

NESTING HABITAT USE BY COMMON EIDERS ON STRATTON ISLAND, MAINE

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ABSTRACT.—We examined nesting habitat use of Common Eiders (*Somateria mollissima dresseri*) breeding on Stratton Island, Maine in 2004 and 2005. Eiders generally avoided low-lying, open vegetation, and nested in dense, structurally complex habitats. The three most common habitat types used were Asiatic bittersweet (*Celastrus orbiculata*) patches, red raspberry (*Rubus idaeus*) thickets, and forest (primarily *Malus pumila* and *Prunus virginiana*). Nest densities were highest in bittersweet (> 500 nests/ha). Eiders had little nest predation by *Larus* gulls, and apparent nest success was high in all three habitats (bittersweet: 82–89%, raspberry: 87%, forest: 58–72%). Eiders appeared to select nest sites adaptively to avoid detection or access by predators, although other factors such as nest microclimate, female quality or condition, and energetic demands during incubation may also be important. Received 18 January 2007. Accepted 30 January 2009.

Non-random distribution of animals among available habitats is often cited as evidence of habitat choice, a product of natural selection (Burger 1987, Clark and Shutler 1999). The choice of where to breed can have important consequences for reproductive success (Misenhelter and Rotenberry 2000). Animals are expected to select those habitats that maximize reproductive performance and, ultimately, fitness if reproductive success varies by habitat type. There is considerable evidence for birds that nest-site selection is adaptive and driven, in part, by avoidance of predators (Martin 1993, Burger and Gochfeld 1994, Clark and Shutler 1999).

American Common Eiders (*Somateria mollissima dresseri*) are large, colonial sea ducks that often nest on marine islands. Island-nesting and coloniality may have evolved to reduce the threat of mammalian predators (e.g., Wittenburger and Hunt 1985), but eiders and other seabirds often contend with avian predators in breeding areas (Burger and Gochfeld 1994, Goudie et al. 2000). Large gulls (*Larus* spp.) can be important predators of eider eggs and young (Choate 1967, Bourget 1973, Milne and Reed 1974, Mawhinney and Diamond 1999) and seemingly could exert strong selective pressures on nest placement within a colony. However, the literature on the gull-eider relationship is far from conclusive.

Some studies suggest that waterfowl benefit from nesting in association with aggressive gulls (e.g., Young and Titman 1986, Götmark and Åhland 1988, Swennen 1989), but others document severe predation rates on ducklings (e.g., Dwernychuk and Boag 1972, Mawhinney and Diamond 1999, Donehower and Bird 2008).

We examined Common Eider nesting habitat use on Stratton Island, Maine. Our objectives were to compare nest densities and success in different habitat types. We were particularly interested in use of Asiatic bittersweet (*Celastrus orbiculata*) as eider nesting habitat since this invasive vine provides dense cover but is being eradicated in parts of the island to benefit wading birds. The weight and spread of bittersweet vines can topple trees and prevent foliage growth, destroying nesting trees used by Snowy (*Egretta thula*) and Great (*Ardea alba*) egrets, Glossy Ibis (*Plegadis falcinellus*), and Black-crowned Night (*Nycticorax nycticorax*) and Little Blue (*E. caerulea*) herons (National Audubon Society Seabird Restoration Program, unpubl. data).

METHODS

Study Area.—The study was conducted in 2004 and 2005 on Stratton Island (43° 31' N, 70° 19' W), a 12-ha National Audubon Society waterbird sanctuary 2.4 km south of Prouts Neck, Saco Bay, Maine (Chase 1994, Kress 1998). There are no mammalian predators but hundreds of Herring (*Larus argentatus*) and Great Black-backed (*L. marinus*) gulls use the island for resting, foraging, and attempted nesting; National Audubon Society gull control measures designed to enhance tern (*Sterna* spp.) productivity prevented gulls from raising young on Stratton Island during the study period.

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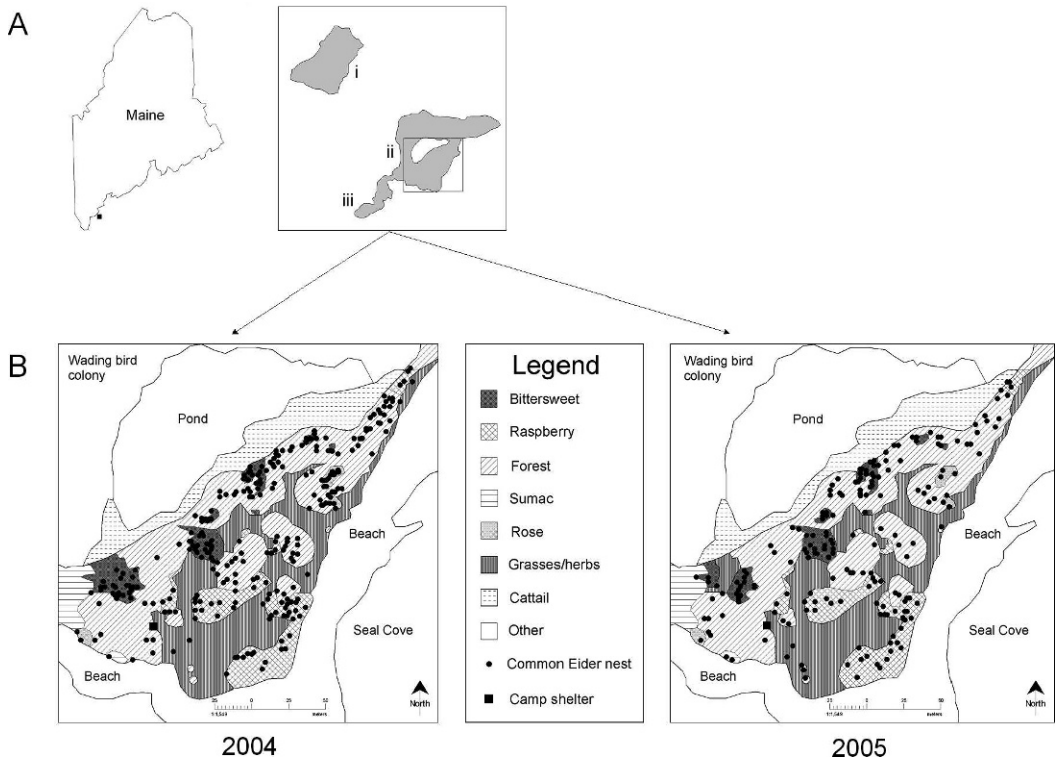


FIG. 1. (A) Stratton Island study area showing Bluff Island (i), Stratton Island (ii), and Little Stratton (iii), and (B) Common Eider nest-monitoring area in 2004 (left) and 2005 (right). Eider nests were mapped in relation to habitat type.

Nest Monitoring.—We recorded GPS (Global Positioning System) coordinates, predominant vegetation (habitat type), and fate (successful, depredated, or abandoned) of all nests found on the southern half of Stratton Island (2004: $n = 285$, 2005: $n = 198$) (Fig. 1A, B); the remainder of the island was avoided to limit disturbance to nesting wading birds and shorebirds. We systematically searched the study area every 7–10 days during the nesting season to locate any new nests and to inspect the contents of known nests. We characterized habitat type as forest (primarily apple [*Malus pumila*] and common chokecherry [*Prunus virginiana*] with an understory of orange jewelweed [*Impatiens capensis*]), red raspberry (*Rubus idaeus*), beach rose (*Rosa rugosa*), grasses/herbs (e.g., introduced grasses [*Festuca* spp. and *Phleum pretense*], stinging nettle [*Urtica dioica*]), Asiatic bittersweet, staghorn sumac (*Rhus typhina*), or other. We considered a nest successful if at least one egg hatched. Other nests were either abandoned (all eggs abandoned) or depredated (all eggs clearly consumed by gulls, as

indicated by broken eggshells with yolk in or beside the nest cup). We mapped eider nest locations in relation to habitat type using GIS (Geographic Information System) (Map Maker 2005). We calculated habitat areas by digitizing a U.S. Geological Survey aerial photograph of the study site. We examined ground-truth data collected at each nest site and local vegetation maps (National Audubon Society Seabird Restoration Program, unpubl. data) to improve accuracy of habitat delineations.

Statistical Analyses.—We calculated apparent nest success for each habitat type as the number of nests hatching at least one egg divided by the total nests monitored. We excluded nests likely depredated because of researcher visitation (2004: $n = 10$; 2005: $n = 6$). We did not calculate Mayfield nest success (Mayfield 1961, 1975) because (1) this estimator does not allow inclusion of nests found depredated (2004: $n = 33$, 2005: $n = 21$) and (2) we attributed most depredated nests of known age to researcher disturbance (Donehower and Bird 2008).

TABLE 1. Nest densities and apparent nest success by habitat type of Common Eiders breeding on Stratton Island, Maine, 2004–2005.

Habitat	Year	Density (nests/ha)	Apparent nest success ^a	<i>n</i>
Bittersweet	2004	506	0.89	79
	2005	553	0.82	65
Forest	2004	117	0.72	115
	2005	66	0.58	69
Raspberry	2004	205	0.87	55
	2005	173	0.87	45
Grasses/herbs	2004	17	0.60	10
	2005	0		0
Sumac	2004	0		0
	2005	22	0.50	2
Rose	2004	731	0.88	16
	2005	231	0.80	5

^a Number of successful nests/total nests monitored after removing nests depredated due to researcher visitation.

We compared eider nest densities in the different habitat types using Poisson regression (PROC GENMOD) (SAS Institute 2002). Number of nests observed in each habitat type was the response variable with habitat type and year as explanatory variables; area (m² habitat) served as an offset variable (Stokes et al. 2000). We assessed overdispersion using the variance inflation factor, *c*, where $\hat{c} = \chi^2/df$ (Stokes et al. 2000, Burnham and Anderson 2002). We scaled the covariance matrix since \hat{c} exceeded 1 (Stokes et al. 2000), suggesting overdispersion, and set $\alpha = 0.05$.

RESULTS

Eiders nested primarily in dense vegetation (i.e., bittersweet, raspberry, forest, rose), generally avoiding grasses/herbs and sumac (Table 1, Fig. 1B). Densities differed among habitat types ($F_{5,5} = 22.8$, $P = 0.002$) but not years ($F_{1,5} = 2.59$, $P = 0.17$). Nest densities were highest in bittersweet (>500 nests/ha), intermediate in raspberry (173–205 nests/ha), and lowest in forest (66–117 nests/ha) (Table 1). Apparent nest success was 0.87 in raspberry and ranged from 0.82 to 0.89 in bittersweet, and 0.58 to 0.72 in forest (Table 1). Only seven (2004: 1 of 79 nests; 2005: 6 of 65 nests) and eight (2004: 5 of 55 nests; 2005: 3 of 45 nests) nests were lost to predators in bittersweet and raspberry, respectively, while 47 (2004: 27 of 115 nests; 2005: 20 of 69 nests) nests were depredated in forest.

Few depredated nests were found in either bittersweet or raspberry compared to forest; this

TABLE 2. Corrected nest totals used in a second Poisson regression analysis to compare Common Eider nest densities on Stratton Island, Maine in different years and nesting habitats. This analysis assumed that observers failed to detect unsuccessful nests in bittersweet and raspberry with the same frequency as in forest.

Habitat	Year	Successful nests	Unsuccessful nests	Total nests	Corrected totals ^a
Bittersweet	2004	70	9	79	97
	2005	53	12	65	91
Forest	2004	83	32	115	115
	2005	40	29	69	69
Raspberry	2004	48	7	55	67
	2005	39	6	45	67

^a Number of nests used in density estimates after correcting for possible bias in detection probabilities of unsuccessful (depredated) nests in bittersweet and raspberry.

could be due to the greater difficulty of finding unsuccessful nests amidst dense and structurally complex vegetation. We conducted Poisson regression analysis using corrected nest densities. We assumed equal predation rates among the three most commonly used habitats, using forest as the standard by which to correct bittersweet and raspberry densities (Table 2); nest densities in the other habitat types were left unaltered. We found significant differences among habitats ($F_{5,5} = 25.2$, $P < 0.0001$) but not years ($F_{1,5} = 0.96$, $P = 0.33$) with highest densities occurring in bittersweet.

DISCUSSION

Eiders preferred dense and structurally complex vegetation for nesting. Highest nest densities were in bittersweet and rose, while lowest densities were in sumac and grasses/herbs. Other studies have shown eiders generally prefer sites with vegetative cover or other forms of shelter (reviewed in Goudie et al. 2000 but see Laurila 1989, Divoky and Suydam 1995, Bolduc et al. 2005, Noel et al. 2005). These habitats likely provide increased protection from avian predators through visual concealment and/or physical exclusion, although factors unrelated to predation such as energetic demands during incubation and female condition/quality may also be important but were not evaluated in this study. For example, incubating females using artificial shelters or forested nest sites can have lower rates of weight loss than those at exposed sites, presumably due to the more thermodynamically favorable microclimate they provide (Kilpi and Lindström 1997, Fast et al. 2007).

Eiders experienced little nest predation and most losses to gulls were probably confined to new, unattended nests (Donehower and Bird 2008). Predation rates were exceptionally low in bittersweet and raspberry habitats (<10% of nests depredated) and were higher in forest (25–33% of nests depredated). The relatively open understory of the forest may have permitted gulls to more easily detect or access nests. These nest success estimates are high (Klett et al. 1988, Goudie et al. 2000). This may be, in part, due to our efforts to exclude nests depredated due to researcher visitation; the impact of researcher disturbance is seldom considered but can dramatically influence predation rates and eider breeding success (Åhlund and Götmark 1989, Keller 1991). Apparent nest success can also be biased high relative to Mayfield-based estimates.

The apparent estimator will be positively biased when unsuccessful nests are less likely to be detected by researchers than successful nests (Mayfield 1961, 1975). Nest density estimates have the same potential biases as apparent nest success. Use of apparent nest success (or apparent nest densities) is justified under certain conditions (Johnson and Shaffer 1990). Our estimates of apparent nest success may be fairly robust because (1) nesting was highly synchronous (mean \pm SD nest initiation dates; 4 May 2004 \pm 8 days and 3 May 2005 \pm 8 days; Donehower and Bird 2008) and (2) the study area was small, and searched thoroughly and frequently. We cannot dismiss the possibility that nest detection probabilities differed by habitat type and biased apparent nest success and density estimates.

A follow-up analysis using corrected nest densities upheld our original findings, but we were unable to similarly validate apparent nest success estimates. We seldom observed gulls entering either bittersweet or raspberry. In contrast, we frequently saw gulls walking in the open understory of the forest. These observations are consistent with our finding that predation was minimal in bittersweet and raspberry. Eiders had little nest predation and, even if nest success estimates in raspberry and bittersweet were positively biased relative to forest, this conclusion remains unchanged.

The National Audubon Society has initiated bittersweet control efforts to reduce the threat of smothering nesting trees used by wading birds (S. W. Kress, pers. comm.). Stands of bittersweet should be left intact where they do not pose a threat to the wading bird colony to ensure that

high quality nesting habitat remains available to eiders. Alternatively, native cover promoting high nest success (i.e., raspberry) should be planted in areas where bittersweet is removed.

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