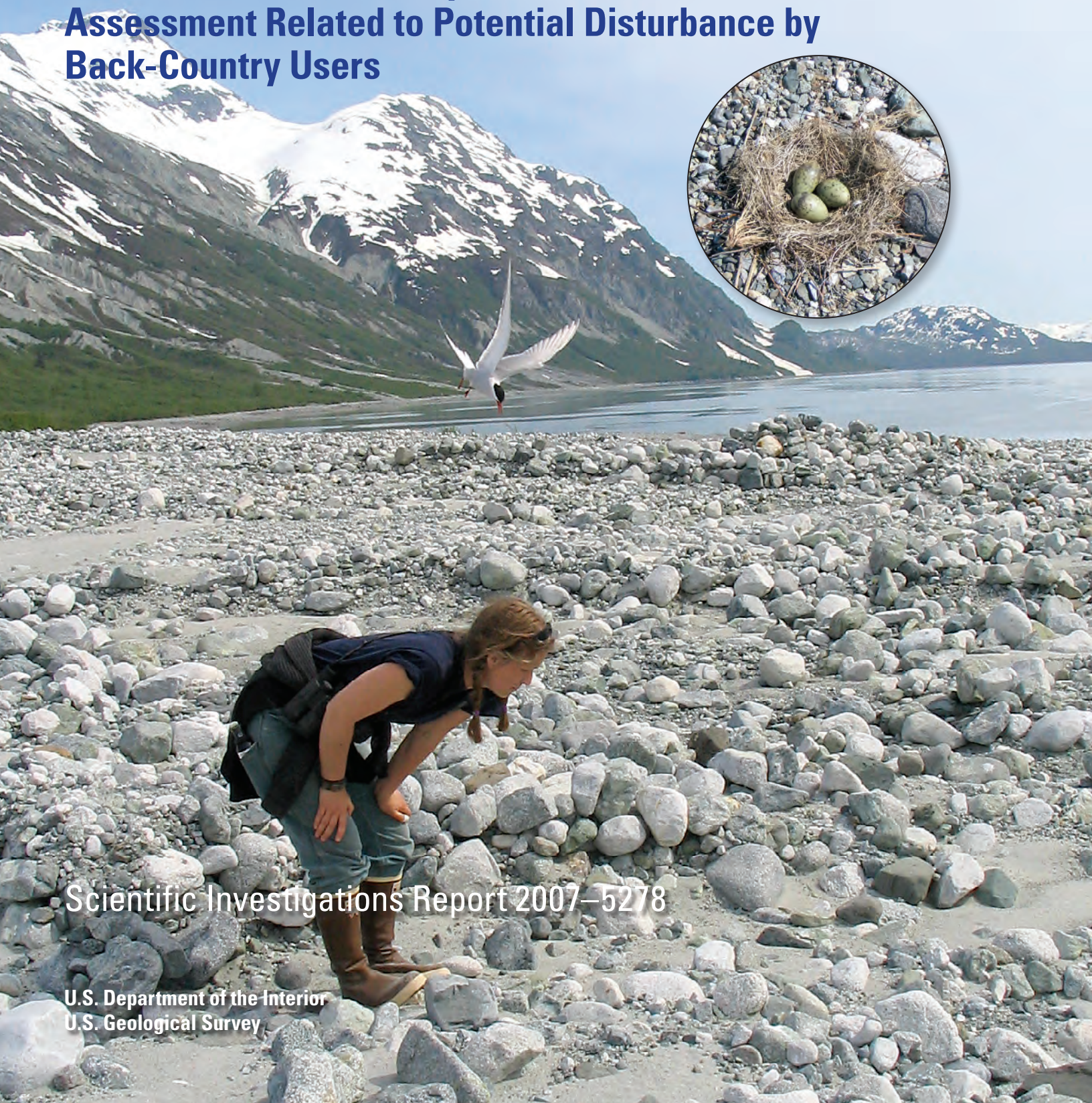


Prepared in cooperation with the National Park Service

Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska: An Assessment Related to Potential Disturbance by Back-Country Users



Scientific Investigations Report 2007–5278

U.S. Department of the Interior
U.S. Geological Survey

Cover: Photograph of typical defense behavior of a nesting Arctic Tern.
Inset: Photograph of a three-egg Mew Gull nest.
Photographs taken by Mayumi Arimitsu, U.S. Geological Survey, 2004.

Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska: An Assessment Related to Potential Disturbance by Back-Country Users

By M.L. Arimitsu, J.F. Piatt, and M.D. Romano

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Conversion Factors

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
hectare (ha)	2.471	acre

Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska: An Assessment Related to Potential Disturbance by Back-Country Users

By M.L. Arimitsu, J.F. Piatt, and M.D. Romano

Abstract

With the exception of a few large colonies, the distribution of ground-nesting marine birds in Glacier Bay National Park in southeastern Alaska is largely unknown. As visitor use increases in back-country areas of the park, there is growing concern over the potential impact of human activities on breeding birds. During the 2003–05 breeding seasons, the shoreline of Glacier Bay was surveyed to locate ground-nesting marine birds and their nesting areas, including wildlife closures and historical sites for egg collection by Alaska Native peoples. The nesting distribution of four common ground-nesting marine bird species was determined: Arctic Tern (*Sterna paradisaea*), Black Oystercatcher (*Haematopus bachmani*), Mew Gull (*Larus canus*), and Glaucous-winged Gull (*Larus glaucescens*). Observations of less abundant species also were recorded, including Herring Gull (*Larus argentatus*), Red-throated Loon (*Gavia stellata*), Canada Goose (*Branta canadensis*), Willow Ptarmigan (*Lagopus lagopus*), Semipalmated Plover (*Charadrius semipalmatus*), Spotted Sandpiper (*Actitis macularia*), Least Sandpiper (*Calidris minutilla*), Parasitic Jaeger (*Stercorarius parasiticus*), and Aleutian Tern (*Sterna aleutica*). Nesting distribution for Arctic Terns was largely restricted to the upper arms of the bay and a few treeless islets in the lower bay, whereas Black Oystercatchers were more widely distributed along shorelines in the park. Mew Gulls nested throughout the upper bay in Geikie Inlet and in Fingers and Berg Bays, and most Glaucous-winged Gull nests were found at wildlife closures in the central and lower bays. Several areas were identified where human disturbance could affect breeding birds. This study comprises the first bay-wide survey for the breeding distribution of ground-nesting marine birds in Glacier Bay National Park, providing a minimum estimate of their numbers and distribution within the park. This information can be used to assess future human disturbance and track natural changes in nesting bird distribution over time.

Introduction

Glacier Bay National Park and Preserve in southeastern Alaska contains a diverse assemblage of marine birds that use the area for nesting, foraging, wintering, and molting. The abundance and diversity of marine bird species in Glacier Bay are unmatched in the region, owing in part to the geomorphic and successional characteristics that result in a wide array of habitat types (Drew and others, 2007). The marine bird community includes several species that nest along shorelines on the ground, either solitarily, or in small colonies. The shorelines used for nesting by these birds generally are beaches and river outwashes. Shorelines in Glacier Bay are complex, with geophysical attributes ranging from steep bedrock cliffs to vast sand and silt tide flats. Cobble and boulder outwashes are common where drainages meet the shore, whereas braided sandy channels characterize many of the glacial outwashes. The abundant pebble beaches are used for landing kayaks—a common means of visiting the backcountry, and for camping. Marine bird nests along the shoreline are susceptible to human disturbance because they are highly dispersed and cryptic and therefore not easily detected.

Ground-nesting marine birds are vulnerable to human disturbance where visitors can access nest sites during the breeding season. Human disturbance of nest sites can be significant because intense parental care is required for egg and hatchling survival, and repeated disturbance can result in reduced productivity or total abandonment (Leseberg and others, 2000). Temporary nest desertion by breeding birds in disturbed areas has been shown to increase predation on eggs and hatchlings (Bolduc and Guillemette, 2003). Human disturbance of ground-nesting birds also may affect incubation schedules and adult foraging success, which in turn can reduce breeding success (Verhulst and others, 2001). Human activity can result in colony failure when disturbance prevents the initiation of nesting (Hatch, 2002). However, it has been

2 Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska

argued that although some levels of human disturbance may cause a temporary change in behavior or physiology of birds (for example, walking away from the nest and returning, or raising the heart rate for a short time), these types of disturbance may not adversely affect breeding success (Nisbet, 2000).

Most of the shoreline within Glacier Bay proper is open to camping use; however, some critical wildlife areas have been closed to camping, foot traffic, and vessel approach because they contain large numbers of nesting marine birds. Data collected from individuals with back-country permits indicated visitor use at individual beaches from 1996 to 2002 varied between 1 and 416 overnight camping uses (National Park Service, unpub. data, 2004). Wildlife closures have been established at some seabird colonies, and approach within 100 m is restricted at most sites.

Previous studies of ground-nesting marine birds in Glacier Bay focused on localized populations, such as those found on single islands in wildlife closures. Patten (1974) found that Glaucous-winged Gulls (*Larus glaucescens*) on North Marble Island began laying eggs in mid- to late May and that intermittent interruption of incubation (about once every 4 days) did not have an adverse effect on hatching. Nelson and Lehnhausen (1983) documented 23 nesting colonies in Glacier Bay and found unusually high breeding concentrations of Arctic Terns (*Sterna paradisaea*), Black Oystercatchers (*Haematopus bachmani*), and Mew Gulls (*Larus canus*) compared to the rest of southeastern Alaska. The breeding ecology of Black Oystercatchers in the Beardslee Islands region of the lower bay was studied in 1989 (Lentfer and Maier, 1995). Fifty-nine nests were found in the study area and the average clutch size was 2.66 eggs. Densities of breeding Black Oystercatchers were higher on sparsely vegetated islands and reefs than on forested islands. Glaucous-winged Gull nesting activity at South Marble Island was documented in 1999 and 2000 to assess the effects of egg collection by Alaska Native peoples on breeding success (Zador and Piatt, 1999; Zador and others, 2006). In June 1999, the minimum breeding population was 570 birds and 285 active nests were found on South Marble Island. Results from the study led researchers to recommend a conservative approach to egg harvest that limited the time period, the number of collections, and the proportion of nests available for harvest.

Because of park management concerns about the nesting birds' susceptibility to disturbance from human activities, the U.S. Geological Survey (USGS), in cooperation with the National Park Service (NPS), Glacier Bay National Park and Preserve, studied the bay-wide distribution of ground-nesting marine birds in Glacier Bay. This report summarizes results obtained during a 3-year study to measure the distribution

and abundance of ground-nesting marine birds in Glacier Bay and to examine the potential for human disturbance of those nesting birds. This study provides the park with a broad assessment of ground-nesting marine-bird breeding sites in Glacier Bay, including a geographic information system database containing the location and status of all known and likely nest sites discovered during the course of this study.

Methods

Nesting distributions were determined for the more common ground-nesting bird species in Glacier Bay, including Arctic Tern, Black Oystercatcher, Mew Gull, and Glaucous-winged Gull. Observations of less abundant ground-nesting marine bird species were recorded, including Herring Gull (*Larus argentatus*), Red-throated Loon (*Gavia stellata*), Canada Goose (*Branta canadensis*), Willow Ptarmigan (*Lagopus lagopus*), Semipalmated Plover (*Charadrius semipalmatus*), Spotted Sandpiper (*Actitis macularia*), Least Sandpiper (*Calidris minutilla*), Parasitic Jaeger (*Stercorarius parasiticus*), and Aleutian Tern (*Sterna aleutica*).

The study area included shoreline within Glacier Bay proper, a recently deglaciated estuarine fjord within Glacier Bay National Park and Preserve (fig. 1). Ground-nesting marine birds and their associated nests were surveyed from June 4 through July 15, 2003; May 17 through July 1, 2004; and May 20 through June 26, 2005 (table 1). About 353, 692, and 158 km of shoreline was surveyed in 2003, 2004, and 2005, respectively (table 1 and fig. 2).

The focus of the survey areas differed during each year of the project. Areas of high visitor use were surveyed in 2003. These areas were defined on the basis of data from the National Park Service (unpub. data, 2004) as shoreline sites having 30 or more overnight visits between 1995 and 2002.

Table 1. Survey dates and effort by year during the ground-nesting marine bird survey in Glacier Bay, Alaska, 2003–05.

Survey date	Survey duration (minutes)	Distance surveyed (kilometers)
June 4–July 15, 2003	12,900	353
May 17–July 1, 2004	12,807	692
May 20–June 26, 2005	6,827	158
Total	32,534	1,203



Figure 1. Locations of Glacier Bay, southeastern Alaska, and place names mentioned in this report.

4 Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska

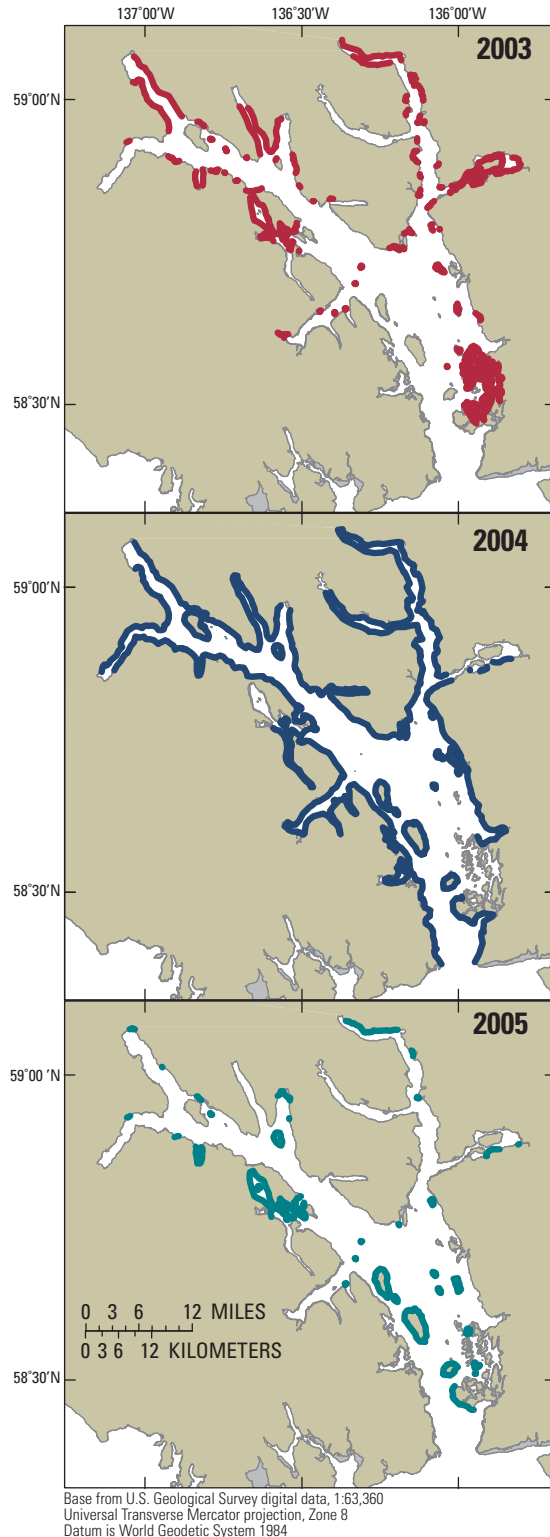


Figure 2. Shoreline surveyed for ground-nesting birds in Glacier Bay, southeastern Alaska.

Owing to relatively low nesting activity observed at sites surveyed in 2003, the survey was expanded in 2004 to include the entire shoreline except the Beardslee Islands. In 2005, the survey focused on areas where nesting activity was identified in 2003–04 and included wildlife closures and egg-collection sites historically used by Alaska Native peoples (fig. 3; Hunn and others, 2002). In 2004 and 2005, areas with higher nesting concentrations and the potential for disturbance from visitor use were revisited. These sites included the islet at the entrance to Scidmore Bay, the north spit at McBride Glacier, Sealers Island, the islet at Tlingit Point, and the west entrance to Reid Inlet (fig. 1). The number of nests and territorial pairs present were noted during each visit to these sites.

Surveys were conducted in a way to maximize the detection of birds. All areas classified as high visitor use were surveyed using a land-based approach, where observers walked the length of the beach. In areas classified as low visitor use (< 30 overnight visits in 7 years), the shoreline was surveyed from a distance of 3–15 m using a skiff in motorized waters, or a kayak in non-motorized waters. When potential nesting behavior was observed (including concentrations of birds on shore, defensive behavior by one or more birds, the presence of paired birds, or birds sitting in an incubation posture), the vessel was brought ashore and the survey was continued by walking the length of the beach. At all survey locations, the site and nest positions were recorded by using hand-held Garmin eTrex Venture Global Positioning System (GPS) units, and nest contents (eggs, chicks) also were recorded. Adult behavior, general habitat characteristics, and evidence of human disturbance also were noted.

Potential nest sites were identified by noting the location of territorial pairs. These sites were areas where defensive adults were present and nesting was likely to occur but clutches had not been initiated or found. Territorial pairs exhibited defensive behavior that included wing displays, piping or “alarm call” vocalizations, circling overhead or “dive bomb” aerial displays, and reluctance to flush from an area. When defensive behavior was observed but a clutch was not found, the location was marked as containing a territorial adult or pair.

Surveys of closed areas were conducted by tallying all birds and marine mammals on the water and on land. One or two observers went ashore to count all visible nests and note nest contents. Efforts were made to minimize disturbance and, owing to the high density of nests at these sites, GPS waypoints were not recorded at each nest.

In 2004–05, Black Oystercatcher and Arctic Tern nesting data were obtained from a concurrent study on Black Oystercatchers conducted in the Beardslee Islands region (Tessler and Garding, 2006). These nesting locations were included to describe bay-wide distribution in this report.

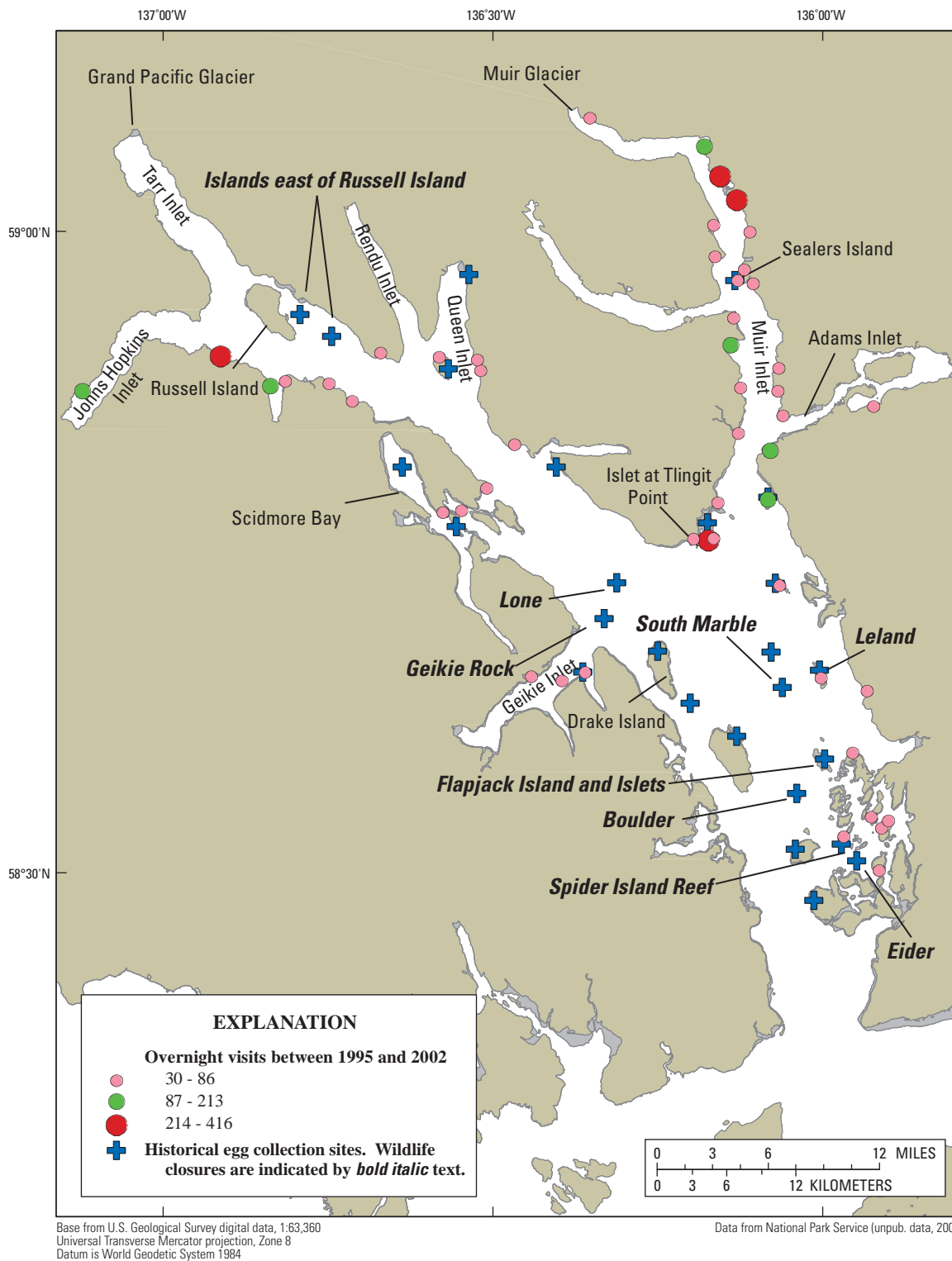


Figure 3. High visitor use areas, defined as 30 or more overnight camping visits, and areas identified in Hunn and others (2002) as historical egg-collection sites by Huna Tlingit, Glacier Bay, southeastern Alaska.

6 Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska

Data from Sharman and others (2005) were used to define nesting habitats used by nesting birds in Glacier Bay. These data, collected between 1997 and 2003 during Glacier Bay's Coastal Resources Inventory and Mapping Project, included segment class and sediment type. Shoreline segments (generally 50–1,000 m in length) within Glacier Bay proper were classified as typical, complex, and glacial outwash. Typical segments generally were consistent in geomorphic attributes throughout the horizontal boundaries of the segment, whereas complex segments lacked consistent topographic qualities, such as slope or ratio of shoreline length to vegetation boundary length. Examples of complex segments include extensive estuarine habitats near stream mouths, rocky spits, and embayments with sinuous shorelines. Glacial outwash segments were extensive hydrologically dynamic outwashes near glacier termini. Primary sediment types were qualified as bedrock, a continuous rock surface; boulder, > 256 mm in diameter; cobbles, 64–256 mm; pebbles, 4–64 mm; granules, 2–4 mm; coarse sand, 1–2 mm; fine sand, 0.06–1 mm; and silt, < 0.06 mm or mud. A geographic information system was used to locate the shoreline segment that contained each active nest and the segment's classification and primary substrate type was used to determine the type of habitat used for nesting by common species. More information on the methodology for the Coastal Resources Inventory and Mapping Project is available at <http://www.nps.gov/archive/glba/InDepth/learn/preserve/projects/coastal/index.htm> (accessed April 20, 2007).

Distribution of Ground-Nesting Marine Birds

Ground-nesting marine birds were widely distributed throughout the bay, and nesting was documented for the first time at some sites. The largest previously undocumented breeding habitat was found in the recently deglaciated area along the north shore of Muir Inlet, where nesting was highly dispersed in outwashes and along the hillsides. Notable concentrations of ground-nesting birds at previously undocumented locations also were found on the Grand Pacific Glacier moraine, the Adams Glacier outwash, and at the small unnamed islet at Tlingit Point.

Overall, 252 active nests and 52 territorial pairs were mapped in 2003, 402 active nests and 158 territorial pairs were mapped in 2004, and 941 active nests and 49 territorial pairs were mapped in 2005 (table 2). The difference in nest and territorial pair counts

among years reflects differences in the shoreline covered and the areas of focus for a given year. Summaries of nest counts and contents at different locations are provided for the more common ground-nesting species.

Life history traits of the common species, including solitary versus colonial nesting habits, determined the bay-wide distribution patterns observed. Black Oystercatchers, a solitary nesting species, were abundant and widely distributed within Glacier Bay. Mew Gulls nested either solitarily or sometimes in mixed colonies with other species and were more widely distributed than other colonial species. In contrast, Arctic Terns and Glaucous-winged Gulls were relatively abundant; however, they occurred in fewer areas of Glacier Bay within more concentrated colonies.

In this section, findings are presented for the four common species and for several less common species. Observations are then described for nesting at specific sites within the bay, including three sites with current high visitor use, six sites with current low visitor use, at wildlife closures, and at historic egg-collection sites. The section concludes with a discussion of shoreline habitat availability and use by ground-nesting birds in Glacier Bay.

Arctic Tern

Nesting distribution for Arctic Terns was largely restricted to the upper arms of the bay and a few treeless islets in the lower bay (fig. 4). The largest Arctic Tern colonies were found near the moraine of the Grand Pacific Glacier, on Sealers Island, and on the islet at Tlingit Point. Smaller nesting concentrations were located in Adams Inlet and on an islet at the entrance to Scidmore Bay (table 8, at back of report). Additionally, 10 nests containing eggs were found at Topeka outwash by NPS researchers conducting unrelated research on June 15, 2004; however, all nests were gone by June 30 (Tania Lewis, National Park Service, oral commun., 2004), and no nesting activity was observed during the survey of that outwash on July 1, 2004. Nesting attempts also were observed at Reid Inlet in 2004 and at McBride Inlet in 2004 and 2005 (see section, "Areas of Concern"). Arctic Terns commonly nested in mixed colonies with Mew Gulls, Glaucous-winged Gulls, and Aleutian Terns (at one site).

Table 2. Number of nests and territorial pairs for common species in Glacier Bay Alaska, 2003–05.

[Nests: Number of active nests. Pairs: Number of territorial pairs]

Year	Arctic Tern		Black Oystercatcher		Mew Gull		Glaucous-winged Gull		Other	
	Nests	Pairs	Nests	Pairs	Nests	Pairs	Nests	Pairs	Nests	Pairs
2003	43	1	90	34	20	17	81	0	18	0
2004	¹ 92	8	¹ 133	89	82	28	40	4	55	29
2005	¹ 249	5	¹ 183	22	82	11	383	0	44	11

¹Counts also include data from Alaska Department of Fish and Game.

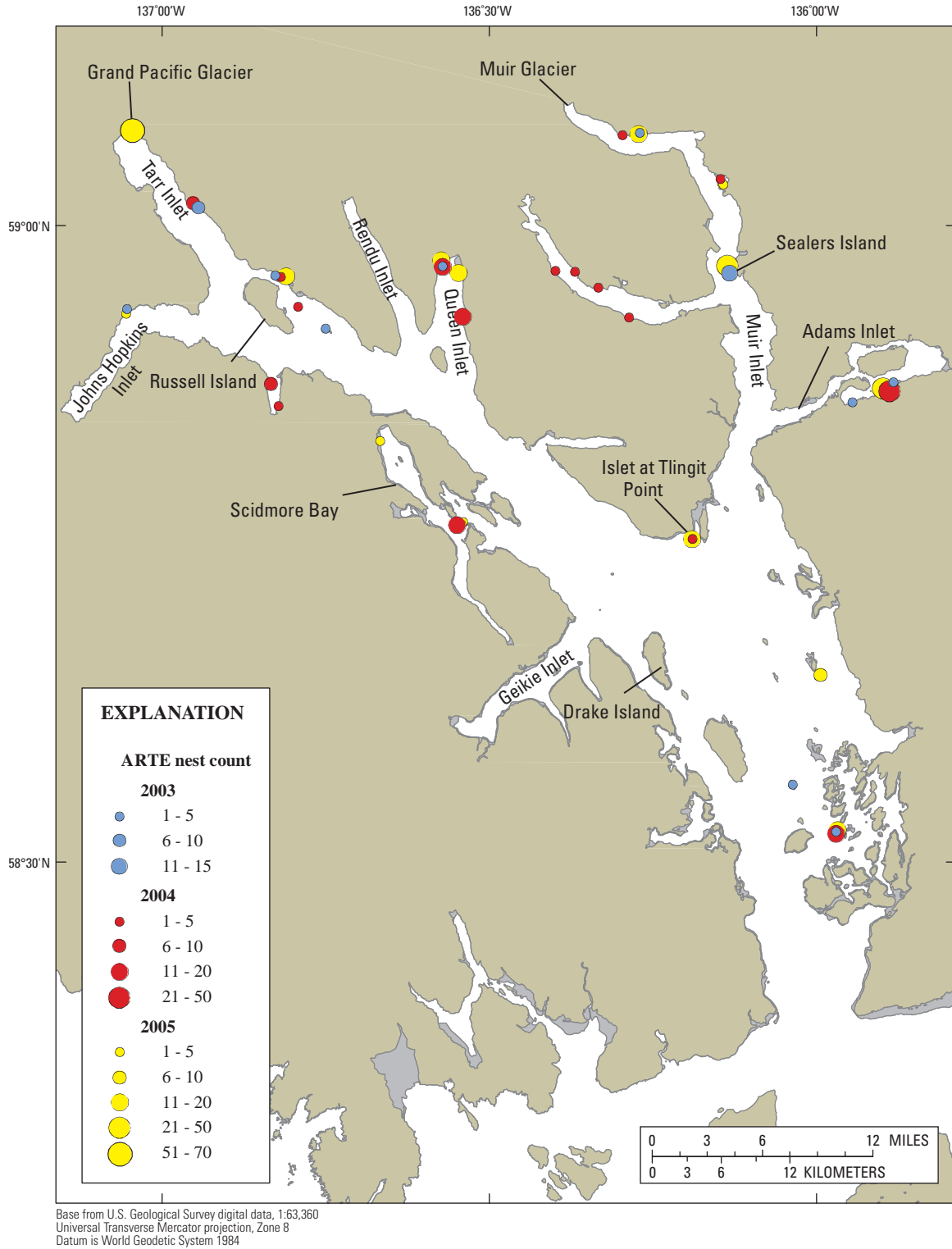


Figure 4. Distribution of Arctic Tern (ARTE) nests, Glacier Bay, southeastern Alaska, 2003–05.

Black Oystercatcher

Breeding Black Oystercatchers were widely distributed in Glacier Bay (figs. 5 and 6). Notable concentrations of breeding birds were found on Leland Islands, the islet at Tlingit Point, on several islands in the Beardslee Islands in 2005 (Tessler and Garding, 2006), and on Sturgess Island (table 9, at back of report). Black Oystercatchers nested solitarily or near nesting Mew Gulls, Arctic Terns, or Glaucous-winged Gulls. Black Oystercatcher nests commonly were found near old (indicated by vegetation overgrowth) empty scrapes, indicating that one or more pairs had nested nearby previously (within the same season or in past years).

Mew Gull

Mew Gulls nested throughout the upper bay in Geikie Inlet and in Fingers and Berg Bays (figs. 7 and 8). Higher concentrations of nests were found at the head of Queen Inlet and along the north shore of Muir Inlet between Riggs and Muir Glaciers (table 10, at back of report). Mew Gulls also were found nesting on the largest unnamed closed island near Russell Island. In some areas, they nested in mixed colonies with Arctic Terns, Glaucous-winged Gulls, and other species, whereas they were solitary nesters in other areas.

Glaucous-Winged Gull

Most Glaucous-winged Gull nests were found at islands that generally were closed to public visitation (so called wildlife closures) in the central and lower bay (fig. 9 and table 11, at back of report). Glaucous-winged Gulls generally nested in concentrated colonies, such as those found at South Marble Island, Lone Island, Geikie Rock, and Boulder Island. At these sites, they nested in close proximity to one another with nests commonly hidden in ryegrass (*Elymus arenarius*) or built on bedrock. An exception to the concentrated colonies was along the north shore of Muir Inlet, where nests were dispersed along a 10-km stretch of early successional habitat between Riggs and Muir Glaciers. Although most nests along the north shore of Muir Inlet colony were found close to the shore, one nest was located nearly 400 m inland on the top of a hill.

Herring Gull

Herring Gull nests were found near the head of Muir Inlet, on a cliff in Johns Hopkins Inlet, on Geikie Rock, and on the islet at Tlingit Point (fig. 10). This species nested in mixed colonies with Glaucous-winged Gulls, Mew Gulls, and Arctic Terns. Herring Gull nests were considerably less

abundant than those of Glaucous-winged Gulls. Evidence of hybridization between Herring and Glaucous-winged Gulls was observed. Three gull nests could not be identified as either species because the nests were high on a cliff and the incubating adult could not be identified. In one case, an individual from each species was attending the same nest. Copulation between a Herring Gull and a Glaucous-winged Gull was observed at the mixed gull colony along the north shore of Muir Inlet, and adults with blackish-grey wing-tips, an intermediate characteristic between the two species, were observed at the same location.

Other Species

In addition to the abundant ground-nesting species, several other less abundant species also were observed nesting on beaches in Glacier Bay. These species are solitary nesters and have well camouflaged nests. Because of these cryptic nesting habits, the survey methods did not adequately detect breeding activity for the species and nests were only found incidental to searching on land for other nests. Thus, our results represent a minimum estimate of pairs and nests for these species. Because of low sample size, average clutch size for these species was not calculated.

Red-Throated Loon

A Red-throated Loon nest containing one egg and attended by one adult was located at a small pond along the northern shore of Muir Inlet (fig. 11). Another adult was observed at an adjacent pond, but no nest was found.

Canada Goose

One Canada Goose nest was found near the entrance to Scidmore Bay (fig. 11).

Willow Ptarmigan

One Willow Ptarmigan nest was located in Reid Inlet (fig. 11). Willow Ptarmigan were observed at the alluvial fan near Russell Cut, but no nest was found there.

Semipalmated Plover

Semipalmated Plovers were found nesting at several locations throughout the bay, with notable concentrations at the north spit of McBride Inlet, at Reid Inlet, and at the Adams Glacier outwash (fig. 12). They were found nesting near low vegetation on flat, sand and gravel shorelines and mostly up-bay, where early successional habitat is abundant.

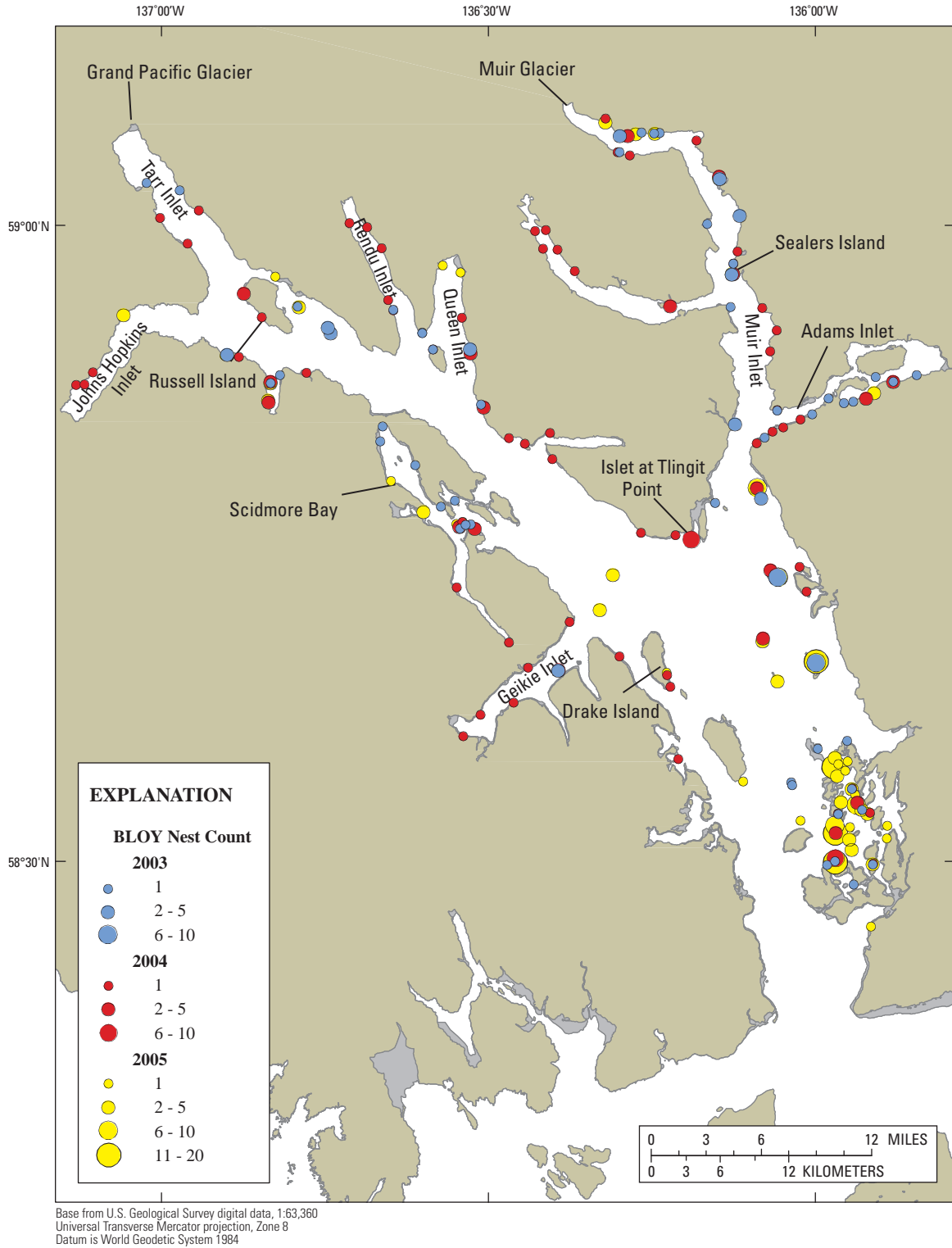


Figure 5. Distribution of Black Oystercatcher (BLOY) nests, Glacier Bay, southeastern Alaska, 2003–05.

10 Distribution of Ground-Nesting Marine Birds Along Shorelines in Glacier Bay, Southeastern Alaska

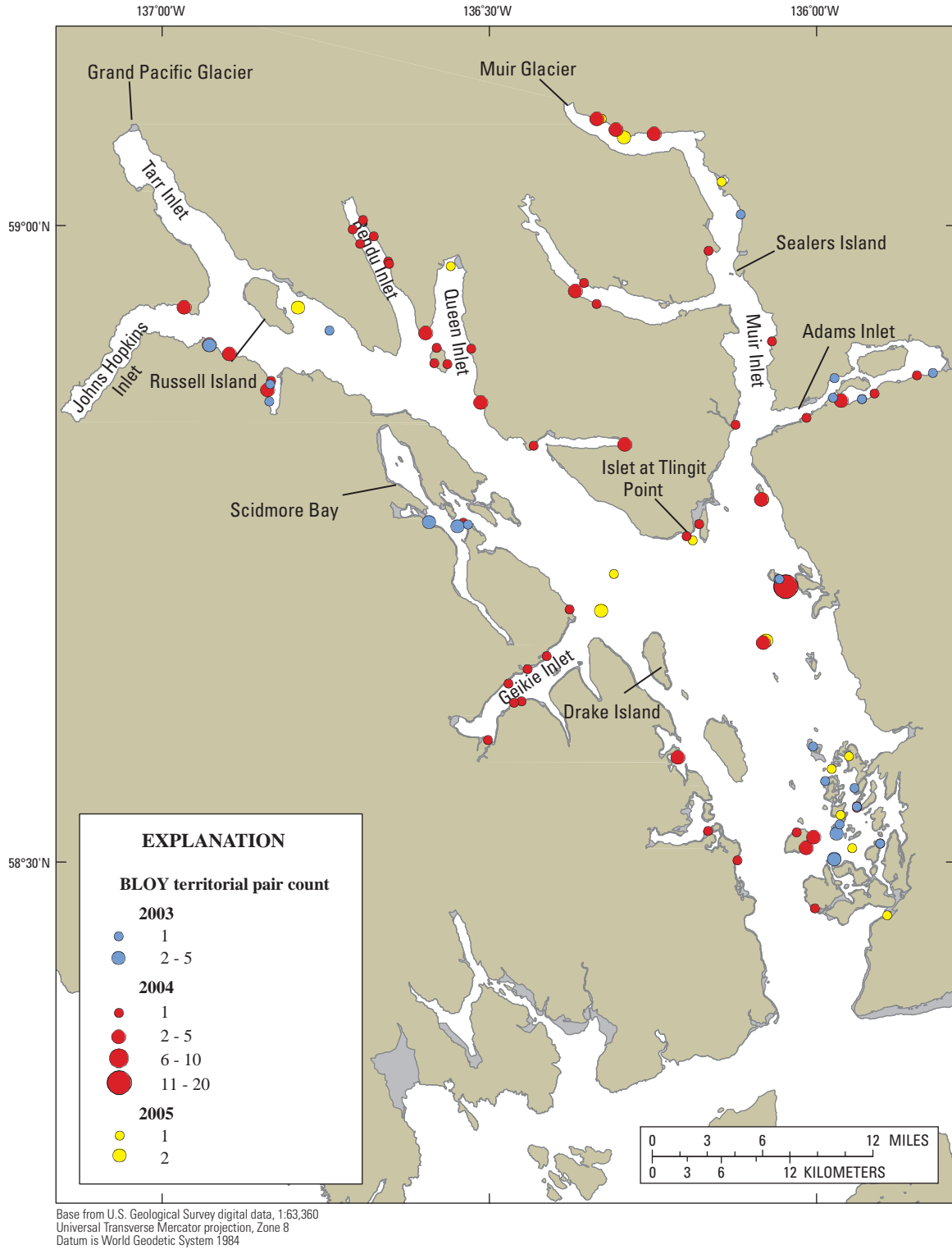


Figure 6. Distribution of Black Oystercatcher (BLOY) territorial pairs, Glacier Bay, southeastern Alaska, 2003–05.

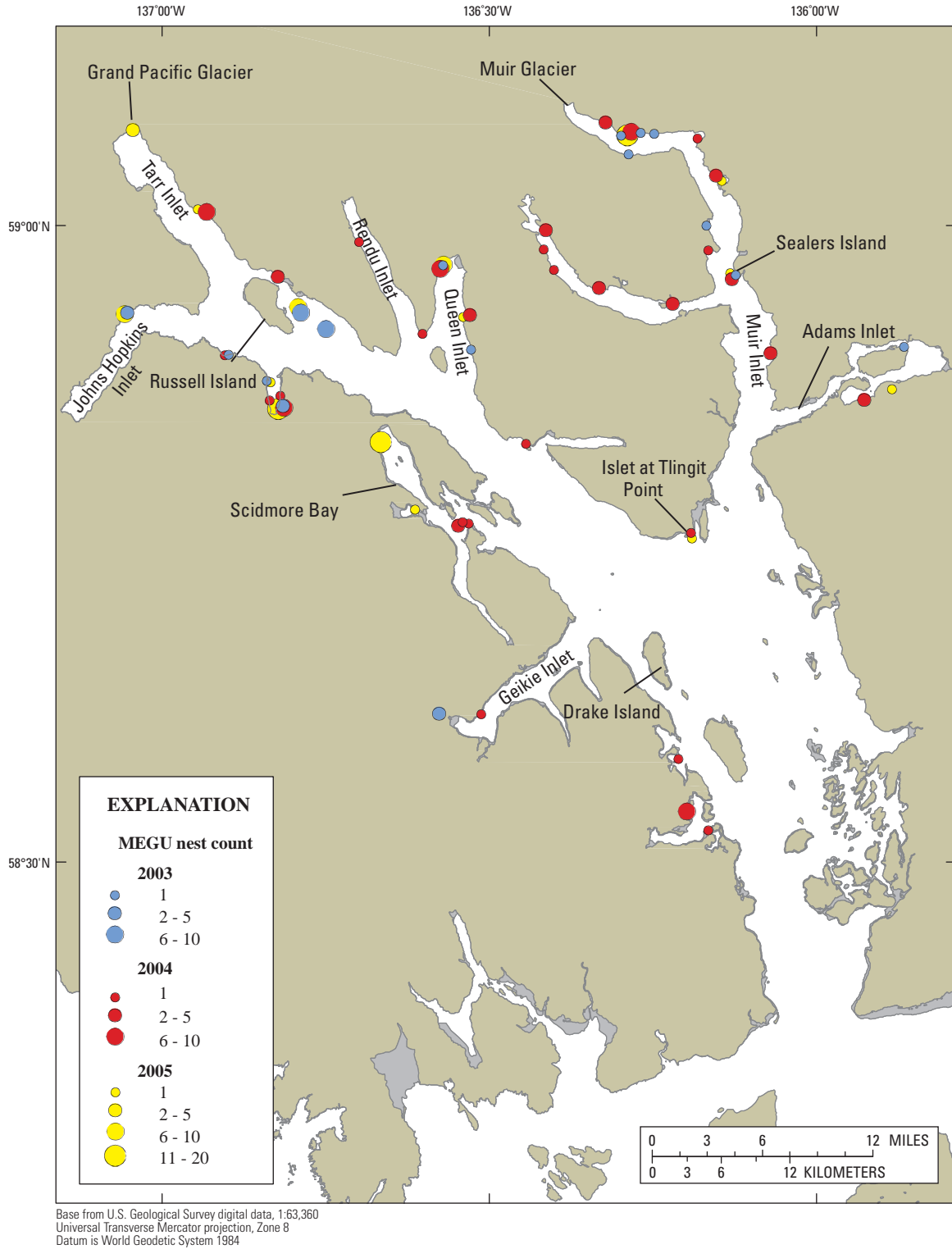


Figure 7. Distribution of Mew Gull (MEGU) nests, Glacier Bay, southeastern Alaska, 2003–05.

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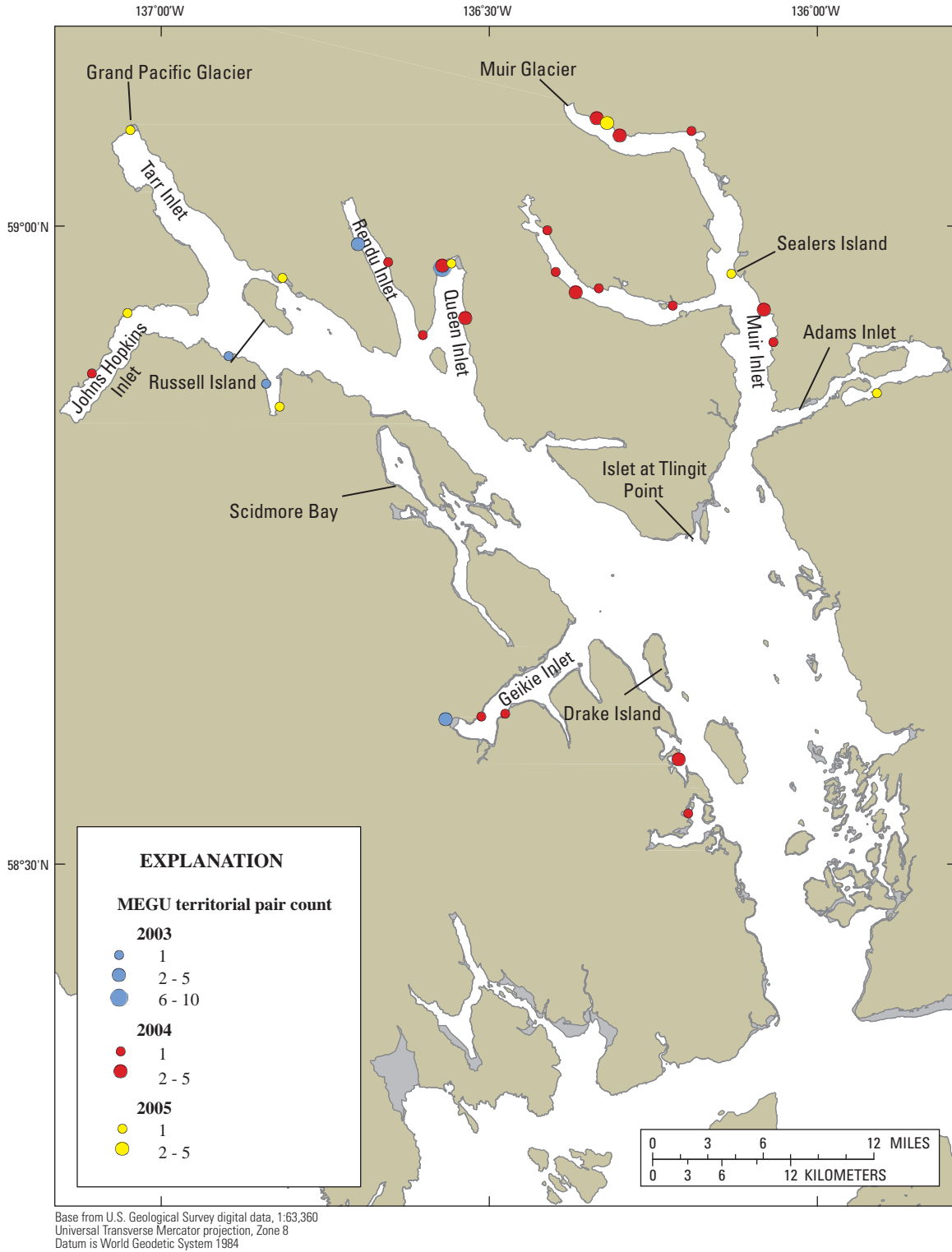


Figure 8. Distribution of Mew Gull (MEGU) territorial pairs, Glacier Bay, southeastern Alaska, 2003–05.

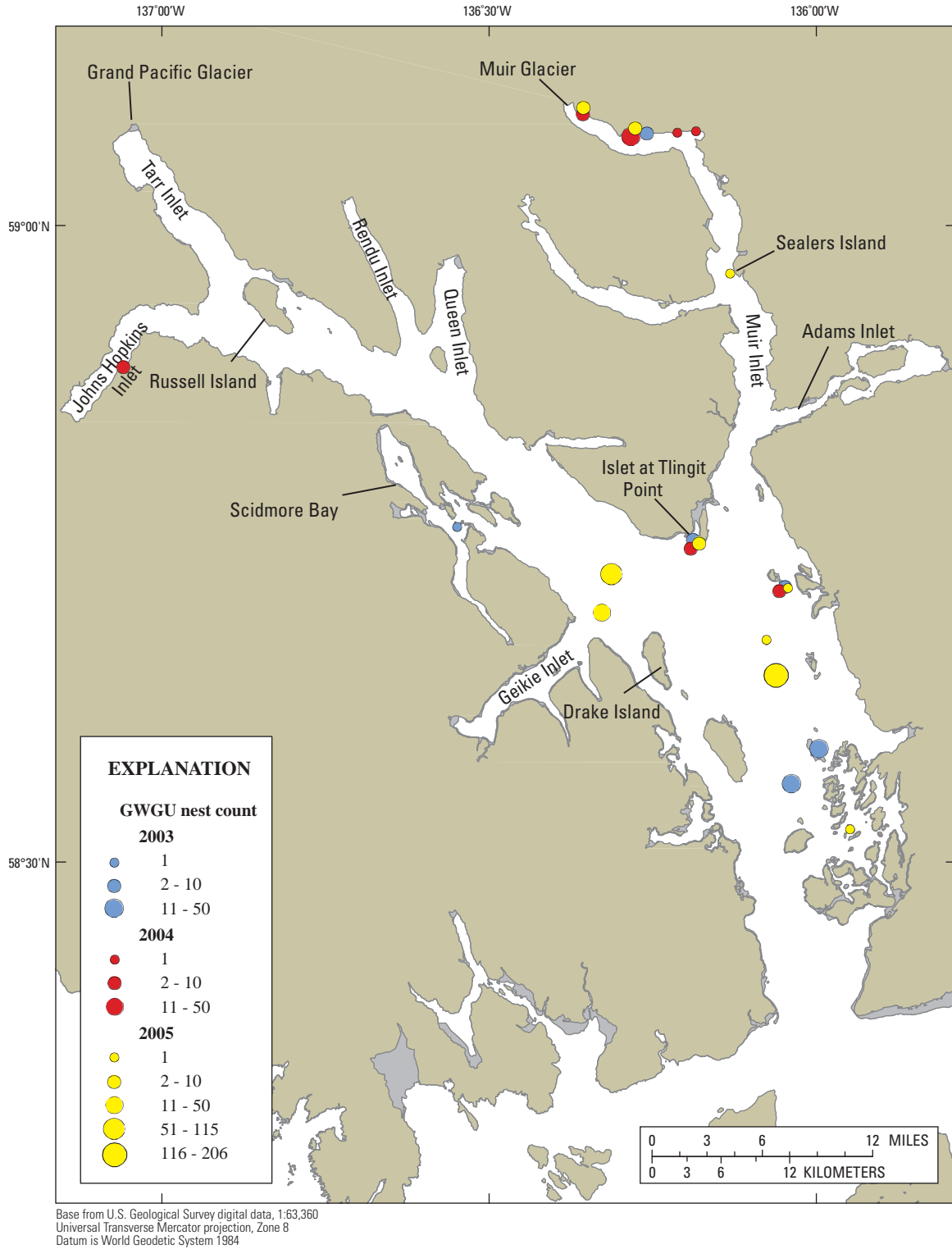


Figure 9. Distribution of Glaucous-winged Gulls (GWGU) nests, Glacier Bay, southeastern Alaska, 2003–05.

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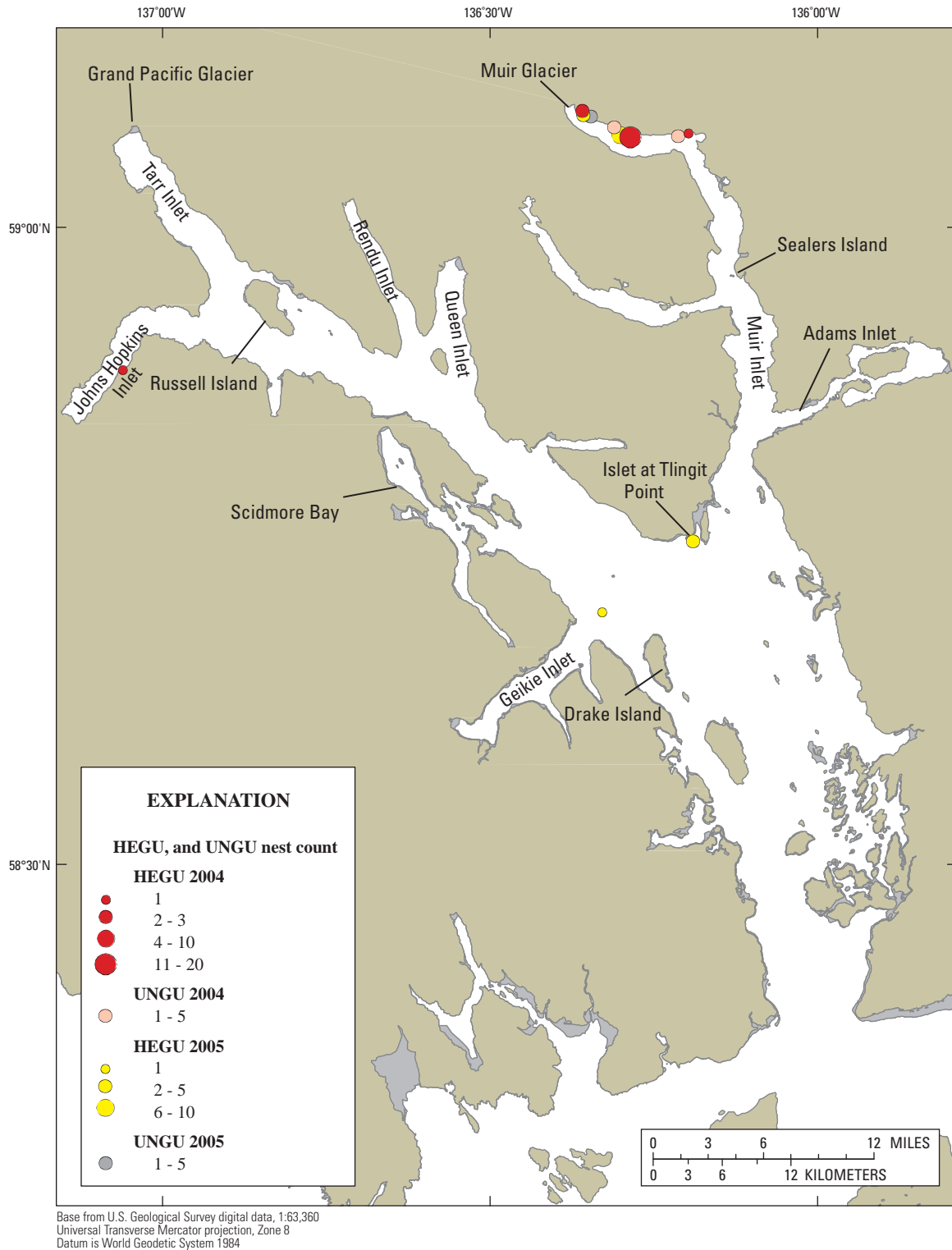


Figure 10. Distribution of Herring Gull (HEGU) and unidentified gull (UNGU) nests, Glacier Bay, southeastern Alaska, 2003–05. Unidentified gull nests belonged to Glaucous-winged Gulls, Herring Gulls, or hybrids.

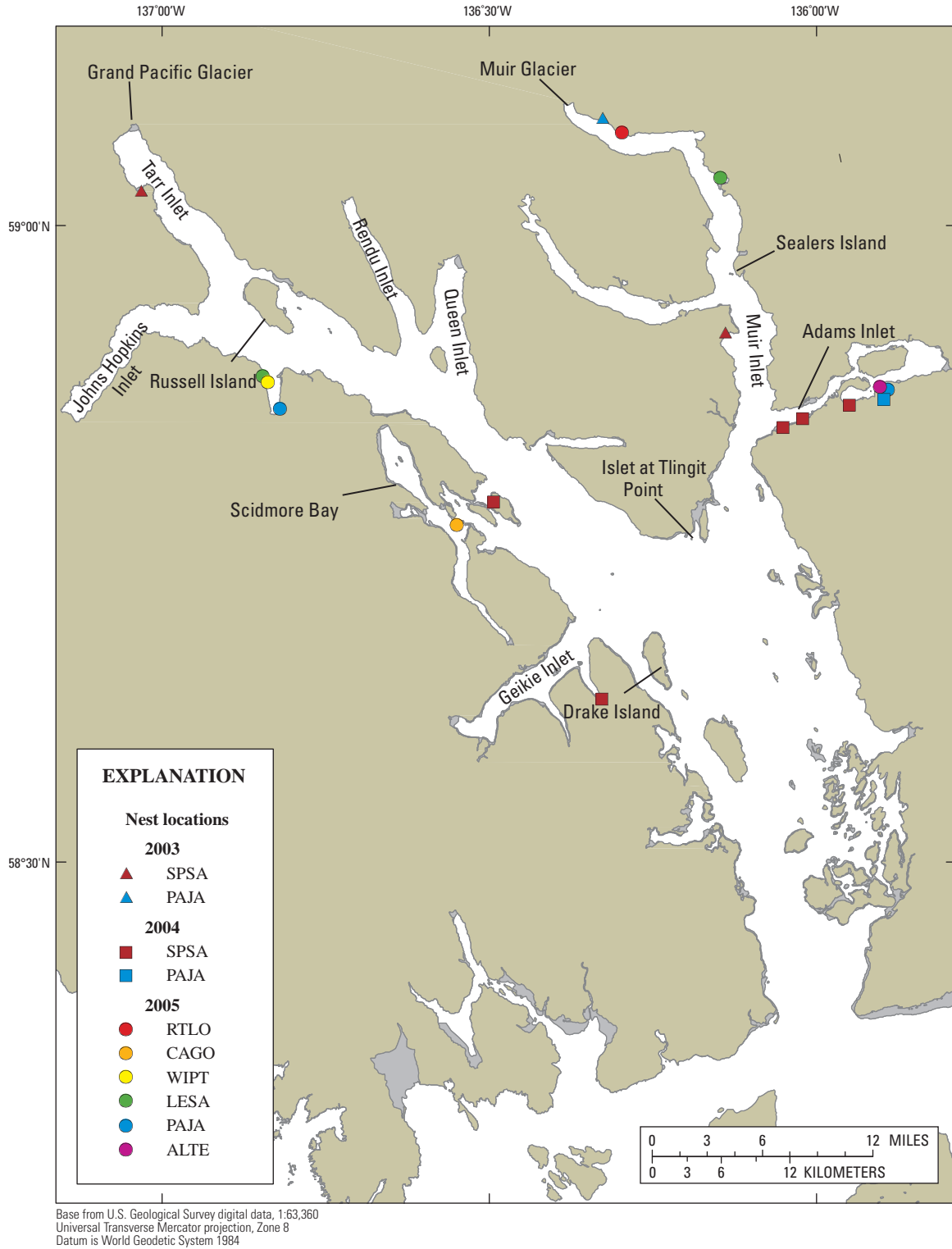


Figure 11. Nest locations for Red Throated Loons (RTLO), Canada Goose (CAGO), Willow Ptarmigan (WIPT), Spotted Sandpipers (SPSA), Least Sandpipers (LESA), Parasitic Jaegers (PAJA), and Aleutian Terns (ALTE), Glacier Bay, southeastern Alaska, 2003–05.

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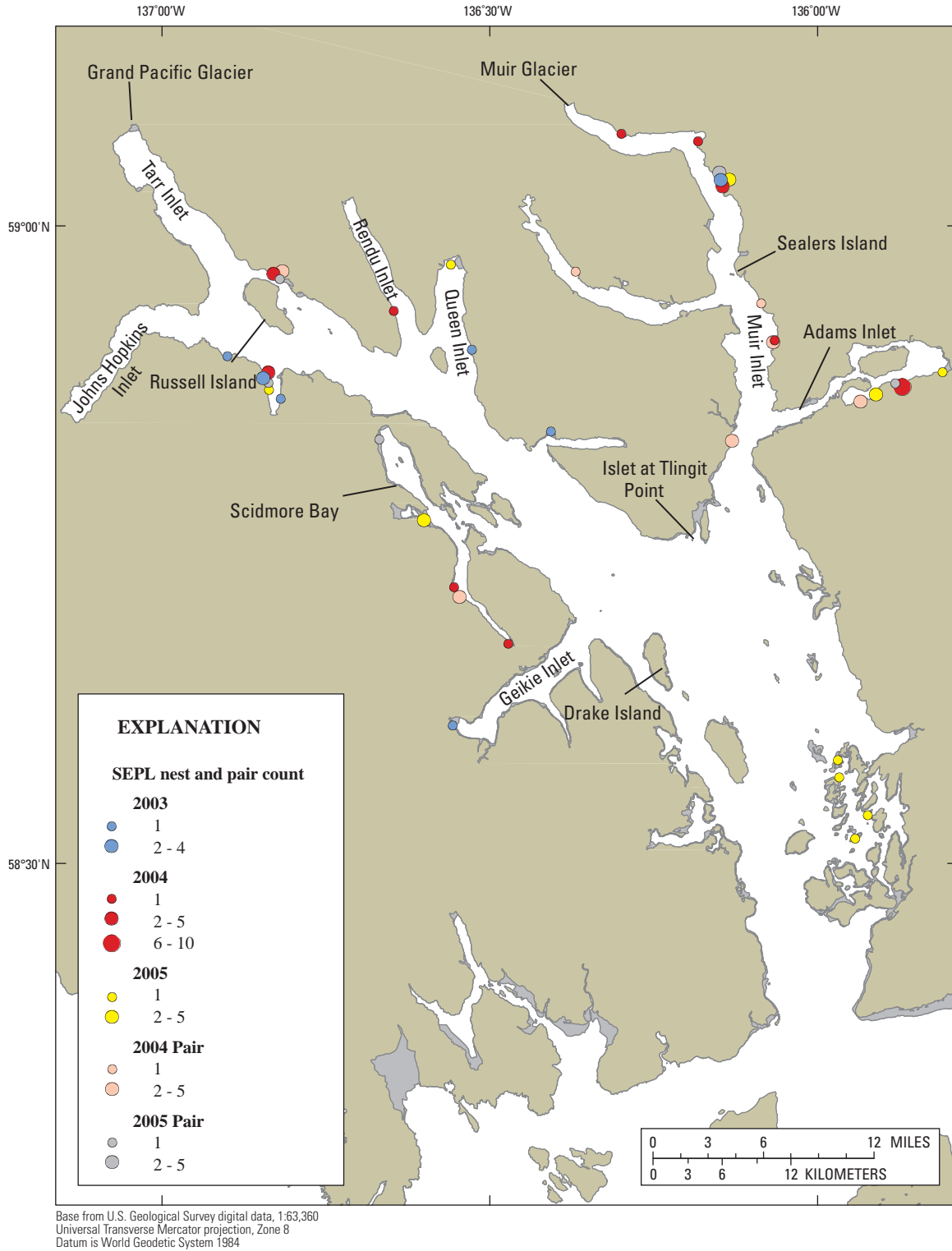


Figure 12. Distribution of Semipalmated Plover (SEPL) nests and territorial pairs, Glacier Bay, southeastern Alaska, 2003–05.

Spotted Sandpiper

Surveys located two active Spotted Sandpiper nests in 2003 and six active nests in 2004. In addition, nine territorial pairs were located in 2004 ([fig. 11](#)). Their nests commonly were found near freshwater runoff within dense vegetation.

Least Sandpiper

Two Least Sandpiper nests were found that contained eggs: one at Reid Inlet and one at McBride Inlet ([fig. 11](#)).

Parasitic Jaeger

Parasitic Jaeger nests were found near Reid Glacier and in Adams Inlet ([fig. 11](#)). Pairs of Parasitic Jaeger were observed flying at the east glacier face in Reid Inlet and over Forest Creek in Muir Inlet in 2004.

Aleutian Tern

Four Aleutian Tern nests and one territorial pair were found in Adams Inlet ([fig. 11](#)). There were 37 adult Aleutian Terns at this site on June 14, 2005. In addition, one adult Aleutian Tern, behaving in a moderately defensive manner (alarm calling, circling overhead) was observed at the alluvial fan near Russell Cut on May 21, 2004. All observations of Aleutian Terns were within Arctic Tern nesting colonies. In flight, the Aleutian Terns could be distinguished most easily from the Arctic Terns by their call. The four nests were made on top of vegetation (including yellow mountain avens, *Dryas drummondii*) adjacent to sparse Sitka Alder (*Alnus viridis subsp. sinuata*) shrubs. The Arctic Terns nesting in the same outwash were nesting closer to shore on bare sand and were separate from the Aleutian Tern nests.

Areas of Concern Open to Public Access

Sites that met either of the following criteria were defined as areas of concern:

1. Shorelines currently receiving high visitor use (> 30 overnight visits) that contain concentrated nesting activities.
2. Shorelines currently receiving low visitor use (< 30 overnight visits) that contain concentrated nesting activities in areas where visitor use may increase in the future because of changing camper drop-off locations and small islands where camping may seem attractive to visitors who want to avoid bear encounters.

We identified areas of concern in three high visitor use areas and six low visitor use areas ([fig. 13](#) and [table 3](#)).

High Visitor Use

Sealers Island

The high visitor use area at Sealers Island supports nesting Arctic Terns, Black Oystercatchers, Mew Gulls, and Glaucous-winged Gulls ([table 3](#)). In 2003, the survey found 16 Arctic Tern nests at this site. During the survey in 2004, recently depredated Arctic Tern eggshells and 8–10 defensive adults were noted at this site on May 28. Nesting had not been successfully reinitiated by June 16. In 2005, Sealers Island was visited three times: May 29, June 6, and June 26. During these visits, surveys found 46 nests with 75 adults present, 14 nests with 45 adults present, and 13 nests with 55 adults present, respectively ([table 4](#)).

Survey observations suggest that predation of Arctic Tern nests, by either bears that frequented the colony or by Northwestern Crows (*Corvus caurinus*) that nest in the center of the island, was a factor in the reduced nesting activity on the island during the 2005 breeding season. Predated eggshells were observed on the second and third visits in 2005. Furthermore, on the second visit, there was recent bear scat on the far edge of the nesting area, indicating that at least one bear walked through the colony. At least five Northwestern Crow nests were observed in the center of the island in 2003, and one pair nested in the Arctic Tern colony area in 2004.

North Spit at McBride Glacier

In the past, Arctic Terns have nested in fairly low concentrations at the spit in front of McBride Glacier (Greg Streveler and Bruce Paige, retired, National Park Service, oral commun., 2005). Nesting Arctic Terns were absent from the McBride Glacier area during the survey in 2003 for this study. Only 3–8 nests were found in 2004 and 2005. In all years of the survey, terns were observed flying in the area and feeding offshore. Mew Gulls, Black Oystercatchers, and Semipalmated Plovers also nested within the high visitor use area on the north spit ([table 3](#)).

West Entrance to Reid Inlet

Arctic Terns also have used the spit at the entrance to Reid Inlet for nesting in the past (Wik, 1968; Bruce Paige, retired, National Park Service, oral commun., 2005). Arctic Terns were absent from Reid Inlet during the survey in 2003; however, 15 nests were found in 2004 between May 27 and June 6. By June 26, 2004, all Arctic Tern nests had disappeared. One of those nests was trampled by a visitor on June 20, 2004. This was the only observation of direct human impact on beach-nesting birds during the study. No Arctic Terns were observed nesting at this site during four visits between May 21 and June 18, 2005 ([table 4](#)). Black Oystercatcher, Mew Gull, and Semipalmated Plover nests also were found on the west spit at the entrance to Reid Inlet during all years of the study.

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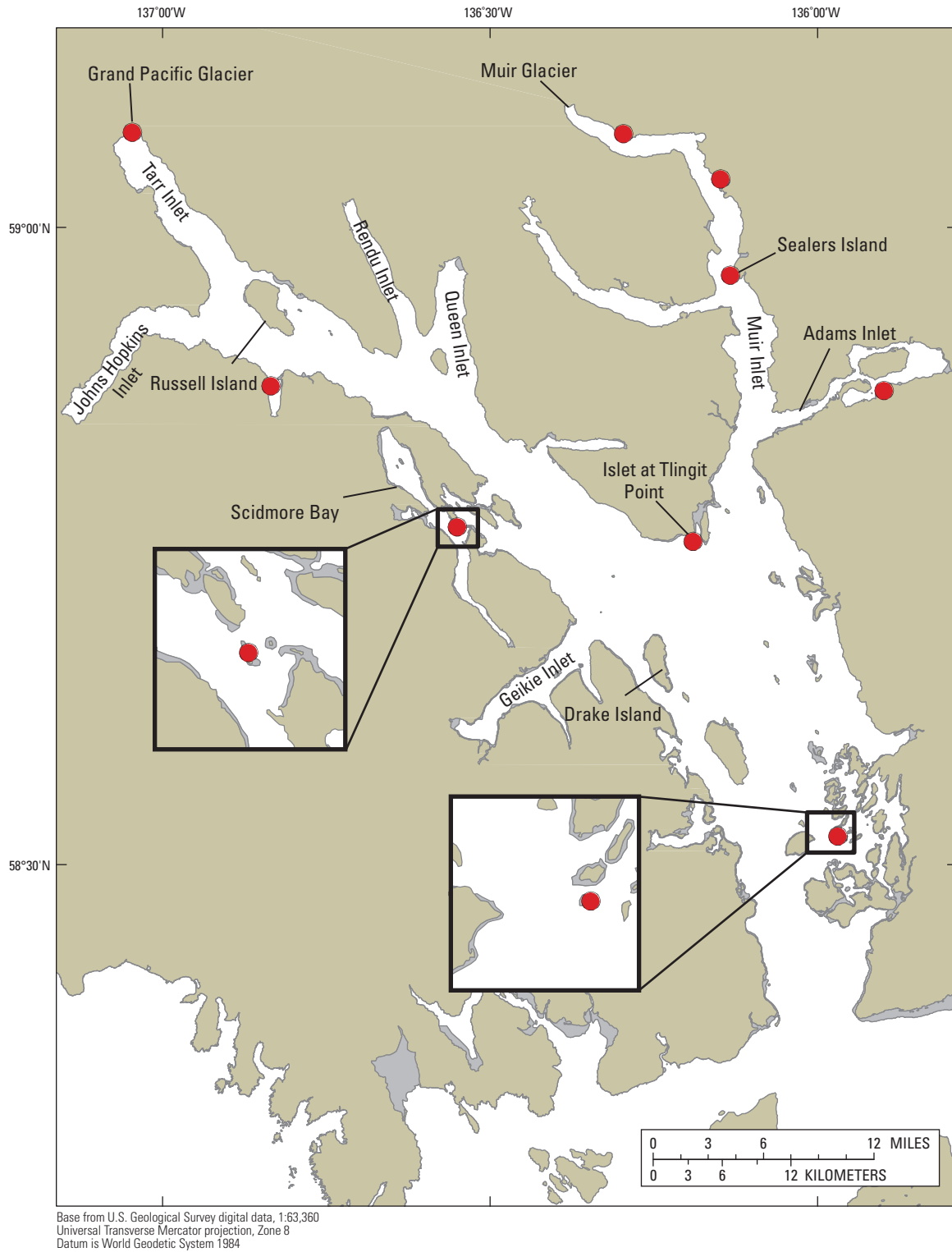


Figure 13. Areas of concern owing to concentrated nesting activities at high and low visitor use areas, Glacier Bay, southeastern Alaska, 2002–05. Map insets of the Hugh Miller (west arm) and Beardslee Islands (lower bay) show the exact locations of the colonies.

Table 3. Nests and territorial pair counts at areas of concern, Glacier Bay, Alaska, 2003–05.

[Nests: Number of active nests. Pairs: Number of territorial pairs. Adult counts: Number of adults observed at the site during the survey with the highest number of nests. Note: Because of interannual variation at sites and the need to assess potential risk to nesting birds, all counts reflect data from the survey with the highest nest counts for all years of the study]

Location	Latitude	Longitude	Visitor use	Date	Arctic Tern		Aleutian Tern		Black Oystercatcher		Mew Gull	
					Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts
Sealers Island	58.95979	-136.12680	High	5-29-2005	46	0	0	0	4	0	7	1
McBride Inlet, north spit	59.03528	-136.14452	High	6-26-2005	8	0	0	0	2	0	8	0
Reid Inlet, west entrance	58.86523	-136.81927	High	5-27-2004	9	0	0	0	4	3	11	0
Muir Inlet, north shore	59.06913	-136.29306	Low	5-29-2004	2	0	0	0	6	11	42	6
Adams Glacier outwash	58.87129	-135.89135	Low	6-14-2005	41	3	357	4	3	0	10	1
Grand Pacific moraine	59.06083	-137.04116	Low	6-13-2005	64	0	200	0	0	0	0	3
Islet northwest of Eider Island	58.52163	-135.95215	Low	6-20-2005	15	0	0	0	15	0	(¹)	0
Islet at Scidmore Bay	58.75828	-136.53234	Low	6-30-2004	18	0	(²)	0	1	0	(²)	4
Islet at Tlingit Point	58.75095	-136.17675	Low	6-18-2005	25	0	60	0	3	1	17	4

Location	Visitor use	Date	Glaucous-winged Gull		Herring Gull		Semipalmated Plover		Red-throated Loon		Parasitic Jaeger	
			Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts
Sealers Island	High	5-29-2005	1	0	0	0	0	0	0	0	0	0
McBride Inlet, north spit	High	6-26-2005	0	0	0	0	2	0	22	0	0	0
Reid Inlet, west entrance	High	5-27-2004	0	0	0	0	3	0	5	0	0	0
Muir Inlet, north shore	Low	5-29-2004	31	1	17	2	1	0	6	0	2	(³)
Adams Glacier outwash	Low	6-14-2005	0	0	0	0	4	1	65	0	0	1
Grand Pacific moraine	Low	6-13-2005	0	0	0	0	(³)	0	(³)	0	0	0
Islet northwest of Eider Island	Low	6-20-2005	0	0	0	0	1	0	0	0	0	0
Islet at Scidmore Bay	Low	6-30-2004	0	0	0	0	0	0	0	0	0	0
Islet at Tlingit Point	Low	6-18-2005	4	0	0	0	0	0	0	0	0	0

¹Count occurred over the course of the summer and included Alaska Department of Fish and Game data (unpub. data, 2005).

²Adults were not enumerated.

³Adults or nests may have been present.

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Table 4. Location, date, number of active nests by species, and total nest count for sites that were visited more than one time in a season, Glacier Bay, 2004–05.

Area	Date	Number of active nests by species								Total nest count
		Arctic Tern	Black Oystercatcher	Mew Gull	Glaucous-wing Gull	Herring Gull	Semipalmated Plover	Least Sandpiper	Willow Ptarmigan	
2004										
Islet at Tlingit Point	6-01	0	10	1	3	0	0	0	0	14
revisit 1	6-10	4	5	1	7	0	0	0	0	17
Sealers Island west point	5-28	0	1	1	0	0	0	0	0	2
revisit 1	6-16	0	0	1	1	0	0	0	0	2
Islet at Scidmore	5-23	0	2	5	0	0	0	0	0	7
revisit 1	6-30	18	1	4	0	0	0	0	0	23
Reid Inlet, west entrance	5-27	9	4	0	0	0	3	0	0	16
revisit 1	6-06	6	2	0	0	0	0	0	0	8
revisit 2	6-26	0	1	0	0	0	0	0	0	1
2005										
Islet at Tlingit Point, revisit 1	6-07	18	2	2	7	4	0	0	0	33
revisit 2	6-18	25	3	4	4	0	0	0	0	36
revisit 3	6-24	13	3	1	3	0	0	0	0	20
Sealers Island	5-29	46	4	1	0	0	0	0	0	51
revisit 1	6-06	14	3	0	0	0	0	0	0	17
revisit 2	6-26	13	3	0	1	0	0	0	0	17
Reid Inlet, west entrance	5-21	0	4	1	0	0	1	0	0	6
revisit 1	6-05	0	3	1	0	0	0	0	0	4
revisit 2	6-12	0	4	1	0	0	0	0	0	5
revisit 3	6-18	0	2	0	0	0	0	1	1	4
McBride Inlet, north spit	5-29	0	3	1	0	0	0	1	0	5
revisit 1	6-06	3	1	1	0	0	3	0	0	8
revisit 2	6-26	8	2	0	0	0	2	0	0	12

Low Visitor Use

North Shore of Muir Inlet

The low visitor use area on the north shore between Riggs and Muir Glaciers had more nests than any other area open to visitors in the bay; surveys found 69 nests in 2004 and 63 nests in 2005. There also were at least 21 nests in this area in 2003; however, not all nests on this shoreline were mapped during the survey. The poor weather prompted the survey team to minimize egg exposure time while adults were off the nest. In general, nesting was spread out over a large area of early successional, sparsely vegetated hillside.

Adams Glacier Outwash

The large outwash on the southwest shore of Adams Inlet had at least 30 and 54 active nests from several species in 2004 and 2005, respectively. At this site, about 500 Arctic Terns were noted in 2004 and 357 Arctic Terns were noted in 2005 (table 3). Most of the adult Arctic Terns were feeding in the nearshore area at this site. The survey also found nesting Black Oystercatchers, Mew Gulls, Semipalmated Plovers, Parasitic Jaegers, and Aleutian Terns. Nests were highly dispersed within this large cobble outwash, and it is possible that the number of nests was underestimated owing to the cryptic nature of nests.

Moraine at Grand Pacific Glacier

The moraine at the base of Grand Pacific Glacier is notable because the Arctic Tern bird count and nesting activities were the highest in the bay. A total of 64 Arctic Tern nests and 3 Mew Gull nests were found at this site on June 13, 2005. In addition, there were about 200 adult Arctic Terns, 11 Mew Gulls, and 2 Parasitic Jaegers flying over this area (table 3).

Unnamed Islet Northwest of Eider Island

The unnamed islet northwest of Eider Island had 13 Arctic Tern and 4 Black Oystercatcher active nests, and some 300 Arctic Tern adults on May 27, 2004. Fifteen Arctic Tern nests contained eggs on June 20, 2005. Fifteen Black Oystercatcher nests were initiated over the course of the summer (Alaska Department of Fish and Game, 2006).

Islet at the Entrance to Scidmore Bay

On June 30, 2004, a total of 23 nests of Black Oystercatchers, Mew Gulls, and Arctic Terns were found on the islet at the entrance to Scidmore Bay (table 3). A Canada Goose nest containing six eggs was found on June 17, 2005. Arctic Terns were not found on this islet in 2003 or 2005.

Islet at Tlingit Point

Nesting concentration was relatively high at the islet at Tlingit Point during all 3 years of this study, with 11 nests and 3 territorial pairs in 2003, 18 nests and 3 territorial pairs in 2004, and 36 nests and 1 territorial pair in 2005. Arctic Terns, Black Oystercatchers, Mew Gulls, Glaucous-winged Gulls, and Herring Gulls nest on this small island (table 3). This island is close to a regular camper dropoff at Sebree Island and therefore has a high potential for camping.

Wildlife Closures

Areas that have been historically closed to foot traffic because of concerns about disturbance to wildlife were surveyed in 2003 and 2005 to assess the current status of nesting birds.

Unnamed Islands East of Russell Island

The four unnamed islands east of Russell Island were surveyed on July 2, 2003, and the largest island was surveyed again on June 18, 2005 (table 5). Arctic Terns, Black Oystercatchers, and Mew Gulls were nesting on the group of three small islands to the east of the largest island in 2003. The largest and westernmost island in this group is an important nesting area for these species. Most of the nesting activity was limited to the west point of the island. In 2003, surveys observed nesting Arctic Terns, Black Oystercatchers, and Mew Gulls; 1 Arctic Tern egg was hatching and 1 Black Oystercatcher chick and 13 Mew Gull chicks were at the water's edge. In 2005, surveys located two Black Oystercatcher nests and two territorial pairs, and nine Mew Gull nests. Arctic Terns were not nesting on the island during the 2005 survey, although two adults were present.

Lone Island

On July 15, 2003, there were nine harbor seals (*Phoca vitulina*) and three Steller's sea lions (*Eumetopias jubatus*) hauled out on Lone Island; therefore, observations were made from the boat to minimize disturbance. There were 44 empty Black-legged Kittiwake (*Rissa tridactyla*) nests, and adults were stomping on nesting material or standing in pairs on nests; however, no chicks were observed nor any eggs in the nests. The Northwestern Crows were concentrated in alder where they may have been nesting. One Tufted Puffin (*Fratercula cirrhata*) was seen flying from a burrow on the northeast side of the island. In 2003, survey members did not go ashore because the NPS waiver to conduct research in a closed area was issued after the incubation period and it was not possible to quantify nests at the time of the survey.

The survey team circumnavigated Lone Island and landed ashore to count nests on June 12, 2005. A total of 125 active nests were found and 115 of these were Glaucous-winged Gull nests (table 5). Most Glaucous-winged Gull nests were in the grassy meadow near the center of the island; average clutch size was 2.4 eggs/nest ($n = 115$). Of the 47 Black-legged Kittiwake nest bowls observed, 15 were being incubated by an adult. Eight of those were active nests, 5 contained two eggs, and 3 contained a single egg. From the water, the survey also observed four Herring Gulls sitting on nests, although it was unsafe to check the contents of these cliff nests while the survey members were on land. Two Black Oystercatcher nests and one territorial pair were found during the survey on land.

Geikie Rock

Geikie Rock was surveyed from a skiff on July 15, 2003. Five Glaucous-winged Gull chicks were at the shoreline, and fish-holding behavior was observed in Arctic Terns and Pigeon Guillemots (*Cephus columba*), which suggests they also were nesting in the area. Of the 250 Black-legged Kittiwakes on the rock, about 90 percent were immature. The survey team stayed offshore to minimize disturbance to the colony during chick rearing.

On June 12, 2005, a total of 52 active nests were found at Geikie Rock (table 5). The survey located 3 Black Oystercatcher nests and 2 territorial pairs, 48 Glaucous-winged Gull nests, and 1 Herring Gull nest. The average Glaucous-winged Gull clutch size was 2.52 eggs/nest ($n = 48$).

Leland Islands

Leland Islands were surveyed by foot on July 7, 2003. Eight Black Oystercatcher nests, all containing eggs, were found on the northern part of the island. On June 23, 2005, the survey found 24 active nests. Nine Arctic Tern and 2 Black Oystercatcher nests were mapped on the southern part of the island, and 13 Black Oystercatcher nests were mapped on the northern part of island.

Boulder Island

Boulder Island was surveyed by foot on July 12, 2003. A total of 41 active Glaucous-winged Gull nests were found with an average clutch size of 2.58 eggs/nest ($n = 40$). One nest had one chick and one hatching chick. Two active Black Oystercatcher nests also were found on this island.

Table 5. Species, adult count, number of active nests, and territorial pairs for wildlife areas closed to human use, Glacier Bay, Alaska, 2003 and 2005.

[Unnamed Islands east of Russell Island: Count data for that site were averaged from two surveys, the only case where a closed area was visited twice. **Nests:** Number of active nests. **Pairs:** Number of territorial pairs]

Species	Unnamed Islands east of Russell Island		Lone Island		Geikie Island		Leland Island		Boulder Island		Flapjack Island		South Marble Island		Eider Island	
	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts	Nests	Adult counts
Arctic Tern	7	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0
Bald Eagle	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Black Oystercatcher	8	35	2	9	3	2	15	0	40	2	0	1	43	3	0	8
Black Scoter	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
Black Turnstone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black-legged Kittiwake	0	0	8	47	146	0	0	0	0	0	0	0	1,125	134	277	807
Caspian Tern	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Merganser	0	0	0	0	2	0	0	0	112	0	0	0	14	0	0	2
Common Murre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Double-crested Cormorant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Glaucous-wing Gull	0	84	115	0	195	48	0	0	252	41	0	600	26	0	200	200
Harlequin Duck	0	81	0	0	95	0	0	0	48	0	0	0	0	0	0	18
Herring Gull	0	0	(¹)	4	4	1	0	0	0	0	0	0	0	0	0	5
Horned Puffin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Kittlitz's Murrelet	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Mew Gull	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northwestern Crow	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
Pelagic Cormorant	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4
Pigeon Guillemot	(¹)	0	0	0	29	0	0	0	0	0	0	0	0	0	0	195
Red-breasted Merganser	0	0	0	0	0	0	0	0	0	0	0	0	300	0	0	41
Surf Scoter	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0
Tufted Puffin	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	29
Unidentified Scoter	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0

¹ Active nests are suspected but we were unable to enumerate them.

Flapjack Island

Flapjack Island was surveyed from land on June 26, 2003. The survey found 26 active Glaucous-winged Gull nests concentrated on the north end of the island. Average clutch size was 1.68 eggs/nest ($n = 25$). Twenty-five Glaucous-winged Gull nests contained eggs, and one nest had a single chick. One Black Oystercatcher nest with eggs and one territorial Black Oystercatcher pair also were found on the island. This island appears to be an important roosting area for birds. A group of 43 non-breeding Black Oystercatchers, about 225 adult and more than 900 subadult Black-legged Kittiwakes, 200 mostly subadult Glaucous-winged Gulls, and about 300 Red-breasted Mergansers (*Mergus serrator*) were found on the beach (table 5).

South Marble Island

South Marble Island was surveyed on June 10, 2005. The survey noted 311 Black-legged Kittiwake nests, 34 of which were being incubated. Three potential Tufted Puffin nests were identified from adults flying from crevices, and 85 Glaucous-winged Gull adults were sitting on nests on cliffs viewed from the water. Five additional Glaucous-winged Gull nests were viewed from land and they had incubating adults and therefore unknown nests contents. There were an additional 200 Glaucous-winged Gull nests visible from land, and the average clutch size was 2.4 eggs/nest ($n = 200$). Three Black Oystercatcher nests also were located on the island.

Efforts were made to minimize disturbance to marine birds and mammals on the island; however, most of the Steller's sea lions that were hauled out were flushed from the island when the survey team landed. About 305 Steller's sea lions were noted on the island during our survey: 120 were on the southern islet, 85 were near the center of the island facing east, and 100 were on the north end of the island.

Eider Island

Eider Island was surveyed on June 26, 2005. Two active Black Oystercatcher nests and one territorial pair were found on the island.

Egg-Collection Sites Historically Used by Alaska Native People

There were five sites identified in Hunn and others (2002) that contained more than 25 Glaucous-winged Gull nests: Flapjack Island, Boulder Island, South Marble Island, Lone Island, and Geikie Rock. Five sites had zero nests of any bird species and eight sites had less than 10 nests (table 6). Many of the historical native egg-collection sites do not support nesting populations of marine birds, owing to the succession of terrestrial vegetation after glacial retreat. For example, Willoughby Island was once a large nesting colony for gulls with little vegetation or soil along the western slope (Bailey, 1927). During our surveys, only a single nesting pair of Black Oystercatchers was found on Willoughby Island and the western slope of the island was covered in woody vegetation.

Habitat

Shoreline habitat in Glacier Bay varies in complexity and substrate type (Sharman and others, 2005; fig. 14). Primary substrate for complex shoreline segments consisted largely of pebbles, fine sand, and silt. Glacial outwash shoreline segments were dominated by fine sand and silt, whereas the more typical shoreline segments consisted mostly of pebbles, fine sand, and silt. Typical shoreline segments also contained more bedrock, boulder, and cobbles as primary substrate than other segment types. Overall, there is more shoreline classified as typical than as complex or glacial outwash.

Habitat used for nesting varied by species (fig. 15). Arctic Tern nests were found more often in fine-sand habitats than in other habitat types. Black Oystercatcher nests were usually found along shorelines with pebbles as the primary substrate, whereas most Glaucous-winged Gulls nested on bedrock. Mew Gulls nested in a variety of substrate types. Frequency of occurrence for Arctic Tern nests in glacial outwash shoreline types was higher than the frequency for other shoreline types. Nests of Black Oystercatchers, Mew Gulls, and Glaucous-winged Gulls were usually found on typical shoreline types (table 7).

Table 7. Frequency of occurrence for active nests by shoreline type, Glacier Bay, Alaska, 2003–05.

[Numbers in parentheses are the number of active nests included in this analysis]

Shoreline type	Frequency of occurrence			
	Arctic Tern (384)	Black Oystercatcher (401)	Glaucous-winged Gull (504)	Mew Gull (183)
Complex	0.12	0.33	0.31	0.22
Glacial outwash	.48	.04	.0	.31
Typical	.40	.63	.69	.47

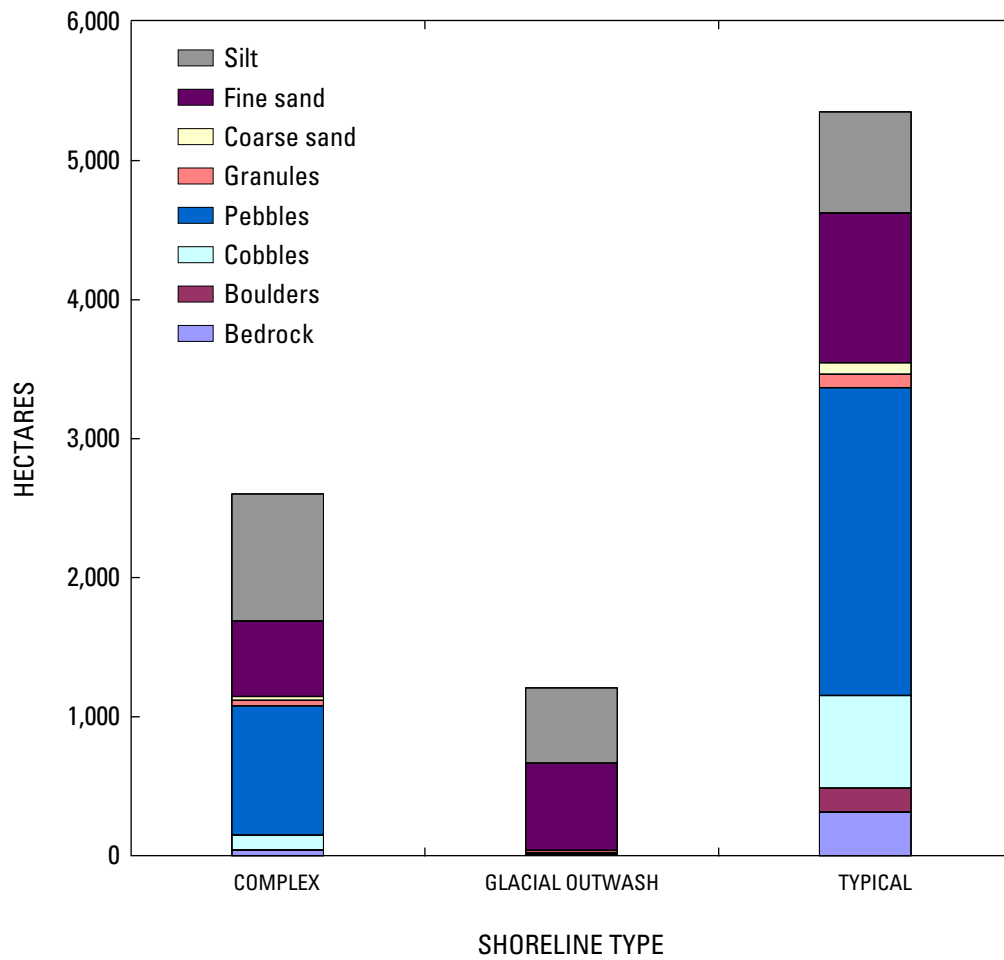


Figure 14. Total area of primary substrate classes that constituted Glacier Bay shoreline types during coast mapping, southeastern Alaska, 1997–2003. (Data from Sharman and others, 2005).

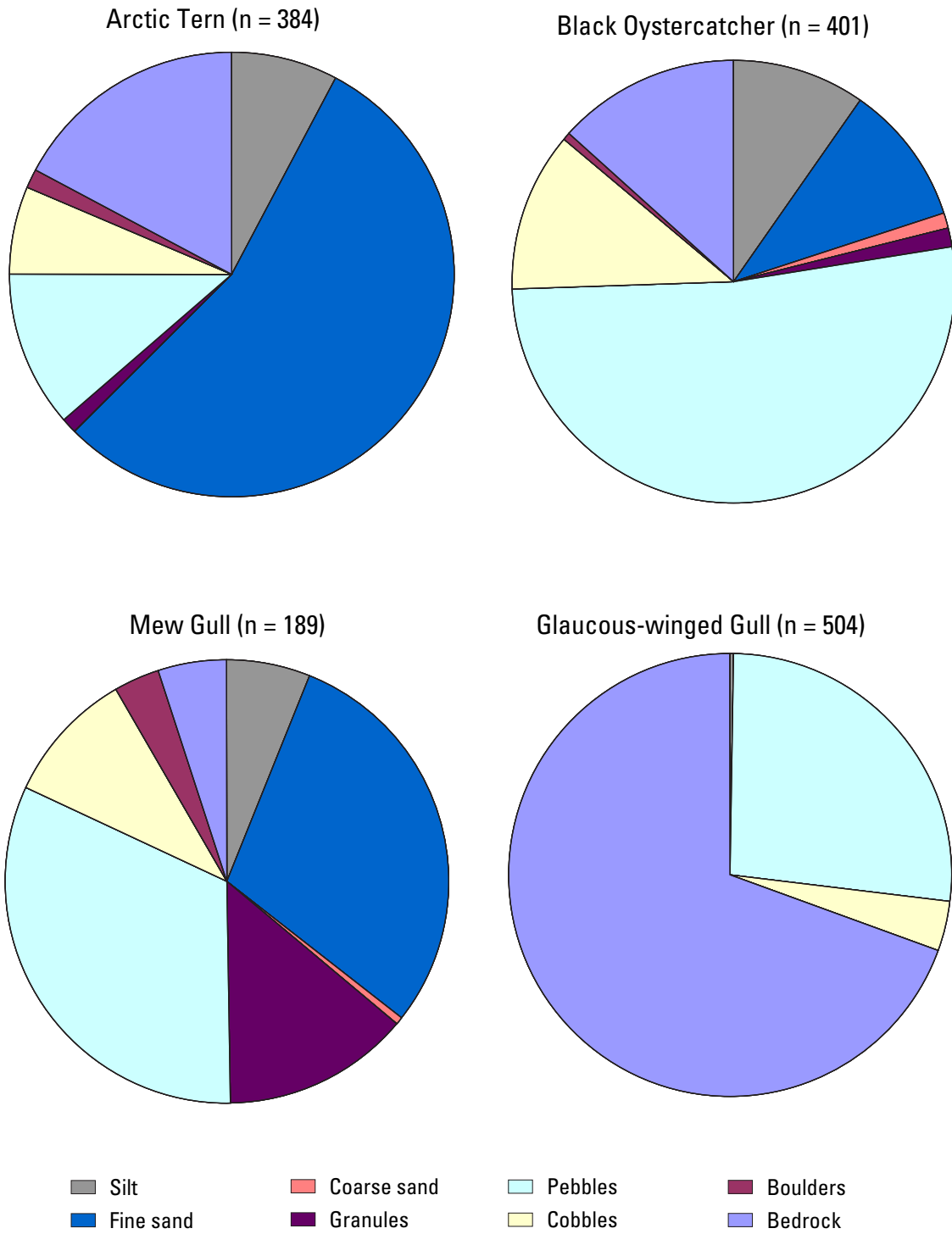


Figure 15. Substrate used by common ground-nesting marine birds in Glacier Bay, southeastern Alaska, 2003–05.

Discussion

Glacier Bay is an important breeding area for several species of ground-nesting marine birds in southeastern Alaska. This section discusses the relevance of distribution, habitat, and behavior, and the potential for human disturbance at nest sites for common and notable species of ground-nesting birds. It also presents a summary of findings on the areas of concern, wildlife closures, and historical native egg collection sites. Finally, it discusses data limitations and management applications associated with this study.

Arctic Terns

The majority of Arctic Tern nesting concentrations were found in areas open to overnight visitation within the upper arms of Glacier Bay. The preferred nesting habitat for Arctic Terns—cobble outwash areas and rocky outcrops on small islands (Hatch, 2002)—is found mostly up-bay in early successional habitats. Nelson and Lehnhausen (1983) noted that Arctic Terns were more common in Glacier Bay

than elsewhere in southeastern Alaska, and their survey found nesting terns in the upper bay at six of nine sites. The aggressive behavior exhibited by nesting Arctic Terns when humans approach may make their nesting areas less vulnerable to human disturbance; however, individual Arctic Tern nests are inconspicuous and therefore are more likely to be trampled. On several occasions, Arctic Terns were observed eating and holding small schooling fish, such as capelin (*Mallotus villosus*) and pink salmon (*Oncorhynchus gorbuscha*), and feeding these fish to their young. On several occasions, hundreds of Arctic Terns were observed feeding nearshore close to colony sites on glacial outwashes. The colony sites in Glacier Bay may be important to Arctic Terns because of the availability of nesting habitat and the relative proximity to surface schooling fish (Arimitsu and others, 2007). However, Arctic Tern nest counts were variable among years and within years at sites that were revisited in this study (table 4 and fig. 16) and the counts represent only a snapshot in time. A better understanding of factors influencing the spatial and temporal variability in Arctic Tern nesting requirements would improve assessment of visitor disturbance risks.

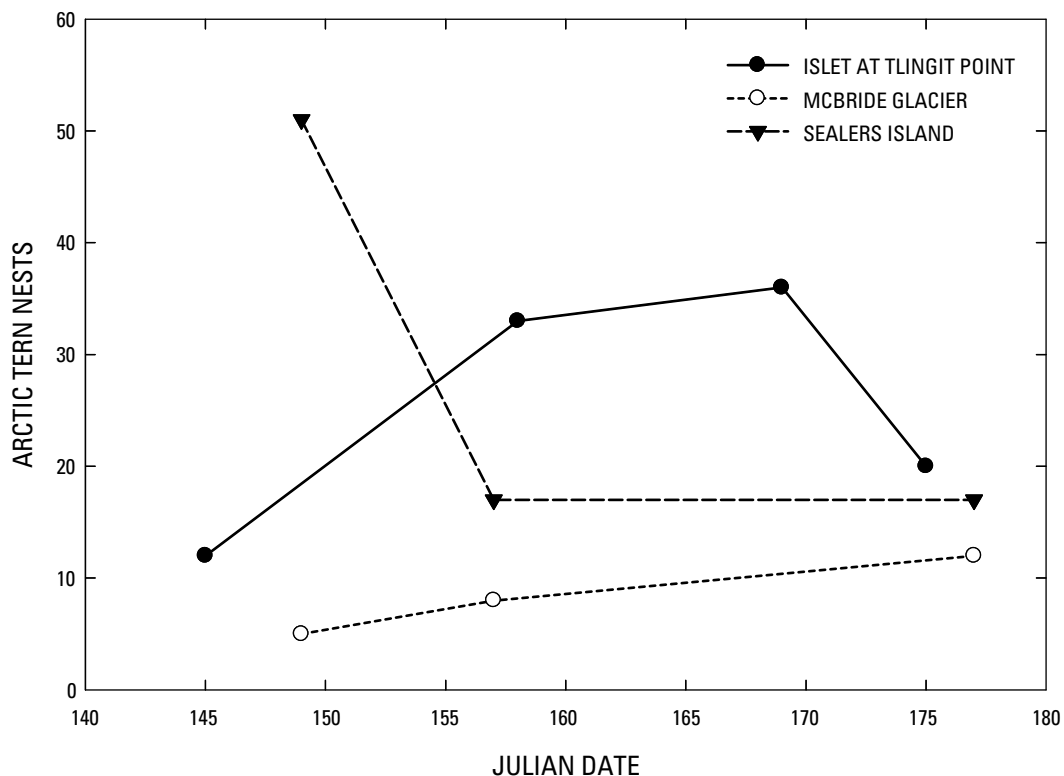


Figure 16. Number of Arctic Tern nests at three revisit sites, Glacier Bay, southeastern Alaska, 2005.

Black Oystercatchers

Black Oystercatcher pairs were found nesting throughout Glacier Bay in areas within wildlife closures and areas open to public visitation. They prefer to nest on gravel beaches with low-sloping substrates and usually nest near the high-tide line (Andres and Falxa, 1995), and these areas may be more readily available in Glacier Bay owing to newly emergent reefs formed by glacial rebound (Lentfer and Meier, 1995). Oystercatcher nests may be particularly susceptible to disturbance because kayakers tend to use the same beaches for camping. Nests are made of gravel and may be trampled when boats are hauled above the high-tide line.

Glacier Bay appears to be an important range-wide breeding and post-breeding area for Black Oystercatchers. Nelson and Lehnhausen (1983) found unusually high concentrations of Black Oystercatchers in Glacier Bay compared to the rest of the species' range, including a count of 67 adults at the closed area at Flapjack Reef. A non-breeding aggregation with 43 Black Oystercatchers was observed at the same reef in June 2003 during this study. Large aggregations of Black Oystercatchers during the post-breeding season, including one sighting of an estimated 600 adult and hatch-year birds in September 1992 (Gus van Vliet, State of Alaska Department of Environmental Conservation, oral commun., 2003), have been documented in Geikie Inlet and date back at least to the 1960s (Wik, 1967). The proximity to mammalian predator-free roosting sites at the closed Geikie Rock and Lone Island, location within relatively protected waters, and the freshwater runoff from small streams (which may enhance intertidal productivity, or increase bathing opportunity for post-breeding plumage maintenance) may make this area particularly suitable for these birds (Gus van Vliet, State of Alaska Department of Environmental Conservation, written commun., 2004).

Mew Gulls

With the exception of a small number of nests in Berg and Fingers Bays, Mew Gull nests were found only in the upper reaches of Glacier Bay during this study. Mew Gulls prefer nesting in areas with little or no vegetation and on gravel banks or beaches, often near freshwater streams (Moskoff and Bevier, 2002). Nelson and Lehnhausen (1983) found that Mew Gulls made up about 2.9 percent of the birds in Glacier Bay and documented five colonies at the islet at Shag Cove, Hugh Miller Complex, White Thunder Mountain, the head of Rendu Inlet, and the islet east of Russell Island. During this study, nesting activity was found at all those sites

except the islet at Shag Cove, which was overgrown with vegetation, and White Thunder Mountain. Mew Gull chicks may be susceptible to human disturbance because they usually entered the water when humans approached them during this study. This behavior might make them more accessible to predators, such as Bald Eagles.

Glaucous-Winged Gulls and Herring Gulls

Although Glaucous-winged and Herring Gulls are known to use a wide variety of habitat types for nesting (Verbeek, 1993), in Glacier Bay they were found nesting mostly in flat areas with low vegetation or on rocky cliffs. They are conspicuous birds who place their eggs in large nest bowls. Therefore, trampling of these nests by humans is less likely than for other ground-nesting bird species.

The occurrence of breeding Herring Gulls in Glacier Bay was documented by Wik (1968) and Patten (1974). Further accounts of Herring Gulls are lacking, which may be due to the difficulty of distinguishing between the relatively rare Herring Gull and the rather ubiquitous Glaucous-winged Gull (Wik, 1968). Hybridization between these species occurs in Glacier Bay (Patten and Weisbrod, 1974) and is common in other areas where their breeding ranges overlap (Grant, 1987).

Aleutian Terns

Glacier Bay represents the southeastern edge of the breeding range for Aleutian Terns (North, 1997). Aleutian Terns nest very rarely in Glacier Bay; low concentrations of nesting birds have been observed on Sealers Island, North Marble Island, and Johns Hopkins Inlet in the past (Bruce Paige, retired, National Park Service, oral commun., 2005). Breeding Aleutian Terns are highly sensitive to human disturbance and may seasonally or permanently abandon colonies when disturbed (Haney and others, 1991; North, 1997). However, they may benefit from nesting in mixed colonies with Arctic Terns, who generally are more aggressive in their nest defense (Hanley and others, 1991).

Areas of Concern

Although nesting bird concentrations generally were low in most areas open to visitor use, the potential for disturbance to nesting birds exists at several high visitor use areas, including the north spit at McBride Glacier, the west entrance to Reid Inlet, and Sealers Island. These areas have historically supported nesting colonies of Arctic Terns and

other bird species (Wik, 1968; Greg Streveler, retired, National Park Service, oral commun., 2003; Bruce Paige, retired, National Park Service, oral commun., 2005). Owing to their close proximity to tidewater glaciers, they are among the more heavily used areas in the bay (National Park Service, unpub. data, 2004). There also was concentrated nesting activity in several low visitor use areas including the north shore of Muir Inlet, the Adams Glacier outwash, the moraine of the Grand Pacific Glacier, an unnamed islet northwest of Eider Island, the islet at the entrance to Scidmore Bay, and the islet at Tlingit Point. These areas represent the largest unprotected nesting concentrations in the bay.

Arctic Tern nesting concentrations were highly variable at several areas of concern. Terns are known to relocate colony sites in response to disturbance (Roby and others, 2002). In a study of the related Caspian Tern (*Sterna caspia*), Cuthbert (1988) found that the majority of terns with failed nests deserted the colony, and 39 percent of those re-nested at a different location. Although the number of Arctic Tern nests and adults decreased at Sealers Island, numbers of nests at McBride Glacier and the islet at Tlingit Point increased over the course of the 2005 breeding season (fig. 16). Given the proximity of McBride and the islet at Tlingit Point to this colony, the possibility that the increase in nesting activity at adjacent sites was a result of nest failure at Sealers Island in 2005 cannot be ruled out.

Wildlife Closures

Nesting activity was documented at all wildlife closures surveyed. Geikie Rock, Boulder, Flapjack, and Lone Islands are some of the more important Glaucous-winged Gull nesting areas in the bay. The four unnamed islands east of Russell Island are small islands that have evidence of concentrated nesting activity. In addition, camping potential is relatively poor on these islands. Leland Islands, including the southern portion, are important for nesting and roosting birds.

Although our census of South Marble Island was conducted with considerably less effort than the 1999 census (1 day compared to a summer's worth of effort in 1999), a comparison of count data suggests that Glaucous-winged Gull and Pelagic Cormorant (*Phalacrocorax pelagicus*) populations have not changed and that the Black-legged Kittiwake population has increased since 1999 (table 12, at back of report; Zador and Piatt, 1999). A total of 285 active Glaucous-winged Gull nests were counted in mid-June 2005, and 200 nests containing eggs and another 90 nests with incubating adults were found in 2005 (tables 5 and 12). This suggests that the number of nesting Glaucous-winged Gulls has remained

stable since 1999, although the maximum count of adults was higher in 2005 than was previously documented (table 12). We also found that the number of Pelagic Cormorants roosting on the island was comparable, with 201 and 195 individuals in 1999 and 2005, respectively. Although the number of Black-legged Kittiwakes in incubation posture remained about the same (Zador and Piatt, 1999), the number of adults observed on the island increased from 159 in 1999 to 647 in 2005. It was not possible to examine trends for other species because the counts were too small (for example, Common Murres, *Uria aalge*, and Tufted Puffins) or were potentially affected by the time of observation (for example Pigeon Guillemots).

Egg-Collection Sites Historically Used by Alaska Native People

Several traditional egg-collection sites no longer support Glaucous-winged Gull breeding populations, and this may be due to ecological succession following deglaciation. For example, Triangle Island (at the head of Queen Inlet) was once a treeless islet that supported a colony of several species of gull (Wik, 1968), but during our survey of the area, the island was overgrown with vegetation and surrounded by loose gravel. North Marble Island, which had an estimated 300 Glaucous-winged Gull nests in 1982 (Nelson and Lehnhausen, 1983), was also among the sites with fewer than 10 Glaucous-winged Gull nests in 2005 (table 13, at back of report). However, it is unknown whether succession played a role in the abandonment of the North Marble Island colony.

Zador and others (2006) found that a controlled harvest at South Marble Island restricted to the early incubation period would not impact the population size. Although the gull population at South Marble Island in 2003–05 had not changed since the study conducted in 1999–2000 (table 12), continued monitoring of the breeding population would be appropriate if harvesting is to occur.

Data Limitations

Although it was not possible to determine how many nests were missed in the surveys, it is likely that most nesting birds were accounted for by recording territorial birds, especially for conspicuous species like Arctic Terns, Black Oystercatchers, Mew Gulls, and Glaucous-winged Gulls. The surveys attempted to locate nests during the incubation period in order to minimize disturbance and because chicks are mobile, inconspicuous, and therefore harder to count later in the season. In any case, the location and numbers

of nests reported here must be considered as minimum estimates for Glacier Bay because of the variation in timing and detectability of different species. Data collected during this study provide a snapshot in time and are limited by seasonality, nest detectability, and differing levels of effort each year. Data from sites that were visited only once may underrepresent the actual nesting counts if they were collected too early or too late in the season. Variability in nest counts among years may be due to timing of surveys or to natural variability within the season and among years. An example of the latter is demonstrated from data collected at sites that were visited each year and more than once within a breeding season (see section, "[Sealers Island](#)"). The surveys were focused on the more abundant and conspicuous species to maximize nest detectability, and the distribution and abundance of the more cryptic nesters were undoubtedly underestimated. In addition, during the pilot year of the study (2003), the surveys were intended to focus only on high visitor use areas with the potential for disturbance. Because nesting counts overall were very low in these areas, comprehensive searches were conducted for nesting activities throughout the study area during the rest of the study. This shift in survey focus makes it harder to compare nesting densities among years.

Management Applications

Most of the largest seabird nesting areas in Glacier Bay are already closed to human use and therefore largely protected from disturbance by park visitors. In this study,

surveys found additional concentrations of ground-nesting birds along shorelines that currently have high visitor use, and human disturbance could affect these breeding activities ([fig. 13](#)). Concentrations of ground-nesting birds also were found along shorelines that currently have low visitor use. Closing both types of concentration areas to human activities could reduce the potential for disruption of nesting. On the basis of our general understanding of breeding for these species, closures during incubation and chick rearing periods would likely be most effective. Further study on nest timing to identify key closure dates would facilitate use of this management and provide the most protection of nesting activities.

Many of the nest/territorial pairs found were solitary and dispersed along Glacier Bay shorelines. Closing all shorelines that have the potential to support nesting birds would be difficult. Perhaps the simplest way to minimize disturbance to nesting birds broadly in Glacier Bay is to educate visitors about where they may encounter nesting birds, nest identification (see [fig. 17](#)), nesting bird behavior, and appropriate responses (such as moving elsewhere) to encroachment upon nest sites or nesting behavior.

The baseline data gathered on the distribution and abundance of ground-nesting birds in the park can not only inform science-based visitor management but also can be used for monitoring changes in breeding-bird abundance and distribution over time, whether those changes are due to human disturbance or natural factors (such as climate change or landscape succession).



A. Glaucous-wing Gull



D. Mew Gull



B. Semipalmated Plover



E. Black Oystercatcher



C. Herring Gull

Figure 17. Nests in Glacier Bay, southeastern Alaska.



F. Parasitic Jaeger



I. Arctic Tern



G. Spotted Sandpiper



J. Mew Gull nest containing (2) Mew Gull eggs and (1) Arctic Tern



H. Red-throated Loon

Figure 17.—Continued.

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Table 8. Summary of Arctic Tern nests and contents in Glacier Bay, Alaska, 2003–05.

[Areas of concern are shown with gray shading. **Number of nests and contents:** C, chick; E, egg; F, nests with predated eggs or dead chicks. **Active unknown:** Nests in which adults were observed sitting on nests but would not move or behaved in an unusually aggressive manner but the nest contents were not observed. ADF&G, Alaska Department of Fish and Game]

Location	Date	Number of nests and contents										Total
		1E	2E	3E	1C	2C	3C	1C, 1E	2C, 1E	F	Active unknown	
2003												
Adams Inlet	6/18–6/19	1	2									3
Closed Boulder Island	7-12										1	1
Closed Islands east of Russell Island	7-02	3	1		1							5
Fan at Russell Cut	6-29		2									2
Islet northwest of Eider	6-13	2									1	3
Queen Inlet	7-01	1	1									2
Riggs to Muir	6-22		1	1								2
Sealers Island	6-15	4	8	1	2				1			16
Tarr Inlet	6-29		1		5	1	1	1				9
Topeka outwash	6-28		1									1
2004												
Adams Inlet	6/12–6/14	7	12		1					1		25
Beardslee Islands (ADF&G data)	5-27		3									3
Beardslee Islands (ADF&G data)	6-10	1	2									3
Beardslee Islands (ADF&G data)	6-17	2	4	1								7
Fan at Russell Cut	5-21	1	4								2	7
Geikie Islet	5-24										1	1
Islet at Tlingit Point	6-01										1	1
McBride, north spit	5-28	1	2								1	4
Queen Inlet	5-20	6	12	4						1		23
Reid Inlet	5-27	2	10	1								13
Riggs to Muir	5-29			2								2
Tarr Inlet	5-23	3	3	1								7
Wachusett	5/31–6/01	2	3									5
Adams fan	6-14	9	18	7	2					4	3	44

Table 9. Summary of Black Oystercatcher nests and contents in Glacier Bay, Alaska, 2003–05.

[Areas of concern are shown with gray shading. **Number of nests and contents:** C, chick; E, egg; F, nests with predated eggs or dead chicks. **Active unknown:** Nests in which adults were observed sitting on nests but would not move or behaved in an unusually aggressive manner but the nest contents were not observed.]

Location	Date	Number of nests and contents										Territorial pair	Active unknown	Total			
		1E	2E	3E	4E	1C	2C	3C	1C, 1E	2C, 1E	F						
2003																	
Adams	6/17–6/20	1	2	2		1					1				4		11
Beardslees (not including closed islands)	6/05–6/15	2	2	1		1								2	15		23
Caroline Point	6-16		1														1
Closed Boulder Island	7-12		1		1												2
Closed Flapjack Island	6-26		1												4		5
Closed islands east of Russell Island	7-02	1	1			2					1				1		6
Closed Leland Island	7-07	1	4														8
Composite Island	7-10	1															1
East arm entrance	6-16	1		1													2
Garforth Island	6-17	3	1														4
Hugh Miller Complex	6/27–6/30	1	3												1		5
Geikie Islet	6-08			2													2
Islet at entrance to Scidmore Bay	6-29		1												3		4
Laplugh to Ptarmigan Beach	6-20		1			1									2		4
McBride, north spit	6-13	1		2							1						4
Muir Point	7-10						1										1
Nunatak Cove	7-09						1										1
Nunatak Cove to McBride	6-21	1						1							1		3
Point George	7-10						1										1
Queen Inlet	6-22	1	1								1						3
Reid Inlet	6/20–6/21			2											2		4
Rendu	6/30–7/01	1		2													3
Riggs to Muir	6/22–6/23	1	1	1		1			2	3							9
Rowlee Point	7-09			1													1
South of Wolf Point	6-14								1								1
Scidmore Bay	6-28		1	1					1								3
Sealers Island	6-15								2								2
Secret Bay	6-04	2															2
Sturgess Island	6-12	2		1		1			1		1			1			8
Tarr	6-29	1															2
West of Gloomy Knob	7-11														1		1

Table 9. Summary of Black Oystercatcher nests and contents in Glacier Bay, Alaska, 2003–05.—Continued

[Areas of concern are shown with gray shading. **Number of nests and contents:** C, chick; E, egg; F, nests with predated eggs or dead chicks. **Active unknown:** Nests in which adults were observed sitting on nests but would not move or behaved in an unusually aggressive manner but the nest contents were not observed]

Location	Date	Number of nests and contents										Territorial pair	Active unknown	Total		
		1E	2E	3E	4E	1C	2C	3C	1C, 1E	2C, 1E	F					
Sealers Island	5-28	2	2	2												4
Shag Cove	6-15	2	1	1			1							6		10
Shore north of Sealers Island	5-28		1	2												3
Strawberry Island	6-05													5		5
Stream outfall north of Geikie Inlet	5-24			1												1
Sturgess Island	6-16					1								12		14
Tarr Inlet	5-23			3												3
Tarr to Jaw Point	5-26													2		2
Tidal Inlet	5-19			2										2		4
Tidal Inlet to Thingit Point	6-10		2											1		3
Islet at Thingit Point	6-01		3	7												10
Wachusett Inlet	5-31		2	5										4		11
White Thunder Mountain to Stump Cove	5-28												1			1
2005																
Adams Inlet	6-14					1					2					3
Closed Eider Island	6-26			2										1		3
Closed Flapjack	6-25		1													1
Closed Geikie Rock	6-12		3											2		5
Closed Island east of Russell	6-18	1		1										2		4
Closed Leland Island	6-23		2	5					3		2					15
Closed Lone Island	6-12	1	1											1		3
Closed South Marble Island	6-10		2	1												3
Closed Spider Island Complex	6/25–6/26	1	1	1			2		1							5
Drake Island	6-10												1			1
Garforth Island	6-06	1	1	4									1	2		9
Hugh Miller	6-17	1	1	1												2
Islet at entrance to Scidmore Bay	6-17		1													1
McBride, north spit	5-29	1	1	1												3
McBride, south spit	6-06			1										1		2
North Marble Island	6-10	1	2				1							2	1	7

Table 9. Summary of Black Oystercatcher nests and contents in Glacier Bay, Alaska, 2003–05.—Continued

[Areas of concern are shown with gray shading. **Number of nests and contents:** C, chick; E, egg; F, nests with predated eggs or dead chicks. **Active unknown:** Nests in which adults were observed sitting on nests but would not move or behaved in an unusually aggressive manner but the nest contents were not observed]

Location	Date	Number of nests and contents										Territorial pair	Active unknown	Total		
		1E	2E	3E	4E	1C	2C	3C	1C, 1E	2C, 1E	F					
Ptarmigan Beach	5-21	1												1		2
Queen Inlet	6-05			1										1		2
Queen, northwest outwash at head	5-22			1												1
Reid Inlet	5/20–5/21	2	4													6
Riggs to Muir	5-28	1	6											3		10
Fan at Russell Cut	6-04			1												1
Scidmore Bay	6-18					1										1
Sealers Island	5-29			4												4
Strawberry Island	5-31	1														1
Sturgess Island	6-23					6	1									7
Islet at Tlingit Point	5-25			5										1		6
Topeka outwash	5-21	1		1												2
Weird Bay	6-19	1		1			1									3
Willoughby Island	6-22		1													1

2005—Continued

Table 10. Summary of Mew Gull nests and contents in Glacier Bay, Alaska, 2003–05.

[Areas of concern are shown with gray shading. **Number of nests and contents:** C, chick; E, egg; F, nests with predated eggs or dead chicks. **Active unknown:** Nests in which adults were observed sitting on nests but would not move or behaved in an unusually aggressive manner but the nest contents were not observed]

Location	Date	Number of nests and contents										Territorial pairs	Active unknown	Total	
		1E	2E	3E	1C	2C	3C	1E,1C	F						
2003															
Adams Inlet	6-19	1													1
Closed islands east of Russell	7-02	1			1										2
Geikie Inlet, outwash at head	6-07		2											3	5
Lamplugh to Parmigan Beach	6-20			1										1	2
Queen Inlet	6-22		1												1
Queen, west shore	7-01	1												8	9
Reid Inlet	6/20–6/21		1			2								1	4
Rendu	6-30													4	4
Riggs to Muir	6/22–6/23	1		1	1	1									4
Sealers Island	6-15			1											1
Topeka outwash	6-28			3											3
Wolf Point, south	6-14	1													1
2004															
Adams Inlet	6/12–06/14	2	1	2											5
Berg and Fingers Bays	6/11–06/13		2	1										4	7
Cove south of Gloomy Knob	5-27		1												1
Fan at Russell Cut	5-21	1		1											2
Goose Cove to Adams Inlet	6-02			1										3	4
Hugh Miller Complex	6/27–7/01					1				1					2
Islet at Entrance to Scidmore Bay	5-23		1	4											5
Islet at Tingit Point	6-01			1											1
Johns Hopkins	7-16												1		1
Shoreline north of Adams Inlet	6-02			2											2
McBride, north spit	5-28			1											1
McBride, south spit	5-28	1													1
Parmigan Beach	5-26			1											1
Queen Inlet	5-22		1	2										3	6
Queen northwest outwash at head	5-20	4	1	5										2	12
Reid Inlet	5-27			8											8
Rendu	6/22–6/23												2	1	3

Table 11. Summary of Mew Gull nests and contents in Glacier Bay, Alaska, 2003–05.

[Areas of concern are shown with gray shading. **Number of nests and contents:** C, chick; E, egg; F, nests with predated eggs or dead chicks. **Active unknown:** Nests in which adults were observed sitting on nests but would not move or behaved in an unusually aggressive manner but the nest contents were not observed]

Location	Date	Number of nests and contents										Total	
		1E	2E	3E	4E	1C	2C	2E,1C	F	Terri- torial pair	Active unknown		
2003													
Closed Boulder Island ¹	7-12	3	13	24			1		4				41
Closed Flapjack Island ¹	6-26	8	7	5	1								21
Islet at the entrance to Scidmore Bay	6-29	1											1
Islet at Tlingit Point	6-17	1	2	4				1					7
Riggs to Muir	6-22	1	1	1		3	1						7
Sealers Island ¹	6-15							1					1
Sturgess Island ¹	6-12		1	1									2
2004													
Islet at Tlingit Point ¹	6-01	1	2										3
Johns Hopkins Jaw Point	7-16										3		3
Riggs to Muir	5-29	3	7	10						3			7
Sturgess Island ¹	6-16			2									2
Tidal inlet to Tlingit Point ¹	6-10									1			1
2005													
Closed Spider Island Complex ¹	6-26			1									1
Closed Geikie Rock ¹	6-12	8	7	33									48
closed Lone Island ¹	6-12	21	28	66									115
Closed South Marble Island ¹	6-10	43	37	120	1	1					4		206
North Marble Island ¹	6-10			1									1
Riggs to Muir	5-28	4	1	3									9
Sturgess Island ¹	6-23			1									1

¹Historical native egg-collection area.

Table 12. Historical information on seabirds breeding on South Marble Island, Glacier Bay, Alaska.[Data from Zador and Piatt, 1999, Appendix 1, with updates. **Source:** FWS, Fish and Wildlife Service; NPS, National Park Service]

Year	Date	Number	Comments	Source
Pelagic Cormorants				
1907	?	250–300	100 breeding, 150–200 non-breeding	Grinnell, 1909
1970	5-17	200	Flew off island	NPS Ranger logs
1970	7-08	175	No details	NPS Ranger logs
1972	6-13	80	Unidentified cormorants	NPS Ranger logs
1973	?	200	Data from S. Patten	Sowls and others, 1978
1975	7-29	50	Unidentified cormorants	NPS Ranger logs
1976	5-26	~150	Unidentified cormorants	NPS Ranger logs
1999	6-07	201	Maximum count	Zador and Piatt, 1999
2005	6-10	195	Maximum count, also 2 double-crested cormorants	This study
Glaucous-winged Gulls				
1941	7-14	200	With eggs and young	Jewett, 1942
1973	?	550	Data from S. Patten?	Sowls and others, 1978
1975	?	?	~1,000 nests on North and South Marble Island, breeding failure	NPS Ranger logs
1999	5-24	829	Maximum count	Zador and Piatt, 1999
2005	6-10	1,042	Maximum count, at least 200 nests contain eggs	This study
Black-legged Kittiwakes				
1989	?	6	First time nests built, no young	G. Streveler, NPS, unpub. data
1991	?	0	None nesting in 1991	Climo and Duncan, 1991
1991	June	+	Present on cliffs	
1994	7-06	24	10 nests, 2 chicks	E. Hooge, NPS, unpub. data
1995	June	~70	~30 nests	R. Yerxa, NPS, unpub. data
1996	7-02	199	135 nests	E. Hooge, NPS, unpub. data
1996	7-17	135	97 nests. North colony appears	E. Hooge, NPS, unpub. data
1997	6-25	171	96 nests	E. Hooge, NPS, unpub. data
1998	6-19	261	131 nests	M. Kralovec, NPS, unpub. data
1999	5-24	159	July 24: 76 chicks at southern colony 0 chicks at northern colony	Zador and Piatt, 1999
2005	6-10	807	Maximum count (includes 120 rafted, and 40 juvenile) 311 nests built, 34 incubating adults	This study
Common Murres				
1978	7-02	15	–	NPS Ranger logs
1991	June	+	Present on cliffs	J. Piatt, FWS, personal observation
1999	May-July	29	Maximum count: 12 on cliff, 17 on water	
2005	6-10	3	Maximum count	This study
Pigeon Guillemots				
1907	?	+	Breeding	Grinnell, 1909
1970	5-20	150	Northwest end of island	NPS Ranger logs
1973	?	100	S. Patten data?	Sowls and others, 1978
1975	7-29	27	No details	NPS Ranger logs
1999	5-24	171	Maximum count, whole island	Zador, 1999
2005	6-10	41	Maximum count	This study

Table 12. Historical information on seabirds breeding on South Marble Island, Glacier Bay, Alaska.—Continued[Data from Zador and Piatt, 1999, Appendix 1, with updates. **Source:** FWS, Fish and Wildlife Service; NPS, National Park Service]

Year	Date	Number	Comments	Source
Tufted Puffins				
1920	?	+	100+ around “Marble”, Drake, and Willoughby Islands	Bailey, 1927
1970	7-17	50	“Off South Marble”	NPS Ranger logs
1971	7-24	40	No details	NPS Ranger logs
1972	9-01	23	No details	NPS Ranger logs
1973	?	40	Data from S. Patten?	Sowls and others, 1978
1975	7-29	17	No details	NPS Ranger logs
1979	6-07	30	No details	NPS Ranger logs
1999	May-July	18	Maximum on the water	Zador and Piatt, 1999
2005	6-10	29	Maximum count, 3 fly from crevices	This study
Horned Puffins				
1907	?	2+	Nesting, 2 adults collected	Grinnell, 1909
1969	6/09	3	2 in crevice	NPS Ranger logs
1970	7/16	6	On island, maximum summer count	NPS Ranger logs
1972	8/17	11	Maximum summer count	NPS Ranger logs
1972	Summer	6	Breeding population	Patten, 1974
1973	Summer	6	Breeding population	Patten, 1974
1975	7/29	5	No details	NPS Ranger logs
1985	7/30	1	No details	NPS Ranger logs
1999	7/19	1	Flying around island	Zador and Piatt, 1999
2005	6/10	8	Maximum count	This study

Table 13. Historical information on seabirds breeding on North Marble Island, Glacier Bay, Alaska.

[Data from Zador and Piatt, 1999, Appendix 2, with updates. Source: NPS, National Park Service]

Year	Date	Number	Comments	Source
Pelagic Cormorants				
1969	July	18+	“Numerous”, 4 nests with 3,3,4,5 eggs	NPS Ranger logs
1970	7-27	150	Survey of all seabirds	NPS Ranger logs
1972	9-14	47	No details	NPS Ranger logs
1972	Summer	6	Breeding population	Patten, 1974
1973	Summer	60	Breeding population	Patten, 1974
1982	5-27	30	28 adults, 2 juveniles, estimated 16 nests	Nelson and Lehnhausen, 1983
1999	5-24	0	Entire island surveyed from water	Zador and Piatt, 1999
2005	6-10	0	Entire island surveyed from water	This study
Glaucous-Winged Gulls				
1941	7-14	100	“100 pairs” with eggs and young	Jewett, 1942
1972	Summer	1,000	Breeding population	Patten, 1974
1973	Summer	1,000	Breeding population	Patten, 1974
1975	?	+	~1,000 nests on North and South Marble Islands, breeding failure	NPS Ranger logs
1982	5-22	674	Estimated 300 nests	Nelson and Lehnhausen, 1983
1999	5-24	25	On grassy slope on southwest corner	Zador, 1999
2005	6-10	9	Entire island surveyed from water, 1 nest	This study
Herring Gull				
1973	Summer	15	Hybridize with Glaucous-winged Gull	Patten, 1974
2005	6-10	0	Entire island surveyed from water	This study
Common Murres				
1967	?	20	“Breeding confirmed”	Wik and Streveler, 1968
1969	7-22	33	3 breeding ledges with 20, 5, and 8.	NPS Ranger logs
	8-01	15	On ledges, eggs observed	NPS Ranger logs
1970	5-29	120	Off island in 2 flocks	NPS Ranger logs
	7-14	25	6 on ledge, 19 in water	NPS Ranger logs
1971	6-15	46	Summer maximum count, 14 on ledges	NPS Ranger logs
1972	6-12	61	Summer maximum count, 3 on ledges	NPS Ranger logs
1972	Summer	16	Breeding population	Patten, 1974
1973	Summer	36	Breeding population	Patten, 1974
1975	7-29	12	No details	NPS Ranger logs
1982	5-22	0	Entire island surveyed from water on 2 days	Nelson and Lehnhausen, 1983
1999	5-24	0	Entire island surveyed from water	Zador and Piatt, 1999
2005	6-10	0	Entire island surveyed from water	This study
Pigeon Guillemots				
1970	7-27	350	Summer maximum count	NPS Ranger logs
1971	6-15	200	No details	Ranger logs
1972	Summer	100	Breeding population	Patten, 1974
1973	Summer	120	Breeding population	Patten, 1974
1975	7-23	50	No details	NPS Ranger logs
1982	5-27	200	Estimated 100 nests	Nelson and Lehnhausen, 1983
1999	5-24	127	Many in caves on west side	Zador, 1999
1999	7-24	115	Surveyed east side only	Zador, 1999
2005	6-10	38	Entire island surveyed from water	This study

Table 13. Historical information on seabirds breeding on North Marble Island, Glacier Bay, Alaska.—Continued[Data from Zador and Piatt, 1999, Appendix 2, with updates. **Source:** NPS, National Park Service]

Year	Date	Number	Comments	Source
Tufted Puffins				
1920	?	+	100+ around “Marble”, Drake and Willoughby Islands	Bailey, 1927
1970	7-26	75	East side of island	NPS Ranger logs
1971	7-24	56	Summer maximum count	NPS Ranger logs
1972	6-21	19	No details	NPS Ranger logs
1972	Summer	50	Breeding population	Patten, 1974
1973	Summer	60	Breeding population	Patten, 1974
1975	7-23	30	No details	NPS Ranger logs
1983	5-27	31	Estimated 20 nests	Nelson and Lehnhausen, 1983
1999	5-24	0	Entire island surveyed from water	Zador and Piatt, 1999
2005	6-10	0	Entire island surveyed from water	This study
Horned Puffins				
1970	8-19	1	No details	NPS Ranger logs
1973	Summer	2	Breeding population	Patten, 1974
1975	7-29	2	No details	NPS Ranger logs
1982	5-27	1	Estimated 1 nest	Nelson and Lehnhausen, 1983
1999	5-24	0	Entire island surveyed from water	Zador and Piatt, 1999
1999	7-24	4	Surveyed east side only	Zador and Piatt, 1999
2005	6-10	1	Entire island surveyed from water, flew from crevice	This study

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