Diurnal and Seasonal Patterns of Colony Attendance in the Northern Fulmar, *Fulmarus glacialis*, in Alaska

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The annual cycle of Northern Fulmars (*Fulmarus glacialis*) in the western Gulf of Alaska includes about six months from mid-April to mid-October when birds are associated with land at the Semidi Islands. The pre-laying stage in five years was marked by recurrent peaks in attendance that included up to 90% of the population, and alternate periods of 2 to 12 days when the breeding ground was deserted. Serial correlation of daily attendance indicated a cyclic pattern with a half-period of five to seven days. Maximum attendance at breeding sites usually occurred in the evening after a gradual increase in numbers during the day. Percentage of attendance by nonbreeding and failed birds varied widely with breeding success, but the seasonal occurrence of nonbreeders followed a consistent pattern: attendance by site-holding nonbreeders peaked before egg-laying, then steadily declined, whereas an influx of nonbreeding floaters occurred in July and August. Different wind directions and speeds influenced the number of birds at the colony for up to three days after they occurred, but it was not possible to explain the birds' behaviour during the pre-laying period in terms of simple linear relationships between attendance and weather. Rather, synchronized attendance appeared to be a social phenomenon mediated by environmental cues such as a change in wind direction.

Key Words: Northern Fulmar, *Fulmarus glacialis*, colony attendance, weather effects, time-series analysis, Alaska.

Information on patterns of colony attendance is essential for developing effective census procedures for seabirds (Lloyd 1975; Nettleship 1976). Such data are also of ecological interest since they describe important features of the annual cycles and social systems of colonial species. Few definitive data have been published on patterns of colony attendance in petrels (Procellariidae), though there have been a number of detailed studies of breeding biology in this group (e.g., Richdale 1963; Harris 1966; Pinder 1966; Serventy 1967; Imber 1976; Warham et al. 1977). Undoubtedly, that is because most species nest in burrows and are nocturnal on land. The Northern Fulmar, *Fulmarus glacialis*, is better suited to the detailed study of attendance patterns because of its diurnal, cliff-breeding habits.

From 1976 to 1981 I studied the population dynamics, breeding ecology, and behaviour of Northern Fulmars at the Semidi Islands (56°N, 156°W), one of four major breeding locations of the species in the northeastern Pacific. Here, I describe the major diurnal and seasonal patterns of colony attendance, both in terms of overall numbers and in relation to the breeding status of the birds present. I also examine the influence of weather on day-to-day changes in numbers.

Methods

Field Techniques

In addition to making daily counts of birds on study plots and all-day watches to determine diurnal changes, I made observations on individual breeding sites to determine attendance patterns among birds of known breeding status (breeding, nonbreeding, failed, pre-laying). All study plots and individual breeding sites were on a 2-km expanse of cliffs on the west side of Chowiet Island, an area of representative habitat occupied by about 40 000 of the estimated 440 000 fulmars on the Semidis (Hatch and Hatch 1983). Observations in five years spanned a four-to-five month period from three to eight weeks before egg-laying through late August or early September, when the oldest young were still about a week away from fledging; in 1978, the study was limited to the period 24 May to 29 June, which encompassed egg-laying and early incubation.

From 500 to 700 breeding sites were included in the study plots used to monitor overall attendance, depending on the year (eight plots in 1976-79, six plots in 1980-81). Counts of single birds and pairs on those plots were generally made between 0900 h and 1600 h. During eight all-day watches from 10 May to 21 August 1977, single birds and pairs were counted at 15-min intervals on one plot of about 130 breeding sites.

The sample of individually monitored breeding sites included 292 sites in 1976 and 540 to 550 sites in later years. Many of those sites were on the plots already described; others were in similar habitat off the plots. Sites were numbered and identified in photographs for permanent reference. Information recorded on daily visits included attendance of adults (0, 1, or 2 birds present) and the presence or absence of an egg or chick. A breeding pair of fulmars produces only one egg a season.

For analyses that concerned the relative proportions of breeding and nonbreeding birds, I included only sites selected before eggs were laid to avoid an over-representation of breeding birds in the sample. Thus, most of the information presented is based on a sample of 217 sites in 1976 and about 425 sites in all other years. Apart from a few deletions or additions of sites in the early years, the same sample was used throughout the study. All observations of sample plots and individual sites were made from a distance using binoculars or spotting scope, and attendance appeared to be unaffected by my presence.

Fulmars occurred in a continuous gradation of colour phases, but for purposes of record-keeping I classified birds into four groups, denoted LL, L, D, and DD, following Fisher (1952). About 82% of the birds on the Semidis were DD, whereas a majority of breeding sites chosen for study included at least one bird in the rarer LL, L, or D plumage categories. Thus, the occasional occurrence at breeding sites of individuals other than the usual residents was partially accounted for in the analysis. Otherwise, I assumed that a bird seen at a site in which an egg eventually was laid was a future breeder, and that a bird in a site from which an egg or chick had been lost was a failed breeder.

Birds that regularly occupied a particular site I call site holders. Birds that did not produce an egg were nonbreeders, a category that included about 17% of all site holders (Hatch 1987). I use the term "floaters" for birds that did not acquire mates or take possession of breeding sites in a given season, and I refer collectively to birds not engaged in incubation or chick-rearing (failed or nonbreeding) as unemployed.

Weather parameters recorded two or three times a day included wind speed (estimated to ± 5 knots from sea surface conditions), wind direction (compass bearing), cloud cover, visibility, and the presence or absence of fog. Maximum and minimum air temperatures, precipitation, and barometric pressure were recorded daily.

Data Analysis

On a few foggy days it was not possible to obtain counts for all study plots. The totals for those days were prorated according to the average contribution to the total of each plot or combination of plots missed so that all daily counts could be compared.

Floaters were recognized during extended behaviour watches by their lack of attachment to any particular breeding site on the cliffs. No attempt was made to count floaters separately during routine counts, but their numbers were estimated indirectly by combining information from the plot counts and individually monitored sites. First, I estimated the number of breeding pairs on the study plots by dividing the number of chicks produced (an easy determination to make at the end of the season) by the rate of breeding success observed in my sample of individually monitored breeding sites. I then expressed daily attendance in breeding sites as birds per egg laid and applied that ratio to the daily counts of birds on study plots. This provided an "expected" value for attendance by site holders. The difference between expected values and the actual counts was an index of floaters on the study plots.

To test whether a given series of attendance counts exhibited periodicity, I calculated serial correlation coefficients and plotted an autocorrelation function. Each plotted coefficient (r_s) is a correlation between pairs of observations separated by a lag interval (s) of 1 to 25 days. An autocorrelation function that became significantly negative for some values of s was taken as evidence of regular oscillations in the time series. For example, a negative correlation at $s = 5$ would indicate that low and high counts tended to occur five days apart. The interpretation of autocorrelation functions was based on definitions and guidelines provided by Pielou (1974).

Results

Seasonal Occurrence on Study Plots

The first landings by fulmars at their breeding sites in spring were observed only in 1981. Birds were abundant in the area on most days in early April that year, but they tended to stay 1-2 km offshore, flying low over the water or sitting in large rafts. Thousands finally approached the cliffs and landed en masse on the evening of 11 April. The first egg was laid on 31 May in 1981, 50 days after the first landfall. That interval may be fairly characteristic, since other features of the annual cycle were quite similar in all years (Figure 1).

Attendance during the pre-laying period was marked by sharp peaks in the number of birds on land, alternating with intervals of total absence for 2 to 12 days. Birds apparently travelled a considerable distance from the islands on foraging trips because I frequently was unable, using a spotting scope, to see any fulmars over the water during one of the periods of absence. In contrast, the pre-laying peaks of attendance included about twice as many birds as occurred at any time after the start of laying and incubation. From that point onward, a gradual decline in average attendance was evident most years.

Diurnal Rhythm

A gradual increase in numbers during the day was observed early in the season (pre-laying to

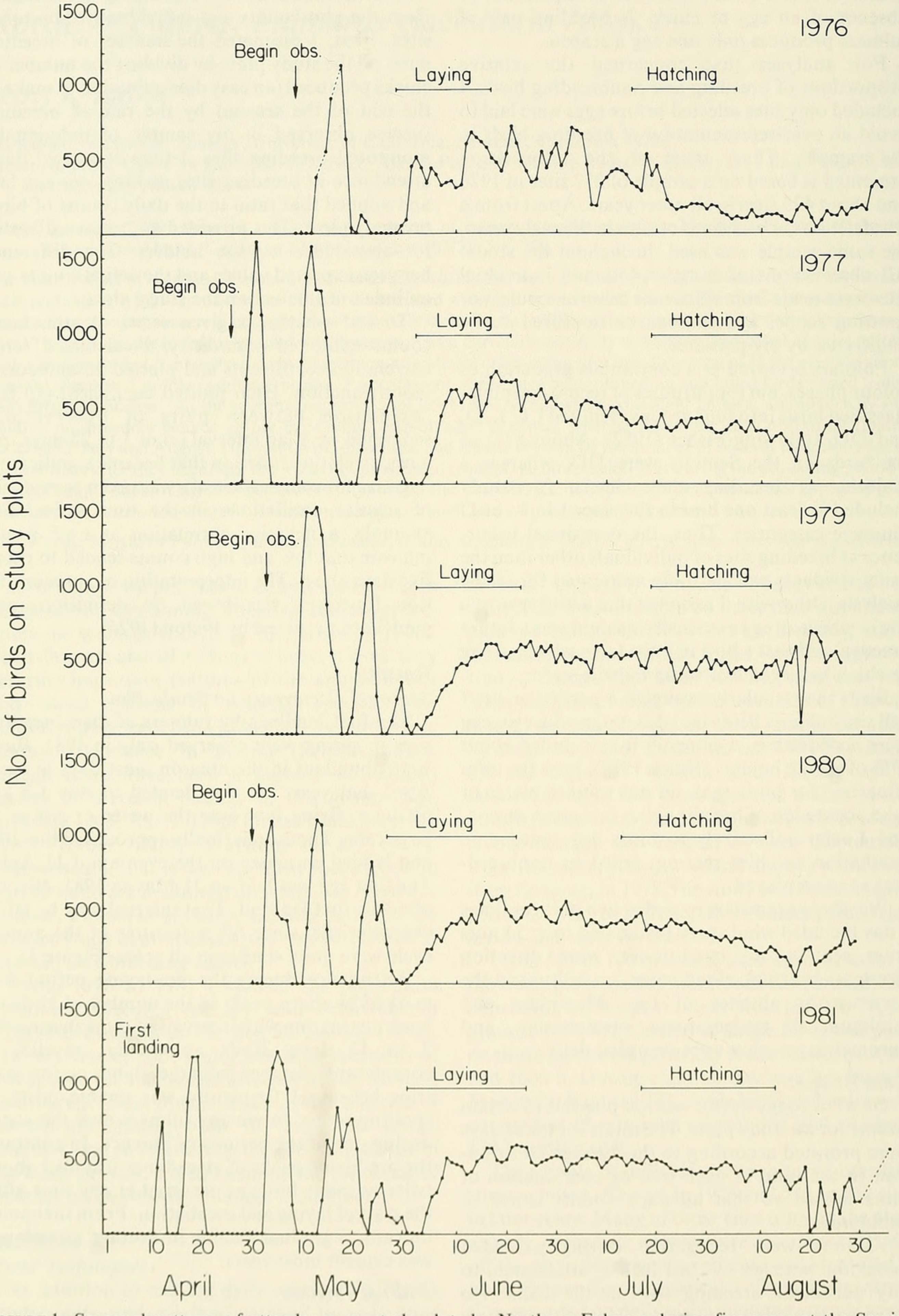

FIGURE 1. Seasonal patterns of attendance on study plots by Northern Fulmars during five years at the Semidi Islands. The final count in 1981 was made after a hiatus of six days.

mid-incubation), with maximum attendance occurring in the evening (Figure 2). During hatching and the early chick period (12 July to 5 August) there was no clear pattern except a rise in numbers early in the morning and a corresponding drop at dusk. The wide diurnal range in attendance observed on 21 August reflected in part the greater mobility of parents once their chicks no longer required constant brooding. However, the pattern observed that day was also exceptional in that it followed a strong gale on the previous day, during which nearly the entire adult population had evacuated the cliffs.

Maximum counts during the first seven all-day watches ranged from 204 birds on 10 May to as few as 76 birds on 22 July. Minimum counts, generally those made soon after dawn, were 60 to 80% of daily maxima. Thus, variation in colony attendance between days was usually much greater than variation within days. Considering only that portion of the day when daily counts were made (0900 h to 1600 h), the average change in attendance within days was +11% (range 0 to 26%), whereas the mean counts for the same seven days differed by 123%.

Attendance and Breeding Status

The pattern of attendance during the pre-laying period was similar in all years. For example, in 1977, about 90% of breeding-site holders were present on days of peak attendance in the pre-laying stage (Figure 3a). Actually, the proportion was even higher because the calculation is based on two birds in every breeding site constituting 100% attendance, whereas some sites were never seen to be occupied by more than a single, possibly unmated bird. The patterns depicted for 1977 typify those recorded in other years.

After 1 June, both the overall level of attendance and the composition of the population depended on the level of breeding success in a particular year (Figure 4). The data for 1976 and 1981 show the extremes (15% success in 1976 versus 72% success in 1981). A third graph in Figure 4 shows the average composition observed in five years (omitting the incomplete data for 1978). At no time after the start of egg-laying did the number of birds on the cliffs comprise more than about 50% of the known population of site holders; the highest proportion was only 35% in 1976.

The number of birds actively engaged in incubation or chick-rearing steadily declined as unsuccessful pairs joined the ranks of failed breeders. Otherwise, attendance by breeders was relatively constant, and daily fluctuations in colony attendance after 1 June resulted mainly from the movements of failed and nonbreeding birds ($r = 0.94$, on average, for the correlation between overall attendance and the number of failed and nonbreeding birds present, compared with $r = 0.56$ for the relationship between number of active breeders and total attendance).

The proportion of nonbreeders in my sample of breeding sites averaged 17.3% over five years, whereas only about 5% of experienced birds (i.e., those that had bred at least once before) skipped breeding annually (Hatch 1987). Nonbreeders made up about 20% of the birds at breeding sites on most days during the pre-laying period (Figure 3a), but usually comprised no more than about 10% over the remainder of the season (Figure 4). The largest number of nonbreeders in any one count invariably occurred in the first half of May.

After 1 June there were no days on which most or all of the nonbreeders were present at one time, as was the case in May, so the following approach was used to reveal seasonal changes in the number of nonbreeders visiting the colony. I selected data for nonbreeders of known identity (i.e., individuals of the rare plumage types: LL, L, and D) and calculated the percentage of birds that visited their sites at least once during a running 10-day interval, incremented one day for each calculation (Figure 5a).

Five-day means are plotted to smooth the curve, but the maximum value observed in each five-day interval is also given since the pre-laying value used to represent full attendance (100%) was itself a single, maximum count. The clear result is a population of nonbreeders at breeding sites during most of June that was little changed from the pre-laying period, followed by a steady decline to about 40% of the pre-laying maximum by the end of August.

The above information on attendance at breeding sites does not take nonbreeding floaters into account. I estimated that total nonbreeders (site holders and floaters) made up 30-35% of the population of fulmars around the islands in spring, nearly double the number associated with breeding sites (Hatch 1987). Floaters tended to alight wherever they were tolerated by site holders and were little inclined to spend time sitting in established breeding sites, even when the residents were away. The largest number of nonbreeding floaters occurred before egg-laying, so I again plotted five-day means and maximum values relative to the highest value estimated for the pre-laying period (Figure 5b).

The lack of highly synchronized attendance among floaters after egg-laying explains why all plotted values after 1 June are small in relation to the pre-laying maximum. The major finding was that a downward trend in the floating population occurred in June and July, followed by a sharp increase during August. In fact, that influx appeared earlier each year as an increasing number

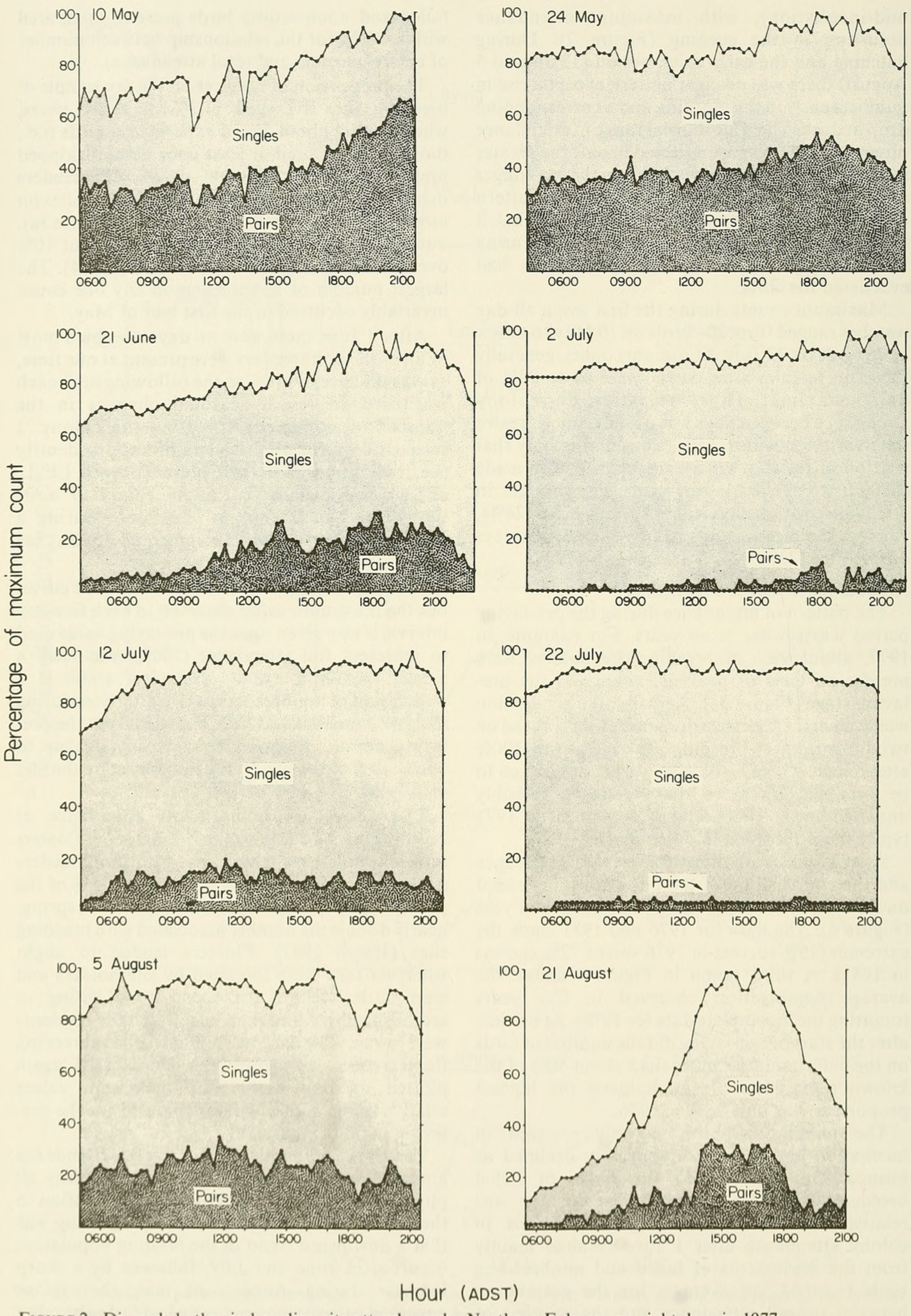

FIGURE 2. Diurnal rhythm in breeding site attendance by Northern Fulmars on eight days in 1977.

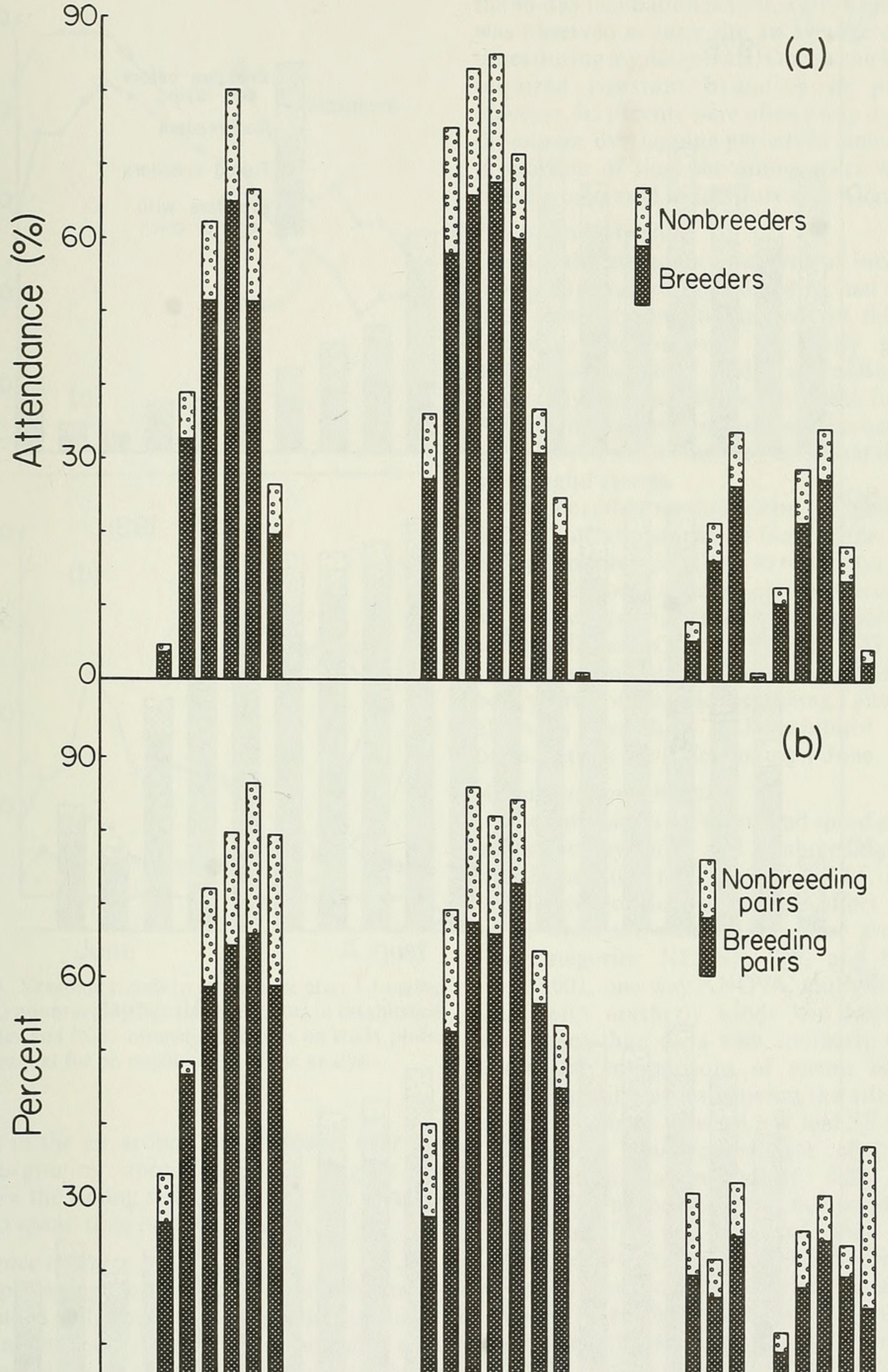

FIGURE 3. Attendance patterns during the pre-laying period in 1977: (a) proportions of total breeding and nonbreeding site holders present (two birds per site counted as 100% attendance) and (b) percentage of occupied sites containing pairs.

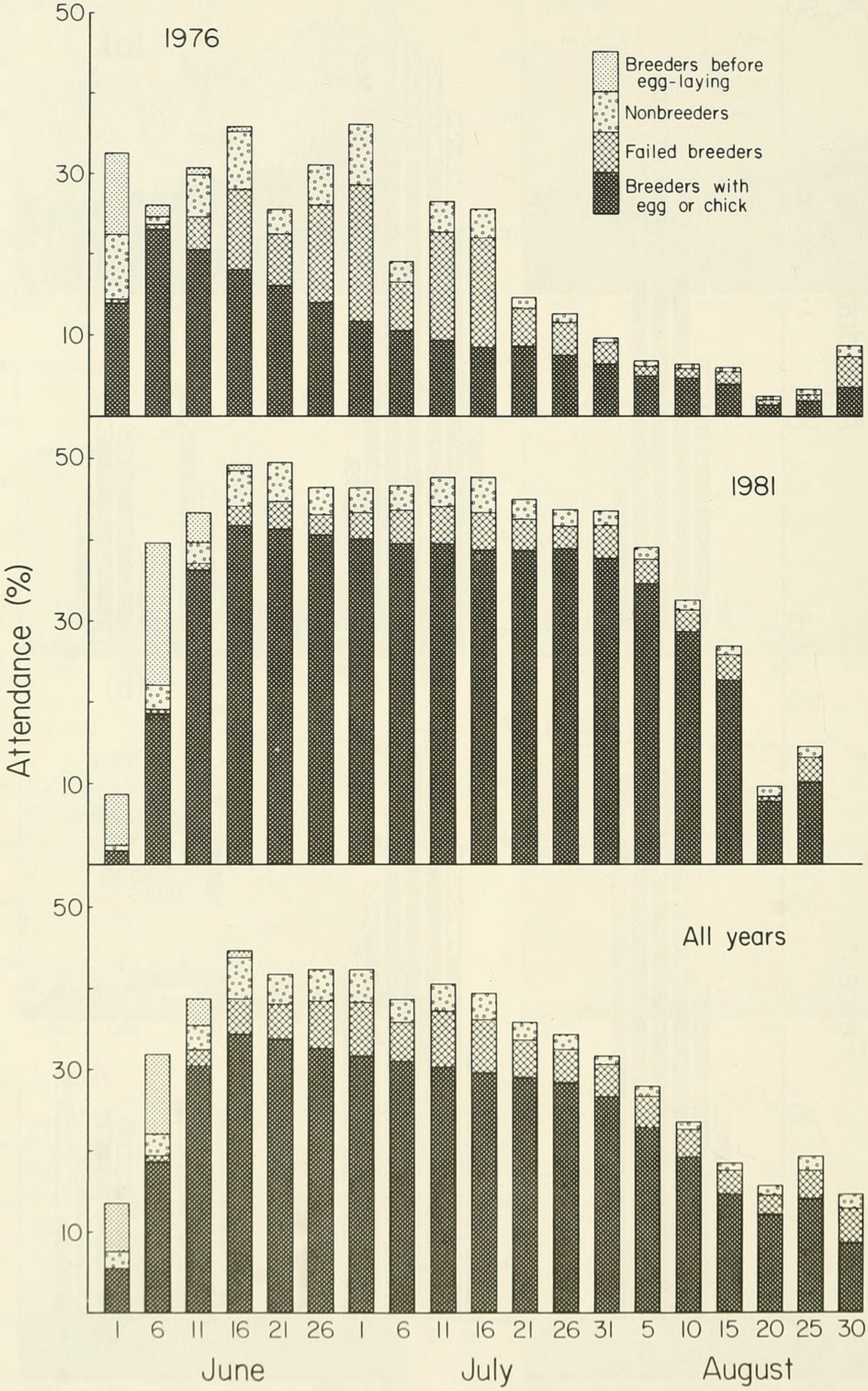

FIGURE 4. Attendance and breeding status of Northern Fulmars in two years with contrasting levels of breeding success (1976 and 1981) and a generalized pattern based on an average of five years. Bars represent average daily attendance at breeding sites in five-day intervals beginning on the dates indicated. Two birds in every site constituted 100% attendance.

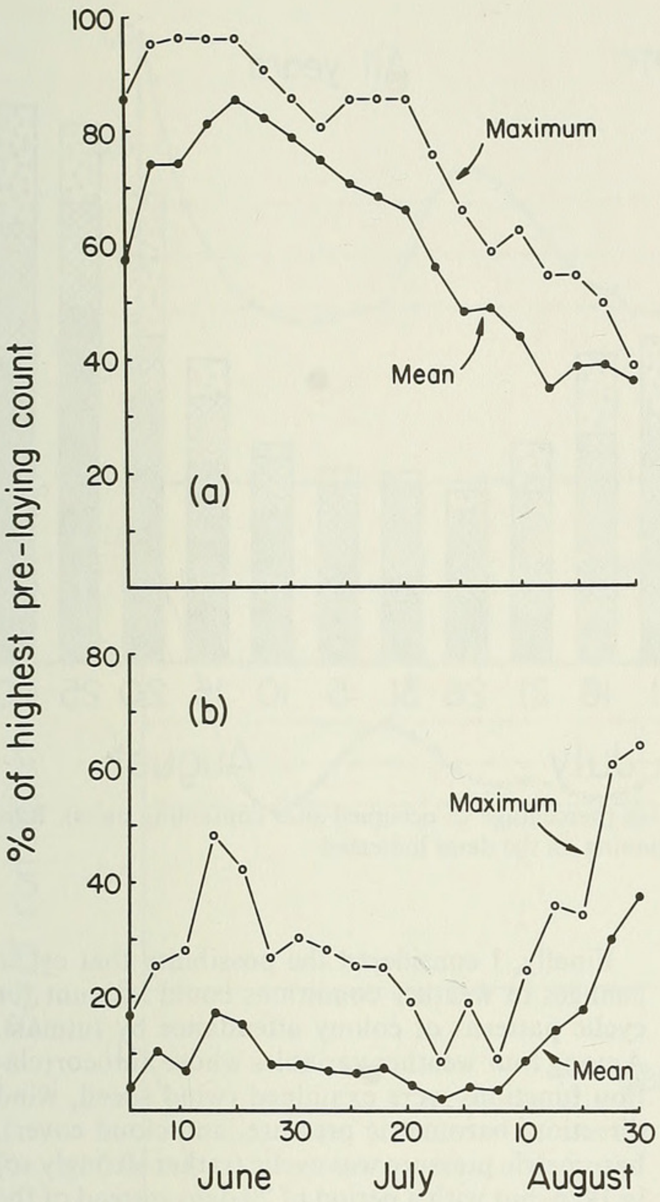

FIGURE 5. Seasonal trends in attendance after 1 June by (a) nonbreeding Northern Fulmars in established sites and (b) nonbreeding floaters on study plots. See text for an explanation of the analysis.

of birds in the air around the cliffs and over the water beginning about mid-July. Figure 5b illustrates the timing with which the new arrivals began to spend time on the ground.

Occurrence of Pairs

The percentage of occupied sites containing pairs tended to follow a pattern similar to that of overall attendance. About 90% of occupied sites contained pairs on days of peak attendance during the pre-laying period (Figure 3b), whereas only 6-10% had pairs in June and July (Figure 6). All but a small fraction of the pairs observed during incubation and the early chick stage were failed or nonbreeding pairs, because breeders rarely spent more than a few minutes with their mates when changing shifts of incubation or brooding. Over the 48-day incubation period, a given breeding pair was observed at their site an average of only 1.1 times during my daily visits. Once a chick no longer required constant brooding or protection, however, its parents were often away or present at the site for overlapping periods of time. Thus, the proportion of sites containing pairs with chicks steadily increased in late July and August.

Time Series Analysis

Since the attendance patterns of breeders were tightly constrained once breeding had begun, the time series chosen for analysis in this and the following section was the daily percentage attendance of failed and nonbreeding birds. I arbitrarily truncated the series in late July or early August, depending on the year, because too few unemployed birds remained after that time to give meaningful results.

Autocorrelation functions suggested cyclic patterns of attendance in four of the five years, with periods ranging from 10 to 15 days (Figure 7). As would be expected, large fluctuations in attendance during the pre-laying period had a strong influence. Only in 1976 and 1977 did r_s have significantly negative values (at a lag of five days in both years) for the series beginning 1 June, whereas all years (including 1981) exhibited significant periodicity in the series ending 1 June.

Attendance and Weather

The correlation between wind speed and percent attendance by failed and nonbreeding birds was weakly negative ($r = -0.09$, $P < 0.05$, d.f. = 487). Wind direction had a stronger effect than wind speed when the observations were grouped into four categories: NE, SE, SW, and NW winds ($P < 0.001$, one-way ANOVA, multiple $R = 0.28$). Days with northerly winds had lower average attendance than days with southerly winds, but unplanned comparisons of means revealed no significant differences between the effects of NW and NE winds or between SW and SE winds.

Increased cloud cover was also positively correlated with attendance ($r = 0.20$, $P < 0.001$, d.f. = 487), but the effect was not significant after controlling for the effect of wind direction. Cloudiness was strongly associated with southerly winds at the Semidis, whereas clear weather occurred when the wind blew from the north. It seems likely that fulmars responded more to wind direction than to cloud cover per se. None of the other weather variables examined (maximum daily temperature, barometric pressure, precipitation, and fog) had a significant effect on attendance.

The above correlations for wind speed (r^2) and direction (R^2) indicate relatively minor effects of weather conditions on attendance (only 8% of the variability was explained by wind direction, and

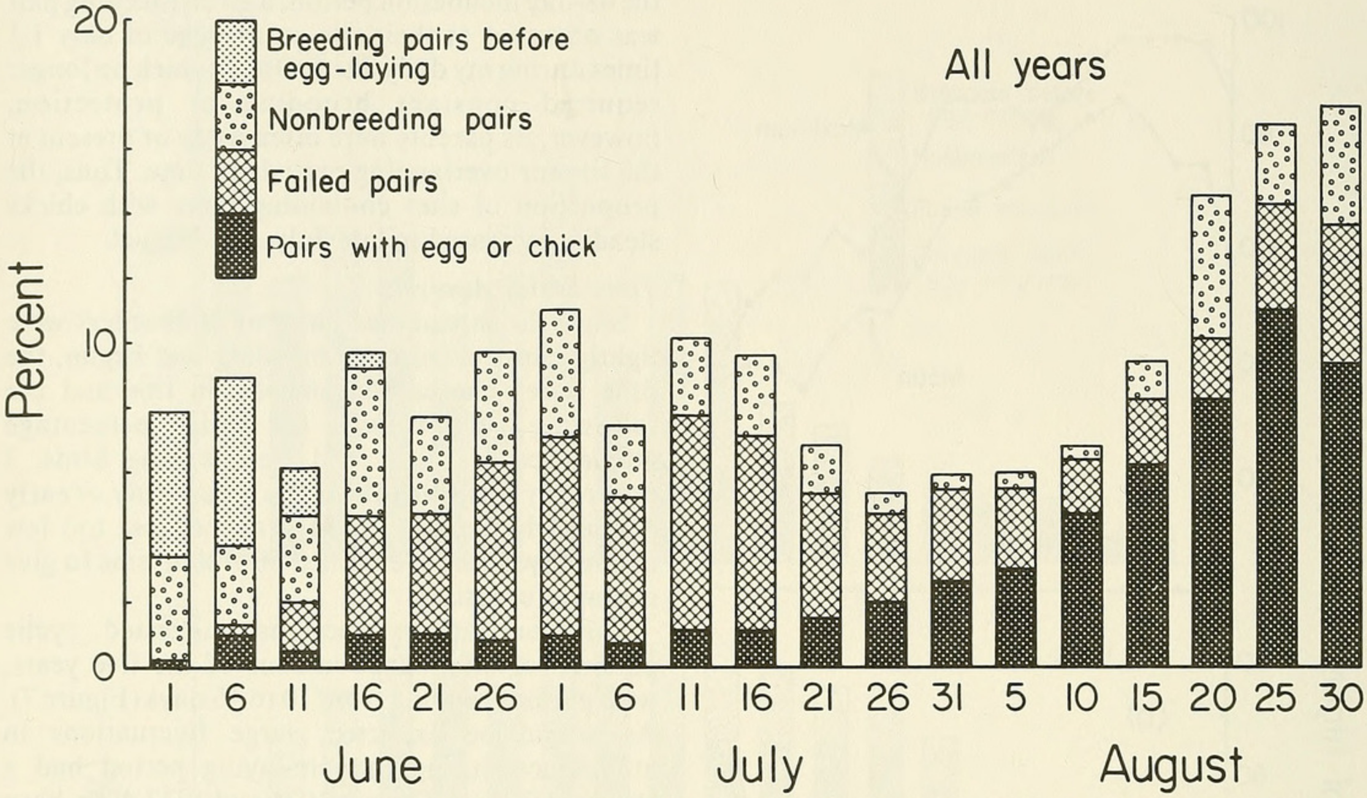

FIGURE 6. Occurrence of pairs in relation to breeding status (percentage of occupied sites containing pairs). Bars represent mean attendance in five-day intervals beginning on the dates indicated.

less than 1% could be attributed to wind speed). The effects were detectable mainly because of the large sample sizes available for analysis (n = 492 days over six years).

However, the most notable responses to weather appeared to be nonlinear, since the mass departures and arrivals in the pre-laying period were often associated with a marked change in weather conditions. To illustrate, I identified 16 obvious "spikes" in the attendance patterns observed before 1 June (Figure 1). The first day of attendance after an absence of one or more days I treated as day 0 and calculated average weather conditions on the two previous days, on the day of return, and on the following two days. The conspicuous transition in weather conditions associated with the return to land was a shift from northerly to southerly winds, increasing clouds, and rain (Table 1).

Throughout the breeding season, fulmars made foraging trips lasting several days. Therefore, the effect on attendance counts of a change in weather conditions would be expected to last for several days. To test that possibility, I compared means of attendance on day *i* resulting from different conditions of wind speed or direction on each of the five preceding days. Attendance was still significantly depressed up to three days after a strong wind (>10 knots), and two days after a north wind (Table 2).

Finally, I considered the possibility that cyclic changes in weather conditions could account for cyclic patterns of colony attendance by fulmars. Among four weather variables whose autocorrelation functions were examined (wind speed, wind direction, barometric pressure, and cloud cover), barometric pressure was cyclic (rather strongly so) in 1976, but with a period of 20 days instead of the 15-day period observed in attendance. Other variables exhibited no patterns comparable to the functions plotted in Figure 7.

Discussion

The interval between first landing and egg-laying in 1981, about seven weeks, was similar to the pre-laying period observed in several other petrels (e.g., Davis 1957; Pinder 1966; Serventy 1967). Although I did not determine the timing of final departure in the fall, it seems unlikely that adults remain on land at the Semidis for any appreciable time after the young are fledged. Information from the Pribilof Islands (57°N, 170°W) indicated that fulmars had all but disappeared from the cliffs there by late September or early October (Preble and McAtee 1923).

The diurnal range of attendance on the cliffs varied with the proportion of birds that were able to come and go freely (i.e., failed and nonbreeding birds and parents of older chicks), but a recurring pattern was for maximum numbers to occur in the

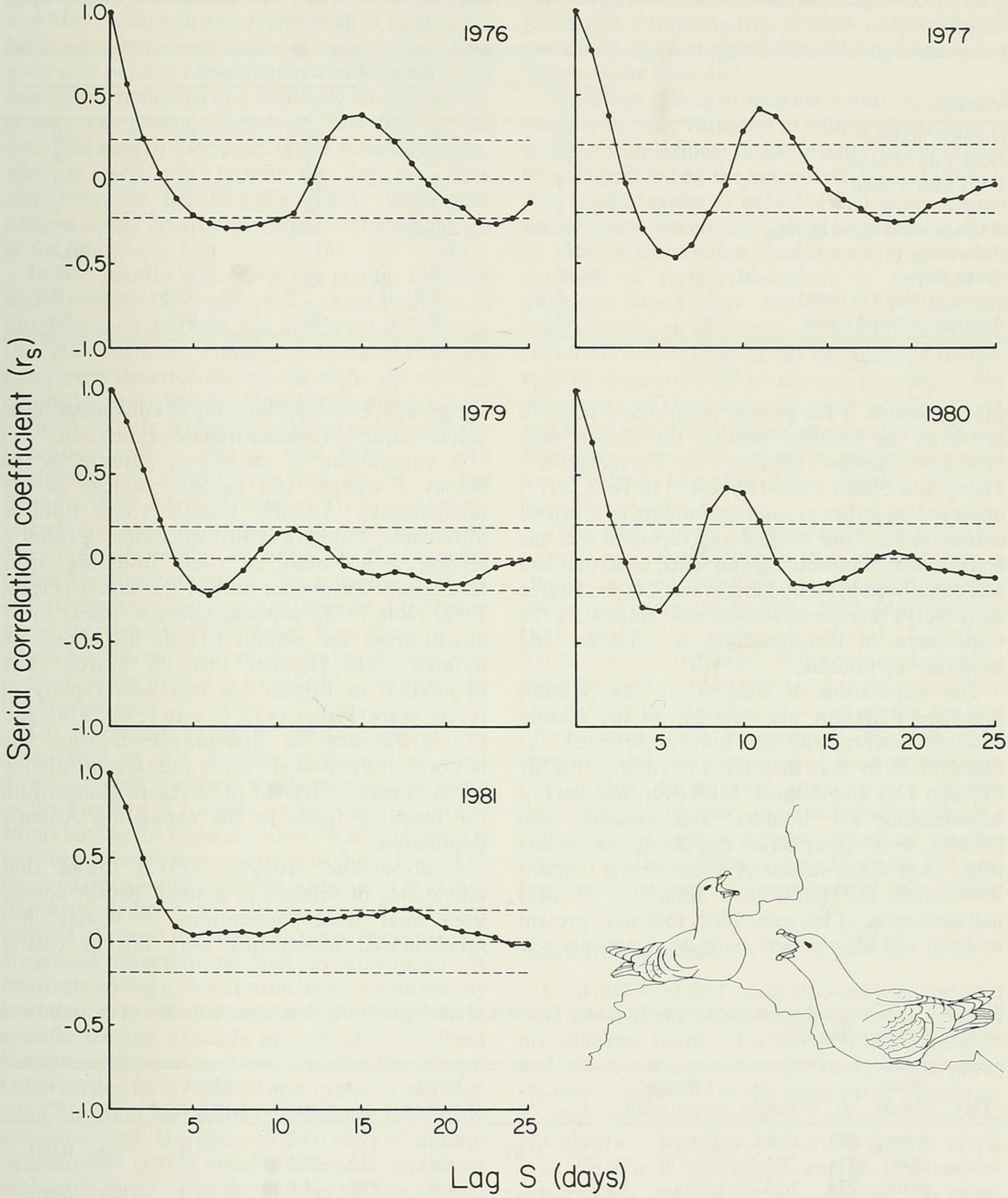

FIGURE 7. Serial correlation of daily attendance counts (failed and nonbreeding birds only) from pre-laying through late July or early August in five years. Upper and lower broken lines define an approximate range of ± 2 SE around the 0 value.

early evening (Figure 2). The drop in numbers observed just before dark on most days is consistent with the finding that fulmars feed largely at night, at least at certain times of the year (Furness and Todd 1984; Hatch, unpublished data). Even under conditions of continuous daylight, however, fulmars at Jan Mayen Island (71° N, 80° W) exhibited a diel rhythm of colony attendance, with a lull in activity and partial evacuation of the cliffs around midnight (Cullen 1954; Moss 1965).

A pattern frequently observed in petrels and

TABLE 1. Changes in weather conditions associated with a return of fulmars to land after an absence in the pre-laying period.

	Days before or after return				
Variable	-2	-1	0	+1	+2
Number of days	16	16	16	16	16
Days with N wind	10	5	1	2	4
Days with S wind	4	8	13	10	9
Calm days	2	3	2	4	3
Average wind speed (knots)	14.4	13.8	15.4	14.7	15.2
Barometric pressure (mbar)	1014	1015	1013	1011	1012
Rainy days	6	5	10	12	11
Average rain/day (mm)	0.5	0.9	3.7	2.4	3.0
Average % cloud cover	44	58	80	84	70

other seabirds is for young, prospecting birds to arrive at the colonies later in the season than established breeders (Nelson 1966; Serventy 1967; Fisher and Fisher 1969; Harris 1983). Dott (1973) observed an influx of molting fulmars to a British colony in July and August and surmised that the arrivals were nonbreeding and failed birds that had just completed primary molt at sea. My data agree with Dott's interpretation but also emphasize the importance of distinguishing site holders and nonbreeding floaters.

The population of floaters on the Semidis increased markedly near the end of the season, whereas nonbreeding site holders behaved like failed birds in that they left the colony steadily through July and August. Moreover, numbers of nonbreeding site holders, and possibly also floaters, were higher before egg-laying than at any other stage of the season. A question that remains is whether the late-season influx of floaters included some of the same birds that were present in April and May or was made up of entirely new age groups. Extensive banding of known-age birds will be required to make that determination.

A comparison of attendance patterns in the colony I studied and fulmar colonies in the northeastern Atlantic reveals some notable differences. Fulmars at British colonies exhibit a strong attachment to their breeding sites throughout the greater part of the winter (Fisher 1952; Dott 1973), whereas fulmars appear to be absent from the Semidi Islands for about six months from October through March. The population in Britain has increased rapidly in recent years (Fisher 1952; Cramp et al. 1974), and the difference in attendance during the nonbreeding season at Pacific and eastern Atlantic colonies may be related to increased competition for breeding space in the expanding Atlantic population.

Coulson and Horobin (1972) found that attendance of fulmars at a small British colony underwent wide fluctuations in winter, but synchronized movements were not as clearly

TABLE 2. Effect on colony attendance by Northern Fulmars of wind speeds and directions on the day of the count and on the five preceding days.

Day	Wind speed[a]	n	Count[b]	Effect of strong wind	t	P<	Wind direction	n	Count[b]	Effect of north wind	t	P<
i	strong	278	19.6	-3.5	2.26	0.05	north	195	17.6	-5.9	3.45	0.001
	light	214	23.1				south	211	23.5			
i-1	strong	274	18.8	-5.5	4.72	0.001	north	192	16.0	-7.9	4.87	0.001
	light	212	24.3				south	208	23.9			
i-2	strong	268	18.8	-6.0	4.01	0.001	north	188	17.5	-5.3	3.12	0.01
	light	212	24.8				south	206	22.8			
i-3	strong	263	19.9	-3.9	2.54	0.05	north	185	19.2	-2.9	1.67	NS
	light	211	23.8				south	203	22.1			
i-4	strong	258	21.3	-0.1	0.63	NS	north	183	20.9	-1.1	0.58	NS
	light	210	22.2				south	199	22.0			
i-5	strong	255	22.0	+0.8	0.53	NS	north	180	21.8	+0.2	0.09	NS
	light	207	21.2				south	197	21.6			

[a]Strong wind > 10 knots; light wind ≤ 10 knots.
[b]Percentage of failed and nonbreeding site holders present.

defined as those observed at the Semidis in April and May. Although departures of all or most of the birds occurred on occasion in their study, there were also periods of two to three weeks when site occupancy remained at a relatively constant level. It was exceptional for more than 60% of the occupied sites to have pairs in the Atlantic colony, whereas 90% was typical on days of peak attendance at the Semidis. Those differences suggest longer or more synchronized foraging trips at the Semidis.

In the months preceding egg-laying, Coulson and Horobin (1972) observed a rapid build-up in numbers each morning and an abrupt decrease in the afternoon or evening, leaving the ledges completely deserted during the night. At another colony in Great Britain, Dott (1975) noted a daily cycle of activity featuring peak attendance in the forenoon after about mid-July. In the comparatively short pre-laying period at the Semidis, there was no counterpart to brief daytime attendance and night-time desertion, and peak attendance generally occurred in the evening rather than mid-morning. The meaning of those differences is unclear, but if fulmars tend to feed at night throughout their range, then the hour at which birds arrive at a colony during the day may depend on the distances travelled to and from the feeding grounds.

The strongest effect of weather on colony attendance at the Semidis pertained to wind direction, with northerly winds causing a decrease in the number of fulmars on land and southerly winds having the opposite effect. When the wind is blowing, fulmars use a method of flight known as slope soaring, in which ocean waves are the slopes (Pennycuick 1975). It is an energetically efficient method of travel that tends to carry the birds in a crosswind direction as well as downwind. A relatively strong effect of wind direction on colony attendance would be expected if fulmars have specific feeding grounds located at some fixed distance and bearing from a particular colony. Other studies have revealed no correlation between wind direction and colony attendance in fulmars (Coulson and Horobin 1972; Dott 1975), but Manikowski (1971) noted differences associated with wind direction in the number of fulmars and other seabirds observed at sea.

The depressing effect on colony attendance of either a strong wind or a northerly wind lasted about three days at the Semidis (Table 2). In contrast, Coulson and Horobin (1972) found that a strong wind depressed colony attendance on the day of the count and on the following day, but an increase in attendance occurred on the second day following a strong wind, irrespective of the wind speed at the time. They interpreted this as indicating the time it takes fulmars to return after leaving on a foraging trip. If that interpretation is correct, it again suggests that feeding trips lasted longer at the Semidis.

The mean effects of weather variables were too weak to explain variation in colony attendance in terms of simple linear relationships. An alternative view, supported by the autocorrelation analysis, is that regular cycles of presence and absence were endogenous. Specifically, the damped wave form of the autocorrelation functions in Figure 7 is expected of cycles (biological, as opposed to physical ones) that are prone to become progressively out of phase over time (Pielou 1974). However, conclusions about endogenous rhythm may be premature for series that encompass few repetitions of the purported cycle (Pielou 1974), and there was evidence that the mass arrivals and departures observed during the pre-laying period were indeed triggered by particular weather conditions (Table 1).

Thus, the correct interpretation may be that fulmars use certain cues in their environment, a change in wind direction for one, and possibly others unknown, to mediate behaviour patterns that primarily serve a social function. Synchronized attendance at the colony during the pre-laying period may be related to the acquisition and defence of breeding sites and mates, for it is otherwise difficult to account for the total desertion and re-occupation of the breeding area that occurs during that stage of the season. According to this view, once the birds have made a collective response to a particular set of weather conditions, the pattern of attendance for the next few days is set, largely irrespective of the weather.

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