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Introduction

There are three populations of *Branta leucopsis* in the world, usually named after their different breeding grounds (Ogilvie, 1978; Owen, 1980):

– the Russian or Barents Sea population, wintering in the Netherlands and northern Germany,

– the Svalbard population, wintering along the Solway in south-western Scotland, and

– the Greenland population, wintering on the Inner and Outer Hebrides in Scotland and along the north and west coast of Ireland.

Since the species received full protection in the Federal Republic of Germany in 1977, it can now only be hunted legally in parts of Scotland. Under the 1981 Wildlife and Countryside Act, however, it will be protected in Scotland as well, and from then on all three populations will be fully protected from hunting over their entire ranges.

The aim of this paper is to present the most up to date information available on the status of these populations.

The author is most grateful to all who helped in gathering this information, and especially to *R. Beinert, H. Blijleven, D. Cabot, H. Krethe, E. Kumari, M. Lok, M. A. Ogilvie, M. Owen and B. Spaans*. *M. Ogilvie* and *M. Owen* commented on an earlier draft of this paper.

Methods

Regular censuses of all three populations are made on their wintering grounds, whereas additional counts from the spring staging areas are only available for the Barents Sea population.

Usually birds are counted from the ground, but in special cases aerial surveys are made as well.

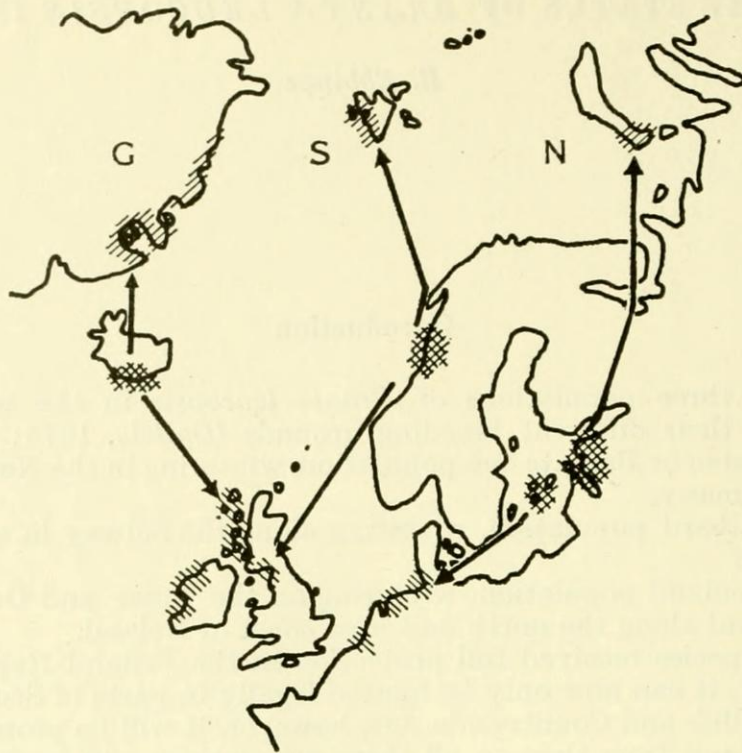
Population sizes have been plotted on a logarithmic scale so that changes in the rate of increase are immediately apparent from the figures. Mortality rates have been calculated using ringing recoveries or resightings but also, in periods of a fairly constant rate of increase, from the mean fraction of juvenile birds in the wintering population allowing for the rate of increase in population size, using the following formula:

$$m = j - i(1 - j)$$

where m = annual mortality rate,

j = mean fraction of juveniles in winter,

i = mean annual rate of increase in population size.






-  breeding areas.
-  wintering areas
-  spring staging areas

Figure XVIII|1: World range of *Branta leucopsis*

The mean annual rate of increase (i) is calculated as follows over a period of x years:

$$i = e^{\frac{1}{x} \ln \frac{n_{t+x}}{n_t}} - 1$$

where n_t = population size in year t .

Results

a) *The Russian or Barents Sea population*

Numbers

In the 1980–81 season three complete censuses of this population were carried out (Table 1), resulting in a mean of 38 000 individuals. Since the difference between the January count and the May counts can be explained in part by mortality, this mean figure will be too low for the population size in midwinter.

As a check on this figure population size has also been estimated by measuring the density of a known number of individually coded colour-ringed birds (Table 2). The agreement between the two independent estimates is striking and confirms the reliability of the counts.

This means, however, that this population has markedly declined in numbers from almost 60 000 in 1976–77 (see Fig. 2) to about 40 000 in 1980–81.

Table XVIII/1.

Total census of the Barents Sea population of Branta leucopsis in 1980–81

Date	Netherlands	Germany (FRG)	Sweden	Estonian S.S.R.	Total
11–1–81	41 350 ¹	216 ²	—	—	41 500
29–3–81	?	36 000 ¹	?	?	?
7–5–81	—	—	10 700 ³	25 200 ⁴	35 900
18–5–81	—	—	8 300 ³	28 835 ⁴	37 100

¹ Counts by Res. Inst. Nature Mgmt, supplemented by H. Blijleven and M. Lok.

² H. Krethe

³ R. Beinert

⁴ E. Kumari

Table XVIII/2.

Estimate of Barents Sea population of Branta leucopsis in 1980–81, using individually marked birds

	Mean:	S.D.:	Sample size:
Density of marked birds:	0.68%	0.48	27 756
Number of marked birds alive:	252		

Population size: $\frac{252}{0.68} \times 100 = 37\ 000$ (95 % conf. interv.: 30 400–47 500)

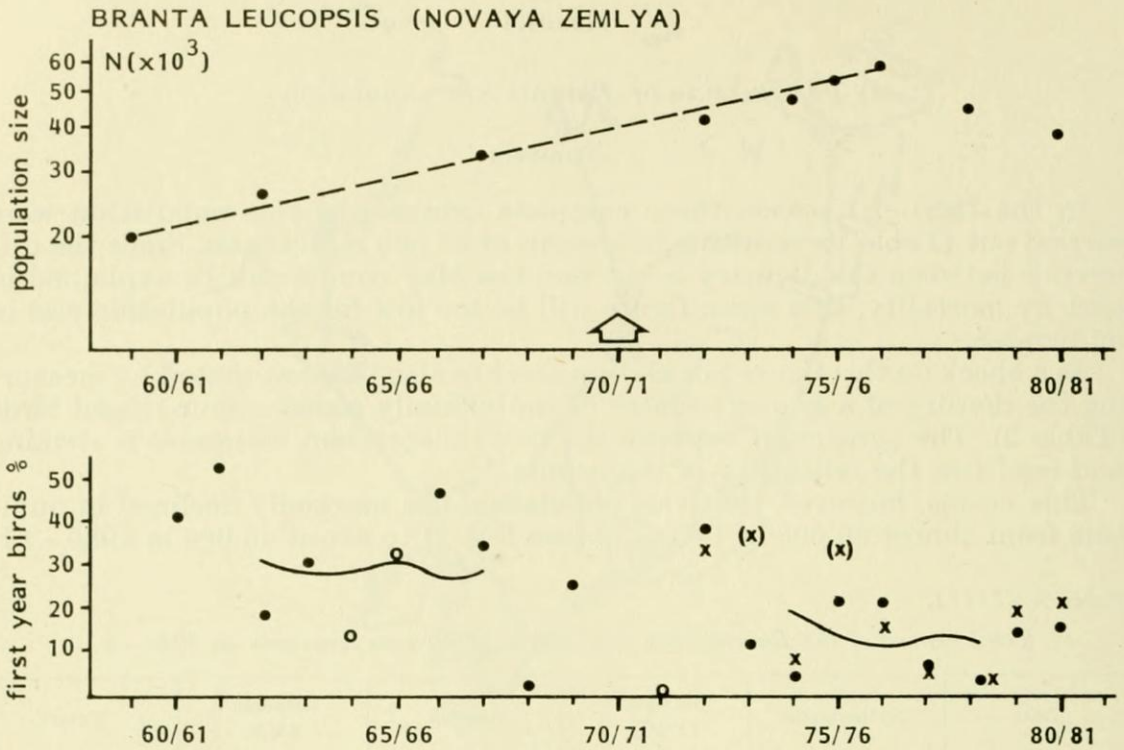


Figure XVIII|2: Change in size of the Russian breeding population of *Branta leucopsis* in the last twenty years (upper panel). Arrow indicates abolition of spring hunting in the Baltic. Breeding success (lower panel) was measured on the wintering grounds by catching on average 200 birds per season (circles: solid circles indicate a sample size of > 100 birds, whereas open circles < 100 birds). In the last ten years breeding success was also estimated by scanning large samples (> 1000 from grazing flocks crosses). Crosses in brackets are based only on samples from the SW. Netherlands, whereas the others are based on samples from both the northern Netherlands and the sw. part of the Netherlands

Breeding success

In the lower panel of Fig. 2, data on the proportion of juvenile birds on the wintering grounds are assembled. This is based on birds caught for ringing purposes using clapnets. Since in this old-style technique only live decoys and no bait is used to lure the birds into the catching area, this way of sampling is not likely to be biased in favour of juveniles. To check this supposition the age-ratio has been estimated more recently by a second method as well: scanning grazing flocks with high-powered telescopes and scoring the proportion of juveniles in samples of at least 200 birds (see *Ogilvie, 1978*). The results of this latter method have also been plotted in the lower panel of Fig. 2.

The mean values of both methods in the seventies do not differ significantly (paired t-test; $t = 1.44$, $p = 0.20$). The agreement would have been even better if not for two seasons: 1973–74 and 1975–76. For these two seasons only scanning data from the southwestern part of the Netherlands were available. This area holds on average one third of the whole population in winter, whereas the majority stays in the northern Netherlands and Germany. All clapnetting of *Branta leucopsis* takes place in the northern Netherlands. The

discrepancy between the two methods in these seasons could be explained if a higher proportion of juveniles occurred in the flocks wintering further to the south.

To test this I compared five seasons in which age-ratio counts were available for both the southwestern part and the northern part of the Netherlands. Though the means do not differ significantly (paired t-test, $t = 1.61$, $p = 0.10$), there seems to be a tendency towards a higher proportion of juveniles in the more southern wintering areas: 20% on average in the southwestern part against 13% in the north.

Although the clapped samples are almost exclusively from the northern Netherlands they seem to be reliable estimates for the proportion of juveniles in the whole wintering population (see Fig. 1).

When comparing these samples the proportion of juveniles in the sixties ($\bar{x} = 31\%$) is significantly higher than in the seventies ($\bar{x} = 15\%$) (t-test, $t = 2.45$; $p = 0.02$).

Mortality

In 1970 spring hunting of *Branta leucopsis* was banned in the Baltic, and in 1977 the autumn hunting of this species in Germany came to an end. Therefore the Russian *Branta leucopsis* population is now fully protected over its entire range. The effect of these protective measurements is illustrated in Fig 3. At present hunting is thought to have a negligible effect on mortality.

Before 1980, when this population was only protected in the Netherlands the annual mortality rate was 26% according to Haldane's method (Haldane, 1955). The relevant data are shown in Table 3.

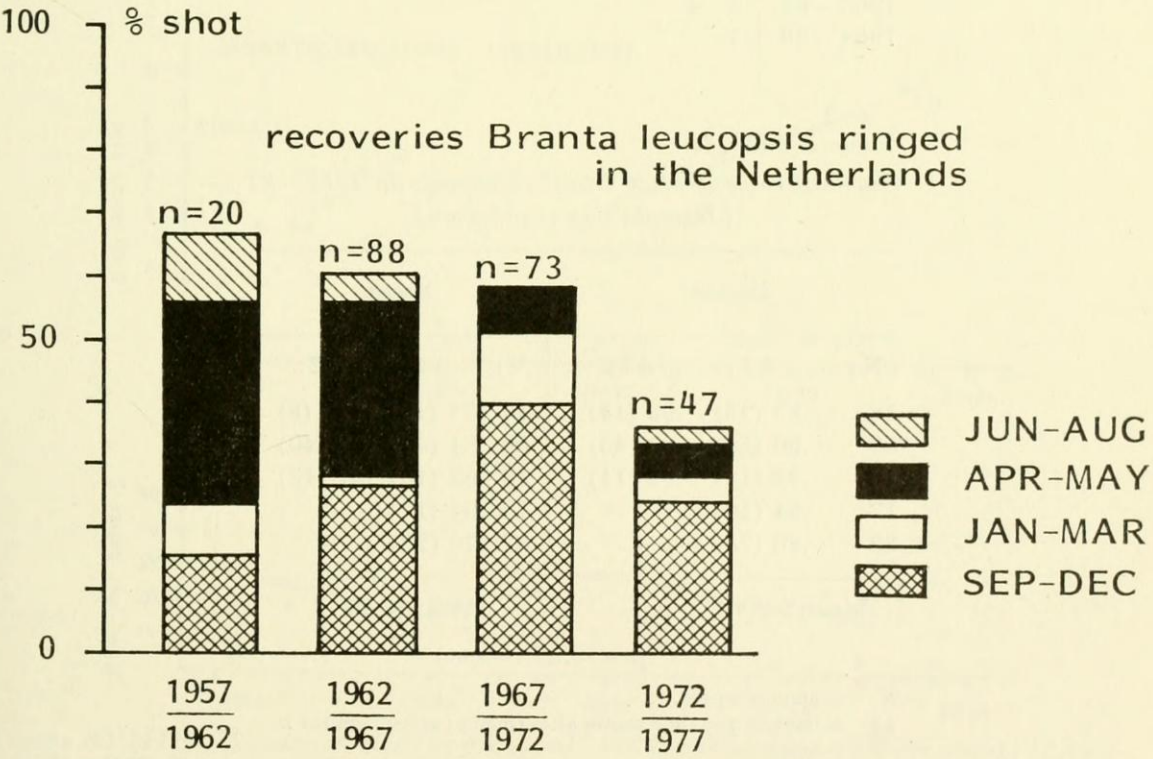


Figure XVIII/3: Decreasing impact of hunting on overall mortality of the Russian population of *B. leucopsis* during 1957 - 1977.

The present mortality rate can be calculated from the resightings of individually colour-ringed birds (design Wildfowl Trust). This colour-ring program was started in March 1979, and we have adopted the strategy of ringing rather few birds in combination with a high observation intensity in order to ensure that every ringed bird which is still alive will be detected. Table 4. shows

XVIII/3.

Recoveries of Branta leucopsis, ringed in the Netherlands, in 1958 - 1970

Ringing season:	Number recovered (dead) after x seasons											
	1	2	3	4	5	6	7	8	9	10	11	12
1957 - 58	5	1	-	-	-	-	-	1	-	-	-	-
1958 - 59	-	-	-	-	-	-	-	-	-	-	-	-
1959 - 60	-	1	1*	2	-	1	-	1	-	-	-	-
1960 - 61	-	2	2	1	1	-	-	-	1	-	-	-
1961 - 62	12	8	3	6	3	1	1	2	-	-	-	-
1962 - 63	-	3	3	-	-	1	-	-	-	-	-	-
1963 - 64	1	2	1	1	-	1	-	-	-	-	-	-
1964 - 65	-	-	-	-	1	-	-	-	-	-	-	-
1965 - 66	1	-	-	-	-	-	-	-	-	-	-	-
1966 - 67	10	8	4	-	-	-	-	-	-	-	-	-
1967 - 68	3	4	-	-	-	-	-	-	-	-	-	-
1968 - 69	7	-	-	-	-	-	-	-	-	-	-	-

Table XVIII/4.

Survival rates of adult Branta leucopsis in 1979 - 81 (Barents Sea population)

Females:			Males:		
N:	A1:	A2:	N:	A1:	A2:
18	.83 (15)	.93 (14)	17	.77 (13)	.62 (8)
60	.90 (54)	.80 (43)	58	.81 (47)	.85 (40)
13	.92 (12)	.92 (11)	18	.83 (15)	.87 (13)
17	.94 (16)	-	18	.94 (17)	-
29	.86 (25)	-	37	.76 (28)	-

Mean: .89

Mean: .81

$p < 0.05$ (t-test)

N = number ringed.

A1 = fraction alive one season after ringing; actual number in brackets.

A2 = fraction surviving from the first to the second season after ringing; actual number in brackets.

the resightings of five different catches of adult birds after one and two breeding seasons. Since there is so little variation in survival rate between the different groups, I presume that virtually no ringed bird has escaped our attention. This is only possible because the occurrence of this species is restricted to rather few sites and a team of about 50 volunteers cooperates in identifying the ringed birds using high-powered telescopes (50x or even more).

Another striking feature in Table 4. is the significant difference in survival rate between males and females, males suffering a higher mortality than females. Imber (1968) documents the same phenomenon in *Branta canadensis*, but Owen *et al.* (1978) suggest the reverse in the Svalbard population of *Branta leucopsis*.

b) The Svalbard population

Numbers

This very carefully monitored population (Owen & Norderhaug, 1977; Ogilvie, 1978; Owen, 1980) numbered in 1980–81 9050 individuals (Owen, pers. comm.). As can be seen in Fig. 4. this population started to increase markedly in 1971 at a surprisingly stable rate. In this particular year their wintering area on the Solway in southern Scotland was made a special reserve and hunting in Norway and Svalbard was no longer permitted. During the last few years, however, its rate of increase seems to be levelling off.

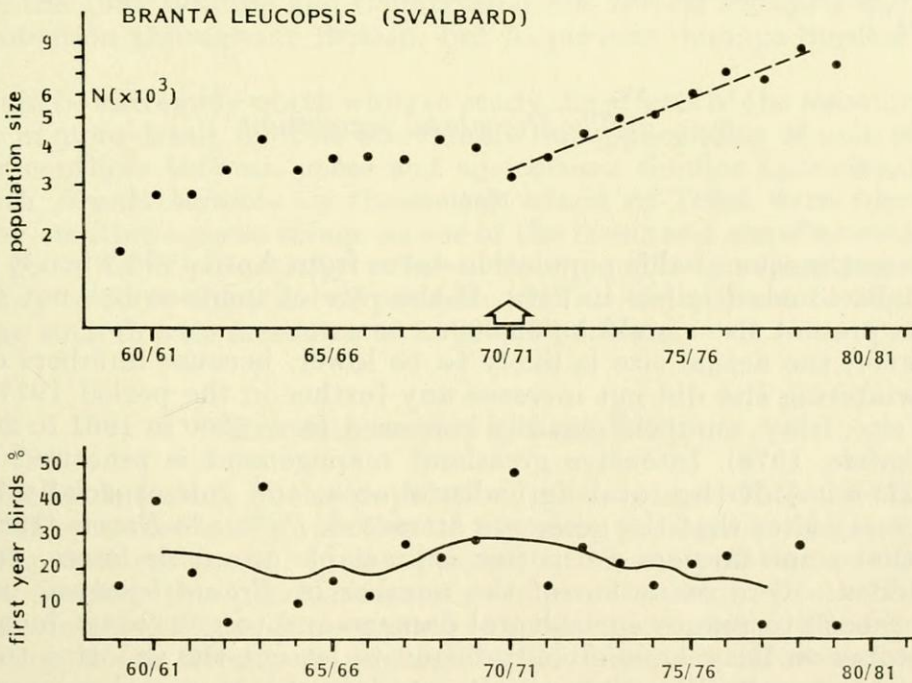


Figure XVIII/4: Population size (upper panel) and breeding success (lower panel) of Svalbard-breeding *B. leucopsis* during the last twenty years. Breeding success measured by scanning grazing flocks in winter. Arrow indicates onset of protective measures in its entire range

Breeding success

Despite this increase there is no significant decrease in breeding success, as could be observed in the Russian population.

The recent poor breeding results in 1977, 1979 and 1981 are due to bad weather conditions on Spitzbergen (the main island of the Svalbard archipelago) rather than to increased competition for suitable nest sites or moulting areas as a result of the increased population size (*Prop*, pers. comm.). Therefore the recent levelling off in the rate of increase in numbers in the near future is to be expected, particularly because the proportion of juveniles following recent breeding seasons under favourable weather conditions (1978 and 1980) is still high (see Fig. 4, lower panel).

Mortality

Over the last ten years this population increased from 2300 to 9050 a mean rate of 11% annually. The mean proportion of juveniles in this period was 18.2%, and therefore the mean annual mortality rate was 9.2% (see Methods).

An independent estimate of the annual mortality rate is obtained from the annual survival rate of individually marked birds and amounts to 9.8% for adults and 17% for yearlings (*Owen*, pers. comm.). According to *Owen* (1980) the latter method overestimates the annual mortality rate due to probable ring loss.

For further details regarding the Svalbard population the reader is referred to *Owen's* contribution to this symposium ("Studies of Spitzbergen *Branta leucopsis*").

c) *The Greenland population*

Numbers

The latest census of this population dates from April 1978 when it totalled 33 000 individuals (*Ogilvie* in litt.). If the rate of increase has not changed since, its present size should be 39 000.

However, the actual size is likely to be lower, because numbers on their major wintering site did not increase any further in the period 1977–1981. On this site, Islay, numbers steadily increased from 5800 in 1961 to 24 000 in 1976 (*Ogilvie*, 1978). Intensive grassland management is practised here on 5.2% (2774 ha) of the total agricultural area, and it is especially to these green, grassy sites that the geese are attracted. *Patton & Frame* (1981) have shown that some farmers can suffer appreciable economic losses, and have advocated a severe reduction of the number of *Branta leucopsis* on Islay. In trying both to reduce agricultural damage and to gain extra income, the large estates on Islay have already begun to let out the shooting to paying visitors. As a result the number of *Branta leucopsis* shot each winter has increased from about 500 before the mid-1970s to 1200–1400 at present (*Ogilvie*, in prep.).

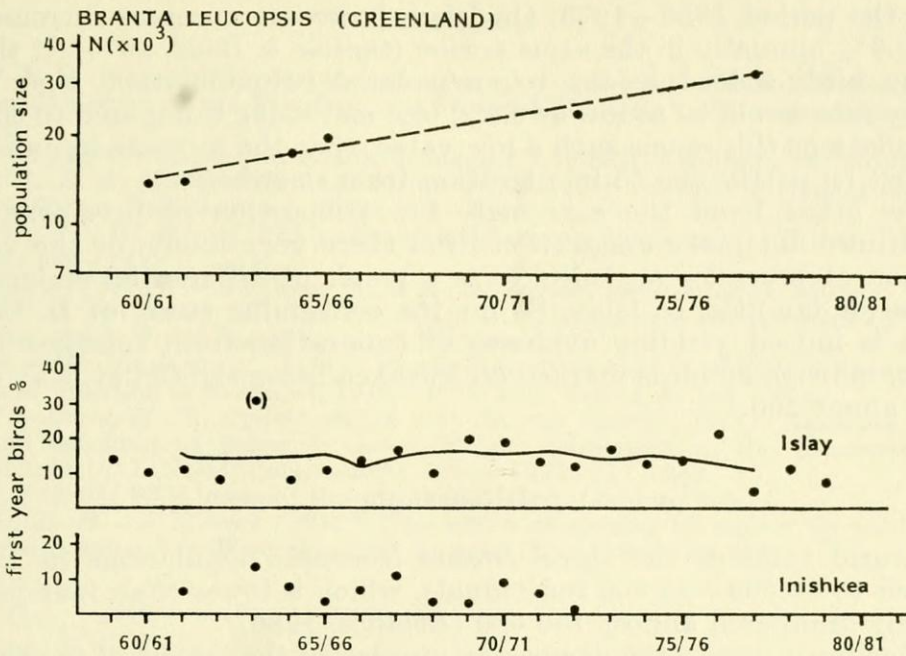


Figure XVIII/5: Population size (upper panel) and breeding success (two lower panels) of Greenland-breeding *B. leucopsis* over the last twenty years. Breeding success was measured by scanning grazing flocks on two wintering areas: Islay in Scotland, and Inishkea in Ireland

Since this deliberately increase in shooting pressure, numbers on Islay have no longer increased, but have stabilized at about 20 000.

Under the 1981 Wildlife and Countryside Act *Branta leucopsis* will receive total protection throughout Britain, but to prevent damage licences can be issued.

It would be extremely worth while to study the effects of the measures taken on Islay in more detail, in order to evaluate the applicability of such measures in other conflicts between geese and agriculture. Similar agricultural problems with *Branta bernicla* on the Dutch island of Texel were successfully solved by creating a goose refuge on one of the farms and simultaneously scaring the geese from potentially vulnerable crops. This obviously is a much better way to solve this kind of problem, and should at least be tried before accepting such drastic measures as large scale killing.

Breeding success and mortality

A remarkable feature of this population, when compared to the other two, is the stable, rather low proportion of juveniles throughout the last twenty years (Fig. 5, lower panel). In the fraction of this population wintering on Inishkea, Ireland, this phenomenon is even more striking. Do the Islay and Inishkea wintering birds form separate subpopulations with different rates of increase, or is the Greenland population concentrating more and more on Islay at the expense of other wintering sites? On all other sites along the Scottish westcoast and in Ireland, numbers are very stable (Cabot & West, 1973; Ogilvie & Boyd, 1975), with a mean yearly rate of increase of only

0.2% in the period 1956–1973. On Islay, however, numbers increased at a rate of 9.9% annually in the same period (Ogilvie & Boyd, 1975). If the Islay wintering birds indeed belong to an isolated subpopulation, their annual mortality rate would be as low as 6.8% (see methods). Compared to the other two populations this seems such a low value, that the increase in numbers on Islay must be partly due to immigration from elsewhere.

On the other hand the extremely low proportion of juveniles on e.g. Inishkea does not make emigration from there very likely, or the very low proportion of juveniles on Inishkea is a result of differential emigration of juveniles (or families) to Islay. So far the continuing study of D. Cabot on Inishkea is indeed yielding evidence of emigration from Inishkea to Islay (*D. Cabot* in litt.), 20 birds marked on Inishkea being sighted at Islay out of a total of about 200.

Discussion

The world total of the three *Branta leucopsis* populations in 1980–81 amounted to 80 000–90 000 individuals, which is lower than four years ago when they numbered almost 100 000 (Ebbinge, 1980).

This decline is due to the decreasing number of the largest of the three, the Russian or Barents Sea population, but the increased hunting pressure on the second largest population, the Greenland one, may have caused a decline in this population as well. However, no recent full counts of this latter population are available since April 1978. In the Russian population the proportion of juveniles has decreased significantly in the last twenty years. Decrease of reproductive output in a growing population is also observed in other goose species, e.g. the Icelandic *Anser anser* (Owen, 1980), and might be a result of increased intraspecific competition.

The other two populations do not show a marked decrease in their breeding success. The smallest, and most rapidly growing population, breeding on Svalbard, still has a fairly high reproductive output, whereas the larger Greenland population has, ever since the Wildfowl Trust started its monitoring program in 1959, been characterized by a low and rather constant reproductive output.

To find a way to solve present conflicts between agriculture and *Branta leucopsis* wintering on Ksley (west Scotland), more research is badly needed. Especially scaring activities (including shooting) should be carefully monitored as to their effects on the geese.

Apart from the studies already mentioned in last year's report on *Branta leucopsis* (Ebbinge, 1980), L. Gustafsson from the Zoological Department of the University of Uppsala will start a special study on the influence of spring feeding on subsequent breeding success (financially supported by the Swedish W. W. F.) in close cooperation with the I. W. R. B.—Barnacle Goose Research Group.

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