Report of the Grasslands Trials Unit 1975 - 79

FALKLAND ISLANDS

APPENDIX 6

6 GOOSE STUDY

6.1 Ground Counts

6.1.1 Natural pastures

Introduction

The aim of this study was to describe the seasonal changes in the density of geese and sheep on different natural vegetation types in a 10km radius of Darwin. The vegetation of the Falkland Islands has probably been greatly altered since the introduction of sheep and unintentional introduction of many grass species so that it is probably misleading to call the vegetation "natural". However, many indigenous plants are still dominant in the Camp so the term "natural" is retained. It also helps to distinguish this type of vegetation from "improved" areas that have been rotavated, burned and seeded with yorkshire fog or other alien grasses.

Methods

Geese and sheep were counted on transects 250m wide on either side of a landrover on four routes through the Camp; Goose Green to Bodie Creek Ponds (7.7km), Goose Green to Orqueta Park (9.7km), Burntside to Laguna Verde (3.5km) and Burntside to Old House Pond (4.3km). The transects were covered monthly. All the transects were largely through Whitegrass, though included patches of diddle dee on dry slopes, bogged Whitegrass in valley bottoms, and a variety of greens (areas of very short and lush green vegetation). Greens can be split into different types depending on where they are found and the types of plants growing on them. In this study three types are recognised;

1. Pond greens which occur round ponds and are largely composed of Juncus scheuzeriodes and Plantago sp.,

2. Valley greens which occur in valleys and are often composed of Agrostis sp. and

3. Poa greens which are dominated by Poa annua and/or Poa pratensis and are found around settlements in sheep pens, at gates, corners of paddocks, along tracks or anywhere there has been intensive grazing, manuring and trampling by sheep.

The transects covered very few valley greens since rover tracks do not follow valleys. It is hoped that valley greens will be covered by aerial transects.

Results

The densities of geese found on the transects are shown in Figures 1 & 2. The data for all four transects have been combined. The larger densities of Upland Geese were found on the greens. The numbers on pond greens decreased through the winter whilst those on Poa greens were relatively constant. No distinct trend emerged for the bogged whitegrass though a peak in density occurred for whitegrass in winter.

Brent geese had a similar density on pond greens and showed a similar decrease through the winter (Figure 2). Smaller densities occurred on Poa greens and values were fairly similar for much of the year. Brent geese were not seen on whitegrass and diddle-dee though a few occurred in bogged whitegrass.

6.1.2 Improved pastures in Camp

Introduction

The aim of this study was to describe the seasonal charges in the numbers of geese and sheep on areas in Camp that have been improved by rotavating, burning and re-seeding with yorkshire fog. At present this is the only seed type that has been used to improve camps for the sheep.

Methods

Geese and sheep were counted on two yorkshire fog reseeds, near Burntside at the top of Choiseul Sound and on the north shore of Bodie Creek. Counts were carried out weekly at Burntside and monthly at Bodie Creek.

Results

The numbers of geese observed in the two areas is shown in Figures 3 & 4. No Upland Geese were present in February at Burntside and numbers did not increase much until late May. The population was relatively constant through the winter and decreased in October (Figure 3). Numbers then increased through November as birds gathered to shed at the water's edge where the reseed abuts with the head of Choiseul Sound, and a peak of 186 geese recorded. About 80 Upland Geese shedders were culled on 18th December 1978 and the remaining geese departed from the area when they regained flight. Few birds were present by mid January.

The population on the reseed at Bodie Creek had a similar pattern of change to that at Burntside except for one major difference; the population remained low thrcugh the summer since no flock of shedders occurred there (Figure 4).

No Brent geese were seen at either site.

6.1.3 Improved pastures near settlements

Introduction

The aim of this survey was to describe the seasonal changes in the numbers of geese on pastures near settlements where reseeding has been carried out with grasses other than yorkshire fog and with fertilizers, or where the management of reseeds is different than for those in Camp.

Methods

Counts of geese were carried out in the fields of Darwin dairy, and the fields used for the stud flock at Burntside. Although the fields at Darwin dairy are primarily used for dairy cattle and the present work is related to the sheep industry, these fields are only ones composed of the better grass types (cocksfoot, red fescue etc.) which are likely to be used in the Camp in the future. Therefore information on the way the geese use these different grass types is likely to be useful. 128ha of Darwin dairy was censused. In 1978 it was largely composed of established (over two years old) yorkshire fog (72ha) sown mainly in the early 1970's. There were 29ha of established cocksfoot sown in 1975, 10ha of established red fescue and smooth-stalked meadow grass sown in 1976, and 17ha of establishing (less than two years old) yorkshire fog, cocksfoot, red fescue and oats. (Figure 5).

The fields at Burntside (15ha) were reseeded with yorkshire fog about 15 years ago. The wetter areas in the fields also contain *Agrostis* and *Juncus scheuzeriodes*.

6.1.3

Results

Figure 6 shows the changes in numbers of Upland and Brent Geese on the two areas. Periods of snow or intensive shooting caused the birds to leave the fields. Approximately 400 Upland Geese were shot at Darwin dairy. Most shooting only has a localised disturbing effect. A group containing birds which are shot at will fly up and land approximately 50m away and resume feeding. Snow covered the ground for about 15 days during winter 1978 so only has a short term effect on the geese using the fields.

Largest numbers of Upland Geese occurred from May to September and there was a small but distinct peak in early November due to an influx of first year birds (Figure 6c). Brent geese arrived later in the winter and numbers fell rapidly through September (Figure 6d).

Numbers of Upland Geese changed erratically at Burntside fields with highest numbers in late winter and spring, and smallest numbers in December (Figure 6a). Brent Goose numbers were less erratic with largest numbers in winter. There was a steady decline in numbers through spring and early summer (Figure 6b).

6.2 Aerial Transects

Introduction

The aim of this study was to obtain information on the densities of geese and sheep over large areas of the Falklands and over vegetation types that could not be covered from ground counts (e.g. valley greens). To date we have only had two flights, an initial survey with Professor Dunnet on 2nd February 1978 over part of the North Arm transect and a complete run of the North Arm transect on 8th June 1978. The latter was with a different pilot from the initial run so lacked the continuity required in this work. Further flights have been impossible for the Falkland Islands Government Air Service have lacked either pilots, planes or flying time. The resulting major gap in our knowledge of sheep and goose numbers will make it impossible to predict the effects of geese and sheep on those vegetation types that we hoped to cover.

6.3 Breeding Biology

Introduction

Breeding birds were studied in order to describe the following aspects of the Upland Goose's breeding biology; the season of territory establishment, dispersion of territories, fidelity to territory and mate, age at first breeding, egg production and timing, gosling production and timing, behaviour and dispersal of successful and failed breeders.

Methods

Breeding birds were studied in the Ceritos Arroyo, one of its tributaries and at Laguna Verde. Isolated pairs in the High Hill district were also observed. Breeding adults and their young were individually marked in these areas.

Hatching dates were back calculated by measuring goslings and estimating their age from growth curves of goslings of known age. The onset of incubation was calculated by subtracting the incubation period from the hatching date.

Results

Breeding adults were found in the Ceritos Arroyo valley throughout 1978 though most left during autumn. Many had returned by late June/early July and the last marked pair to return did so by mid September.

Pairs which were successful in breeding in 1977 were still accompanied by the young from that year, but the young were chased away by their parents mainly in August and September. The first family party known to break up did so by late May, and the last family party seen together was on 11th October. The parents from this latter family did breed in 1978.

The dispersion of Upland Goose pairs in the Ceritos Arroyo and its tributary is shown in Figure 7. There were 34 pairs where both birds were in adult plumage and three pairs where the female was a first year bird and the male adult.

In 1977 both birds in 17 pairs were marked and birds from 13 of these pairs were seen in 1978. In 2 of the 13 pairs one member was not identified and the remaining marked bird took a new partner. The remaining 11 pairs were the same as in 1977; i.e. divorce was not recorded.

Birds from 15 pairs bred in the same area (within 200m) in 1978 as they did in 1977.

Nests were built virtually anywhere within the rim of the valley of the Ceritos Arroyo and up to 100m outside the valley. Eight of 17 nests found in the Ceritos were in whitegrass, four in bogged whitegrass, and five in a combination of whitegrass and Rostkovia, a relatively uncommon vegetation type. Two nests at Laguna Verde were in whitegrass about 100m from the water's edge.

Egg-laying started in the latter half of September. The mean date for the onset of incubation was 13th October (range 22nd September - 18th December). The mean clutch size was 6.1 $\pm$ 1.2 (3 - 8) eggs. The incubation period was measured twice and found to be 30 days on both occasions.

19 nests were found and one was deserted due to my interference. Five nests were lost to predators but only part of the clutch was taken in four of these, and the remainder were deserted.

15 other pairs were known to have bred (the male was seen "laying off") and four of these were not found with goslings suggesting that they too lost their clutch. Thus out of 33 known breeding attempts (the deserted nest was excluded from the analysis) 24 (72.7%) pairs were known to have produced goslings. The mean number of eggs hatched from the 13 successful nests was 4.9 $\pm$ 1.5. The total number of eggs hatched was 64, i.e. 82.1% of the 78 eggs in successful nests, or 59.3% of the total of 108 eggs if total losses are included.

The mean hatching date was 12th November. The average brood size when goslings were less than one week old was 5.2 ± 1.2 (n = 21). This figure was derived from outside, as well as inside, the study area, and is similar to the mean number of eggs hatched from known successful nests (4.9).

Almost all broods were raised in the stretch of valley where the nest was located. The goslings fed on the grass at the edges of the river in the early part of their life and retreated to the water at signs of danger. They foraged further from the river when they got older and may then run into the whitegrass rather than seek the shelter of the river when danger approaches.

Many goslings were lost to predators or died from other causes. 36 pairs were known to have hatched goslings and the subsequent fate of 32 of these broods was determined. 19 (59.4%) of these broods gave rise to fledged young. The fledgling period was found to be approximately 10 weeks giving the mean fledgling date as 21st January. The mean size of 57 fledged broods in February was 3.9 ± 1.7.

We are now in a position to give estimates of the breeding production from a population of Upland Geese. A breeding population of say 100 pairs would lay 610 eggs which would give rise to 378 goslings and ultimately 168 fledged young. Therefore the production per pair, when losses of complete clutches and broods are included, is 1.7 young per annum.

Ten pairs were known to have failed breeding at the egg stage and one of these was subsequently found with goslings indicating that they had re-nested. The female completed her first clutch between 9th and 13th October and deserted on the later date when I caught her on the nest. She was found with a brood on 19th December and it was calculated from the chick weights that she started incubating her replacement clutch on 15th November. Therefore approximately one month separated the two nesting attempts.

One pair, which nested very early, lost their clutch to predators between 26th September and 3rd October. Incubation had not started by 26th September for the nest was not lined with down. Despite losing the clutch early in incubation, and early in the season, this pair apparently did not re-nest for the pair was always seen together until late November when both left the Ceritos. This pair, and the 8 others which lost their clutch failed to re-nest. Thus it appears that re-nesting is relatively uncommon.

Three females marked as first year birds in a shedding flock at Old House Pond in December 1977, were found with a mate and goslings in 1978, indicating that females can breed for the first time in their second year (i.e. when c. 23 months old).

6.4 Social Organisation

6.4.1 Shedding

Introduction

A large section of the Upland and Brent Goose population undergoes moult of their main flight feathers (shedding), during which time they are flightless. Shedding birds were studied in order to describe the timing of the moult and the composition of the shedding flocks.

Methods

Trapped shedders were sexed and aged (first year birds have grey median coverts and adults have only white ones). The state of moult of primary feathers was described as follows: wing still with old primaries (old); old primaries dropped but new feathers not yet emerged (missing); pin feather forming (pin); and the length of the new growing vane measured in tenths (1 - 10) of its final length.

Results

A series of counts of the numbers of shedders was made at three localities (Figure 8 & 9). The numbers increased from mid November to early December, were fairly stable through December and fell during late December and early January. Although there were 10 shedders present at Bodie Creek Pond on 15th January it was found that they could all fly. They had been marked as flightless birds in December so could be distinguished as shedders. There was a similar situation at the beginning of shedding when birds gathered at the shedding site before losing the power of flight.

Shedders were trapped at 11 localities in 1978 and Table 1 shows the composition of the Upland Goose flocks in terms of sex and age. Males predominated in all flocks. The percentage of first year birds was higher in the flocks around Goose Green and at Cape Dolphin, and much lower in the north east of East Falkland.

The condition of moult of the birds caught at Salinas beach (3rd December), Teal Creek (5th December), Burntside (5th December) and Bodie Creek Pond (6th December) was combined for analysis. The percentage of birds in each moult class was calculated for adult males, first year males and adult females (Figure 10) and it was found that the first year birds were more synchronised in their moult than the adult males (Chi square = 19.4, $p < 0.01$). No difference was found between adult males and adult females (Chi square = 7.2, $p > 0.2$).

Upland Geese could fly once the vane of their primaries had grown to about 75% of their final length.

Data on shedding Brent Geese were obtained from four ponds (Table 2). The first catch at Bodie Creek Pond showed a high percentage of first year birds, whilst the second catch was more in line with the other catches. The birds were sexed (on calls) on the second catch and the ratio was 1 : 1.05 males to females.

6.4.3 Longevity

Introduction

The aim of this study is to determine the annual survival rate of adult breeding birds and from this, the average expectation of further life. Breeding birds were chosen for they tend to be faithful to their breeding territories and to return to them each year. This makes it easier to check on their survival.

Methods

Adult geese were trapped at the nest (females) or with their goslings (both sexes) and given a unique combination of colour rings. Geese were mainly marked in the Ceritos Arroyo valley, and also at Laguna Verde and High Hill district, all in the Darwin area.

Results

39 male and 48 female (total 87) breeding Upland Geese and 19 Brent Geese have been marked by the end of 1978.

19 male and 22 female (total 41) breeders were marked in 1977. Subsequent searches for these birds in 1978 were concentrated in the Ceritos Arroyo though all sites were revisited except one pond (where a pair had been marked). Of the 39 birds actively searched for in their previous breeding areas 29 were located. Two pairs from Laguna Verde and a pair from the tributary of the Ceritos were not found. Two birds from two pairs were not found, and the remaining member of these pairs had taken another partner. These initial results give an annual survival rate of 74% and an average expectation of further life of 3.4 years (based on the equation $2 - m/2m$ when m is the annual mortality rate). These figures must be regarded as a minimum and it is possible that some of the missing birds will be located in future searches.

It is unlikely that I will get meaningful results from the Brent Geese for although some of the 11 birds marked in 1977 returned to the breeding area in 1978 none were subsequently found with goslings. Part of the problem here is that they tend to run off and hide when they are with their young. Further it was not possible to mark large numbers of the breeding adults.

TABLE 1: THE COMPOSITION OF UPLAND GOOSE SHEDDING FLOCKS

Date	Place	Feeding Area	Number Present	Number Caught	% ♂	% IY ♂ in ♂ population	% IY ♀ in ♀ population	% IY
26.11	Bodie Creek Pond	Pond Green	45	40	60.0	41.7	18.8	32.5
6.12	Bodie Creek Pond	Pond Green	80	72	58.3	33.3	36.7	34.7
2.1	Bodie Creek Pond	Pond Green	45	39	56.4	31.8	35.3	33.3
3.12	Salinas beach	Poa Green	200	103	56.3	55.2	35.6	46.6
5.12	Teal Creek	Fog reseed	90	62	59.7	51.4	48.0	50.0
5.12	Burntside	Fog reseed	150	142	62.0	53.4	29.6	44.4
20.12	Seccomb Is.	Poa Green	150					
13.12	Swan Pond (Port Louis)	Pond Green	c.500	147	64.6	17.9	21.2	19.1
14.12	Cow Bay	Pond Green	90	66	51.5	8.8	18.2	13.6
25.12	Swan Pond (C. Dolphin)	Pond Green	590	233	54.2	32.8		
28.12	Trypot	Pond Green	191	162				
29.12	Sorrel Pond	Pond Green	434	70	54.4			
25.12	Pen's Pond	Pond Green	50		52.0			

TABLE 2: THE COMPOSITION OF BRENT GOOSE FEEDING FLOCKS

Date	Place	Feeding Area	Number Present	Number Caught	% IY	%
6.12	Bodie Creek Pond	Pond Green	15	15	66.7	46.2
2.1	Bodie Creek Pond	Pond Green	50	39	38.5	
20.12	Laguna Verde	Pond Green	70	68	42.7	
20.12	Seccomb Island	Poa Green	120	97	37.1	
26.12	Swan Pond (C. Dolphin)	Pond Green	360	102	31.4	
29.12	Scrrel Pond	Pond Green	250			

TABLE 3: TRAPPING STATISTICS OF SHEDDERS 1978

Date	Place	UPLAND GOOSE			BRENT GOOSE		
		No. caught	No. collared	Colour	No. caught	No. collared	Colour
26.11.78	Bodie Pond	41					
3.12.78	Salinas beach, Goose Green	103	98	White			
5.12.78	Teal Creek	62	60	White (spot)			
5.12.78	Burntside reseed	142					
6.12.78	Bodie Pond	72	72	White (stripe)	15		
13.12.78	Swan Pond, Port Louis	147	147	Blue (stripe)			
14.12.78	Cow Bay, Johnsons Harbour	66	66	Blue (spot)			
20.12.78	Laguna Verde				68	68	Green
20.12.78	Seccomb Is. Goose Green				97	89	Green
25.12.78	Swan Pond, Cape Dolphin				102	102	Red
26.12.78	Swan Pond, Cape Dolphin	233	233	Red	1	1	Red
28.12.78	Trypot, Cape Dolphin	162	162	Red			
29.12.78	Sorrel Pond, Cape Dolphin	70	70	Red			
2.1.79	Bodie Pond	39	9	White (stripe)	39	25	Green
	TOTAL	1140	917		322	285	

TABLE 4: SEASONAL DISTRIBUTION OF SIGHTINGS OF UPLAND AND BRENT GEESE (MARKED AS GOSLINGS) IN RELATION TO WHERE THEY WERE MARKED

UPLAND GEESE

Distance from place of marking (km)

	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Jan			2	1		3					1	(24km)
Feb	12	2	1	4		2		3	3			
Mar	18		5	3	6		3	3	4	1		
Apr	7	5	2	2			7	4	6		1	(33km)
May	21	5		2			2	1				
June	23	6	1			2	3		2	1		
July	6	4	1					3	2	4	3	(11 and 12km)
Aug							3		2			
	87	22	12	12	6	7	18	14	19	7	5	209

BRENT GEESE

Distance from place of marking (km)

	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	
Jan									
Feb	1			1					
Mar	1			2				3	
Apr	2							5	
May	3							4	
June	5							2	
July								1	
Aug	2								
	14			3				13	30

Table 5. The mass of Upland Goose and Brent Goose droppings collected on greens in winter (14th July 1978 to 8th August 1978) and summer (8th February 1979 to 1st March 1979)

			Fresh mass (g)				Dry mass (g)			
Species	Sex	Season	Mean	S.D.	n	Range	Mean	S.D.	n	Range
Upland	Male	Winter	8.4	2.4	20	5.3-15.5	1.13	0.31	20	0.75-1.96
Upland	Female	Winter	6.4	2.0	20	3.2-9.7	0.89	0.26	20	0.51-1.54
Upland	Male	Summer	8.5	2.1	22	6.3-13.5	1.23	0.32	22	0.79-1.88
Upland	Female	Summer	6.8	1.4	21	4.5-9.3	1.05	0.24	21	0.71-1.69
Brent		Summer	4.4	0.80	23	2.75-6.00	0.67	0.14	23	0.42-0.89

Figure 1. Densities of Upland Geese on different types of pasture

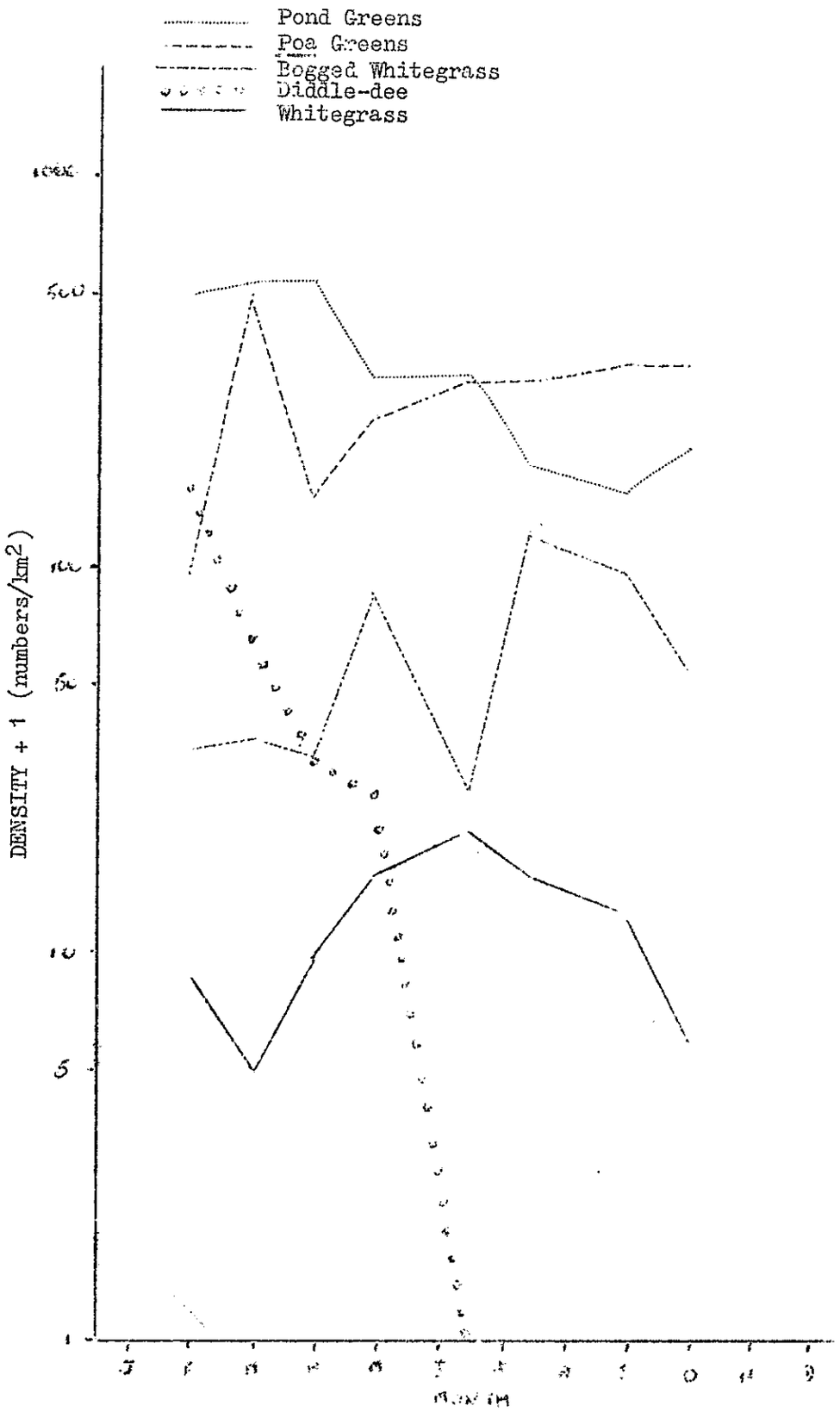


Figure 2. Densities of Brent Geese on different types of pasture

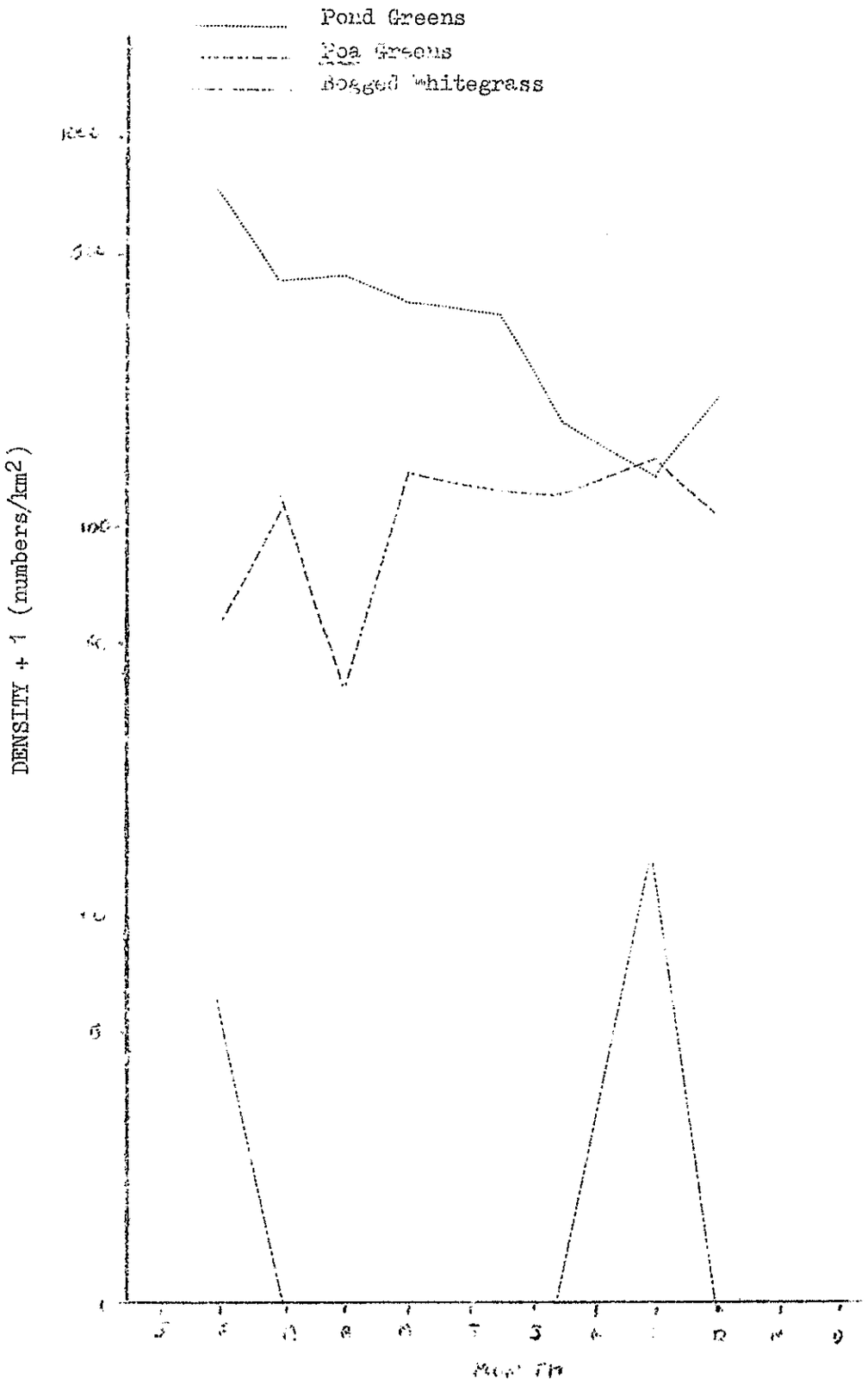


Figure 3. The number of Upland Geese at Burntside yorkshire fog reseed in 1978

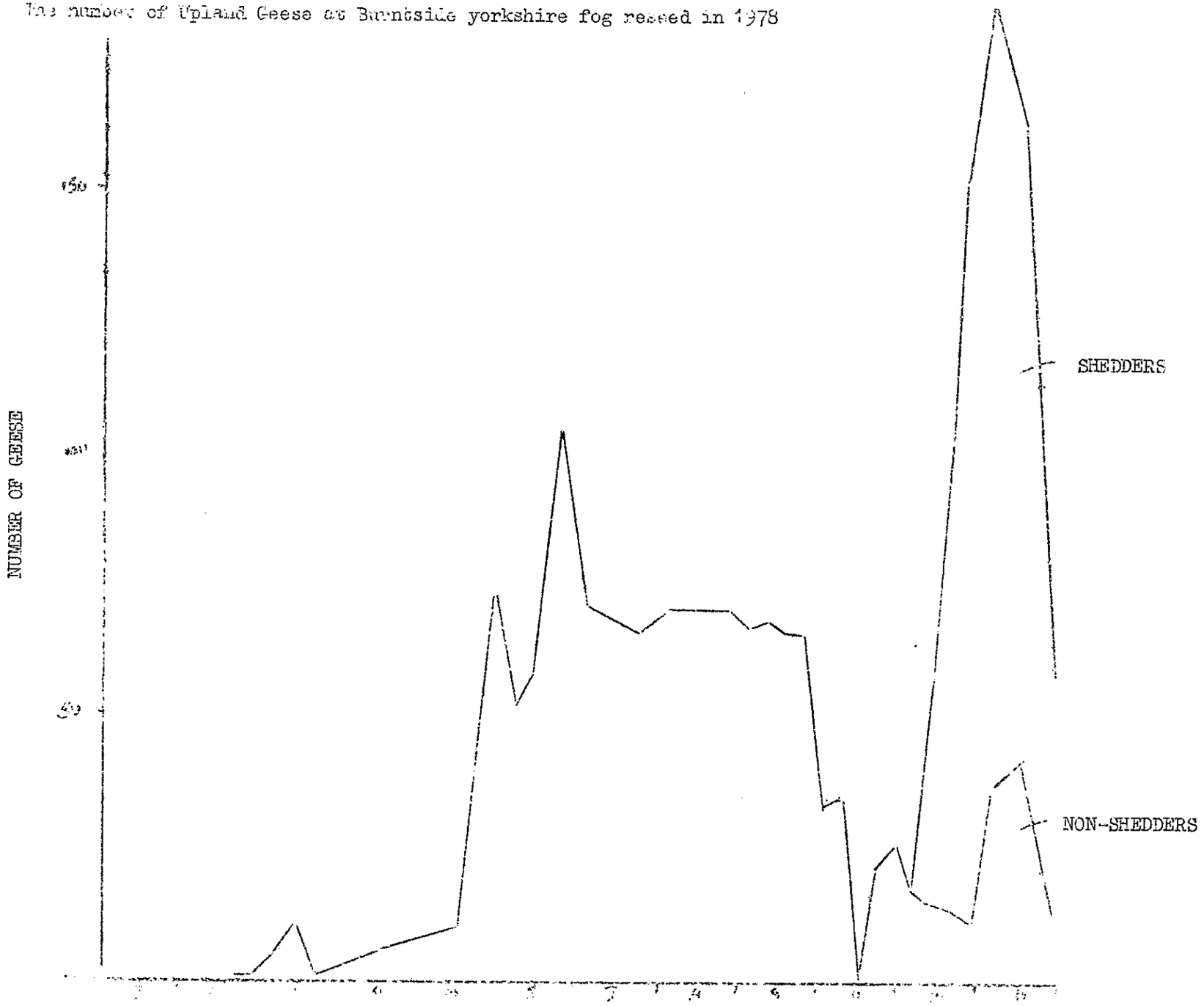


Figure 4. The number of Upland Geese at Bodie Creek yorkshire fog reseed in 1978

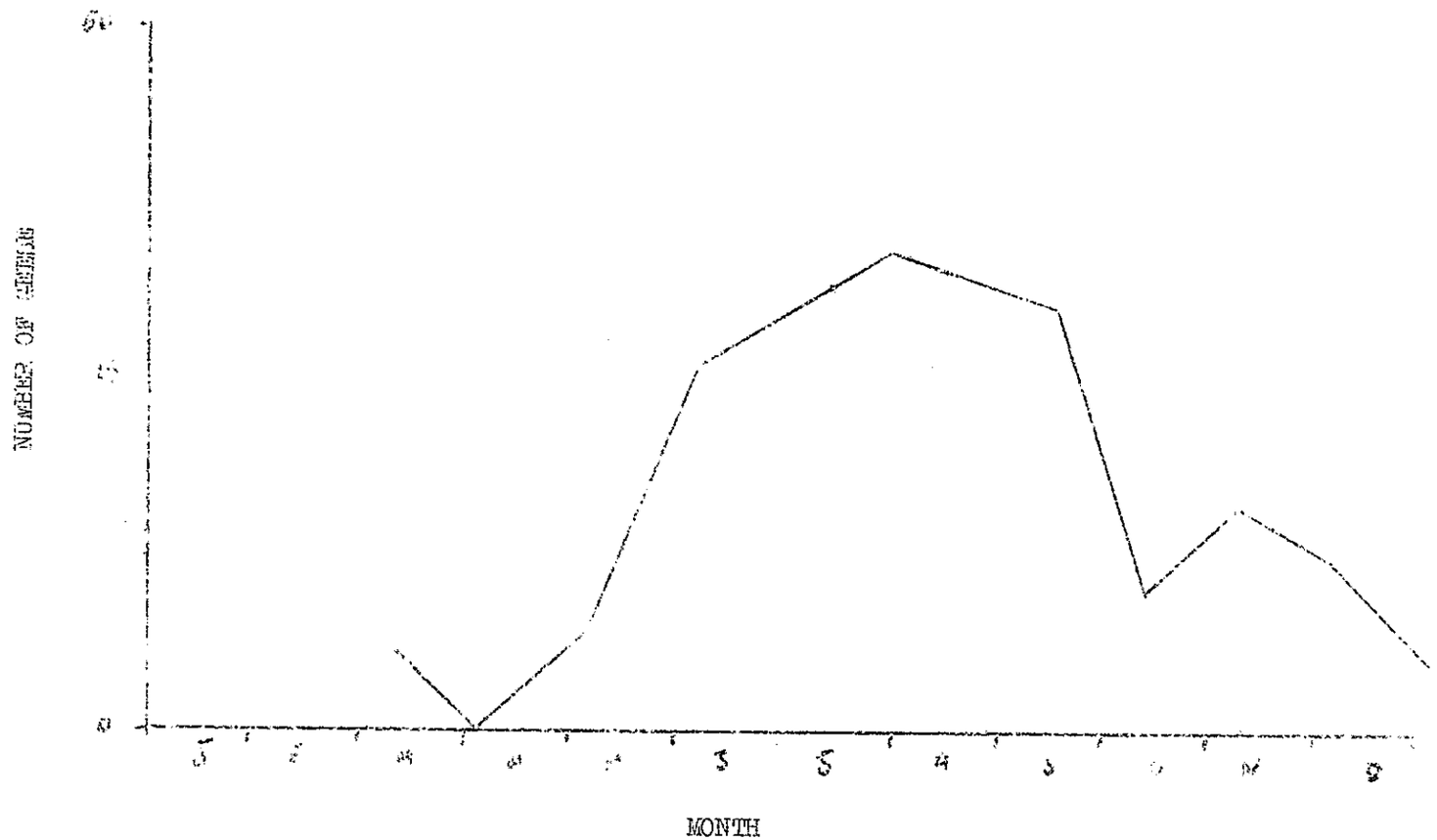


Figure 5. Fields at Darwin Dairy. Total area 128ha.

Established yorkshire fog

Established cocksfoot

Established red fescue and smooth stalked meadow grass

Young fog, cocksfoot, red fescue and smooth stalked meadow grass

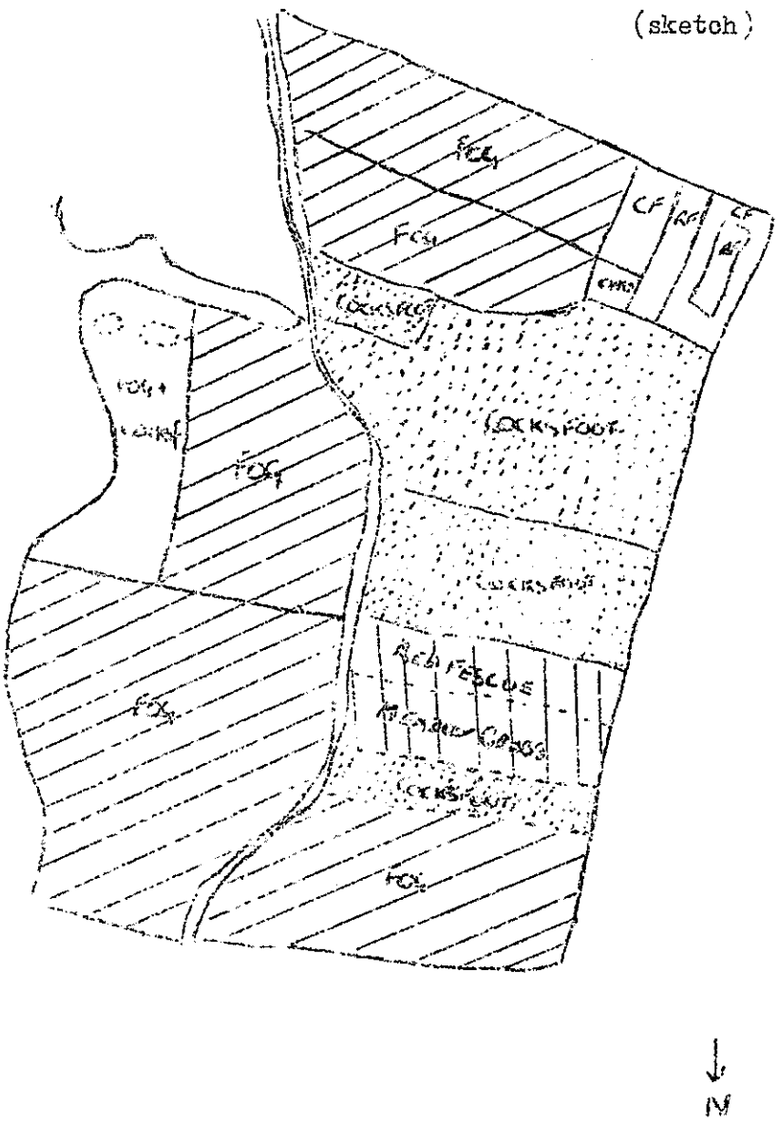


Figure 6. Numbers of Upland and Brent Geese on fields at Burntside and Darwin Dairy.

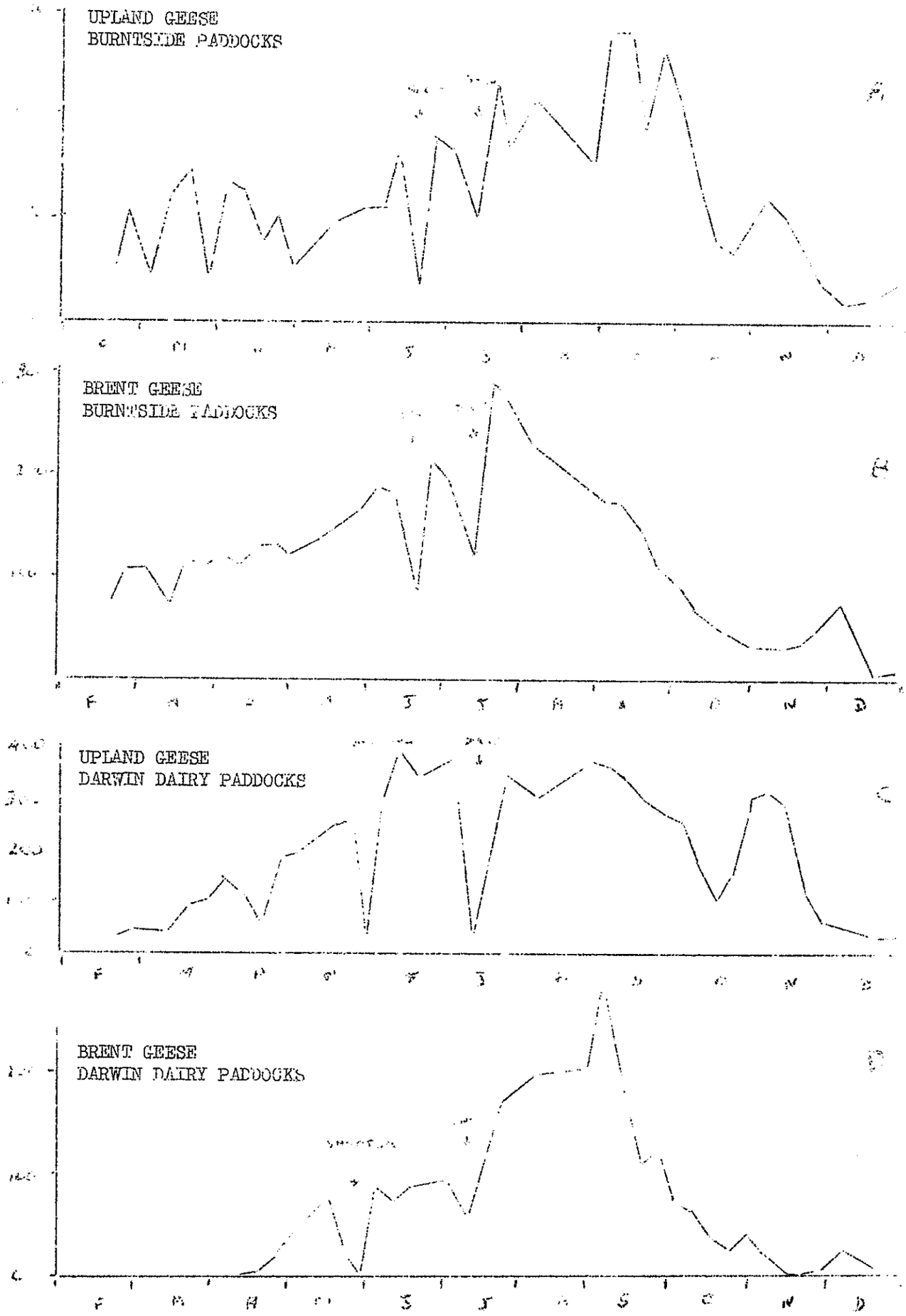
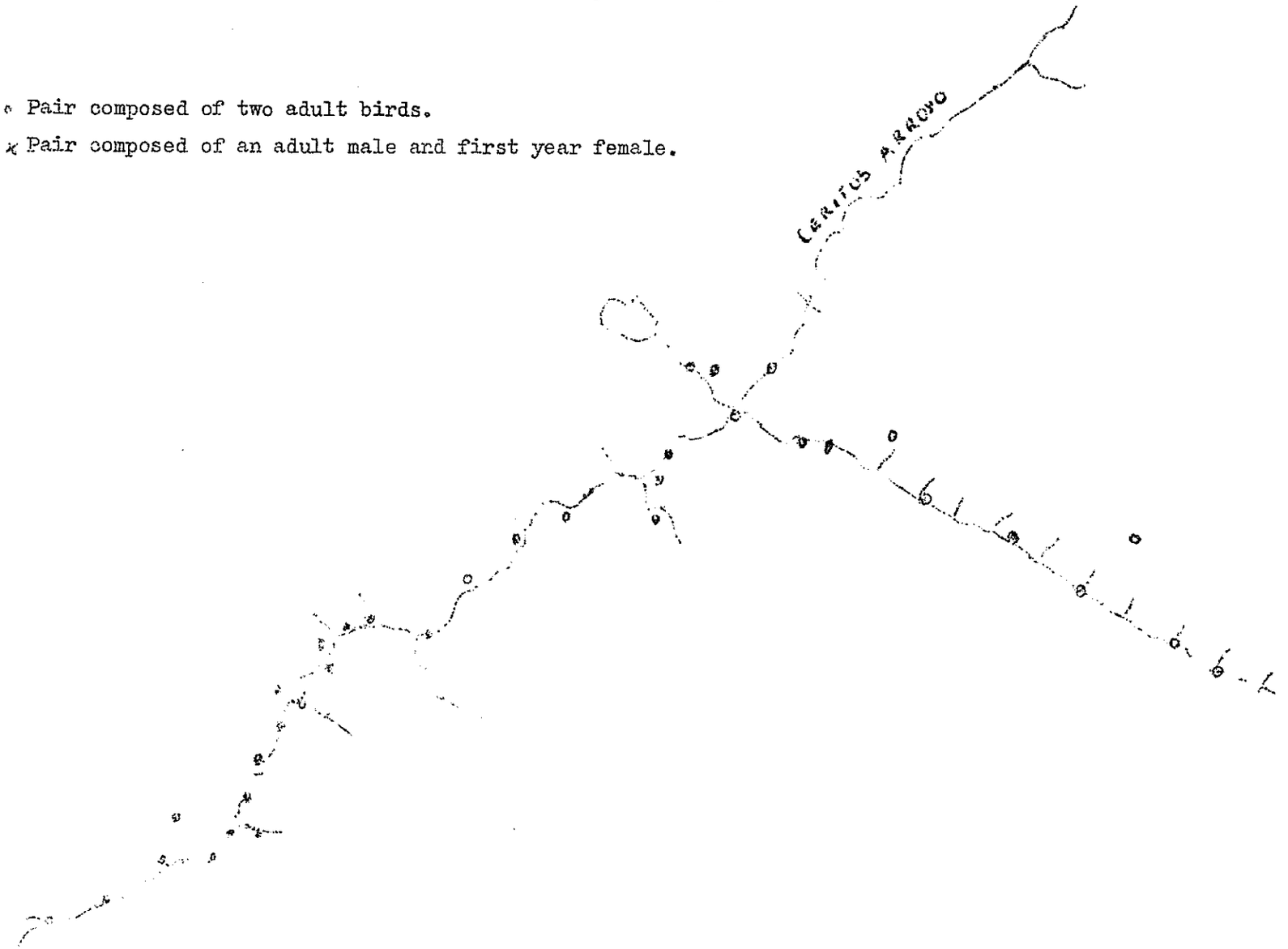


Figure 7. Ceritos Arroyo showing the distribution of pairs of Upland Geese

o Pair composed of two adult birds.

x Pair composed of an adult male and first year female.



Scale 1:25000

Figure 8. The numbers of Upland Geese at localities where they shed. Solid lines: total number of birds present (flightless birds and fliers). Dashed lines: number of flightless birds i.e. number trapped. Fliers leave the flock during trapping operation.

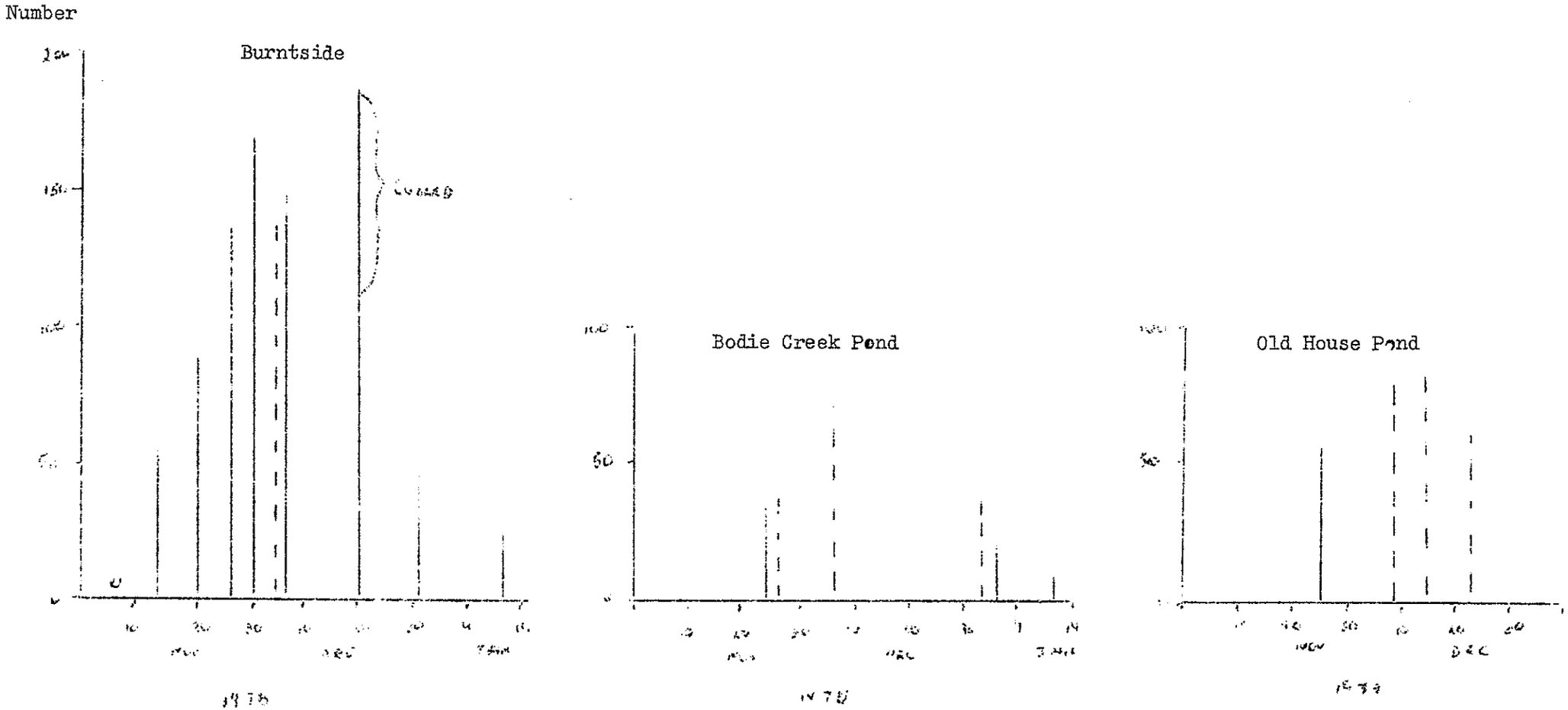
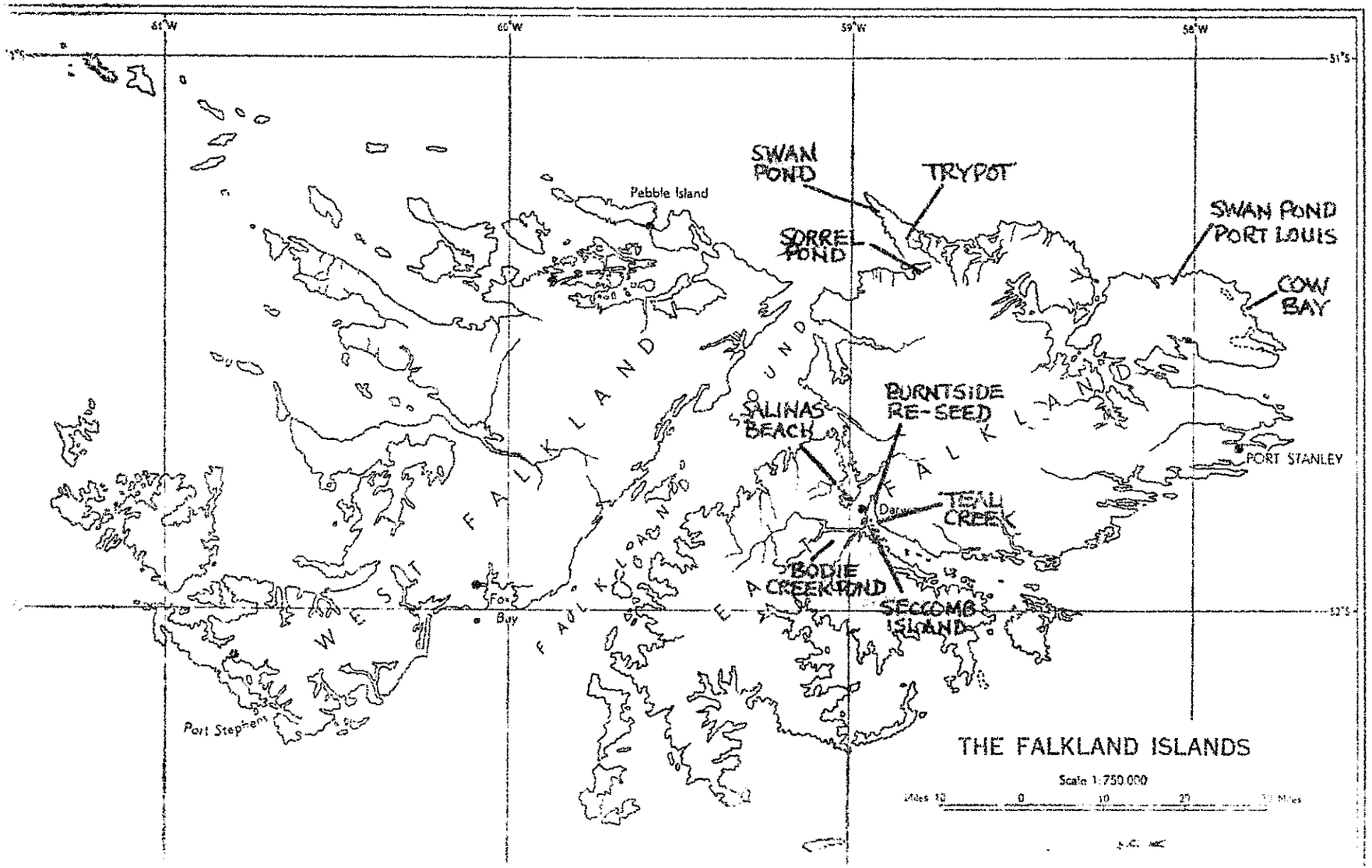


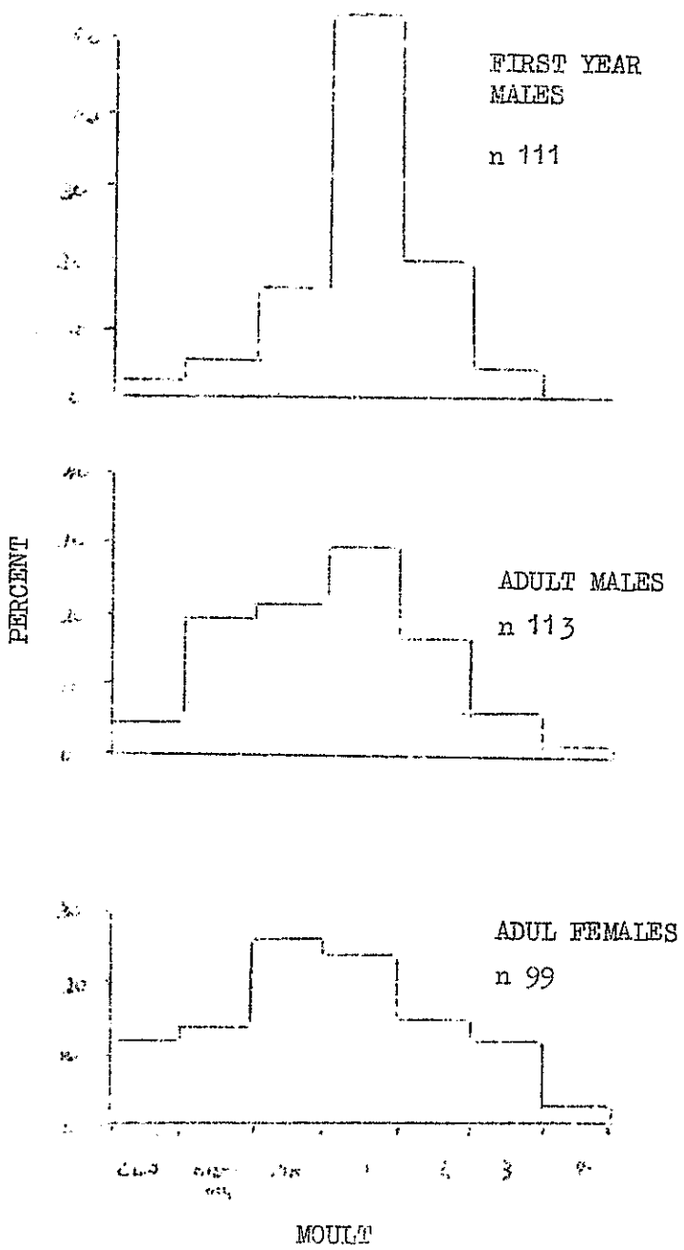
FIGURE 9

SECTION 6 GOOSE STUDY



LOCATIONS (11) WHERE SHEDDERS WERE CAUGHT IN 1978

Figure 10. Condition of primary moult of shedders caught 3-6 Dec 78



6.7 Intake Studies

This paper presents information on aspects of the feeding ecology; diet, diurnal pattern of grazing, digestive efficiency and food intake, which are required to assess the impact that geese have on pastures in the Falkland Islands.

Methods

Diurnal activity was recorded on tape each half hour from dawn to dusk. The percentage of time devoted to each activity was calculated as follows; the percentage of birds carrying out each activity in each half hour was calculated, and then averaged for all half hour periods. Percentages were taken since sample sizes varied for each half hour.

Periods between successive droppings were measured with a stop watch while geese were continually observed with a X20-60 telescope.

Feeding experiments with captive geese were made in cages in a shed and pens (5 x 10m) set over grass. The indoor cages (0.9 x 0.9 x 1.5m) were made of chicken wire and raised off the floor so that droppings fell through into collection trays. Geese were fed on cylindrical grass pellets (9% water) 6mm in diameter and about 10mm long. These were obtained from Ford and Etal Farms Ltd., Letham Hill, Cornhill on Tweed. Geese were 'trained' to eat pellets by initially setting the cage over grass scattered with pellets. When accustomed to eating pellets they were transferred to an indoor cage and fed entirely on pellets. Two days were allowed to elapse before starting an experiment. Geese were fed daily at 1300 hrs and surplus food was always provided. A sample of 100g pellets was dried and weighed each day so that the dry mass of pellets given to a goose could be determined. Food residues and droppings were collected daily. Water was provided in such a way that the geese could not climb into the trough and foul it with droppings.

Droppings and food samples were dried in a convection oven at 60°C. The cell wall content of droppings and food were measured by the techniques described by Goering and Van Soest (1970). Three determinations were made for each sample.

Diet

The diet was described from food found in the oesphagus of shot birds, from analysis of droppings, and from direct observations. The amounts of each plant species found in the oesophagus were usually measured by dry weights though once, volumes of each food species were visually estimated (Table 1).

The diet depended largely on the vegetation type that the geese were feeding on. Those on a Poa green, and reseeds of yorkshire fog and cocksfoot had a diet composed of over 90% of the main grass species growing in these areas. The Whitegrass/diddle dee community is a natural one and more complex than reseeds and greens. The geese on this type were taking mainly pig-vine berries (Table 1). They ate the whole fruiting head for the stalks to which the berries were attached were also found in the oesophagus.

On 25th June 1978 snow covered the ground completely and both Upland and Brent Geese were seen on the intertidal zone at low tide. Nine Upland Geese were observed eating Ulva sp. at Fish Creek. On 11th July 1978 snow again covered the ground and 56 Brent and 57 Upland Geese were seen at Darwin feeding on Ulva sp. washed up on the top of the shore and growing in the intertidal zone. They picked up large pieces and shook them to break off a piece which was then eaten. Further observations were made on 15th July at Darwin. This time they were seen feeding on filamentous green alga which coats the rocks.

On 30th January 1979 groups of 4, 2, and 3 Upland Geese were seen taking the seeds from Whitegrass stems. On 6th February 1979 groups of 2, 16, 1, 2, and 17 Upland Geese were seen in a field of yorkshire fog which had gone to seed. All birds were feeding on seed heads. They gripped a seed clump with the bill tip and with a short upward nod broke the seeds from the stem.

Throughout January to May 1978 Upland Geese were regularly observed foraging in diddle dee, and droppings composed entirely of diddle dee berry remains were commonly found. The summer of 1978-79 was very dry and the berry crop was noticeably smaller in the autumn of 1979. Consequently the habit of feeding on diddle dee berries was not seen so frequently. Two birds were shot on 31st January 1979 while feeding close to diddle dee clumps in Whitegrass. Both had only diddle dee berries in their oesophagus.

Diurnal Pattern of Attendance and Grazing

The diurnal patter of grazing was investigated to determine when and for how long geese fed and if they moved from one area to another during the day.

Five dawn to dusk watches were carried out and the numbers of geese and their activity recorded each half hour. On 27th September 1978 a watch was carried out on a 5.3ha reseed of yorkshire fog and cocksfoot. (Fig. 1). Numbers remained fairly steady through the day though were smaller in the afternoon. The birds which left the reseed mainly moved into the next field. A buzzard disturbed the geese in the early morning but all settled back in the same field within a few minutes.

On 25th October 1977 it was just getting light at 0350 hrs and geese were heard calling from the shore and slightly further up the sound near Darwin settlement. At 0410 hrs a group was seen swimming just off the settlement and later walked up onto the green. They were soon joined by others who flew in and numbers increased to a stable population of about 50 to 60 for most of the day, except when disturbed at midday (Fig 2). The Brent Geese showed a similar pattern of attendance. At 1910 hrs all the Brent Geese were gathered in one flock and flew out across the sound and landed on exposed rocks in the intertidal zone. Twenty geese were still present on the green when darkness fell.

On 13th February 1979 there were no geese present before sunrise on a 6.5ha Poa green near Salinas beach. However, both Upland and Brent Geese were seen flying in small groups to the green and large numbers were present from 0800 hrs onwards. A buzzard put all geese to flight at 0855 hrs and most Brent Geese departed to a nearby green whilst the Upland Geese resettled. Numbers of Brent Geese built up throughout the day whilst numbers of Upland Geese remained about 110 (Fig. 3). At 2000 hrs many geese were calling and had formed into large groups. Ten minutes later it was evident from silhouettes that most had stopped feeding and at 2015 hrs groups of 2, 3, and 5 Brent Geese and 4 Upland Geese left the green. At 2020 hrs all birds took off with much calling and headed for Salinas beach. Thus all birds left within one hour of sunset. Apart from the movements onto the green in the early morning and departure at the end there was littel movement of birds into and out of the area indicating that the same birds were present for most of the day.

On 22nd March 1978 many birds were already on the fields at Burntside when observations started. Two Caranchos put all the geese to flight but they circled and landed again. Numbers of Upland Geese did not reach a plateau until 0830 hrs whereas Brent Goose numbers were high early in the day and fell during the day (Fig. 4). It is believed that the Upland Geese had been feeding elsewhere on diddle dee berries for droppings composed entirely of diddle dee berry remains were found on these fields. Numbers of Upland Geese dropped markedly two hours before sunset but birds were still present when observations stopped at dusk (Fig 4).

Three weeks later on 12th April 1978 numbers of Upland Geese showed a different diurnal pattern on a 10.1ha yorkshire fog/cocksfoot reseed. Forty-fifty birds were present at sunrise, increasing to 100 at 1400 hrs. Numbers then dropped and all birds were frightened away by a buzzard before sunset (Fig. 5). Droppings containing diddle dee berry remains were also found here indicating that birds had fed elsewhere before travelling to this field.

Further information on the diurnal pattern of attendance was obtained by timing the arrival and departure of Upland Geese on greens at dawn and dusk respectively. At 0700 hrs on 19th July 1978 no geese were present on Darwin green but 12 were present by 0730 hrs. On 28th July when continuous observations were made at dawn the first geese arrived at 0710 hrs and started grazing at 0715 hrs. Sunrise was at 0735 on 28th July. The end of the grazing day was recorded three times in winter. The last geese flew from Darwin green at 1700 hrs on 26th July. On 27th July all geese (20) flew onto the beach at 1650 hrs where they rested, drank from a puddle and preened before flying away at 1710 hrs. The geese departed from the preen between 1705 hrs and 1720 hrs on 19th July when sunset was 1622 hrs. Therefore the length of the grasing day in late July (winter) was about 9 hrs 45 mins (0715-1700 hrs), one hour longer than the period between sunrise and sunset.

The length of the grazing day was greater in summer. On 26th February 1979 no Upland Geese were present and by 0505 hrs 17 were present and grazing. These represented most of the geese to use this green for 24 were counted that afternoon. On 13th February grazing finished at 2000 hrs (Fig. 3). Therefore the length of the grazing day was 15 hrs (0500-2000 hrs) for February (summer).

The activity pattern through the day was measured during three of the dawn to dusk watches. Most of the geese were grazing at any one time and the changes in the percentage of the flock that was grazing can be seen in Fig. 6-10. There was a tendency for relatively fewer Upland Geese to be grazing in the middle of the day and more grazing early and late in the day (Fig. 6-8). Also, at the end of the day the percentage grazing was consistently high whereas at the beginning of the day the values for percent grazing were more variable. Figs. 9 and 10 show a different pattern for Brent Geese; an apparent increase in the percent grazing through the day on 27th September 1978 and a fairly constant percent grazing on 13th February 1979, though consistently high values at the end of the day.

The average of these percentages gives an estimate of the percent time grazing by an individual goose. Similar calculations were carried out for other activities (Table 2). The values for September and February were similar for the two species. "Grazing" refers to birds with their heads down cropping the grass so that movements ("walking") and pauses ("standing") between bouts of cropping may also be related to foraging. Only "fighting", "flying", "sitting", "preening" and "drinking" are entirely non-foraging activities. These represent 13 and 17% for Upland Geese and 16 and 16% for Brent Geese in September and February respectively.

Digestive Efficiency

The efficiency with which a food type is digested can be determined from the following equation provided that a component of the food is indigestible and that this component can be measured.

$$\% \text{ digested} = \left(1 - \frac{Mf}{Md}\right) \times 100\%$$

where Mf = dry gm of the indigestible component per 100g dry food and Md = dry gm of the indigestible component per 100g dry faeces.

Marriott & Forbes (1970) showed that fibre (cellulose plus lignin) (called cell wall material in this paper) was not significantly digested by the Cape Barren Goose Cereopsis novaehollandia. Also Mattocks (1971) found that bacteria in the caeca of domestic geese Anser anser were unable to breakdown cellulose in portions of filter paper. Therefore the cell wall of grasses are now being used as the indigestible component in studies on the digestive efficiency of geese (e.g. Ebbinge, Canters & Drent 1975). However, cell wall material is chemically complex and, as yet, it cannot be assumed that what is measured in grass is the same as that measured in faeces. Before the above method of calculating digestive efficiency can be accepted it must be checked by the direct method which involves measuring amounts ingested and ejected.

A male Upland Goose with a mass of 2.6kg was kept in an indoor cage and fed grass pellets for 7 days. The amount ingested and faeces produced was measured for the latter five days and the percent digested was 25.8% (Table 3). The cell wall content of the grass pellets was 27.6% (26.6 - 29.0) and that for the faeces collected on the third day of the experiment was 36.9% (36.3 - 37.7). Therefore the percent of grass pellets digested was 25.2% as calculated from the above equation. The similarity of this value to those obtained by the input/output experiment (Table 3) indicates that the use of cell walls as an indigestible marker in digestive efficiency studies of geese is acceptable.

Faeces were collected from greens and yorkshire fog reseeds and birds in these pastures were shot so that food samples could be collected from the oesophagus. Faeces and food samples were analysed for their cell wall content and digestive efficiencies calculated (Table 4).

N.B. Food samples and faeces not taken at same time - more samples to be taken.

Daily Intake by Free-living Upland Geese in Winter and Summer

Daily intake was measured by measuring the daily production of droppings and relating this to grass ingested using figures for digestive efficiency.

Periods between successive droppings were measured whilst geese were observed continuously. Seventy-three timings were made in winter 1978 (6th July to 10th August 1978) and 70 in summer 1979 (7th to 27th February 1979) from geese feeding on greens. All winter timings refer to birds feeding for most of the time they were observed (Fig. 11). There was no significant effect of time of day on the rate of production of droppings. (One way analysis of variance $F(6, 56) = 2.19$ $p > 0.05$) so the data are best described by a single mean (241 $\pm$ 72 seconds). In contrast, birds in summer often took long spells of not feeding. Therefore the data for summer is split into those which spent most of the inter-dropping period feeding and those that spent most of that period not feeding (Fig. 12). Clearly, the inter-dropping periods for those that were not feeding were longer than those that were. The mean period for the former was 465 $\pm$ 117 seconds and for the latter it was 258 $\pm$ 65 seconds. Thus feeding birds produced droppings at much the same rate in summer as they did in winter. However, the overall rate for birds in summer was slower since they spent long periods not feeding when dropping rates were slow.

Owen (1975) has indicated where possible errors may affect measurements of dropping rates; e.g. long inter-dropping periods are less likely to be recorded since the observed bird has more chance of being obscured, and hence the observation terminated, during the period of observation. Fortunately, Upland Geese can be observed from short distances (30m and over) and feeding groups are small (2 is the usual group size) so uninterupted viewing of individuals for long periods is possible. Inter-dropping periods of sitting birds can also be measured readily for even if the bird is not tail-on to the observer the tail is raised during defaecation making the event obvious.

Droppings were not produced throughout the day for geese arrive on the pastures at first light with an empty gut. The time at which droppings start to be produced was determined on 28th July 1978. The first geese arrived at 0710 hrs and started grazing 5 minutes later. Individuals were watched continuously for periods of over 5 minutes (greater than the average inter-dropping period) and at 0730 hrs one produced a watery faeces which did not contain grass remains. The first droppings which contained grass remains was produced at 1813 hrs, about one hour after the start of grazing.

The length of the grazing day was 9.75 hrs in July and 15 hrs in February of which 8.75 hrs and 14 hrs would have been spent producing droppings. In winter, most of the day is spent feeding so that the total number of droppings produced would be 130. However, in summer when a minimum of 71% (9.9 hrs) are spent grazing and 29% (4.1 hrs) not grazing the total number of droppings produced would be about 170.

The above totals only refer to droppings produced during the day time. When geese leave the pastures at dark they have grass in their guts and therefore continue to produce droppings at the roost. Two females and one male Upland Goose were captured at dusk on 7th August 1978, 14th November 1977 and 20th February 1979 respectively and held in a cage so that their overnight production of faeces could be collected. This amounted to 35.6, 31.7 and 28.8 dry g which would be equivalent to 40, 30 and 23 droppings respectively. The droppings could not be counted as they were broken up in the confines of the cage.

Overnight production was also measured by counting droppings in piles left by roosting birds. This is likely to give an under-estimate for if a bird shifts its position in the roost before its gut was emptied then two or more piles may result from one bird. On 20th July 1978 when geese had been roosting in a field during full moon counts of droppings from 13 discrete and larger piles gave an average of 20.8 $\pm$ 5.4. The largest number was 28. At Bodie Creek Pond on 19th February 1978 a further series of 23 piles of droppings were examined. The average number in the larger piles was 19.8 $\pm$ 5.5, and the largest number was 29. As expected, the numbers in the roost piles were smaller than that estimated from the captured birds, though there is some overlap. It is likely that 20 to 30 droppings are produced overnight.

The total daily production of droppings is therefore 150-160 for winter and 190-200 for summer. In order to establish that these values obtained from free-living geese were not subject to unforeseen errors the daily production of droppings was collected from two captive geese. One would expect that captive geese would eat less since their activity was restricted. A free-living male and female Upland Goose were captured on 14th and 18th March 1978, the primaries and secondaries clipped and held in pens (5 x 10m) set over short grass. After being in captivity for about 3 weeks the daily output of droppings was collected over 7 days, dried and weighed. It amounted to 192 $\pm$ 28g and 135 $\pm$ 13g for male and female respectively and this would have been equivalent to 163 and 139 droppings. This is similar to the values obtained for the free-living geese. The masses of the captive birds remained the same (3.00 and 2.40kg) over the 7 days.

Samples of droppings were collected in winter and summer and there was no seasonal difference in mass (Table 5). Therefore the average mass of an Upland Goose dropping was taken as 1.1 dry g. Therefore the mass of droppings produced daily was 165-176g in winter and 209-220g in summer. This would represent 275-293g of grass eaten daily in winter and 348-488g in summer if the digestive efficiency was 40%

Several of the steps in the above calculations require further information so the results will be refined after further field work.

Table 1. The diet of the Upland Goose on a variety of vegetation types

Date	July 78	May 78	Nov 77	Oct 77
Vegetation type	*Holcus* reseed	Whitegrass & Diddle dee	*Datylis* reseed	*Poa* green
No. of birds examined	6	4	2	2
Described as	% dry weight	% volume	% dry weight	% dry weight
Sorrel	0.2			2.9
Pig vine berries		77.5		
Luzula sp.	3.1			
Holcus lanatus	93.3	7.5		
Poa pratensis	2.8	10.0	0.1	96.6
Agrostis sp.	0.4			
Aira praecox		5.0		
Cortaderia pilosa				0.5
Dactylis glomeratus			99.9	
Unknown grass	0.2			

Table 2

Daily time budget of Upland and Brent geese at Berwick quay on 27th September 1978 and at Salinas green on 13th February 1979. + indicates a non-zero value less than 0.5%.

	Percent of time at each activity					
	Upland Goose			Brent Goose		
	Sept	Feb		Sept	Feb	
Grazing while standing	65	70	71	60	69	69
Grazing while sitting	6	1	71	6	+	66
Standing	10	6		12	8	
Walking	6	6		6	7	
Fighting	1	+		+	1	
Flying	+	+		+	1	
Sitting	8	9		10	8	
Preening while sitting	2	3		2	1	
Preening while standing	+	1		1	1	
No. of observations	1313			1471		

Table 3

Intake, faecal production and percent digested by a male Upland Goose fed on grass pellets

Date	Dry mass of pellets eaten (g)	Dry mass of faeces (g)	Mass of food digested (g)	Percent digested
29-30.5.78	397.3	289.2	108.1	27.2
30-31.5.78	455.1	348.7	106.4	23.4
31.5-1.6.78	471.4	368.1	123.3	26.2
1-2.6.78	435.2	324.9	110.3	25.3
2-3.6.78	441.8	321.4	120.4	27.3
TOTAL	2200.8	1632.3	568.5	25.8

Table 4. Cell wall contents of Upland Goose faeces and samples of food, and the resulting digestive efficiency on the different pasture types at different seasons.

Sample	Pasture type	Season	Cell wall content		Digestive efficiency
			Mean	Range	
Faeces	Yorkshire fog reseed	Winter (July)	32.0%	31.8–32.3	45.6%
Grass	Yorkshire fog reseed	Autumn (April)	17.4%	16.1–18.6	
Faeces	Poa green	Winter (July)	30.8%	30.7–31.0	41.6%
Grass	Holcus & Agrostis	Autumn (April)	18.0%	16.9–19.5	

Fig 1. Numbers of Upland and Brent Geese at Darwin dairy field 10 + 11 27/9/78

Last quarter 24/9/78

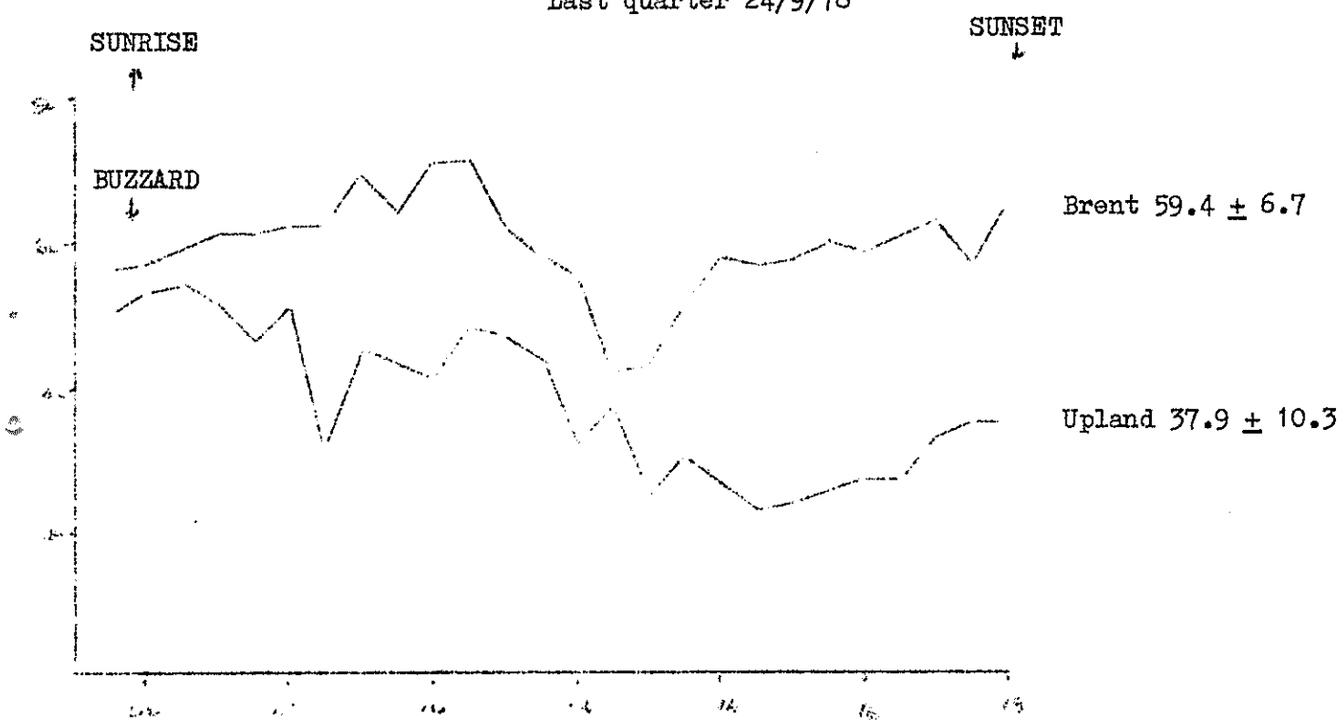


Fig 2. Numbers of Upland and Brent Geese on Darwin Green 25/10/77

Full moon on 26/10/77

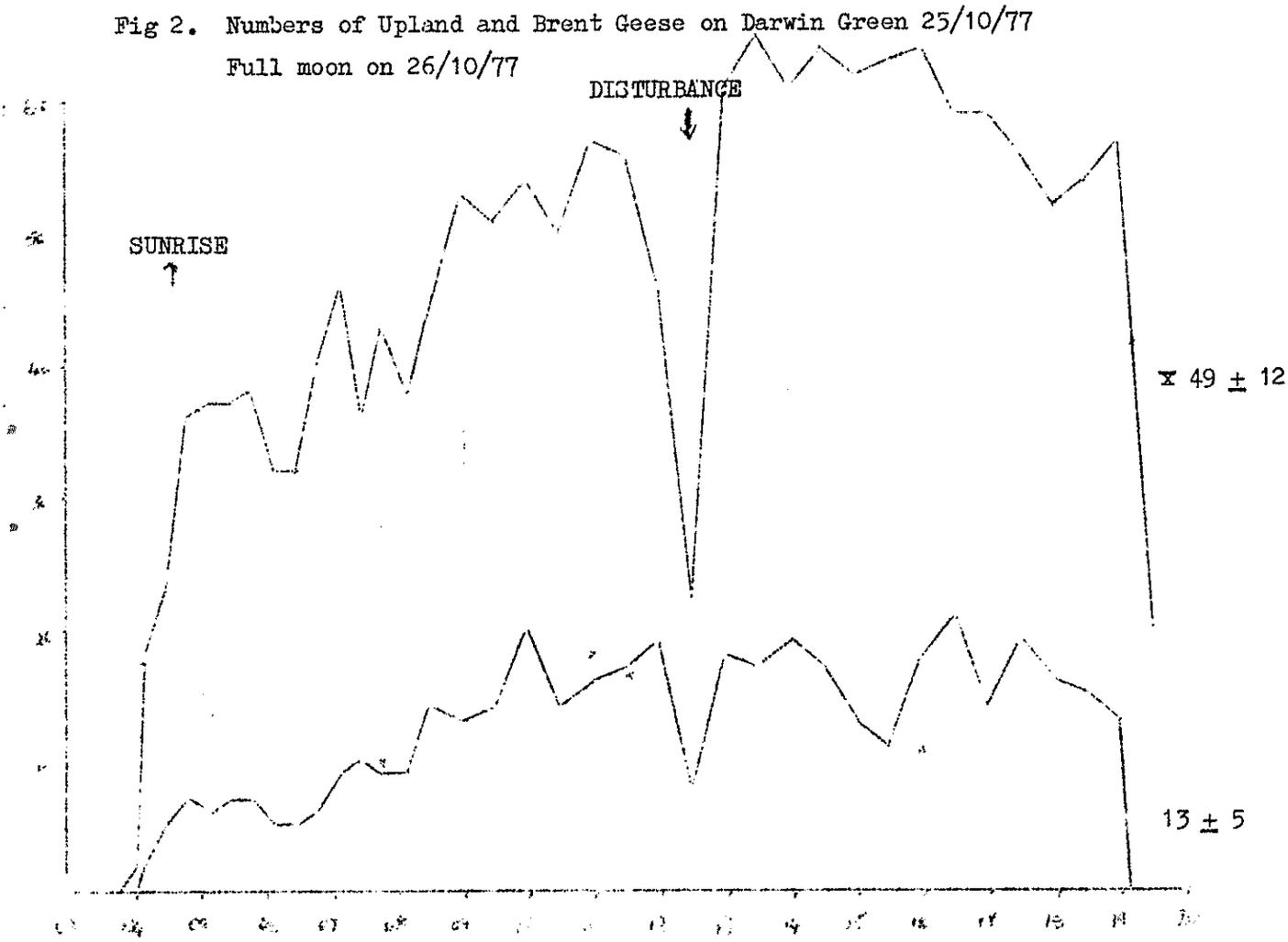


Fig 3. Numbers of Upland and Brent Geese at Salinas Green 13/2/79

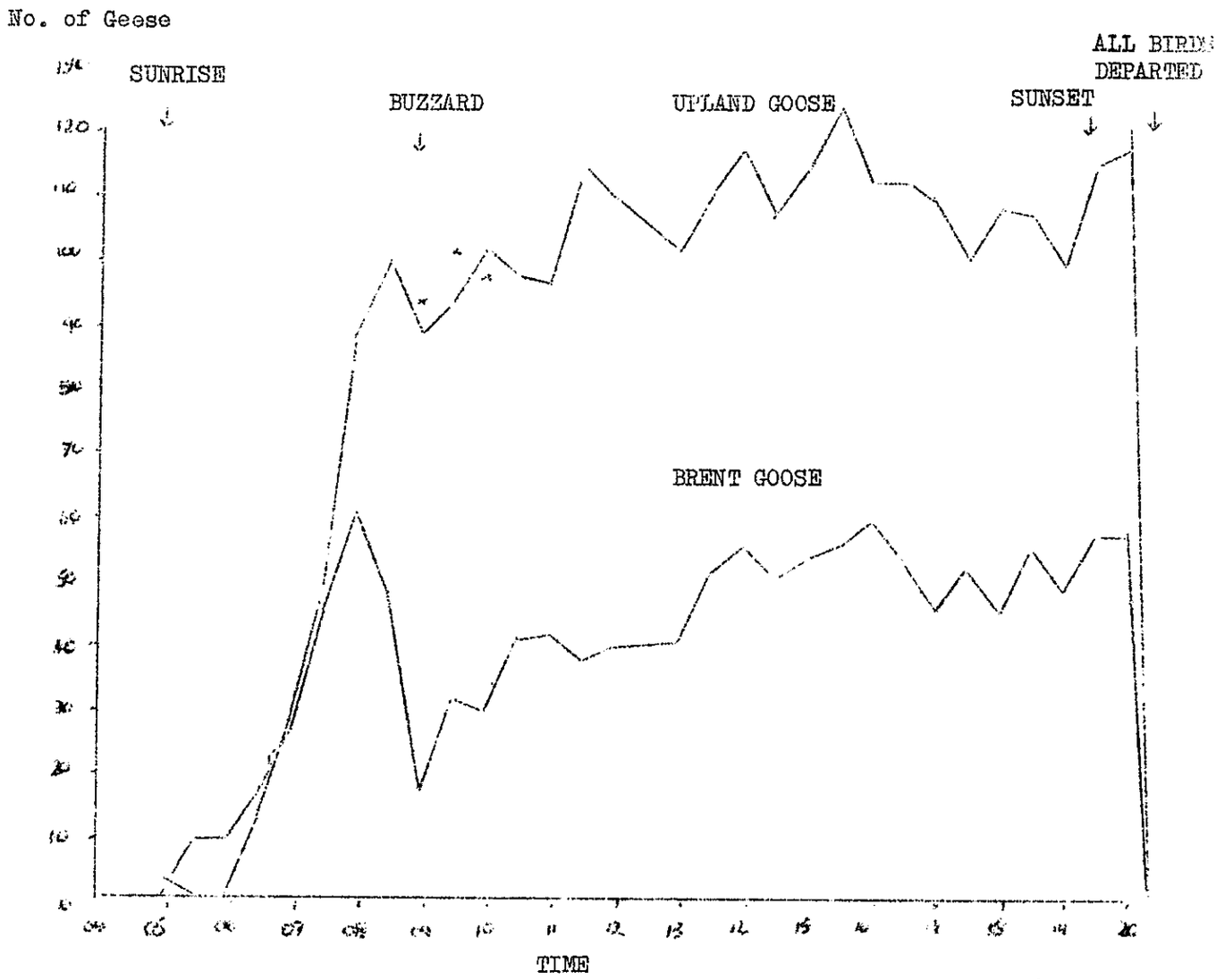


Fig 4. Numbers of Upland and Brent Geese on Burntside paddocks 22/3/78 20ha
Full Moon 24/3/78

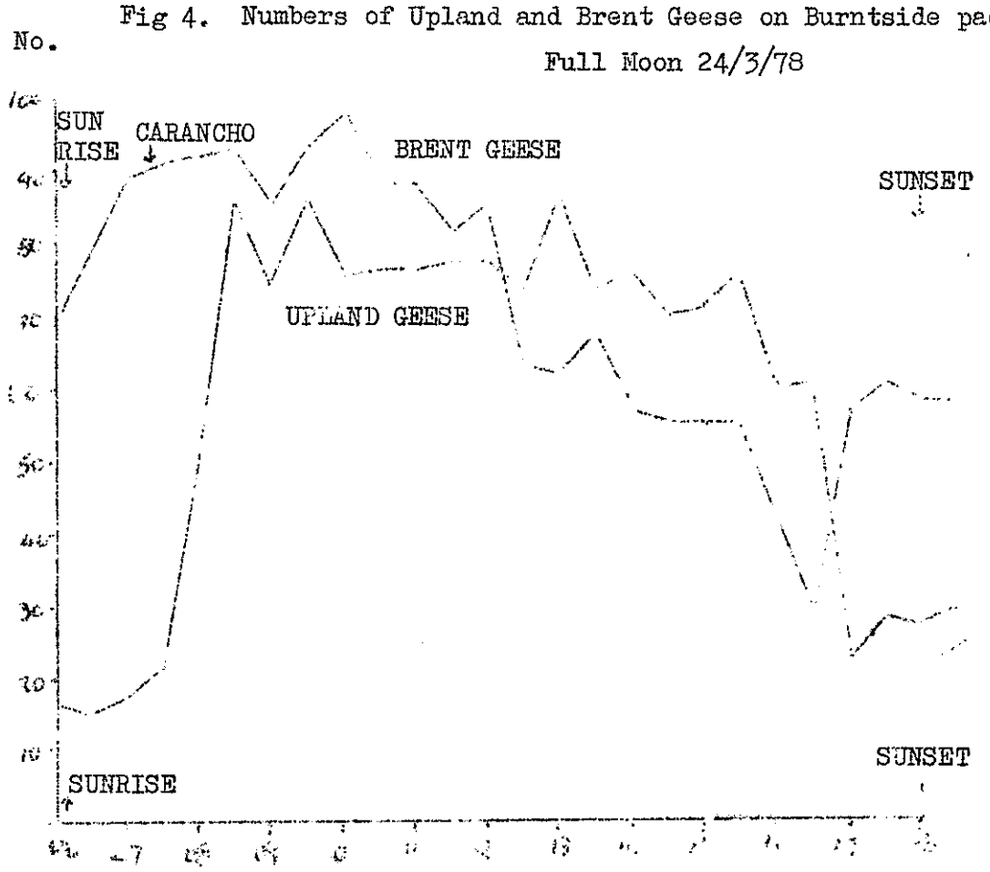


Fig 5. Numbers of Upland Geese at Darwin dairy on 12/4/78

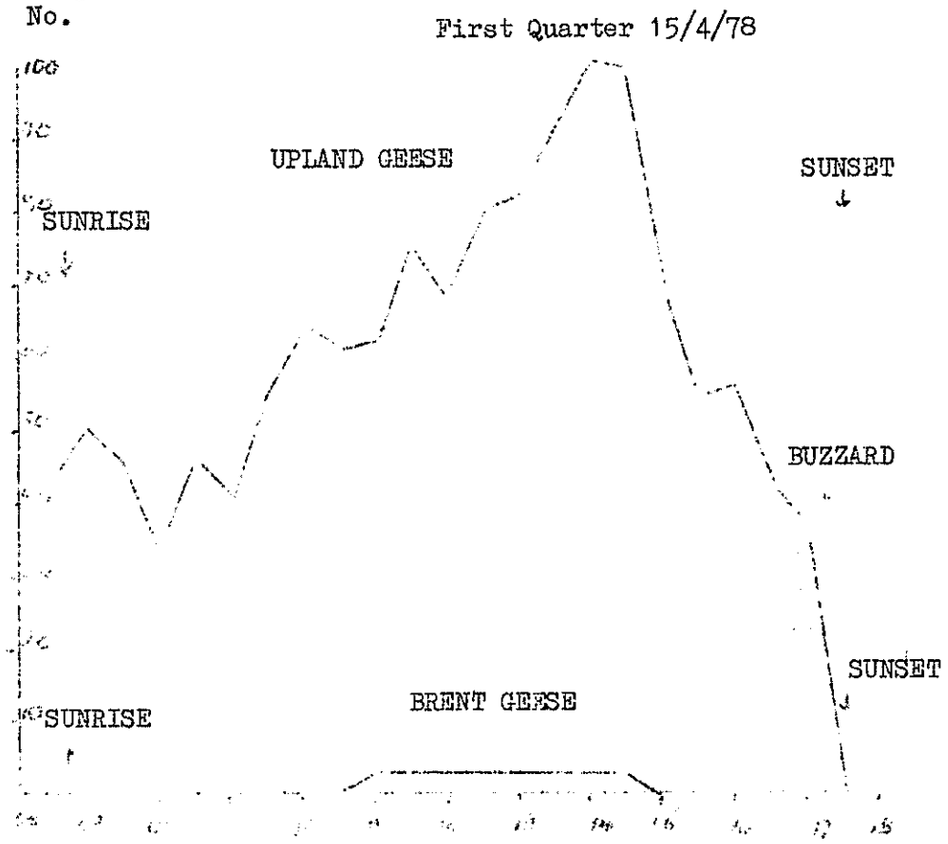


Fig 6. The grazing pattern of Upland Geese on 27/9/78 at Darwin diary field

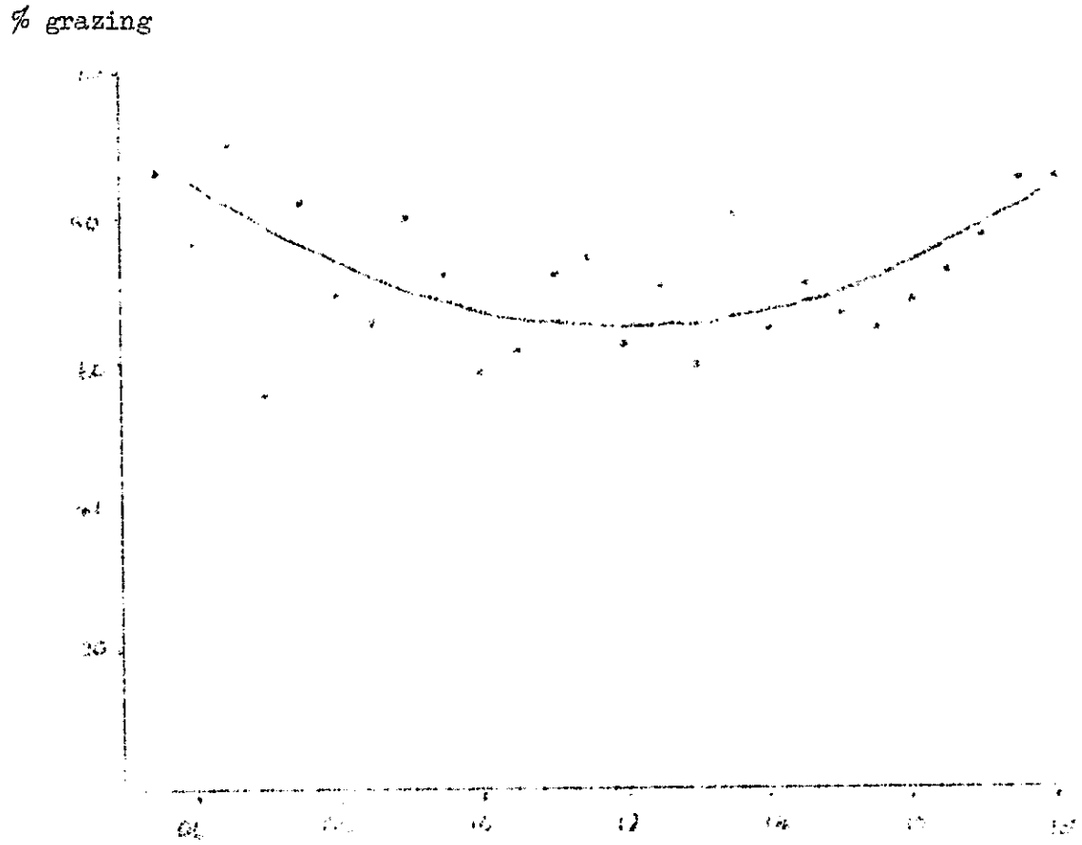


Fig 7. The grazing pattern of Upland Geese on 13.2.79 at Salinas Green

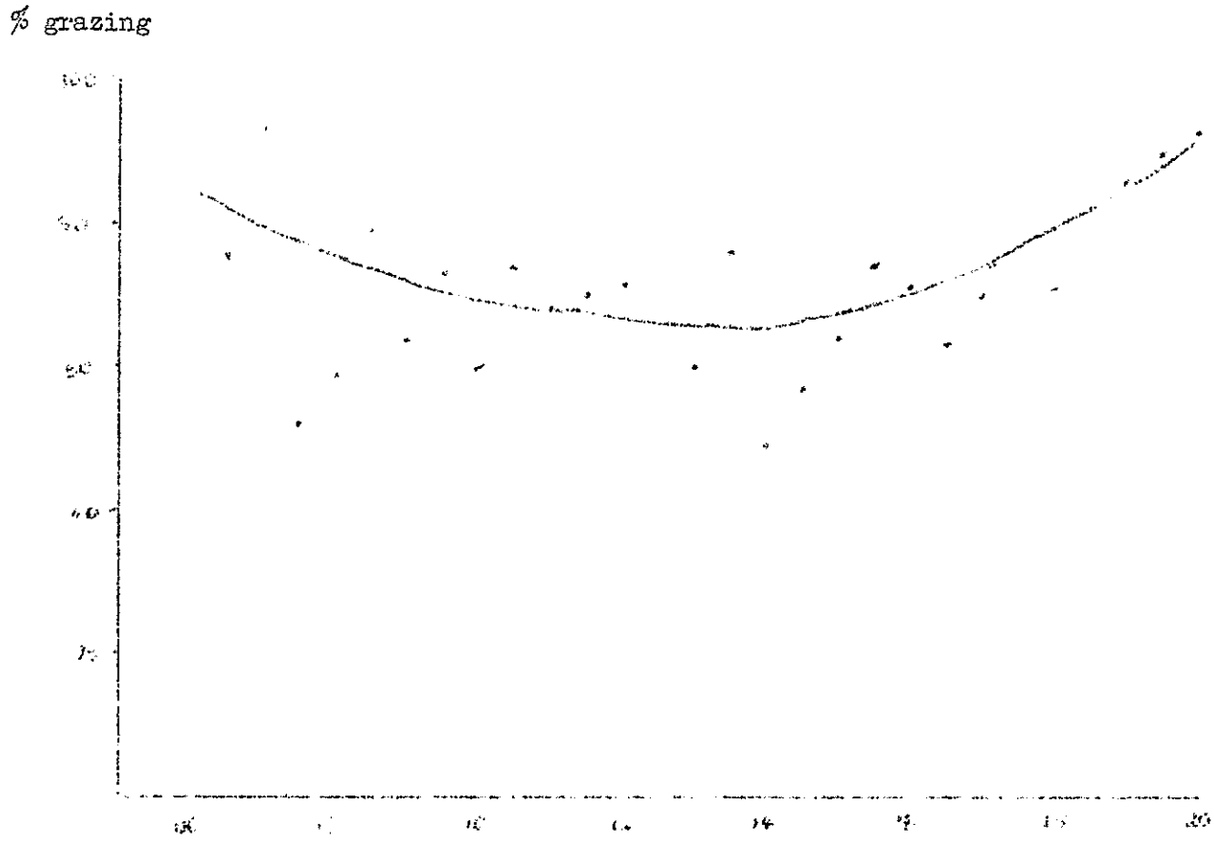


Fig 8. The grazing pattern of Upland Geese on 25/10.77 at Darwin Green

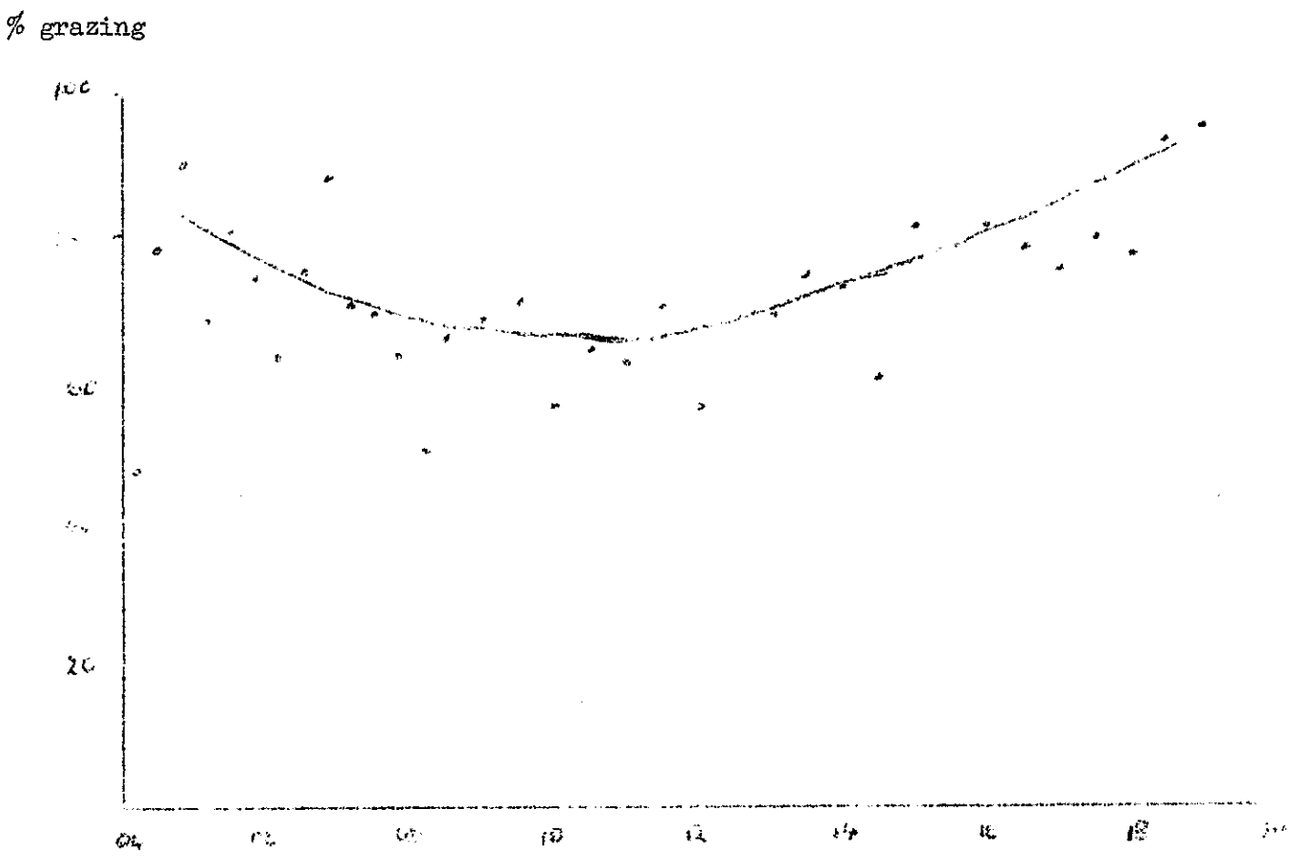


Fig 9. The grazing pattern of Brent Geese at Salinas Green on 13.12.79

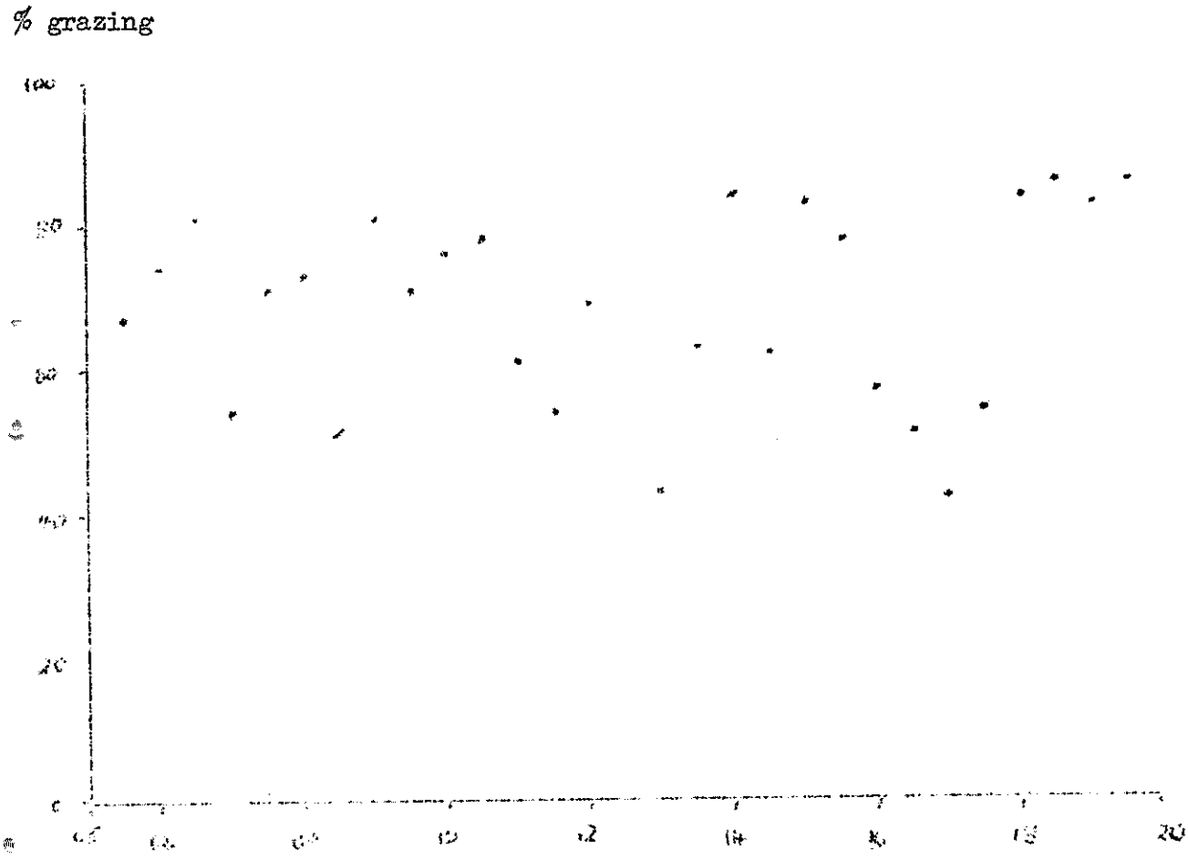


Fig 10. The grazing pattern of Brent Geese at Darwin diary on 27.9.78

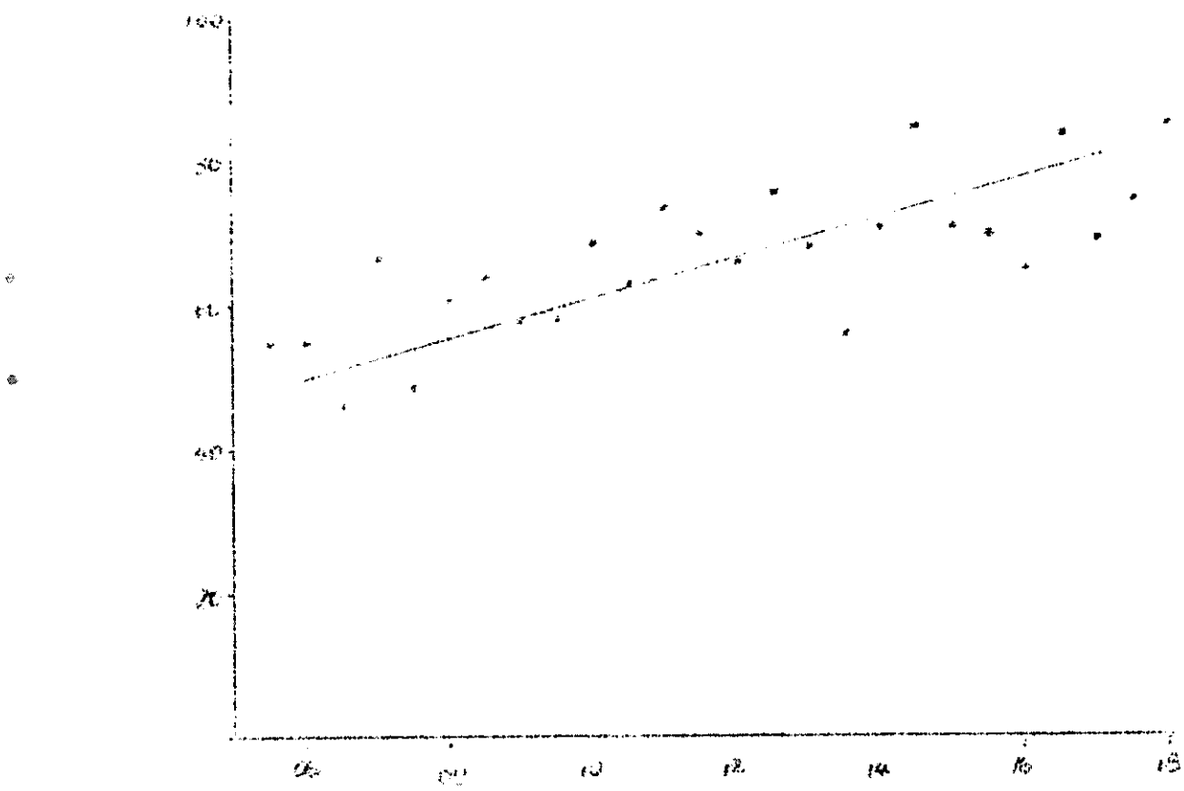


Fig. 11. Inter dropping periods of Upland Geese foraging on greens between 6.7.78 and 10.8.78

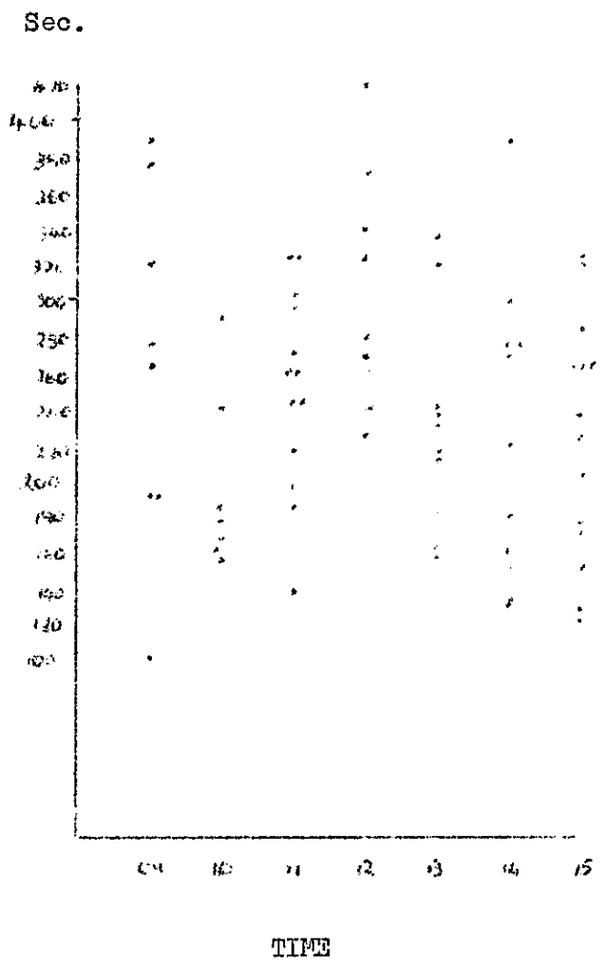
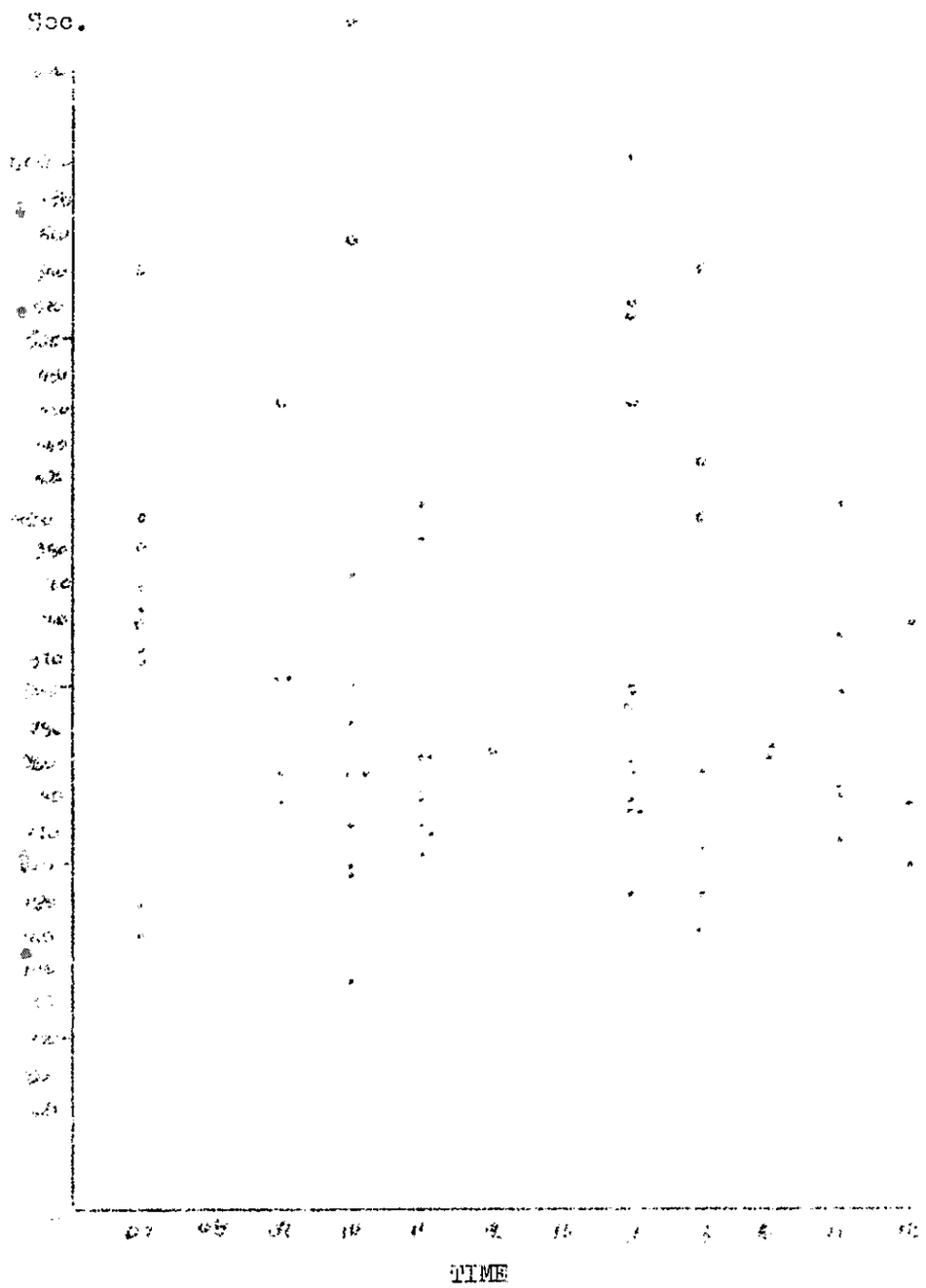


Fig 12. Inter dropping periods of Upland Geese grazing on greens in summer



CARCASS ISLAND

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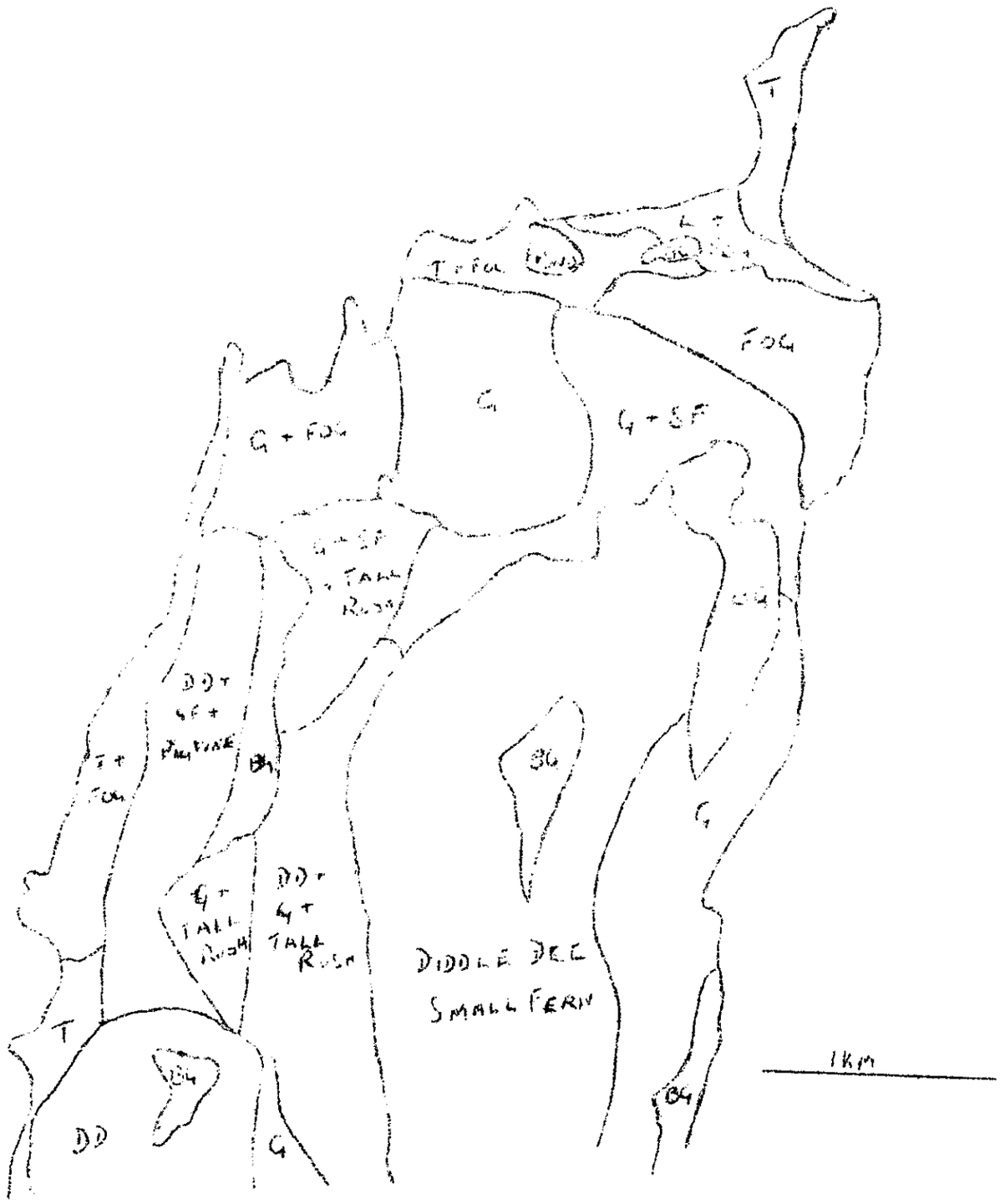

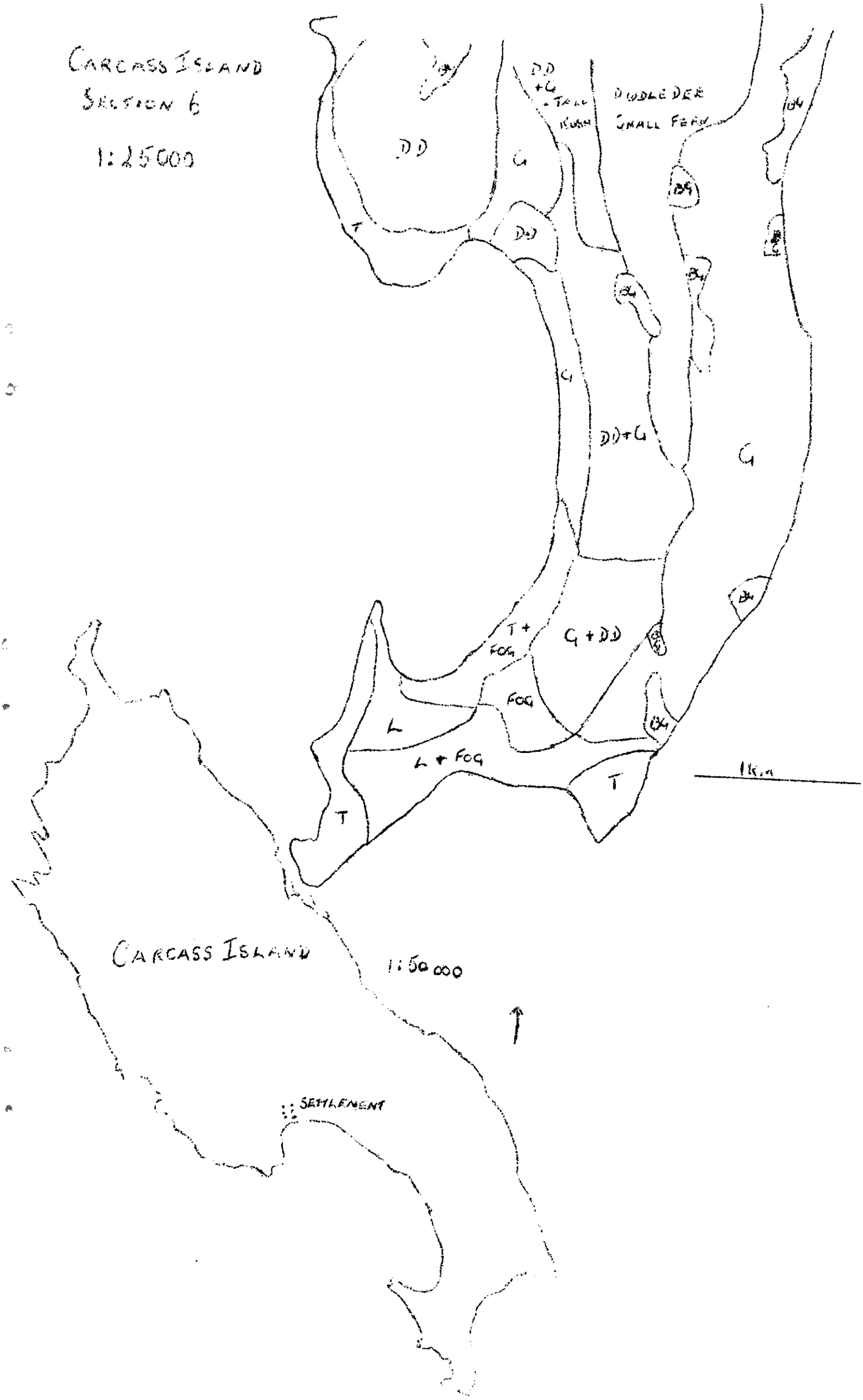
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