Table VI. Regional differences in rate of recovery in January–March 1963 of Mute Swans ringed in 1962

	south -west	*London & south-east*	*east Anglia*	*east midlands & north-east*	*west midlands & north-west*
recovered	24	30	22	10	20
ringed 1962	456	617	296	219	903
% recovered	5·3	4·9	7·4	4·6	2·2

Deaths of wild White-fronted Geese at Slimbridge in January 1963

J. V. BEER and H. BOYD

Summary

Heavy and persistent snow cover caused a serious shortage of food for White-fronted Geese in England and Wales from late December, 1962, to February, 1963. Fifteen Whitefronts found dead or dying at Slimbridge in January were all underweight and at least four had died from starvation. Recoveries of ringed birds show a similar concentration of losses in mid-January elsewhere in England and Wales, with an exceptional proportion of geese 'found dead' as well as unusually heavy shooting casualties. Recoveries from the Netherlands and France were also exceptionally numerous but do not show marked grouping in mid-January, perhaps because of emergency legal restrictions imposed in those countries.

On 26th December, 1962, the feeding grounds of the White-fronted Geese (*Anser a. albifrons* (Scopoli)) at Slimbridge, Glos., became wholly covered in snow, which remained until early March, 1963. White-fronted Geese are not seriously inconvenienced by light snow cover, searching widely for exposed grass or exposing it for themselves by sitting on the snow until it melts sufficiently for them to pull at the grass beneath. But the snow of late December lay so deep and thick and even that there was nothing for the geese to eat. 3,000 Whitefronts had been counted on 26th December and were still present on 29th. By 6th January the number had fallen to 800 and on 9th there were only 350. Fewer than 50 were seen on any day during the next four weeks. By 5th February, wind action and slight daytime thawing had exposed small areas of grass and thereafter the snow cover was not complete, even though the ground remained frozen until 5th March. By 9th February 500 geese had returned and their numbers increased to 1,200 on 14th, 2,000 on 16th and 2,750 on 25th.

Between 29th December and 28th January 15 dead or dying Whitefronts were brought in for examination. 13 of these were found between 8th and 17th January, when there were hardly any geese living at Slimbridge. None was picked up after the return of larger numbers in February. This paper reports on the condition of the birds that died and discusses why the deaths took place when they did.

Age and sex of casualties

Only two of the fifteen geese handled were first-winter birds. This proportion (13·3%) is little different from that of 9·6% first-winter birds seen in 1,400 inspected at Slimbridge on 21st December. This was the lowest proportion of young birds seen in late December in any year since 1946, when age-ratios were first studied. (The scarcity of young birds seems to have been due to widespread breeding failure in Siberia in 1962.) Since there were so few young geese, any difference in the response of young and older geese to the effects of thick snow cover would scarcely have been detectable in so small a number of corpses.

The sex of one badly-damaged goose could not be determined. Of the others, 10 were males and 4 females. Since the sex-ratio in Whitefronts flocks is normally very close to unity (Beer and Boyd, 1963), this disparity suggests that males were more vulnerable than females.

Causes of death

Four corpses were too badly damaged for the proximate cause of death to be discovered. Six of the remainder (five males) had been shot and four males seemed to have died from starvation. An adult female

picked up in a weak condition was killed by other birds when released some days later among captive geese.

No organised shoots took place at Slimbridge in the winter of 1962-63 but, as the post-mortem findings confirm, the abnormal movements of the geese in their search for food exposed them to considerable 'shooting pressure' even after the broadcast appeal to stop shooting made on 8th January, on behalf of the Wildfowl Trust and the Wildfowlers' Association.

Condition of dead geese

Table I summarises the information on condition given by the weight of each bird, by the presence of deposits of fat under the skin and among the viscera, and by the extent of wasting of the pectoral muscles and of the liver. Beer and Boyd (*loc. cit.*) have shown that in normal winters the weight of a Whitefront is closely correlated with its size, so that its normal weight can be estimated from the equation of regression of weight on wing length. The entries in the column 'expected weight' were obtained in this way, using different equations for males and females and for first-winter and older birds.

All the geese found were lighter than their predicted weights. The shot birds averaged 17% and the starved birds 42% below expectation. All six of the birds with weights less than 80% of expected which were examined after death showed reduction of the liver and five also had wasted pectoral muscles. Only one retained any subcutaneous fat. In three, the intestines were markedly reduced. The condition of the heart varied considerably in the six low-weight geese: it was soft and flabby (and hence probably reduced) in two and apparently normal in one. In two the pericardium was thickened and in one of these the valves were also thickened. In the sixth the right ventricle was distended.

Among the geese with relatively high weights at death only the female picked up on 29th December and a male found on 10th January retained substantial fat deposits. These two and three others (the latest found on 16th January) showed little wasting of the breast muscles or of the liver and intestines. Three of the comparatively heavy birds, including the early-taken female, had greatly enlarged gall-bladders.

The effects of starvation on geese do not seem to have been studied. Latham (1947) included game-farm Mallard (*Anas p.platyrhynchos* (L.)) in an experimental study of the ability of game birds to withstand starvation and low temperatures. His principal finding was that females survived longer than males. Jordan (1953) investigated the effects of starvation on wild Mallard held in captivity. He found *inter alia* that starvation was accompanied by a high rate of body weight loss, rather less in females than males, the internal organs of females being more resistant to atrophy. Males died

Table I. The condition of White-fronted Geese picked up at Slimbridge in January 1963

date found	*sex*	*wing length (mm)*	*recorded weight (kg)*	*expected weight (kg)*	*recorded wt. / expected wt. (%)*	*body fat*	*wasting of breast*	*wasting of liver*	*state when found*
Shot									
8 Jan	♂	408	1·94	2·30	84	0	+		moribund
9 Jan	♂	419	1·82	2·47	74	1			dying
10 Jan	♂	419	2·35	2·47	95	2			dead
12 Jan	♂	407	1·54	2·27	68	0	++	++	weak, died 13th
14 Jan 1st W	♀	379	1·51	1·91	79	0	+	+	died when picked up
16 Jan	♂	433	2·46	2·60	95	1			freshly dead
Starved									
9 Jan	♂	436	1·40	2·63	53	0	++	++	crow-damaged
11 Jan	♂	436	1·28	2·63	49	0	++	++	dead
(17 Jan	♂	414	1·86	2·37	78		++		weak: recovered)
28 Jan	♂	429	1·35	2·54	53	0	++	++	died 29th
Killed by captive geese									
29 Dec	♀	383	1·72	2·09	82	2			weak

'expected weight' derived from regression of weight on wing length, see text.
body fat: scored on a 4 point scale, 0 = no fat deposits, 3 = heavy fat.
wasting of breast muscles and liver: + marked, ++ severe

sooner than females, deteriorating very rapidly after about three weeks starvation. The livers of starved birds lost proportionately more weight than did other organs. In both sexes the gall-bladders were enlarged to nearly three times their normal weight. The condition of the starved geese seems to be consistent with Jordan's findings, although enlargement of the gall-bladder was not recorded in the birds most severely affected.

Since the true weight of each individual at the onset of the severe weather is not known, no estimate of the rate of weight loss is practicable, but in this connection another small series of weights of White-fronted Geese trapped for ringing in the Netherlands is of some interest. Table II compares data published by Doude van Troostwijk (1964) with those from Slimbridge. Nearly all English-wintering Whitefronts spend part of the winter in the Netherlands so that the geese are of a common stock. The comparison is restricted to adult males, the only class with sufficient post-mortem material. The weight of Slimbridge geese in December shown in italic is the average of the hypothetical 'expected weights', obtained as described above. It is included here because of the possibility suggested by the relatively low average of the Dutch December sample that the geese may have been unusually light even at the onset of the severe weather.

There is marked difference between the average weights of Whitefronts trapped in the Netherlands in January, 1963, and of those picked up at Slimbridge. Those birds remaining in good enough condition to fly about and to be caught in clap-nets seem to have lost little weight (the average being scarcely 5% less than in December), being little if any lighter than geese caught in late January 1962, when the weather was not unusually cold. Yet the Netherlands records from late February and March 1956, another period of severe cold, show that appreciable weight reduction probably occurred in that year. The interpretation of these data is made difficult not only by their fragmentary nature but also by the possibility that geese wintering in the Netherlands may tend to weigh rather less than those moving on to England.

The individual listed in Table I as having recovered is of some interest. Picked up on 17th January in a very weak condition, it was kept in a warm room and given a diet of turkey starter pellets. In a very few days it began to regain its strength and after three weeks or so was so vigorous and belligerent that it became difficult to approach and eventually escaped on 20th February by pushing aside the person who had come to feed it. This goose was weighed at frequent intervals (Table III). For a fortnight before its escape the bird was heavier than its 'expected weight'. There is an interesting change in its rate of gain somewhere between the 8th and 12th day, the earlier increase (after the initial lag) being at more than twice the rate of the later ones. This suggests that two methods of gain may have been involved: perhaps a replacement of atrophied tissues initially and the deposition of fat later. Such a sequence would be the inverse of that occurring during starvation (Jordan, 1953). Jordan also studied the rehabilitation of Mallard after starvation and reported that one week after feeding was resumed males had recovered 80%, and females 83·6%, of the weight lost during starvation while after two weeks weights were nearly equal to those at the beginning of fasting. The corresponding intervals for this male goose seem likely to have been about two and three weeks.

Time of occurrence of death

It has already been remarked that 13 of the 15 casualties were picked up between 8th and 17th January and only one later (on 28th January), despite the continued severity of the weather. What significance attaches to the concentration of deaths in mid-January, 2-3 weeks after the ground became completely snow-covered? Jordan (1953) suggested that it was unlikely that even wholly starved Mallard would die in less than two weeks 'in nature in normal winter weather' (average air temperature

Table II. Mean weights of adult male White-fronted Geese picked up at Slimbridge in January 1963 compared with those of adult males trapped for ringing at Slimbridge and in the Netherlands

	December II	*January I*	*January II*	*February II & March I*
picked up at Slimbridge, 1963	*2·47*	1·76 (6)	1·89 (3)	
trapped in Netherlands, 1962-63	2·18 (5)	2·08 (8)	2·08 (3)	2·05 (25)
trapped at Slimbridge, 1958-62				2·45 (87)
trapped in Netherlands, 1962			2·16 (11)	
trapped in Netherlands, 1956				1·96 (11)

Netherlands data from Doude van Troostwijk, 1964. Weights in kg. Sample sizes in parenthesis.

29·8°F., –2°C., in his study). The air temperatures at Slimbridge in early January 1963 remained almost continuously below 0°C. and may have been rather lower than in Jordan's experiment, but the difference seems unlikely to have been enough to be important. Thus it can be argued that the small numbers of known deaths before 8th January show that the geese had not yet been incapacitated by starvation. The virtual absence of known deaths from 17th January to early February was inevitable if there were hardly any geese present to die during that time. Reason and observation suggest that the geese returning in February found enough food to keep them alive.

During January, 1963, White-fronted Geese were reported, often in exceptional numbers, in many of their usual haunts in England and Wales and from many places where they had rarely or never been seen before. The reports of living geese are insufficiently complete to demonstrate whether especial losses occurred in mid-January, nor were useful reports of dead geese received from elsewhere. Recoveries of rings, both from geese ringed in earlier years at Slimbridge and from those ringed in the Netherlands, are of considerable help on this point (Table IV). The recoveries in England and Wales show a concentration in mid-January almost as marked as the timing of casualties at Slimbridge, confirming that this was the worst period for the geese.

Full recovery details of Dutch-ringed geese in 1962-63 have not yet been published. Five of the Slimbridge-ringed geese were reported 'found dead' and five were shot (cause of death of three uncertain); in marked contrast, of twelve recovered in England and Wales in earlier winters, eleven were reported shot and only one found dead. These twelve earlier recoveries were spread over thirteen years, so that the recovery-rate in early 1963 was quite exceptionally high.

Among the recoveries of Slimbridge-ringed birds, including two overseas, eight were males and seven females. Of the five found dead, three were males. The lack of marked disparity between males and females seems to contradict the preponderance of males in the geese found dead at Slimbridge. In conjunction with Doude van Troostwijk's (1964) data, showing little loss of weight of either males or females in the Netherlands in January, 1963, this parity of reported losses away from Slimbridge may mean that males only succumb more readily than females at an advanced stage in their deterioration through starvation. Such an

Table III. Gains in weight of an adult male White-fronted Goose picked up at Slimbridge on 17th January 1963 and kept well fed until 20th February

day	*weight (gm)*	*gain (gm)*	*average daily gain*	*rate of gain (%)*	*day*	*weight (gm)*	*gain (gm)*	*average daily gain*	*rate of gain (%)*
0	1860	–	–	–	20	2470	130	32·5	1·32
2	1890	30	15	0·81	22	2500	30	15	0·61
4	2010	120	60	3·17	23	2530	30	30	1·20
6	2150	140	70	3·48	25	2590	60	30	1·19
8	2250	100	50	2·32	27	2690	100	50	1·93
12	2260	10	2·5	0·11	30	2750	60	20	0·73
16	2340	80	20	0·88	32	2820	70	35	1·27

Table IV. Dates of recovery of ringed White-fronted Geese in England and Wales, from December 1962 to March, 1963, compared with geese found dying at Slimbridge and with recoveries in the Netherlands and France

	period of recovery						
	Dec 21–31	*Jan 1–10*	*Jan 11–20*	*Jan 21–31*	*Feb 1–10*	*late Feb & March*	*total*
Slimbridge-ringed	0	5	3	2	1	2	13
Dutch-ringed	1	3	7	2	1	2	16
found in England & Wales	1	8	10	4	2	4	29
(unringed) geese picked up at Slimbridge	*1*	*6*	*7*	*1*	*0*	*0*	15
found in Netherlands	5	3	5	5	2	0	20
found in France	2	7	8	3	4	11	35

Recoveries of Dutch-ringed birds from Doude van Troostwijk (1964).

inference is consistent with the physiological evidence presented by Jordan (1953).

In the Netherlands and France the timing of recoveries was very different. Shooting was stopped by law in the Netherlands on 3rd January, 1963 and in France from 17th January to 16th February and again from 21st February to 8th March. The ban in France evidently reduced the kill in late January and early February. The situation in the Netherlands is less clear: large-scale emigration occurred after blizzards on 30th December and 3rd-4th January, yet recoveries did not diminish until February, though the rate of loss was relatively low (Doude van Troostwijk, 1964).

A thorough evaluation of the effects of the hard weather of early 1963 on the White-fronted Geese wintering in western Europe cannot be made until several years have elapsed. This preliminary study suggests, however, that losses both from starvation and from shooting were probably much higher in 1963 than in any winter since 1948.

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Shelduck food supply in severe weather

JOHN HORI

Shelduck (*Tadorna tadorna* (L.)) suffered heavy mortality in the Thames estuary during the icy conditions of January and February 1963. On one stretch of shore on Sheppey, Kent, 18 dead birds were found during visits on 10th February, 3rd March and 10th March. On the first date another 22 dead were found on the opposite side of the island by D. Burkett and on 17th February, D. L. Davenport found 33 in a third locality. The recorded dead represented approximately 5% of the birds in the area; actual deaths were probably much more numerous. Further up the Thames other correspondents informed me that some 150 dead were found between 26th January and 10th March (and see p. 26 of this Report).

The stomachs of nine of the birds which I found were sent to P. J. S. Olney who discovered that eight contained food and that this consisted entirely of the small snail *Hydrobia ulvae*. Only three of the birds were emaciated. One of these and one other had been shot; the rest were not obviously starved or diseased. By coincidence my own captive Shelduck 'went off' their food during the same period, ignoring 'rich feed' and consuming only corn. Unfortunately the danger was not realised until one had frozen to death during the night. The others were then found to be in poor condition.

The presence of *Hydrobia ulvae* in the stomachs of the wild birds examined indicates that it is an important part of the Shelduck's diet in the Thames estuary. It also confirms direct observations that during winter this species has a feeding preference for the higher levels of mud flats, since it is there that the snail is most common (C. M. Yonge, *The Sea Shore*. Collins, London, 1949). During the cold spell the upper foreshore was blocked by pack ice and snow for long periods and although the birds managed to find small quantities of snails it is apparent that other essential food was either unavailable or in short supply. It seems probable that most deaths resulted from exposure amongst birds weakened by food shortage, just as my own bird died. It also seems probable that the essential food is in the upper levels of the mud flats and the outer fringe of the saltings since had they wished to feed on marine mollusca they could have done so at most low tides. During the breeding season Shelduck also feed on the fresh marshes (Hori, in press), but they do not use them to any extent in the winter. During the period in question the marshes were, of course, snow covered.