CHARACTERISTICS OF THE HARVEST OF GREATER SNOW GEESE

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Abstract: The size of fall flights of greater snow geese *(Anser caerulescens atlanticus)* has increased from an average of less than 75,000 in the period 1950-70 to more than 200,000 in 1975-80. Since the turn of the century, sport hunting has occurred each fall in Canada but in the United States there was no open season from 1932 to 1974. The size of the sport harvest has been estimated in Canada since 1967 and in the U.S. since 1975. The estimates of Canadian kill show wide annual variations but indicate an increasing trend (1967-80). When the estimated U.S. kill, which also shows an increasing trend, is added to the Canadian kill a substantially larger and increasing harvest is evident since 1975. The effects of the size of fall flights and the proportion of young birds on the size of the harvest are examined. Those and other factors are also examined in relation to their impacts on population size, and some management implications are discussed.

At the turn of the present century, the greater snow goose population numbered less than 5,000 individuals. A gradual increase was evident through to the mid-1960's when estimates indicated about 60,000 birds in the fall flight. Over the following decade the increase was more rapid with fall flights, reaching in excess of 200,000 geese in 1974 and 1975. A more moderate rate of increase has been apparent since 1975. Over the same time period fall hunting occurred each year on the Canadian staging haunt in the St. Lawrence estuary but the hunting season was closed in the U.S. from 1932 to 1974. The size of the Canadian sport harvest has been measured since 1967 through the National Harvest Survey. The U.S. harvest has been estimated, since the reinstatement of an open season in 1975, through the U.S. Fish and Wildlife Service (USFWS) Harvest Survey and various state surveys. An increasing Canadian harvest, to which a large and increasing U.S. harvest has been added since 1975, has prompted us to examine various factors that influence the harvest and to appraise the impact of that take on the goose population.

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MEASURING THE HARVEST

In both Canada and the United States the only harvest surveys that systematically cover all of the geographic area in which sport hunting of greater snow geese occurs are the respective national surveys of migratory

game bird harvest: the Canadian national harvest survey and the USFWS harvest survey. Both national surveys combine mail questionnaire and parts surveys (see Boyd and Finney [1978] for a description of the Canadian survey). They are designed to provide reliable estimates for numerically important species that are taken over large geographic areas.

An indication of the limitations are reflected in the relatively broad confidence intervals that have been derived for recent Canadian national harvest survey estimates (Table 1). A further attempt to appraise the reliability of the Canadian national harvest survey results is presently being conducted by a special greater snow goose harvest survey that involves intensive sampling of waterfowl hunters from those areas that past records indicated to be most heavily inhabited by greater snow goose hunters. The results of the 1st 2 years of that study (Table 1) are not conclusive and a 3rd year's data will be required before a thorough analysis can be conducted.

Confidence intervals are not available for the USFWS estimates. Several biologists within the Atlantic Flyway believe that the harvest estimates for certain northeastern states in some years are unrealistically large (see Table 2); certainly some individual state estimates for certain years are based on comparatively small samples of goose tails. Annual estimates for all states combined are undoubtedly much more reliable, being based on larger samples of tails and covering a larger area. An alternative means of evaluating the reliability of the USFWS estimates, a comparison with the state operated surveys (Table 3), is rendered difficult because of the incompleteness and differing designs of those surveys.

Another check on the reliability of the combined Canadian and U.S. harvest estimates can be made by subtracting that harvest from the number of geese estimated present during the fall flight, and to compare the remainder (survivors) with the subsequent spring's population (Table 4). The combined harvest estimates were on average within 2.2% of the recorded losses over the fall-winter period, and in 3 of the 5 years the discrepancy was less than 10%. Because no important losses to factors other than hunting have been recorded for the fall-winter period, it must be concluded that estimates of the combined harvest have been remarkably accurate in most years.

SIZE AND DISTRIBUTION OF THE HARVEST

An examination of band recovery data revealed that less than 6% of 752 Canadian recoveries (1957-79) occurred in the Northwest Territories. Those recoveries can be attributed almost entirely to subsistence hunting by native peoples and indicate that a small harvest occurs in arctic Canada, which is not covered by harvest surveys. Of the remaining 711 Canadian recoveries attributable to sport hunting, all but 3 are from southern Quebec and the bulk of them occurred along a 100-km stretch of the St. Lawrence estuary, downstream from Quebec City. One recovery has been reported for each of the provinces of Nova Scotia, Ontario, and Manitoba.

According to the National Harvest Survey the Canadian sport harvest has fluctuated between 2,700 and 41,200, averaging 18,600 over the 13 seasons of 1967-79 (Table 1). Although there were large annual fluctuations, there was an apparent trend of increasing Canadian harvest (Fig. 1).

Both band recoveries and harvest estimates show that more than 95% of the U.S. harvest occurs in the 5 states of New Jersey, North Carolina, Maryland, Virginia, and Delaware (Table 2). New Jersey and North Carolina show a combined harvest of more than 60% of the U.S. total. Approximately 1-2% of the harvest occurs in each of the 3 states of New York, Pennsylvania, and Vermont, and a very few birds are taken in Connecticut, West Virginia, Massachusetts, and Rhode Island. A few greater snow geese are taken outside the boundaries of the Atlantic Flyway as evidenced by 2 band recoveries in both Illinois and North Dakota and one in Texas (from 279 U.S. recoveries, 1957-80).

The USFWS harvest estimates for the major wintering states of New Jersey, Delaware, Maryland, Virginia, and North Carolina rose steadily from 8,400 in 1975 to 25,000 in 1979, averaging 17,300 for the 5 seasons, in parallel with the U.S. total (Table 2). The combined Canadian and U.S. harvests showed a marked increasing trend over time (Fig. 1).

FACTORS INFLUENCING THE HARVEST

Over the 11-year period, 1969-79, the size of the kill was closely correlated to the size of the fall flight (Table 5, correlation coefficient $r = 0.73$, $P < 0.01$, using Canadian and U.S. harvest; $r = 0.79$, $P < 0.01$, using Canadian harvest only). Thus the larger fall flights from 1974 onwards led to larger harvests, both in Canada and continent-wide. Neither the absolute numbers of juvenile birds nor their proportion of the fall flight were significantly correlated to the size of the harvest. This is surprising in view of the greater vulnerability of young birds to hunting. The apparent contradiction appears to be due to a tendency for the juvenile harvest rate to decrease as the size of that cohort increases ($r = 0.76$, $P < 0.05$, using Canadian data, 1972-79).

IMPACT OF THE HARVEST

The percentage of the fall flight removed by sport hunting in Canada and the U.S. from 1969 to 1979 varied from 3.4 to 25.4%, averaging 13.9% (Table 5), and was correlated with the size of the fall flight ($r = 0.63$, $P < 0.05$). The Canadian harvest rate has not shown a pronounced trend with respect to time but the combined rate for Canada and the U.S. from 1975 to 1978 showed a steady increase, from 17.7% in 1975 to 25.4% in 1978 dropping to 22.1% in 1979, averaging 21.3% over that 5-year period.

Although the above-average harvest rates that occured in 1970 and 1975-79 reduced the fall flights substantially, those losses were compensated for by recruitment that exceeded 20% during the subsequent breeding seasons for 5 of those 6 years. Recruitment rate over the 11 years of the study averaged 23.8%, higher than that for harvest in all years but 1978. However, the annual rates fluctuated widely (0.4 - 45.6%), primarily in response to weather conditions on the breeding grounds. Thus the effects of hunting and recruitment can combine in various ways to produce different effects on the size of the subsequent fall's flight. In the period 1969-79 the size of the subsequent year's

fall flight decreased on 4 occasions and increased on 6 (Table 6). The percentage change in population showed a correlation with recruitment rate ($r = 0.89$, $P < 0.001$) but was not correlated with harvest rate ($r = 0.52$, $P > 0.05$). Prior to 1975 recruitment was exerting a greater immediate influence on population change than was the harvest rate. Since 1975 the 2 rates have come closer together as a result of an increasing harvest rate and a steadying of recruitment close to the mean rate for the decade.

Further examination of the data provided in Table 6 reveals that none of the fall flights from 1969 to 1978 was subjected to that combination of conditions likely to produce the greatest decline in population: a high harvest rate (> 19%) and low subsequent recruitment rate (< 13%). Because there is no obvious biological reason why those conditions could not occur in combination, it therefore follows that population decline greater than those recorded over that period are likely to occur in some years.

MANAGEMENT IMPLICATIONS

Ensuring a constant supply of harvestable geese, particularly high arctic-breeding species whose recruitment rates show wide annual variations, is a challenge to managers. An important requirement is to be able to predict the size of fall flights in order to regulate hunting so that the following spring's population is not reduced below that level required to replace losses.

It is as yet difficult to predict the size of fall flights of greater snow geese on the basis of either remote sensing of ground conditions in the arctic or direct observations of breeding performance; in the former case cloud cover, which affects the quality of satellite images, is particularly frequent over the breeding range, and in the latter the costs are prohibitive. On the other hand accurate counts are being routinely conducted by aerial photography in late spring in the St. Lawrence.

The field data from 1962-1979 were used to examine the relationship between observed spring populations and the fall flights that they produced (Table 7). The size of fall flights was plotted against the number of geese in the spring population, and the linear regression and 95% confidence intervals were computed (Fig. 2). From that, the expected range of fall flights (maximum and minimum at the 95% confidence level), which would be produced by a given level of spring population, can be calculated. As an example, such estimates have been produced for 2 population levels (Table 8).

The potential harvests that could be taken from those fall flights have been calculated using harvest rates of 15, 20, 25, and 30% (Table 8). The 1st 3 of those rates approximate the lowest, average, and largest rates, respectively, recorded during the 5 seasons (1975-79) since the reinstatement of hunting in the U.S. (Table 5). The 3rd rate, 30%, is a rate that could soon occur, given the increasing trend of harvest rate. It can be seen from Table 8 that a spring population level of 90,000 individuals would provide a potential harvest of 15,200 to 40,300 and that of 120,000 individuals, 21,100 to 51,800. By subtraction, the expected number of survivors can be calculated for the various combinations of fall flights and harvest rates.

Such a model would allow managers to predict a range of expected fall flight sizes by early summer and to appraise the possible impact of harvest on the next spring's population. In this way the possibility of important losses from hunting could be foreseen and regulations adjusted early enough to minimize risks of overharvest. By recognizing the need for harvest restriction prior to the hunt, rather than after, restrictions of lesser severity and shorter duration would be required; a rapid recovery of the population would be achieved with minimal inconvenience to hunters.

LITERATURE CITED

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Table 1. The sport harvest of greater snow geese in Canada, 1967-79.

Year	Estimated harvest	
	National harvest survey[a]	Special greater snow goose harvest survey
1967	16,800	
1968	2,700	
1969	3,300	
1970	25,300	
1971	13,300	
1972	6,100	
1973	26,200	
1974	9,000	
1975	31,400 ± 7,520	
1976	25,100 ± 8,820	
1977	20,100 ± 7,280	
1978	41,200 ± 10,510	43,100 ± 8,000
1979	21,800 ± n.a.	31,800 ± 5,490

[a]Includes all snow geese taken in zone 01 (southern region) of Quebec; see for example: Cooch and Newell (1977), Wendt *et al.* (1978).

Table 2. Sport harvest of greater snow goose in the U.S., 1975-79.

State	USFWS estimate based on mail questionnaire & parts surveys						% total band recoveries[a]
	1975	1976	1977	1978	1979	% total	
New Jersey	2,340	2,215	9,358	11,766	13,136	42.9	21.1
North Carolina	2,169	7,078	7,449	5,895	5,614	31.2	41.4
Maryland	1,658	727	2,483	-	4,625	10.5	11.2
Virginia	1,759	1,175	1,626	944	527	6.6	18.7
Delaware	492	935	491	880	1,126	4.3	2.8
Other states[b]	668	203	986	607	1,548	4.4	4.8
Total	9,086	12,333	22,393	22,092	26,576	99.9	100.0
Size of tail sample	70	77	153	161	213		

[a]Based on 251 band recoveries in the U.S., 1975-80.

[b]In order of importance: New York, Pennsylvania, Vermont, Connecticut, West Virginia, Massachusetts, and Rhode Island.

Table 3. Results of state operated surveys of greater snow geese harvest, 1975-79[a].

States	Estimated harvest				
	1975	1976	1977	1978	1979
New Jersey (Field Survey)	1,885	1,853	1,954	2,438	3,746
(Mail Quest.)	3,603	5,359	1,366	9,416	13,216
Delaware (Field Survey)	1,917	370	1,420	2,000	3,191
Maryland (Field Survey)	400	1,000	1,500	500	2,000
Virginia (Field Survey)	600	1,000	1,200	1,200	600
North Carolina (Field Survey)	1,391	1,675	2,300	2,000	915
Total 5 states (Field Survey)	6,193	5,898	8,374	8,138	10,452

[a]Data from 1980 report of the Snow Goose, Brant and Swan Committee of the Atlantic Flyway Technical Section.

Table 4. Population budget for greater snow geese, 1975-79.

Year	Size of fall flight[a]	Combined Canadian and U.S. sport harvest	Numbers of survivors	% difference from next spring's count[b]
1975	228,500	40,500	188,000	+ 13.5
1976	183,000	37,400	145,600	- 9.0
1977	204,100	42,500	161,600	- 16.1
1978	241,100	61,300	179,800	+ 5.7
1979	219,500	48,400	171,100	- 4.9
Average	215,200	46,000	169,200	- 2.2

[a]Estimated on the basis of current year's spring population, expanded on the basis of proportion of juvenile birds in fall flight: see "A greater snow goose management plan", draft prepared for Atlantic Flyway Council, technical section meeting, March 1981.

[b]Spring populations are derived from aerial photo counts in the St. Lawrence in May: "A greater snow goose management plan", ibid.

Table 5. Size of fall flights of greater snow geese, harvest and recruitment rates, 1969-79[a].

Year	Size of the fall flight (x 10^3)	Total harvest (x 10^3)	Harvest rate (%)	Recruitment rate (%)
1969	98.3	3.3	3.4	30.0
1970	164.7	25.3	15.4	45.6
1971	175.4	13.3	7.6	29.7
1972	135.3	6.1	4.5	0.4
1973	267.8	26.2	10.9	40.6
1974	176.3	9.1	5.2	6.4
1975	228.5	40.5	17.7	32.7
1976	183.0	37.4	20.4	12.6
1977	204.1	42.5	20.8	21.6
1978	241.1	61.3	25.4	20.1
1979	219.5	48.4	22.1	22.5
Average 1969-79	190.4	28.5	13.9	23.8

[a]Data on the size of fall flights and on recruitment rates are from "A greater snow goose management plan", draft prepared for the Atlantic Flyway Council, March 1981.

Table 6. Population change, harvest, and recruitment rates of greater snow geese, 1969-78[a].

Year	% change by next fall	Harvest rate (%)	Recruitment rate in next summer (%)
1969	+ 67.5	3.4	45.6
1970	+ 6.5	15.4	29.7
1971	- 22.9	7.6	0.4
1972	+ 97.9	4.5	40.6
1973	- 34.2	10.9	6.4
1974	+ 29.6	5.2	32.7
1975	- 19.9	17.7	12.6
1976	+ 11.5	20.4	21.6
1977	+ 18.1	20.8	20.1
1978	- 9.0	25.4	22.5
Average 1969-78	+ 14.5	13.1	23.2

[a]Data from same source as Table 5.

Table 7. Sizes of spring populations and fall flights of greater snow geese, 1969-1978[a].

Year	Size of population in spring	Size of fall flight
1962	49,700	69,400
1963	64,900	98,200
1964	59,700	75,100
1965	46,500	47,800
1966	43,400	68,900
1967	59,900	68,400
1968	50,500	57,700
1969	68,800	90,900
1970	89,600	168,400
1971	123,300	139,000
1972	134,800	135,000
1973	143,000	267,800
1974	165,000	176,000
1975	153,800	288,500
1976	165,600	183,000
1977	160,000	204,100
1978	192,600	241,100
1979	170,100	219,500

[a]Data from same source as Table 5.

Table 8. Expected sizes of fall flights, potential harvests, and survival of greater snow geese in relation to different spring population levels.

Spring population level	Range expected fall flight (95% confidence limits) (in thousands)	Potential harvest in thousands at rates of 15%	20%	25%	30%	Expected number of survivors in thousands at end of hunting season at harvest rates of 15% ⟵ 30%
90,000	min. 101.6	15.2	20.3	25.4	30.5	86.4 ⟵ 71.1
	max. 134.4	20.2	26.9	33.6	40.3	114.2 ⟵ 94.1
120,000	min. 140.9	21.1	28.2	35.2	42.3	119.8 ⟵ 98.6
	max. 172.7	25.9	34.5	43.2	51.8	146.8 ⟵ 120.9

Fig. 1. Harvest of greater snow geese, based on national harvest surveys in the United States and Canada, 1967-79.

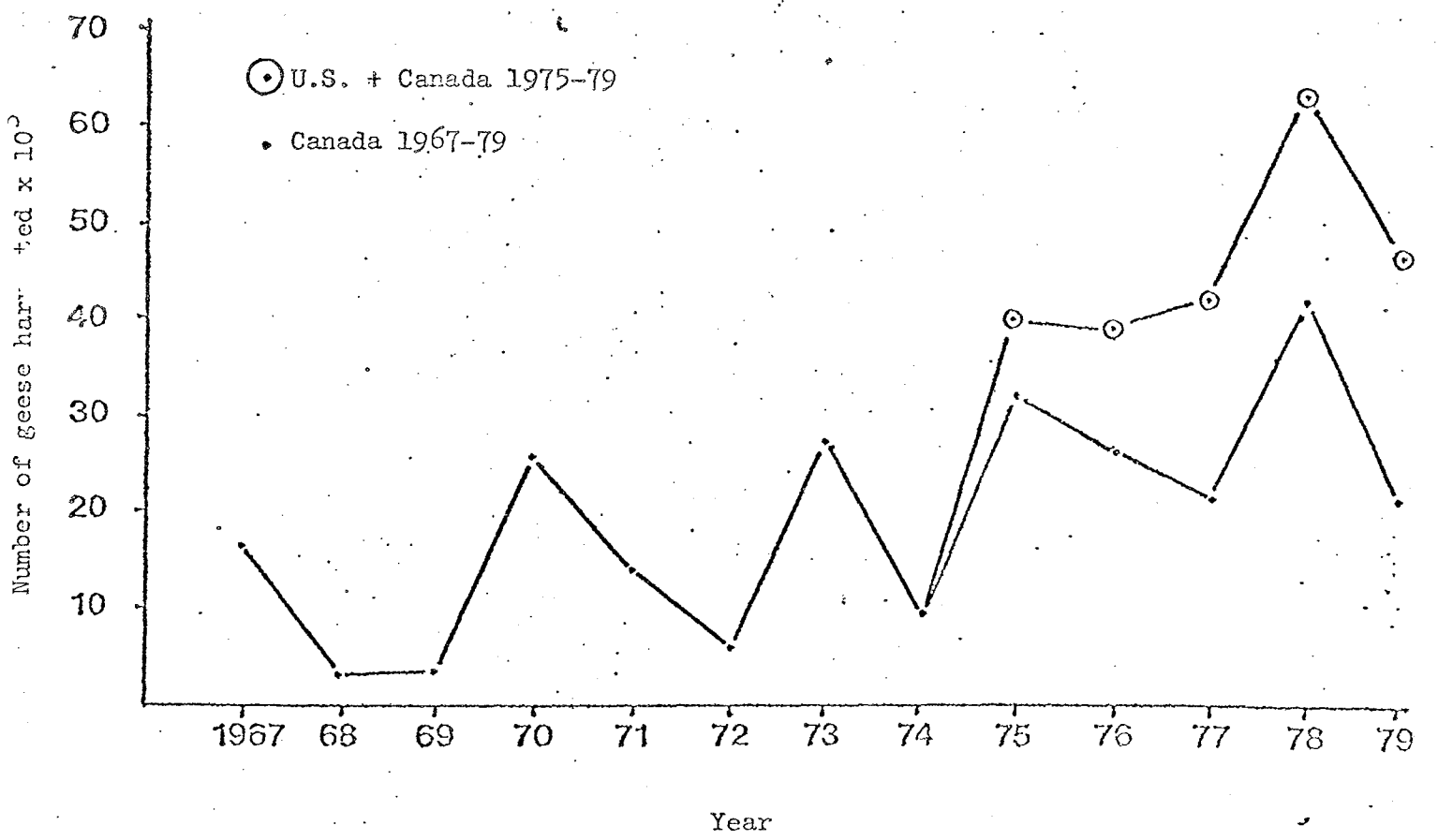

Fig. 2. Size of fall flights of greater snow geese in relation to the size of the spring population, 1962-79.