AN EVALUATION OF PRODUCTIVITY AND MORTALITY FACTORS INFLUENCING GEESE AT THE TUTAKOKE RIVER, ALASKA

A report of results from 1984

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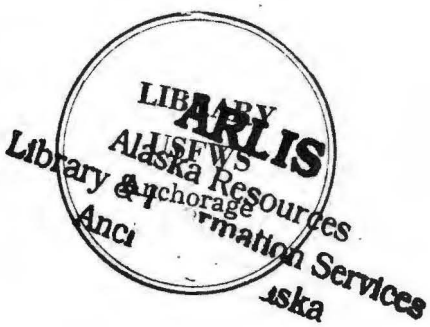

I. Introduction.

Long term declines in numbers of geese nesting on the Yukon-Kuskokwim Delta, Alaska have recently stimulated a great deal of concern about the status of these populations (Raveling 1983), which has been heightened by dramatic declines in cackling Canada geese and Pacific black brant since the 1970's. Yukon Delta National Wildlife Refuge began a large scale program monitoring goose populations nesting on the Y-K Delta in 1982, which was expanded in both 1983 and 1984. Here, I report the results from 1984 of this monitoring effort at the mouth of the Tutakoke River, which is one of 3 major brant colonies remaining on the Y-K Delta.

While I am responsible for any errors in analysis or presentation of data, the design of the study was the responsibility of the staff of Yukon Delta National Wildlife Refuge. Methods of data collection and presentation follow those prescribed by the refuge staff as nearly as possible.

II. Methods.

Methods were as described in Wege and Garrett (1983) except for minor differences noted below.

A. Weather.

Wind direction, wind speed, visibility, barometric pressure, temperature and percent cloud cover were recorded at about 0800 and 2000 daily. Minimum and maximum temperature, and precipitation were recorded daily. In addition,

temperature, relative humidity and barometric pressure were recorded continuously on a Meteorgraph chart recorder.

B. Snow cover transects.

Three 1.6 km transects (Fig. 1) were established and sampled at about 3 day intervals. Transects 1 and 2 were established on 30 April and 1 May, respectively, while transect 3 was first sampled on 8 May. Photographs were taken in all 4 directions (NESW) at each sample point along each transect (see Wege and Garrett 1983 for details of sampling along transects).

C. Chronology of Migration.

Observations were made for 2 hours daily between arrival of biologists on 30 April and 27 May (usually between 1000 and 1200) in a single 90^{o} arc running SE to SW from camp. On days of major goose movement observations were continued for several hours to document the magnitude of migration on those days. Both binoculars and a 20X spotting scope were used for observation and all birds either on the ground or passing through the designated area were counted.

D. Study Area: Location and Search.

Calibration Plots (see Wege and Garrett 1983 for description of plot categories) were placed in high (Calibration Plot I), medium (Calibration Plot II) and low (Calibration Plot III) density brant nesting areas (see Fig. 1 for location of plots) based on densities observed in 1983. Calibration Plot III contained some medium density areas to provide enough nests to meet quotas established by the refuge staff. Calibration plots were searched or visited

every 3 days, beginning during egg laying and continuing until hatching, when it was sometimes necessary to visit plots daily to determine precise hatch dates of eggs. The one Validation Plot (Plot I) in the brant colony proper was located in a medium density area. Other Validation Plots coincided with widely spaced Cackling Goose Plots (plot numbers 15A, 15B, 16A and 17A) which were searched as part of a larger program organized by Yukon Delta NWR. I assigned numbers to these plots corresponding to the last 2 digits in the refuge numbering system (e.g. 5A corresponded to 15A). Two Primary Plots (1 and 3) were used to census areas not censused in 1983. Primary Plot 1 was established in the area between the Kashunuk and Tutakoke Rivers while Primary Plot 3 was placed in an area about 8 km south of the Tutakoke River. Primary Plot 2 was in the Tutakoke Brant colony proper. No Secondary Census Plots were searched in 1984.

Subplots were intended to be areas within plots that could be searched by one person during a 50-70 minute period. In most cases natural geographic features delineated subplot boundaries, which sometimes necessitated establishment of subplots that required between 45 and 110 minutes to search. Three, 6 and 9 subplots were initially searched in Calibration Plots I, II and III, respectively. I added 6 and 3 subplots, respectively, to Calibration Plots I and III on the second search to meet refuge quotas for number of nests per plot.

E. Nest depredation.

Methods were as described by Wege and Garrett (1983) except that eggs in all nests were individually marked to allow a more precise description of partial predation during egg laying.

F. Brood size.

Brood counts (size and number of broods) were made opportunistically during travel in the Tutakoke and lower Kashunuk River areas. Brood counts were also made from towers located in both of these areas.

III. Results and Discussion.

A. Weather.

Temperatures during the first 10 days of May were colder in 1984 than 1983 (Fig. 2 and see Wege and Garrett 1983). Daily maximum temperatures did not exceed freezing until 8 May and exceeded 40° F on only 11 days during the entire month. Consequently, river breakup was typical of a late spring. Nest sites, however, were available at about the same time as in 1983 (compare Fig. 3 to data in Wege and Garrett 1983), an early spring. The nearly average timing of nest availability apparently resulted from the low snow pack present on 1 May, allowing snow-melt and runoff to occur rapidly when temperatures rose above freezing. A total of 5.3 cm of precipitation fell on 26 days between 1 May and 20 July.

B. Snow cover transects.

Exposure of bare ground proceeded at similar rates in all 3 snow-melt transects (Fig. 3). In contrast to 1983 at Kigigak Island (Wege and Garrett 1983), little bare ground was exposed prior to 15 May, when rapid runoff of melt-water and exposure of nest sites began. The first nest sites were available for nesting by 17 May.

C. Chronology of migration.

A single white-fronted goose on 4 May was the first goose observed in 1984. Cackling geese were first seen on 10 May, while emperor geese and black brant were first observed on 11 May. Peak arrival of cackling geese and emperor geese occurred on 11 and 13 May, respectively. Brant arrived in at least 2 waves that were associated with major flights of brant through the area from the south. The first major arrival of brant occurred on 13-14 May with a subsequent major arrival on 19-20 May. Large movements to the north by Brant were also observed on 16 and 21 May but I did not detect an increase in numbers of brant on the Tutakoke area as a result of these movements. Major arrival of brant on the study area was 3-4 days earlier than in 1982 which was an extremely late spring (Byrd et al. 1982).

D. Nesting density and nest location.

Density--At this time density estimates have not been made due to unavailability of study area maps. Number of nesting pairs using the Tutakoke River area continued the rapid decline of recent years. The Tutakoke colony was estimated to contain 14,000 nesting pairs in 1982 (Byrd et al. 1982) which declined to about 2,000 pairs in 1983. I estimated about 1,000 pairs nested in the area in 1984. My estimates of nesting density for 1984 are probably low because high predation rates caused the destruction of some nests before they were identifiable as nests of the year. The presence of foxes in the colony every day during nest initiation may also have caused some brant to forgo nesting.

Weather could have also influenced nesting densities in 1984. Weather during early May was typical of years with delayed breakup and nest

initiation. However the low snow pack due to the mild 1983-84 winter resulted in rapid exposure of potential nest sites when thawing began and nesting was only slightly later than in early to normal nesting years. If birds on spring staging areas "predicted" a delayed nesting season some may have "decided" not to nest prior to arrival on nesting areas.

Nest location--Brant located 59% of their nests on islands, while 92% and 48% of cackling goose and emperor goose nests, respectively, were located on islands (Table 5). Twenty-nine % of brant nests were located on sites other than islands or peninsulas. A greater proportion of nests of all species were located on islands than observed at Kigigak Island in 1983 (Wege and Garrett 1983). This may reflect reduced competition for nest sites due to fewer nesting geese in 1984. Alternately, the larger fraction of goose nests found on islands could have resulted from early destruction of nonisland nests, causing them to go undetected. This was especially true for emperor and cackling goose nests, most of which were found late in incubation.

E. Nest initiation.

Nest initiation dates were determined for 44 nests (35 brant and 9 cackling geese, Table 6). Sample size was too small to make a precise between-species comparison but cackling geese initiated nests an average of 4 days earlier than brant. There was no clear association between nest initiation date and nest site location (Tables 7-9) but there was a tendency for larger clutches to be initiated earlier by brant and cackling geese (Tables 18,19). For the chronology of location of nests on calibration plots see Tables 10 - 12.

F. Clutch size determination.

Modes for "complete" brant and cackling goose clutches were 3 and 6, respectively (Table 13). Average complete clutch size for brant was 3.3, while that for cackling geese was 5.8. Complete clutch size for brant was slightly smaller than that reported from Kigigak Island in 1983 (3.6). As reported in 1983, incomplete clutches were smaller than complete clutches for both brant and cackling geese (compare Tables 13 and 14). Mean clutch size of brant nests on islands was larger than that for other sites (3.5 vs. 2.4, Tables 15,16). This comparison was not possible for cackling geese because the only complete clutches recorded were for island nests (Table 17).

G. Nest success.

Brant at Tutakoke had the lowest nest success (2.6%) yet recorded for that species on the Yukon-Kuskokwim Delta (Table 1). Cackling geese and emperor geese, however, had approximately "normal" nesting success rates of 68 and 73%, respectively (Tables 2-3). Our sample of white-fronted goose nests was too small to provide a reliable estimate of nest success (Table 4). Abandonment of nests accounted for only 2% of failures of brant nests in calibration plots (Table 32). This was probably an underestimate because high predation rates resulted in the destruction of some abandoned nests before abandonment was detected.

Nest location--Island nesting provided little advantage to brant because drought conditions reduced water levels sufficiently to either connect nesting islands to shore or allow easy wading by foxes. As a result there was little difference in nest success related to island nesting (4% of 252 nests) vs. other sites (0% of 174 nests, Table 21). Cackling geese nesting on islands

were clearly at an advantage compared to those selecting other sites and emperor geese also tended to be more successful on islands, although small sample sizes tended to obscure the latter result. The increased success of island nesting cackling and emperor geese reflects their nesting in deeper ponds that did not dry up as severely as those used by brant. Two cackling goose nests located on penninsulas within moderate density brant nesting areas (Calibration Plots II and III) both successfully defended their nests against foxes. The ability of these geese to defend their nests may have been due partially to the availability of brant clutches as alternate food.

Number of revisits-- There was no clear relationship between number of revisits and nest success, but because of the high predation rate and early destruction of nests there tended to be a positive correlation between number of visits and nest success (Tables 22-26), i.e. successful nests were visited more times because they survived longer. This difficulty in interpreting the relationship between number of visits and nest success indicates that some other method will be necessary for evaluation of visitor impact on nesting success.

Clutch size--There was no relationship between clutch size and hatching success of goose nests in plots (Tables 27-31). Sample size for cackling goose and emperor goose nests and the extremely high predation rate on brant nests may have obscured relationships that would have otherwise been evident.

H. Hatch date.

Cackling goose clutches (N = 9) hatched between 22 and 27 June (Table 20), which was about 2 - 3 days later than at Kigigak Island in 1983 (Wege and Garrett 1983).

I. Nest depredation.

I was unable to estimate the average rate of partial predation on brant nests because of the nearly total destruction of brant nests. Only 2 of 9 cackling goose nests (found with eggs) located in calibration plots sustained partial predation, losing 1 and 3 eggs, respectively (Table 2). Unlike Kigigak Island in 1983, there was no spring harvest of geese or eggs in the Tutakoke area. The primary cause of nest destruction was predation by arctic foxes but I believe that Glaucous Gulls also took a large number of eggs, which was not apparent from my results because of the complete destruction of brant nests in calibration plots. Moreover, some of the complete destruction of nests was the result of repeated partial predation which I was also unable to verify. For a summary of predation of nests in plots see Table 38.

J. Waterfowl harvest.

No harvest was observed prior to hatch. There was little opportunity for the harvest of brant during brood rearing because virtually no broods were present. Shooting did occur near the mouth of the Kashunuk River between 12 and 15 July but the location of hunters and the one bird I saw shot indicated that common eiders were the primary focus of hunting in the area during 1984.

K. Brood size.

A total of 6 brant broods (not necessarily distinct) were observed during 14 observation periods (averaging 1 hour) in towers, and boat travel between 21 June and 17 July (Table 40). Five of these broods contained a single gosling. Although sample sizes were small, cackling goose broods appeared to decline in size between 24 June ($\bar{X}$ = 4.3 goslings) and 13 July ($\bar{X}$ = 3.1).

There was no clear trend in the size of emperor goose broods ($\bar{X}$ = 4.2)

L. Chronology of events.

I have provided a summary of the chronology of events occurring in calibration plots in Tables 33 - 37 as per the report format requested by the staff of Yukon Delta NWR.

M. Methods and study design.

The biological program initiated by Yukon Delta NWR in 1983 was a commendable effort to solve very difficult problems related to geese nesting on the Yukon-Kuskokwim Delta. It provided the means for making among year comparisons in number of nesting geese and nesting success. The refuge program also provided detailed data on the chronology of events during the nesting season. However, the refuge program failed to provide other critical data. It did not provide unbiased estimates of the total number of nesting pairs of geese, nor was an effort made to obtain data necessary to make such estimates. The 1984 program also did not provide unbiased estimates of nesting success because visitor impact on nesting success was not properly examined and unlocated nests were not accounted for. Estimates of nesting success also failed to account for interactions between nesting density and success, which could have biased estimates. In fact, an emphasis on having a minimum number of nests per plot forced field workers to place plots in relatively high density areas, thus causing lower density areas to be underrepresented. It is my belief that redesign of the program will be necessary to properly collect data required for better management of geese nesting on the Yukon-Kuskokwim Delta.

IV. Acknowledgments.

I want to especially thank my assistants Dan Welsh and Jeff Moreton (volunteer) who cheerfully worked long hours under difficult conditions to meet the objectives the refuge staff had set forth. I would also like to thank the staff of Yukon Delta NWR, particularly Bill Butler, who did an admirable job of handling logistics and supplying camps. Bill always brought along some cheerful conversation in addition to our mail and food. Finally, Sandra Fristensky, who organized supplies for field camps and monitored the refuge radio, contributed greatly to whatever success was achieved during 1984.

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Table 1. Production data for Pacific Black Brant at Tutakoke, 1984.

Category	Plots												
	Calib. I	Calib. II	Calib. III	Valid. I	Valid. 5A	Valid. 5B	Valid. 6A	Valid. 7A	Prim. I	Prim. II	Prim. III	Prim. 76	Total
Average complete clutch	3.4 (20)[a]	2.0 (2)	4.0 (1)	-	-	-	-	-	-	-	-	-	3.3 (23)
Average clutch at end of incubation	-	-	-	1.0 (2)	4.0 (1)	-	-	4.0 (7)	-	1.0 (1)	-	-	3.1 (11)
Average number of eggs/nest[b] lost	2.9 (93)	2.0 (19)	2.7 (21)	2.0 (4)	0.0 (1)	-	-	0.8 (11)	-	2.0 (5)	-	-	2.5 (154)
Average clutch hatched[c]	-	-	-	1.0 (2)	4.0 (1)	-	-	4.1 (7)	-	1.0 (1)	-	-	3.2 (11)
Average number of goslings hatched per nesting pair[c]	0.0 (180)	0.0 (60)	0.0 (33)	<0.1 (47)	4.0 (1)	-	0.0 (4)	1.1 (31)	0.0 (9)	<0.1 (44)	0.0 (17)	-	0.1 (426)
% successful nests	0.0	0.0	0.0	4.3	100.0	-	0.0	22.6	0.0	2.3	0.0	-	2.6
Nests - status determined	180	60	33	47	1	-	4	31	9	44	17	-	426
Nests - found	180	60	33	47	1	-	4	31	9	44	17	-	426
Nests/km^2 (Nests/mi^2)													

[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 Cackling Canada Geese at Tutakoke, 1984.

Category	Plots												
	Calib. I	Calib. II	Calib. III	Valid. I	Valid. 5A	Valid. 5B	Valid. 6A	Valid. 7A	Prim. I	Prim. II	Prim. III	Prim. 76	Total
Average complete clutch	-	6.0 (4)[a]	6.0 (1)	-	4.0 (1)	5.0 (1)	-	-	-	-	-	-	5.6 (7)
Average clutch at end of incubation	-	5.2 (5)	5.5 (4)	-	5.4 (17)	5.2 (8)	5.9 (13)	5.1 (9)	-	3.0 (1)	7.0 (1)	4.6 (5)	5.3 (63)
Average number of eggs/ nest[b] lost	-	0.8 (5)	0.0 (4)	-	0.0 (17)	0.0 (8)	0.5 (15)	0.0 (9)	-	0.0 (1)	0.0 (1)	0.0 (5)	0.2 (65)
Average clutch hatched[c]	-	5.2 (5)	5.5 (4)	-	5.4 (17)	5.4 (7)	5.9 (13)	5.1 (9)	-	3.0 (1)	7.0 (1)	4.6 (5)	5.4 (62)
Average number of goslings hatched per nesting pair[c]	-	5.2 (5)	2.4 (5)	-	3.5 (26)	3.5 (11)	4.6 (17)	3.8 (12)	-	3.0 (1)	7.0 (1)	2.1 (11)	3.6 (89)
Successful nests	-	100.0	80.0	-	65.4	63.6	76.5	75.0	-	100.0	100.0	45.5	69.7
Nests - status determined	-	5	5	-	26	11	17	12	-	1	1	11	89
Nests - found	0	5	5	0	27	12	17	12	0	1	1	11	91
Nests/km^2 (Nests/mi^2)													

[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 Emperor Geese at Tutakoke, 1984

Category	Plots												
	Calib. I	Calib. II	Calib. III	Valid. I	Valid. 5A	Valid. 5B	Valid. 6A	Valid. 7A	Prim. I	Prim. II	Prim. III	Prim. 76	Total
Average complete clutch	-	-	-	-	-	-	-	-	-	-	-	-	
Average clutch at end of incubation	-	-	-	-	6.0 (2)[a]	6.2 (10)	4.0 (1)	5.2 (4)	-	-	-	5.0 (1)	5.8 (18)
Average number of eggs/ nest[b] lost	-	-	-	-	0.0 (3)	0.1 (11)	0.0 (1)	0.0 (4)	-	-	-	0.0 (1)	<0.1 (20)
Average clutch hatched[c]	-	-	-	-	6.0 (2)	6.4 (11)	4.0 (1)	5.2 (4)	-	-	-	5.0 (1)	5.9 (19)
Average number of goslings hatched per nesting pair[c]	-	-	-	-	1.5 (8)	5.8 (12)	4.0 (1)	5.2 (4)	-	-	-	2.5 (2)	4.1 (27)
Successful nests	-	-	-	-	25.0	91.7	100.0	100.0	-	-	-	50.0	70.4
Nests - status determined	-	-	-	-	8	12	1	4	-	-	-	2	27
Nests - found	0	0	0	0	8	12	1	4	0	0	0	2	27
Nests/km^2 (Nests/mi^2)													

[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. Production data for White-fronted Geese at Tutakoke, 1984.

Category	Plots												
	Calib. I	Calib. II	Calib. III	Valid. I	Valid. 5A	Valid. 5B	Valid. 6A	Valid. 7A	Prim. I	Prim. II	Prim. III	Prim. 76	Total
Average complete clutch	-	-	-	-	-	-	-	-	-	-	-	-	
Average clutch at end of incubation	-	-	-	-	-	4.0 (1)[a]	-	5.0 (1)	-	-	-	4.0 (1)	4.3 (3)
Average number of eggs/ nest[b] lost	-	-	-	-	2.0 (1)	0.0 (1)	-	0.0 (1)	-	-	-	0.0 (1)	0.5 (4)
Average clutch hatched[c]	-	-	-	-	-	4.0 (1)	-	5.0 (1)	-	-	-	4.0 (1)	4.3 (3)
Average number of goslings hatched per nesting pair[c]	-	-	-	-	0.0 (1)	4.0 (1)	-	5.0 (1)	-	-	-	2.0 (2)	2.2 (5)
Successful nests	-	-	-	-	0.0	100.0	-	100.0	-	-	-	50.0	60.0
Nests - status determined	-	-	-	-	1	1	-	1	-	-	-	2	5
Nests - found	0	0	0	0	1	1	0	1	0	0	0	2	5
Nests/km^2 (Nests/mi^2)	0	0	0	0					0	0	0		

[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 5. Nest site locations for Pacific Brant, Cackling Canada Geese, Emperor Geese and White-fronted Geese, 1984.

Species - Plot[a]	Nest Location			
	Island	Peninsula	Other	Total
Brant: Total	59%, N = 252	12%, N = 50	29%, N = 124	426
Calibration I	102 (57)[b]	11 (6)	67 (37)	180
Calibration II	24 (40)	4 (7)	32 (53)	60
Calibration III	26 (79)	6 (18)	1 (3)	33
Validation I	25 (53)	14 (30)	8 (17)	47
Validation 5A	1 (100)	0 (0)	0 (0)	1
Validation 6A	3 (75)	1 (25)	0 (0)	4
Validation 7A	19 (61)	7 (23)	5 (16)	31
Primary Census I	0 (0)	0 (0)	9 (100)	9
Primary Census II	35 (80)	7 (16)	2 (5)	44
Primary Census III	17 (100)	0 (0)	0 (0)	17
Cackling Goose: Total	92%, N = 84	5%, N = 5	2%, N = 2	91
Calibration II	5 (100)	0 (0)	0 (0)	5
Calibration III	4 (80)	1 (20)	0 (0)	5
Validation 5A	24 (89)	3 (11)	0 (0)	27
Validation 5B	12 (100)	0 (0)	0 (0)	12
Validation 6A	16 (94)	0 (0)	1 (6)	17
Validation 7A	11 (92)	1 (8)	0 (0)	12
Primary Census II	1 (100)	0 (0)	0 (0)	1
Primary Census III	1 (100)	0 (0)	0 (0)	1
Primary Census 76	10 (91)	0 (0)	1 (9)	11

TABLE 5 (cont.). Nest site locations for Pacific Brant, Cackling Canada Geese, Emperor Geese and White-fronted Geese, 1984.

Species - Plot[a]	Nest Location			
	Island	Peninsula	Other	Total
Emperor Goose: Total	48%, N = 13	41%, N = 11	11%, N = 3	27
Validation 5A	4 (50)[b]	3 (38)	1 (13)	8
Validation 5B	8 (67)	3 (25)	1 (8)	12
Validation 6A	0 (0)	1 (100)	0 (0)	1
Validation 7A	1 (25)	3 (75)	0 (0)	4
Primary Census 76	0 (0)	1 (50)	1 (50)	2
White-fronted Goose: Total	20%, N = 1	60%, N = 3	20%, N = 3	5
Validation 5A	0 (0)	0 (0)	1 (100)	1
Validation 5B	0 (0)	1 (100)	0 (0)	1
Validation 7A	0 (0)	1 (100)	0 (0)	1
Primary Census 76	1 (50)	1 (50)	0 (0)	2

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

[b] Numbers in parentheses are percentages.

Table 6. Nest initiation dates for Pacific Brant and Cackling Canada Geese at Tutakoke, 1984.

	Julian Day													
Species - Plot	141	142	143	144	145	146	147	148	149	150	151	152	153	Total
Brant:														
Calibration I	0	0	1	0	4	3	6	5	1	4	0	0	2	26
Calibration II	0	0	0	0	0	0	0	1	7	0	0	0	0	8
Calibration III	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Cackler:														
Calibration II	0	0	1	0	1	1	1	1	0	0	0	0	0	5
Calibration III	2	0	1	0	1	0	0	0	0	0	0	0	0	4
Total:	2	0	3	0	6	4	7	8	8	4	0	0	2	44

Table 7. Initiation dates by nest location for Pacific Black Brant in Calibration Plot I at Tutakoke River, 1984.

Species-Nest location	Julian day											
	143	144	145	146	147	148	149	150	151	152	153	Total
Brant:												
Island	1	0	1	3	5	2	1	3	0	0	1	17
Peninsula	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	3	0	1	3	0	1	0	0	1	9
Total	1	0	4	3	6	5	1	4	0	0	2	26

Table 8. Initiation dates by nest location for Pacific Black Brant and Cackling Canada Geese in Calibration Plot II at Tutakoke River, 1984.

Species-Nest location	Julian day										
	143	144	145	146	147	148	149	150	151	152	Total
Brant:											
Island	0	0	0	0	0	1	4	0	0	0	5
Peninsula	0	0	0	0	0	0	2	0	0	0	2
Other	0	0	0	0	0	0	1	0	0	0	1
Cackling Goose:											
Island	1	0	1	1	1	1	0	0	0	0	5
Total	1	0	1	1	1	2	6	0	0	0	13

Table 9. Initiation dates by nest location for Pacific Black Brant and Cackling Canada Geese in Calibration Plot III at Tutakoke, 1984.

Species-Nest location	Julian day											
	140	141	142	143	144	145	146	147	148	149	150	Total
Brant:												
Island	0	0	0	0	0	0	0	0	1	0	0	1
Cackling Goose:												
Island	0	1	0	1	0	1	0	0	0	0	0	3
Peninsula	0	1	0	0	0	0	0	0	0	0	0	1
Total	0	2	0	1	0	1	0	0	1	0	0	5

Table 10. Number of Pacific Black Brant nests located during successive searches of Calibration Plot I at Tutakoke 1984.

Species	Search	Julian day	Number of nests located: Nests initiated and found since last search	Number of nests located: Nests initiated but not found	Total
Brant	1	145	16	22[a]	38
	2	148	87	2	89
	3	151	28	1	29
	4	154	24	0	24
Total			155	25	180

[a] Six new subplots were added to the plot on the second search, resulting in the large number of nests initiated but not found on the first search.

Table 11. Number of Pacific Black Brant and Cackling Canada Goose nests located during successive searches of Calibration Plot II at Tutakoke, 1984.

Species	Search	Julian day	Number of nests located: Nests initiated and found since last search	Nests initiated but not found	Total
Brant	1	149	43	0	43
	2	152	16	0	16
	3	155	1	0	1
	Total		60	0	60
Cackling Goose	1	149	5	0	5
	Total		5	0	5

Table 12. Number of Pacific Black Brant and Cackling Canada Goose nests located during successive searches of Calibration Plot III at Tutakoke, 1984.

Species	Search	Julian day	Number of nests located: Nests initiated and found since last search	Nests initiated but not found	Total
Brant	1	150	20	2[a]	22
	2	153	11	0	11
	Total		31	2	33
Cackling Goose	1	150	4	1	5
	Total		4	1	5

[a] Three new subplots were added to the plot on the second search. See Table 10.

Table 13. Frequency of clutch size from completed clutches for Pacific Black Brant and Cackling Canada Geese on Calibration Plots[a] at Tutakoke, 1984.

	Clutch size								
Plot-species	1	2	3	4	5	6	7	8	Total
Calibration Plot I									
Brant	0	3	9	6	2	0	0	0	20
Calibration Plot II									
Brant	1	0	1	0	0	0	0	0	2
Cackling Goose	0	0	0	0	1	2	1	0	4
Calibration Plot III									
Brant	0	0	0	1	0	0	0	0	1
Cackling Goose	0	0	0	0	0	1	0	0	1

[a] Only 2 complete clutches in Validation Plots with clutches of 4 and 5 eggs for single Cackling Goose clutches in Validation Plots 5A and 5B, respectively.

Table 14. Frequency of clutch size from "incomplete" clutches for Pacific Black Brant and Cackling Canada Geese nesting on Calibration Plots at Tutakoke, 1984.

	Clutch size								
Plot-species	1	2	3	4	5	6	7	8	Total
Calibration Plot I									
Brant	9	9	11	12	12	0	0	0	53
Calibration Plot II									
Brant	1	2	0	0	2	0	0	0	5
Cackling Goose	0	0	0	0	0	1	0	0	1
Calibration Plot III									
Brant	0	3	3	3	1	0	0	0	10
Cackling Goose	0	0	0	0	2	1	0	0	3

Table 15. Frequency of clutch size from completed clutches by nest location for Pacific Black Brant in Calibration Plot I[a] at Tutakoke, 1984.

Clutch size	Nest location			
	Island	Peninsula	Other	Total
1	0	0	0	0
2	2	0	1	3
3	6	0	3	9
4	6	0	0	6
5	2	0	0	2
6	0	0	0	0
$\bar{X} \pm$ SE	3.5 ± 0.2 (16)[b]	- (0)	2.8 ± 0.2 (4)	3.4 ± 0.2 (20)

[a] All nests for which complete clutch sizes were determined occurred on islands in Calibration Plots II and III. See Table 13 for these values.

[b] Sample size.

Table 16. Frequency of clutch size from completed clutches by nest location for Pacific Black Brant in Calibration Plots II and III at Tutakoke, 1984.

Clutch size	Nest location			
	Island	Peninsula	Other	Total
1	0	0	1[a]	1
2	0	0	0	0
3	1[a]	0	0	1
4	1[b]	0	0	1
5	0	0	0	0
6	0	0	0	0
$\bar{X} \pm$ SE	3.5(3-4)[c] (2)[d]	-	1.0 (1)	2.7 $\pm$ 0.9 (3)

[a] From Calibration Plot I.

[b] From Calibration Plot II.

[c] Range.

[d] Sample size.

Table 17. Frequency of clutch size from completed clutches by nest location for Cackling Canada Geese in Calibration Plots II and III at Tutakoke, 1984.

Clutch size	Nest location			
	Island	Peninsula	Other	Total
3	0	0	0	0
4	0	0	0	0
5	1	0	0	1
6	3[a]	0	0	3
7	1	0	0	1
$\bar{X} \pm$ SE	6.0 ± 0.3 $(\bar{5})$[b]	-	-	6.0 ± 0.3 $(\bar{5})$

[a] Includes one nest from Calibration PLot III. All other nests were from Calibration Plot II.

[b] Sample size.

Table 18. Nest initiation dates by clutch size from completed clutches[a] for Pacific Black Brant at Tutakoke, 1984.

	Julian day												
Clutch size	142	143	144	145	146	147	148	149	150	151	152	153	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	2	0	0	3	0	0	0	0	0	5
3	0	0	0	1	0	5	1	0	3	0	0	2	12
4	0	1	0	0	1	1	1	1	2	0	0	0	7
5	0	0	0	1	2	0	0	0	0	0	0	0	3
Total	0	1	0	4	3	6	5	1	5	0	0	2	27

[a] Includes incidental nests found during egg laying.

Table 19. Nest initiation dates by clutch size from completed clutches[a] for Cackling Geese at Tutakoke, 1984.

	Julian day												
Clutch size	141	142	143	144	145	146	147	148	149	150	151	166	Total
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	1	0	1	0	0	0	0	0	0	0	0	2
5	0	0	0	0	0	1	0	0	0	0	0	1	2
6	0	0	0	1	1	0	1	1	0	0	0	0	4
7	0	1	1	0	0	0	0	0	0	0	0	0	2
8	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	2	1	2	1	1	1	1	0	0	0	1	10

[a] Includes incidental nests found during egg laying.

Table 20. Hatch dates for Cackling Geese at Tutakoke, 1984[a].

	Julian day									
Plot	170	171	172	173	174	175	176	177	178	Total
Calibration II	0	0	0	2	0	0	1	0	2	5
Calibration III	0	0	0	1	2	0	1	0	0	4
Total	0	0	0	3	2	0	2	0	2	9

[a] Only Cackling Goose nests hatched on calibration plots.

Table 21. Percent nesting success for Pacific Black Brant, Cackling Geese, Emperor Geese and White-fronted Geese at Tutakoke, 1984.

	Brant			Cackling Goose		
Plot	Island	Peninsula	Other	Island	Peninsula	Other
Calibration I	0(102)[a]	0(11)	0(67)	-	-	-
Calibration II	0(24)	0(4)	0(32)	100(5)	-	-
Calibration III	0(26)	0(6)	0(1)	75(4)	100(1)	-
Validation I	8(25)	0(14)	0(8)	-	-	-
Validation 5A	100(1)	-	-	74(23)	0(3)	-
Validation 5B	-	-	-	64(11)	-	-
Validation 6A	0(3)	0(1)	-	81(16)	-	0(1)
Validation 7a	37(19)	0(7)	0(5)	73(11)	100(1)	-
Primary I	-	-	0(9)	-	-	-
Primary II	3(35)	0(7)	0(2)	100(1)	-	-
Primary III	0(17)	-	-	100(1)	-	-
Primary 76	-	-	-	50(10)	-	0(1)
Total	4(252)	0(50)	0(124)	73(82)	40(5)	0(2)

Table 21(cont.). Percent nesting success for Pacific Black Brant, Cackling Canada Geese and White-fronted Geese at Tutakoke, 1984.

	Emperor Goose			White-fronted Goose		
Plot	Island	Peninsula	Other	Island	Peninsula	Other
Calibration I	-	-	-	-	-	-
Calibration II	-	-	-	-	-	-
Calibration III	-	-	-	-	-	-
Validation I	-	-	-	-	-	-
Validation 5A	50(4)[a]	0(3)	0(1)	-	-	0(1)
Validation 5B	88(8)	100(3)	100(1)	-	100(1)	-
Validation 6A	-	100(1)	-	-	-	-
Validation 7A	100(1)	100(3)	-	-	100(1)	-
Primary I	-	-	-	-	-	-
Primary II	-	-	-	-	-	-
Primary III	-	-	-	-	-	-
Primary 76	-	0(1)	100(1)	0(1)	100(1)	-
Total	77(13)	64(11)	67(3)	0(1)	100(3)	0(1)

[a] Sample size in parentheses.

Table 22. Fate of Pacific Black Brant nests in relation to the number of nest vistis (prior to final fate) in Calibration Plot I at Tutakoke, 1984.

	Number of visits									
Nest fate[a]	0	1	2	3	4	5	6	7	8	Total
Unhatched clutches:										
abandoned prehatch	1	0	0	1	1	1	0	0	0	4
predation	83	17	13	20	19	6	11	1	0	170
Continued clutches:										
predation	1	0	2	3	0	0	0	0	0	6

[a] No nests were in categories: hatched clutches, harvest, failed to develop (see Wege and Garrett 1983).

Table 23. Fate of Pacific Black Brant nests in relation to number of nest visits (prior to final fate) in Calibration Plot II at Tutakoke, 1984.

	Number of visits									
Nest fate[a]	0	1	2	3	4	5	6	7	8	Total
Unhatched clutches:										
abandoned prehatch	0	0	1	0	0	0	0	0	0	1
predation	37	16	3	0	2	0	0	0	0	58
Continued clutches (post predation):										
predation	0	0	0	0	1	0	0	0	0	1

[a] No nests in categories: hatched clutch, harvest, failed to develop.

Table 24. Fate of Cackling Canada Goose clutches in relation to number of nest visits (prior to final fate) in Calibration Plot II[a] at Tutakoke, 1984.

	Number of visits											
Nest fate[b]	0	1	2	3	4	5	6	7	8	9	10	Total
Hatched clutches:												
without egg loss	0	0	0	0	0	0	0	0	0	2	1	3
with egg loss	0	0	0	0	0	0	0	0	1	0	1	2

[a] No Cackling Goose nests in Calibration I.

[b] No nests in categories: unhatched, continued clutches (see Wege and Garrett 1983).

Table 25. Fate of Pacific Black Brant nests in relation to number of nest visits (prior to final fate) in Calibration Plot III at Tutakoke, 1984.

	Number of visits									
Nest fate[a]	0	1	2	3	4	5	6	7	8	Total
Unhatched clutches:										
abandoned prehatch	0	0	0	0	0	0	0	0	0	0
predation	11	11	9	2	0	0	0	0	0	33
Continued clutches (post-predation):										
predation	0	0	0	0	0	0	0	0	0	0

[a] No nests in categories: hatched, harvested, failed to develop (see Wege and Garrett 1983).

Table 26. Fate of Cackling Canada Goose nests in relation to number of nest visits (prior to final fate) in Calibration Plot III at Tutakoke, 1984.

	Number of visits											
Nest fate[a]	0	1	2	3	4	5	6	7	8	9	10	Total
Hatched clutches:												
without egg loss	0	0	0	0	0	0	0	0	2	2	0	4
with egg loss	0	0	0	0	0	0	0	0	0	0	0	0
Unhatched clutches:												
predation	1	0	0	0	0	0	0	0	0	0	0	1

[a] Nest fate categories (see Wege and Garrett 1983) that contained no cases were excluded.

Table 27. Hatching success of completed clutches for Pacific Black Brant at Tutakoke, 1984.

Plot	1	2	3	4	5	6	7
Calibration I	-	0(3)[a]	0(9)	0(6)	0(2)	-	-
Calibration II	0(1)	-	0(1)	-	-	-	-
Calibration III	-	-	0(1)	-	-	-	-

[a] Sample size in parentheses.

Table 28. Hatching success of completed clutches for Cackling Canada Geese at Tutakoke, 1984.

	Clutch size						
Plot	1	2	3	4	5	6	7
Calibration II	-	-	-	-	100(1)[a]	100(2)	100(1)
Calibration III	-	-	-	-	-	100(1)	-

[a] Sample size in parentheses.

Table 29. Hatching success for Pacific Black Brant in Primary census plots at Tutakoke, 1984.

	Clutch size[a]						
Plot[b]	1	2	3	4	5	6	7
Primary I	-	-	-	-	-	-	-
Primary II	0(1)[c]	0(2)	50(2)	-	-	-	-
Primary III	-	-	-	-	-	-	-

[a] Clutch size when nest located.

[b] No Brant nests in Primary 76.

[c] Sample size in parentheses.

Table 30. Hatching success for Cackling Canada Geese in Primary census plots at Tutakoke, 1984.

	Clutch size[a]						
Plot[b]	1	2	3	4	5	6	7
Primary II	-	-	100(1)[c]	-	-	-	-
Primary III	-	-	-	-	-	-	100(1)
Primary 76	-	-	-	100(3)	100(1)	100(1)	-

[a] Clutch size when nest located.

[b] No Cackling Goose nests in Primary Plot I.

[c] Sample size in parentheses.

Table 31. Hatching success for Emperor Geese in Primary census plots at Tutakoke, 1984.

	Clutch size[a]						
Plot[b]	1	2	3	4	5	6	7
Primary 76	-	-	-	-	100(1)[c]	-	-

[a] Clutch size when nest located.

[b] Primary 76 only primary plot containing Emperor Goose nest.

[c] Sample size in parentheses.

Table 32. Percent of nests which were abandoned or contained unhatched eggs for Pacific Black Brant and Cackling Canada Geese at Tutakoke, 1984.

	Brant		Cackling Goose	
Plot	Abandoned	Unhatched	Abandoned	Unhatched
Calibration I	2(180)[a]	0(180)	-	-
Calibration II	2(60)	0(60)	0(5)	0(5)
Calibration III	0(33)	0(33)	0(4)	0(4)
Total	2(273)	0(273)	0(9)	0(9)

[a] Sample size in parentheses.

Table 33. Chronology of spring harvest, migration-arrival and nesting of Pacific Black Brant in Calibration Plot I at Tutakoke, 1984.

	Julian day																					
Nest status[a]	121	122	123	124	125	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156
Unhatched clutches																							
Abandoned: prehatch																					2		
Predation												4			53			23			25		
Continued clutches:																							
Predation:																					2		
Total												4			53			23			29		

I Migrat.-Arrival I I Nest Initiation I
I Begin Incubation I

Table 33(cont.).

Nest status	Julian day																				Total
	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	
Unhatched:																						
Abandoned: prehatch				1																		3
Predation:	27			20			8			11												171
Continued clutches: (post-predation)																						
Predation:	4																					6
Total	31			21			8			11												180

I Hatch I

[a] Only categories that contained at least one nest were included (see Wege and Garrett 1983).

Table 34. Chronology of spring harvest, migration-arrival and nesting of Pacific Black Brant in Calibration Plot II at Tutakoke, 1984.

	Julian day																				
Nest status[a]	121	122	123	124	125	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156
Unhatched:																							
Predation:																22			29			5	
Continued clutches: (post-predation)																							
Predation:																							
Total																22			29			5	

I Migrat.-Arrival I

I Nest Initiation I

I Begin Incubation I

Table 34(cont.).

Nest status	Julian day																				
	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	Total
Unhatched:																						
Predation:		2			1																	59
Continued clutches: (post-predation)																						
Predation:					1																	1
Total		2			2																	60

I Hatch I

[a] Only categories that contained at least one nest were included (see Wege and Garrett 1983).

Table 35. Chronology of spring harvest, migration-arrival and nesting of Cackling Canada Geese on Calibration Plot II at Tutakoke, 1984.

Nest status[a]	Julian day																				Total
	121	122	123	124	138	139	140	141	142	143	144	145	166	171	172	173	174	175	176	177	178	
Hatched clutches:																						
Without egg loss:																		1	1		1	3
With egg loss:																1					1	2
Total																1		1	1		2	5

I Migrat.-Arrival I
I Nest Initiation I
I Begin Inc.I
I Hatch I

[a] Only categories that contained at least one nest were included (see Wege and Garrett 1983).

Table 36. Chronology of spring harvest, migration-arrival and nesting[a] of Pacific Black Brant in Calibration Plot III at Tutakoke, 1984.

	Julian day																				
Nest status[b]	123	124	139	140	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	Total
Unhatched:																						
Predation:												9			4			16			4	33
Total												9			4			16			4	33

I Migr.-Arrival I
I Nest Initiation I
I Begin Incubation I

[a] See Table 33 for hatch dates.

[b] Only categories that included at least one nest were included (see Wege and Garrett 1983).

Table 37. Chronology of spring harvest, migration-arrival and nesting of Cackling Canada Geese in Calibration Plot III at Tutakoke, 1984.

	Julian day																				
Nest status[a]	121	122	123	124	139	140	141	144	145	146	147	148	149	150	166	171	172	173	174	175	176	Total
Hatched clutches:																						
Without egg loss:																		1	2		1	4
Unhatched:																						
Predation:														1								1
Total														1				1	2		1	5

I Migr.-Arrival I
I Nest Initiation I
I Begin Incubation I
I Hatch I

[a] Only categories that contained at least one nest were included (see Wege and Garrett 1983).

Table 38. "Animal" predations of Pacific Black Brant, Cackling Canada Geese, Emperor Geese and White-fronted Geese at Tutakoke, 1984.

	Brant			Cackling Goose		
Plot	Island	Peninsula	Other	Island	Peninsula	Other
Calibration I	96[a](102)	100(11)	100(67)	-	-	-
Calibration II	100(24)	100(4)	97(32)	0(5)	-	-
Calibration III	100(26)	100(6)	100(1)	25(4)	0(1)	-
Validation I	92(25)	100(14)	100(8)	-	-	-
Validation 5A	0(1)	-	-	26(23)	100(3)	-
Validation 5B	-	-	-	36(11)	-	-
Validation 6A	100(3)	100(1)	-	19(16)	-	100(1)
Validation 7A	63(19)	100(7)	100(5)	27(11)	0(1)	-
Primary I	-	-	100(9)	-	-	-
Primary II	97(35)	100(7)	100(2)	0(1)	-	-
Primary III	100(17)	-	-	0(1)	-	-
Primary 76	-	-	-	50(10)	-	100(1)
Total	94(252)	100(50)	99(124)	27(82)	60(5)	100(2)

Table 38(cont.).

Plot[b]	Emperor Goose			White-fronted Goose		
	Island	Peninsula	Other	Island	Peninsula	Other
Validation 5A	25(4)	100(3)	100(1)	-	-	100(1)
Validation 5B	12(8)	0(3)	0(1)	-	0(1)	-
Validation 6A	-	0(3)	-	-	-	-
Validation 7A	0(1)	0(3)	-	-	0(1)	-
Primary 76	-	100(1)	0(1)	100(1)	0(1)	-
Total	15(13)	36(11)	33(3)	100(1)	0(3)	100(1)

[a] Percent.

[b] Only plots that contained nests of Emperor or White-fronted Geese were included in the continued table.

Table 39. Chronology of subsistence activity at Tutakoke, 1984.

Chronology of arrival and nesting	Julian day	Number in party	Area	Remarks
	122	1	1.6 km E. of camp	
	123	2	1 km W. of camp	
	124	2	1.6 km E. of camp	Attempted harvest of cranes.
	124	2	3.2 km S. of camp	
	126	3	0.5 km W. of camp	Appeared to be carrying a seal.
Arrival and nesting of geese.				
	193	?	mouth of Kashunuk R.	Two boats, 8-12 shots.
	194	?	mouth of Kashunuk R.	Two boats, several shots.
	195	5 (2 adults)	camp	Stopped to visit. Were from fish camp on Kashunuk. Had 1 male common eider. Said were not hunting brant.
	196	3	camp	Traveling up Tutakoke.
	196	?	mouth of Kashunuk R.	One shot.

Table 40. Brood sizes in the Tutakoke-Lower Kashunuk River region, 1984.

Time period	Brood size (X ± SE)			
	Brant	Cackling Goose	Emperor Goose	White-fronted Goose
23-29 June	1.0 ± 0.0 (3)[a]	4.3 ± 0.4 (6)	4.1 ± 0.3 (28)	-
1-7 July	1.0 (2)	5.7 ± 0.6 (6)	4.2 ± 0.4 (22)	5.0 (1)
11-17 July	8.0 (1)	3.1 ± 0.5 (8)	4.2 ± 0.6 (24)	2.0 (1)

[a] Sample size.

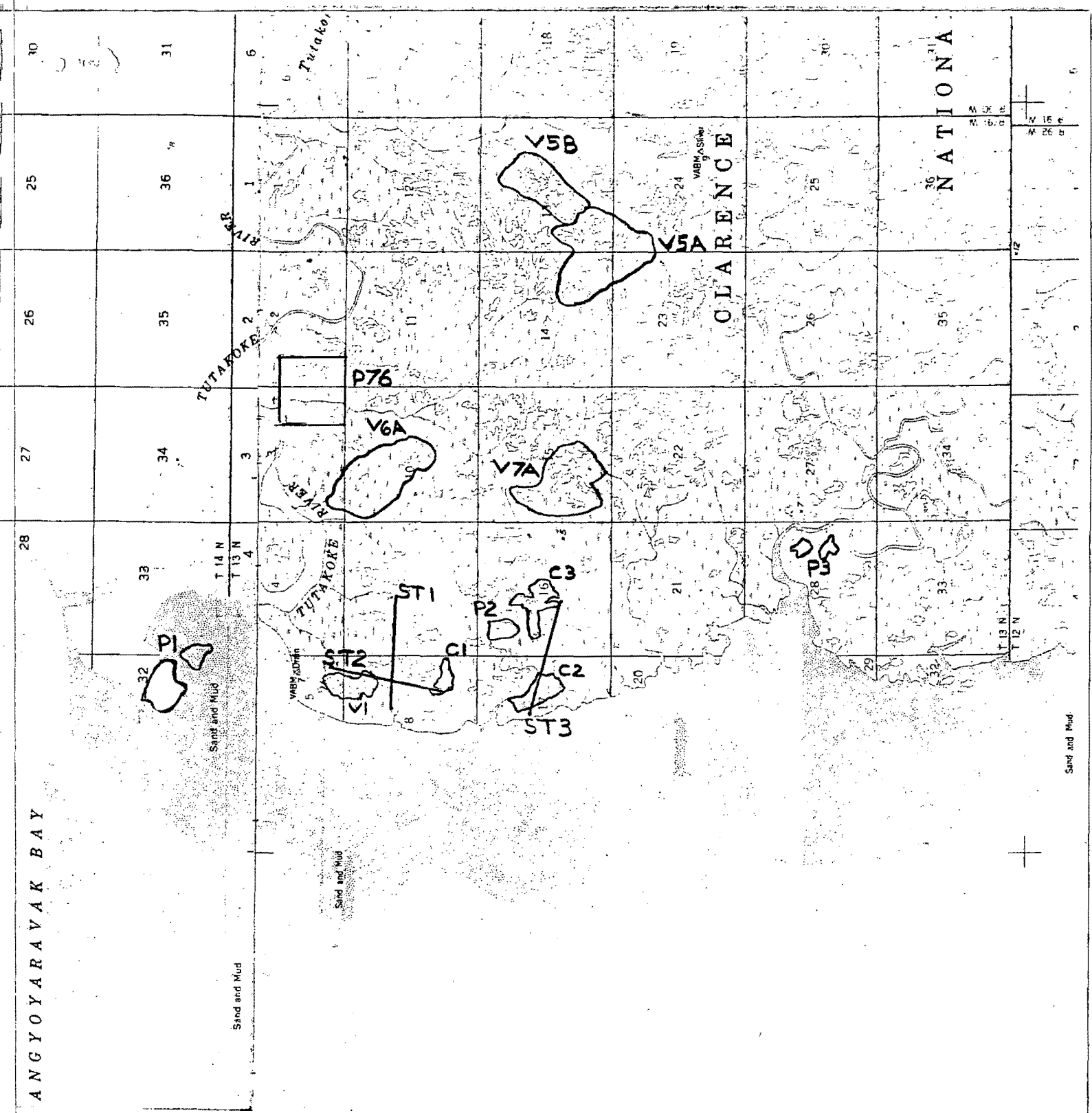

Figure 1. Location of goose nesting plots and snowmelt transects at Tutakoke, 1984. Calibration, validation and primary plots are denoted by the letters C, V and P, respectively.

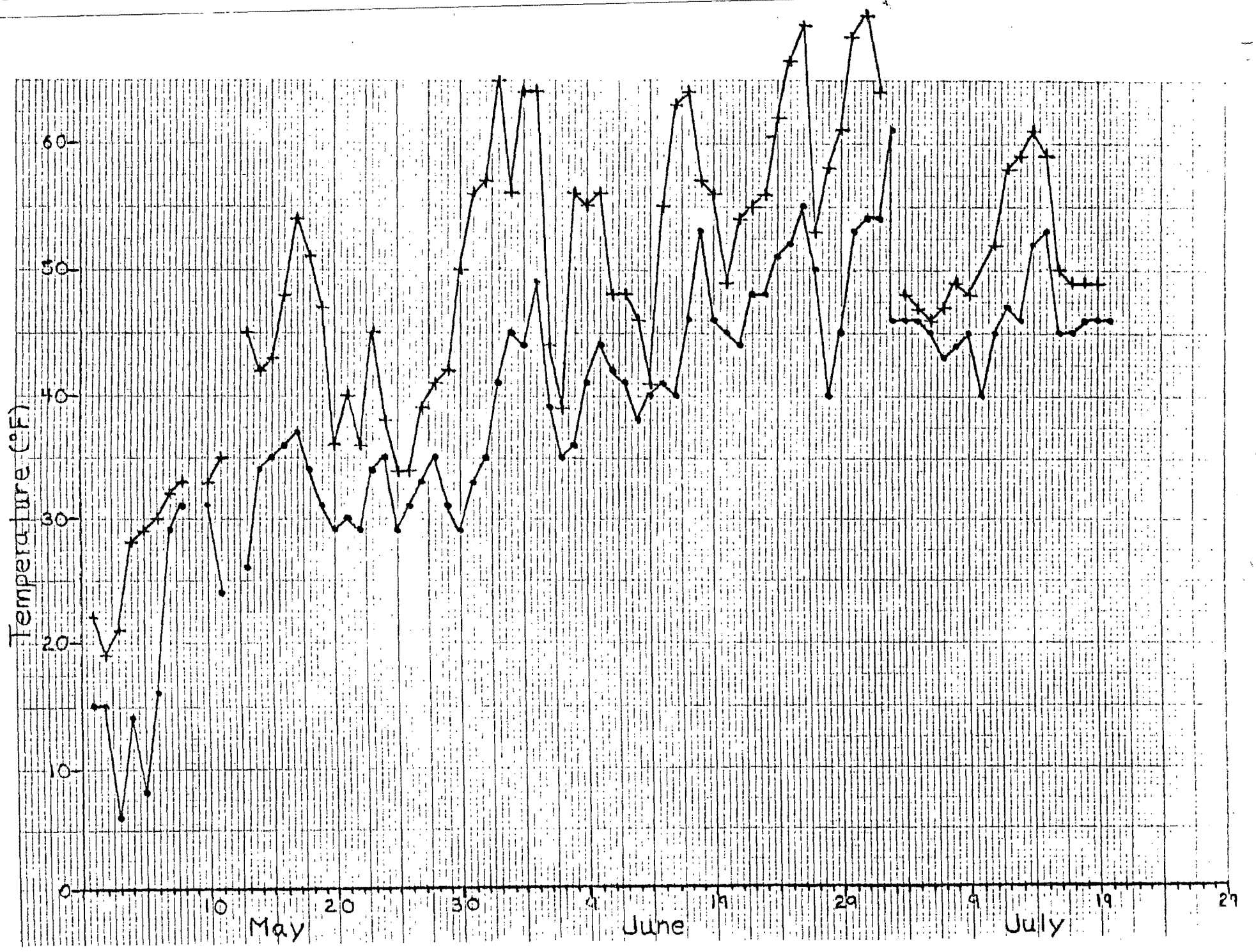

Figure 2. Maximum (+) and minimum (•) temperatures at Tutakoke, 1984.

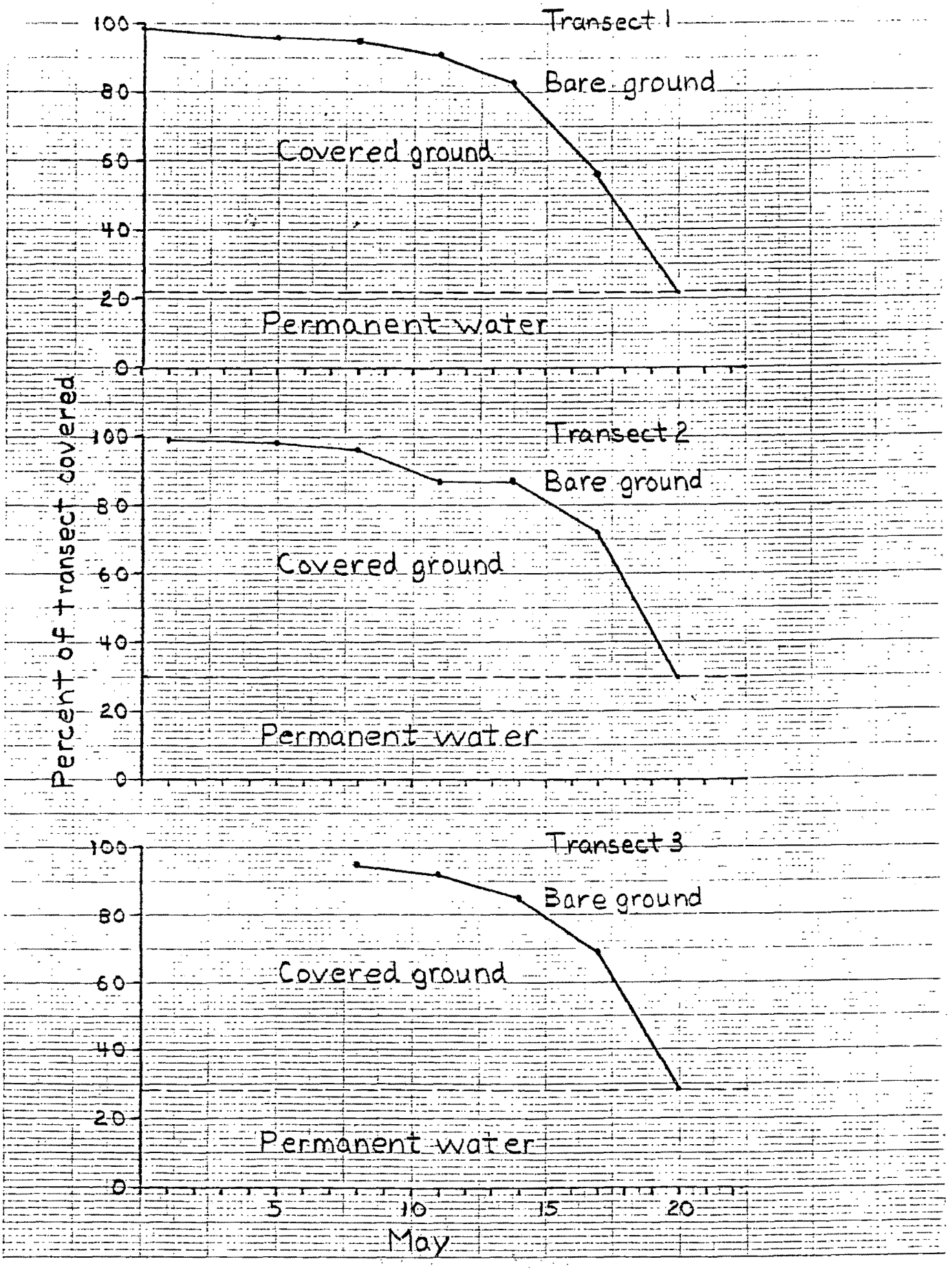

Figure 3. Progress of exposure of bare ground on snowmelt transects at Tutakoke, 1984.