THE RELATIONSHIP BETWEEN NESTING DENSITY AND PRODUCTIVITY IN THE TUFTED PUFFIN (Lunda cirrhata)

33p

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mice predation on clutches eggs

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BACKGROUND

Tufted puffins (Lunda cirrhata) are pelagic birds inhabiting the northern Pacific Ocean. They nest on islands or maritime cliffs, in dense colonies because of the extreme localisation of their breeding sites. In a given colony areas of different densities occur; the low density areas presumably indicate areas less suitable for nesting sites.

Existing studies of the numbers, nesting preferences and food habits of tufted puffins (Whele 1976, Amaral 1977, Baird & Hatch 1979, Nysewander & Barbour 1979, Vermeer 1979) have not identified the factors critical to their breeding success. The purpose of this study is to determine whether differences in breeding ecology (phenology, reproductive success, food, predators) exist between high and low density areas and to evaluate complementary hypotheses. These hypotheses may be separated into three fundamentally distinct categories. The first, habitat quality, is concerned with abiotic environmental influences. The second, gull interference, examines the effects of interspecies interactions. The last, breeding density, will examine the interspecific effects of competition for nest sites and social facilitation. The prediction of these three types of effects can be used to evaluate them with respect to the puffins of the Triangle Island colony.

I. HABITAT QUALITY DETERMINES BREEDING DENSITY AND PRODUCTIVITY.

The high density nesting areas are characterized by better soil for digging burrows and better take-off conditions. Soil depth and soil composition (% rocks contained) are important factors affecting burrow length and "quality" e.g. insulation, protection against breaking and predation. However, even low density areas must contain good landing sites, because of the large size and heavy wing-load of the tufted puffin . Therefore, the rate of gull attacks and successful robberies may not be as critical as for common puffin (c.f. Nettleship 1972).

II. INTERACTION WITH GULLS DIRECTLY INFLUENCES THE NESTING SUCCESS OF THE TUFTED PUFFINS.

1. In areas where nesting gulls are present, predation by gulls on eggs or nestlings will be greater than in areas free of gulls.

2. Gull predation rate is lower and puffin production consequently higher in high density nesting areas than in low density nesting areas. This can be related to habitat quality and length of burrow, since the predation risk is inversely related to burrow length.

3. Alternative prey immediatly adjacent to puffin nesting areas reduces gull predation on puffins. Some puffin nesting areas are adjacent to common murres colonies, which are also susceptible to gull predation.

III. BREEDING SUCCESS IS DIRECTLY CORRELATED WITH BREEDING DENSITY.

Apart from the direct influence of the abiotic habitat and nest predators (gulls), other factors can be proposed to explain differences in productivity between high and low density sites.

1. Competition for "preferred" sites, in high density areas, would result in occupancy by individuals of higher quality than those using low density sites. The higher quality birds may be older or more proficient foragers and thereby heavier, which may result in them producing larger eggs which in turn produce bigger, more viable offspring. Also,they would be more effective at feeding their young, thus increasing the growth rate and survival of nestlings.

2. During periods of high feeding activity, higher density of fish-carrying birds may reduce the effectiveness of gull attacks, and thus individual birds can bring more fish to their young. Social facilitation of this sort may be the result of high densities without being the cause of them.

METHODS

Field work was conducted from 4 May to 19 September on Triangle Island, 46 km west of the north end of Vancouver Island , which supports a colony of about 25,000 pairs of tufted puffins (Vermeer 1979).

An area of high nesting density was identified on the south west peninsula of the island (Puffin Rock) and two low density areas were located on the main island (West Slope and North Slope), see Fig. 1. On Puffin Rock, we could distinguish high density nesting areas of puffin surrounded by high concentrations of nesting gulls (20-25 pairs) and areas of similar size and puffin density where low numbers of gulls (1 or 2 pairs) were nesting. No gulls were observed nesting near the low density areas.

The methodology outlined in the 1981 proposal (Vallee 1981 and Table I) was implemented when possible. Because of very inclement weather in May, we could not monitor the timing of settlement patterns over the different areas. It was also impossible (time constraints) to carry long-term observations in the low density areas. Therefore, we do not have information on frequency and size of fish loads brought to chicks and kleptoparasitism rates of gulls in this area. These observations and measurements will be made during the next field season.

RESULTS

1) HABITAT QUALITY

Tufted puffins nest on steep slopes, predominantly covered by tufted hairgrass (Deschampsia cespitosa). The principal characteristics of the different sites are outlined in Table II. The birds dig burrows in an organic soil containing high proportions of small rocks and grass roots.

The lower nesting densities are located in areas of deeper soil and steeper slopes. Burrow dimensions (length) did not vary significantly between high and low density areas (ANOVA, $P>0.05$) which suggest that establishment of burrows was constrained by soil surface characteristics. Low density areas are associated with either the presence of tall shrubby vegetation (e.g. Salmonberry, Rubus spectabilis) which can make take-offs ability and refinding of the burrow more difficult (Lehnhausen 1980), or high concentration of rocks in and above the ground.

It was impossible to monitor occupancy of the nesting sites. Birds started massive circling flights simultaneously over the whole island and very few (if any) aggressive interactions were observed during the pre-laying period.

It is well documented that in seabirds, nest site acquisition by new breeders often occurs during the middle of the previous nesting season and that pairs then retain the same nest every year (in gannet, Sula bassana, Nelson 1978, common puffin, Fratercula artica, Ashcroft 1976). On Triangle Island, we noted more social (aggressive) interactions during the latter part of the incubation period and later in the chick-rearing period. The social activities occuring in the high density areas could serve as an indicator of quality nesting habitat and thereby attract immature birds seeking a burrow for the following spring. This could produce a positive feedback loop insuring the continuum of high densities in high density areas. Such a possibility must remain an open question until social interactions in the low density areas can be more closely observed.

2) INTERACTIONS WITH GULLS

- Losses at hatching

The initial hypothesis that puffin productivity was affected by predation on eggs or hatching youngs and that gulls are the main predator. Although gulls were never observed in the low density area, the chick production was significantly lower there in 1981 (Figure 2). However the proportion of eggs lost around hatching time (possibly predation on pipping eggs or very young chicks) was similar in both high and low density areas and quite low compared to 1980. Egg disappearance occured over the whole length of the incubation period.

- "chick pipping" experiment

Preliminary investigations of gull response to chick pipping were conducted twice, for period of two hours. Although a gull would be standing two or three feet below the hidden microphone, we never observed any reaction to the recording.

The test was carried in the high gull nesting density where the birds sit on their territory all day, possily too interested in defending nest or youngs to be reacting to puffins' presence (even for birds carrying fish).

- Gulls' food

Prior to hatching, we localized all the active gull nests near the puffin study plots and surveyed nesting activity to collect remains of food regurgitated or brought to the chicks. The technique was limited since most of the food was almost completely digested. We only found two remains of puffin chicks during the whole hatching period (see Table III).

- Alternate prey

One puffin study plot is located adjacent to a large murre group, in an area of high gull nesting density . In this area, we did find some murre eggs in gull nests. However this did not seem to influence puffin productivity as this plot did not produce more chicks than others located near similar gull concentration, but away from murres.

- Other predators?

At the end of the summer, we placed dummy (chicken) eggs inside empty burrows in both Puffin Rock and North Slope. The eggs were far enough from the entrance to be invisible. After three days, a higher proportion of intact eggs (50% vs 22%) disappeared from the high density area (Table IV). After the eggs were cracked, all were eaten or removed during the same time period. We suspect that deermice (Peromyscus maniculatus triangularis) are responsible of this scavenging as the eggs were probably inaccessible to bird predators (gull or crow). These results are to be interpreted cautiously since the test was carried at the end of the nestling period, when mice could be wandering in burrows looking for dropped fish, but not for eggs. It only shows that mice can feed on eggs. This idea will be explored further next summer.

3) BREEDING SUCCESS

Thirty adults were banded in identified burrows, on both Puffin Rock and North Slope (Table V). Birds from the high density area were significantly heavier for a similar body size (no significant difference in wing length).

However puffin in the high density area did not lay larger eggs (Table VI) and were not earlier or more synchronized in their breeding activities (Figure 3). Actually, hatching was slightly earlier on the North Slope (MWU, $p<0.001$) than on Puffin Rock or West Slope.

Hatching weights did not vary significantly and patterns of growth rate looked similar (Figure 4). There were no differences in weight and age at fledging between any of the areas. Chick survival was the same (70-72 %) everywhere.

Since no observations on food delivery and kleptoparasitism were made in the low density areas, the quantity and type of food brought to chicks there was not determined. There was no direct evidence indicating a difference in food items. No interactions with gulls were observed in the low density areas.

4) COMPARISON 1980-1981 (Puffin Rock)

In 1980, hatching success was lower (Figure 2) particularly in the high density areas without gulls, where a high proportion of eggs or chicks were lost around hatching time. 1980 fledging success in the high density areas with gulls was very good. Losses of chicks in areas free of nesting gulls occured within the first ten days after hatching. We suspect that most chicks were lost due to predation or chilling of unattended or weakened chicks. No instances of starvation were observed. In 1981, hatching success was higher but chick survival was lower (Figure 2). Hatching was more successful in longer burrows in 1980, but this relationship was not observed during the next summer. Chicks in shorter burrows may be more accessible to bird predators. When comparing both years, overall breeding performance is approximately the same although the timing and causes of losses are different.

The breeding success of the tufted puffins seem to be largely influenced by the abundance and availability of the food supply. In 1981, the amount of food brought to the chicks was very low during the last part of the nestling period. Fledging weights were significantly lower than in 1980, although egg size and weight at birth did not differed significantly (Table VII).

Current ongoing analysis will examine growth rates of the chicks between diferent years. Chick weights in 1981 show an initial fast gain, followed by a plateau and high variability later in the season. Individual curves presented erratic patterns. In 1980, rate of weight gain was more constant. Also it seems that 1980 growth rates were slower than initial growth in 1981.

Observations of feeding rates in the high density areas will allow determination of whether lower weights and higher variation in 1981 are related to lower and more variable quantities of food brought.

DISCUSSION

The second field season raised more questions about the importance of parental care, predation and the abundance of food on the puffin breeding performance. Diminished food availability in July 1980 could have caused a decrease in adult nest attendance and increased the risk of predation on young chicks. Evidence consistant with this hypothesis is the slower rate of growth and smaller amount (quantity or size) of food delivered in late July and early August (analysis in progress). In 1981, major losses occured during the incubation period. Hatching success is the major difference between high and low density areas. This difference could be caused by differences in parental attendance associated with variation in the microclimate of the nest burrows (low densities are located on steep, wind-exposed slopes) or higher concentration of mammal predators on the main island. More abundant food in July 1981 could explain higher 1981 hatching success and the lower proportion of losses at hatching time. During the 1982 field season, the impact of adult attendance during incubation and levels of losses to microtines will be evaluated.

The ultimate cause of growth declines in mid-August are unclear. Weight losses began to occur when sea conditions became quite rough (approximately ten days of 30-40 mph winds). Maybe schools of fish moved lower in the water column. Some unnoticed change in water temperature might have caused migration of the fish further away from the breeding grounds. There are correlations between weight, age at fledging, and hatching date ($p<0.05$). Earlier chicks did better. However some food was available at the end of August, thus adult foraging efficiency can also be important. Some chicks born later were quite heavy and also fledged at an early age.

Why do some birds nest in low density? Productivity was lower in these sites. Was this an effect of our disturbance, as it was the first year of work done in these areas compared to five years on Puffin Rock (our work and K. Vermeer, C.W.S.); or is there some biological reason? During the next field season, we plan to concentrate on what happens during the incubation period, identifying when and how losses occur; and also fill up information gaps identified this summer (i.e. monitoring at hatching, food type and quantity brought to chicks in low density areas).

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FIGURE 1. Map of Triangle Island, showing the location of the different study sites, summer 1981.

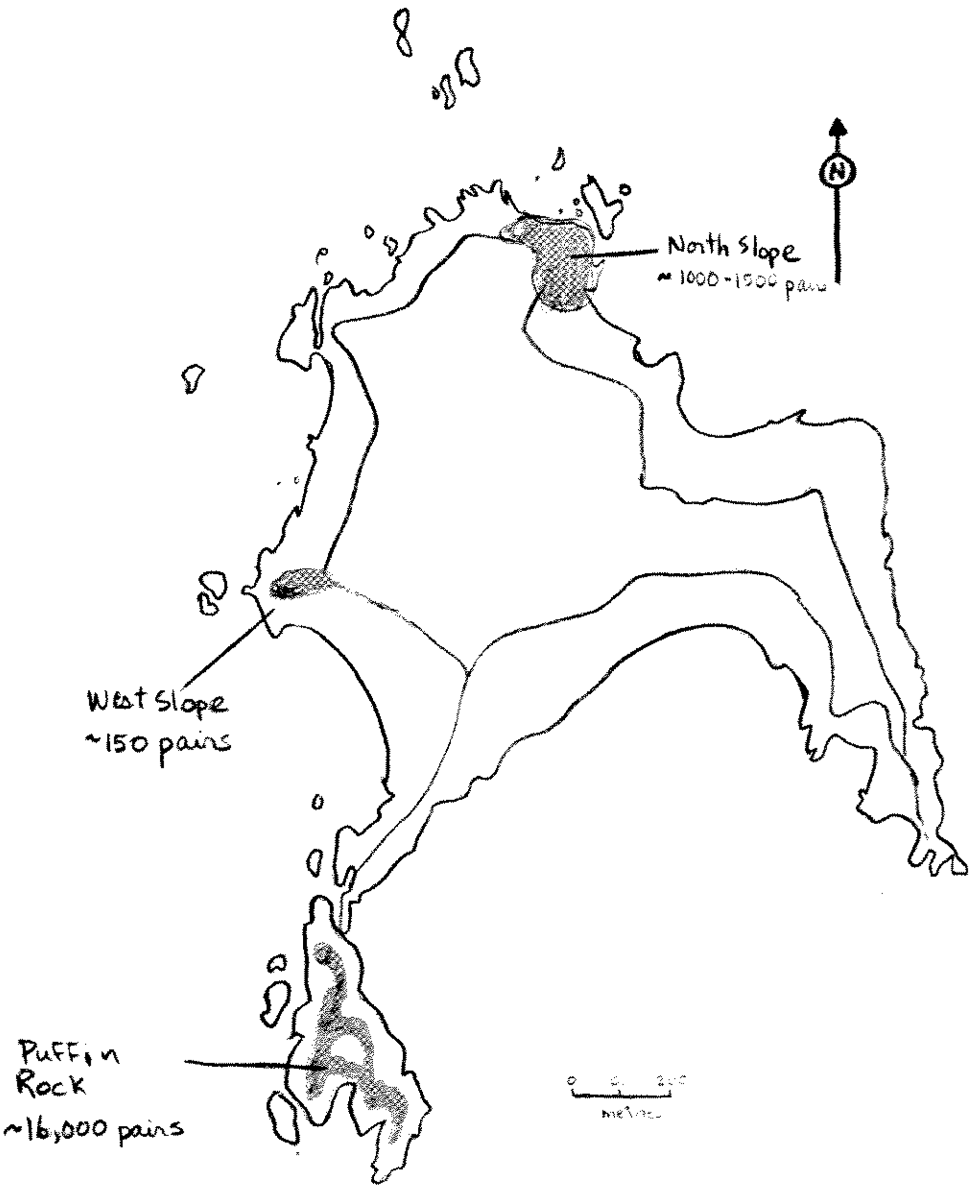
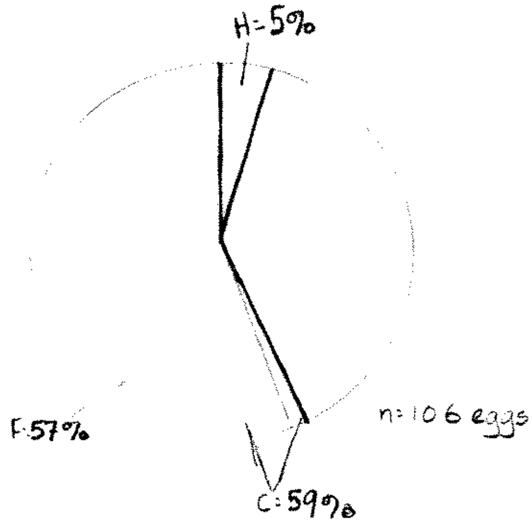
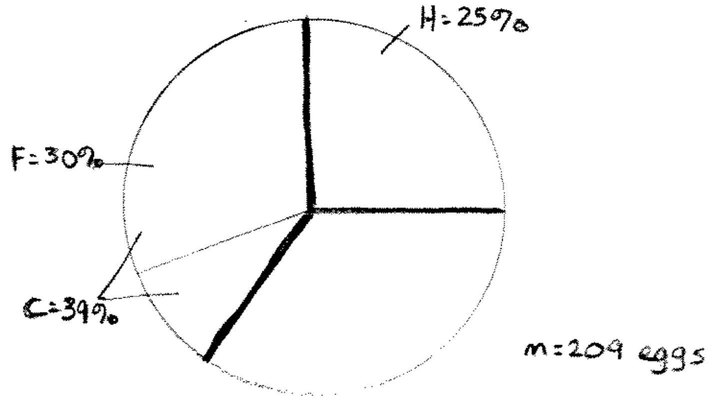


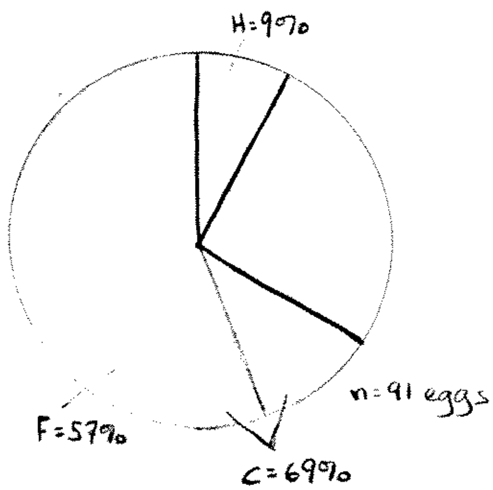
Figure 2. Tufted puffin productivity on different study sites,
Triangle Island, 1980 & 1981.



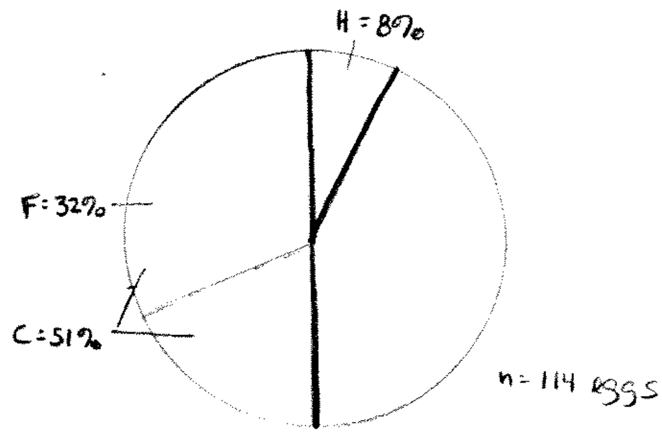
High Density w̄ gulls 1980



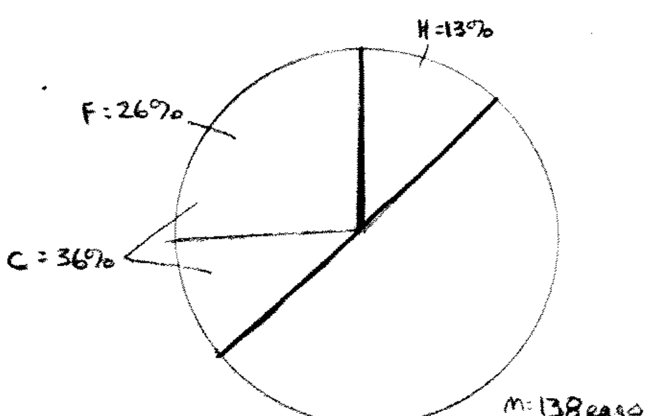
High density, no gulls 1980



High density w̄ gulls 1981



High density, no gulls 1981



Low density 1981

H: % of eggs or chicks lost around hatching time (predation?)

F: % chicks fledged per egg laid

C: % chicks hatched per egg laid

FIGURE 3. Hatching phenology of tufted puffins, Triangle Island, summer 1981.

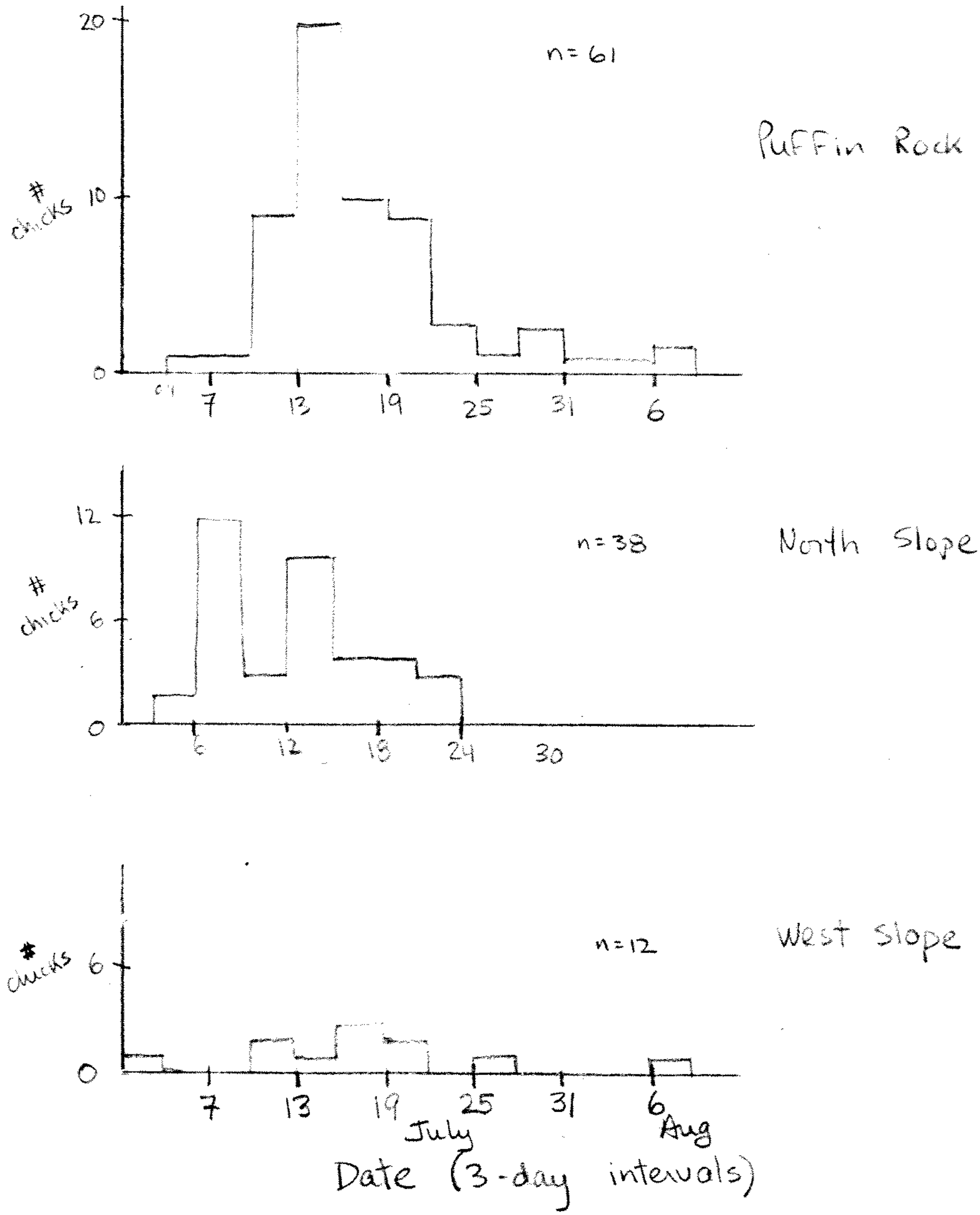
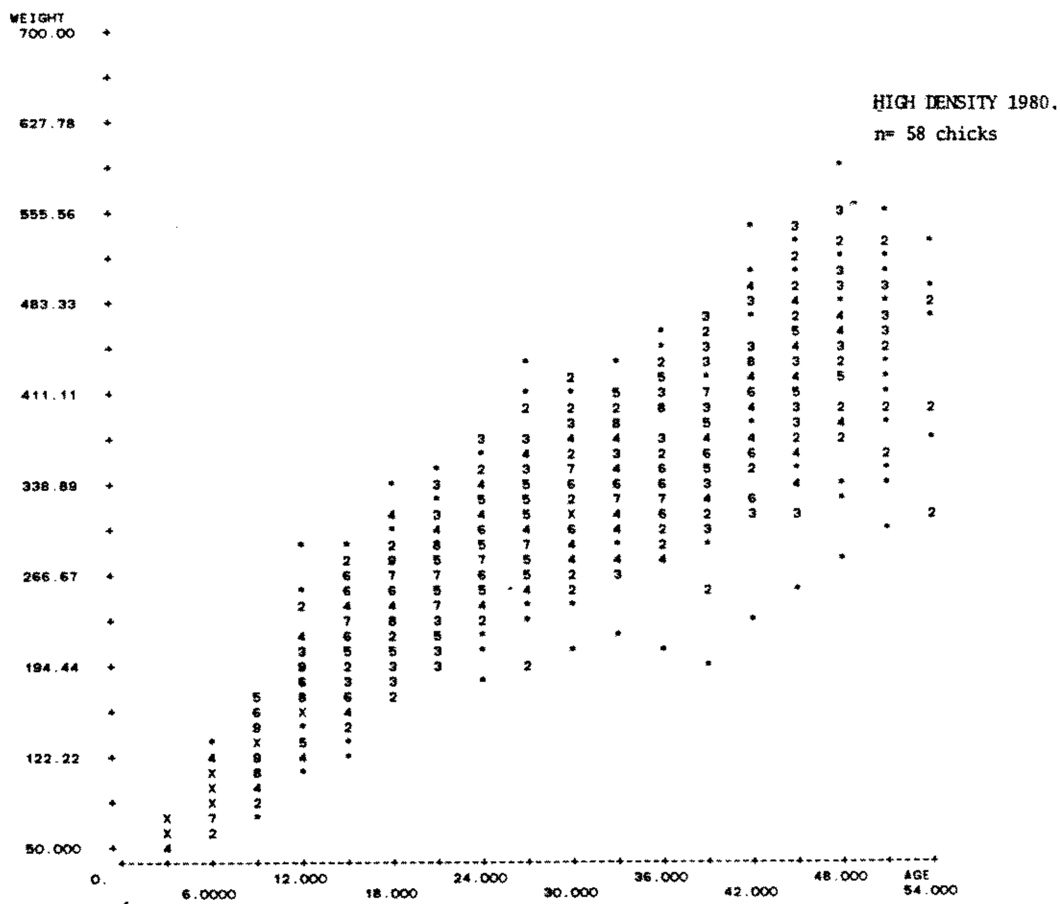
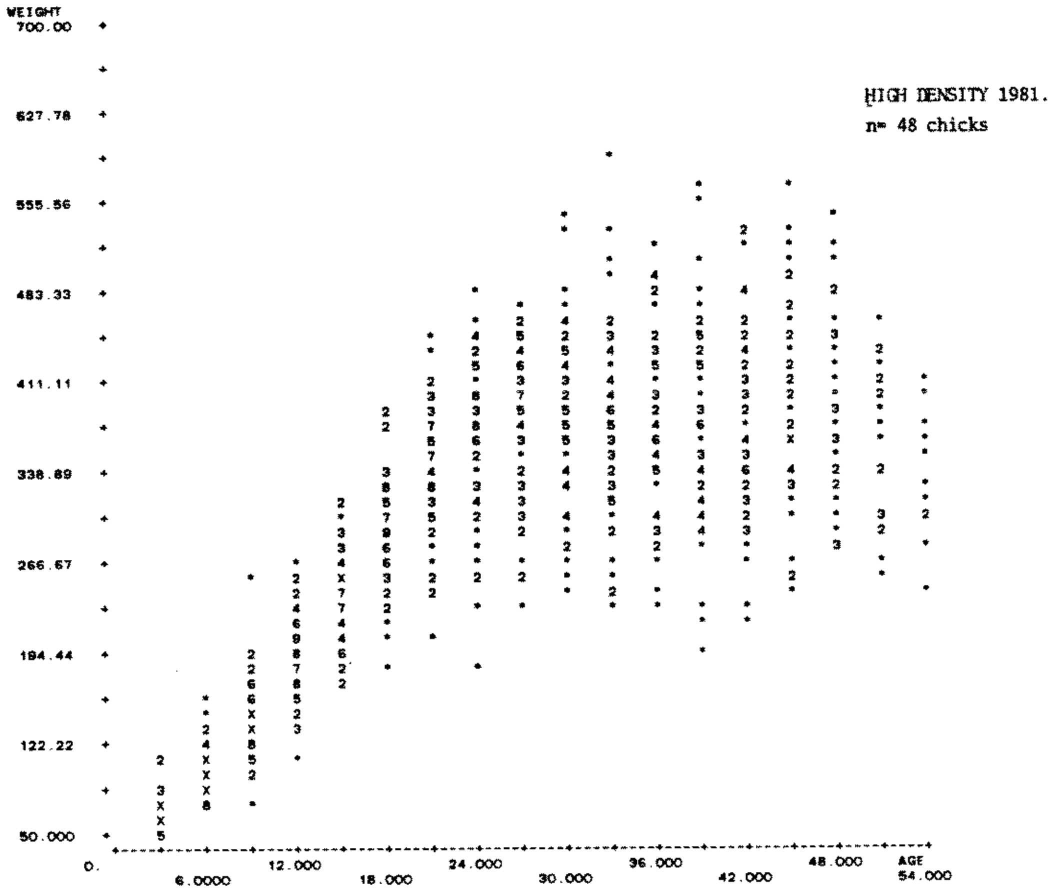


FIGURE 4. Weight increment of tufted puffin chicks, Triangle Island, 1980 & 1981.




WEIGHT
700.00
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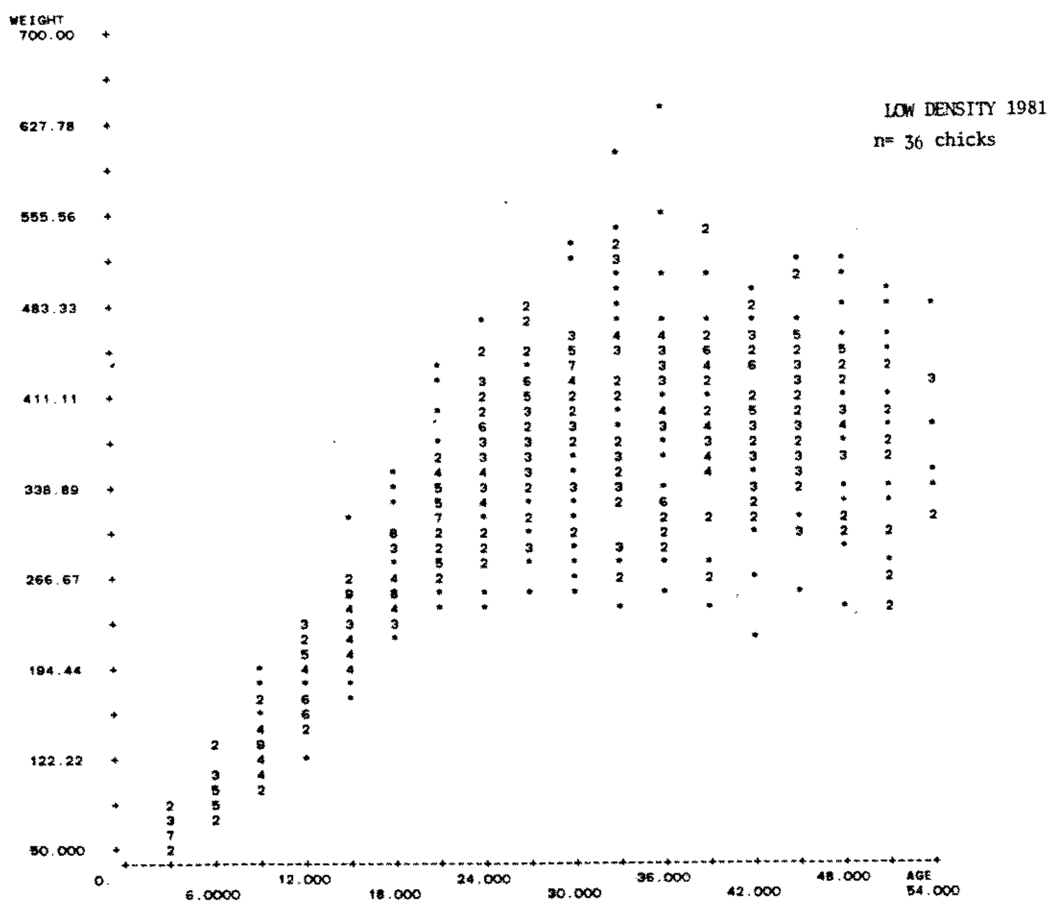
AGE
54.000
HIGH DENSITY 1981.
n= 48 chicks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24.000
30.000
36.000
42.000
48.000
AGE
54.000
LOW DENSITY 1981.
n= 36 chicks

TABLE I. OUTLINE OF DATA COLLECTION, SUMMER 1981.

3 areas: high and low (2) density.

Paired plot #	Data collected
All (1-2-3-4)	A) Census and mapping of gull & murres nesting areas
2-3 only	A) Habitat characteristics
	B) Egg-laying dates and egg size
1 (H.D. only)	A) Feeding activities
	B) Gull kleptoparasitism
	C) "Chick pipping" experiment
2	A) Growth rate
	B) Test for mice predation on dummy eggs
3	A) Reproductive success, undisturbed plots
4	A) Adult banding
	B) Reproductive success, disturbed plots

TABLE II. Density and habitat characteristics of tufted puffin study areas, Triangle Island. (all in 95% confidence intervals)

	PUFFIN ROCK (high density)	WEST SLOPE (low density)	NORTH SLOPE (low density)
Density (# burrows per 9 m^2)	7.0-8.4	1.0-3.0	2.5-5.0
Slope (degrees)	29-34	40-46	39-46
Vegetation cover	100% grass	95% grass 5% rocks	95% grass 5% salmonberry
Vegetation height (cm)	35.2-37.6	37.0-43.0	42.0-48.0
Soil depth (cm)	28.0-41.0	20.0-70.0	47.0-80.0
Soil composition			
% soil	40-62	55-70	90-100
% grass	30-52	13-50	0- 3
% rocks	1-10	0-20	0-12
Burrow length (cm)	89 0-90.0	79.0-93.0	89.0-99.0

$\bar{x}$?

TABLE III. Food items found near gull nesting sites, on Puffin Rock, summer 1981.

DATE	# nests w̄ chicks	# nests with: shellfish	fish	Cassin's chick	Puffin chick	Small mammal	Murre eggs
4-7	19	-	1	-	-	-	-
7-7	43	-	2	1	-	-	-
10-7	84	-	4	2	-	-	2
14-7	110	1	7	2	-	1	2
21-7	137	-	5	2	-	1	5
27-7	137	4	6	-	2	2	-
2-8	139	2	3	-	-	-	-
11-8	139	-	-	-	-	-	-

N.B. Peak of puffin hatching occured from 10-07 to 27-07.
After mid-August, gull chicks were too mobile and dispersed to allow us to collect any food remains.

TABLE IV. Mice predation on dummy (chicken) eggs, 4 to 11 September 1981.

	PUFFIN ROCK (high density)			NORTH SLOPE (low density)		
	initial number	number left	predation rate (%)	initial number	number left	predation rate (%)
Intact eggs	30	15	50%	32	25	22%
Cracked eggs	15	0	100%	25	0	100%

N.B. In most cases, the egg was completely gone. Sometimes, few pieces of eggshell and remains of the embryo were left. Eggs were left for three days.

TABLE V. Measurements of adult tufted puffins (banded birds), June 1981. (n=30 birds/area)

	PUFFIN ROCK (high dens.)	NORTH SLOPE (low dens.)	P (T-test)
Wing length (mm)	206.5 s.d.=1.2	208.8 s.d.=1.6	n.s.
Body weight (g)	785.3 s.d.=21.0	754.3 s.d.=18.5	< 0.05

TABLE VI. Egg size and chick weights in different nesting areas, Triangle Island, summer 1981.

	PUFFIN ROCK (high dens.)		WEST SLOPE (low dens.)		NORTH SLOPE (low dens.)		T-test bw high & low d.
	N	Mean (S.D.)	N	Mean (S.D.)	N	Mean (S.D.)	
index of egg volume (cm^3) (length×width^2)	207	171.6 (14.1)	27	169.0 (10.5)	92	170.0 (12.5)	n.s.
Weight at birth (g)	54	67.8 (10.3)	5	67.8 (10.5)	7	64.6 (11.4)	n.s.
Weight at fledging (g)	48	389.0 (80.4)	5	432.0 (46.2)	31	411.0 (60.0)	n.s.

TABLE VII. Egg size and chick weights in the high density nesting area (Puffin Rock), summers 1980 & 1981.

	1980		1981		P
	N	mean (s.d.)	N	mean (s.d.)	
Index of egg volume (cm^3) (length×width^2)	307	172.6 (13.7)	207	171.6 (14.1)	n.s. (T-test)
Weight at birth (g)	50	64.8 (7.5)	54	67.8 (10.3)	n.s. (M.W.U.)
Weight at fledging (g)	58	459.0 (59.4)	48	389.0 (80.4)	< 0.001 (M.W.U.)

RESEARCH PROPOSAL, SUMMER 1982.

(addition to Progress Report, Fall 1981)

by Anne Vallée
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January 1982

This is a review of my previous working hypotheses as well as a proposal for the next field season, in summer 1982. I intend to adress the original ideas and discuss or modify them according to our actual knowledge of the system.

I. HABITAT QUALITY DETERMINES BREEDING DENSITY AND PRODUCTIVITY.

Low density areas are located on steeper slopes and orientated towards the north or west side of the island. It seems that the presence of obstacles (shrubs, rocky outcrops) among the grassy vegetation prevents the birds from settling evenly all over the slopes. Burrow dimensions and soil composition do not vary significantly between high and low density sites.

Low density areas may be exposed to prevailing winds and this could cause a difference in the microclimate of the burrows. Eggs or young in these locations could be more exposed to chilling. However, we would expect that the burrow itself buffers extreme variations of temperature and humidity. So far, there is no evidence of differences in habitat "quality" which could create a difference in productivity.

Next summer, we proposed to:

- measure total wind exposition on the slope in high and low density areas with cumulative wind meters and compare susceptibility to wind-chill.
- measure extreme variations of temperatures in the two sites with min-max thermometers in "average" burrows.

II. INTERACTIONS WITH GULLS DIRECTLY INFLUENCES THE NESTING SUCCESS OF THE TUFTED PUFFINS.

By now, we suspect that glaucous-winged gulls (<u>Larus glaucescens</u>) are not the only predators on puffin chick or egg. Deer mice (<u>Peromyscus maniculatus triangularis</u>) could exerce significant predation as well. This idea has to be demonstrated and quantified during the next field season.

1) In areas where nesting gulls are present, predation by gulls on eggs or nestlings will be greater than in areas free of gulls.

In the high density areas, we could distinguish two types of nesting sites: puffins nesting among a high concentration of nesting gulls and areas free of gulls, where only one or two pairs would nest close to the puffins. No gulls where nesting anywhere near the low density sites. We never observed gulls landed on these slopes, although we did not make extensive observations.

In 1980, we observed a lower hatching productivity and a higher proportion of losses at hatching time in the high density areas with no gulls (see report 1981, Figure 2). We hypothesized that gulls nesting in high concentrations spend more time in territorial defense and intraspecific interactions (observed with Atlantic puffin, Fratercula artica, and herring gulls, Larus argentatus, Pierotti, in press). We assumed that the high proportion of losses at hatching time was mainly due to predation on unattended chicks.

In 1981, we did not observe such a high proportion of losses around hatching although high density areas with gulls again showed a slightly higher hatching success. Observations and surveys of gull nests did not show that gulls were predating heavily on puffin chicks at all.

This hypothesis would need another year of testing. I suspect that variations in the availability of food at a critical time can affect puffin attentiveness to incubation and thereby influence predation risk.

2) Gull predation rate is lower and puffin production consequently higher in high density nesting areas than in low density nesting areas.

Productivity was higher in the high density areas. Chick survival was similar in the two areas but hatching was not as successful in the low density sites. Thus, the difference in productivity was caused by losses during incubation.

We did not observe any gulls in the low density sites but both areas support large populations of mice.

Hypothesis:

Birds in the low density areas experience relatively higher predation from mice & gulls either because of a denser mouse population on the main island compared to Puffin Rock (high density area) or because of a higher predator/prey ratio in the lower puffin densities.

Cassin's auklet nests are very abundant near the low density sites but their breeding phenology is earlier so eggs are vulnerable at a different time.

I propose to test this idea in 1982 with the following methods:

- census of mouse population in the two areas, from May to July, by live-trapping for 2 days every two weeks and mark-recapture.
- predation experiment. install groups of high and low density of eggs (dummy or chicken eggs) in unused burrows in both areas and monitor their disappearance. Eggs will be surrounded by smoked plates to record tracks of the eventual predator. I am also thinking of injecting either a dye (visible in feces) or strychnine in the eggs. Predators could be readily identified.

3) Alternative prey.

The puffin study plot located near a murre colony did not produce more chicks than other high density areas with gulls: 58% compared to 67% and 80% in 1981, see Table I. The proximity of murres did not seem to reduce the predation risk on puffins. But if in 1981 gull predation during hatching time was lower (because of higher food availability to adult puffins and better parental care on egg??) we would not expect to observe a significant difference between the high density sites. We can monitor this plot for another year in 1982 and see if this idea still holds.

III. BREEDING SUCCESS IS DIRECTLY CORRELATED WITH BREEDING DENSITY.

1) Higher quality birds in the "preferred" high density sites.

High density birds are heavier although their size (wing length) is smaller. Assuming that weight should be proportional to size, this could suggest that high density birds are relatively "fatter". If, at the end of the incubation period the birds are under a food stress, low density birds may be more prone to desert their egg, exposing them to a higher risk of predation or chilling.

However, egg size and chick weights do not vary between the two areas. Weight increment is similar and significantly different than in 1980 (Figure 1).

Hypothesis:

Parental attendance on the egg is higher in the high density areas, and thus hatching success is higher.

Next summer we propose to make:

- all-day observations, once a week, in the two areas. We will record bird attentiveness to identified burrows. Unfortunately, devices to record incubation shifts are too expensive to allow a representative sample size.
- collect more information on adult size to see if there really is a significant difference.

2) During periods of high feeding activity, higher density of fish-carrying birds may reduce the effectiveness of gull attacks, and thus individual birds can bring more fish to their young.

I do not have any observations on food deliveries in the low density areas. Therefore I do not know if similar growth is due to similar food loads or if rate of gull interactions could significantly affect feeding rates.

Next summer, I will set up a blind in the low density area as well. I might schedule observation shifts differently: since highest activity occurs in the morning, just after sunrise, I will set up simultaneous observations in the two areas, for four hours in the morning, twice a week. This will increase sample size and reduce variation between the two areas (because of possible difference in weather or sea condition on different days).

Figure 2 presents a flowchart of what I considered the important factors influencing the breeding success of the tufted puffins. Next summer I intend to compare more intensely the two density sites during incubation and look for differences in:

- nest microclimate (wind, T°)
- parental care
- predation risk (what proportion of available eggs are eaten and by who)

During the nestling period, I will follow chick growth and survival and compare frequencies of food deliveries and food loads.

Table II outlines the proposed data collection.

FIGURE 1. GROWTH OF TUFTED PUFFIN CHICKS, TRIANGLE ISLAND, SUMMER 1980 & 1981.

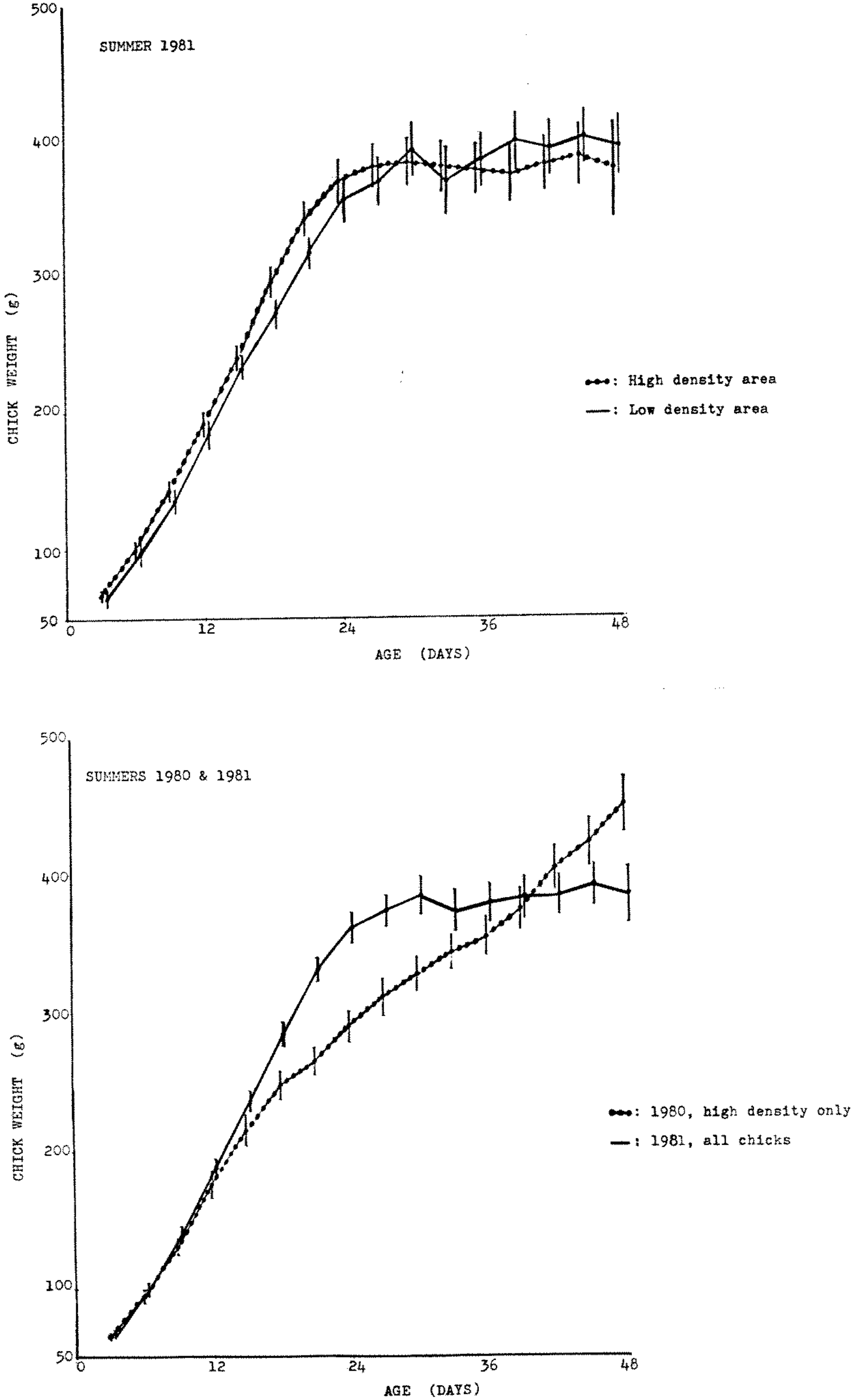

FIGURE 2. Variables influencing the breeding success of tufted puffins on Triangle Island.

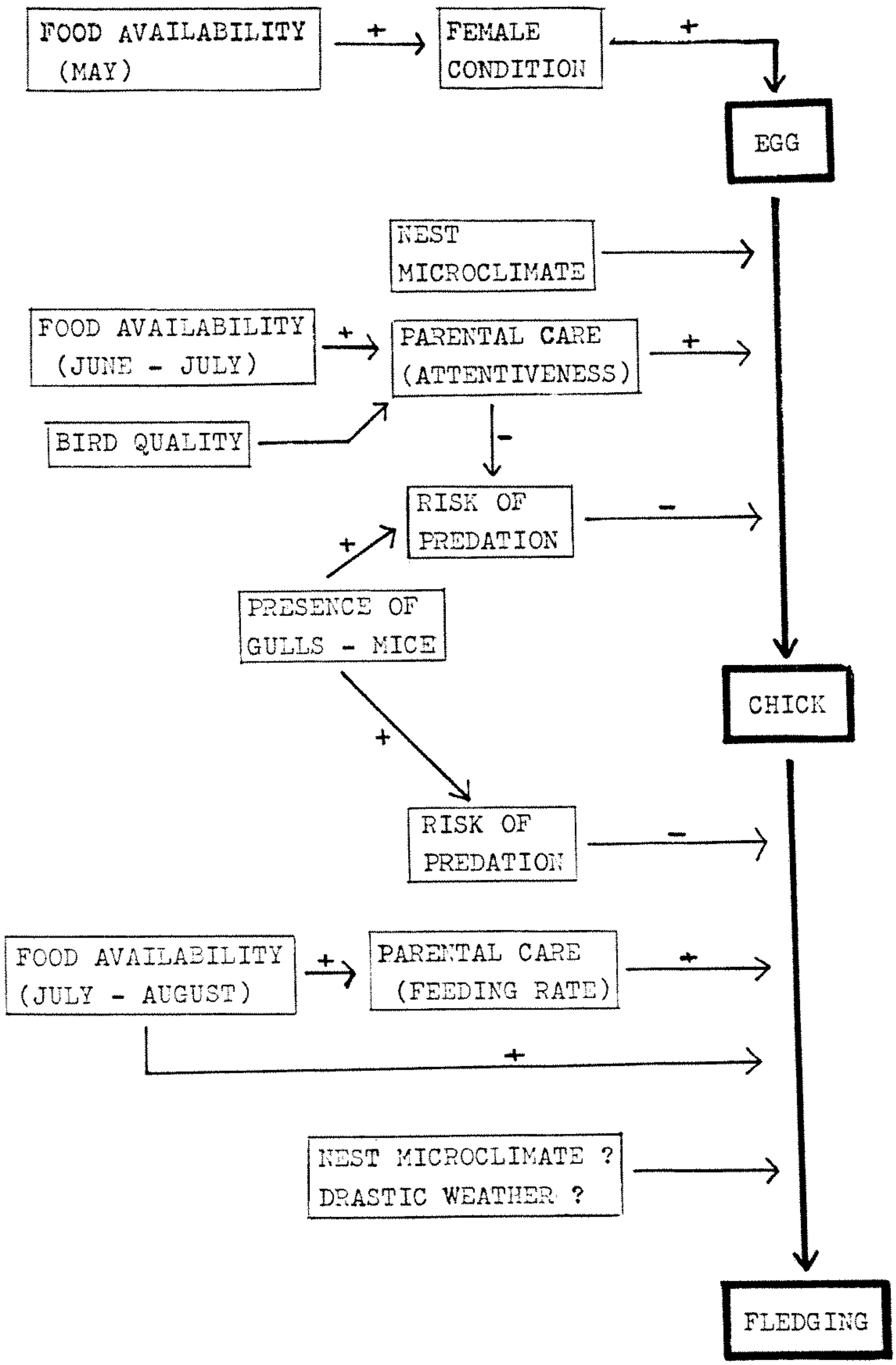

TABLE I. Tufted puffin productivity on the different study sites, Triangle Island, summers 1980 & 1981.

	1980			1981			
Study plots	% hatched per egg	% fledged per egg	% fledged per chick	% hatched per egg	% fledged per egg	% fledged per chick	
HIGH DENSITY							
WP2	44	38	81	48	30	63	
ER	59	58	95	80	54	71	G
TR	30	21	70	61	-	-	
WP3	60	60	100	58	-	-	G+M
SL2	31	24	80	-	-	-	
SL1	43	33	77	-	-	-	
WE	55	55	100	67	-	-	G
EE	60	-	-	44	32	75	
WP1	41	-	-	-	-	-	
Banded adults	-	-	-	72	-	-	
LOW DENSITY							
WS	-	-	-	31	14	45	
NS	-	-	-	39	31	79	
Banded adults	-	-	-	41	-	-	

NB: -G indicates proximity to high concentration of nesting gulls.
-M indicates proximity to a murre colony.

- I don't know if I will work again in the low density WS next summer because it involved a lot of time for a very small amount of information. Only 11 chicks out of 37 (the maximum eggs we could find over there) hatched. Five eventually fledged.

TABLE II. Proposed outline of data collection, summer 1982.

3 areas: - high density with gulls
- high density with no gulls
- low density

PLOT	DATA
All	- Census and mapping of gulls and murres nesting areas - Mice trapping - Microclimate measurements (temperature and cummulative winds) in representative areas.
1	Observations: - Parental attendance - Feeding activities - Gull kleptoparasitism
2	- Egg laying dates & egg size - Growth rate
3	- Reproductive success, undisturbed areas
4	- Adult size - Experiment with chicken eggs.

We plan to set plots of 50 burrows each.