FINAL REPORT
31 May 2002

Nesting Status of the Common Eider in the Central Alaskan Beaufort Sea, Summer 2001

Prepared for

BP EXPLORATION (ALASKA) INC.
Environmental Studies Group
P.O. Box 196612
Anchorage, Alaska 99519-6612

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P600

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This report was prepared under contract to BP Exploration (Alaska) Inc.
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Cite report as:

Noel, L.E., R.J. Rodrigues, and S.R. Johnson. 2002. Nesting status of the common eider in the central Alaskan Beaufort Sea, summer 2001. Report for BP Exploration (Alaska) Inc., by LGL Alaska Research Associates, Inc., Anchorage, Alaska. 66 p.

Cover Photo by John Ward

ABSTRACT

Global sea duck populations appear to be in decline, including the Pacific race of the common eider (*Somateria mollissima v-nigrum*). Whether or not this decline is expressed in nest numbers found in the vicinity of Alaska's North Slope oilfields in not known. To assess the nesting status of common eiders in this region, common eider, glaucous gull (*Larus hyperboreus*), and arctic tern (*Sterna paradisaea*) nests were located on 9 barrier islands along the central Alaskan Beaufort Sea coast from Thetis Island to the Stockton Islands during 12–16 July 2001. Common eider nests were most numerous, accounting for 82% (110 of 134) of all active nests within the approximately 308.1-ha area searched. Glaucous gull and arctic tern nests represented approximately 16% (21 of 134) and 2% (3 of 134), respectively, of all active nests. Mean and 95% confidence intervals of clutch size for common eider nests were 2.7 ± 0.43 eggs per nest ($n = 43$) and for glaucous gulls 2.4 ± 0.39 eggs per nest ($n = 16$). Active common eider nests were not distributed evenly across islands and island groups searched during 2001 either in proportion to island surface area ($P < 0.001$), or in proportion to the available island area with driftwood habitat ($P < 0.001$). In both cases, there where more active nests on the McClure Islands and Lion Point than expected, and fewer active nests on the Stockton Islands than expected. Of the islands searched during 2001, Narwhal Island supported the most active common eider nests (27%, 30 of 110) although nest density was highest on Duck Island #1&2 and on Lion Point. Duck Island #1&2 also supported the highest number and density of glaucous gull nests. Of the 620 active and failed common eider nest sites with habitat data, 3 nest sites (<1%) were within buildings, 23 nest sites (4%) had no driftwood, 307 nest sites (49%) were located in low-density driftwood, 218 (35%) were in medium-density driftwood, and 69 (11%) were in high-density driftwood. More active nests than depredated nests were found in high-density driftwood, and fewer were in low-density driftwood on islands searched during 2001 ($P < 0.001$). Active and depredated nests were distributed similarly within medium-density and no driftwood habitats. Predation by arctic fox and glaucous gulls at the islands searched in 2001 had a marked impact on nesting success of common eiders (82% of 620 nests were depredated). Because common eiders are long-lived and exhibit remarkable fidelity to nest sites, it seems reasonable to concentrate nest searches on those islands which consistently support large numbers of nesting eiders. The most productive nesting islands from 1970-2001 have included Cross Island (mean = 116.8 nests/year), Pole Island (mean = 59.1 nests/year), Stump Island (mean = 48.9 nests/year), Egg Island (W) (mean = 45.8 nests/year), Lion Point (mean = 48.0 nests/year), and Thetis Island (mean = 39.4 nest/year). During the period 1970-1991, many islands had 14 or more years of data. During the period 1998-2001 most islands had 3 years of data. The mean annual number of nests for 25 islands was lower during 1970-1991 (485 nests/year) than during 1998-2001 (589 nests/year). Variation for individual islands was high and the paired difference for 1970-1991 (19 ± 11.6 [95% confidence limit] nests/island) and 1998-2001 (24 ± 13.3 [95% confidence limit] nests/island) by individual island was not significant ($P = 0.236$). Variation in timing of nest searches across years may influence the number of active nests counted because of missed late-initiated nests, early failed nests, or not recognizing some empty nests as hatched.

Key words: arctic tern, driftwood habitat, egg depredation, glaucous gull, *Larus hyperboreus*, *Somateria mollissima v-nigrum*

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INTRODUCTION

Global sea duck populations appear to be in decline, including the Pacific race of the common eider (*Somateria mollissima v-nigrum*; Elliot 1997; USFWS 1999). Oil and gas exploration and development activities have been implicated in nesting failures by causing disturbance, nest abandonment, habitat destruction, and facilitating nest and duckling depredation.

Although several hundred thousand eiders of 4 species migrate to the Beaufort Sea each spring (Dickson 1997), only 2000 to 3000 common eiders (*Somateria mollissima v-nigrum*) nest along the Beaufort Sea coast of Alaska (Johnson and Herter 1989, Johnson 2000). Most common eiders nest in loose aggregations or colonies on coastal sand and gravel barrier islands and many of the most productive aggregations occur in driftwood accumulations on relatively high-elevation islands that lie in the flood plumes of large rivers. Common eiders initiate nests during mid- to late June (Johnson and Herter 1989), producing an average of 4 eggs, which they incubate for approximately 26 days. Female common eiders generally select nest sites in areas with relatively dense driftwood and/or beach rye grass (*Elymus arenarius*) that provide concealment for the hen and nest. However, common eider nests are sometimes located on bare sand/gravel without driftwood or vegetative cover. Peat banks may also be used for nesting, with hens making nest bowls within the eroded and terraced peat shorelines. Hatching success is positively correlated with cover density (Schamel 1977, Johnson et al. 1987). Broods remain near lakes, in tidal ponds or lagoons, or in the nearshore-ocean for up to 6 to 12 weeks before migrating out of the Beaufort Sea (Johnson 2000). Details on the biology of common eiders in the Alaskan Beaufort Sea are described by Johnson (2000).

Predation on eggs and ducklings by arctic foxes (*Alopex lagopus*) and glaucous gulls (*Larus hyperboreus*) can be heavy in some years (Larson 1960), and has been shown to be a major factor in population declines of common eiders in southern Sweden (Pehrsson 1973). A study that assessed impacts of petroleum development activities on nest success of common eiders on Thetis Island, off the Colville River delta, indicated that restrictions in low-level aircraft over-flights, limited human intrusions, and removal of arctic foxes, substantially increased common eider hatching and fledging success compared to most other wild populations (Johnson 1984, Johnson et al. 1987).

Other species that nest on barrier islands include glaucous gulls and arctic terns (*Sterna paradisaea*). In the Alaskan Beaufort Sea, glaucous gulls nest on coastal gravel/sand bars and low islands (Johnson and Herter 1989), and are most abundant on barrier islands adjacent to river outflows. As with common eiders, glaucous gulls probably select these islands because they are surrounded by open water during spring runoff, which isolates these sites from mammalian predators. Barrier islands provide gravel/sand areas with sparse vegetation, which is the preferred nesting habitat for arctic terns (Hawksley 1957 in Johnson and Herter 1989).

Study Rationale

Recently there has been concern over the apparent decline in 10 of the 15 species of North American sea ducks (Elliot 1997, USFWS 1999). These include species occurring within the central Alaskan Beaufort Sea: long-tailed duck (*Clangula hyemalis*), common eider, king eider (*Somateria spectabilis*), spectacled eider (*Somateria fischeri*), Steller's eider (*Polysticta stelleri*), black scoter (*Melanitta nigra americana*), surf scoter (*Melanitta perspicillata*), and white-winged scoter (*Melanitta fusca deglandi*). Specific concern has been expressed with the reported 54% decline in the number of common eiders migrating past Point Barrow in the spring between 1976 and 1994 (Suydam et al. 1997, USFWS 1999). The Alaska Natural Heritage Program, the U.S. Geological Survey Biological Resources Division and the Alaska Audubon have listed the common eider as a species of concern.

The development of oil and gas reserves in the nearshore Beaufort Sea increases the risk of damage and/or disturbance to biological resources from industry related activities such as aircraft over-flights, marine vessel traffic, construction of gravel islands, drilling activities, accidental oil or fuel spills, and increased predator populations. Understanding the impact of ongoing operations and projected developments to productivity and survival of common eiders is essential for planning and development of mitigation strategies. Continued monitoring of nesting common eiders on the barrier islands will provide useful information to resource agencies and industry during planning, development, and operation of nearshore oil and gas facilities.

Since the early 1970s, sporadic agency and industry sponsored studies have documented the nesting effort of common eiders on Beaufort Sea barrier islands between the Colville and Canning Rivers (Schamel 1974; Gavin 1976; Divoky 1978; Johnson and Richardson 1981; Johnson 1984; USFWS, Office of Ecological Services, Fairbanks, Alaska [unpublished data]; Noel et al. 1999a, 2001; Noel and Johnson 2000; Flint et al. 2001; Lanctot et al. 2001). Research efforts declined during the 1990s, but with prospects for development in the Point Thomson Unit, were resumed in 1998 (Noel et al. 1999a, 2001; Noel and Johnson 2000; Flint et al. 2001; Lanctot et al. 2001). Since 2000, LGL Alaska Research Associates, Inc. and the U.S. Geological Survey, Alaska Science Center have cooperatively censused the central Alaskan Beaufort Sea barrier islands for nesting common eiders. Dividing the effort among these islands has allowed for the collection of a more complete data set.

Issues

Four aspects of oil and gas development can affect common eiders and other species that nest on barrier islands in the central Alaskan Beaufort Sea: (1) disturbance and displacement during nesting, (2) loss of nesting habitat, (3) potential increased predation by arctic foxes, glaucous gulls, grizzly bears (*Ursus arctos*), and polar bears (*Ursus maritimus*) that may be attracted to development, and (4) exposure to spilled oil or fuel from nearshore developments.

Objectives

The objectives of this study were to:

1. Determine the distribution and abundance of common eiders and other species nesting on barrier islands in the central Alaskan Beaufort Sea for 2001.
2. Determine the presence of mammalian and avian predators on these barrier islands and document nest depredation.
3. Mark a sample of common eider females to determine nest site fidelity among selected barrier islands.

ISLAND DESCRIPTIONS

It is important to understand that the configurations of the barrier islands along the coast of the central Alaskan Beaufort Sea are constantly changing (Figure 1). Ice movement and ice override along the northern sides of the barrier islands often rearrange large quantities of sand and gravel on the barrier islands, primarily during late winter/spring when heavy winter ice is driven against the barrier islands by strong easterly winds. During the summer and fall open water period, strong winds, waves, and long-shore currents move large quantities of sand and gravel westward, thereby eroding away northern and eastern portions of the islands and adding to the western ends of the islands.

In addition to these constructional events caused mainly by ice, winds, waves, and currents, strong west and southwest winds during the fall often cause storm surges that result in significant increases in nearshore sea level and flooding of low-lying portions of the barrier islands. These flooding events often rearrange driftwood and other buoyant debris (i.e., common eider nesting habitat) in such a way that it is concentrated on the highest portions of the barrier islands (Figure 2). In some instances, large sections of tundra or vegetation on barrier islands may be affected by these storm surges. The surges of seawater onto tundra and other vegetation on the barrier islands usually result in the loss of these communities and further exposure to winds, waves and ice accelerates the processes of coastal erosion and barrier island habitat alteration.

The following descriptions of the barrier islands used as nesting habitat by common eiders along the central Alaskan Beaufort Sea coast are based on both historical and current information about the islands. Island descriptions are based on a combination of digital base maps provided by BP Exploration (Alaska) Inc. (BPXA) Cartography Department; field notes; aerial videography of the islands during 2000-2001 provided by Mike Anthony of the U.S. Geological Survey, Alaska Science Center; and descriptions by Angus Gavin (1976). The digital maps for the Jones/Return Islands based on 1981-1993, 1500 ft aerial photography (BPXA Cartography metadata) were updated using 2000 photography. Digital maps for islands from Reindeer

Island to Flaxman Island were updated based on 1998 aerial photography. Updated files were used for area and distance computations. Elevation data in descriptions are based on the most recent digital maps, unless otherwise cited. Some comparisons of changes between map sets are given to illustrate the dynamic nature of these islands.

The Jones Islands

Thetis Island (52 ha) is located in the spring flood plume of the Colville River about 9 km northeast of the river delta and 8.6 km from the coastline. Thetis Island is approximately 4.8 km long with a maximum width of ~500 m, although most of the island is less than 100 m wide. The maximum elevation of the island is about 6 ft (2 m, Gavin 1976) with about 30% of the island surface higher than 1 m above sea level. Substrates consist of fine sand and gravel (Gavin 1976). Driftwood and vegetation that may provide nesting cover for eiders occurs on less than 10% of the island surface. Areas with vegetation, including *Puccinellia phryganodes*, and *Artemisia* sp., are primarily located in the central portion of the island. An exploratory drilling pad was constructed on the western lobe of Thetis Island and remains as the highest portion of the island. A small cabin was located near the middle of island but has since eroded away. Current human use of this island was documented during common eider nesting surveys in 1999-2001 (Noel and Johnson 1999, Noel et al. 2001). During 1999, Thetis Island remained intact, but during 2000 and 2001 the island was separated by small channels into 3 pieces.

Spy Island (60 ha) is located about 18 km from the Colville River delta and 5.7 km from Oliktok Point. Spy Island is approximately 5.5 km long with a maximum width of 200 m, although most of the island is less than 100 m wide. The maximum elevation of the island is about 3-4 ft (1 m, Gavin 1976), with about 15% of the area higher than 1 m above sea level. Substrates consist of silt, very fine sand, and gravel (Gavin 1976). There is no vegetation cover on the island and driftwood cover occurs across 25% of the island surface. Spy Island has increased 20% in surface area based on comparisons of 1981-1993 mapping with 2000 mapping.

Leavitt Island (42 ha) occurs as a spit west of Pingok Island, and is often attached to Pingok Island. Located 6.3 km offshore from No Point (Milne Point Unit F Pad), Leavitt Island is approximately 5 km long with a maximum width of 150 m, although most of the island is less than 100 m wide. The maximum elevation of this island is 6.2 ft (2 m), with 26% of the island surface higher than 1 m above sea level. Substrates consist of silt, sand and various sizes of gravels (Gavin 1976). High to medium density-driftwood cover occurs across about 20% of the island surface, but there is no vegetation cover. Leavitt Island was attached to Pingok Island during eider nest searches in 1999, but a break that formed between Pingok and Leavitt during 2000 still exists. Leavitt Island has decreased 12% in surface area based on comparisons of 1981-1993 mapping with 2000 mapping.

Pingok Island (~300 ha) is located 3.4 km north of Milne Point. Pingok Island is 6.8 km long with a maximum width of 950 m, although most of the island is less than 500 m wide. Nearly 85% of Pingok Island is covered by tundra vegetation. Maximum elevation on the island is 16.6 ft (5 m) on the western tundra lobe. Fine gravels cover 15% of the island surface and are found along the seaward side of the island and at either end (Gavin 1976). Driftwood accumulations on gravel areas and beach ryegrass mounds at the eastern edge of the island that may provide nesting cover for eiders occur across 25% of the island's gravel surface. The gravel portion of Pingok Island has increased 36% in surface area based on comparisons of 1981-1993 mapping with 2000 mapping.

Bertoncini Island and Peat Island (38 ha) are located 3.4 km north of the coastline northeast of Milne Point. Bertoncini Island is 5.2 km long, with a maximum width of 320 m, although most of the island is less than 50 m wide. The maximum elevation of Bertoncini Island is 10.3 ft (3 m) on the tundra covered portion, and 10% of the gravel surface is higher than 1 m above sea level. Bertoncini Island was described by Gavin (1976) as completely tundra covered with fine silt, sand and gravels. Comparison of maps in Gavin (1976) with 1981-1993 and 2000 mapping indicates that tundra covers approximately 21% of the island, and gravel spits have formed off both the west and east ends of the island. Connectivity between Bertoncini Island and Bodfish Island to the east has changed in recent years. Portions of the spit on the west end of Bertoncini may also have extended to Peat Island and then westward to Pingok Island in past years, and there appears to be inconsistency in the designation of the location and extent of the island boundaries. Peat Island was a small island consisting almost entirely of peat mounds and the remains of a dwelling (vertical driftwood poles and a collapsed roof structure); the peat portion of this island disappeared during a fall storm in the late 1980s and now consists entirely of sand and gravel that is sometimes connected to Bertoncini Island and/or Pingok Island. The gravel portion of Bertoncini Island has increased 25% in surface area based on comparisons of 1981-1993 mapping with 2000 mapping.

Bodfish Island (60 ha) is located east of Bertoncini Island 3.3 km from the mainland coast. Bodfish Island is 2 km long with a maximum width of 700 m. Maximum elevation is 16.7 ft (5 m) on the tundra covered portion of the island, with 20% of the gravel surface of the island higher than 1 m above sea level. Bodfish Island was described by Gavin (1976) as completely tundra covered. Recent mapping indicates that tundra covers 52% of Bodfish Island and gravel spits have developed on both the east and west ends of the island. Scattered driftwood covers about 5% of the island's gravel surface. The gravel surface area of the island has increased 31% based on comparisons of 1981-1993 mapping with 2000 mapping.

Cottle Island (104 ha) is located approximately 2.6 km from the coastline. Cottle Island is 8.1 km long with a maximum width of 300 m, although most of the island is less than 100 m wide. Current mapping identifies 3 patches of tundra with elevations greater than 10 ft (3 m) covering 12% of the island. About 30% of the gravel surface is higher than 1 m above sea level. Gavin (1976) described Cottle Island as long and thin, composed of sand and fine gravels with a small patch of tundra, but otherwise unvegetated. Driftwood occurs across about 15% of the island surface. Gavin (1976) shows a distinct breech between Cottle Island and Long Island. Mapping since 1981-1993 has consistently shown a connection between Cottle Island and Long Island, although a low area between the islands that over-washes is evident. The gravel area of the island has increased 20% based on comparisons of 1981-1993 mapping with 2000 mapping.

The Return Islands

Long Island (110 ha) is located 2.8 km from coast, with the eastern third of the island 4.2 km from Kuparuk River delta. The eastern portion of Long Island is within the spring flood plume of the Kuparuk River. Long Island is 10.8 km long, 125 m wide, and has no vegetation. The maximum elevation is 9.2 ft (3 m) with 28% of the surface area higher than 1 m above sea level. Gavin (1976) described Long Island as a long thin island, broken in places by narrow, shallow cuts, and composed of silt, sand, and various grades of gravel, with considerable debris (logs, etc.). Scattered driftwood occurs across about 6% of the island surface. During summer 1999, Long Island was contiguous. Long Island was divided into 2 parts based on mapping from 1981-1993, and into 3 parts based on 2000 mapping. The gravel surface area has increased 22% based on comparisons of 1981-1993 mapping with 2000 mapping.

Egg Island (10 ha) is located 2.1 km from the coast within the spring flood plume of the Kuparuk River. Egg Island is 2 km long with a maximum width of 150 m, although most of the island is less than 75 m wide. Maximum elevation is 5.8 ft (1.8 m), with 32% of the island surface area higher than 1 m above sea level. Gavin (1976) describes Egg Island as composed of silt, fine sand, and a mixture of gravels with little or no vegetation and some driftwood. Scattered driftwood covers 5-10% of the island surface. During summer 1999, Egg Island was contiguous, but during 2000 and 2001 the island was split into 2 parts similar to previous descriptions (Gavin 1976). The island surface area has decreased 4% based on comparisons of 1981-1993 mapping with 2000 mapping.

Stump Island (52 ha) is less than 1 km from the coast and lies within the spring flood plume of the Kuparuk River. Stump Island is approximately 6.5 km long with a maximum width of 500 m, although most of the island is less than 75 m wide. Maximum elevation is 6.8 ft (2 m), and 17% of the surface area is higher than 1 m above sea level. Gavin (1976) describes Stump Island as composed of silt and fine sand with some pea sized gravel, no vegetation, and some driftwood. Driftwood occurs across 25% of the island. The surface area of Stump Island has increased 33% based on comparisons of 1981-1993 mapping with 2000 mapping.

The Midway Islands

Reindeer Island (35 ha) is located 12 km from the coast north of Prudhoe Bay. Reindeer Island is 3.5 km long with a maximum width of 300 m, although most of the island is less than 100 m wide. Gavin (1976) described Reindeer Island as a low, long, thin island with an elevation of 3-4 ft (1-1.2 m), composed of silt and fine sand with no vegetation. Detailed topographic information does not exist for Reindeer Island; about 20% of the island's surface is higher than 1 m above sea level. Driftwood occurs across about 10% of the island surface. Reindeer has been split into 2 parts since summer 2000.

Argo Island has existed as only a submerged shoal since our common eider nesting surveys began in this area in 1999.

Cross Island

Cross Island (58 ha) is 17 km from the Sagavanirktok River delta. Cross Island is 4 km long with a maximum width of approximately 350 m. Detailed topographic information does not exist for Cross Island; about 40% of the island's surface is higher than 1 m above sea level. Gavin (1976) described Cross Island as composed of silt and sand with coarse gravels and some patches of vegetation, and an old cabin near the center of the island which did not appear to be active. Scattered driftwood, patches of concentrated driftwood, and some vegetation that provide nesting cover for eiders occur on about 20% of the island surface. Cross Island is used as a whaling station by Nuiqsut whaling captains and contains numerous structures and whale bones. The western end of the island has been modified by piling gravel to an elevation of 20 ft (6 m) or higher to support buildings.

No Name Island (5 ha) is a narrow spit southeast of Cross Island, 14 km from the Sagavanirktok River. No Name Island is broken into several pieces, and is at most 100 m wide and 0.8 km long. Elevation was 3-4 ft (1 m) above sea level (Gavin 1976). There is no detailed topographic information for No Name Island; about 30% of the island is higher than 1 m above sea level. Gavin (1976) described No Name Island as composed of silt, sand, and fine gravel with no vegetation and scattered driftwood. About 5% of the island surface contains scattered driftwood.

The McClure Islands

Narwhal Island (38 ha) is located 15 km north of Point Brower. Narwhal Island is split into 2 parts with a total length of 3.8 km. The maximum width of the island is 275 m, although most of the island is less than 100 m wide. Detailed topographic information is not available for Narwhal Island; about 30% of the island surface is higher than 1 m above sea level. There are a few buildings and wooden structures on the western lobe of the island. Gavin (1976) described Narwhal Island as composed of silt, fine sand with some pockets of coarse gravel, and a fair amount of driftwood. About 10% of the island surface contains potential nest cover material.

Jeanette and Karluk Islands (19 ha) are located 16 km north of the mainland coast. Jeanette Island and Karluk Island occur as 6 small pieces, 3 km in total length. The maximum width is approximately 130 m, although most of the islands are less than 70 m wide. Gavin (1976) described Jeanette and Karluk as low islands about 3-4 ft (1 m) high composed of silt, fine sand, and some pea sized gravel with scattered driftwood. Detailed topographic information is not available for these islands; an estimated 20% of the surface is higher than 1 m above sea level, with about 5% of the surface containing potential nest cover material. Because it is difficult to distinguish boundaries for these islands, even for historical mapping (Gavin 1976), we have combined these islands for discussion and analyses.

The Stockton Islands

Pole Island (71 ha) is located 14.2 km from the Shaviovik River delta. Based on current nomenclature, Pole Island is 5.1 km long; with a maximum width of 450 m. Gavin (1976) described Pole Island as 3-4 ft (1-1.2 m) above sea level, composed of silt, sand and pea gravel with coarser gravels along the higher elevations. No detailed topographic information exists for Pole Island; about 40% of the island's surface area is higher than 1 m above sea level. About 30% of the island contains potential nest cover material. Remains of several structures have accumulated sand and support clumps of beach ryegrass which are used for nesting by common eiders and glaucous gulls. Gavin (1976) notes a Cold Island as the second island in the Stockton chain. The location of Cold Island, according to Gavin's (1976) map, is between Pole Island and Belvedere Island. Gavin's description of Cold Island fits what appears on current maps as Belvedere Island (Gavin 1976). Gavin's description of Belvedere Island matches the unnamed shoals south of the current Belvedere Island (Gavin 1976).

Belvedere Island (29 ha) is located 12.7 km from the mainland coast. As currently represented on maps, Belvedere Island is 4.4 km long, and composed of several pieces. The maximum width is 250 m, although most of the island is less than 50 m wide. Gavin (1976) described this island as 3-4 ft (1-1.2 m) in elevation, composed of silt, sand and fine gravel, with patches of coarser gravels, and no vegetation. No topographic information exists for Belvedere Island; about 30% of the island is higher than 1 m above sea level, with about 10% of the island containing potential nest cover materials.

The Maguire Islands

Challenge Island (19 ha) is located 5.5 km from the mainland coast between Bullen Point and Point Hopson. Challenge Island is 3.5 km long with a maximum width of 170 m, although most of the island is less than 50 m wide. Gavin (1976) described Challenge Island as 3-4 ft (1 m) in elevation, composted of silt, fine sand and some gravel with no vegetation. No topographic information exists for Challenge Island; about 30% of the island is higher than 1 m above sea level. About 10% of the island surface contains potential nest cover material. The divisions between Challenge and neighboring Alaska Island have changed over the years, as with other island groups. Challenge Island, as described by Gavin (1976), represented only a portion of what is currently mapped as Challenge Island.

Alaska Island (25 ha) is located 3.9 km from the mainland coast. Alaska Island is 3.6 km long, with a maximum width of 200 m, although most of the island is less than 100 m wide. No topographic information exists for Alaska Island; about 20% of this island is higher than 1 m above sea level. Gavin (1976) describes Alaska Island, the largest island in the Maguire group, as quite narrow and composed of silt, fine sand and some gravel, with scattered pieces of driftwood. About 10% of the island's surface contains potential nest cover material. It appears that part of what was once Alaska Island is now part of Challenge Island (Gavin 1976).

Duchess Island (34 ha) is located 3.9 km from the mainland coast. Duchess Island is 3.9 km long with a maximum width of 350 m. No detailed topographic information exists for Duchess Island; about 30% of the island is higher than 1 m above sea level. Gavin (1976) described Duchess Island as composed primarily of silt and fine sand, with some gravels, and no vegetation. About 15% of the island surface contains potential nest cover material. Current mapping shows Duchess and North Star islands (below) connected, although previous mapping has shown these islands as discontinuous.

North Star Island (26 ha) is located 3.7 km from the mainland coast. The island is 3.4 km long with a maximum width of 250 m, although most of the island is less than 100 m wide. An exploration pad was constructed on North Star Island and remains at the western end of this island. Gavin (1976) described North Star Island as composed of silt, sand and pea sized gravel, without vegetation, and subject to ice scour. No topographic information exists for North Star Island; an estimated 30% of the island is greater than 1 m high. Approximately 15% of the island contains potential nest cover material. BPXA's Northstar Development is located on an artificial island formerly called Seal Island, which is north of the Return Island group (Figure 1).

Flaxman Island

Flaxman Island (367 ha) is 2.4 km north of the coast near the western edge of the Canning River delta. Flaxman Island consists of an eastern tundra-covered portion and a western gravel portion. This western spit has been variously referred to as ***Flaxman Island-West*** or ***Mary Sachs Island***. The gravel extension was connected to the tundra covered portion of Flaxman Island according to Gavin (1976), but has been disconnected in recent years. The western gravel island (56 ha; Flaxman Island-West or Mary Sachs Island) is 5 km long and generally less than 150 m wide. This gravel portion of Flaxman Island was described by Gavin (1976) as about 3 ft (1 m) in elevation and composed of silt, sand and some gravel. No detailed topographic information exists for Flaxman Island-West; about 20% is higher than 1 m above sea level. About 5% of Flaxman Island-West contains potential nest cover material.

The eastern tundra portion of ***Flaxman Island-East*** is 6 km long, with a maximum width of 1 km, although most of the area is less than 500 m wide. Two abandoned exploration pads are located on this tundra portion of Flaxman Island. There is a gravel spit along the northwestern edge of Flaxman Island-East, and approximately 14 ha of this 297 ha island is composed of sand and gravel. About 30% of this 14 ha sand and gravel island is higher than 1 m above sea level. About 10% of the gravel portion of this island contains potential nest cover material.

Lion Point

Lion Point (6 ha), a gravel spit off the northwest corner of Tigvariak Island, is 5.5 km from the Shaviovik River delta. Lion Point is 1.9 km long, with a maximum width of 140 m, although most of the island is less than 50 m wide. The maximum elevation of this island is 2.6 ft (1 m), with no area higher than 1 m above sea level. This island is composed of loose gravels with some areas of fine sands. Driftwood is scattered across about 5% of the island surface. Lion Point was not connected to Tigvariak Island in 2001, although this spit has been connected in the past.

METHODS

We coordinated our search area during July 2001 with biologists from the U.S. Geological Survey, Alaska Science Center (ASC) to cover as many of the islands between Thetis Island and Brownlow Point as possible (Figure 1, Table 1). Nest searches were conducted by LGL Alaska Research Associates, Inc. (LGL) on Thetis Island, the Midway Islands (Reindeer), Cross Island, the Endicott Causeway, Duck Island #1&2, the McClure Islands (Narwhal and Jeanette), Lion Point, and the Stockton Islands (Pole and Belvedere). Nest searches were conducted by the ASC on Spy Island, the Jones-Return Islands, the Maguire Islands, and Flaxman Island in conjunction with common eider and long-tailed duck studies (Lanctot et al. 2001, Figure 1). The ASC searches were not as intensive as our searches for coverage across the island surface, and nest scrapes and driftwood cover were not recorded, although biologists visited islands several times to monitor nesting success (Flint et al. 2001, Lanctot et al. 2001). Our searches during 12-16 July 2001 covered the entire surface area of each barrier island and documented the number of nesting common eiders, glaucous gulls, and arctic terns (Figure 2, Table 1). During surveys, we recorded the number of active nests, failed nests, and nest scrapes for each species, and recorded any evidence of predators. Access to the islands was by Bell 212 twin-engine helicopter (Figure 2).

Nest searches were conducted on foot by 2 to 5 observers spaced across the width of the island. For each observation we recorded the species, nest type (scrape or nest), nest status (active, depredated, or unknown), and driftwood density and/or presence of vegetation near the nest or scrape. We tried to avoid flushing incubating hens from nests. If a hen did flush, the number of eggs was recorded and eggs were then covered with down and twigs to minimize their exposure to predators.

Driftwood density was classified into 4 categories based on a visual estimate of the percentage of ground covered by driftwood within a 1-m diameter area centered on the nest bowl. Density categories included none (0%), low (1% to 33%), medium (34% to 66%), and high (67% to 100%) density (Figures 3 and 4, after Johnson et al. 1987).

Survey track lines were recorded at 15-sec intervals using Garmin® XL12 Global Positioning System (GPS) receivers. Data from GPS receivers were downloaded daily and exported as ASCII text files. Nests were then geo-referenced by matching GPS recorded positions with date, time, and GPS number records in the nest site database. Available island areas were calculated using MapInfo Professional™ Geographic Information System (GIS). Area calculations were based on gravel habitats mapped at 1:6000 and 1:63,360-scale.

Nesting effort for each island was calculated as the number of nests and nest scrapes divided by the total number of nests and nest scrapes found on all islands searched. Nests included a pronounced bowl with eggs and/or some associated down (Johnson et al. 1987; Johnson 1990, 2000). Nests were classified as active if they contained one or more live eggs, were occupied by a laying/incubating female, or contained thickened eggshell membranes (evidence of successful hatching, Figure 5). Nest scrapes were depressions in the ground with or without small sticks but with no associated down (Johnson et al. 1987, Johnson 1990). Scrapes are frequently made by juvenile females attempting their first nests, or by adult females during early nest prospecting. These scrapes are subsequently abandoned when the juvenile female fails to nest or the adult female nests in a more suitable location. In some instances, scrapes may also be remnants of failed nests (Johnson et al. 1987).

Nests were considered depredated when eggshell fragments in the nest bowl or vicinity indicated a bird or mammal had eaten or dislodged the eggs, or when nests with down contained no eggs. Predator type was determined by signs near the disturbed nest such as tracks or scat, the characteristics of remaining egg fragments, or direct observation of predators on the island. Depredated eggs with rounded openings were generally attributed to avian predators, especially when there were no signs of other predators. Nests with down and no eggs or egg shell fragments were generally considered depredated by avian species when avian predators were also observed on the island, and there were no obvious signs of other predators.

To determine nest site fidelity among islands, we continued to band and mark a sample of female common eiders with nasal disks (Figure 5: Federal Bird Marking and Salvage Permit No. 21414-J). Color combinations of nasal disks allowed us to identify individual females. Common eider hens were first banded and marked on Narwhal Island in 1999. Before applying any additional nasal disks, we looked for females marked in 1999 and 2000 on Narwhal

Island to determine if these disks had caused any damage to the nares. Additional banding and marking efforts in 2001 were conducted on Narwhal Island. A salmon dip net was used to capture female common eiders as they sat on their nests. Stainless steel tarsus bands and colored nasal disks were applied. Standard bill and tarsal measurements and body weight were recorded. Glaucous gull chicks were captured opportunistically, and marked with adult size stainless steel tarsus bands lined with plasticine. The plasticine allows proper fit of the adult size band and wears out as the chick grows (Figure 5).

Chi square analyses (χ^2, Zar 1974), followed by habitat use-availability analyses (Neu et al. 1974, Manley et al. 1993) in some cases, were completed to test for differences in the distribution of active nests, predated nests and/or nest scrapes among islands and among habitats. Bonferroni-corrected confidence intervals were built about the used proportions of island habitats and compared to expected values based on the island surface area or the area of driftwood habitat cover for use-availability analyses (Neu et al. 1974, Manly et al. 1993). Expected values for use-availability analyses were calculated based on the area of individual islands or island groups, and estimated areas of driftwood habitat. Distributions of all nests and active nests among driftwood cover classes were assessed by comparing observed distributions to both even distributions, and distributions based on the proportions of nest scrapes and predated nests within each cover class using χ^2 analyses (Zar 1974). A Wilcoxon rank sum paired sample test (Zar 1974) was used to compare the current (1998-2001) mean number of active common eider nests for 25 islands with the historical mean (1970-1991).

RESULTS

This report presents the results of nest searches on Thetis Island, Reindeer Island, Cross Island, Duck Island #1&2, Narwhal Island, Jeanette Island, Lion Point, Pole Island, and Belvedere Island during July 2001 (Figure 1, Table 1).

Nesting Effort

Common eiders, glaucous gulls, and arctic terns were recorded nesting on central Alaskan Beaufort Sea barrier islands during July 2001 (Figures 6-12, Table 2). The total nesting effort was dominated by common eiders at 95% (total nests and pre-nesting scrapes recorded), followed by glaucous gulls at 4%, and arctic terns at 1% (Table 2). Common eider nests composed 82% of the total number of active nests, followed by glaucous gulls (16%), and arctic terns (2%) (Table 2). Of the 620 common eider nests recorded, 18% were active nests with live eggs or incubating hens, and 82% were depredated (Tables 2 and 3). The largest number of nests occurred on Pole Island where all nests were depredated. All common eider nests on Belvedere Island, which was attached to Pole Island, were also depredated. Active nests were rarely greater that 50% of the total number of nests on any of the barrier islands searched (Tables 2 and 3).

Mean and 95% confidence intervals (95% CI) of clutch size for common eider nests was 2.7 ± 0.43 eggs per nest ($n = 43$), and for glaucous gulls was 2.4 $\pm$ 0.39 eggs per nest ($n = 16$). Two arctic tern nests had 1 egg each and one nest had 2 eggs. Many incubating common eider hens remained undisturbed, which limited data on nest clutch sizes.

For all 3 species combined and for common eider alone, total nesting effort, expressed as the sum of active and failed nests, nests of unknown fate, and nest scrapes, was highest on Pole Island (Table 2). Narwhal Island, Cross Island, and Lion Point each had less than half the total nesting effort seen at Pole Island. Nesting effort on the remaining islands was much lower. Glaucous gull nesting effort was highest on Cross Island and Duck Island #1&2, followed by Reindeer, Thetis, and Belvedere islands. Total glaucous gull nesting effort was lower on the remaining islands. Most of the arctic tern nesting effort was concentrated on Cross and Pole islands (Table 2).

Active common eider nests were not distributed evenly across islands and island groups searched during 2001 either in proportion to island surface area (Table 4, $\chi^2 = 159.38$, df = 5, $P < 0.001$), or in proportion to the available island area with driftwood habitat (Table 5, $\chi^2 = 559.15$, df = 5, $P < 0.001$). In both cases, there where more active nests on the McClure Islands and Lion Point than expected, and fewer active nests on the Stockton Islands than expected (Tables 4 and 5). Combined active and depredated common eider nests were also not distributed evenly across islands and island groups searched during 2001 based on island surface area (Table 6, $\chi^2 = 498.62$, df = 5, $P < 0.001$), or based on driftwood habitat area (Table 7, $\chi^2 = 1479.97$, df = 5, $P < 0.001$). Results for island area and driftwood habitat area were consistent for 3 of 6 cases; Thetis Island with fewer than expected nests, Cross Island with fewer than expected nests, and Lion Point with more than expected nests (Tables 6 and 7). Results for island area and driftwood habitat area were inconsistent for 3 of 6 cases (Tables 6 and 7). Reindeer Island had fewer nests than expected based on island surface area, but numbers of nests were not different from expected based on available driftwood habitat area. The McClure Islands were within the expected number of nests based on island surface area, but had more nests than expected based on driftwood habitat area. The Stockton Islands had more nests than expected based on island area, but were within expected numbers based on driftwood habitat area (Tables 6 and 7).

Habitat

During 2001, the density of active common eider nests was highest at Duck Island #1&2, an artificial gravel exploration island, followed by Lion Point (Table 3). The density of active common eider nests on the remaining islands was much lower. The density of active glaucous gull nests was also highest on Duck Island #1&2 (Table 3).

Of 620 common eider nest sites, active and failed nests combined, with habitat data, <1% were inside abandoned buildings, 4% had no driftwood, 49% were located in low-density driftwood, 35% were in medium-density driftwood, and 12% were in high-density driftwood habitat (Figure 3, Table 8). Common eider nests were not distributed evenly among driftwood categories ($\chi^2 = 336.41$, df = 3, $P < 0.001$, Table 8). Nests occurred more frequently than expected, based on an even distribution, in medium- and low-density driftwood and less frequently than expected in high-density driftwood and no driftwood (Table 8). Common eider nest scrapes were also not distributed evenly among driftwood categories ($\chi^2 = 523.28$, df = 3, $P < 0.001$, Table 4). More common eider scrapes were in low-density driftwood cover, and fewer were in high-density, medium-density, and no driftwood.

These analyses, however, do not account for the availability of each category of driftwood habitat. Because the available area of each driftwood category is unknown, we compared the distribution of all nests with nest scrapes, and active nests with depredated nests to assess selection of habitat cover categories. The distribution of common eider nests was different from the distribution of scrapes among driftwood categories ($\chi^2 = 75.17$, df = 3, $P < 0.001$, Table 8). More nests than expected occurred in high- and medium-density driftwood, and fewer nests occurred in low-density driftwood. Nests and scrapes were not different in distribution in areas with no driftwood cover. Similarly, more active nests than depredated nests were in high-density driftwood and fewer were in low-density driftwood ($\chi^2 = 60.83$, df = 3, $P < 0.001$). Active and depredated nests were distributed similarly within medium-density and no driftwood habitats.

Vegetation cover at common eider nest sites may includes beach rye grass, seabeach sandwort (*Honckenya peploides*), lungwort (*Mertensia maritima*), and *Puccinellia phryganodes*. Vegetation was recorded at 112 common eider nest sites on 4 islands (Figure 3, Table A-1). Most of these sites were on Pole Island (99 sites) and on Cross Island (10 sites). Of the 99 nest sites on Pole Island with vegetation cover, 94 included beach rye grass. Beach rye grass was noted at 4 of the 10 nest sites on Cross Island. Pole Island and Cross Island were the only barrier islands searched during 2001 with beach rye grass habitat.

Glaucous gull nest sites occurred more frequently than expected, based on an even distribution, in low-density driftwood and less frequently than expected in high-density driftwood ($\chi^2 = 10.16$, df = 3, $P = 0.017$, Figure 4, Table 8).

Depredation

All 510 failed common eider nests were thought to have failed due to predation, primarily by arctic fox and glaucous gulls (Table 3). An arctic fox was observed on Pole Island during the nesting surveys in 2001 and was probably responsible for most of the depredation on that island. The same fox was probably responsible for most of the depredation on Belvedere Island, which was attached to Pole Island. Numerous observations of fox tracks were recorded on each of these islands. All common eider and glaucous gull nests on Pole and Belvedere islands were unsuccessful during the 2001 nesting season.

Most depredations of common eider nests on the remaining islands were probably due to glaucous gulls. Glaucous gulls were observed on all barrier islands searched during 2001 (Table 1). No live arctic foxes or fresh fox sign were observed on any islands other than Pole Island, Belvedere Island and possibly Lion Point; but a dead arctic fox in winter pelage was noted on Narwhal Island. Polar bears may have been responsible for some of the depredated common eider nests on Reindeer, Cross, Narwhal, and Belvedere islands where polar bear tracks and/or beds were observed. Muskoxen (*Ovibos moschatus*) tracks, likely made by muskoxen that accessed the island during winter, were observed on Pole and Belvedere islands but it is unlikely that muskoxen were responsible for any common eider nest depredation.

For the 7 failed glaucous gull nests, there was direct evidence of depredation for 2 of these nests. Five glaucous gull nests hatched before the nest searches were completed.

Banding

During 1999 and 2000, 13 common eider hens were captured, banded, and marked with nasal discs on Thetis Island (1 hen), Narwhal Island (5 hens), and Pole Island (7 hens, Figure 13, Table 9). Two additional common eider hens were captured and marked on Narwhal Island in 2001. Two of the marked birds were resighted one year after they were marked. A common eider hen marked on Narwhal in 1999 (No. 23, Table 9) was resighted on Narwhal Island in 2000, and a hen marked on Narwhal Island in 2000 (No. 25, Table 9) was resighted on Narwhal Island in 2001. Both resighted birds were checked at a distance for abnormal wear on the bill and general body condition. Both marked birds appeared to be in good condition with no obvious wear on the bill where the nasal discs were attached. Weights, measurements, nest identification number, clutch size, band numbers, banding dates, and disc color combinations of marked birds are listed in Table 9. Four glaucous gull chicks were banded during 2001, 2 on Jeanette Island and 2 on Reindeer Island (Table 10).

DISCUSSION

Nesting Effort

Common eiders, glaucous gulls, and arctic terns nest on Beaufort Sea barrier islands (Johnson and Herter 1989). Data on active common eider nests along barrier islands in the central Alaskan Beaufort Sea have been recorded for most years from 1970-2001 (Table 11). The most productive islands have been Cross Island, Pole Island, Lion Point, Egg Island, Thetis Island, and Stump Island (Table 11). For those islands with recent nesting data, active common eider nest density was greatest on Egg Island and Lion Point followed by Stump Island and Karluk Island (Figure 14). Cross Island has also been an important common eider nesting area, but nest density during 2001 was low (Table 11). In addition to these natural islands, some artificial exploration and production structures have been searched for nesting common eiders since 1982 (Table 12). For the 2 locations searched during 2001, Duck Island #1&2 was the most productive with the highest numbers and density of common eider nests (Table 3).

Because common eiders are long-lived and exhibit remarkable fidelity to nest sites (Reed 1975 in Johnson 2000, Wiggins and Johnson 1992), nest searches could concentrate on those islands supporting the largest numbers of nesting common eiders. Of the 15 common eider hens that have been individually marked, 2 hens have been resighted nesting on the islands where they were originally captured (Table 9). The islands with the most marked hens (Pole and Narwhal) were disturbed by predators during 2001. There were no common eiders remaining in the areas where these marked birds were expected to nest in 2001. In addition, we have received no reports of marked birds on any other barrier island searched during 2000-2001.

To evaluate changes in the size of the nesting population of common eiders over time, we compared the mean number of active common eider nests by island during 1970-1991 to 1998-2001 (Figure 15). During the period 1970-1991, many islands had 14 or more years of data (Table 11). During the period 1998-2001 most islands had 3 years of data. The mean annual number of nests for 25 islands was lower during 1970-1991 (485 nests/year) than during 1998-2001 (589 nests/year). Variation for individual islands was high and the paired difference between 1970-1991 (19 ± 11.6 [95% CI] nests/island) and 1998-2001 (24 ± 13.3 nests/island) by individual island was not significant (Figure 15, Wilcoxon paired-sample rank sum test: $Z = 1.186$, $n = 24$, $P = 0.236$). Variation in timing of nest searches across years may influence the number of active nests counted because of missed late-initiated nests, early failed nests, or not recognizing some empty nests as hatched.

Habitat

Not all barrier island sand and gravel habitats represents good nesting habitat for common eiders, glaucous gulls, or arctic terns, but surface area totals provide a rough basis for comparison among islands. As described above, island configurations and island surface areas are annually variable. Channels and boundaries between individual islands are also not consistent from year to year, which confounds attempts to make inter-annual comparisons when the extent of individual islands is unclear.

It appears that the presence of remnant tundra on an island is associated with lower nesting effort for common eiders, even though remnant tundra can provide nesting habitat both on the tundra surface and along the peat shorelines. Pingok, Bodfish, Cottle, and Flaxman (East) islands, all with remnant tundra, have averaged less than 3 nests/year (Table 11). We identified 5 active common eider nests on Cottle Island in 1999. These nests were located on the peat bank above the beach. Many searches may not have included these shoreline tundra habitats, and may have missed these inconspicuous nests. However, it is also likely that the larger size and presence of tundra on these islands provide habitat for arctic foxes, which prey on nesting eiders and decrease nesting success. An arctic fox was sighted in 1998 on Flaxman Island (Noel et al. 1999a), in 1999 on Pingok Island (Noel and Johnson 2000), and in 2001 on Pole Island.

Female common eiders generally select nest sites with cover composed of beach rye grass/lymegrass, driftwood, and other debris (Schamel 1977; Johnson et al. 1987; Wiggins and Johnson 1991, 1992; Johnson 2000). Beach rye grass cover was rare on most of the 9 islands searched during 2001, except on Pole Island. Some small patches of beach rye grass were also noted on Cross Island. Most nests with vegetation cover during 2001 were in beach rye grass.

Schamel (1977) and Johnson et al. (1987) reported that hatching success was positively correlated with cover density in the vicinity of the nest site. Hatching success could not be determined in this study. However, more active than depredated nests occurred in high-density driftwood, and fewer active nests were in low-density driftwood in 2001. This is contrary to our findings in both 1998 and 1999, when there was no significant difference in driftwood cover for active and depredated common eider nests (Noel et al. 1999a, Noel and Johnson 2000), but agrees with our finding in 2000 (Noel at al. 2001).

Two other interrelated habitat factors that probably influenced common eider nesting habitat selection were: 1) island elevation, and 2) location of driftwood above the waterline. Common eiders that occupy high-elevation barrier islands have the highest nesting success and are the most productive (Johnson 2000). Several nests on the Jones-Return Island group disappeared during flooding in 2000 (R. Lanctot, U.S. Geological Survey, Alaska Science Center, pers. comm.). Height of driftwood above the waterline is determined by the elevation of the barrier island (Wiggins and Johnson 1991). Fall storm surges typically move driftwood to the highest points on the barrier islands. The sand-gravel barrier islands with the highest elevation typically accumulate the most driftwood (Johnson 2000). Driftwood patches deposited high above the waterline can essentially protect nests from future storms and inclement weather. Another beneficial characteristic of high elevation islands is the potential for accumulation of wind-blown soil leading to development of vegetation, which is also used as nesting cover.

Depredation

Arctic foxes were responsible for most nest failures on islands searched during both 1998 and 1999, while glaucous gulls or other avian predators were responsible for most nest failures in 2000 (Noel et al. 1999a, 2001, Noel and Johnson 2000). In 2001, an arctic fox on Pole Island was probably responsible for most, if not all, of the depredation on Pole and Belvedere islands. This accounted for over half the depredation observed on all the islands surveyed in 2001. The total destruction of all nests on Pole Island by this arctic fox indicates that cover is probably meaningless when mammalian predators have access to an island. In most instances where foxes had access to an island, virtually all nests were destroyed. Arctic foxes locate prey by scent as well as by sight, and cryptic coloration and cover appear to matter little when foxes have access to an island. Cover is probably most important when the primary predators are avian. Driftwood and vegetation cover at common eider nest sites may help to conceal nests from avian predators. Common eiders nesting in low-density driftwood may be more vulnerable to avian depredation than those nesting in medium- and high-density driftwood. Wiggins and Johnson (1991, 1992) stated that eiders prefer areas with dense driftwood cover, partly for protection from predators.

Wiggins and Johnson (1991, 1992) found that arctic foxes and common ravens (*Corvus corax*) were the main predators of common eider eggs and that glaucous gulls were the main predators of common eider ducklings along the Endicott Causeway. Other studies have similarly found that arctic foxes prey on common eider eggs (Quinlan and Lehnhausen 1982; Wiggins and Johnson 1991, 1992). The Endicott Causeway, situated in the Sagavanirktok River delta, was constructed during winter 1984-1985. Driftwood and other debris that serve as nesting cover for common eiders began to increase, and 5 years after construction the causeway had a healthy and increasing common eider population. During 1992, an arctic fox gained access to the causeway and subsequently the number of eider nests and eider nest success declined dramatically (Johnson et al. 1993). Little nesting has occurred on the causeway since this date (Table 12). But Duck Island #1&2, adjacent to the causeway, appears to support numerous common eider nests (Table 12). During surveillance of Howe and Duck Islands, grizzly bears have been noted feeding on nests on Duck Island #1&2 (LGL unpublished data). Most recently, Johnson (2000) reported that depredation by foxes, ravens, and gulls on common eider eggs and young is likely the major factor regulating the abundance of common eiders in the North Slope oilfields.

During this study, the principal predators identified on barrier islands were arctic fox in 1998 (Noel et al. 1999a), arctic fox and glaucous gulls in 1999 (Noel and Johnson 2000), glaucous gulls in 2000 (Noel et al. 2001), and arctic fox and glaucous gulls in 2001. The arctic fox present on the contiguous Jones-Return Islands (Long Island to Bertoncini Island) during 1999, may have influenced common eider nesting during nest initiation resulting in fewer nesting attempts on these islands rather than more depredated nests. In contrast, the number of nesting attempts on Pole Island in 2001 was high; 279 nests were recorded, all of which failed. The fox on Pole Island in 2001 may have accessed the island after most nests had been initiated.

The fate of glaucous gull nests was more difficult to determine than the fate of common eider nests. When no eggs or chicks were found in a nest, determination of the status of glaucous gull nests was based on the presence of feathers. It is likely that some nests classified as failed during 2001 based on this criterion may have been active during previous nesting seasons but inactive in 2001. This could lead to an overestimate of the number of failed glaucous gull nests.

Avian depredation on common eider eggs observed in 2001 was due to glaucous gulls. During the summer months, glaucous gulls opportunistically prey on the eggs of other birds (Eberhardt et al. 1982, Hiruki and Stirling 1989), but because common eiders and glaucous gulls often nest in close proximity to each other, glaucous gulls prey most heavily on eider eggs (Johnson and Herter 1989). Parasitic jaegers (*Stercorarius parasiticus*) and common ravens also prey on eggs of common eiders. Female common eiders do not feed while they are incubating their eggs and thus are on a strict energy budget (Gorman and Milne 1971, 1972). Because of this, eiders may not have sufficient energy reserves to deal with disturbances by predators during incubation.

Depredation on individual islands is annually variable depending on predator access (Johnson 2000, Table 6) and this variability may account for some of the differences in nest activity and success among islands and among years. Access of mammalian predators, such as arctic fox, grizzly bears, or polar bears, to large nesting colonies can decimate nesting success (Johnson et al. 1993, Noel et al. 1999b, Divoky 1978). Common eiders begin nesting on the barrier islands after ice connections to the mainland have melted and after delta islands have become surrounded by river floodwaters (Johnson et al. 1987). Arctic foxes on the sea ice moving to the mainland in late spring may have access to barrier islands in some years via the sea ice, traveling from ice floe to ice floe. In 1998, sea ice on the northern sides of Flaxman, Northstar, and Duchess islands remained intact past the initiation of eider nesting allowing an arctic fox access to nesting eiders on these islands (Noel et al. 1999a). In 1999, the sand-gravel connections between the Jones-Return Islands allowed an arctic fox access to nearly this entire island group (Noel and Johnson 2000). A similar situation occurred in 2001 on Belvedere and Pole islands.

Development

Oil exploration and development activities may cause disturbance to nesting or brood-rearing common eiders. Presence of people on the barrier islands during nesting may cause common eider hens to flush from their nests leading to abandonment of the nest and depredation on the unattended nests by glaucous gulls or other avian predators. Because common eider energy reserves are low during incubation, disturbance during this period may result in reduced fitness and survival as well as reduced reserves to protect ducklings (Gorman and Milne 1971, 1972). Even nests that are left unattended for a few minutes may be destroyed by avian predators. Disturbance of eider crèches by boat or low-level aircraft traffic may lead to depredation by glaucous gulls.

Oil development activities may affect predator abundance in various ways. Oil development and production infrastructure may create new habitat, which can attract certain avian predators such as glaucous gulls and common ravens. Some abandoned offshore exploration islands contain glaucous gull nesting colonies. Ravens may nest in man-made structures such as towers and production modules. Landfill sites, uncovered dumpsters, and handouts provide food sources for glaucous gulls and ravens. Oilfield activities and garbage around landfill sites may also attract terrestrial predators, such as foxes and grizzly bears. These sources are unlikely to provide sufficient quantities of food to maintain these predators, which may then move to nearby nearshore islands and prey on bird eggs or ducklings (Noel et al. 1999b).

Certain types of industrial development may not adversely affect common eider nest success. Wiggins and Johnson (1991, 1992) found that common eiders could colonize man-made permanent gravel islands and causeways, such as the Endicott Causeway and Duck Island #1&2. Johnson et al. (1987) found that mitigation measures implemented during industrial activities on Thetis Island helped increase common eider hatching and fledging success on the island. The mitigation program included controlling development activities that could disturb nesting eiders such as aircraft over-flights and human intrusion, and also included removal of all foxes from Thetis Island. In addition, Johnson (1984) and Divoky and Suydam (1995) found that man-made nesting structures placed on barrier islands attracted nesting female common eiders. Such structures, along with other mitigation measures (garbage, fox and gull control) could be used as mitigation tools during industrial development on barrier islands.

ACKNOWLEDGMENTS

This study was funded by and conducted for BP Exploration (Alaska) Inc. (BPXA). For assistance with the 2001 study we thank Bill Streever, Dave Trudgen, Allison Erickson, and Wilson Cullor, BPXA Environmental Studies Group. Bill Streever, BPXA Environmental Studies Group Leader, reviewed and provided comments which improved this report. Cindy Baily BPXA, External Affairs, coordinated permission with the Nuiqsut Whaling Captains Association for access to Cross Island. Rick Lanctot and Paul Flint, U.S. Geological Survey, Alaska Science Center, provided data for the number of active common eider and glaucous gull nests on Spy Island, the Jones-Return Islands, the Maguire Islands, Mary Sachs Island, and Flaxman Island for 2000-2001. Mike Anthony of the U.S. Geological Survey, Alaska Science Center, provided video coverage for the barrier islands during 2000-2001 that was used to develop the island descriptions. Craig Reiser and Karen Truman of LGL Alaska Research Associates, Inc. assisted with the nest searches. We also thank Air Logistics of Alaska, Inc. for coordinating logistics for helicopter access to the islands during the field program.

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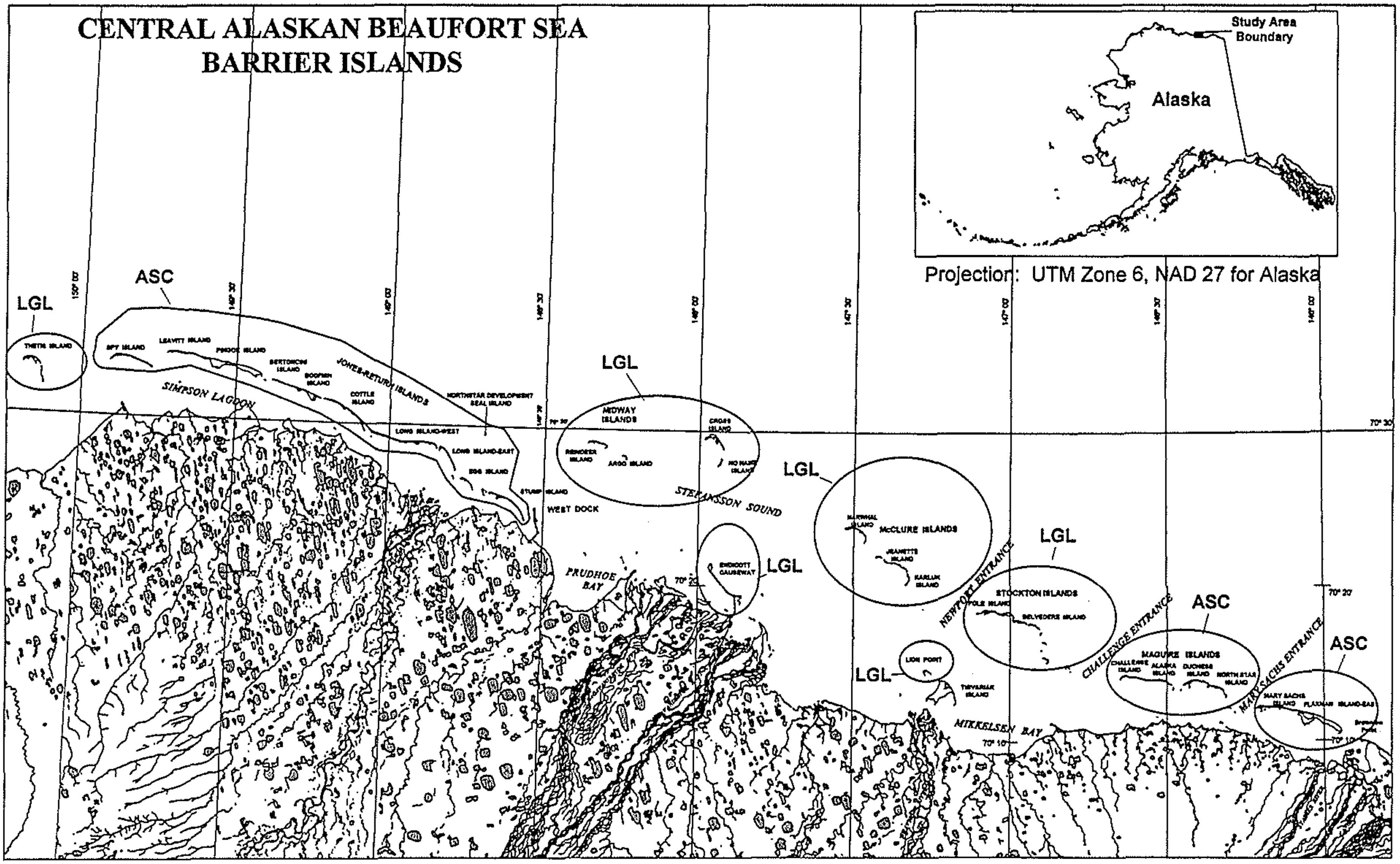

Figure 1. Search area for barrier island nesting birds from Thetis Island to Flaxman Island, central Alaskan Beaufort Sea, 1970-2001. Islands searched by LGL Alaska Research Associates, Inc. (LGL) and U.S. Geological Survey, Alaska Science Center (ASC) during 2001 are circled.

Photo by Lynn Noel

Nest search crew and helicopter pilots on Reindeer Island, 16 July 2001.

Photo by Lynn Noel

Driftwood habitat on Reindeer Island, 16 July 2000.

Photo by Lynn Noel

Scattered driftwood habitats on Pole Island, 15 July 2000.

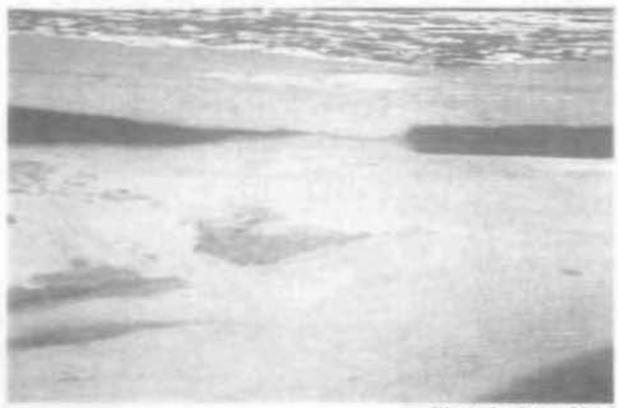

Photo by Lynn Noel

Elymus mounds with nesting common eiders on Pole Island, 15 July 2000.

Photo by Lynn Noel

Driftwood accumulation on east end of Narwhal Island, 11 July 2000.

Photo by Lynn Noel

Driftwood pile with common eider nest on Belvedere Island, 15 July 2000.

Figure 2. Bell 212 twin-engine helicopter used to transport search crew to barrier islands, and examples of island habitats searched for nesting common eiders, central Alaskan Beaufort Sea barrier islands, July 1999-2001.

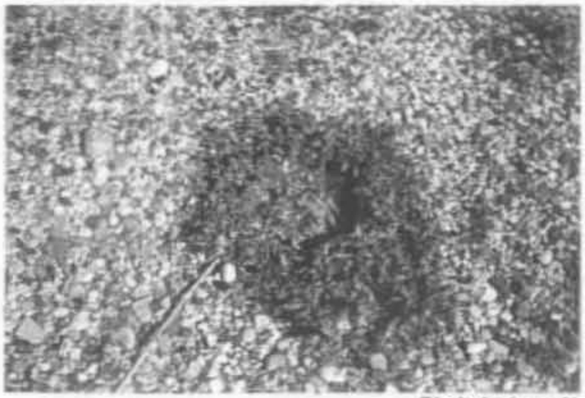

Photo by Lynn Noel

Artemesia glomerata, no driftwood, Cross Island, 16 July 2001.

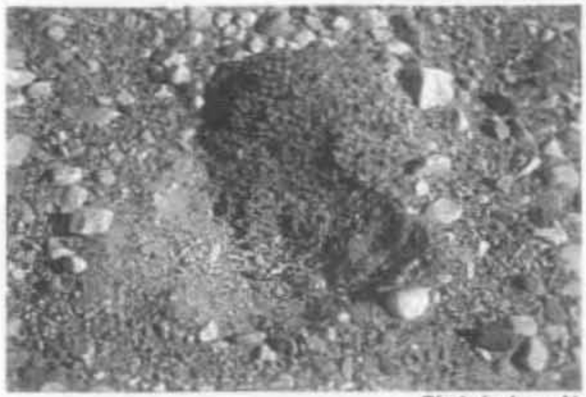

Photo by Lynn Noel

Aerenaria sp., no driftwood, Pole Island, 12 July 2000.

Photo by Bob Rodrigues

Elymus arenarius, low driftwood, Pole Island, 14 July 2001.

Photo by Lynn Noel

Low driftwood, Endicott, 6 July 2001.

Photo by Lynn Noel

Medium driftwood, Endicott, 6 July 2001.

Photo by Lynn Noel

High driftwood, Endicott, 6 July 2001.

Figure 3. Examples of common eider nest cover types, central Alaskan Beaufort Sea barrier islands, July 1998–2001.

No driftwood, Duck Island #1&2, 7 July 2001.

Peat block, no driftwood, Duck Island #1&2, 7 July 2001.

Lungwort (*Mertensia maritima*), no driftwood, Pole Pole Island, 14 July 2001.

Low driftwood, Duck Island #1&2, 7 July 2001.

Medium driftwood, Pole Island, 14 July 2000.

High driftwood, Narwhal Island, 11 July 2000.

Figure 4. Examples of glaucous gull nest cover types, central Alaskan Beaufort Sea barrier islands, July 1998-2001.

Photo by Lynn Noel

Common eider eggs.

Photo by Lynn Noel

Glaucous gull eggs.

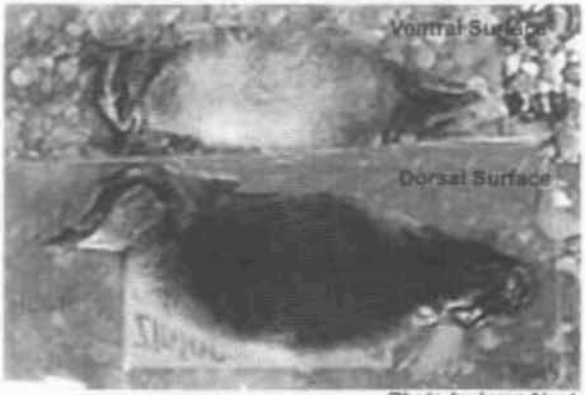

Photo by Lynn Noel

Common eider ducklings (deceased)

Photo by Lynn Noel

Glaucous gull chicks

Photo by Lynn Noel

Common eider hen with nasal disk.

Photo by Lynn Noel

Glaucous gull chick with leg band.

Figure 5. Eggs, young, and marks applied to common eider hens and glaucous gull chicks, on central Alaskan Beaufort Sea barrier islands, July 1999-2001.