Nesting Ecology of Spectacled Eiders *Somateria fischeri* on the Indigirka River Delta, Russia

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In 1994 and 1995 we investigated breeding biology and nest site habitat of Spectacled Eiders on two study areas within the coastal fringe of the Indigirka River Delta, Russia (71° 20′ N, 150° 20′ E). Spectacled Eiders were first observed on 6 June in both years and nesting commenced by mid-June. Average clutch size declined with later nest initiation dates by 0.10 eggs per day; clutches were larger in 1994 than 1995 and were slightly larger on a coastal island study area compared to an interior area. Nesting success varied substantially between years, with estimates of 1.6% in 1994 and 27.6% in 1995. Total egg loss, through avian or mammalian predation, occurred more frequently than partial egg loss. Partial egg loss was detected in 16 nests and appeared unrelated to nest initiation date or clutch size. We found no difference among survival rates of nests visited weekly, biweekly, and those at which the hen was never flushed, suggesting that researcher presence did not adversely affect nesting success. A comparison of nine habitat variables within each study area revealed little difference between nest sites and a comparable number of randomly located sites, leading us to conclude that Spectacled Eiders nest randomly with respect to most small scale habitat features. We propose that large scale landscape features are more important indicators of nesting habitat as they may afford greater protection from land-based predators, such as the Arctic Fox. Demographic data collected during this study, along with recent conservation measures implemented by the Republic of Sakha (Yakutia), lead us to conclude that there are few threats to the Indigirka River Delta Spectacled Eider population. Presently, the Indigirka River Delta contains the largest concentration of nesting Spectacled Eiders and deserves continued monitoring and conservation.

Key words: Breeding Biology, Nesting Ecology, Habitat Use, Indigirka River, Russia, Spectacled Eider, Somateria fischeri

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The Spectacled Eider *Somateria fischeri* is a Beringian sea duck that breeds in coastal tundra of Alaska and northeastern Russia between the Chaun and Yana River deltas (Bellrose 1980, U. S. Fish & Wildlife Service 1996; **Figure 1**) and winters in pelagic waters of the Bering Sea (Petersen *et al.* 1995). A dramatic population decline in the western Alaska breeding population (Stehn *et al.* 1993, Ely *et al.* 1994) prompted listing of Spectacled Eiders as threatened in North America in 1993 (U. S. Fish & Wildlife Service 1993). At the time of listing, the status of Spectacled Eiders breeding in Russia was virtually unknown.

Spectacled Eiders in Russia were first studied in the 1970s by Kistchinskii & Flint (1974, 1979), who investigated nesting biology and population distribution on the interior portion of the Indigirka River Delta (IRD). Unlike Alaska breeding grounds, where eiders nest solitarily, Kistchinskii & Flint (1974) found that Spectacled Eiders nested in both solitary and clumped distributions. Clumped eider nests were discovered in proximity to nests of other species, such as the Herring Gull *Larus argentatus, Glaucous Gull L. hyperboreus*, Ross's Gull *Rhodostethia rosea*, Arctic Tern Sterna *paradisaea* and Sabine's Gull *Xema sabini*. Kistchinskii & Flint (1974) hypothesised that female Spectacled Eiders selected such sites to gain protection from the territorial and mobbing behaviours exhibited by these associated species as they protected their own nests from potential nest predators.

Since the listing of Spectacled Eiders as threatened, studies in western Alaska have investigated aspects of nesting ecology (Flint & Grand 1997, Grand & Flint 1997), exposure to heavy metal contamination (Flint *et al.* 1997) and winter distribution (Petersen *et al.* 1995). Uncertainty about breeding population size and connectivity with Alaska populations prompted the initiation of a collaborative study regarding the nesting ecology of Spectacled Eiders on the IRD. Concurrently, aerial surveys were initiated to address Spectacled Eider abundance throughout their Russian breeding range (U. S. Fish & Wildlife Service 1996). During 1994 and 1995, we studied nesting ecology of Spectacled Eiders on the IRD. Our objectives were to describe basic reproductive and ecological parameters (nesting chronology, clutch size, nesting success, and nest site habitat use) of Spectacled Eiders from a poorly-known portion of their range and compare our findings to historical work on the IRD and to recent studies of Spectacled Eider populations in western Alaska.

Study Area

The IRD (71° 20' N, 150° 20' E) is one of four major arctic river deltas in the Republic of Sakha (Yakutia) of eastern Siberia (**Figure 1**). The IRD is considered to be at the western edge of Beringia (West 1996) and consists of approximately 5000 km^2 of southern subzone arctic tundra (Treshnikov 1985, Stishov *et al.* 1989). Plant species characteristic of arctic polygonal tundra were present and included *Carex aquatilis*, *Eriophorum spp.*, *Arctophila fulva*, *Poa spp.*, *dwarf Salix spp.*, and *Sphagnum spp.* (Uspenskii et al. 1962, Matveev 1989). The IRD is an important wetland area for numerous avian species (Pearce *et al.* 1998) and the primary breeding area for the vast majority of Spectacled Eiders (U. S. Fish & Wildlife Service 1996).

We selected two principal study areas (**Figure 1**) based on the presence of large numbers of nesting eiders located during ground surveys. The interior area, located 25 km inland from the coast near Tabor, consisted of approximately 12 km^2 of polygonal tundra and several large drained-basin complexes (Bergman *et al.* 1977). Basin complexes investigated were characterized by deep (>1 m) lakes that often contained numerous small islands (< 9 m^2). Islands were covered primarily by mosses and sedges with some sparse herbaceous vegetation. Polygon ridges and pingos often rose above surrounding wet tundra, resulting in more xeric vegetative communities. The coastal study area (approximately 25 km^2), situated at the mouth of the central river channel, included ten islands, averaging 160 m^2 in size, that were part of a larger coastal island archipelago. Islands were completely surrounded by river channels that decreased in depth (often to < 1 m) during

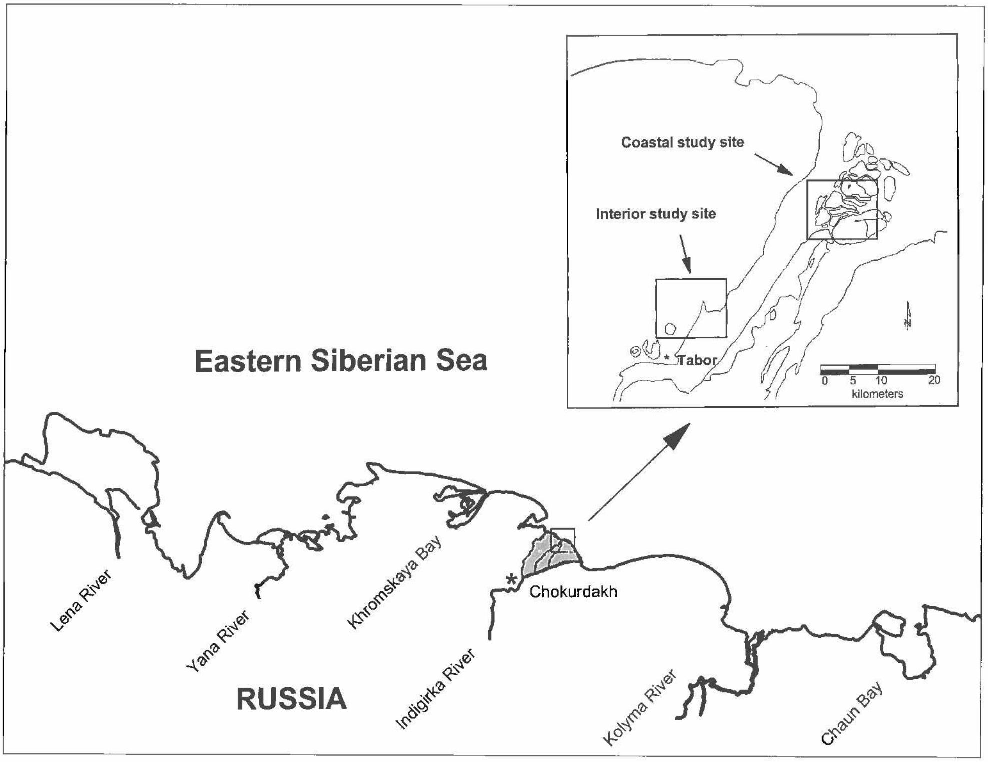

Figure 1. Map of the northeastern Russian coast showing the Indigirka River Delta (shaded) and approximate boundaries of study areas.

summer months. The few water bodies present on these coastal islands were deep ponds with emergent Arctophyla fulva. Island vegetation consisted primarily of wet Eriophorum spp. meadows with drier areas of graminoids and dwarf willows. Interior tundra and wetlands were typically snow and ice free by mid-June and ice in river channels broke by 20 June. Summer temperatures ranged from - 4° to 22°C with an average of 5°C. We believe that the combination of these two study sites is representative of coastal IRD arctic tundra habitat.

Methods

We searched both study areas on a weekly basis for Spectacled Eider nests. Each nest was assigned a unique number and marked with a wooden stake placed approximately 20 m from the nest. We determined status of each nest (active - containing at least one egg; or depredated - nest bowl containing some or abundant down, but no eggs), and recorded the number of eggs and stage of egg development by candling (Weller 1956).

Clutch size was defined as the number of eggs in nests of incubating females (*ie*, nests containing eggs with visible embryonic development by candling). We summarised data for nests, regardless of clutch size, and also for all nests after excluding clutches with < 3 eggs, which likely suffered partial egg loss before the nest was discovered. Initiation dates were estimated by back-dating from the date of discovery with the estimated egg age obtained from candling plus the number of eggs found in the nest, under the assumption that Spectacled Eiders lay one egg per day (Dau 1974). We used analysis of covariance to examine variation in clutch size related to nest initiation date, year, study site, and all interactions. We used backward elimination to remove nonsignificant variables ($P > 0.05$) starting with highest order interactions. We also documented occurrence of partial and total egg depredation among all incubating nests.

Active nests were revisited every seven days to calculate nesting success. We used a maximum likelihood estimator (Bart & Robson 1982) to estimate daily survival rates. This method assumes that survival rates were constant throughout the study period. We compared survival rates using the CONTRAST program (Hines & Sauer 1989) based on the methods of Sauer & Williams (1989). In 1995, we examined effects of observers on nesting success using three randomly applied nest revisitation schedules: (1) visit nests every seven days; (2) visit nests every 14 days; or (3) visit nests every seven days, but without flushing the female from the nest. The last treatment was possible due to the small amount of vertical vegetation cover at some nests and a high degree of female nest site tenacity. Daily survival rates were compared among treatments as described above.

To examine nesting habitat use by female Spectacled Eiders, we collected information in 1995 on a series of habitat variables at nests and a comparable number of random sites. First, we described three categorical habitat features: habitat type within 100 m of each site (wetland complex, grass/shrub tundra, or wet meadow), the nearest wetland type (pool - <5 m in diameter; pond - ≥5 m, but <3 ha; lake- ≥3 ha; or river), and if the site was located on a distinct landscape feature (e.g., water body shoreline, polygon rim, or island). Second, we visually estimated percent ground cover of graminoids (*Eriophorum spp., Carex spp., and Poa spp.*), moss *Sphagnum spp.*, and willow *Salix spp.* within a one square metre frame placed over the site. An upright vegetation density board (Jones, 1968) was used to measure vertical cover at each site by placing a three-sided board in the centre of the metre frame and counting the total number of coloured squares ≤50% obscured by standing vegetation (0 = no vegetation cover, 48 = complete cover). Finally, we recorded maximum water depth and percent open water (1 minus the percent of emergent vegetation) of the nearest wetland. Random habitat sites were generated by plotting random latitude and longitude co-ordinates onto study area maps. Sites were located with Global Positioning System (GPS) units.

We used likelihood ratio G tests to assess differences between nests and random sites in the proportions within categories of habitat type, nearest wetland type, and occurrence on distinct landscape features. We used Kruskal-Wallis tests for univariate comparisons of continuous micro habitat variables. We also tested homogeneity of variances of continuous variables between nests and random sites. Stepwise logistic regression (Press & Wilson 1978) was used to determine the combinations of variables that best separated nests from random sites. Due to the large number of zero data points, percent Salix spp. was excluded from logistic regression models. Significance level for entry into the stepwise procedure of logistic regression was set at $\alpha = 0.10$ and removal from the model at $\alpha = 0.15$ (Hosmer & Lemeshow 1989).

Results

Spring Arrival and Nest Initiation

In 1994, we arrived on the interior study area on 1 June and the first Spectacled Eiders were observed on 6 June. We arrived on 6 June in 1995 and Spectacled Eiders were observed on that date. Flocks of up to 50 Spectacled Eiders were observed until mid-June in both years on large flooded tundra basins and along river shores. Flocks contained approximately even sex ratios and single sex flocks were rarely observed during migration. We observed copulations only on 8 June in both years.

In 1994, nest initiation averaged (±SE) 22 June (± 0.32 days; n =122) and did not differ between study areas ($P = 0.07$). However, 1995 initiation dates differed significantly ($t = 5.46$, $df = 105$, $P < 0.01$) between coastal (22 June ± 1.1 days; $n = 35$) and interior (15 June ± 0.75 days; $n = 72$) areas. Ninety percent of nest initiations in 1994 occurred within a 12 day period (17 to 28 June); however, in 1995, 90% of

Table 1. Mean (± SD) of partial and total predation events of incubating Spectacled Eider nests on study sites of the Indigirka River Delta.

	Partial depredation				Total depredation			
	Initiation date	Depredation date	Clutch size	n (% of nests)*	Initiation date	Depredation date	Clutch size	n (% of nests)*
1994								
Coastal site	19 June (0.8)	10 July (2.8)	5 (0.8)	4 (6.3)	22 June (0.3)	1 July (3.4)	4.6 (1.1)	55 (84.6)
Interior site	20 June (2.2)	5 July (2.5)	5.3 (1.9)	4 (14.8)	22 June (3.9)	4 July (5.1)	3.9 (2.4)	13 (48.3)
1995								
Coastal site	14 June	20 June	4	1 (9.0)	22 June (6.2)	30 June (7.6)	4.1 (0.9)	8 (72.7)
Interior site	13 June (3.4)	28 June (6.1)	4.7 (2.4)	7 (18.9)	14 June (6.3)	28 June (3.2)	4.4 (1.5)	14 (37.8)

* Number and percent of nests within each study site that incurred partial or total depredation.

nests were initiated over 21 days (13 June to 3 July) on the coast and 17 days (8 to 24 June) on the interior area.

Clutch Size

Clutch size averaged 4.3 (± 0.10 SE) eggs (n = 199) over all years, study areas, and nest initiation dates. We suspect that nests containing < 3 eggs (n = 24) may have suffered partial depredation during laying or before nest discovery. When small clutches were excluded, average clutch size increased to 4.7 (± 0.08) eggs (n = 175). In 1995, with a sample of 68 nests from both study areas that contained eggs with ≥6 days of development by candling (n = 291), we found only one inviable egg. In 1994, average egg length and width were 67.8 mm (± 0.10) and 45.4 mm (± 0.04), respectively (n = 788).

We found that clutch size varied by nest initiation date (P < 0.01), year (P < 0.01), and study site (P = 0.05) with all interactions not significant. On both study areas in 1994 and 1995, clutch size declined 0.10 (± 0.01) eggs for each day that nest initiation was delayed. After accounting for effects of other model parameters, clutch size averaged slightly higher (0.66 eggs; ± 0.15) in 1994 than 1995 and also averaged slightly higher (0.33 eggs; ± 0.16) on the coastal study site than on the interior study site.

Nesting Success and Egg loss

Daily survival rates of nests were higher (P < 0.01, Z = -7.33) in 1995 (0.956 ± 0.005; n = 123) than in 1994 (0.866 ± 0.011; n = 163). Using an estimate of 29 exposure days (5 eggs and 24 days incubation), we estimated overall nesting success to be 1.6% in 1994, compared to 27.6% in 1995. Daily survival rates of nests were marginally higher on the interior site than the coastal site for both 1994 (0.884 ± 0.015, n = 68 and 0.850 ± 0.015, n = 95, respectively; P = 0.056, Z = 1.59) and 1995 (0.963 ± 0.006, n = 83 and 0.938 ± 0.013, n = 40, respectively; P = 0.045, Z = 1.70). Using logistic regression, we found no habitat variables that explained variation in nest depredation. We detected no differences (P > 0.20) in daily survival rates of nests among visitation treatments (never flushed 0.944 ± 0.017, n = 16; 7-day interval 0.958 ± 0.007, n = 78; and 14-day interval 0.959 ± 0.010, n = 29) for either site or for both sites combined.

Partial egg loss from all nests was an uncommon event across both years and study areas (**Table 1**). For all but 1994 coastal nests, the timing of both total and partial egg loss occurred only within the first two weeks of incubation. None of the nests that suffered partial egg loss were subsequently observed to incur total egg loss.

Nest Site Habitat Use

Since the interior area consisted of numerous small islands within a large lake basin, all interior nests and random sites were located in the same general habitat type (wetland complex) and were located on structural features (islands or shorelines) as we did not use sites that were situated in the water. On the coastal area, we detected no difference in the distribution of nests and random sites with respect to nearest wetland type (G = 3.99, df = 3, P = 0.26; **Figure 2**). Distance to nearest wetland and percent open water were also similar between nests and random sites (**Table 2**). We found no difference in the distribution of coastal nests and random sites among general habitat types (G = 2.24, df = 1, P = 0.13; **Figure 2**) and most nests (86.8%) and random sites (77.0%) were found in wet meadow tundra. Coastal nests were more frequently associated with a structural habitat feature (eg, polygon rims, small islands, and wetland shorelines) than random sites (G = 33.5, df = 1, P < 0.01). There was no detectable difference between coastal nests and random sites with regard to vegetation groundcover, except that nests had a greater amount of moss (G = 5.14, df = 1, P = 0.023; **Table 2**). However, this may be confounded by the large number of zero data points for this variable (nearly 90% of all observations). We found lower variances for coastal nests than random sites for vertical vegetation density ($F_{60,75}$ = 1.66, P = 0.04) and percent graminoid ($F_{60,75}$ = 2.49, P < 0.01), likely

Table 2. Means (± SE) of continuous habitat variables associated with nests and random sites on coastal and interior study sites, 1995.

	Coastal		Interior	
Variable	Nest (n = 76)	Random (n = 61)	Nest (n = 45)	Random (n = 29)
Distance to wetland (m)	75.4 (8.9)	101.6 (12.5)	0.842 (.09)	1.2 (0.16)
Percent open water	62.5 (4.6)	69.4 (5.2)	44.6 (3.3)	50.0 (4.2)
Percent Salix spp.	3.4 (1.0)	7.5 (2.3)	-	-
Percent moss	8.5 (1.5)*	5.9 (1.9)	49.4 (4.5)	62.6 (6.2)
Percent graminoid	85.4 (2.2)	79.9 (3.9)	28.7 (3.8)*	21.5 (5.7)
Vertical vegetation density	11.4 (0.53)	9.9 (0.77)	10.4 (0.87)***	2.8 (0.95)

Significance indicated by: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, for Kruskal-Wallis comparisons of nests to random sites within study areas.
1 - 0 = no vertical cover, 48 = complete cover (see Methods).

a result of females avoiding sites with lowest values of these variables. Interior nests exhibited a greater percent grass cover score ($G = 6.0$, df = 1, $P < 0.01$) and a higher vegetation density ($G = 25.6$, df = 1, $P < 0.01$) than random sites (**Table 2**).

Distance to nearest wetland and vegetation density were the only variables that entered the logistic regression model for the coastal area, resulting in a significant classification between nests and random sites ($G = 6.87$, df = 2, $P = 0.03$). A model based solely on distance to nearest wetland correctly classified 87% of nests, but only 21% of random sites. When vegetation density was added to the model at a = 0.05, the model improved correct classification of random sites to 43%. However, a histogram of group membership probabilities for nests and random sites (**Figure 3**), overlapped considerably and the majority of random site misclassifications occurred near the 0.5 probability level. On the interior area, vegetation density was the only variable that entered the model and contributed to significant group separation ($G = 28.5$, df = 1, $P < 0.01$). Vegetation density was also significant in univariate comparisons of nests and random sites (**Table 2**). This model correctly identified 89% of nests and 83% of random sites. A histogram of probabilities of group membership (**Figure 3**) demonstrated a stronger classification than for the coastal area.

Discussion

Spring Arrival and Nest Initiation

We observed dates of Spectacled Eider arrival and nesting phenology on the IRD to be nearly identical to those described previously by Kistchinskii and Flint (1974). In comparison to the Yukon-Kuskokwim (Y-K) Delta (Dau 1974, Grand & Flint 1997), average date of nest initiation on the IRD was approximately 20 - 25 days later, presumably due to latitudinal differences and thus, timing of spring ice break-up and availability of nest sites. Similar to Grand & Flint (1997), we believe that local variation in initiation date is tied to timing of spring break-up. In 1994 and 1995, river ice

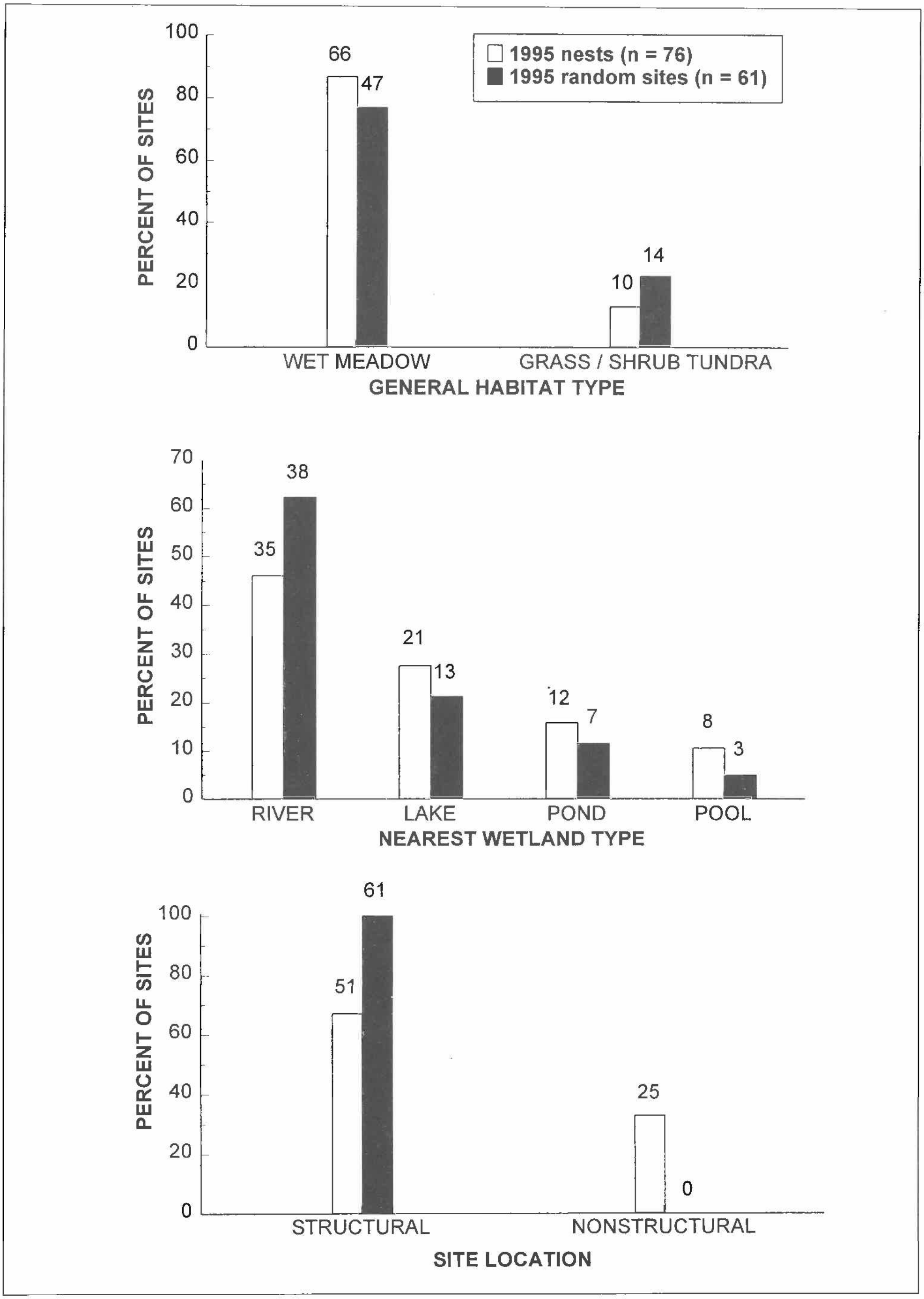

Figure 2. Distributions of nests and random sites on the coastal study site with respect to categorical habitat measurements (see Methods for details). Sample sizes are given above each bar.

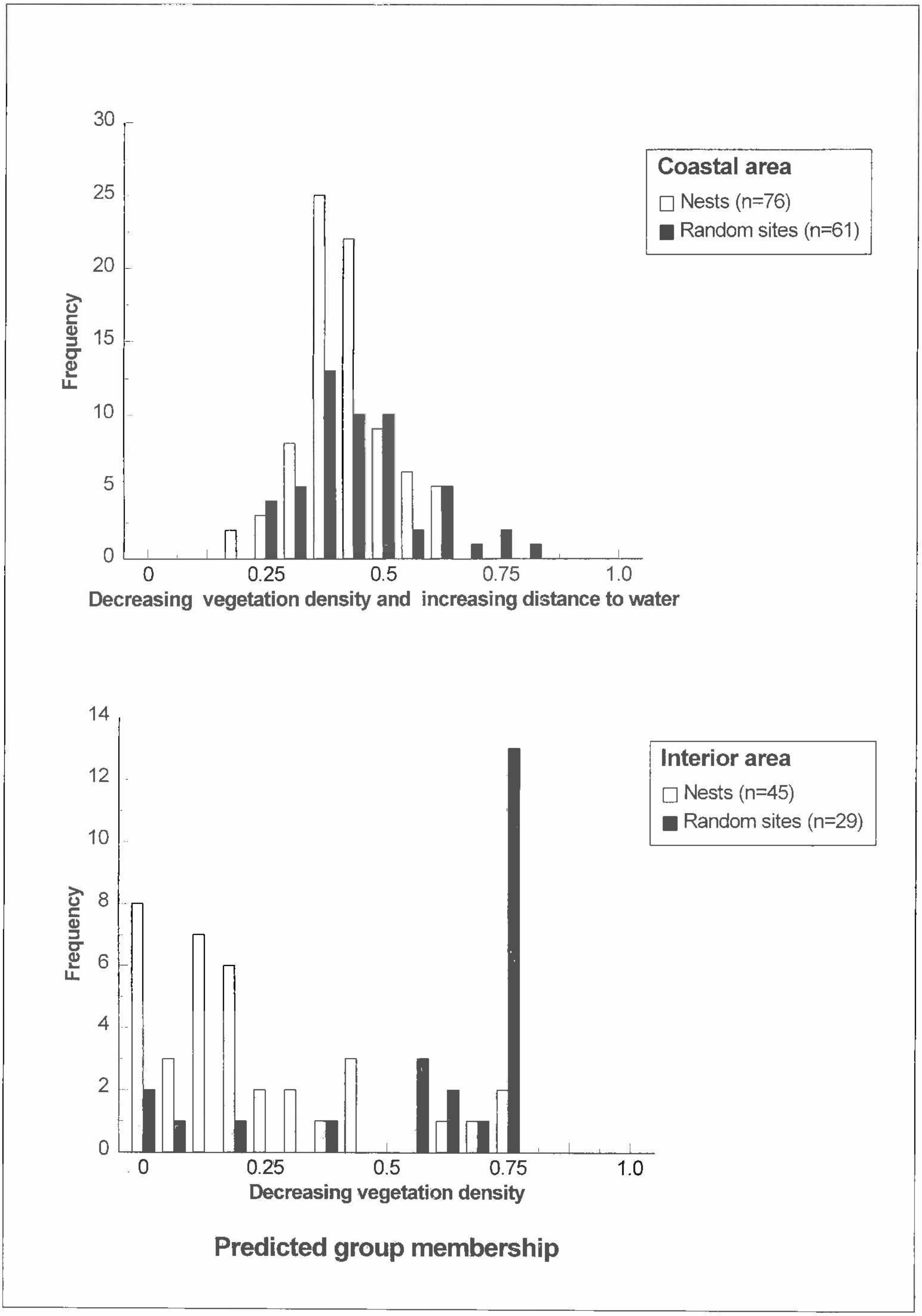

Figure 3. Predicted probabilities of group membership based on logistic regressions of habitat variables for coastal and interior study areas.

break-up occurred on 16 and 10 June, respectively, and mean nest initiation date occurred within seven days of break-up in both years. We attribute differences in interior area initiation dates between years to spring storms and flooding that delayed break-up and nesting in 1994.

Clutch Size

Kistchinskii & Flint (1974) noted a larger average clutch size on the IRD (5.56 eggs) than observed in this study after they excluded small 'repeat' clutches (< 4 eggs). However, their total sample size (n = 9) was small. With a larger sample size (n = 101), Kondratyev & Zadorina (1992) reported an average clutch size of 4.6 eggs for Spectacled Eiders on the Chaun River Delta **(Figure 1)**, which is similar to our estimate. On the Y-K Delta, (Grand & Flint 1997), average clutch size (5.2 eggs; n = 263) was larger (t = 67.1, df = 447, P < 0.001) than on the IRD when all clutches were included. From a inter- and intraspecific analyses of several waterfowl species, Rohwer (1992) observed a slight decline in clutch size with increasing latitude and concluded that the most likely explanation is decreased nutrient availability among Arctic breeding species for egg laying and incubation. Swennen (1983) was unable to document such a tendency in the Common Eider across a broad latitudinal range (53E - 79E N) as a result of partial egg loss that may have biased average clutch size estimates. Because we found partial egg loss to be a rare occurrence, we conclude that smaller clutch sizes on the IRD, as compared to the Y-K Delta, are the result of latitudinal differences that delay timing of spring break-up, and thus nest initiation date. As a result, either fewer eggs can be laid due to the shortened time period of available nesting and brood rearing areas or female nutrient reserves are restricted due to longer migration distances, fewer spring forage opportunities, or increased energy requirements during clutch formation or incubation.

We observed a seasonal decline in Spectacled Eider clutch size on both study areas and in both years. Kistchinskii & Flint (1974) did not investigate seasonal decline in clutch size, but a similar rate of decline has been documented for Spectacled Eiders nesting on the Y-K Delta, Alaska (Dau 1976, Grand & Flint 1997). While differences in latitude appear to delay initiation date and shorten the nesting season, similar factors relating to the cost of laying eggs later in the season appear to operate in both populations, resulting in a similar rate of decline in clutch size. Seasonal decline in clutch size is a nearly ubiquitous trait among waterfowl (Rohwer 1992). Dau (1976) suggested that earlier, larger clutches were initiated by older, more experienced females. A similar conclusion was reached by Baillie & Milne (1982) in a study of the Common Eider *Somateria mollissima*. Among other waterfowl species, nutritional condition has been related to nest initiation date, with females with smaller nutrient reserves having smaller clutches later in the season (Esler & Grand 1994).

Of nests monitored by Grand & Flint (1997) on the Y-K Delta, 24% contained at least one inviable egg, which they attributed to embryonic mortality or infertility, a possible outcome of exposure to lead shot during the breeding season (Franson *et al.* 1995, Flint *et al.* 1997). In contrast, only one inviable egg was found in a sample of 291 eggs in 1995 on the IRD. Of 11 male and 12 female Spectacled Eiders caught in 1995 during early spring (12 - 16 June), only one male had an elevated blood lead level (M. R. Petersen, *pers. comm.*). However, Flint *et al.* (1997) showed that the probability of lead exposure on the Y-K Delta was lowest during early spring. Thus our sample may not truly reflect lead contamination conditions on the IRD. Further research is needed to fully evaluate lead exposure rates on the IRD and the relationship between lead contamination and egg viability.

Nesting Success

No data are available for historic rates of nesting success of Spectacled Eiders on the IRD. The daily survival rate of nests and estimates of nesting success on the IRD in 1995 are within the range of values reported for the Y-K Delta (Grand & Flint 1997). However, the daily survival rate and nesting success estimate for 1994 on the IRD is below the range ever observed in Western Alaska. We suggest that such low values of nesting success in some years are sustainable when interspersed with years of higher productivity. Sea ducks are a long-lived species group with relatively low reliance on annual recruitment for population maintenance. Population dynamics of Spectacled Eiders is probably more affected by variation in adult survival, as has been found in other species with similar life history characteristics (Goudie *et al.* 1994, Schmutz *et al.* 1997).

We found no evidence that our nest visitation adversely influenced nesting success. Previous studies have also found that nest visits do not influence depredation (Sedinger 1990, Grand & Flint 1997) unless visits occur at rates much higher than typical nest monitoring (Esler & Grand 1993) or if nests are not covered by observers after each visit (Vacca & Handel 1988).

Nest Site Habitat

Analysis of micro habitat features on the two study areas revealed that vegetation height and density were more important predictors of Spectacled Eider nest sites on the interior study area than on the coast. Interior nests were found almost exclusively within a Glaucous and Herring Gull colony and the additional cover may have provided protection from Gulls, especially during laying when females were less likely to be on the nest. Coastal study area nests did not show this tendency, but were closely associated with structural habitat features that possibly served to elevate nests above the wet marsh tundra typical of the coastal islands.

Kistchinskii & Flint (1974) concluded that most Spectacled Eiders on the IRD sought out gull colonies for nesting, typically on small islands within large lake basins. Other studies have found that eider nesting success is greater when nests are situated near avian species that actively defend nest site territories. For example, Common Eider egg loss was lower among nests placed close to Snow Goose *Chen caerulescens* nests and when situated within gull colonies (Gerell 1985, Götmark & Åhlund 1988, Götmark 1989). Kellett & Alisauskas (1997) found that King Eider *Somateria spectabilis* nesting success was improved when nests were associated with nesting Arctic Terns. Although we did not test the preference of eiders for gull colonies, we conclude that other factors besides aggressive associated species may also be involved in nest site selection. For example, coastal area nests were not associated with gull, jaeger or tern nests and coastal study area nests were only marginally less successful than interior nests.

We observed two years with vastly different estimates of nesting success and propose that the probability of nest predation may depend less upon small scale habitat features and more on predator access to insular habitats. Robertson (1995) observed that once an Arctic Fox *Aloplex lagopus* gains access to an insular island nesting area, all nests are subject to predation. During ground surveys, we observed nest densities to be low on most mainland areas where nests are presumably more accessible to mammalian predators. Additionally, nearly half of all successful 1994 coastal nests (n = 13) were on the same island, suggesting that this island escaped Arctic Fox visitation.

We suggest that female Spectacled Eiders are responding to large scale geographical features that afford better protection from land-based predators such as the Arctic Fox, an important predator of arctic nesting birds (Larson 1960, Reed 1975). Such large scale habitat selection has been suggested for Common (Robertson 1995) and King Eiders (Kellett & Alisauskas 1997) as nesting success increased for nests located on islands farther from the mainland where mammalian predators were rare. This tendency has also been hypothesised for other avian species where habitat characteristics of nests and surrounding random sites do not differ (Knopf & Sedgwick 1992, Seamans & Gutiérrez 1995).

Conservation Implications

The Spectacled Eider is the most abundant waterfowl species on the IRD (Pearce et al., unpublished data) and with the decline of

Spectacled Eiders in western Alaska (Stehn *et al.* 1993, Ely *et al.* 1994), the IRD now has the largest breeding population known to exist within the species' range (U.S. Fish & Wildlife Service 1993, B. Elldridge, *pers. comm.*). A moratorium on hunting currently exists for all eider species in Yakutia as Steller's and Common Eider are included in the Red Book of the Yakutian Republic (Solomonov 1987). However, Syroechkovskii & Zöckler (1997) estimate that 700-1500 Spectacled Eiders are shot each year on the Yana River Delta in northern Yakutia. Current harvest levels on the IRD are unknown.

The historical harvest of waterfowl and recognition of the IRD as an important breeding area for unique Beringian species prompted Uspenskii et al. (1962) to suggest the creation of a nature preserve on the IRD for the management and conservation of these birds. Conservation measures have been initiated in the Republic of Sakha (Yakutia) through the creation of several nature reserves between the IRD and Khromskaya Bay. Hunting of all bird species is currently closed within the coastal zone (from the coast to 30 km inland) of the IRD and Khromskaya Bay.

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