Gull Predation and Breeding Success of Common Eiders on Stratton Island, Maine

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Abstract.—Common Eider (*Somateria mollissima dresseri*) breeding success and gull-eider interactions were studied at Stratton Island, Maine in 2004 and 2005. Eiders suffered little nest predation, and most egg losses to gulls were either facilitated by researcher intrusions or confined to newly initiated, unattended nests. Despite high nest success (>80%) in both study years, predation watches indicated that few, if any, ducklings survived to fledging as a result of extreme harassment and predation by Great Black-backed Gulls (*Larus marinus*). Gull attacks were opportunistic, involved one to 36 gulls, and often resulted in complete crèche destruction. Herring Gulls (*L. argentatus*) also took occasional young and eggs. Although Stratton Island is managed as a tern restoration site, and gull control measures to enhance tern productivity include nest destruction and shooting of tern predators, gulls continued to congregate around crèching areas and to prey on ducklings. We suggest that additional gull control measures, particularly at a nearby gull colony, may enhance duckling survival. We also recommend monitoring of other eider colonies in the region to better assess duckling survival and recruitment rates. *Received 13 January 2007, Accepted 1 January 2008.*

Key words.—Common Eider, Great Black-backed Gull, Gulf of Maine, gull predation, Herring Gull, *Larus argentatus*, *Larus marinus*, nest success, *Somateria mollissima dresseri*.

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Common Eiders (*Somateria mollissima dresseri*) nest in mixed colonies with Herring (*Larus argentatus*) and Great Black-backed (*L. marinus*) gulls on marine islands throughout much of their breeding range in northeastern North America (Bourget 1973). While large gulls are well-known predators of eider eggs and ducklings (Ahlén and Andersson 1970; Bourget 1973; Milne and Reed 1974), nesting in association with aggressive gulls may provide protection from other nest-robbing avian predators (Young and Titman 1986; Swennen 1989). Whether the costs resulting from gull predation outweigh the benefits of nest protection varies considerably and may be influenced by human disturbance, alternative food sources available to gulls, weather, and the condition of eider young (Mendenhall and Milne 1985; Åhlund and Götmark 1989; Swennen 1989; Keller 1991). The adaptive significance of the gull-eider relationship remains unclear. Gull predation upon ducklings has been characterized, in its extremes, as both an "ecological trap" (Dwernychuk and Boag 1972) and a "sanitary removal of already moribund ducklings" (Swennen 1989).

Mawhinney and Diamond (1999) suggested that severe gull predation rates on ducklings at a New Brunswick colony might reflect the recent range expansion of the Great Black-backed Gull southward along the Atlantic coast. Like other *Larus* gulls, Herring and Great Black-backed gull populations grew dramatically in the last century, benefiting from increased amounts of garbage and fishery waste and reduced hunting pressure (reviewed in Mudge 1978; Pierotti and Good 1994; Good 1998). In New England, Great Black-backed Gull increases over the last 30 years have come at the expense of Herring Gulls (reviewed in Rome and Ellis 2004), presumably due to the larger size and aggressive behavior of Great Black-backed Gulls (Good 1998; Rome and Ellis 2004; Ellis and Good 2006). Despite the long lifespan and high survivorship of adult eiders (Krementz *et al.* 1996), the presence of a new, abundant predator could threaten the persistence of eider colonies subjected to low productivity year after year.

In the Gulf of Maine, many islands used by nesting eiders and large gulls are managed as tern restoration sites. Mawhinney

(1999) found that the number of eider ducklings surviving to fledging was higher in the Petit Manan/Green Island Archipelago, a tern restoration site where intensive gull control was practiced, than at the Wolves Archipelago, Bay of Fundy, where there was limited or no control. The removal of breeding gulls through shooting and poisoning at the former site appeared responsible for reduced depredation of ducklings. However, incidental reports suggest that eider productivity is poor at many other tern restoration sites employing similar gull control techniques (S. W. Kress, pers. comm.). While large numbers of downy young are often sighted early in the season, older ducklings (class II-III; Gollop and Marshall 1954) are seldom, if ever, seen. Since there has been little eider monitoring at these sites, it is unclear whether gull predation, brood movement, or some other factor is responsible for duckling disappearance. The objectives of this study were to investigate causes of duckling disappearance and to evaluate the impact of gull predation on the reproductive success of Common Eiders breeding on Stratton Island, a tern restoration site in southwestern Maine.

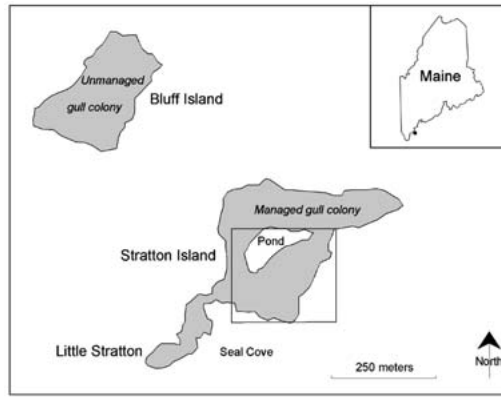

Figure 1. Map of Maine with detail showing Bluff Island, Stratton Island, and Little Stratton. Little Stratton is connected to Stratton Island at low tide. In 2004-2005, Bluff Island supported a large, unmanaged Herring and Great Black-backed gull colony, while gull control was practiced on Stratton Island and Little Stratton to enhance tern productivity (see text for details). Common Eiders nested at all three sites, and the rectangle delineates the nest-monitoring area from which nest success estimates were generated. Principal crèching areas (a freshwater pond and sheltered saltwater cove) used by eider hens and newly-hatched ducklings are also indicated.

METHODS

Study Area

The study was conducted from early May to late June, 2004-2005 on Stratton Island (43°31'N, 70°19'W), Saco Bay, Maine, USA. Stratton is located 2.4 km south of Prouts Neck (Fig. 1) and is owned and managed by the National Audubon Society. Several researchers occupy a seasonal field camp on the island from May to August. Stratton and Little Stratton (connected to Stratton at low tide) are approximately twelve ha and include diverse habitats: a small freshwater pond, a deciduous forest of apple (*Malus pumila*) and chokecherry (*Prunus virginiana*), shrub thickets of raspberry (*Rubus idaeus*) and rose (*Rosa rugosa*), meadows, dense stands of invasive Asiatic Bittersweet (*Celastrus orbiculata*), sumac (*Rhus typhina*) patches, and gravel and sand beaches. In addition to Common Eiders, a variety of seabirds (tern *Sterna* spp., Double-crested Cormorant *Phalacrocorax auritus*), wading birds (Great Egret *Ardea alba*, Snowy Egret *Egretta thula*, Black-crowned Night Heron *Nycticorax nycticorax*, Glossy Ibis *Plegadis falcinellus*) and waterfowl (*Anas* spp.) nest on the island.

Gull control measures to enhance tern productivity include destruction of Herring and Great Black-backed gull nests and shooting of gulls seen preying on tern eggs and chicks. In 2004, gull eggs and nests were removed in all but the eastern tip of Stratton Island, where eggs were wire-poked to prevent hatching but gulls were allowed to remain on their nesting territories. In 2005, gull eggs and nests were removed throughout the entire island. Although gulls do not breed on Stratton, Bluff Island is <400 m away and supports an active, unmanaged Herring and Great Black-backed gull colony (Fig. 1).

Eider and Gull Census

Stratton and Little Stratton were searched systematically in mid-late May, 2004-2005 to locate all Common Eider nests and to poke eggs and/or destroy nests of Herring and Great Black-backed gulls. Only nest cups with at least one egg and/or eggshells with yolk (indicating recent avian predation) were counted (Traylor *et al.* 2004).

Eider Nest Survival

A sample of eider nests (2004: N = 259, 2005: N = 191) was monitored to assess nest survival. These nests were located on the southern half of Stratton Island (Fig. 1); other parts of the island were avoided for fear of disturbing nesting wading birds and shorebirds. To facilitate relocation, GPS coordinates were recorded for each nest. Because eiders nested in high densities in some areas, it was also necessary to mark nests with numbered flags. Nests were checked every seven to ten d, though this interval was shortened near the predicted hatch date (Flint and Grand 1996). On the first visit, clutch size was recorded and one to two eggs were floated to predict hatching dates (Westerkov 1950) using a 28-d initiation and incubation period (Goudie *et al.* 2000). Whenever a hen was flushed from her nest, the exposed eggs were covered with nest material and down to reduce detection by predators (Götmark 1992). Following brood departure, nests were checked a final time to infer egg fates from nest contents. Depredated and unhatched eggs were subtracted from the total eggs laid to estimate the number of ducklings produced (Grand and Flint 1997). A nest was considered successful if at least one egg hatched, as indicated by the presence of egg membranes and/or ducklings.

To determine if habitat type influenced eider nest survival, nesting vegetation was characterized as 'forest', 'bittersweet', 'raspberry', 'rose', 'sumac', or 'other' for all nests monitored. After hatching or nest failure, percent vertical cover was also measured as the "average percentage of each of five 6.5-cm^2 squares on a cardboard disc that were occluded in the vertical plane when viewed from one m above the nest bowl" (Clark and Shutler 1999).

Gull-Eider Interactions

Gull predation was monitored from mid May to late June by observing crèches from a tower and blinds. All gull-eider interactions were recorded in 2-4 h watches. Crèching areas were observed for a total of 87 h in 2004 and 212 h in 2005. Interactions were classified as: 'fly-over'—gull flew over a crèche at low altitude (<10 m) with head/bill directed toward the crèche, 'successful attack'—one or more ducklings taken, 'unsuccessful attack'—gull lunged toward crèche but failed to capture a duckling, and 'harassment'—gull swam toward crèche and came within five m. For each event, the number and species of gulls involved, quantity of ducklings taken, and crèche size and composition were recorded. In 2005 only, the times when ducklings were present and number of ducklings observed during each watch were recorded to obtain an estimate of 'duckling minutes'; predation rates were calculated as the number of events per 200 duckling min (modified from Mendenhall and Milne 1985).

Brood Movement and Duckling Counts

To track brood movement, 120 hens (2004: N = 50, 2005: N = 70) were captured on the nest by hand or with a net as they flushed from the nest. Hens received unique color- and shape- coded nape tags and metal U.S. Geological Survey bands. Tags were made from colored vinyl hazard tape (Identi-Tape, Inc., Golden, Colorado) or cloth hockey tape (Inline Warehouse, San Luis Obispo, California) and attached to the nape feathers with superglue (design modified from C. Waltho, pers. comm.; Fig. 2). Attempts were made to re-sight marked hens daily, and re-sighting locations were plotted on an aerial photograph. The number and plumage class (Gollop and Marshall 1954; modified by Mawhinney 1999 to suit eiders) of accompanying young were also recorded. Daily duckling counts from high vantage points, combined with weekly boat trips around the island and to historical brood-rearing areas near the mainland, were used to estimate colony productivity.

Statistical Analyses

Factors influencing Common Eider nest survival were examined using Program MARK (White and Burnham 1999; Dinsmore *et al.* 2002). Because we were interested in nest mortality due to gull predation, abandoned nests (2004: N = 15, 2005: N = 19) were excluded from all analyses. Since nests found depredated cannot be used in estimates of nest survival based on the Mayfield method (Mayfield 1975), they too were excluded (2004: N = 33, 2005: N = 21). Following Dinsmore *et al.* (2002), candidate models based on the following *a priori* hypotheses were developed:

Figure 2. Common Eider hens were fitted with unique color- and shape-coded nape tags to allow identification and tracking on the water. Tags were made of vinyl or cloth tape and attached to the feathers with superglue (design modified from C. Waltho, pers. comm.).

1) *Habitat.* It was anticipated that nest survival would differ among habitat types. Of the three most common nesting habitats (bittersweet patches, raspberry thickets, and deciduous forest), it was predicted that survival of nests in bittersweet would be higher than in either raspberry or forest because the dense vines would limit nest detection and gull mobility.
2) *Temporal Variation within Season.* Linear and quadratic time trends were included to see if nest survival varied seasonally. It was reasoned that early- and/or late- nesters might suffer undue predation if predator swamping through breeding synchrony is important (Buckley and Buckley 1980; Wittenburger and Hunt 1985) or if vegetative growth provides increased nest concealment as the season advances (Klett and Johnson 1982).
3) *Daily Nest Age.* Since eiders rarely leave their nests after the onset of incubation (Goudie *et al.* 2000), it was expected nest survival would be lowest when nests were young and eggs were periodically unattended (Klett and Johnson 1982).
4) *Researcher Disturbance.* Nesting eiders are sensitive to human disturbance, particularly in the early stages of incubation (Bolduc 1998). Upon the approach of researchers checking nests, frightened hens often flush from the nest, leaving nest contents vulnerable to opportunistic predators. Since eiders rarely leave the nest during incubation under natural circumstances, it was reasoned that daily survival rate would be depressed by the visitation if gulls keyed into nest disturbances. A dummy variable for daily researcher disturbance (1 = hen flushed, 0 = hen did not flush) was created by recording whether or not a hen flushed from the nest during each nest check.
5) *Nearest Neighbor Distance.* It was predicted that small nearest neighbor distances, a proxy for high local nest density, would confer high nest survival through predator dilution effects (Hamilton 1971; Bertram 1978). Alternatively, predators may be attracted to concentrations of prey (Burger and Lesser 1978; Wittenburger and Hunt 1985; Brunton 1997), reducing survival of clumped nests.

6) *Distance to Cabin.* Despite gull control efforts, gulls continued to defend nesting territories and to attempt renesting in many areas that were not frequently disturbed by humans. Therefore, it was predicted that individual eider nest location in relation to the field camp could be important; it was expected that nest survival would decrease with increasing distance to the cabin.

Twenty models were included in the candidate set. Constant daily survival {*S*(.)}, main effects only {*S*(year), *S*(habitat)}, and time trend only {*S*(linear trend), *S*(quadratic trend)} models were fitted first. Linear and quadratic time trends were then added to each of the main effects {*S*(year + linear trend), *S*(habitat + linear trend), *S*(year + quadratic trend), *S*(habitat + quadratic trend)}. Models with daily nest age only {*S*(age)} and main effects plus daily nest age {*S*(year + age), *S*(habitat + age)} were also considered. All possible combinations of covariates vertical cover (*vertcov*), distance to cabin (*loc*), and nearest neighbor distance (*nnd*) were added to the best model so far {*S*(habitat + age)}. Finally, researcher disturbance (*dist*) was added to the top model {*S*(habitat + age + vertcov + loc)} to see if fit was further improved. An information-theoretic approach for model selection based on Akaike's Information Criterion corrected for small sample size (AIC_c) was used. Akaike weights, w_i, measured the strength of evidence in support of each model (Burnham and Anderson 2002).

RESULTS

Eider and Gull Census

Since the first census in 1992, eider numbers have increased greatly on Stratton Island, and the number of Herring and Great Black-backed gulls attempting to nest on the island has steadily declined (Fig. 3). In 2004, a record number of 1,244 eider nests was found. In 2005, nest numbers fell to 980 but remained well above the estimate of 884 nests in 2000. Breeding parameters were nearly identical in both 2004 and 2005 (Table 1): mean nest initiation date fell within the first week of May, and mean clutch size was 4.6-4.7.

Eider Nest Survival

The unequivocal best model for eider nest survival included habitat type, daily nest age, vertical nest cover, location, and researcher disturbance (Table 2). This model was 98 times better supported than the second-ranked model. Researcher disturbance was clearly important ($ß_{dist}$ = -2.21, 95% CL: -3.34, -1.08) and may have interacted with any of the other variables. After removing 16 nests potentially depredated due to visitation (2004: N = 10, 2005: N = 6), apparent nest success (no. nests hatching at least one egg per total nests) was 85% in 2004 (N = 234 nests) and 82% in 2005 (N = 161 nests) (Table 1).

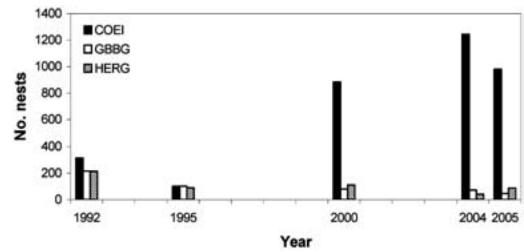

Figure 3. Number of Common Eider (COEI), Great Black-backed Gull (GBBG), and Herring Gull (HERG) nests found on Stratton Island and Little Stratton, Maine during censuses in 1992-2005. Historical data (1992-2000) provided by the National Audubon Society Seabird Restoration Program.

Gull-Eider Interactions

Altogether, 647 gull-eider interactions were recorded during watches (2004: 144 flyovers, 95 attempts, 16 successes, and 54 harassment events; 2005: 156 flyovers, 44 attempts, 28 successes, and 110 harassment events). In 2005, this corresponded to 0.53 flyovers per 200 duckling min, 0.15 attempts per 200 duckling min, 0.10 successes per 200 duckling min, and 0.38 harassment events per 200 duckling min; duckling min were not estimated in 2004. Additional successes were observed outside predation watches and are included in all subsequent results.

Great Black-backed Gulls were the principal duckling predators. Herring Gulls were witnessed taking only six ducklings in both study years. On 13 occasions (one event in 2004, twelve events in 2005), Great Black-backed Gulls were seen attacking (lunging after and striking with the bill) adult eiders on the water. Gulls were never observed killing adult eiders, but in 2005, a Great Black-backed Gull was seen feeding on a fresh eider carcass and remains (i.e., carcass cleaned of flesh and viscera) of two additional eiders were found, suggesting that kills do occur. Herring Gulls were occasionally seen eating failed or unattended eggs. No other mamma-

Table 1. Breeding parameters of Common Eiders on Stratton Island, Maine in 2004 and 2005. Data shown as $\overline{x}$ ± SD.

Year	No. nests[a]	NID[b]	N	Clutch size	N	Apparent nest success[c]	N
2004	1,244	4 May ± 8	236	4.6 ± 1.3	217	0.85	234
2005	980	3 May ± 8	170	4.7 ± 1.2	149	0.82	161

[a]No. nests found in annual censuses of Stratton Island and Little Stratton in mid-late May.
[b]Nest initiation date, assumes a two-d initiation and 26-d incubation period.
[c]No. successful nests per total nests, excluding abandoned nests and those depredated following researcher nest visitation.

lian or avian predators were observed preying on eider adults, eggs, or ducklings. However, nocturnal predation by Black-crowned Night Herons may have contributed to eider duckling disappearance since boluses containing duckling remains were collected in previous years (National Audubon Society Seabird Restoration Program, unpubl. data).

Predation events included both single and group gull attacks. Group attacks were highly opportunistic and involved as few as two and as many as 36 gulls ($\overline{x}$ = 9.65, SD ± 8.85; N = 31). In group attacks, gulls took an average of 6.33 (SD ± 5.36; N = 30) ducklings per event, often resulting in complete crèche destruction. Group attacks were stimulated by a single, successful gull attack; gulls loafing nearby then joined in a "feeding frenzy" in which gulls hovered above the crèche and plunge-dived repeatedly to take ducklings until none were left or the crèche was able to retreat into the rocks or vegetation. While several attacks may have been facilitated by human disturbance, most occurred in the absence of human activity.

Crèches of all sizes and compositions were vulnerable to gull attack. Attacked crèches (N = 37) ranged in size from one to 40 ducklings ($\overline{x}$ = 13.5, SD ± 12.0), 1-34 hens ($\overline{x}$ = 7.22, SD ± 6.45), and had ratios of 0.03-6.00 ducklings per hen ($\overline{x}$ = 2.37, SD ± 1.44). The presence of male eiders around crèches early in the breeding season appeared to facilitate predation in some instances. Courting drakes struggled and fought to get close to hens, often separating hens from ducklings.

Brood Movement and Duckling Counts

Few, if any, ducklings survived to fledging in 2004 and 2005. In 2004, only three ducklings >14 d (plumage class Ic, Gollop and

Table 2. Summary of model-selection results for factors affecting Common Eider nest survival on Stratton Island, Maine in 2004 and 2005. Models examined the effects of year, nesting habitat (*habitat*), daily nest age (*age*), percent vertical nest cover (*vertcov*), location (*loc*), nearest neighbor distance (*nnd*), researcher disturbance (*dist*), and linear and quadratic trends on eider nest survival. Log(L) is the log-likelihood, K is the number of parameters, ΔAIC_c is the difference between the model with the lowest AIC_c value (best-fitting model) and the current model, and w_i is the model weight.

Model[a]	log(L)	K	AIC_c[b]	w_i
S(habitat + age + vertcov + loc + dist)	1.00	7	0.00	0.98
S(habitat + age + vertcov + loc)	0.01	6	8.56	0.01
S(habitat + age + vertcov + loc + nnd)	0.01	7	10.50	0.01
S(habitat + age + vertcov)	0.00	5	12.50	0.00
S(habitat + age + vertcov + nnd)	0.00	6	14.50	0.00
S(habitat + age + loc)	0.00	5	15.20	0.00
S(habitat + age + loc + nnd)	0.00	6	17.10	0.00
S(habitat + age)	0.00	4	19.80	0.00
S(age)	0.00	2	21.60	0.00
S(habitat + age + nnd)	0.00	5	21.80	0.00

[a]Only the top ten models from the candidate set are shown; the ten models not shown each had w_i = 0.00.
[b]AIC_c for the top model was 215.5.

Marshall 1954) were seen on the island or near historical brood-rearing areas closer to the mainland. In 2005, at least eight ducklings survived beyond three weeks (plumage class IIa, Gollop and Marshall 1954), but one was killed by a Great Black-backed Gull (R. E. Lambert, pers. comm.), and the others were never seen again. Only three crèches traveling from Stratton Island toward the mainland were located during weekly boat searches in 2004 and 2005, and all were experiencing gull attack prior to our arrival in the area.

Of the 105 nape-tagged hens that hatched ducklings, 71 individuals were re-sighted (Table 3). Tag loss was likely responsible for our failure to re-sight some individuals; tag retention (from marking to last sighting) ranged from one to 47 d ($\bar{x}$ = 17, SD ± 11; N = 84). Of the 71 re-sighted hens, 59 (2004: 25 of 33 hens, 2005: 34 of 38 hens) were later observed without ducklings or in crèches harassed/attacked by gulls (Table 3). After losing their ducklings, many tagged hens remained close to the island and were re-sighted regularly, feeding, resting, and accompanying other crèches.

DISCUSSION

Eider and Gull Census

Historical and recent censuses indicated that the number of eiders nesting on Stratton Island and Little Stratton grew dramatically over the last ten years. Concurrently, the number of Herring and Great Black-backed gulls attempting to nest at the site declined, presumably due to successful gull control measures designed to enhance tern productivity. Because of lack of monitoring, it is unclear whether the eider increase can be attributed to past years of successful recruitment or to immigration. Though not quantified, we suspect that some eiders have moved from Bluff to Stratton in recent years, since Stratton provides an attractive, gull-reduced nesting area with abundant, dense vegetation (particularly bittersweet, which has expanded in area in the last ten years (H. Cerny, unpubl. report)). In contrast, Bluff supports an unmanaged gull colony of >200 pairs of Herring Gulls and >100 pairs of Great Black-backed Gulls and has mostly open, grassy habitat (National Audubon Society Seabird Restoration Program, unpubl. data). Although Common Eider hens are typically philopatric (Goudie *et al.* 2000), Bluff Island is only 400 m away, so a move between the two sites does not seem impossible.

Eider Nest Survival

Overall, apparent nest success for eiders on Stratton Island exceeded 80% in both 2004 and 2005. This is considerably higher than most estimates reported for colonies in other regions (Spitsbergen: 27-93%, Ahlén and Andersson 1970; St. Lawrence estuary, QC: 14-52%, Milne and Reed 1974; van Dijk 1986; Scotland: 9.8%, Milne 1974; Beaufort Sea, AK: 33%, Schamel 1977; all in Goudie *et al.* 2000) but is similar to another Maine colony (Flag Island, Casco Bay: 75%, R. B. Allen, pers. comm.). It is also important to consider that our nest success estimate may be inflated

Table 3. Re-sighting data for Common Eiders nape-tagged in 2004 and 2005 on Stratton Island, Maine.

Year	No. tagged hens	No. successful hens[a]	No. successful hens re-sighted[b]	No. hens that lost all ducklings or were seen harassed by gulls[c]
2004	50	47 (94%)	33 (70%)	25 (76%)
2005	70	58 (83%)	38 (66%)	34 (89%)
Total	120	105 (88%)	71 (68%)	59 (80%)

[a]No. tagged hens with nests that produced at least one duckling.
[b]Of the successful hens, 33 and 38 were re-sighted in 2004 and 2005, respectively.
[c]Of the successful, re-sighted hens, 25 and 34 were later seen alone or in crèches that were harassed/attacked by gulls in 2004 and 2005, respectively.

relative to other studies since we excluded abandoned nests and those potentially depredated due to researcher disturbance.

It is well known that human disturbances can facilitate gull predation (Åhlund and Götmark 1989; Keller 1991; Mikola *et al.* 1994), and that Common Eiders are particularly sensitive to research activities (Götmark and Åhlund 1984; Bolduc 1998). However, surprisingly few studies have attempted to quantify these effects. In a gull predation study, we felt it was particularly important to distinguish between predation likely caused by our presence and 'natural' predation levels. We found that nest visitation by researchers likely contributed to the depredation of 16 of the 450 nests monitored during the study period.

While not reflected in the nest survival analyses, 54 eider nests were found depredated, prior to any human activities in the area. Thirty-two of these nests had little or no down, indicating that they were still in the initiation stage and/or the earliest stages of incubation when predation occurred. Unattended nests may be particularly vulnerable to gulls, and lower vegetative growth early in the season may make them more visible (Klett and Johnson 1982). We conclude that eiders experienced little nest predation, and that egg losses to gulls were due primarily to researcher intrusions or confined to new, unattended nests.

Gull-Eider Interactions, Brood Movement, and Duckling Counts

Gull predation upon ducklings appeared responsible for near-complete (perhaps complete) reproductive failure of the Stratton Island eider colony in 2004 and 2005. Daily watches indicated high predation rates on ducklings by Great Black-backed Gulls, and boat searches around the island and to historical brood-rearing areas revealed few crèches. Only a handful of ducklings older than plumage class Ia (Gollop and Marshall 1954) were ever observed. Some studies have found that eiders lead their broods away from nesting islands to coastal feeding areas soon after hatching (Bédard and Munro 1976; Munro and Bédard 1977b; Mawhinney 1999). However, sightings of lone, marked hens around Stratton, combined with surveillance camera imagery of frequent gull harassment (CED, unpubl. data), further supported the idea that gull predation, not emigration, was responsible for low duckling counts.

Great Black-backed Gulls were the principal eider duckling predators. Unlike Herring Gulls, Great Black-backed Gulls frequently participated in group gull attacks. Group attacks were highly opportunistic and often resulted in complete crèche destruction. This behavior was described previously by Dwernychuk and Boag (1972) with California (*L. californicus*) and Ring-billed gulls (*L. delawarensis*) preying collectively on duck broods in Alberta and by Munro and Bédard (1977a) with Herring Gulls and occasional Great Black-backed Gulls attacking eider crèches in the St. Lawrence estuary, Quebec. Although crèching may have evolved as an antipredator defense, Munro and Bédard (1977a) noted that the "clear benefit of crèching breaks down completely in the peculiar circumstance of multiple attack as territorial interference among predators no longer plays a role…". It is likely that eider productivity has been poor at Stratton since at least 2000, when Audubon personnel first reported seeing occasional group gull attacks (H. Cerny, unpubl. report).

Although Herring Gulls can be significant duckling predators in some regions (Munro and Bédard 1977a; Mendenhall and Milne 1985; Swennen 1989), our results support the findings of others in the Gulf of Maine, that Great Black-backed Gulls are the dominant predators (Bourget 1973; Mawhinney and Diamond 1999; R. B. Allen, pers. comm.). Perhaps the larger size, aggressiveness, and/or relative numbers of Great Black-backed Gulls enables them to outcompete Herring Gulls for the eider duckling resource (Burger and Gochfeld 1984; Rome and Ellis 2004). In New England, Great Black-backed Gull numbers are increasing, while Herring Gulls are declining (Ellis and Good 2006). This shift in predator composition could have serious consequences for regional eider productivity (Mawhinney and Diamond 1999).

Recommendations

While eiders enjoy high nest success at Stratton Island, duckling survival is negligible and should be the focus of any management program designed to increase eider production at the site. Gull control measures designed to enhance tern productivity appeared ineffective for eiders. Gulls continued to congregate in large numbers near crèching areas. The close proximity of Bluff Island, an active and unmanaged gull colony, may negate any benefits of gull control on Stratton for eiders. Future management actions to limit the number of loafing gulls at Stratton and its surroundings may improve duckling survival by reducing the potential for group gull attacks. Poking/oiling of Herring and Great Black-backed gull eggs on Bluff Island will be tried as a first step to prevent gulls from hatching chicks and thereby increasing food demands. However, the latter failed to prevent adult gulls from preying heavily on ducklings at the Wolves Archipelago, New Brunswick (Mawhinney 1999). It is likely that some additional measure, such as harassment of gulls observed hunting ducklings and/or loafing near crèching areas will also have to be implemented, though this will be no easy task given the sensitivity of eiders to human disturbance.

Perhaps the more pressing need is to initiate long-term eider monitoring programs at additional sites in the Gulf of Maine. It is important to determine whether Stratton is an anomaly or is representative of regional gull-eider relations. Though programs are in place at some sites, most eider colonies remain unmanaged and sporadically monitored (R. B. Allen, pers. comm.). In the face of increasing harvest pressure, habitat loss, contaminants, and other threats, additional monitoring is essential and would lend valuable insight to eider recruitment rates at a regional level.

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