An Evaluation of Productivity and Mortality Factors Influencing Geese at South Nelson Island, Alaska.

A report of results from 1984

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INTRODUCTION

This report documents a field investigation of goose productivity in 1984 conducted on Nelson Island on the Yukon Delta National Wildlife Refuge. The South Nelson field camp and study area were established in 1983 by Douglas Boyce and Max Joseph and the work this year is a continuation of that effort. The procedures used and the objectives of the study were established by Ron L. Garrett, refuge biologist, as part of a monitoring and research program conducted at 6 permanent field camp locations. The background material, objectives and methods are described in other reports (Garrett, Butler and Wege 1983, Wege and Garrett 1983) and these will not be repeated here.

The contents, data analysis, and format follows the example of Wege and Garrett (1983) to allow comparison among the various field camps. Further data analysis, habitat description, and information on other nesting species are not included in this report.

II. STUDY AREA

The South Nelson Island field camp is located 3 miles north of the mouth of the Kolavinarak River and about 1 mile NW of the river along a small tidal slough which drains to the north joining a larger slough that surrounds the study area. The location is 60° 21'N and 164° 39'W. The study area is additionally bounded by a "U" shaped ridge open to the north that is about 1 1/4 miles E-W and 2 1/2 miles N-S in dimensions. Tidal sloughs enter the area from the N and NW edges. The northern and central areas are slightly lower in elevation, probably more saline due to the influence of occasional storm tides, and have somewhat different plant communities. The southern portion of the study area has deeper lakes, more islands and peninsulas, and more Empetrum dominated communities.

Access to the study area from camp necessitated crossing the circular slough and walking about 3/4 mile to the west edge of the area. Visibility into the study area was improved by a 7 foot driftwood tower built at camp but no geese were visible at that distance. The camp location only allowed walking to the SW without having to cross sloughs. Fresh water quality was excellent in lakes at the camp location. Around the camp there was a fair diversity of habitats (tidal slough margins, river bank flats, shallow ponds, deep ponds, upland hummocks) which provided excellent opportunity for observations on a variety of plant (Table 26) and avian species (Table 25).

III. METHODS

A. Weather conditions were recorded 2 or 3 times daily from 26 April to 17 July. Temperature, wind speed and direction, cloud cover, and precipitation were recorded. Temperatures between 27 April and 4 June were estimated until a broken max-min thermometer was replaced.

B. Snow cover, ice, and meltwater were visually estimated in 4 compass directions by two observers at 5 stations 1/4 mile apart along 2 transects W of camp. After 1 May Stehn replaced Hudson as an observer which began to influence Dragoo's semi-independent estimates as well. No effort was made to calibrate or verify these subjective, highly variable estimates. Estimates of % surface area based on oblique views of ice and snow patches up to 100m distant were difficult to make with any reliability. Nevertheless the relative amount of snow cover was probably adequately recorded.

C. Migration counts were made for a 2 hour period usually around noon from 27 April to 24 May. Days with poor visibility, heavy rain, etc. were not included. Observations were made with binoculars and a spotting scope from the weatherport of all birds seen on or flying across a 90 degree segment from S to W. Distance was not determined. All birds were included however birds that are larger or have characteristic flight patterns were more easily identified and therefore are over represented in the sample. Within a species, peaks in numbers observed indicate periods of migration or high activity.

D. Plots on the study area (Fig. 1) were searched for nests beginning on 25 May. The SW edge of the area was choosen because it was closest to camp, had direct access, and had a good number of nests in 1983. Each person independently searched for 50-70 minute periods establishing subplots of 1.5 to 4.6 hectares (Table 23). Natural boundaries were used as much as possible. These subplots were completely re-searched every third day until 7 June, thereafter only known active nest sites were checked at 3 day intervals. The NE corner of the study area was selected as the second calibration plot with access from the slough on the north. First nest searches on this area were delayed until 4 and 5 June because no boat was available. In this area much larger subplots were selected because the habitat was easier to search and incomplete initial coverage was considered adequate because subsequent visits would result in somewhat different areas being searched each time. Subplots ranged in size from 4.7 to 28.7 hectares. Searches were made every third day until 14 June after which only known active nests were checked. By 26 June the last active nest was either hatched or destroyed.

Validation plots 3, 4 and 5 were established 7, 9 and 12 June respectively and checked 16 or 18 June and checked again on 24 June. Primary plots were searched on 14 and 15 June and checked 23 June. These plots were also subdivided into subplots but neither search time nor area was held constant (Table 23).

E. Nest initiation was determined by back dating based on laying sequence, hatching date, or float angle, in that order of priority. The precision of chronology data is not likely to be better than within 5 days except for Calibration plot # 1. Only five nests were found during laying so the data on so-called complete clutches is very limited. I have combined these nests with those found during incubation for reporting clutch size.

Nesting success was assumed if pipping eggs or large pieces of membranes were found. Partial nest loss was underestimated because egg loss during laying or that between the last nest check and hatching was not adequately determined for most nests. Nest success was based only on the proportion of nests found that survived to hatch which often underestimates nest loss. Total nest loss early in laying was not identifiable as to species until down is added to the nests. Sometimes early loss is overlooked entirely due to the difficulty of finding empty nests or determining if grass nest bowl construction is from this season. Daily rate of mortality was not calculated nor was the potential impact estimated of observer visitation to the nest. Visitation effects may be minimal under some conditions, but in the presence of high predator populations, the effects of human disturbance on nesting success can be more serious.

F. Subsistence activity was not systematically monitored. Incidental observations were recorded whenever possible but neither the fraction observable nor the effective radius of observation were determined. High wind, noise of the radio, generator, or stove at camp, and sleep interrupted recording the number of shots heard.

G. Brood counts were made by an observer standing in the bow of the Zodiac run at medium to high speeds along sloughs. Observations were limited to within 2 hours either side of high tide. The circular slough was run from camp west of the study area north to the Kolavinarak River on 10 days between 25 June and 12 July (Figure 1). Another circular route was run on the east side of the Kolavinarak River 5 times between 26 June and 2 July. Each route took 20 to 35 minutes to run depending on the number of side sloughs explored and the wind speed and direction.

IV. RESULTS

A. Weather

It was reported that the winter conditions for 1983-1984 had been relatively mild with unusually little snow on the YK Delta. On 25 April most of the ground was still snow covered but rain during the next three days melted much of the snow. This warm period was followed by 14 days of generally below freezing weather (Figure 2). The first night with above freezing temperature, which occurred on 14 May, coincided with earliest nest initiation for Emperor (EMGO) and White-fronted (WFGO) geese. The next 2 weeks (14-29 May) remained cool with occasional rain and a snow/rain storm on 26-27 May (Figure 3). This storm occurred on the same average date as clutch completion for EMGO and WFGO and at average nest initiation for Cackling Canada geese (CKGO). Beginning 30 May the daily high temperature was above 50 F, rainfall was light, and the weather conditions were generally warm and dry. Water levels in ponds on the study area decreased by 10-15 cm below early spring levels.

B. Snow Cover Transect

The area around the South Nelson Island field camp was 70-75% ice and snow covered when we arrived on 25 April (day 115). Most of the snow was melted by rain during the next 3 days so that only 20-30% of the ground was covered by snow, ice or meltwater on 28 April when the snow cover transects were established (Table 24). Meltwater and rain water drained off the area fairly rapidly. Although the temperature dropped below the freezing point again on 30 April and stayed below freezing until 5 May, by 6 May less than 5% of the ground was covered by snow/ice and meltwater. By 10 May transects were discontinued, being essentially free of snow and ice.

C. Chronology of Migration

Both WFGO and CKGO were present in low numbers in the camp area when we arrived on 25 April (Table 18,20). The first EMGO were seen on 28 April (Table 19) and the first flocks of Brant were observed on 12 May. The peak arrival occurred on 5 May for EMGO, 6 May for WFGO, and 12 May for CKGO (Tables 18,19,20). The peak number of Brant were observed on 16 May. The Brant flocks continued further north and northwest and none were observed to nest on South Nelson Island. A group of 8 Brant were observed on 10 June on the mudflats south of Cackler plot 33B. A flock of 12 Brant were observed flying north on 29 June. These two observations were the only indication that Brant may have been somewhere near the South Nelson area, however these observations were considerably after early nest failures that were common at other study camps.

A total of 61 species of birds were identified. The number of species observed per day varied from 3 on 25 April to 37 on 15 and 17 May (Fig. 4). We saw an average of 24 species per day. Table 25 lists all of the avian species identified, time of first observation, and earliest nests observed.

D. Nest Density

A total of 19 CKGO, 17 EMGO, 21 WFGO and 11 unidentified goose nests were found on the 457.5 hectare study area making the average density 14.8 geese per square kilometer. The density of nests varied between species and the various subplots (Tables 1,2,3). The densest population was CKGO at 23.3 nests per km^2 (60 nests/mi^2) on plot 5 and followed by 16.5 nests/km^2 on plot 1. These plots are adjacent and cover the south central portion of the study area where Empetrum was present in mixed sedge-willow-birch-grass communities and where ponds tended to be deep and clear with numerous islands and peninsulas (Fig. 1). Plot 1 also had the highest density of EMGO with 9.4 nests/km^2. WFGO were most numerous in plot 3 at 11.5 nests/km^2.

All CKGO nests were found on islands. Nearly half of EMGO nests were also on islands, while half of the WFGO were on other than islands or peninsulas, namely on pond edge or grass flat locations (Table 4). The availability of various nest sites was not quantified, however the low density of geese and the apparent abundance of all types of nest site locations supports the preference shown by CKGO for islands, for islands or peninsulas by EMGO, and the relative non-specificity by WFGO.

E. Nest Initiation

The date of nest initiation was established for 53 nests. No obvious trend or bias was noticed in comparing the distribution of initiation dates based on laying sequence vs. back dating from hatch vs. float angle (Table 5). An exception however may be the 2 latest nest initiations estimated to have occurred on 3 and 9 June (day 154,160) which were based only on float angles. The CKGO nest was being partially predated by a jaeger when found, the eggs were cold and may have been adandoned for a period of time after initial incubation. The WFGO nest only had 2 eggs and may have been a continuation of a clutch initiated earlier but lost to a predator. The median and mode nest initiation date was 20 May (day 140) for both EMGO and WFGO while it was 6 days later, 26 May, for CKGO. Initiation dates did not differ between nest site locations (Table 6).

F. Clutch Size Determination

Because only 5 nests were found during laying (Table 8; CKGO with 4,4,and 6 egg complete clutches, EMGO with a 4 egg clutch, and WFGO with a 5 egg clutch) and because the rate of egg and nest loss was high due to foxes and jaegers, the data available on clutch size is very limited. Complete and incomplete clutches were combined in Tables 9-12 which have been included only for possible comparison with data from other years or camps. Species (Table 8), nest site location (Table 9), and nest initiation date (Table 10,11,12) show no clear relationship to clutch size. A possible exception to the lack of any trend is that those WFGO nests initiated early tended to have larger clutches.

G. Hatch Date

All nests that successfully hatched did so between 14 and 24 June within an 11 day period (Table 13).

H. Nest Success

The proportion of nests found on the study area surviving to hatch was 5% for CKGO, 47% for EMGO, and 86% for WFGO(Tables 1,2,3). Combining these with incidental nests found in other areas around camp showed nest success proportions of 5% for CKGO, 45% for EMGO, 68% for WFGO, and 0% for unknown goose species (Table 17). Small sample size prevents any meaningful analysis for correlates of nesting success although Tables 14-17 are included for possible comparison with other data. One interesting difference was noted between EMGO nests on islands where 1 of 10 survived to hatch compared to nests on peninsulas where 6 of 8 hatched (Table 14). Another possible trend is indicated by the increasing proportion of nest success from Calibration to Validation to Primary plots with declining frequency of observer visitation. Emperor's had 25%, 60%, and 75% success while WFGO had 75%, 88%, and 100% success on these plots respectively (Table 17). The number of previous observer visits (Table 15) and clutch size (Table 16) show no clear relationship to success.

I. Nest Depredation

Arctic fox were observed carrying and caching goose eggs, Parasitic jaegers were observed pecking goose eggs, and a Glaucous gull was observed preying on an EMGO gosling. An arctic fox was on one occasion observed being confronted and chased off by a Cackler. Also one observation was made of a fox climbing out of the water at the edge of a pond. It was completely wet except for its head. No active den site was found on the study area although a fox was observed there many times. An active den with kits was found 1/2 mile NW of camp near the mouth of a small slough. Another den with kits was found 1 mile SW of camp.

Glaucous, Mew, and Sabine's gulls and Long-tailed jaegers were frequently observed on the study area but no documentation was made of depredation on goose nests. A river otter was observed once on the study area. No red fox, mink, tundra hare, or lemmings were observed. On 3 and 4 May Microtus oeconomus were caught, one beneath the tent platform, the other in a nest under a board about 1/2 mile from camp. Arctic fox were observed apparently hunting for Microtus on two occassions. Runways and vole feces were found along the overhanging banks of sloughs and in grassy flats near sloughs where the snow had accumulated. Although such areas were repeatedly sampled with a few snap traps, no Microtus were caught and only 3 Sorex cinereus. No Microtus were ever observed after 4 May.

No evidence of egg collecting was observed on the study area but one instance of people searching for eggs was observed SW of camp.

The distribution and chronology of egg predation by foxes and jaegers did not apparently differ between goose species or stage of nesting (Tables 18,19,20). Depredation was observed throughout the nesting period.

J. Waterfowl Harvest

No harvest of geese or eggs was directly observed however substantial harvest of ducks or geese is assumed based on the number of shots heard. Hunting was first recorded on 28 April and last heard on 8 June. Peaks in hunting activity occurred on 6 May, 11-12 May, 16-20 May, and 31 May (Table 21). Egging was observed only on 28 May (Table 21). People were observed hunting on the study area on 16,18, and 21 May. On these three days, 4 , 10, and 20 nests of the 44 nests on the study area with estimated initiation dates had been started although incubation had not begun. With the exception of perhaps 30 and 31 May, hunting activity was consistently low after 20 May.

K. Brood Size

On 15 repeats of 2 brood survey routes along sloughs (Fig. 1), broods were observed on 10 occassions. The single CKGO brood was observed on 1 July and 2 groups of WFGO (7 adults and 14 goslings, 2 adults and 5 goslings) were observed on 2 July. The WFGO were on a small slough nearer to upland habitat W of the study area. The remainder of the sightings were of EMGO broods (Table 22). EMGO apparently prefer slough edge habitats and were fairly easily observed. CKGO and WFGO perhaps are either more wary or tend to prefer different brood rearing habitat.

Table 1. Production data for Cackling Canada Geese at South Nelson Island, 1984.

Category	Plots							
	Calib. 1	Calib. 2	Valid. 3	Valid. 4	Valid. 5	Prim. 6	Prim. 7	Total
Average complete clutch	4.7 (3)[a]	-	-	-	-	-	-	4.7 (3)
Average clutch at end of incubation	-	-	-	-	6.0 (1)	-	-	6.0 (1)
Average number of eggs/ nest[b] lost	4.6 (7)	-	-	-	1.0 (1)	4.0 (1)	-	4.1 (9)
Average clutch hatched[c]	0 (7)	0 (3)	0 (1)	0 (1)	0.8 (6)	0 (1)	-	0.3 (19)
Average number of goslings hatched per nesting pair[c]	0 (7)	0 (3)	0 (1)	0 (1)	0.8 (6)	0 (1)	-	0.3 (19)
Successful nests	0	0	0	0	1	0	-	1 5%
Nests - status determined	7	3	1	1	6	1	-	19
Nests - found	7	3	1	1	6	1	0	19
Nests/km^2	16.5	1.7	1.9	2.4	23.3	1.5	0	4.2
Nests/mi^2	42.7	4.4	4.9	6.2	60.3	3.9	0	10.8

[a] Figures in parentheses are sample sizes.

[b] Sample size only includes nests with egg loss.

[c] The number of eggs present at the last prehatch visit was used to obtain the maximum number of goslings hatched in each area.

Table 2. Production data for Emperor Geese at South Nelson Island, 1984.

Category	Plots							
	Calib. 1	Calib. 2	Valid. 3	Valid. 4	Valid. 5	Prim. 6	Prim. 7	Total
Average complete clutch	4.0 (1)[a]	-	-	-	-	-	-	4.0 (1)
Average clutch at end of incubation	3.0 (2)	-	3.3 (3)	-	-	3.0 (1)	8.0 (2)	4.4 (8)
Average number of eggs/ nest[b] lost	4.5 (2)	5.7 (3)	-	8.0 (1)	-	-	-	5.7 (6)
Average clutch hatched[c]	3.0 (2)	-	3.3 (3)	-	-	3.0 (1)	8.0 (2)	4.4 (8)
Average number of goslings hatched per nesting pair[c]	1.5 (4)	0 (4)	3.3 (3)	0 (2)	-	3.0 (1)	5.3 (3)	2.1 (17)
Successful nests	2	0	3	0	0	1	2	8 47%
Nests - status determined	4	4	3	2	0	1	3	17
Nests - found	4	4	3	2	0	1	3	17
Nests/km^2	9.4	2.3	5.8	4.7	0	1.5	5.8	3.7
Nests/mi^2	24.3	6.0	15.0	12.2	0	3.9	15.0	9.6

[a] Figures in parentheses are sample sizes.

[b] Sample size only includes nests with egg loss.

[c] The number of eggs present at the last prehatch visit was used to obtain the maximum number of goslings hatched in each area.

Table 3. Production data for White-fronted Geese at South Nelson Island, 1984.

Category	Plots							
	Calib. 1	Calib. 2	Valid. 3	Valid. 4	Valid. 5	Prim. 6	Prim. 7	Total
Average complete clutch	5.0 (1)[a]	-	-	-	-	-	-	5.0 (1)
Average clutch at end of incubation	3.3 (3)	5.0 (3)	4.8 (6)	4.0 (1)	-	5.0 (2)	4.0 (3)	5.6 (18)
Average number of eggs/ nest[b] lost	-	2.5 (2)	2.0 (1)	-	2.0 (1)	-	-	2.2 (4)
Average clutch hatched[c]	3.3 (3)	5.0 (3)	4.8 (6)	4.0 (1)	-	5.0 (2)	4.0 (3)	5.6 (18)
Average number of goslings hatched per nesting pair[c]	3.3 (3)	3.0 (5)	4.8 (6)	4.0 (1)	-	5.0 (2)	4.0 (3)	5.6 (18)
Successful nests	3	3	6	1	0	2	3	18 86%
Nests - status determined	3	5	6	1	1	2	3	21
Nests - found	3	5	6	1	1	2	3	21
Nests/km^2	7.1	2.8	11.5	2.4	3.9	3.0	5.8	4.6
Nests/mi^2	18.3	7.3	29.8	6.1	10.0	7.8	15.1	11.9

[a] Figures in parentheses are sample sizes.

[b] Sample size only includes nests with egg loss.

[c] The number of eggs present at the last prehatch visit was used to obtain the maximum number of goslings hatched in each area.

Table 4. Nest locations for Cackling Canada, Emperor and White-fronted Geese at South Nelson Island, 1984.

Species - Plot[a]	Nest Location			
	Island	Peninsula	Other	Total
Cackling: Total	N=19, 100%	N=0, 0%	N=0, 0%	19
Calibration 1	7 (100)[b]	0 (0)	0 (0)	7
Calibration 2	3 (100)	0 (0)	0 (0)	3
Validation 3	1 (100)	0 (0)	0 (0)	1
Validation 4	1 (100)	0 (0)	0 (0)	1
Validation 5	6 (100)	0 (0)	0 (0)	6
Primary Census 6	1 (100)	0 (0)	0 (0)	1
Primary Census 7	0 (0)	0 (0)	0 (0)	0
Emperor: Total	N=8, 47%	N=7, 41%	N=2, 12%	17
Calibration 1	2 (50)	2 (50)	0 (0)	4
Calibration 2	3 (75)	1 (25)	0 (0)	4
Validation 3	0 (0)	2 (67)	1 (33)	3
Validation 4	2 (100)	0 (0)	0 (0)	2
Validation 5	0 (0)	0 (0)	0 (0)	0
Primary Census 6	0 (0)	1 (100)	0 (0)	1
Primary Census 7	1 (33)	1 (33)	1 (33)	3
White-Fronted: Total	N=7, 33%	N=4, 19%	N=10, 48%	21
Calibration 1	0 (0)	2 (67)	1 (33)	3
Calibration 2	1 (20)	0 (0)	4 (80)	5
Validation 3	0 (0)	1 (17)	5 (83)	6
Validation 4	1 (100)	0 (0)	0 (0)	1
Validation 5	1 (100)	0 (0)	0 (0)	1
Primary Census 6	2 (100)	0 (0)	0 (0)	2
Primary Census 7	2 (67)	1 (33)	0 (0)	3

[a] Only plots which contained at least 1 nest are included.

[b] Numbers in parentheses are percentages.

Table 5. Nest initiation dates for Cackling Canada, Emperor and White-fronted Geese as determined by 3 methods at South Nelson Island, 1984.

Species	Method	Julian Date - 1																						
		134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154/160	Total
Cackling	laying sequence										1		2					1					4
	back dating									1													1
	float angle													4								1	5
	Total:	0	0	0	0	0	0	0	0	1	1	0	2	4	0	0	0	1	0	0	0	0 / 1	10
Emperor	laying sequence															1							1
	back dating	1					1	2	1	1													6
	float angle				2	1		2		2			1	1									9
	Total:	1	0	0	2	1	1	4	1	3	0	0	1	1	0	1	0	0	0	0	0	0 / 0	16
White-fronted	laying sequence				1					1		1											3
	back dating	1	2	1	2	1		1	1	1	1		2	1									14
	float angle							4			3				1	1						1	10
	Total:	1	2	1	3	1	0	5	1	2	4	1	2	1	1	1	0	0	0	0	0	1 / 0	27
Species combined		2	2	1	5	2	1	9	2	6	5	1	5	6	1	2	0	1	0	0	0	1 / 1	53

Table 6. Nest initiation dates for Cackling Canada, Emperor and White-fronted Geese for 3 nest locations at South Nelson Island, 1984.

		Julian Date																						
Species	Nest Location	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155/160	Total
Cackling	island									1	1	0	2	4	0	0	0	1	0	0	0	0	0	10
	peninsula																							0
	other																							0
Emperor	island	1				1		2		1				1		1								7
	peninsula				1			2	1	1			1											6
	other				1		1																	2
White-fronted	island							2		1	2		1									1		7
	peninsula		1					2	1		1													5
	other	1	1	1	3	1		1		1	1	1	1	1	1	1								15

Table 7. Number of Cackling Canada, Emperor and White-fronted Goose nests located during successive searches of Calibration plots at South Nelson Island, 1984.

Species	Plot	Search	Julian Date	Nest found since last search	Nest initiated but not found	Cumulative % found of those present
Cackling	1	1	145	2	1	67
		2	148	3	2	71
		3	151	0	2	71
		4	154	1	1	86
		5	157	0	1	86
		6	160	1	0	100
	2	1	156	3	0	100
		2	159	0	0	-
		3	162	0	0	-
Emperor	1	1	145	3	0	100
		2	148	1	0	100
		3	151	0	0	-
		4	154	0	0	-
		5	157	0	0	-
		6	160	0	0	-
	2	1	156	3	1	75
		2	159	1	0	100
		3	162	0	0	-
White-fronted	1	1	145	1	2	33
		2	148	2	0	100
		3	151	0	0	-
		4	154	0	0	-
		5	157	0	0	-
		6	160	0	0	-
	2	1	156	3	2	60
		2	159	2	0	100
		3	162	0	0	-

Table 8. Frequency of clutch sizes for complete clutches, those found during laying, and incomplete clutches, those found after laying, for Cackling Canada, Emperor and White-fronted Geese at South Nelson Island, 1984.

Species	Time	Plot	Clutch Size							
			1	2	3	4	5	6	7	8
Cackling	complete	Calib 1,2				2	0	1	0	
		Valid 3,4,5				0	0	0	0	
		Primary 6,7				0	0	0	0	
	incomplete	Calib 1,2			2	1	0	0	0	1
		Valid 3,4,5			0	0	0	1	0	0
		Primary 6,7			0	1	0	0	0	0
		Total	0	0	2	4	0	2	0	1
Emperor	complete	Calib 1,2				1				
		Valid 3,4,5				0				
		Primary 6,7				0				
	incomplete	Calib 1,2			2	0	3	0	1	0
		Valid 3,4,5			2	1	0	0	0	1
		Primary 6,7			1	0	0	0	0	2
		Total	0	0	5	2	3	0	1	3
White-fronted	complete	Calib 1,2					1			
		Valid 3,4,5					0			
		Primary 6,7					0			
	incomplete	Calib 1,2		1	1	1	1	1	1	
		Valid 3,4,5		1	0	3	2	1	1	
		Primary 6,7		1	0	1	2	1	0	
		Total	0	3	1	5	6	3	2	0

Table 9. Frequency of clutch size for complete and incomplete clutches by nest location for Cackling Canada, Emperor and White-fronted Geese at South Nelson Island, 1984.

		Clutch Size									
Species	Location	1	2	3	4	5	6	7	8	$\bar{X}$	(n)
Cackling	island	1	0	2	4	0	3	0	1	4.5	(11)
	peninsula	0	0	0	0	0	0	0	0	0	(0)
	other	0	0	0	0	0	0	0	0	0	(0)
										4.5	(11)
Emperor	island	0	0	0	1	4	0	3	1	5.9	(9)
	peninsula	0	1	4	1	1	0	0	1	3.9	(8)
	other	0	0	1	0	0	0	0	1	5.5	(2)
										5.0	(19)
White-fronted	island	0	2	0	2	1	1	0	0	3.8	(6)
	peninsula	0	1	1	0	1	1	0	0	4.0	(4)
	other	0	0	0	3	4	1	2	0	5.2	(10)
										4.6	(20)

Table 10. Nest initiation date by clutch size from complete and incomplete clutches for Cackling Canada Geese at South Nelson Island, 1984.

	Julian Date									
Clutch Size	142	143	144	145	146	147	148	149	150 / 160	Total
3					2					2
4		1		1	1				1	4
5										0
6	1			1					1	3
7										0
8					1					1
Total	1	1	0	2	4	0	0	0	1 / 1	10

Table 11. Nest initiation date by clutch size from complete and incomplete clutches for Emperor Geese at South Nelson Island, 1984.

	Julian Date															
Clutch Size	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	Total
3						1	1	1	2							5
4							1		0						1	2
5							1	0	1	0	0	1	1	0	0	4
6							0									0
7	1						1									2
8	0	0	0	2	1	0	0									3
Total	1	0	0	2	1	1	4	1	3	0	0	1	1	0	1	16

Table 12. Nest initiation date by clutch size from complete and incomplete clutches for White-fronted Geese at South Nelson Island, 1984.

	Julian Date																					
Clutch Size	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	Total
2										2											1	3
3								1	1	1			1		1	0	0	0	0	0		5
4				1			1					2		1								5
5			1	0	1	0	3				1											6
6		2	0	1			1		1													5
7	1			1						1												3
Total	1	2	1	3	1	0	5	1	2	4	1	2	1	1	1	0	0	0	0	0	1	27

Table 13. Hatch dates for Cackling Canada, Emperor and White-fronted Geese at South Nelson Island, 1984.

	Julian Date											
Species	165	166	167	168	169	170	171	172	173	174	175	Total
Cackling	0	0	0	0	0	0	0	0	0	0	1	1
Emperor	1	3	0	0	1	0	0	0	0	0	0	5
White-fronted	1	1	3	3	1	0	0	2	0	0	0	11

Table 14. Percent nesting success (sample size) for Cackling Canada, Emperor and White-fronted Geese at different nest locations at South Nelson Island, 1984.

	Cackling			Emperor			White-front		
Plot	Island	Peninsula	Other	Island	Peninsula	Other	Island	Peninsula	Other
Calibration 1	0 (7)	-	-	0 (2)	100 (2)	-	-	100 (2)	100 (1)
Calibration 2	0 (3)	-	-	0 (3)	0 (1)	-	0 (1)	-	75 (4)
Validation 3	0 (1)	-	-	-	100 (2)	100 (1)	-	100 (1)	100 (5)
Validation 4	0 (1)	-	-	0 (2)	-	-	100 (1)	-	-
Validation 5	17 (6)	-	-	-	-	-	0 (1)	-	-
Primary 6	0 (1)	-	-	-	100 (1)	-	100 (2)	-	-
Primary 7	-	-	-	0 (1)	100 (1)	100 (1)	100 (2)	100 (1)	-
misc.	0 (2)	-	-	50 (2)	0 (1)	-	0 (1)	100 (1)	25 (8)
Total	5 (21)	-	-	10 (10)	75 (8)	100 (2)	63 (8)	100 (5)	61 (18)

Table 15. Outcome of nesting attempts by Cackling Canada, Emperor and White-fronted Geese in relation to the number of previous visits to that nest. All plots as well as incidental nests are included.

	Number of Previous Visits										
	0	1	2	3	4	5	6	7	8	9	Total
Cackling											
hatched without egg loss	0	0	0	0	0	0	0	0	0	0	0
hatched with egg loss	0	0	0	1	0	0	0	0	0	0	1
unhatched-predated	10	3	2	3	0	1	0	0	0	1	20
Emperor											
hatched without egg loss	0	5	2	0	0	0	0	0	2	0	9
hatched with egg loss	0	0	0	0	0	0	0	0	0	0	0
unhatched-predated	3	1	3	0	1	1	1	1	0	0	11
White-fronted											
hatched without egg loss	0	4	7	2	0	3	1	0	2	1	20
hatched with egg loss	0	1	0	0	0	0	0	0	0	0	1
unhatched-predated	4	2	2	1	0	0	0	1	0	0	10
Unidentifed goose species											
unhatched-predated	4	4	0	0	1	0	0	0	0	0	9
unhatched-abandoned	3	0	0	0	0	0	0	0	0	0	3

Table 16. Hatching success percent (sample size) of complete clutches, those found on calibration plots during laying, and imcomplete clutches (all other nests) as related to clutch size for Cackling Canada, Emperor and White-fronted Geese at South Nelson Island, 1984.

	Clutch Size							
Species	1	2	3	4	5	6	7	8
Cackling Canada								
complete	-	-	-	0(2)	-	0(1)	-	-
incomplete	0(1)	-	0(2)	0(2)	-	50(2)	-	0(1)
Emperor								
complete	-	-	-	0(1)	-	-	-	-
incomplete	-	0(1)	100(5)	100(1)	0(4)	-	50(2)	67(3)
White-fronted								
complete	-	-	-	-	100(1)	-	-	-
incomplete	-	67(3)	40(5)	100(5)	100(5)	100(5)	33(3)	-

Table 17. Hatching success percent (sample size) in calibration, validation, and primary plots as related to clutch size for Cackling Canada, Emperor and White-fronted Geese at South Nelson Island, 1984.

		Clutch Size									
Species	Plot	1	2	3	4	5	6	7	8	Unknown	Total
Cackling	Calibration	-	-	0(2)	0(3)	-	0(1)	-	0(1)	0(3)	0(10)
	Validation	-	-	-	-	-	100(1)	-	-	0(7)	9(8)
	Primary	-	-	-	0(1)	-	-	-	-	-	0(1)
	Misc.	0(1)	-	-	-	-	0(1)	-	-	-	0(2)
											5(21)
Emperor	Calibration	-	-	100(2)	0(1)	0(3)	-	0(1)	-	0(1)	25(8)
	Validation	-	-	100(2)	100(1)	-	-	-	0(1)	0(1)	60(5)
	Primary	-	-	100(1)	-	-	-	-	100(2)	0(1)	75(4)
	Misc.	-	0(1)	-	-	0(1)	-	100(1)	-	-	33(3)
											45(20)
White-fronted	Calibration	-	100(1)	100(1)	100(1)	100(2)	100(1)	0(1)	-	0(1)	75(8)
	Validation	-	0(1)	-	100(3)	100(2)	100(1)	100(1)	-	-	88(8)
	Primary	-	100(1)	-	100(1)	100(2)	100(1)	-	-	-	100(5)
	Misc.	-	-	25(4)	-	-	100(2)	0(1)	-	0(3)	30(10)
											68(31)
Unidentified Goose Nest	Calibration	-	0(3)	0(2)	-	-	-	-	-	0(1)	0(6)
	Validation	-	0(2)	-	-	-	-	-	-	0(2)	0(4)
	Primary	-	-	-	-	-	-	-	-	0(1)	0(1)
	Misc.	-	-	-	-	-	-	-	-	0(1)	0(1)
											0(12)

Table 18. Chronology of migration, nest initiation, clutch completion, latest possible nest predation date, and hatching of Cackling Canada Geese at South Nelson Island, 1984.

	Calender Date	Julian Date-1	Number of Nests
First Observation	25 April	115	
Peak Arrival	12-17 May	132-137	
First/Last Nest Initiation	22 May/9 June	142/160	
Average Nest Initiation	27 May	147	10
First/Last Clutch Completion	26 May/13 June	146/164	
Average Clutch Completion	2 June	153	9
First/Last Nest Predation	31 May/23 June	151/174	
Average Nest Predation	11 June	162	21
Distribution of Predation	31 May	151	1
	3 June	154	3
	7 June	158	1
	8 June	159	3
	9 June	160	1
	11 June	162	2
	12 June	163	6
	17 June	168	1
	21 June	172	1
	23 June	174	2
First/Last Hatching	24 June	175	
Average Hatching	24 June	175	1

Table 19. Chronology of migration, nest initiation, clutch completion, latest possible nest predation date, and hatching of Emperor Geese at South Nelson Island, 1984.

	Calender Date	Julian Date-1	Number of Nests
First Observation	28 April	118	
Peak Arrival	5,11-13 May	125,131-133	
First/Last Nest Initiation	14/28 May	134/148	
Average Nest Initiation	21 May	141	16
First/Last Clutch Completion	21/31 May	141/151	
Average Clutch Completion	25 May	145	16
First/Last Nest Predation	31 May/20 June	151/171	
Average Nest Predation	13 June	164	11
Distribution of Predation	31 May	151	1
	8 June	159	1
	9 June	160	1
	11 June	162	1
	15 June	166	4
	16 June	167	1
	17 June	168	1
	20 June	171	1
First/Last Hatching	14/18 June	165/169	
Average Hatching	16 June	167	3

Table 20. Chronology of migration, nest initiation, clutch completion, latest possible nest predation date, and hatching of White-fronted Geese at South Nelson Island, 1984.

	Calender Date	Julian Date-1	Number of Nests
First Observation	25 April	115	
Peak Arrival	28 April,6,11-15 May	118,126,131-135	
First/Last Nest Initiation	14 May/3 June	134/154	
Average Nest Initiation	21 May	141	25
First/Last Clutch Completion	20 May/4 June	140/155	
Average Clutch Completion	25 May	145	25
First/Last Nest Predation	1/28 June	152/177	
Average Nest Predation	10 June	161	10
Distribution of Predation	1 June	152	3
	8 June	159	1
	9 June	160	1
	11 June	162	3
	23 June	174	1
	26 June	177	1
First/Last Hatching	15/21 June	166/172	
Average Hatching	17 June	168	10

Table 21. Chronology of subsistence activity recorded at South Nelson Island, 1984.

Goose Activity	Julian Day-1	Shots	People	Snowmachines	Boats	Comments
First WFGO,CKGO	115 (25 Apr)		2	2		seal hunting, wood collecting
First EMGO	118	3	14	14		seal hunting
	119	1	3	3		
	123 (3 May)	2		2		
	124			4	2	
Peak EMGO	125	8				
Peak WFGO	126	45		2		
	127	17		7		
	128	19	5	8		
	129			2		
	130	30		4		
Peak CKGO	131	47				
First BRAN	132 (12 May)	217		5		
	133	11				
First nest init. EMGO,WFGO	134					
River break up	135					
Peak BRAN	136 (16 May)	75	10		4	6 people,2 tents on study area
	137	154				

Table 21(cont.). Chronology of subsistence activity recorded at South Nelson Island, 1984.

Goose Activity	Julian Day-1	Shots	People	Snowmachines	Boats	Comments
	138 (18 May)	162	9			7 people NW of camp and 2 on study area
	139	96				
	140	64	6		3	
	141	13			1	2 tents on study area
First nest init. CKGO	142	18			1	
	145	2				
	148	14	8		3	people with buckets S of camp
	149	5				
	150	30	3			S edge of study area
	151	59	2		4	SE edge of study area
	152	14				
	153	10				
	154	18			1	
	158	4				
	159	4				
	160				2	
First hatch EMGO,WFGO	165					

Table 22. Broods observed during boat survey routes and plot habitat work at South Nelson Island, 1984.

Species	Brood Class	Average Size	Number	Earliest Date	Latest Date
Emperor	IA	3.0	20	25 June	4 July
	IB	4.1	14	26 June	10 July
	IC	2.7	3	10 July	
Cackling	IA	3.0	1	1 July	
White-fronted	IB	3.8	5	2 July	
	IC	1.0	2	2 July	6 July
Pintail	2C	5.0	1	2 July	
Oldsquaw	IA	6.5	2	6 July	12 July

Table 23. Total area in hectares of plots and subplots searched for nests at South Nelson Island, 1984.

Plot / Subplot	Calib 1	Calib 2	Valid 3	Valid 4	Valid 5	Prim 6	Prim 7
A	2.56	7.35	4.46	4.79	4.99	28.73	4.41
B	2.79	8.48	4.43	4.74	3.17	10.61	12.58
C	4.63	8.40	5.52	7.01	2.34	9.54	4.25
D	3.24	9.51	7.77	8.64		7.40	7.57
E	2.36	12.66	5.54				
F	2.98	7.82					
G	2.07	7.63					
H	2.13	5.45					
I	4.01	14.71	6.57	9.27	11.58	10.30	4.87
J	1.53	21.75	6.48	7.94	3.66		8.97
K	1.52	28.65	4.33				8.93
L	2.08	20.63	6.99				
M	2.84	4.71					
N	3.67	5.31					
O	4.05	7.95					
P		5.63					
Total	42.46	176.64	52.09	42.39	25.74	66.58	51.58

457.48

Table 24. Visually estimated percent of ground covered by snow or ice, meltwater, ponds, and sloughs along 2 transects SW of camp on South Nelson Island, 1984.

Transect	Date	Snow/Ice	Meltwater	Pond	Slough
1	28 April	21	7	29	5
	30 April	12	6	24	5
	2 May	5	0	15	2
	6 May	4	1	13	1
	10 May	2	2	13	2
2	29 April	12	5	22	6
	2 May	6	0	14	3
	6 May	2	1	9	2
	10 May	1	1	9	3

Table 25. List of avian species observed at South Nelson Island, 1984.

Species	Date of first sighting (Julian date)	first nest/ eggs seen	first pipped egg/ nestling seen
Arctic loon - *Gavia arctica*	136	*	---
Red-throated loon - *G. stellata*	129	*	---
Pelagic cormorant - *Phalacrocorax pelagicus*	165	---	---
Sandhill crane - *Grus canadensis*	117	137	165
Tundra swan - *Cygnus columbianus*	116	144	174
Greater white-fronted goose - *Anser albifrons*	115	142	165
Snow goose - *Chen caerulescens*	132	---	---
Emperor goose - *C. canagica*	118	144	165
Cackling canada goose - *Branta canadensis minima*	115	154	175
Brant - *Branta bernicla nigricans*	132	---	---
Mallard - *Anas platyrhynchos*	118	*	---
Green-winged teal - *A. crecca*	118	167	---
American wigeon - *A. americana*	117	---	---
Northern pintail - *A. acuta*	117	139	---
Northern shoveler - *A. clypeata*	135	---	---
Greater scaup - *Aythya marila*	135	165	---
Common eider - *Somateria mollissima*	156	---	---
Spectacled eider - *S. fischeri*	135	148	181
Black scoter - *Melanitta nigra*	139	*	---
Oldsquaw - *Clangula hyemalis*	135	154	187
Common goldeneye - *Bucephala clangula*	135	---	---
Bufflehead - *B. albeola*	150	---	---

Red-breasted merganser - *Mergus serrator*	134	---	---
Black-bellied plover - *Pluvialis squatarola*	119	149	---
Lesser golden plover - *P. dominica*	118	*	---
Bar-tailed godwit - *Limosa lapponica*	130	154	---
Bristle-thighed curlew - *Numenius tahitiensis*	174	---	---
Whimbrel - *N. phaeopus*	178	---	---
Greater yellowlegs - *Tringa melanoleuca*	183	---	---
Red-necked phalarope - *Phalaropus lobatus*	133	150	168
Red phalarope - *P. fulicaria*	135	*	---
Short-billed dowitcher - *Limnodromus griseus*	133	---	---
Long-billed dowitcher - *L. scolopaceus*	135	---	---
Common snipe - *Gallinago gallinago*	137	*	---
Black turnstone - *Arenaria melanocephala*	127	148	166
Rock sandpiper - *Calidris ptilocnemis*	123	---	---
Dunlin - *C. alpina*	120	142	165
Western sandpiper - *C. mauri*	129	144	166
Pectoral sandpiper - *C. melanotos*	136	*	---
South polar skua - *Catharcta maccormicki*	156	---	---
Pomarine jaeger - *Stercorarius pomarinus*	139	---	---
Parasitic jaeger - *S. parasiticus*	119	---	---
Long-tailed jaeger - *S. longicaudus*	128	160	---
Mew gull - *Larus canus*	117	145	---
Glaucous gull - *L. hyperboreus*	116	158	---
Glaucous-winged gull - *L. glaucescens*	116	---	---
Black-legged kittiwake - *Rissa tridactyla*	195	---	---
Sabine's gull - *Xema sabini*	119	*	---
Arctic tern - *Sterna paradisaea*	131	*	---

Northern harrier - *Circus cyaneus*	128	---	---
Willow ptarmigan - *Lagopus lagopus*	116	192	---
Short-eared owl - *Asio flammeus*	117	---	---
Snowy owl - *Nyctea scandiaca*	124	---	---
Tree swallow - *Tachycineta bicolor*	150	---	---
Common raven - *Corvus corax*	120	---	---
Savannah sparrow - *Passerculus sandwichensis*	132	158	175
Golden-crowned sparrow - *Zonotrichia atricapilla*	131	---	---
Lapland longspur - *Calcarius lapponicus*	118	143	155
Snow bunting - *Plectrophenax nivalis*	120	---	---
McKay's bunting - *P. hyperboreus*	118	---	---
Common redpoll - *Carduelis flammea*	175	---	---

* = nests of these species probably occurred in the area but were not found by researchers.

Table 26. List of vascular plants found on South Nelson Island, 1984.

BETULACEAE
Betula glandulosa
Betula nana

CARYOPHYLLACEAE
Stellaria calycantha

COMPOSITAE
Achillea borealis
Chrysanthemum arcticum
Petasites frigidus
P. hyperboreus

CORNACEAE
Cornus suecica

CRASSULACEAE
Sedum rosea

CRUCIFERAE
Cardamine pratensis
Cochlearia officinalis

CYPERACEAE
Carex Lyngbyaei
C. Mackenziei
C. Ramenskii
C. rariflora
C. subspathacea
Eleocharis spp.
Eriophorum angustifolium
E. russeolum

EMPETRACEAE
Empetrum nigrum

ERICACEAE
Ledum palustre
Vaccinium vitis-idaea

GRAMINEAE
Alopecurus alpinus
Arctogrostis latifolia
Calamagrostis canadensis
C. deschampsioides
C. inexpansa
Dupontia Fischeri
Elymus arenarius
Festuca rubra
Hierochloe pauciflora
Poa eminens
P. lanata
Puccinellia phryganodes
Vahlodea atropurpurea

HALORGACEAE
Hippuris tetraphylla

JUNCACEAE
Luzula arcuata
L. multiflora

JUNCAGINACEAE
Triglochin palustris

LEGUMINOSAE
Lathyrus maritimus

ONAGRACEAE
Epilobium angustifolium
E. palustre

POLEMONIACEAE
Polemonium acutiflorum

POLYGONACEAE
Rumex arcticus

PRIMULACEAE
Primula spp.
Trientalis europaea

RANUNCULACEAE
Ranunculus hyperboreus
R. lapponicus
R. Pallasii

ROSACEAE
Potentilla Egedii
P. palustris
Rubus arcticus
R. chamaemorus

RUBIACEAE
Galium spp.

SALICACEAE
Salix fuscescens
S. ovalifolia

SCROPHULARIACEAE
Pedicularis Kanei
P. sudetica

UMBELLIFERAE
Angelica lucida
Cicuta mackenzieana
Ligusticum scoticum

VALERIANACEAE
Valeriana capitata

JULIAN DATE CALENDAR

(PERPETUAL)

Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	1
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	3
4	004	035	063	094	124	155	185	216	247	277	308	338	4
5	005	036	064	095	125	156	186	217	248	278	309	339	5
6	006	037	065	096	126	157	187	218	249	279	310	340	6
7	007	038	066	097	127	158	188	219	250	280	311	341	7
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	11
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029		088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

FOR LEAP YEAR USE REVERSE SIDE

Figure 1. Outline map of South Nelson Island camp, study area, and brood survey routes.

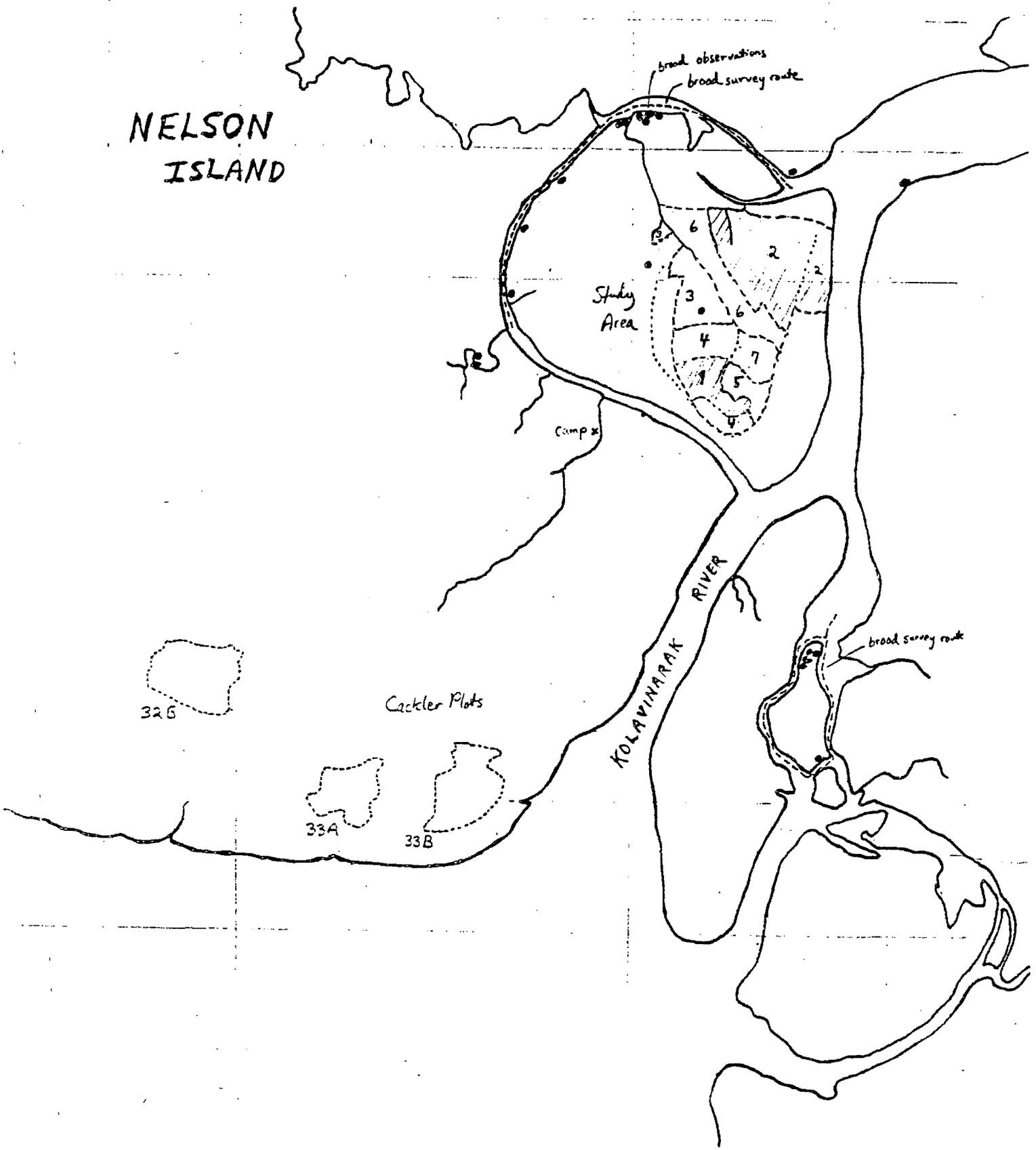

Figure 2. Maximum and minimum daily temperature at South Nelson Island, 1984.

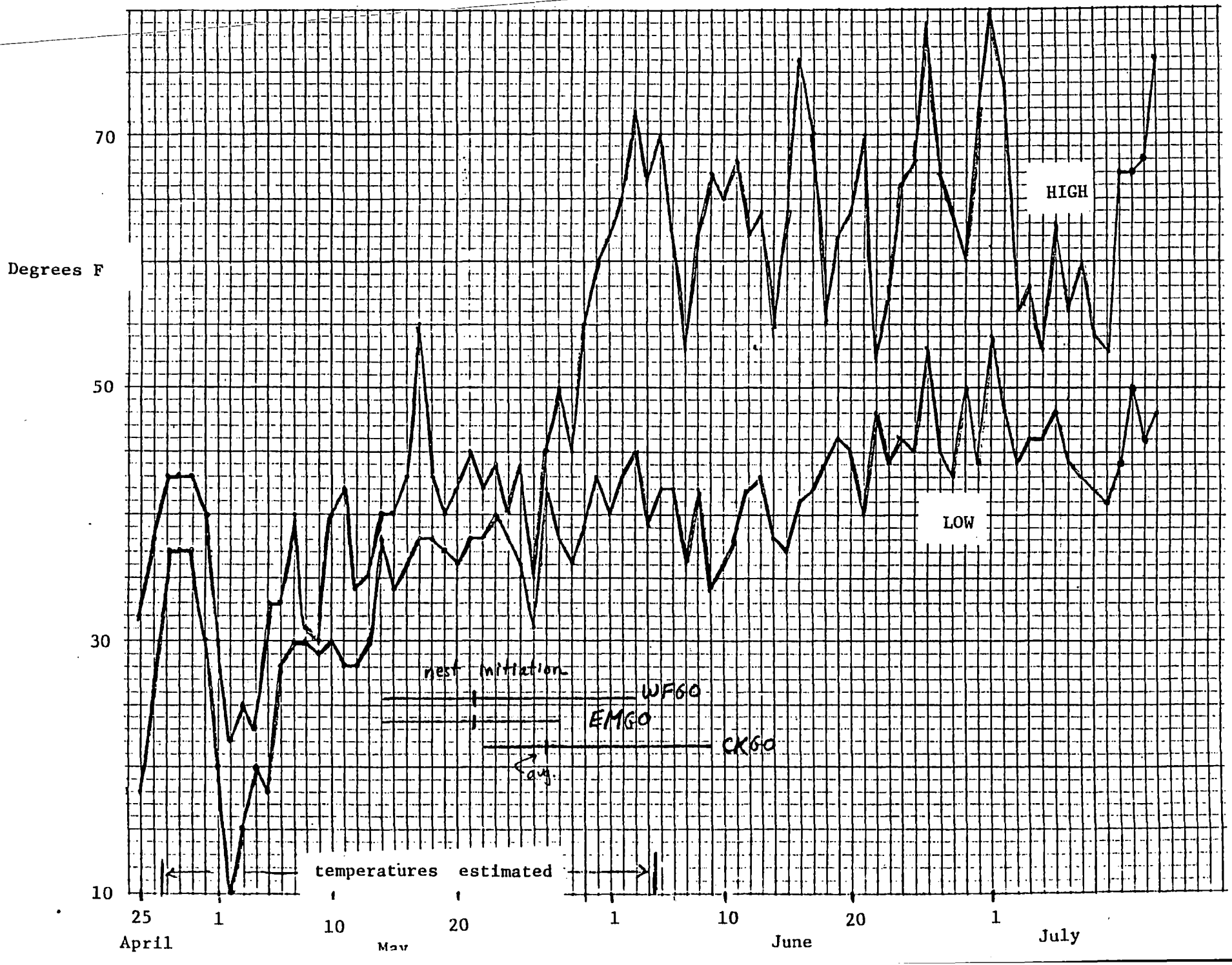

Figure 3. Barometric pressure and pattern of precipitation at South Nelson Island, 1984.

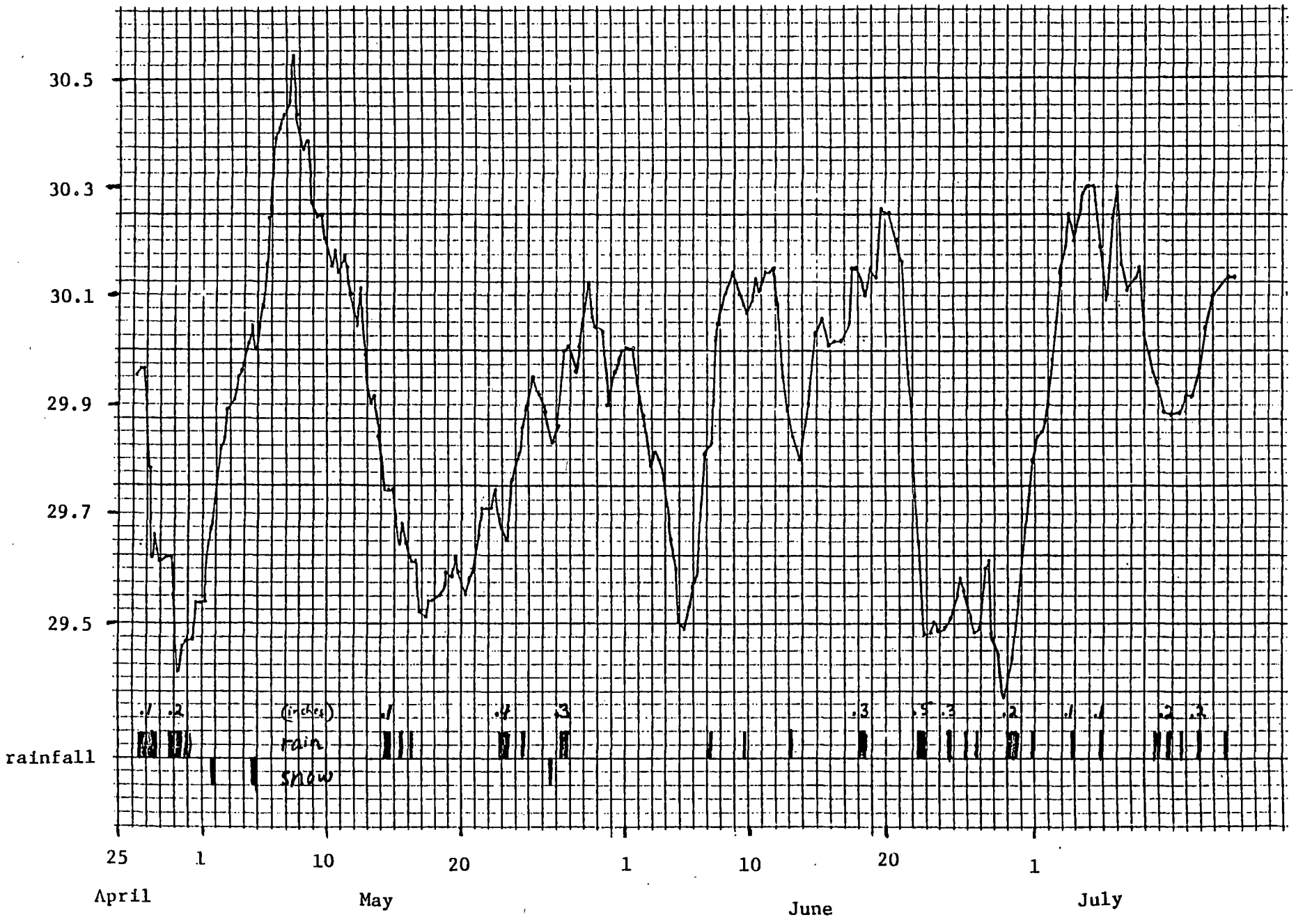

Figure 4. Number of avian species observed per day at South Nelson Island, 1984.