor buccinator*) by Banko (1960).

In the light of the apparent low harvest in the United States and Canada and the excellent production of young for four out of five years (table 5), we would have been justified in expecting faster growth of the wintering population since 1960 (table 4). Too little is known of the population dynamics of the species to construct a meaningful life table. Breeding age, per cent of successful potential breeders, and total natural and hunting mortality of young or adults are still unknown, as are general production figures. Unmeasured or minor mortality factors operating throughout the year could possibly account for the continuing loss of several thousand birds over and above those taken by hunters. However, John Lynch (*in litt.*), utilizing a broad spectrum of population dynamic data from other arctic nesting geese, cautions against use of the late winter counts for critical management appraisals. The increasing population size over the last decade may be a reflection of progressively more efficient coverage of the wintering grounds and a growing sensitivity on the part of aerial observers to look for and record this rare species. Both of these factors have also been echoed by Dave Marshall (*in litt.*), who has acted as observer on some of the late winter counts, and by MacInnes (1964). The need for a study on all aspects of the life history of the species is obvious.

#### SUMMARY

In Canada the Ross Goose has traditionally utilized the marshes of the Athabasca River delta of northern Alberta and the region about Sullivan Lake in central Alberta as congregating areas in autumn and spring. A shift eastward of up to one-third of the population of Ross Geese into the Kindersley district of Saskatchewan was recorded in the autumn of 1960, when a peak population of 5600 was counted. Prior to 1960, the species was an uncommon autumnal migrant in the province. Large scale yearly influxes have persisted until 1964 when over three-quarters of the known pop-

ulation migrated through Saskatchewan. The change in migratory pathways is associated with a flooding of the feeding marshes of the Athabasca delta and a drying of the traditionally utilized resting areas in central Alberta. Such changes in migratory routes appear to have occurred in the past.

The Ross Goose is one of the earliest fall migrants, moving into the Canadian prairies about the second week of September and departing by mid-October. A few remain until forced out by freezing weather. In exceptionally warm autumns large flocks remain until late October.

Banding recoveries show a yearly interchange of birds between the staging areas in Alberta and Saskatchewan. Sightings of Ross Geese neckbanded on the breeding grounds of Perry River have been made in Saskatchewan. Most band recoveries of 2000 Ross Geese banded in Saskatchewan are from Saskatchewan, California, Alberta, and Montana, along the traditional migration routes and in the wintering areas. Prior to 1963, in Alberta and Saskatchewan, the yearly kill by hunters, that is, birds shot inadvertently when Ross Geese mix with Lesser Snow Geese, has been estimated at between 500 and 2235 birds. The first legal hunting season for the species was initiated in early October, 1963, and such a season was repeated in 1964. Preliminary reports indicate a reduced take of Ross Geese because of the late opening of the hunting season on all white geese. In spite of the formerly illegal and now legalized take, the late winter population in California has apparently increased fivefold from approximately 6000 in 1955 to 31,880 in 1965. Because of the continuing difficulty in separating Ross Geese from Snow Geese over the widespread and overlapping wintering range, any recent increase may not be of the magnitude shown. The yearly fluctuations are more apparent than real.

Between 1960 and 1964 sizes of broods in autumn have varied between 2.22 and 2.77 young per pair. Production of young has been good for four out of the five years, with immatures making up between 25 to 40 per cent of the population which migrates through Saskatchewan. A population of 34,300 Ross Geese was estimated in Canada during late September, 1964, whereas the continental population may now be as high as 44,000.

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