RELATION OF EIDERS AND GULLS NESTING IN MIXED COLONIES IN PENOBSCOT BAY, MAINE[1]

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THE Great Black-backed Gull (*Larus marinus*), the Herring Gull (*Larus argentatus*), and the Common Eider (*Somateria mollissima dresseri*) have increased markedly in numbers along the Atlantic coast, including Maine, since early in the 20th century (Gross 1944, 1945, Peakall 1967, Mendall 1968, Kadlec and Drury 1968). During the past three decades eider ducks have become increasingly important in Maine from both hunting and aesthetic standpoints (Mendall 1968).

Both of the gull species and the eider share to a large degree the same breeding range in northeastern North America. They nest mostly on marine coastal islands, often in mixed colonies. All known eider colonies in Maine are on islands where gulls also nest (Mendall, in litt.). That gulls prey on eider eggs and young is well-established, and two recent studies of the Maine Cooperative Wildlife Research Unit (Choate 1966, Clark 1968) showed egg predation to be the main factor limiting eider nesting success. I studied the interrelationships between gulls and eiders nesting in mixed colonies in Penobscot Bay, Maine, during the spring and summer of 1969 (Bourget 1970).

Some of the principal findings of the latter study are discussed in the present paper. Specific objectives are to point out: (1) which species of gull (when both occur with eiders) is the more serious predator of eider eggs, (2) under what conditions may predator pressure shift by species during the season, and (3) what are the predatory effects of resident vs. nonresident gulls upon eggs and young of eiders and other birds nesting in mixed colonies.

STUDY AREA AND METHODS

The study area was four islands southwest of Islesboro Island in Penobscot Bay, the largest inlet along the Maine coast, chosen mainly because of accessibility, differences in size and in ratios of breeding species, and because of information available from previous studies. These islands are somewhat elongated in shape and steep sided. Linear distances between them vary from about 1–3 miles. Goose Island and Mouse Island are rather flat, while East Goose Rock and Robinson Rock are more rugged. All four lack woody vegetation but are covered by herbs and miscellaneous grasses (For a more detailed description, see Choate 1966, Clark 1968, Bourget 1970).

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In addition to the gulls and eiders, the Double-crested Cormorant (*Phalacrocorax auritus*) and the Black Guillemot (*Cepphus grylle*) nested on the study islands.

I visited the islands at regular intervals, weather permitting, throughout the eider's nesting period, and spent a total of 175 hours studying bird display and behavior from a portable blind on one of the islands or adjacent ledges and from a permanent blind on Mouse Island. I recorded on tape 373 conflicts between all species breeding on the islands and later transcribed these on data sheets.

I searched for new eider and gull nests and checked nests previously located at about 10-day intervals. I believe I recorded between ⅓ and ½ of all probable nesting attempts of the three species, which I marked and followed until their fate was determined. I marked nests with numbered wooden stakes and assigned a color to each species. I took a sample of eggs of each species at varying stages of incubation from nests with known initiation dates to establish a collection of known-aged embryos for later reference in deriving chronology tables.

I determined clutch initiation dates for eider nests from the date of hatching and/or the day the clutch was completed, and at times by comparing the embryo from one egg of each clutch with the known-aged embryo samples. Cooch's (1965) assumption that female eiders lay one egg per day under normal weather conditions, and an incubation period of 26 days as found by Choate (1966) and later confirmed by Guignion (1967, 1968), were used to draw nesting chronology charts for this species. I determined nest fate by Girard's (1939) method of looking at the separation of the shell lining from the shell, with either hatched or destroyed as the recorded fate. A nest was considered successful if at least one egg hatched.

When nests of Herring Gulls and Black-backed Gulls could not be identified by direct observation of the attendant birds, the species was identified by egg measurements as given by Bent (1921) and by the general nest location as described later. I assumed the incubation period for the Herring Gull to be 30 days (Tinbergen 1953) and that for the Black-backed Gull 29 days as found by Clark (1968) for eight clutches. I assumed that 48 hours elapsed between the laying of two successive eggs as reported by Tinbergen (1953), also that in both gull species, effective incubation did not start until the complete clutch was laid (Harris 1964).

RESULTS AND DISCUSSION

Gulls have been found to be important predators on both eggs and young of numerous species of ducks other than eiders (Reed 1964, Vermeer 1968, and others). Gull behavior and activity have been reported to change as the breeding cycle progresses (Tinbergen 1953), and female eiders become more attentive toward their nests as the season progresses. Such changes in the breeding behavior of each species throughout the season suggest that differences in gull predation rates could be expected.

Relation to breeding chronology of the species.—The rate of predation by gulls on eggs and young of other species was related to the breeding cycles of both gull species and of the eider duck. Figure 1 shows the chronology of nesting, behavior, and predatory activities of the Black-backed Gull. This large gull tended to behave aggressively through most of the breeding season. There was no high level of aggressiveness

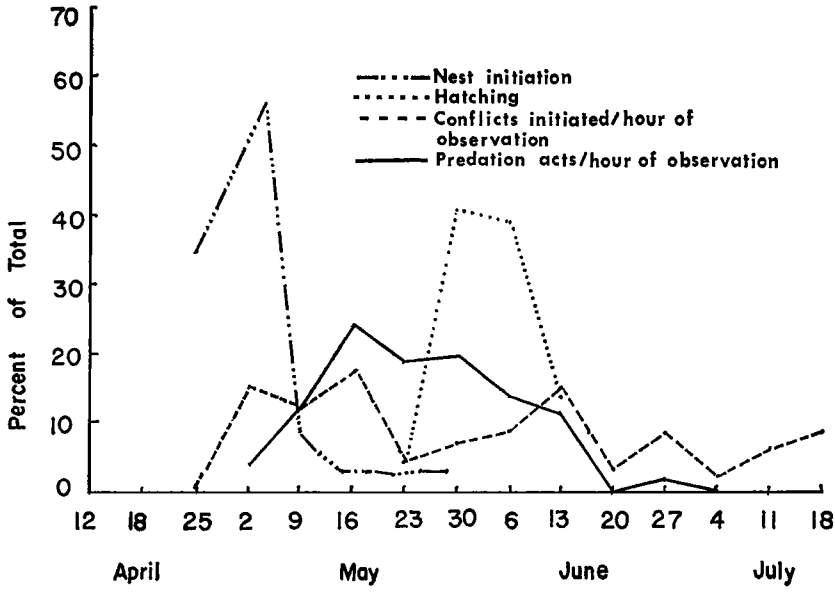

Figure 1. Black-backed Gull nesting, behavior, and predation.

and its predatory activities were distributed over a 6-week period, though it did take a heavier toll of other birds' eggs during the last half of its incubation and at hatching time of its own eggs. During incubation the nonincubating member of a pair tended to roam around more often and had more opportunities to find unattended eider nests than after the young gulls hatched. Then the adults alternated in trips away from the island to obtain food, leaving the other mate to guard the chicks on territory. Parental attachment to their chicks seemed to lessen the gulls' predatory activities.

The Herring Gull was less aggressive than the Black-backed Gull throughout the breeding season as a whole, but showed a sharp peak of aggressiveness at the height of its laying period, which coincided with its highest number of observed predatory acts performed on other species' eggs (Figure 2). Also a second period of high aggressiveness started when its own young were hatching. At this time most Herring Gull attacks were directed toward trespassing young gulls, which initiated conflicts among adults of that species. During this second period of high aggressiveness, most of the eiders had already hatched their clutches and the eider colony as a whole suffered little adverse effect. This is based, of course, on the pattern of chronology that existed in 1969.

McLaughlin (1967) briefly studied the interrelationships between

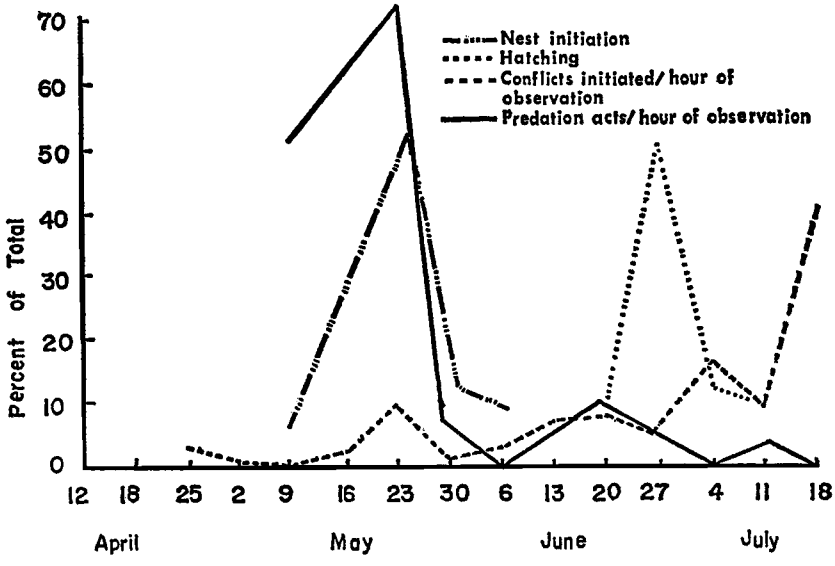

Figure 2. Herring Gull nesting, behavior, and predation.

gulls and eiders breeding on some of these same islands in Maine. He made a limited number of observations that started with the beginning of Herring Gull nesting. He noted that both gull species showed peaks in predatory activities shortly before their eggs hatched. Tinbergen (1953) stated that aggressive behavior in the Herring Gull increased and reached a peak prior to hatching, but neither McLaughlin (1967) nor Tinbergen (1953) reported a peak of aggressiveness at the start of nesting, which I found so marked in the present study.

During observations from the blind the eider duck, like the gulls, showed behavior differences as the season progressed. I found two peaks of aggressiveness, one at nest initiation time, and one at hatching (Figure 3). Aggressive behavior by female eiders consisted of threatening movements alternated with chin-lifting, the latter often accompanied by "gog-gog" calling (McKinney 1961). Early in the breeding season aggressiveness by females was directed toward gulls and other eiders mainly while returning to their nests to lay or incubate and also when selecting nest sites. As hatching time approached female eiders became even more aggressive than earlier in the season. Periodically they walked a few feet away from their nests to sit on ledges, where they often provoked encounters with other eiders or with gulls. Occasionally when the eiders were returning to their nests after I entered the blind, I even saw them chasing Black-backed Gulls with young from their own territories.

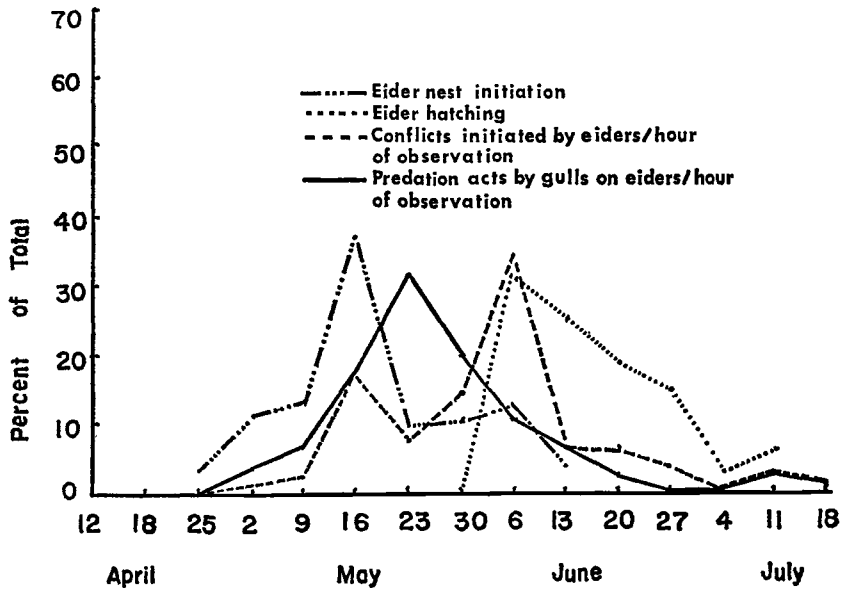

Figure 3. Relationships between eider nesting chronology, aggressive behavior, and nest losses by predation.

Predation on eider nests was higher in the early stage of this bird's breeding cycle (Figure 3). This is partly dependent upon the availability of eggs in unguarded nests, resulting from frequent absences of the females during laying and the first few days of incubation, as Cooch (1965) and Clark (1968) pointed out. During the present study the height of egg losses by eiders occurred a week after their nest initiation peak. I believe this resulted largely from the concurrent increased predatory activities of the Herring Gull that corresponded with the peak of its own nest initiation. Other nest losses at this time were due to Black-backed Gulls as already mentioned.

Previous workers also found that the extent of eider nest losses varied throughout the breeding season. Lewis (1939) noted that predation decreased as the season progressed, while Choate (1966, 1967) reported the reverse. Paynter (1951) found no significant difference in hatching success between early and late eider nests, but Guignion (1967) mentioned that eider nests started at nest initiation peak had a higher success than those initiated earlier or later than this peak. Thus it is apparent that dissimilar patterns of predation have been observed, which I believe the varying nesting chronologies of the gulls and eiders may explain in part.

TABLE 1
GULL PREDATION RATE AND EIDER NESTING SUCCESS AS RELATED TO GULL SPECIES COMPOSITION BY ISLAND

	Mouse Island	Robinson Rock
Nb. BB[1] (pairs)	45	17
Nb. H (pairs)	45	110
H:BB ratio	1.00:1	6.47:1
Number of predations by BB/hour	2.48 (24)[2]	0.77 (6)
Number of predations by H/hour	0.24 (2)	1.65 (12)
Total number of predations by gulls/hour	2.72 (26)	2.42 (18)
Number of predations on eider nests/hour	2.13 (20)	2.19 (16)
Eider nesting success in vegetation (%)	45.5	22.5

[1] Key: H = Herring Gull, BB = Black-backed Gull.
[2] Figures in parentheses represent total number of predations.

Influence of gull species composition.—On the study islands both gull species composition and eider nesting success varied. In the sample of marked eider nests, success decreased as the ratio of Herring Gulls over Black-backed Gulls increased. Although this might suggest that Herring Gulls are more detrimental to eiders than Black-backed Gulls, it shows only the proportion of successful nests and not the nests destroyed by each species of gull.

Table 1 compares my records of predatory activities by both gulls between the two islands that were studied most intensely. The distribution of birds on the islands had an important role on the predation rate by the two gull species. Mouse Island, which has a rather regular topography, also has extensive stands of dense vegetation used by eiders, but avoided by gulls. Although both the Herring Gull and the Black-backed Gull nesting populations were equal, about 25% more individual Black-backs than Herring Gulls were under observation from the blind, and the number of Black-backed Gull predations per hour of observation was almost ten times that of the Herring Gulls (Table 1). My frequent presence at the start of nesting apparently delayed the Herring Gull breeding cycle. Also the Herring Gulls were displaced toward the edge of the colony by the more powerful and dominant Black-backs that had already established their territories before the Herring Gulls started nesting. On Mouse Island the Black-backs nested nearer to the eiders than Herring Gulls did. Thus eiders were more likely to be preyed upon by the Black-backs occupying the central portion of the island than by the evicted Herring Gulls.

On Robinson Rock the nests of both the gull species and eiders were

TABLE 2
SUMMARY OF OBSERVED PREDATIONS BY BLACK-BACKED AND HERRING GULLS

Number and species of predator		Number and species of prey related to each predator		
		Number of nests/species	Number of eggs destroyed	Number of young killed
BB:40[1]	BB:	5	3	3
	H:	0	0	0
	E:	33	37	0
	C:	2	12	0
Subtotal = 40		40	52	3
H:17	BB:	0	0	0
	H:	2	2	0
	E:	14	14	1
	C:	1	2	0
Subtotal = 17		17	18	1
Grand total = 57[2]		57	70	4

[1] Key: BB = Black-backed Gull, H = Herring Gull, E = Eider Duck, C = Double-crested Cormorant.
[2] Total number of predatory acts observed.

more intermingled because of its rugged topography. The predation rates for the Herring and the Black-backed Gulls were respectively 1.65 and 0.77 predatory acts per hour of observation (Table 1). Although eider nests were built under artificial shelters and in the vegetation, only the latter nests were analyzed for gull predation. The higher predation rate of the Herring Gull was probably related to the fact that about four times as many Herring Gulls were under surveillance than Black-backs on Robinson Rock, and also that observations began around the Herring Gull nest initiation peak, the period when most of its depredations occurred. This was related to the high intensity of aggressiveness at this stage of its breeding cycle. It also seems noteworthy that although Robinson Rock supported six times as many Herring Gulls as Black-backs, the Herring Gull depredations were only a little more than twice those of the Black-backs. That the Black-backed Gull is more predatory than the Herring Gull is shown by the fact that they performed 70.2% of all predatory acts observed on all islands, although they represented only 37.4% of all the pairs under surveillance.

Effect of partial predation.—Partial predation is the removal of one or more eggs, but not the whole clutch, by a predator at a particular time. In a sample of 196 eider nests whose fate was determined, 18.4% suffered partial predation. Of these, 36.1% were successful compared

TABLE 3
FATE OF EGGS AND YOUNG TAKEN BY GULLS

	Eaten on the spot	Carried to territory	Carried to club[1]
Number	36	18	20
Percentage	48.7	24.3	27.0

[1] Tinbergen (1953) considers a club a part of the colony where flocks of gulls gather throughout the breeding season. It is considered here also as a relatively neutral area of a nesting island where no territories are defended, although birds may attack each other.

to the 49.9% hatching success in the group of nests without partial predation. While these data suggest that a greater proportion of nests were successful when no partial predation occurred, the difference is not statistically significant ($P > 0.05$). It seemed to me that a nest once visited by a gull, unless completely destroyed, was more likely to be revisited and thus had less chance to succeed. In 17.5% of the gull depredations, the same location was revisited by either the same or neighboring gulls.

Choate (1966, 1967) was apparently the only previous worker to give quantitative data on the effect of partial predation upon eider nesting success. His records over a 2-year period showed the same trend, with a significantly higher nesting success in nests without partial predation during the first year of his study.

Effect of predator social status and behavior.—Gulls preyed most often on the eider duck nests, but they also preyed on each other's and those of the Double-crested Cormorants (Table 2). I noted that when a nest was robbed, usually only one egg and/or young was stolen at a time. Very often after an initial predation, the same predator or other gulls visited that nest or neighboring nests. I believe this behavior is motivated by the sight of potential food that encourages the gulls to wander; in 64% of these instances, the visit was made by birds other than the one that initiated predation.

In 33% of the cases of predation, pursuits and fights ensued over the stolen food. Although I observed a limited number of predatory acts, I feel that such aggressiveness between gulls over eggs or young of the eider may prevent further acts of predation. Aggressiveness between predators was also reported by Kruuk (1964), who felt that aggression between predatory gulls and Carrion Crows (*Corvus corone*) was a significant feature of the reproduction success of the Black-headed Gull (*Larus ridibundus*).

The behavior of gulls before, during, and after a predatory act gave a clue for estimating the rate of destruction by resident and nonresident gulls in the colonies. I divided the fate of eggs and young taken by

gulls into three categories (Table 3). Most of the gulls that ate their prey on the spot or carried it to their territories were birds that had a nest in the vicinity; 27% of the preyed items were taken by birds foreign to that section of the colony. Most of the stranger gulls carried their catch to the beach, which was used as a club and was strewn with remnants of broken eggshells of different bird species. Both Kruuk (1964) and Tinbergen (1953) mentioned that predatory gulls usually ate the contents of the eggs on the spot, although at times they carried eggs or young whole to the territory. I found that most predation by individual alien Herring Gulls occurred at nest initiation time, when aggressiveness in this species was at its peak; the Black-backed Gulls showed no pronounced tendencies in this regard.

The influence of foreign predators in an eider colony varies much from island to island, and depends on several factors such as resident gull density, island size, and topography, cover, and distribution (Choate 1966, Guignion 1967, Clark 1968, Bourget 1970). Thus it is hard to imagine how a distant gull may prey among active territories unless there are clubs scattered through the colony from which birds can infiltrate the surrounding nesting cover. I suggest that the effects of distant predators in the present study might have been greater on eider production if resident gulls had not been present to prevent, through visual stimuli, the arrival of such predators; also to chase away those initiating predatory acts. In eastern Canada, Reed (1968) noted that gulls allowed Black Ducks (*Anas rubripes*) to nest within their territories and he suggested that they protected the latter against egg-hunting gulls and crows while defending their own territories. In Finland, Olsson (1951) reported that on islands with nesting gull populations (*Larus marinus* and *Larus argentatus*), the percentage of eider nests destroyed by Hooded Crows (*Corvus cornix*) was less than on islands where gulls were absent. This led Olsson to believe that it was advantageous for eider ducks to live in joint habitation with gulls.

Conclusions

The breeding chronologies of the Herring Gull, the Black-backed Gull, and the Common Eider, individually or collectively, vary from year to year. If peaks of aggressiveness in gulls coincide with periods of greatest vulnerability of eiders, heavy nest losses may be expected. When such synchronization does not occur, losses will be much less and eider production will be correspondingly higher. Once the periods in the eider's breeding cycle of greater susceptibility to predation are passed, females seem able to defend their nests successfully against pugnacious

gulls, although they do not always do so. Similar viewpoints were expressed by Choate (1966), Guignion (1967), and Mendall (in litt.).

More than two-thirds of the eider eggs and young lost to predation were attributed to gulls nesting within the same general area, but I believe the rate of predation by foreign predators might have been higher had no gulls been nesting among the eiders. It seems likely that the mere presence of an individual gull incubating its eggs or the sight of a pair on territory may prevent potential predators from investigating and destroying other bird's eggs nearby. Koskimies (1957) suggested that nesting gulls afforded protection to ducks nesting in their vicinity, and believed that breeding within gull colonies had definite survival value for certain duck species. Whatever the ultimate factors may be that influence eiders in selecting breeding habitat, the presence of larids may be only incidental, because both ducks and gulls may find on the same island and the surrounding bodies of water the optimum conditions for nesting and raising their young.

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SUMMARY

Predation by Herring Gulls and Black-backed Gulls was the major factor of egg losses among Common Eiders breeding on four islands studied along the Maine coast. Eider nesting success varied on each island, and this was primarily related to differences in gull predation rates that in turn were affected by several ecological factors.

Predation rates by both gull species were related to the chronology of their breeding cycles, as well as to that of the eider. The Black-backed Gull, although less numerous than the Herring Gull on the study area, was more predatory than the latter on eider eggs and young. This was partly due to the fact that the early nesting Black-backed Gull spent at least 2 weeks more time on the nesting islands in association with the eiders than did the Herring Gull. As this additional time occurred in the early stages of the eider breeding cycle, it was an added factor in the more adverse effect of pred ion attributed to the Black-backed Gull.

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