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DISTRIBUTION, ABUNDANCE, AND PRODUCTIVITY OF FALL STAGING LESSER SNOW GEESE ON COASTAL HABITATS OF NORTHEAST ALASKA AND NORTHWEST CANADA, 1982

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Key Words: snow geese, Anatidae, waterfowl, staging waterfowl, population age ratio, Alaska, North Slope, Arctic National Wildlife Refuge

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Distribution, abundance, and productivity of fall staging lesser snow geese in coastal habitats of northeast Alaska and northwest Canada, 1982.

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Abstract: Fall staging of the western arctic lesser snow goose population was monitored on the coastal plain of the Arctic National Wildlife Refuge (ANWR), Yukon Territory and the Mackenzie River delta from 7 August to 22 September 1982. The onset of staging in 1982 was earlier than usual, but major arrivals were normal, occurring 24-26 August. The duration of the staging period (20 days) was the second longest observed since 1971. A gradual buildup in numbers occurred through late August and early September with 30-40,000 birds estimated using the ANWR coastal plain at that time. Peak snow goose numbers were estimated on 14-15 September at 107,072 $\pm$ 13,866 in Alaska; 117,892 $\pm$ 15,279 in Yukon, and 6155 in the Mackenzie delta, for a total western arctic population estimate of 231,119 $\pm$ 29,242. Estimated productivity was low, at 4.6% young. Spatial variation in productivity was observed, with concentrations of higher productivity occurring in Alaska as compared to farther east, a pattern opposite to that observed in 1981. Medium telephoto lenses with a large-format 60 x 70 mm camera and ASA 400 film on cloudy days and a 35 mm camera and ASA 50 fine-grain film on sunny days produced the best photos for counting geese.

Distribution, abundance, and productivity of fall staging lesser snow geese in coastal habitats of northeast Alaska and northwest Canada, 1982.

The fall staging of lesser snow geese using the coastal plain of the Arctic National Wildlife Refuge (ANWR) and adjacent Yukon and Northwest Territories was monitored for the eleventh year since surveys were initiated in 1971 by L.G.L., Inc. (Schweinsburg 1974). The 1982 surveys represented the fifth year of survey by refuge staff, and the fourth year of photographic age ratio sampling using methods standardized in preceeding years (Spindler 1980, 1982). Objectives of the study were to: (1) determine the choronology of migration and staging, (2) estimate the peak numbers of snow geese present during staging, (3) determine distribution and age ratios and (4) identify habitat areas and types used consistently. Emphasis was added in 1982 to more frequently monitor temporal and spatial changes in distribution of snow geese within the arctic coastal plain study area of ANWR.

Methods and Materials

Sampling procedures employed a predetermined 9.7 km-spaced grid of 2.4 km wide north-south aerial transects (Koski 1977b, Spindler 1982). All transects were flown with a Cessna-185 aircraft flying about 150 m above ground level (AGL) at an airspeed of 200 kph. Methods of recording and avoidance of double counting were as described in Spindler (1982); however, crew size and function, and photographic methods changed slightly. A crew of 3 persons (2 photographers and 1 recorder) plus pilot was necessary to simultaneously obtain adequate photos and records. All persons, including the pilot helped find flocks. The primary photographer sitting in the right front seat then photographed the total flock at a distance for a flock size estimate. At this time the primary photographer, backup photographer and recorder all made independent estimates of flock size, and then came to an agreement as to which estimate would be recorded (usually all estimates agreed to within 10%). The pilot circled closer and age ratio photographs were then taken. Care was taken to not circle a flock more than once to avoid excessive disturbances to the geese.

A Mamyia RB-67 60 x 70 mm large format SLR camera was primarily used for the photography, in combination with a 250 mm telephoto lens and ASA 400 TRI-X PAN film. Secondarily, a 35 mm Pentax SLR with 135 mm telephoto lens and ASA 50 H&W VTE PAN (Ferguson and Gilmer 1980) was used. Pilot, photographers, and recorder used headsets interconnected through an aircraft intercom to facilitate coordination of photography, airplane movements, and record keeping.

In addition to the systematic procedures used for the main 14-15 September survey, several reconnaissance flights were made over the ANWR coastal plain study area to provide more complete information on arrival, build up, and emigration of snow geese. Both Cessna-185 and 207 aircraft were used in the reconnaissance, which followed a varying survey route, usually dependent on weather conditions and available daylight.

Photographs were enlarged so that each snow goose flock occupied a 20 x 25 cm sheet of photographic paper. Geese were counted with the aid of a light table. Calculation of the mean age ratio weighted according to flock size was allowable because no correlation was found between percent young and total

flock size (r^2= -0.152). Calculation of weighted mean and its variance weighted by flock size was according to the formulae recommended by S.J. Harbo (pers. comm.):

$$\bar{x}_w = \frac{\sum_{i=1}^{n} (x_i - w_i)}{\sum_{i=1}^{n} w_i},$$

where $\bar{X}_w$= weighted mean
X_i= percent young in flock
W_i= size of flock
n = number of flocks

$$V(\bar{x}_w) = \frac{\sum_{i=1}^{n} (x_i - x_w)^2 \cdot w_i \Big/ \sum_{i=1}^{n} w_i}{n}$$

Age ratio in various groups was compared with F test and students-t (Steel and Torrie 1960). Estimation of flock size and actual photo count comparisons were done using paired-t and linear regression (Steel and Torrie 1960). Confidence limits were determined for regression-adjusted estimates (Draper and Smith 1966).

Results and Discussion

Staging Chronology and Numbers

Snow geese were first observed on the coastal plain in mid-June; flocks were seen 14, 18, 24, 25 June and 12 July 1982. In previous years occasional small migratory or loafing flocks varying in size from 4-50 birds were typically observed on the coastal plain in early summer (USFWS 1982:121). Large flocks were not usually observed until late summer when staging birds depart the Canadian nesting colonies near the Mackenzie River delta and on Banks Island, frequently flying as far east as Barter Island before remaining to rest and feed. Onset of staging was earlier than usual, with the arrival of 7 birds on the Jago River delta on 7 August 1982 (G. Zemansky, pers. comm.). Date of major arrival was normal, occurring 24-26 August 1982 (Table 1, Fig. 1). On 24 August 890 birds were seen incidentally during large mammal telemetry surveys near the upper Okerokovik River, and middle Nigunak and Jago Rivers (Table 1). Estimated numbers increased to approximately 9000 birds by 26 August, when all geese observed were within 8 km of the coast, the majority between the Nigunak River delta and the Kongakut River delta, with the exception of a sizeable flock (2000+) also seen that day 3.2 km south of Camden Bay.

The period of maximum staging use was taken 26 August and 16 September 1982 (Table 2). These data indicate that 30-40,000 snow geese were present on the coastal plain of the refuge between 26 August and 3 September. On 3 and 4 September the influx of snow geese westward into ANWR continued as several large flocks were observed flying west past the Kongakut River (T. Kerasote, pers. comm.) Dense fog shrouded the coastal plain between 3 and 13 September and prevented survey flights to document the final build-up to peak snow goose numbers. On 14 September, a partial grid survey of the ANWR coastal plain was conducted. Patchy fog and low ceilings restricted this survey to a wide area

Table 1. Dates of arrival and departure of snow geese on the Mackenzie River delta, Yukon north slope, and eastern Alaskan north slope, August and September 1971-1976 and 1978-1982. The 1978-1982 data are from Arctic National Wildlife Refuge only.

Year	Date first flock sighted	Dates of major arrival	Duration of staging (days)	Major departure	Date last flock sighted	Survey period[a]
1971[b]	15 Aug.	31 Aug.-2 Sept.	9	12-16 Sept.	17 Sept.	4 June-19 Sept.
1972[c]	17 Aug.	27-29 Aug.	10	7-10 Sept.	15 Sept.	10 July-17 Sept.
1973[d]	23 Aug.	1-12 Sept.	9	22-25 Sept.	4 Oct.	25 Aug.-29 Sept.
1974[e]	21 Aug.	22-25 Aug.	22	17-21 Sept.	30 Sept.	24 Aug.-30 Sept.
1975[f]	18 Aug.	3-5 or 6 Sept.	12	19-24 Sept.	25 Sept.	20 Aug.-25 Sept.
1976[g]	13 Aug.	25-28 Aug.	18	16-26 Sept.	30 Sept.	15 Aug.-2 Oct.
1978[h]	20 Aug.	25 Aug.-1 Sept.	14	16-27 Sept.	27 Sept.	10 June-5 Oct.
1979[i]	24 Aug.	26-28 Aug.	17	15 Sept.	N/D	10 June-12 Sept.
1980[j]	15 Aug.	19-21 Aug.	10	1-2 Sept.	9 Sept.	5 June-12 Sept.
1981[k]	24 Aug.	26-30 Aug.	16	16-18 Sept.	18 Sept.	11 July-20 Sept.
1982[l]	7 Aug.	24-26 Aug.	20	16-18 Sept.	19 Sept.	6 June-25 Oct.

a Dates inclusive of aerial and ground observation period. Locations of ground observation and aerial survey coverage varied: 1971-1976 data emphasized Mackenzie and Yukon locations, while 1978-1981 data emphasized Alaskan locations. The 1982 survey period includes dates between which extensive aerial surveys were conducted in which snow geese could have been observed. For details see respective sources:

b Schweinburg (1974)

c Gollop and Davis (1974)

d. Koski and Gollop (1974)

e Koski (1975)

f Koski (1977a)

g Koski (1977b)

h Spindler (1978)

i Spindler (1979)

j Spindler (1980)

k Spindler (1982)

l This report.

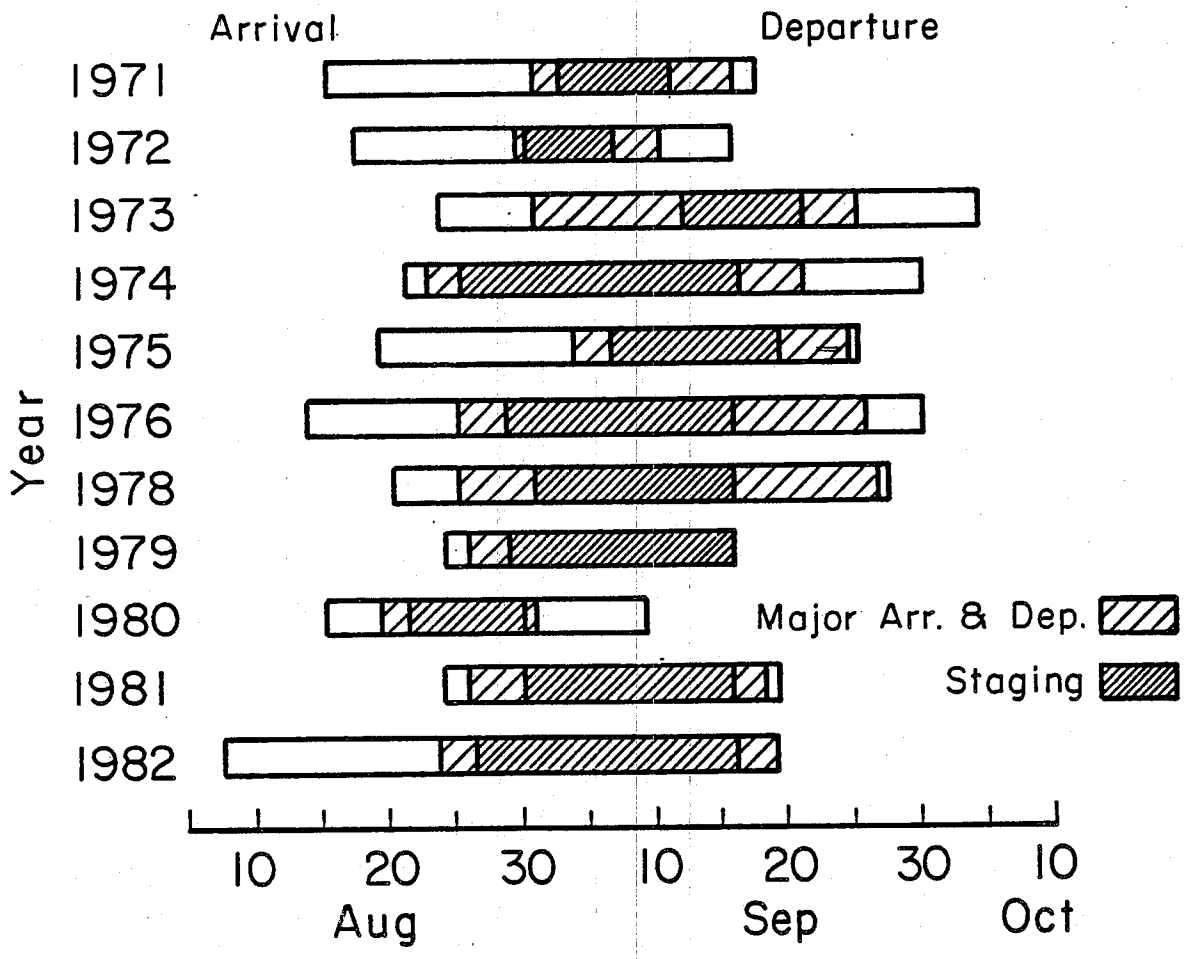


Fig. 1. Chronology of arrival, staging and departure of the western arctic population of lesser snow geese using the coastal plain of the Arctic National Wildlife Refuge, Alaska, the Yukon Territory north slope and the Mackenzie River delta, N.W.T.

reconnaissance covering about 85% of the coastal plain east of the Hulahula River, and 25% of the coastal plain west of the Hulahula River. An estimated 20% of the overall area where geese could have been seen was not covered. A total of 102,000 snow geese was estimated during this survey (which excluded parts of the coastal plain within 6-8 km of the coastline and terrain with elevations greater than the 460 m ceiling).

The survey was continued into Canada on 15 September when the weather cleared and the grid was completed as originally planned from Komakuk Beach to the Mackenzie River. An estimated total of 111,975 snow geese was seen on the Yukon Territory coastal plain portion of the staging area (Table 2). Nearly continuous east winds from mid-August to mid-September 1982 in the northwest Canadian Arctic (T. W. Barry, pers. comm.) and on ANWR (N.O.A.A. records from Barter Island) could have contributed to the extent and duration of westward movement by geese in 1982.

On 15 September several flocks of snow geese totalling about 1000 birds were seen migrating east between Komakuk Beach and the Babbage River during the aerial grid survey in the Yukon. Similar numbers of snow geese were observed migrating east past Demarcation Bay on the same date (S.R. Johnson and D. Herter, pers. comm.). Eastward migration was apparently beginning, and calm winds between the evening of 14 September until the morning of 16 September may have contributed to this onset of migration.

The staging period ended at mid-day on 16 September when westerly winds increased to about 32 kph. A heavy first snow (6-8 cm) fell on the coastal plain between 16 and 18 September. Several flocks of snow geese totalling 400 on 17 September and totalling 1400 on 18 September were seen flying to the southeast, up the Aichilik River valley where it departs the mountains (R. Glesne, E. Nelson, and J. Akaran, pers. comm.). These observations suggest that major departure started on or about 16 September and ended sometime before 21 September, when no snow geese were seen on the ANWR coastal plain (Table 2, Fig. 1).

Distribution of Staging

In late August distribution of snow geese on the ANWR coastal plain was initially restricted to mid-coastal plain portions of the Jago, Okerokovik, Niguanak, Aichilik, and Egaksrak Rivers (Fig. 2). Two days later the size of area occupied by snow geese had not changed significantly, but the Aichilik-Egaksrak concentration moved coastward 8 km, and the Jago-Niguanak concentration split, 1 west of the Jago, the other in the upper-middle third of the Okerokovik and Niguanak River drainages. Major distributional changes occurred between 31 August and 3-5 September: a separate large concentration was established in the upper coastal plain third of the Akutoktak and Okpilak Rivers; the Jago-Okerokovik-Niguanak concentration expanded by moving northward to Niguanak Ridge, and southeastward almost to the Aichilik River (Fig. 2). The separate Aichilik-Egaksrak group had apparently coalesced into another group. The most extensive distribution was observed on 14 September, when a large concentration occurred between the Hulahula and Egaksrak River occupying a majority of the coastal plain between the foothills and 11 km inland (Fig. 2). Another large concentration was located south of Demarcation Bay.

Table 2. Results of aerial snow goose surveys and incidental observations taken during other aerial surveys, coastal plain of the Arctic National Wildlife Refuge, Alaska, Yukon north slope, and Mackenzie River delta August - September 1982.

Date	Alaska Daylight Time	Flight time	Survey type	Estimated numbers seen[a]	Observers
24 August	12:45-17:30	N/A	Incidental obs.	890	L. Martin and J. Koschak
26 August	06:40-17:00	N/A	Incidental obs.	8800	L. Martin, J Koschak, R. Bartels
29 August	16:00-19:00	3.0 hrs.	Reconnaissance for distribution and photographs for age ratio	30,985	L. Martin, M. Spindler, P. Miller
31 August	15:00-16:22	1.3 hrs.	Reconnaissance for distribution	38,515	L Martin, G. Garner
1 September	20:00	N/A	Incidental obs.	20,000	W. Audi
3 September	17:30-18:19	1.3 hrs.	Reconnaissance for distribution	34,250	L. Martin, J. Koschak,
5 September	14:30-18:40	N/A	Incidental obs.	9,830	L. Martin, J. Koschak, P. Miller
9 September	N.D.	N.D.	Bathurst Penninsula distribution and age ratio	4,705	T.W. Barry
10 September	N.D.	N.D.	Mackenzie delta west to Tent Island distribution and age ratio	1,460	T.W. Barry
14 September	13:45-17:50 18:26-19:20	5.0	ANWR distribution and photographs for age ratio	101,684	L. Martin, M. Spindler, P. Miller M. Spindler, P. Miller, L. Aucoin
15 September	09:55-13:45 15:15-13:45	7.5	Yukon Terr. north slope east to Tent Island distribution grid and photographs for age ratio	111,975	L. Martin, M. Spindler, P. Miller
21 September	N.D.	2.6	Reconnaissance for distribution	0	L. Martin, J. Koschak
22 September	N.D.	1.9	Reconnaissance for distribution	0	L. Martin, J. Koschak

[a]Numbers based on visual estimates.

The Yukon north slope survey was planned to coincide with peak numbers and distribution on the Alaska staging grounds. Major concentrations of geese were seen in 6 locations: just south of the Buckland Hills west of the Firth River; on the mainland just south of Herschel Island; where the Crow and Trail Rivers leave the foothills; north of Hidden Lake and east of Ladas Creek; south of Shingle Point near the lower Walking and Blow Rivers; and south of Whitefish Station near Rapid Creek (Fig. 3). When compared to the Alaska side of the staging ground, the Yukon north slope had larger flocks (several of 7-10,000 birds) which were more widely dispersed (Fig. 4). The relative proportion of area used by staging snow geese appeared similar in the Alaska and Yukon portons of the staging area, even though concentrations in Yukon were more widely separated (Fig. 4).

Productivity

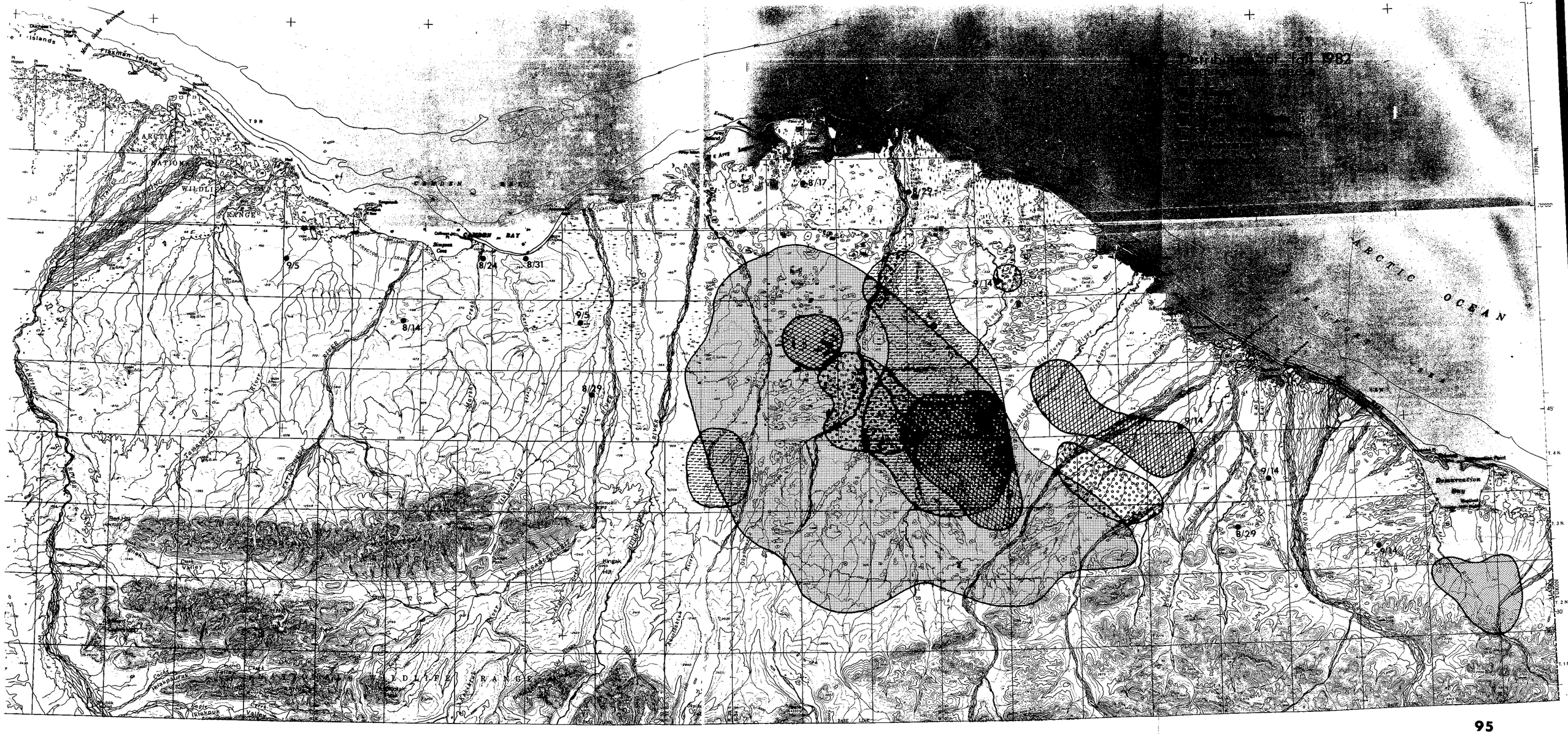
Age ratio sampling coverage was greater than previous years, largely due to 2 days of favorable weather near the end of the peak staging period. A total of 196 frames of 35 mm and 60 mm film were exposed, 82 were printed, and 33 were usable for age ratio determinations. A total sample of 15,803 geese representing 49,092 estimated geese was included in the photographic sample. The overall mean age ratio was 4.6 $\pm$ 0.7% young, which represents a decline since 1981, but is greater than both the 1979 and 1980 photo estimates (Table 3). During 1981 and 1982, photo estimation has covered the majority of the traditional staging grounds. The 1982 estimate is considered more representative than the 1981 estimate since the 1981 survey missed a large segment of the populaton that staged in and migrated through an unusual route east of Paulatuk, N.W.T., where no sampling was planned or accomplished (Spindler 1981). In 1982 extensive concurrent surveys were flown east of the Mackenzie River to Paulatuk and no birds were found (T.W. Barry unpubl. data). Therefore, it is unlikely that a large segment of the population was missed in 1982 as it was in 1981.

Spatial variation in age ratio apparently occurred but was statistically significant only for 2 rather large subgroups (Fig. 3): Hulahula River to Canada border and Canada border to Mackenzie River. A slightly higher percent young was detected west of the border in Alaska (5.6%) as compared to east of the border in Yukon (4.0%) (Table 4). This pattern is opposite to that found in 1981 in the same areas, when percent young generally increased along a gradient eastward from Barter Island to the Mackenzie River (Spindler 1982). No differences were detected between smaller subgroups in 1982 (see Appendix Table A-1).

Temporal variation in age ratio was suggested by the lack of young birds detected in flocks photographed during a preliminary reconnaissance survey on 29 August. No young were detected in photographs of 4 flocks totalling 7330 birds and representing a 24% sampling of the 30,985 geese estimated to have been present (Appendix Table A-1).

Population and Estimation Error

In order to estimate peak population using the staging ground in 1982, several sources of error must be addressed: (1) completeness and extent of area surveyed, (2) timing of survey segments -- concurrent or nearly so, or otherwise, (3) weather conditions under which surveys were conducted and, (4) estimation error for flock size. These factors were standardized so that (1)


Distribution of fall 1982
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CAMDEN BAY
Barter Island
Flaxman Island
ARCTIC NATIONAL WILDLIFE RANGE
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8/24
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Kingak Valley
Bell River
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Old Crow
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FIG. 3 DISTRIBUTION OF STAGING SNOW GEESE YUKON NORTH SLOPE

Distribution of staging snow geese on the coastal plain of Yukon Territory, Canada, as determined by aerial grid survey of 10 km spaced North-south lines, 15 September 1982. Each dot represents 100 geese. (Group size rounded to nearest 100 geese for dot representation; groups less than 50 birds not shown.)

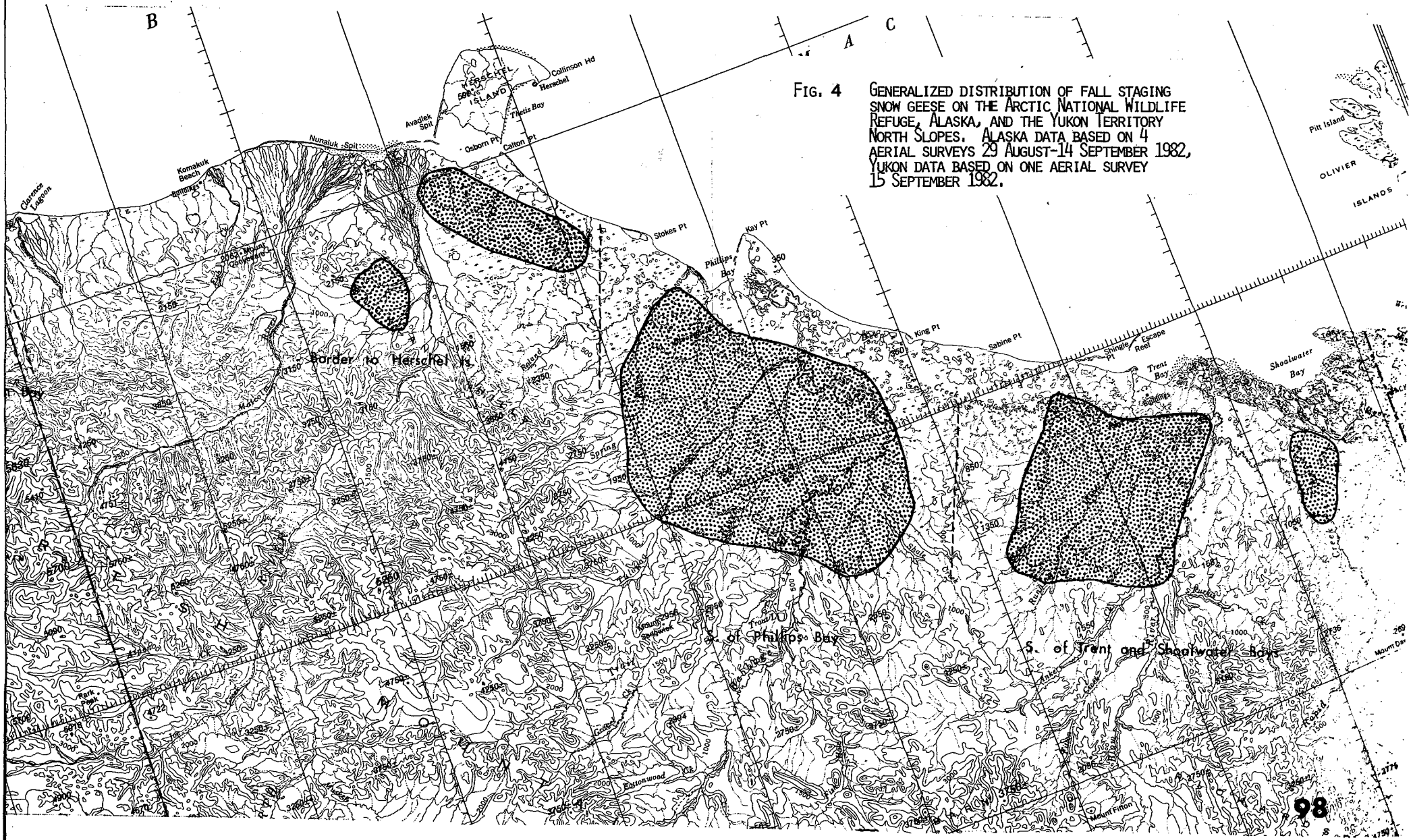
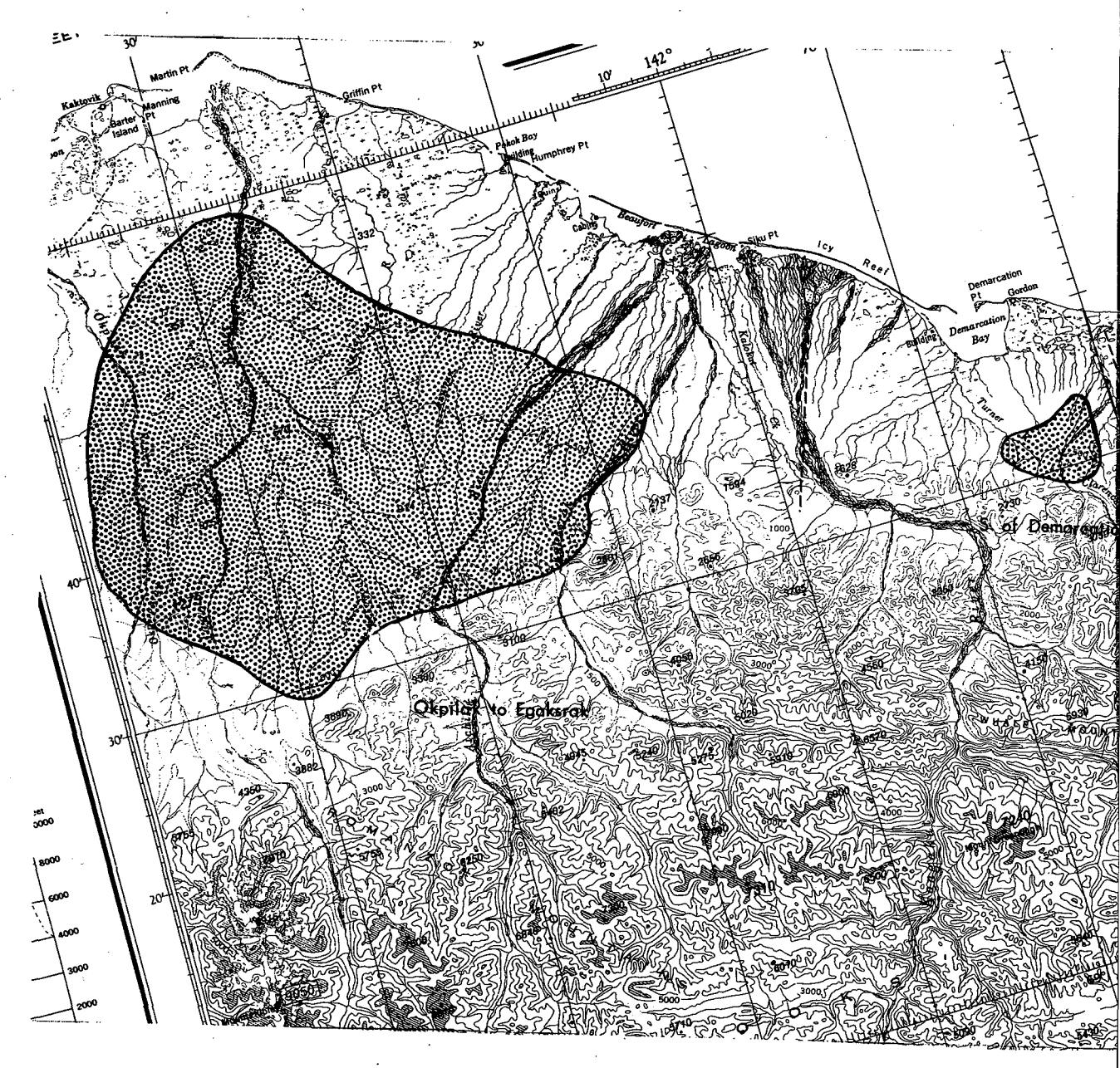


FIG. 4 GENERALIZED DISTRIBUTION OF FALL STAGING SNOW GEESE ON THE ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA, AND THE YUKON TERRITORY NORTH SLOPES. ALASKA DATA BASED ON 4 AERIAL SURVEYS 29 AUGUST-14 SEPTEMBER 1982, YUKON DATA BASED ON ONE AERIAL SURVEY 15 SEPTEMBER 1982.


Martin Pt
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Okpilak to Egaksrak
30'
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Table 3. Age ratios for western arctic snow geese staging on the Alaska and Yukon north slope, and Mackenzie River delta 1973-1976 (Koski 1977b) and 1979-1981 (Barry 1982, Spindler 1982, USFWS 1982, and this study).

Year	Adults	Young	% Young	Area of survey	Technique
1973	4533	5399	119.1	MD, YNS, AK[b]	Comp. count
1974	28,647	29	1.0	MD, YNS, AK	Comp. count
1975	12,223	13,638	111.6	MD, YNS, AK	Comp. count
1976	7375	5541	75.1	MD, YNS, AK	Comp. count
1979	4275	133	3.1	YNS, AK	Photo
1980	1046	37	3.3±1.2[a]	YNS, AK	Photo
1981	39,693	5082	11.3±4.1[a]	MD, YNS, AK	Photo
1981	175,000	75,000	30.0	Paulatuk and southwest	Comp. count (estimate)[c]
1982	14,904	889	4.6 ± 0.7[a]	MD, YNS, AK	Photo

a Mean percent young ± variance weighted according to flock size of samples.
b MD- Mackenzie River delta; YNS-Yukon North Slope; AK-ANWR, Alaska
c Since Paulatuk is a rarely used staging area, no quantitative survey was conducted. Data are estimates made by experienced biologist.

Table 4. Spatial differences in age ratio of snow geese, Arctic National Wildlife Refuge, Alaska, Yukon Territory north slope, 14-15 September, 1982.

Area	Mean	Variance	n	F	Unpaired-t	d.f.
Hulahula River to Egaksrak River	4.9	1.6	15			
				1.313	1.375	21
Border to Herschel Island	4.1	2.1	8			
Arctic National Wildlife Refuge	5.6	2.0	16			
				1.606	3.274[a]	27
Yukon Territory north slope	4.0	1.2	13			

[a] $p < 0.001$

area of coverage was complete using a systematic survey pattern; (2) the FWS and CWS portions of the survey were scheduled to occur concurrently, if possible (concurrent is ideal) (3) certain weather and survey minimum conditions were met (Spindler 1982). Estimation error was first addressed for the 1982 survey data.

Actual numbers of snow geese detected on 26 total flock photos were compared to the instantaneous visual estimates of the same flocks made during the aerial survey. The actual photo counts were significantly greater than the visual estimates ($t = 3.241$, $n = 26$, $P < 0.01$), and a linear relationship existed between the 2 values ($Y = 158.5 + 1.051X$, $r^2 = 0.920$, $P < 0.005$). The survey crew consistently underestimated total flock size by 19%. This relationship was used to adjust visual estimates to give a minimum estimate of actual numbers of geese present in the survey areas (Table 5)

Table 5. Adjusted estimate of lesser snow geese staging in 1982.

Area	Visual estimate	Adjusted by regression	±	95% confidence interval
Alaska-ANWR	101,684	107,072	±	13,866
Yukon	111,975	117,892	±	15,279
Total	213,659	224,806	±	29,242

These estimates (Table 5) for the Alaska and Yukon staging grounds must be added to the 6155 geese visually estimated to have staged on the outer Mackenzie River delta and Bathurst Penninsula a few days earlier, yielding a 1982 total for the western arctic population of 231,100 ± 29,200. This estimate represents a minimum estimate because (1) birds may have been missed in the patchy fog conditions which obscured about 20% of the Alaska area on 14 September, and (2) some birds may have moved between the 9-11 September survey dates flown by CWS personnel, and the 14-15 September survey dates flown by FWS. The relationship between flock estimates and flock size in 1982 was useful in adjusting the estimates. This relationship must be evaluated each year since survey crew and conditions are likely to change. For example, similar comparison of 15 flocks photographed in 1979 with accompanying visual estimates indicated that the estimates exceeded actual photo counts by a factor of 2 (Spindler 1979). Also, estimation error is not consistent between various flock sizes.

Evaluation of Photographic Techniques

Quality photography is critical to the successful outcome of age ratio estimation. The best quality photographs were obtained using various combinations of camera and film, depending on light conditions. On sunny days, the 35 mm camera with a high-quality 135 mm telephoto lens and ASA 50 H&W VTE PAN film produced the best photos because of camera manuverability and rapid shooting characteristics. The same combination produced poor results on cloudy overcast days due to slow shutter speed required by the slow film

speed, and to poor contrast. If higher speed ASA 400 TRI-X PAN film was used with the 35 mm camera, the resolution dropped considerably making the large format camera more desireable. On cloudy, overcast days the 60 x 70 mm camera with 250 mm telephoto lens and ASA 400 TRI-X PAN film produced better results because high film speed and high resolution of the large size format compensated for poor lighting conditions. The 60 x 70 mm/TRI-X PAN combination also produced good results on sunny days, but its large size, awkward handling, and slow shooting characteristics made it a poor choice if sunshine allowed the use of the 35 mm with VTE PAN. Seating of the primary photographer in the right front seat of the aircraft worked best so the pilot could easily determine the proper shooting angle and distance and subsequently manuver the plane in to the correct position. Location of the back-up photographer in the right rear seat also worked well but that position had a limited shooting angle. Both photographers should practice shooting on the ground, and in the air, before transects are initiated. Exposures should be adjusted +1 or 2 f-stops for aerial photography on sunny days, and panning is always recommended to alleviate motion problems. Accurate cross referencing of flock numbers with roll and frame numbers of each photograph is crucial and was readily accomplished by the recorder using an intercom system.

Acknowledgements

I would like to thank the USFWS Arctic National Wildlife Refuge staff, specifically G. Garner, J. A. Koschak, L. D. Martin, and P. A. Miller who assisted with the survey flights. Walt Audi flew all the surveys and contributed many hours worth of additional observations. T. W. Barry, of the Canadian Wildlife Service continued his usual cooperation from Tuktoyaktuk and Edmonton.

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Approved by: Gerald W. Garner Date: 10 December 1982
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APPENDIX

ANWR Progress Report Number FY83-4

Table A-1. Age ratios of snow geese as determined by photograhic counts on 29 August and 14-15 September, 1982, Arctic National Wildlife Refuge, Alaska, and Yukon Territory north slope.

Location date, and photo I.D.	Flock number	Adults	Young	Sample total	Estimated total	% young	$\bar{X} \pm SD$
Sadlerochit to Jago Rivers (29 August)							
1-9	17A	89	0	89	3500	0.0	
1-10	17B	473	0	473	3500	0.0	
2-10	26	86	0	86	250	0.0	
3-3	28	29	0	29	80	0.0	0 ± 0
Total		677	0	677	7300		
Hulahula to Egaksrak Rivers (14 September)							
3-6	56	282	0	282	282	0.0	
3-9	57	97	0	97	97	0.0	
4-1	61	70	0	70	1750	0.0	
5-2	76	773	0	773	800	0.0	
5-3	78	1019	11	1030	1030	1.1	
5-8	80	336	14	350	3000	4.0	
7-1	95	124	11	135	600	8.1	
7-2	96	192	12	204	204	5.9	
7-3	97	573	30	603	2500	5.0	
8-1	110	130	6	136	5000	4.4	
8-7	115	420	16	436	675	3.7	
8-10	117	552	44	596	1000	7.4	
9-4	120	255	26	281	1000	9.3	
9-5	121	383	52	435	1250	12.0	
9-8	122	176	26	202	882	12.9	5.0 ± 1.6
South of Demarcation Bay (14 September)							
9-10	126	300	40	340	1200	11.8	11.8 ± 0
Border to Herschel Island (14 September)							
VTE 2-27	137A	188	108	296	1000	36.57)	19.0[a]
VTE 2-28	137B	851	135	986	1000	13.7)	
10-4	139	71	39	110	110	35.5	
VTE 2-30	140	864	73	937	937	7.8	
VTE 2-32	141	406	29	435	435	6.7	
VTE 2-33	142	762	6	768	1000	0.8	
10-8	142	1993	47	2040	2040	2.3	
VTE 2-35	143	1055	16	1071	6000	1.5	4.1 ± 2.1
South of Phillips Bay (14 September)							
VTE 2-37	159	771	39	810	3500	4.8	
VTE 3-3	185	264	68	332	800	20.5	7.7 ± 29.8
South of Trent Bay to S. of Shoalwater Bay (14 September)							
VTE 3-6	192	566	13	579	7250	2.2	
12-9	205	723	16	739	1500	2.2	
12-10	206	708	22	730	2250	3.0	2.4 ± 1.9
Totals		14,904	899	15,803	49,092	Overall	4.6 ± 0.7

[a]Pooled value for subsamples used in mean calculations.

Table A-2. Photographic count results used to assess accuracy of snow goose flock size visual estimates made 29 August and 14-15 September, 1982. Arctic National Wildlife Refuge, Alaska, Yukon Territory north slope.

Photo I.D. roll and frame	Flock number	Snow geese as counted on photo (Y)	Snow geese as estimated visually (X)
29 August			
VTE 1-12	15	894	750
1-7	15	1377	750
1-3	13	4635	4500
1-8	16	1207	1250
2-1	18	1297	1000
2-4	20	884	650
2-8	24	493	300
2-9	25	1517	2000
14 September			
3-6	56	282	200
3-9	57	97	60
3-10	60	225	125
4-8	66	3701	2750
5-2	76	776	800
5-3	78	1030	1000
5-10	85	462	500
7-2	96	204	75
8-3	112	3020	2500
8-7	115	646	375
9-8	122	882	750
9-9	125	37	35
VTE 2-28	137	986	1000
10-4	139	110	125
VTE 2-30	140	937	400
VTE 2-32	141	435	350
10-8	142	2040	1000
12-1	201	493	100
Mean		1103	898
Standard deviation		± 1123	± 1025
Linear regression (R^2)		0.920	
ANOR $F_{1,24}$		= 276.1[a]	
Equation		Y =158.5 + 1.051X	
Ratio	For each estimated goose, there were 1.2 counted on photos		

Paired-t:	All observations	n=26	3.241[a]
	Flocks < 1000	n=17	3.476[a]
	Flocks 1000-3000	n=6	1.117
	Flocks > 3000	n=3	2.271

[a] $p < 0.005$