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PREDATION AND PIRACY BY GULLS AT A TERNERY IN MAINE

JEREMY J. HATCH

THE current increase in the numbers of large gulls, exemplified by the population of Herring Gulls in New England which is doubling every 12 to 15 years (Kadlec and Drury, 1968), has engendered much concern and speculation about its consequences for other seabirds. The general conclusion is that terns, in particular, suffer heavily from predation and competition for nesting sites (for example, Gross, 1954; Drury, 1965; Howard, 1968). Arctic and Common Terns (*Sterna paradisaea* and *S. hirundo*) are probably unaffected in the nonbreeding season by changing gull populations. Thus the interactions between terns and gulls observable at breeding colonies can be a realistic indicator of the changing fortunes of the terns in the face of predation of eggs and young, competition for nesting sites and cleptoparasitism (seizing food gathered by another, which can be considered a special form of food competition).

This paper considers predation of tern chicks by Herring and Great Black-backed Gulls (*Larus argentatus* and *L. marinus*) and stealing of fish by Laughing Gulls (*Larus atricilla*) at a colony of Arctic and Common Terns on the island of Petit Manan, Maine. These observations were made from 17 June to 13 July 1968 during the course of other studies on the island. It would, of course, be unwise to attribute every reduction in the numbers of breeding terns to the gulls, especially in view of the accumulation of persistent biocides in the oceans (Risebrough et al., 1967), a potential hazard not limited to the breeding season. Nevertheless, it will be shown that a substantial number of chicks are now lost to the large gulls and that fish-stealing is likely to be significant when the terns find fishing difficult.

Petit Manan (44°22' N, 67°52' W) is a small, low, treeless island 4 km SE of the point of the same name in southwestern Washington County, Maine. It lies between two outer islands with large colonies of Arctic Terns (Matinicus Rock, 104 km SW and Machias Seal Island, New Brunswick, 64 km E by N), but is closer to the mainland than either of these. The island is approximately rectangular 300 × 250 m, predominantly grassy, with exposed rocks along the north and east shores and a large shingle bank along the southern and western edges. A small part at the southeastern edge of the island that rises to 6 m above mean sea level is the site of the tall lighthouse tower and the five associated buildings are nearby.

Terns nested all over the island except where disturbed by the activities

of the Coast Guardsmen; I estimated about 1,200–1,500 breeding pairs from six transect counts of active nests on 25 June. About two-thirds of these were Arctic Terns, one-third Common, and there were also four or five pairs of Roseate Terns (*S. dougallii*). A small colony of about 20 pairs of Laughing Gulls nested in the middle of the island. One solitary pair of Herring Gulls nested on Petit Manan Island itself, but most of the large gulls nested on neighboring Green Island, about 550 m to the northwest and accessible by a shingle bar except at high tide. Between 100 and 200 pairs of Herring Gulls and 25–50 pairs of Great Black-backed Gulls were resident (and apparently many nested) on Green Island, but no terns or Laughing Gulls. On neither island was there evidence of any predation by vertebrates other than gulls.

PROCEDURES

Encounters between gulls and terns were watched on most of the days from 17 June to 13 July 1968. The quantitative records of chick predation and the rates of fish-stealing were made from a blind built on the shingle bank and overlooking the major part of the ternery. These records were taken during periods of one or more hours during which the ternery was undisturbed by men, commencing 15 minutes after the last such disturbance. Observations made during many further interrupted hours, while not conforming to the above criteria, do not contradict the findings. The data analyzed below are for 46 hours of observation distributed through the period 21 June to 10 July.

EGGS

Even during the first visit to the ternery on 17 June young chicks were numerous, but at all times the ternery contained deserted eggs and many clutches being incubated, though these latter decreased in numbers as the days passed. I never found eggs broken in a nest in a manner suggesting that gulls had broken and then eaten them, nor did I find evidence that eggs had disappeared as would happen if gulls swallowed them. Laughing Gulls quite often landed in the midst of the ternery and quickly seized and swallowed something that was sometimes certainly, and possibly always, a fish. No large gull was seen to eat anything in the ternery other than apparently live chicks. Why the gulls do not avail themselves of the ready supply of eggs is not clear; perhaps late in the season the probability of striking a watery rotten egg is so great they prefer the more certain rewards of live chicks or fresh fish, although it is not known even if gulls prefer fresh eggs to rotten ones.

CHICKS

Quite frequently a single Herring or Great Black-backed Gull flew over the ternery. If it flew high, more than about 20 m above the ground, the

terns usually ignored it and such a flight is referred to below as an "over-flight." If lower than that, the gull was mobbed by a group of terns. These flights are called "hunting flights" because the intruder seemed always to be seeking a chick unless fleeing from terns that sometimes attacked so vigorously that they pulled or knocked out feathers. Once a chick was caught it was either gulped down on the spot, swallowed in flight, or carried away to the fringe of the ternery and there swallowed. I never saw nor did others report gulls eating eggs or dead chicks. The terns' attentions slackened once a gull landed; indeed the terns concentrated their attacks, possibly to their best advantage, on the hunting gulls. I felt that the predation may have involved only a few gulls, because the intervals between flights were not inconsistent with the movements of small numbers of gulls hunting fairly regularly. Such an interpretation agrees with the specialized feeding habits of individual gulls reported by Harris (1965).

The most successful gulls were those that flew in low and fast over the shingle bank to drop quickly and without warning upon a chick before it had time to hide in the long grass. The attacks by the adult terns on the gulls not only warned the chicks, but also distracted the intruders and sometimes drove them away. Herring Gulls rarely succeeded in catching a chick once the mobbing started, but some gulls, especially the Black-backs, were persistent and successful. The Laughing Gulls occasionally joined in the pursuit of a large gull. Possibly one of the most important effects of the attacks is to minimize the number of gulls that develop the habit of feeding in the ternery.

Chicks were taken throughout the day, though more frequently in the early morning and evening. No correlation with the state of the tide was evident, but the data available are insufficient for a rigorous test. I once saw a Great Black-backed Gull catch a young tern that was flying above the sea.

Table 1 shows the mean number of overflights, unsuccessful and successful low-level hunting flights, and the total chicks caught (i.e. the sum of the successful flights for both species). The predation rate in June was about 2 chicks/hour. In July it decreased to 1.25 chicks/hour. This represented, at least in part, a lower efficiency of the predators as measured by the ratio of successful flights to all flights. This may have been due to smaller numbers of chicks present, or because the older chicks hide more quickly. The Great Black-backed Gulls were more successful than the Herring Gulls in the early observations, and the reverse was true later. If chicks are considered to be available for 16 hours of each of 45 days (15 June to 30 July) and the upper and lower values of the predation rate are 1 and 2 chicks per hour, then the total number of chicks taken

TABLE 1
FLIGHTS BY PREDATORY GULLS OVER TERNERY¹

Dates Hours of recording	21-25 June 23	26-30 June 9	1-5 July 10	6-10 July 4
Great Black-back Gull				
Successful, ² S ₁	1.13 (3)	1.00 (5)	0.4 (2)	0.50 (1)
Unsuccessful, U ₁	1.35 (7)	1.22 (7)	1.4 (4.5)	1.75 (4)
Overflights, ³ O ₁	0.26 (1)	0.33 (1)	0.6 (3)	0.50 (1)
Herring Gull				
Successful, S ₂	0.78 (5)	1.11 (3)	0.8 (2)	0.75 (2)
Unsuccessful, U ₂	1.04 (4)	1.44 (3)	1.2 (5)	0.75 (2)
Overflights, O ₂	0.26 (2)	0.89 (1.5)	0.6 (3)	0
Number of chicks taken/hour (S ₁ + S ₂) = S	1.91	2.11	1.20	1.25
Total flights/hour (O + U + S)	4.82	5.99	5.00	4.25
S/(O + U + S)	0.40	0.35	0.24	0.29
S/(U + S)	0.44	0.44	0.32	0.33

¹ Mean (and maximum) per hour of undisturbed observation. The minimum was 0 in every case.

² Chick captured and eaten.

³ 20 m or more above ground, see text.

during the season would be between 720 and 1,440. This predation represents the loss of 0.48-1.2 chicks per pair of terns per season.

FISH-STEALING

Extent of the cleptoparasitism.—For the first few days of observation (17-23 June) the interactions between the terns and Laughing Gulls were scarcely remarkable. It seemed then that their coexistence might be merely the consequence of similar nesting requirements, or possibly of mutual defense against predation by the larger gulls. During this time (and also later) the terns abandoned fish on the ground, often those that were too large for the chicks to swallow, and the Laughing Gulls ate these fish. Gulls were also seen foraging at sea and feeding on fish offal near the mainland. At any time of day many terns could be seen coming to the island with fish; most of these flew directly towards their nests but some, presumably unmated males, flew above the nesting area carrying a fish. Many unladen terns and a few Laughing Gulls also flew over the ternery constantly. It was quite common to see one tern pursue another and steal its fish, and a few Laughing Gulls also chased terns carrying fish. These chases by gulls only became noticeable about 24 June, but they became increasingly frequent thereafter. Once a gull started to pursue a laden tern it was usually joined within moments by other gulls and the chase continued for seconds or even for up to 3 minutes until the pursuers abandoned it, the tern dropped its fish, or the fish was seized from the tern's bill. The nature of this group pursuit is considered further below.

From 24 June to 10 July chases were recorded during the same un-

TABLE 2
CHASES OF TERNS BY LAUGHING GULLS¹

Date	Chases known to be successful	Total chases ²
Before 24 June	Very few	Very few
24 June to 1 July	0.83 (0.5–2.0)	2.25 (1.67–6.0)
2–10 July	6.45 (4.5–10.0)	9.8 (6.75–16.0)

¹ Mean number (and range) per hour of undisturbed observation.

² Successful, unsuccessful, and unknown.

disturbed periods as for records of predation by the large gulls. Whenever possible the outcome (i.e. whether a gull was successful or unsuccessful in attempts to acquire the fish) and the number of gulls involved were also noted. The mean number of chases per hour (and the range) are shown in Table 2. Some records were incomplete, so that distinguishing all the unsuccessful chases from those with unknown outcome is not possible. In the complete records these occur in approximately equal numbers. The increase in the intensity of cleptoparasitism after about 24 June may be explicable in terms of failure of other sources of food, or increase in opportunities presented by the terns. It is more probably related to the number of gull chicks to be fed. My visits to the gull nesting area were irregular and neither standardized nor exhaustive, but the numbers of chicks seen were as follows: 17 June, none; 25 June, two nests with very young chicks; 2 July, 5 of 15 nests no longer had eggs, one nest with chicks; 9 July, many nests now empty, chicks probably hiding in the grass, only four were caught and banded (7 seen).

Group chases.—A single Laughing Gull chasing a tern was often unsuccessful, but groups of gulls were generally much more successful. Such a group, which often formed within seconds, was frequently strung out in a line behind the dodging and zigzagging tern, and while the tern often outmaneuvered the leading gulls, one of the followers cut across a corner, intercepted the tern, and either seized the fish or made the tern drop it. Terns with fish were always present, but the Laughing Gulls were not continuously chasing them. We saw no obvious signs that the gulls awaited the arrival of a tern carrying a particularly large or inviting fish, rather the gulls seemed to be more responsive to another gull chasing a tern than to a tern with a fish. The terns carried only one fish at a time, which was usually stolen intact, so it was unusual for more than one gull to benefit directly from any chase.

The numbers of gulls involved in all observed chases where the outcome was known (i.e. not limited to those in the observation periods) are shown in Figure 1. As group size increased, the probability of success for an in-

	Number of gulls								
	1	2	3	4	5	6	7	8	
Successful	5	15	15	13	12	5	2	1	68
Unsuccessful	6	4	2	4	2	1	0	0	19
Total chases	11	19	17	17	14	6	2	1	87

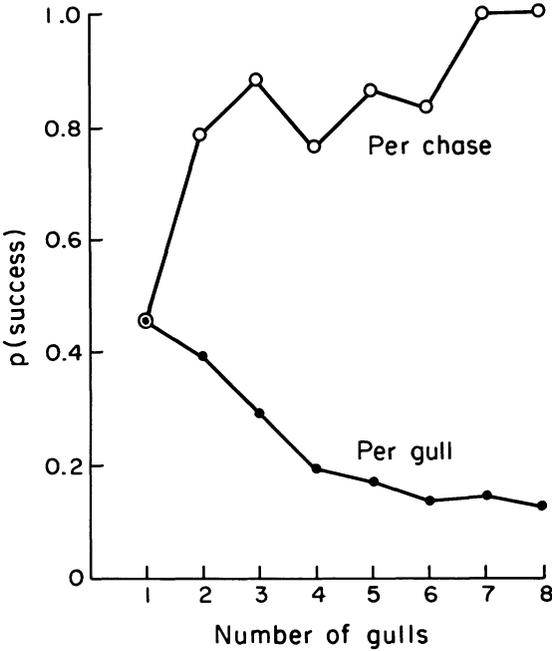


Figure 1. Number of chases of terns by Laughing Gulls in groups of different sizes (upper rows of figures), and the probabilities of success of the chases deduced from these figures (graphs).

dividual gull fell progressively from 0.45 (for a singleton), although the probability of *some* gull's succeeding rapidly approached 1 (Figure 1). This suggests that a gull's best policy is to hunt alone, but because unsuccessful chases by singletons are not conspicuous and are therefore the chases most likely to have been overlooked, there may actually be an advantage in fish per gull for groups of two. On the other hand group chases were often of shorter duration than chases by singletons, and gulls joining a chase often succeeded in getting the fish (the original gull and tern perhaps being tired), which suggests that it may be more economical in energy expended per fish seized for a gull to join a small group than to chase alone. Likewise for a gull to start a chase if other potential

chasers are nearby would be disadvantageous. A proper evaluation of gull tactics must await more detailed information about the chases, including their duration and the activities of each individual gull in relation to the others.

DISCUSSION

Effects of human disturbance.—The presence of persons near the ternery is important not only for its possible effects on the particular observations reported here, but also for the longer-term effects of the continual presence of people upon the nesting of the gulls and the terns. In the course of their daily duties the Coast Guard personnel restrict most of their activities to a small part of the island, and their presence there means that the terns and Laughing Gulls nesting nearby are partly habituated to humans, which is convenient for observers.

The Laughing Gulls seemed to be affected very little by the presence of people, except when close to their nesting area. They seemed not to take advantage of the disturbance among the terns occasioned by persons moving through or round the ternery, nor were they discouraged by it, for they occasionally chased terns at such times. The large gulls, on the other hand, were much more wary and our presence in the ternery may have altered the pattern of their predatory activities, although not in any very obvious way. The gulls did not fly in to seize chicks, for example; indeed their approach seemed to be inhibited, so the effects of disturbance were unlike those at other colonies where a great increase in predation is alleged to occur. The observations of the rates of chick predation may be too high if the gulls confined their activities to undisturbed times, but such an error is probably more than compensated by the instances of predation that were not seen for many reasons, including fog and the topography of the island. By similar reasoning the observed rates of chasing by the Laughing Gulls are minimal for the periods of observation.

At present the Coast Guard Station is manned continuously by two or three men. It is planned to convert the light to automatic operation, in which case the island will be uninhabited and visited only infrequently. The wariness of the Herring Gulls and Great Black-backs suggests that they nest only on Green Island because of the Coast Guardsmen's presence on Petit Manan. That Herring Gulls can nest on Petit Manan is shown by the solitary pair that hatched two chicks. Perhaps more would nest there if they were not disturbed during the early stages of nesting; they return to coastal nesting areas in late February and early March (Palmer, 1949). The terns arrive each year in mid-May (Hawksley, 1957) and are probably unable to discourage established large gulls. Thus the future

for the terns on Petit Manan Island includes not only predation by the gulls but also direct competition for nesting sites.

Eggs.—Although no observations were made before hatching started, the apparent absence of egg predation is rather unusual, for it is a widespread habit in both Laughing and Herring Gulls. For example Bent's (1921) statement that Laughing Gulls destroy many eggs of Royal Terns (*Thalasseus maximus*) is confirmed by P. A. Buckley (pers. comm.) for the colony on Fisherman's Island, Virginia. Ansingh et al. (1960) suggest that in 1958 Laughing Gulls destroyed up to 10 per cent of the eggs laid in a colony of Cayenne Terns (*Sterna sandvicensis*) in Curaçao. Bent (1921) was told that the Laughing Gulls did not molest the Common and Roseate Terns with which they nested at that time on Muskeget Island, Massachusetts. Apparently the prevalence of egg-robbing by Laughing Gulls varies from colony to colony, and possibly from year to year. A similar situation is true for the Herring Gull in northwestern Europe (Tinbergen, 1953).

Chick predation.—In the nearby tern colony on Machias Seal Island, Hawksley (1957) found that the mean clutch size of Arctic Terns was 1.4 but that fledging success was only 0.48 chicks per pair. On the island of Wangeroog, one of the Friesian islands in the North Sea, Boecker (1967) observed the mean clutch size to be 1.95 and he calculated fledging success to be 0.5 in 1963 and 0.6 in 1964 (but zero in 1962 due to storm tides). In both studies predation was not extensive and the majority of deaths occurred during the first few days after hatching, when the chicks are particularly susceptible to cold, wet, and starvation. On Petit Manan Island the predation by the gulls is not limited to the very young chicks—those most likely to die from other causes anyway—but includes many chicks that are sturdy and well-grown. Thus the predation calculated from my data of 0.48–1.2 chicks per pair of terns per season may lower the fledging success to well below the level required to maintain the tern colony at its present size. Very little is known of the numbers of the gulls and terns that have nested on Petit Manan and Green Islands in past years, but the large gulls probably started nesting there about 10 or 15 years ago (Kadlec and Drury, 1968; Drury, pers. comm.). So the predation is a new cause of mortality.

Within some gull colonies adult gulls take gull chicks at an even higher rate than tern chicks in this tern colony; Brown (1967) found that "cannibalism" was the chief cause of death and it probably resulted in the loss of almost two chicks per pair in a mixed colony of Herring and Lesser Black-backed Gulls (*L. fuscus*). In the Ravenglass Gullery in England, Kruuk (1964) found that the three or four pairs of resident large gulls (Herring and Lesser Black-backed) were active and specialist predators

on the chicks (and also the eggs) of the Black-headed Gulls (*L. ridibundus*). Of the 95 hunting flights that he observed, 31 were successful (22 chicks and 9 eggs) and two were unknown. He remarks that this was only a small fraction of the predation by the large gulls which seemed to live practically exclusively on eggs and chicks, but there were so few of them that they did not make a large impact upon the Black-headed Gulls. The success-ratio for the hunting attempts was rather lower in the Raven-glass colony than for the gulls taking tern chicks on Petit Manan Island ($S/(U + S)$ in Table 1).

In August 1957, Burton and Thurston (1959) watched gull predation of chicks at a colony of 600 Arctic Terns in Spitsbergen. They saw hunting flights by Glaucous Gulls (*Larus hyperboreus*) about twice each hour, but only three or four per day were seen to be successful. Yet they found remains of tern chicks in the stomachs of 9 of the 12 gulls that they examined. To reconcile these observations they suggest that the gulls were specialists and took chicks from several tern colonies nearby, and that their sample was nonrandom.

Cleptoparasitism.—The observed loss of fish to the Laughing Gulls probably had only small effects on the tern colony as a whole because there were relatively few gulls. Boecker (1967) reports that Arctic Terns brought food to the nest at a rate of 0.25–3 visits per hour per pair; the rate of feeding is likely to be similar at all colonies, so that on Petit Manan the number of incoming terns with fish far exceeded the needs of the few Laughing Gulls. But when fishing conditions are bad, the loss of just one feeding might be critical for a young tern. On the other hand, for the Laughing Gulls the piracy was an important source of food: 10 fish per hour represents 1 fish per gull nest every 2 hours, although as the gulls are likely to specialize in feeding methods, the booty would not be distributed evenly in this way.

Cleptoparasitism is not uncommon among seabirds (Meinertzhagen, 1959), indeed the jaegers (*Stercorariidae*) and frigate birds (*Fregatidae*) are well-known as pirates, and it has often been reported as a facultative habit among gulls (*Laridae*). Herring Gulls sometimes parasitize puffins (*Fratercula arctica*) (Lockley, 1953), and Black-headed Gulls are known to steal food from ducks (Meinertzhagen, 1959) and also terns (chiefly *S. sandvicensis* and *hirundo*) in the Netherlands (Rooth, 1958). Of the few references to this habit in Laughing Gulls, Bent (1921: 160) mentions them stealing from pelicans (*Pelecanus occidentalis*), and in Curaçao they take fish from Cayenne Terns (Ansingh et al., 1960). It certainly was not an obtrusive habit in 1962 and 1963 on Gull Island in Pamlico Sound, North Carolina, where Laughing Gulls nested with small numbers of Forster's Terns (*S. forsteri*) (J. P. Hailman, pers. comm.).

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SUMMARY

Increasing populations of gulls threaten nesting terns. From 17 June to 13 July 1968 *Larus argentatus* and *L. marinus* ate live chicks but apparently no dead chicks or eggs from the colony of about 1,200–1,500 pairs of *Sterna paradisaea* and *S. hirundo* on Petit Manan Island, Maine. The annual toll may be as high as 0.48–1.2 chicks per pair of terns; in *paradisaea* colonies with little predation mean clutch size is rather less than two, and fledging success about 0.5 chicks per pair.

The terns also suffered cleptoparasitism by about 20 pairs of *Larus atricilla* breeding in their midst; these gulls often formed groups when chasing a tern, and larger groups were more successful (in fish per chase, but not fish per gull per chase) than smaller groups. A great increase in chasing coincided with hatching of the gulls' eggs, and the stolen fish formed an important part of the gulls' food.

At present the large gulls do not nest on the same island as the terns, but on the nearby Green Island. This may be due to the continual presence of Coast Guard personnel upon Petit Manan Island.

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