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GROUND-NESTING MARINE BIRD DISTRIBUTION AND POTENTIAL FOR HUMAN IMPACTS IN GLACIER BAY

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Abstract

With the exception of a few large colonies, the distribution of ground-nesting marine birds in Glacier Bay National Park 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 and 2004 breeding seasons, we surveyed the shoreline of Glacier Bay to locate ground-nesting marine birds and their nesting areas. We determined the nesting distribution of the four most common ground-nesting marine bird species: Arctic Tern, Black Oystercatcher, Mew Gull and Glaucous-winged Gull. We also recorded observations of less abundant species we encountered including Herring Gull, Semipalmated Plover, Parasitic Jaeger and Spotted Sandpiper. When completed, this project will comprise the first bay-wide survey for the nesting distribution of ground-nesting marine birds in Glacier Bay National Park. This information will provide a valuable baseline with which the park can to assess future impacts of human disturbance and track natural changes in nesting bird distribution and populations over time.

Introduction

Glacier Bay National Park and Preserve contains a diverse assemblage of marine birds that use the area for nesting, foraging and molting. The abundance and diversity of marine bird species in Glacier Bay is unmatched in the region, owing in part to the geomorphic and successional characteristics that result in a wide array of habitat types (Robards et al. 2003). The opportunity for proactive management of these species is unique in Glacier Bay National Park because much of the suitable marine bird nesting habitat occurs in areas designated as wilderness.

Ground-nesting marine birds are vulnerable to human disturbance where backcountry visitors can access nest sites during the breeding season. Visitor use at individual sites from 1996 to 2002 varied between 1 and 416 overnight camping uses (NPS data). 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 et al. 2000). Even temporary nest desertion

by breeding birds in disturbed areas has been shown to increase predation on eggs and hatchlings by conspecifics or other predators (Bolduc and Guillemette 2003). Human disturbance of ground-nesting birds may also affect incubation schedules and adult foraging success, which in turn can reduce breeding success (Verhulst et al. 2001). Human activity can even result in colony failure when disturbance is so great as to prevent the initiation of nesting (Hatch 2002).

Except for a few studies that focused on local populations, there has been little documentation of the status of ground-nesting birds in Glacier Bay. The breeding ecology of Black Oystercatchers in the Beardslee Island 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/clutch. Higher densities of breeding Black Oystercatchers were found on sparsely vegetated islands and reefs compared to forested islands. Glaucous-winged gull nesting activity at the Marble Islands was documented in 1999 and 2000 in order to assess the effects of traditional Native Alaskan egg harvesting on breeding success (Zador and Piatt 1999, 2002). In June of 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 which limited the time period, number of collections and the proportion of nests for harvest.

The Black Oystercatcher (*Haematopus bachmani*) is listed as a "species of high concern" within the U.S., Canadian, and Alaskan shorebird conservation plans because of their very small population size, potential threats to their shoreline/intertidal habitat, and their susceptibility to human disturbance. The Black oystercatcher is also on the Audubon Society's Watch List, and is a featured species in Alaska's Comprehensive Wildlife Conservation Strategy. They range from the Aleutian Islands to Baja California, but the vast majority (about 70%) of the global population (estimated at between 8,900 and 11,000 birds) resides in Alaska, conferring a significant amount of the global stewardship responsibility for this species to our state. Current understanding of Black Oystercatcher ecology is severely limited by a general lack of baseline information.

Researchers from multiple agencies began a coordinated, regional effort to gather data on several key aspects of Black Oystercatcher ecology. This cooperatively funded and administered project draws together the efforts of the U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, the Alaska Department of Fish and Game and the University of Alaska Fairbanks. The principal aims of the Black Oystercatcher project are to: 1) Assess the size of several important breeding populations throughout the range, and determine nesting density in each; 2) Determine adult survival, breeding site fidelity, and natal philopatry; 3) Assess regional differences in nesting effort, breeding success/productivity, and local threats or limitations to productivity; 4) Elucidate levels of population structuring and the degree of connectivity between regional breeding populations; 5) Identify the locations of important wintering areas and the number of birds in those areas; and 6) Identify movements between breeding and wintering sites. Work was initiated in Glacier Bay during summer, 2004, to address some of these regional study objectives.

Because of management concerns about the susceptibility of ground-nesting seabirds to disturbance from human activities, we undertook a study of the bay-wide distribution of ground-nesting marine birds in Glacier Bay. This report summarizes results obtained during two years of a three-year study to measure the distribution and abundance of ground-nesting marine birds in Glacier Bay, and to assess the potential for human disturbance of those nesting birds. Preliminary results from the statewide Black Oystercatcher study are also included. When completed, this project will provide a broad assessment of ground-nesting marine bird breeding sites in Glacier Bay, including a GIS database containing the exact location and status of all known and likely nest-sites discovered during the course of this study. This information will complement other projects conducted in the park such as the Marine Predator Survey, which covered at-sea distribution of marine birds and mammals (for details see Robards et al. 2003), and the Coastal Resources Inventory and Mapping Program, which mapped the physical and biological attributes of Glacier Bay's shoreline (Sharman et al. 2004).

Methods

We determined the nesting distribution of the most common ground-nesting bird species in Glacier Bay including Arctic Tern (*Sterna paradisaea*), Black Oystercatcher (*Haematopus bachmani*), Mew Gull (*Larus canus*), and Glaucous-winged Gull (*Larus glaucescens*), We also recorded observations of less abundant ground nesting bird species we encountered including Herring Gull (*Larus argentatus*), Parasitic Jaeger (*Sterorarius parasiticus*), Semipalmated Plover (*Chardrius semipalmatus*) and Spotted Sandpiper (*Actitis mucularia*).

We surveyed for ground-nesting marine birds and their associated nests between 4 June and 15 July, 2003 and between 17 May and 1 July, 2004. Using park service data that detailed visitor use between 1996 and 2002, we determined which coastal areas receive high visitor use. We defined high use as an area that received 30 or more overnight visits during the seven years covered by the park service data set. All areas classed as high use were surveyed by observers walking the length of the particular coastal segment. In areas considered low use (defined as an area that received fewer than 30 overnight visits) we surveyed the shoreline from a distance of 3-15 m using a skiff in motorized waters, or a kayak in non-motorized waters (Fig.1). When potential nesting behavior was observed (concentrations of birds on shore, defensive behavior by one or more birds, or the presence of paired birds) we landed the vessel and walked the length of the beach. At all survey locations we recorded site and nest positions using hand held Garmin E-Trex Venture GPS units, nest contents (eggs, chicks), adult behavior, general habitat characteristics and evidence of human disturbance. High and low use areas that had important concentrations of nesting birds in 2003 were resurveyed in 2004.

In 2003 we also surveyed several islands that were closed to visitors including the three southern unnamed islands east of Russell Island, Leland Island, Boulder Island and Flapjack Island (see Appendix 1 for place names mentioned in this report). Logistic constraints prevented us from visiting the northern most unnamed island east of Russell Island, Lone Island and Geikie Rock early in the season, so we observed them from the boat to minimize disturbance. At these locations we counted marine mammals and birds

on the islands and noted signs of nesting activity. We were unable to quantify or map nesting at these locations. The seabird colonies at South Marble, Spider and Eider Islands were not visited. We requested, but did not obtain permission to survey closed islands in 2004.

We identified potential nest sites by noting the locations of territorial pairs. Potential nest sites were areas where defensive adults were present and nesting was likely to occur but clutches had not been initiated. 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. Territorial pairs were noted for all species in 2004. Although we did not record territorial pairs in the field during the 2003 survey, we reassessed adult presence and behavior at inactive (empty) nests and classified Black Oystercatcher and Mew Gull territorial pairs from 2003 data.

Glacier Bay was one of five summer study areas (also Prince William Sound, Kenai Fjords National Park, Middleton Island, and the Queen Charlotte Islands in British Columbia) where we employed shared protocols in an intensive study of Black Oystercatcher breeding biology. Beginning 14 May, 2004, two technicians in sea kayaks thoroughly searched the study area in the Beardslee Islands region of Glacier Bay National Park for Black oystercatchers. They recorded the locations of all oystercatchers, and identified territorial pairs based on observation of their behavior. Observers searched each of the 31 actively defended territories within the study area to locate nests, and used a commercial GPS to record the locations of both territories and nests. Each identified territory was revisited at least every seven days. Observers recorded the number and size of eggs in each nest, and floated the eggs in tepid water to estimate laying and hatching dates (Gill et al. 2004). When a nest failed prior to hatch, the territorial pair was observed to determine if and when a second nest was initiated. Because Black oystercatchers remain on their territories after successfully hatching young, the survival of chicks on territories was documented by observing them from a distance with

binoculars. Every effort was made to determine the fate of each egg or chick at each nest, and record the cause of any losses. Territories were monitored until 31 July or until any chicks present had fledged.

We attempted to capture adult oystercatchers at each defended territory using a number of capture techniques previously used on either Black or American oystercatchers. Noose mats or mist nets were employed in conjunction with decoys and recorded territorial calls to lure and capture birds away from the nest. Nest nooses were used to capture birds sitting on a nest, but only after the real eggs were temporarily replaced with dummies. Capture efforts took place either during the pre-lay period or during incubation approximately one week after laying, to minimize the potential for nest abandonment. All captured oystercatchers were banded with metal bands and unique combinations of Darvic plastic bands to enable identification of both the individual and its original breeding area (i.e., Glacier Bay). Captured birds were weighed, and the length of the tarsus, flattened wing, head and bill were measured. We collected blood samples (~ 100 microliters) for genetic analysis from the medial metatarsal vein of adult birds (Heg et al. 1993, R. Lanctot, pers. comm.).

Results and Discussion

We mapped the distribution of 251 active nests and 53 territorial pairs in 2003, and we mapped 430 active nests and 163 territorial pairs in 2004. The difference in nest and territorial pair counts between the two years of the study reflects the increased coverage of shoreline in 2004.

Arctic Terns

Nesting distribution for Arctic Terns was largely restricted to the upper arms of the bay and one treeless islet in the Beardslee Islands (Fig. 2). We located 39 Arctic Tern nests in 2003 and 119 nests in 2004. We also found 8 territorial pairs in 2004. The largest tern colonies were found in Adam's Inlet (n=21) and on an island at the entrance to Skidmore and Charpentier Inlets (n=18, see discussion under Areas of Concern). Their preferred

habitat, cobble outwash areas and rocky outcrops on small islands (Hatch 2002), is found mostly up-bay in early successional habitats.

On several occasions Arctic Terns were observed eating, holding and feeding small-schooling fish such as capelin (*Mallotus villosus*) to their young. 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 et al. 2005).

Black Oystercatcher

Black Oystercatchers were the most abundant nesting species in Glacier Bay during our survey. In 2003 we found 89 active nests and 39 territorial pairs (Fig. 3), and in 2004 we mapped 138 active nests and 91 territorial pairs (Fig. 4). Although breeding Black Oystercatchers were widely distributed throughout the bay, the highest concentration was found on the small Islet at Tlingit Point (n=11). They prefer gravel beaches with low-sloping substrates and nest near the high tide line (Andres and Falxa 1995). Oystercatcher nests may be particularly susceptible to disturbance because kayakers tend to use the same beaches for camping. Trampling of nests may also occur when boats are hauled above the high tide line.

At the close of this study, investigators (Tessler et al.) will publish a detailed paper on the breeding ecology of Black oystercatchers throughout their range. Among the major aims of this effort are to determine the roles that different conservation units (e.g., Glacier Bay) play in the life history and conservation of this unique species. Through an exploration of differences in nesting effort, breeding success and productivity, investigators will suggest how local threats or limitations to productivity may be mitigated through management practices. As much of the necessary data have yet to be collected or are still being analyzed, we present only preliminary information in this report.

We assessed productivity at 31 active Black oystercatcher territories in the Beardslee Island region between 14 May and 31 July 2004. Of the 31 territorial pairs, 24 (77%) of

those monitored produced at least one clutch of eggs. No sign of active nesting was found in the remaining seven territories. A total of 58 eggs were produced in the first clutches with an average clutch size of 2.31 eggs. Twelve first clutch nests were completely lost. Four pairs that had lost their first clutch renested, laying a total of 10 eggs (average second clutch size 2.5 eggs). All second clutches were lost. A total of 68 eggs were produced in all clutches.

A total of 40 eggs were confirmed lost. Of those egg losses 34 eggs (85%) were attributed to sea water inundation and flooding of nests. The degree of loss due to flooding is exceptional, and highlights the susceptibility of this species to unusually high tides and/or the coincidence of higher tidal stages with any additive effects, e.g., boat wakes or severe storm events. Two eggs (5% of those lost) appeared to have been depredated. No cause could be attributed to the remaining 4 lost eggs. The fate of 7 of the 68 eggs was completely unknown. These eggs disappeared from their nests sometime after discovery, but no chicks were ever observed. However, behavioral observations of the three territorial pairs in question were consistent with nest loss, and these eggs were presumed lost.

A total of 21 eggs (31% of all eggs laid) were hatched in 9 individual territories, and 2 chicks were subsequently lost. The fate of 2 other chicks is unknown; they were never observed post hatching and behavioral observations of the territorial pair were inconclusive. By the final day of field observation (31 July), the remaining 17 chicks had either fledged or had been sighted in good condition with their parents in the intertidal, and are presumed to have fledged successfully.

A total of 17 adults were captured, measured and banded. No nests were abandoned by breeding birds after successful or attempted captures. A total of 22 samples were collected for genetic analyses (17 blood samples from adults, and 5 eggshell membrane samples from broken eggs). Genetic analyses will be conducted at the Molecular Biology Laboratory of the Alaska Science Center during the next two years. In the first year of this regional project, more than 200 birds were banded (between 2% and 2.5% of the

estimated global population), 150 territories were monitored for productivity, and about 250 genetic samples were collected in Alaska and British Columbia for analyses of population structure.

The research plan also included a complementary winter component of aerial and boat-based surveys and ground counts designed to identify important wintering concentrations and possible movement patterns between wintering and breeding areas. During the winter of 2005 we plan to aerially survey parts of the Aleutian Islands, Kenai Fjords National Park, Prince William Sound, Yakutat Bay, Glacier Bay National Park and a sizable portion of the Southeast Alaska coast to locate concentrations of oystercatchers and estimate their numbers. In Prince William Sound and Glacier Bay, these aerial surveys will be used to target boat-based efforts to resight banded birds and enumerate flocks. Flock location, enumeration and band resighting efforts will be conducted by boat on Kodiak Island, and via ground based surveys on Middleton Island. We plan to repeat these winter efforts in February 2006 and 2007.

Mew Gull

Mew Gulls nested throughout the upper bay, in Geikie Inlet and in Fingers and Berg Bays. In 2003 we found 19 active nests and 14 territorial pairs (Fig. 5). In 2004 we located 86 active nests and 28 territorial pairs (Fig. 6). In some areas they nested in mixed colonies with Arctic Terns, Glaucous-wing Gulls and other species, while in other areas they were solitary nesters. They prefer nesting in areas with little or no vegetation on gravel banks or beaches, often near freshwater streams (Moskoff and Bevier 2002).

Mew Gull chicks may be susceptible to human disturbance because of their response when humans approach them. Chicks were often found away from the nest and near the shore, and they often entered the water when observers approached, usually accompanied by one or more flying adults.

Glaucous-wing Gull

Most Glaucous-wing Gull nests were found on a few protected colonies in the lower bay (Fig. 7). In 2003 we found 88 nests, and the majority was concentrated on Boulder and Flapjack Islands (see discussion under Wildlife Closures). In 2004 we found 40 nests and 4 territorial pairs. Many of those nests were located at a dispersed colony near the head of Muir Inlet (see discussion under Areas of Concern). Although Glaucous-wing Gulls are known to use a wide variety of habitat types for nesting (Verbeek 1993), in Glacier Bay we found them nesting mostly in flat areas with low vegetation or on rocky cliffs.

Herring Gull

There has been little documentation of Herring Gull nesting in Glacier Bay, which may be due to the difficulty distinguishing Herring from Glaucous-wing Gulls, and the relative scarcity of Herring Gulls compared to Glaucous-wing Gulls (Wik 1968). In 2004 we found a total of 18 Herring Gull nests in the bay (Fig. 8). Nest distribution was limited to the head of Muir Inlet and Johns Hopkins Inlet.

Hybridization between Glaucous-wing Gulls and Herring Gulls may occur in Glacier Bay. Hybridization is common in other areas where their breeding ranges overlap (Grant 1986). We were unable to identify three gull nests as either Herring Gull or Glaucous-wing Gull because the nests were high on a cliff and the incubating adult could not be identified. In one case, it appeared that an individual from each species was attending the same nest. We observed copulation between a Herring Gull and a Glaucous-wing Gull on 29 May, 2004 at the mixed gull colony between Muir and Riggs Glacier. At the same location we also observed adults with blackish-grey wing-tips, an intermediate characteristic between Glaucous-wing and Herring Gulls.

Other Species

In addition to the abundant ground-nesting species, we also observed Parasitic Jaegers, Semipalmated Plovers and Spotted Sandpipers nesting on beaches in Glacier Bay. These species are solitary nesters and have well camouflaged nests. The resolution of our surveys is likely too coarse to confidently assert that we located the majority of the nests

for these cryptic species, and thus our results represent a minimum estimate of pairs and nests for these species.

We found one Parasitic Jaeger nest near the head of Muir Inlet in 2003 and one nest in Adam's inlet in 2004 (Fig. 9). We also observed Parasitic Jaeger pairs flying at the east glacier face in Reid Inlet and over Forest Creek in the east arm in 2004. We were unable to determine whether those pairs were nesting. However, a territorial pair was observed by M. Arimitsu at the river outflow on the east side of Reid Glacier in July 2001, and a pair was also observed in August 2003 near Forest Creek (Tania Lewis, pers. comm.). The observed scarcity of nest sites corresponds well with the relative scarcity of jaegers on pelagic surveys (e.g., only 8 on bay-wide surveys in 1999; Robards et al. 2003)

There were13 and 19 active Semipalmated Plover nests in 2003 and 2004 respectively. We also located 21 territorial pairs in 2004 (Fig. 10). Semipalmated Plovers were found nesting near low vegetation on flat sand and gravel shorelines. We found them nesting mostly up-bay, where early successional habitat is abundant.

We found 2 active Spotted Sandpiper nests in 2003 and 6 active nests in 2004. We also located 9 territorial pairs in 2004 (Fig.11). Their nests were often found near freshwater runoff within dense vegetation.

Areas of Concern

<u>High Use Areas</u>

Although we found unprotected nesting bird concentrations to be generally low in most areas, we found potential for disturbance to nesting birds at several high-visitor-use areas including the north spit at McBride Glacier, the west entrance to Reid Inlet and Sealer's Island (Table 1). These areas have historically supported nesting colonies of Arctic Terns and other bird species (Wik 1968, Greg Streveler, pers. comm.). Owing to their close proximity to tidewater glaciers, they are among the more heavily used areas in the bay (NPS data).

Anecdotal information suggested that terns nested historically at McBride Glacier. However, nesting terns were absent from the McBride Glacier area in 2003, although, we found 3 active nests in 2004. In both years of the survey we observed terns flying in the area and feeding offshore. Mew Gulls, Black Oystercatchers and Semipalmated Plovers also nested on the high-visitor-use area on the north spit at the entrance. McBride is an area of concern because visitors commonly set up tents or walk through the nesting area to view the glacier.

During our survey in 2003, Arctic Terns were also absent from Reid Inlet. However, in 2004, we found 14 nests at Reid Inlet between 27 May and 6 June. By 26 June, 2004, all Arctic Tern nests at the entrance to Reid Inlet had disappeared. One of those nests was trampled by a visitor on 20 June, 2004, and this was the only observation of human impact on beach-nesting birds during our surveys. Mew Gull, Black Oystercatcher and Semipalmated Plover nests were also found on the west spit at the entrance to Reid Inlet.

The high-use-area at Sealer's Island had relatively large concentrations of nesting birds compared to other areas of Glacier Bay. We found 16 Arctic Tern nests at Sealer's Island on 15 June, 2003. In 2004, we observed 8-10 Arctic Terns flying over the west point of the island and behaving defensively, but we did not find any active tern nests on 28 May or 16 June. Reduced nesting activity by Arctic Terns in 2004 may have resulted from predation by the Northwestern Crows that nest in the center of the island. There were defensive adults and recently- predated Arctic Tern egg shells on the west point of the island, and we found a crow nest containing 2 chicks that had moved into that area since 2003. Mew Gulls, Glaucous-wing Gulls and Black Oystercatchers also used the island for nesting in both years of our survey.

Other Nesting Areas

There was also concentrated nesting activity in several low-visitor-use areas including the north shore between Muir and Riggs glaciers, the islet at Tlingit Point, the islet at the

entrance to Skidmore Bay and Charpentier Inlet, the southwest outwash in Adams Inlet and an unnamed islet northwest of Eider Island (Table 1). The north shore between Riggs and Muir glaciers had more nests than any other unprotected area in the bay with 68 nests in 2004. However, nesting was more concentrated on smaller islands like the islet at Tlingit Point and the islet at the entrance to Skidmore and Charpentier Inlets with 21 and 29 nests, respectively in 2004. The large outwash on the southwest shore of Adam's Inlet and the unnamed islet northwest of Eider Island are notable because of their Arctic Tern aggregations. In addition to nesting Arctic Terns, we observed about 500 and 300 adult Arctic Terns flying over these areas, respectively, during 2004.

Wildlife Closures

Areas that have been historically closed to foot traffic because of concerns about disturbance to wildlife were surveyed in 2003 to assess the current status of nesting birds. According to park biologists (M. Kralovec, pers. comm.), none of these areas had been censused prior to our surveys. Results and preliminary recommendations are described under the subheading for each area.

Unnamed islands east of Russell Island

The unnamed islands east of Russell Island were surveyed on 2 July, 2003. For reference purposes in this report, the islands are numbered 1 through 4 from the southern-most island to the northern-most island, respectively.

We observed nine Black Oystercatchers and two Pigeon Guillemots (*Cepphus columba*) on Island 1. There were two active Black Oystercatcher nests with chicks and one territorial pair. This island may also be used by nesting Pigeon Guillemots.

We observed six Black Oystercatchers on Island 2. Two active Black Oystercatcher nests containing eggs and one predated Black Oystercatcher egg were found at this island. There were 20-30 adult Pigeon Guillemots resting on land and in the water near the islet. They were seen flying in and out of crevices on the islet, suggesting that they nest at this location.

There were 5 Mew Gulls, 8 Black Oystercatchers, 25 Arctic Terns, and 81 Harlequin Ducks on Island 3, a small treeless outcrop. We observed two Mew Gull nest bowls; one was empty and one contained a single egg. We found empty Black Oystercatcher nests defended by territorial adults in two locations, and one predated Black Oystercatcher egg. We also found three active Arctic Tern nests, all of which contained two eggs.

Island 4 is an important nesting area for Arctic Terns, Black Oystercatchers, and Mew Gulls. We surveyed the west point of this island on foot. Owing to rugged terrain, the rest of the island could not be walked and so it was surveyed from a skiff. Most of the nesting activity was limited to the west point of the island. We observed 6 Pigeon Guillemots, 12 Black Oystercatchers, 20 Mew Gulls, 75 Arctic Terns and 80 Glaucous-winged Gulls roosting on the island. There was one territorial pair of Black Oystercatchers defending 2 empty nest bowls. We also saw one Black Oystercatcher chick and 13 Mew Gull chicks at the water's edge. We recorded 4 Arctic Tern nests containing eggs and one nest contained one chick and a pipped egg. We also found one Arctic Tern egg submerged in water at the high tide line.

All of the 4 unnamed islands east of Russell Island are small and have evidence of concentrated nesting activity. In addition, camping potential is relatively poor on these islands. We recommend these islands remain closed to foot traffic.

Lone Island

On 15 July, 2003 there were 9 harbor seals (*Phoca vitulina*) and 3 Steller sea lions (*Eumetopias jubatus*) hauled out on Lone Island and therefore we made our observations from the boat to minimize disturbance. We observed 266 Glaucous-winged Gulls, 13 Black Oystercatchers, one Bonaparte's Gull (*Larus philadelphia*), 187 Black-legged Kittiwakes (*Rissa tridactyla*), 19 Pigeon Guillemots, one Bald Eagle (*Haliaeetus leucocephalus*), seven Northwestern Crows (*Corvus caurinus*), one Tufted Puffin (*Fratercula cirrhata*), three Black Turnstones (*Arenaria melanocephala)* and 10 Harlequin Ducks *(Histrionicus histrionicus*). The Glaucous-winged Gulls appeared to be

nesting on the hillside facing south. There were 44 empty Black-legged Kittiwake nests. Adults were stomping on nesting material or standing in pairs on nests, but we did not observe any chicks or eggs in the nests. The Northwestern Crows were concentrated in alder where they may have been nesting. We also saw one Tufted Puffin fly from a burrow on the northeast side of the island. This is obviously an important area for marine mammals and birds. We recommend that it remain closed to foot traffic.

Geikie Rock

We surveyed Geikie rock from a skiff on 15 July, 2003. There were 15 harbor seals hauled out, 147 Glaucous-winged Gulls, 30 Pigeon Guillemots, four Arctic Terns, 21 Black Oystercatchers, 130 Harlequin Ducks, 17 Pelagic Cormorants (*Phalacrocorax pelagicus)*, 22 Black Turnstones and one Ruddy Turnstone (*Arenaria interpres)* roosting on the island. Of the 250 Black-legged Kittiwakes on the rock, about 90% were immature. Five Glaucous-winged Gull chicks were at the shoreline, and we observed fish-holding behavior in Arctic Terns and Pigeon Guillemots, which suggests they were nesting in the area. Geikie Rock continues to be an important area for marine birds and mammals and we recommend that it remain closed to foot traffic.

Leland Island

We surveyed Leland Island and the smaller islet to the north of the main island by foot on 7 July, 2003. We found a total of eight Black Oystercatcher nests and all of them contained eggs. All of the nests were on the northern half of the island. Repeated surveys at this site are necessary, but so far we've found little reason for keeping the island closed to foot traffic.

Boulder Island

Boulder Island was surveyed by foot on 12 July, 2003. There were 15 Black Oystercatchers, 1 territorial pair of Arctic Terns and over 600 Glaucous-winged Gulls at this site. There were 2 active Black Oystercatcher nests. We found 41 active Glaucous-winged Gull nests on Boulder Island, average clutch size was 2.58 eggs/nest (n = 40). Most nests contained eggs, one nest with one chick and one hatching chick. We also

found 4 predated Glaucous-wing Gull nests on the island. This was the largest Glaucous-winged Gull colony we encountered during our survey and is one of the more important nesting areas in the bay. We recommend that this island remain closed to foot traffic.

Flapjack Island

Flapjack Island was surveyed by foot on 26 June, 2004. There were 43 Black Oystercatchers, 14 Common Mergansers, 20 Harlequin Ducks, and 7 Black Scoters on the island. In addition, there were approximately 225 adult and over 900 sub-adult Black-legged Kittiwakes, 200 mostly sub-adult Glaucous-winged Gulls and over 300 Red-breasted Mergansers on the beach.

We 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-wing Gull nests contained eggs and 1 nest had a single chick. We also found 1 Black Oystercatcher nest with eggs and 1 territorial Black Oystercatcher pair in the island.

Flapjack Island is an important Glaucous-winged Gull colony and roosting area for Black-legged Kittiwakes, Black Oystercatchers and Red-breasted Mergansers. We recommend that this area remain closed to foot traffic.

Management Implications

Most of the largest seabird nesting areas in Glacier Bay are closed to human use and therefore largely protected from disturbance by park visitors. Nonetheless, there are high-use-areas where significant concentrations of nesting birds gather to breed and human disturbance could affect these breeding activities (Table 1). Short of closing these areas, perhaps the simplest way to minimize disturbance to nesting birds is to educate visitors about where they may encounter nesting birds, how to identify nests (see Appendix 2) and nesting bird behavior, and how they should respond when they encroach upon nest sites. This could be accomplished during the mandatory camper/boater orientation (perhaps aided by an educational brochure) and reinforced in the annual regulations publication that is distributed to all visitors.

The baseline data that we have gathered on the distribution and abundance of ground-nesting birds in the park 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 (e.g., climate change or succession). Upon completion of this project we will provide recommendations for implementing a management program that will minimize human disturbance to breeding birds in Glacier Bay.

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Table 1. Nesting areas with high potential for human disturbance, their specific locations (decimal degrees), human use patterns in the area between 1996 and 2002 (high is ≥ 30 camping uses and low is < 30 camping uses), and nest count and species observed in each area during this study. Nest count represents the maximum number of nests found in one year including all species at each location. Species are listed in order of abundance and abbreviations are as follows: Arctic Tern (ARTE), Black Oystercatcher (BLOY), Glaucous-wing Gull (GWGU), Mew Gull (MEGU), Herring Gull (HEGU), Semipalmated Plover (SEPL), Parasitic Jaeger (PAJA) and Spotted Sandpiper (SPSA).

Site Name	Location	Human Use	Nest Count	Species
Entrance to Reid Inlet	N 58.87117°, W 136.82510°	High	16	ARTE, BLOY, SEPL
N. spit at McBride Glacier	N 59.03763°, W 136.15167°	High	12	BLOY, SEPL, ARTE, MEGU
Sealer's Island	N 58.95912°, W 136.12275°	High	20	ARTE, BLOY, MEGU, GWGU
Shoreline between Riggs and Muir	N 59.06802°, W 136.30057°	Low	68	GWGU, HEGU, MEGU, BLOY, ARTE, SEPL, PAJA
Islet at Tlingit Point	N 58.75108°, W 136.17683°	Low	21	BLOY, ARTE, GWGU, MEGU
Islet at entrance to Skidmore Bay	N 58.75932°, W 136.53368°	Low	29	ARTE, MEGU, BLOY
Gravel outwash in Adam's Inlet	N 58.86348°, W 135.91790°	Low	16	ARTE, BLOY, SEPL, PAJA, MEGU
Islet northwest of Eider Island	N 58.52100°, W 135.95300°	Low	17	ARTE, BLOY

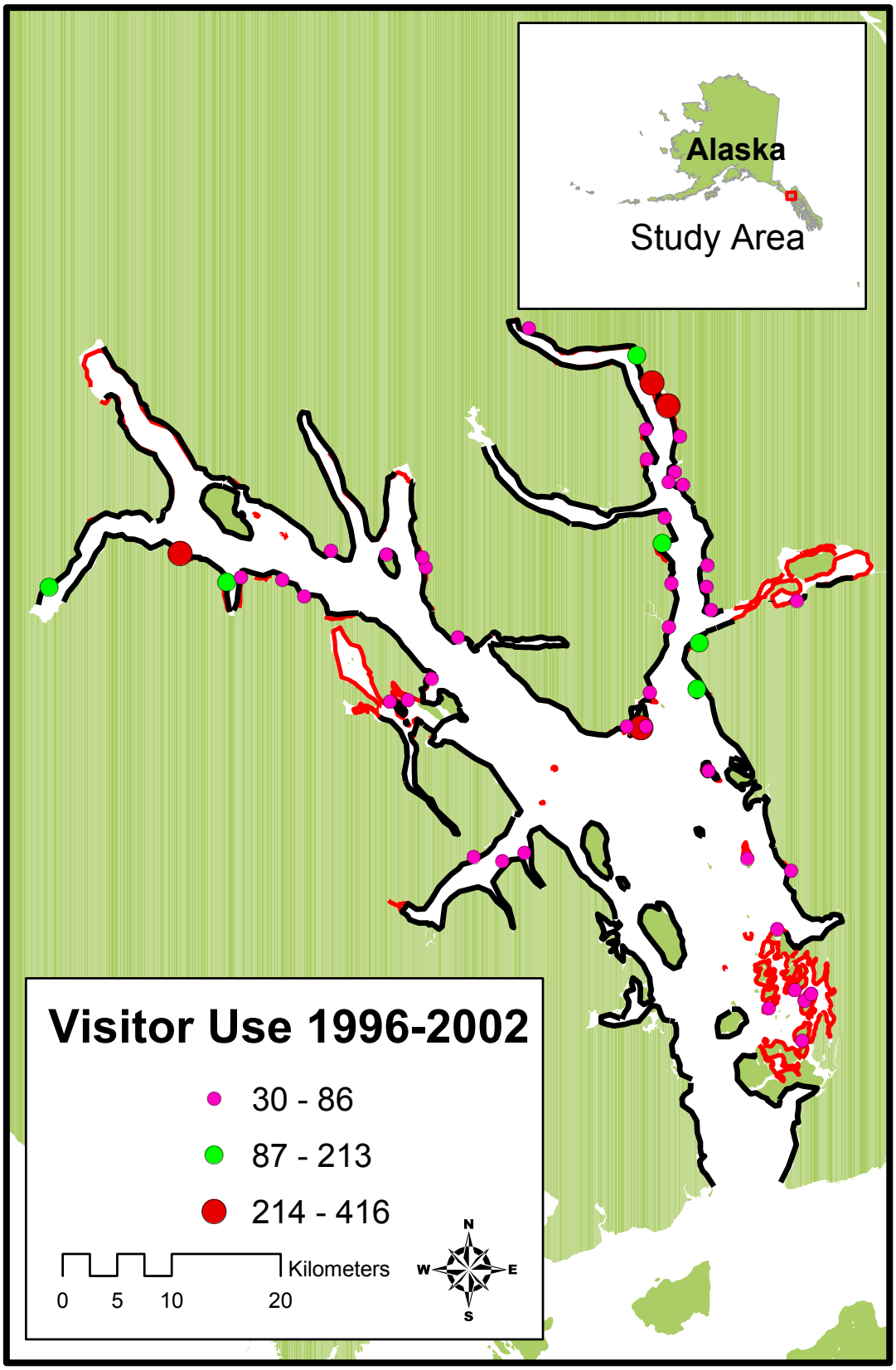


Figure 1. Study area, shoreline surveyed in 2003 (red line) and 2004 (black line) and highest use camping areas. Each circle represents the number of reported overnight camping uses between 1996 and 2002.

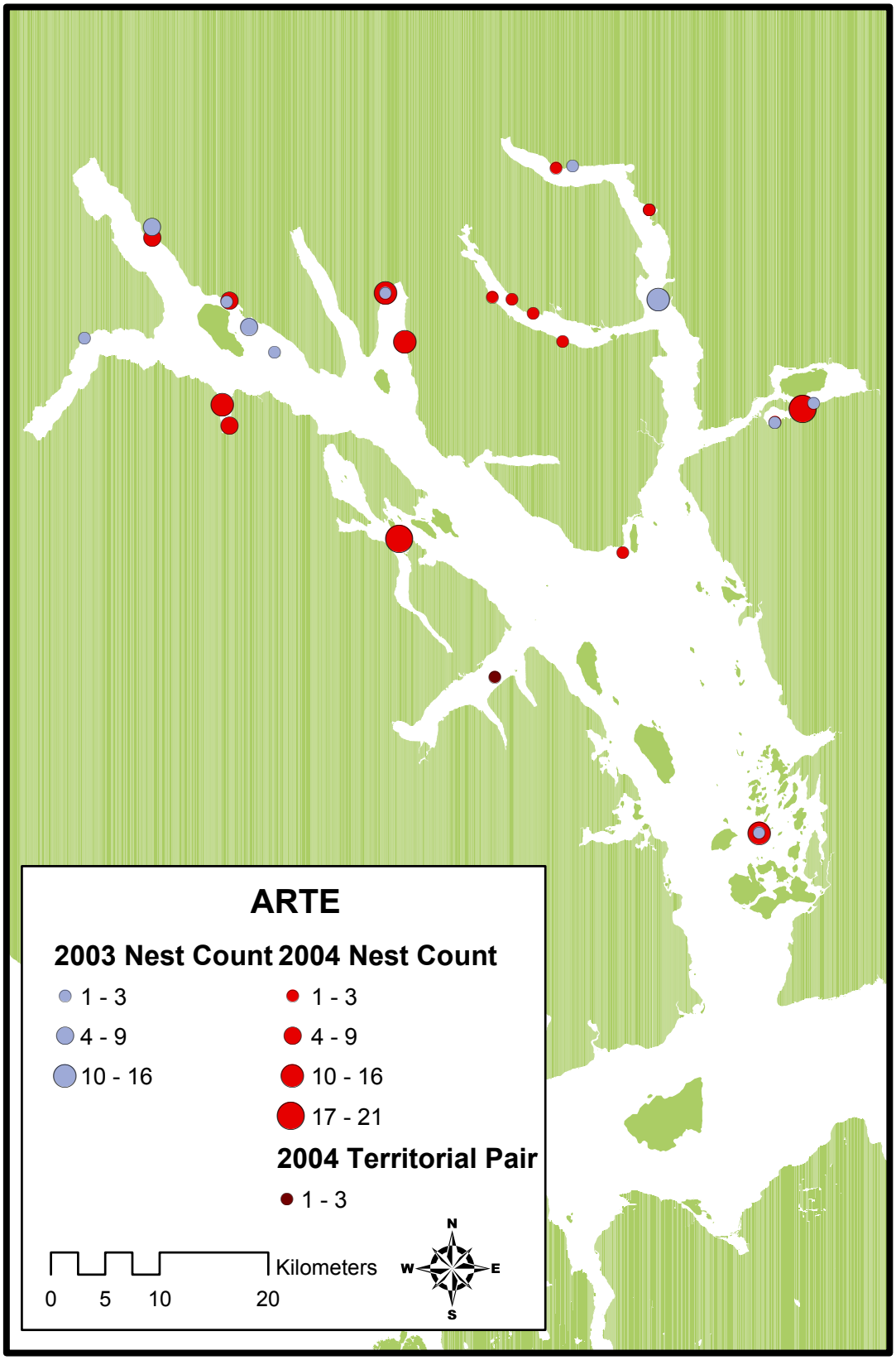


Figure 2. Arctic Tern (ARTE) nest and territorial pair distribution during the 2003 and 2004 surveys.

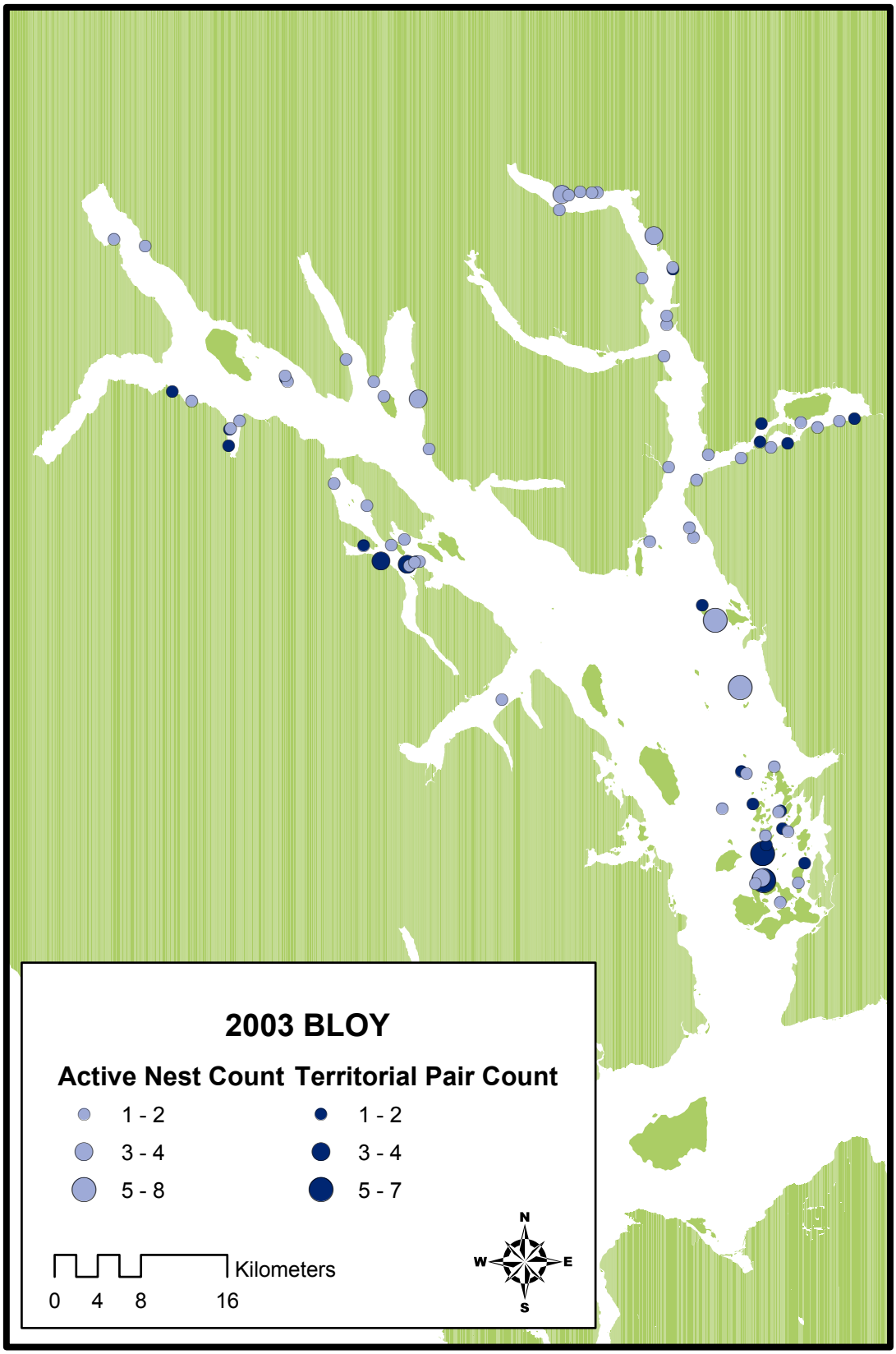


Figure 3. Black Oystercatcher (BLOY) active nest and territorial pair distribution during the 2003 survey.

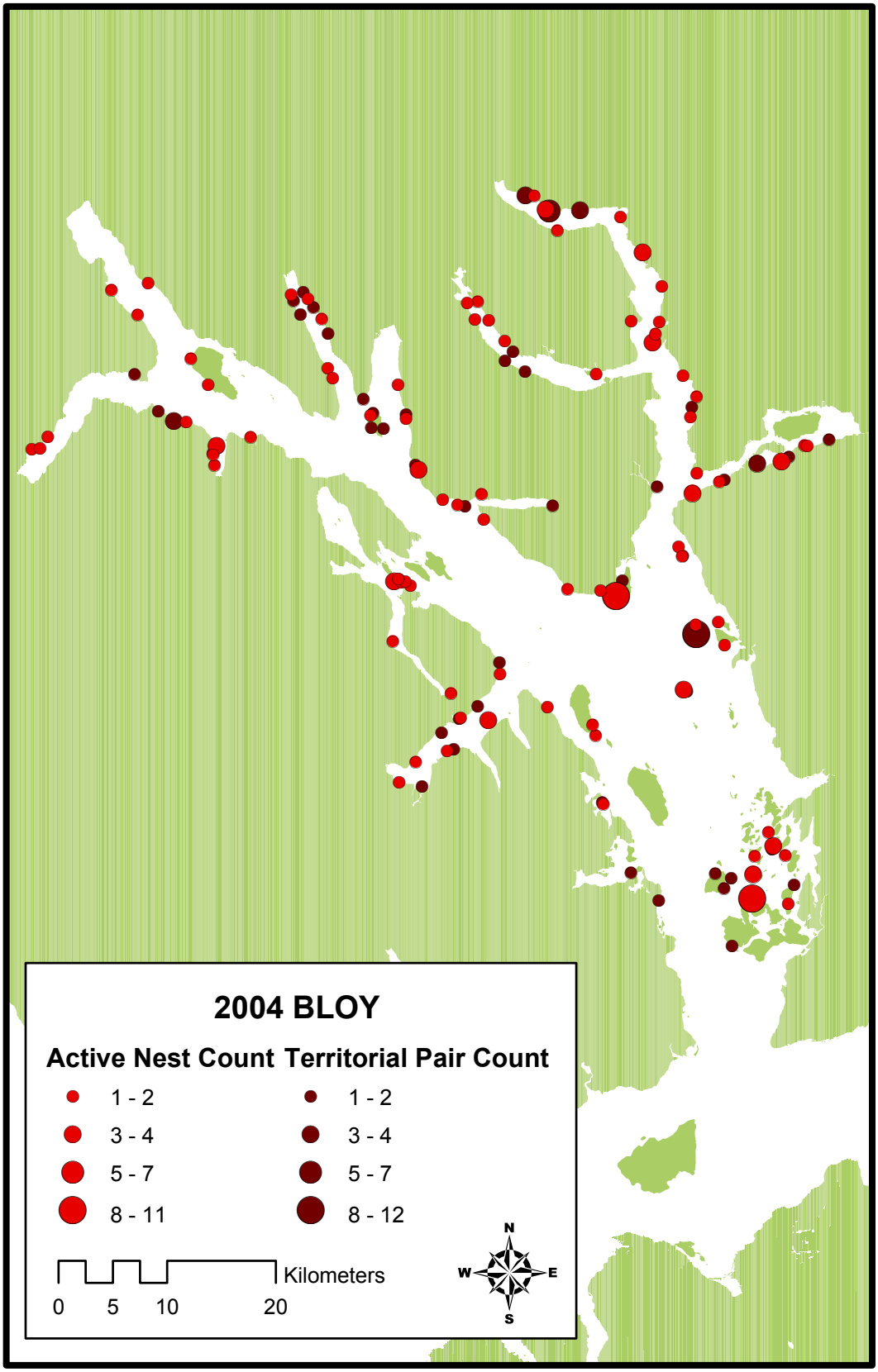


Figure 4. Black Oystercatcher (BLOY) active nest and territorial pair distribution during the 2004 survey.

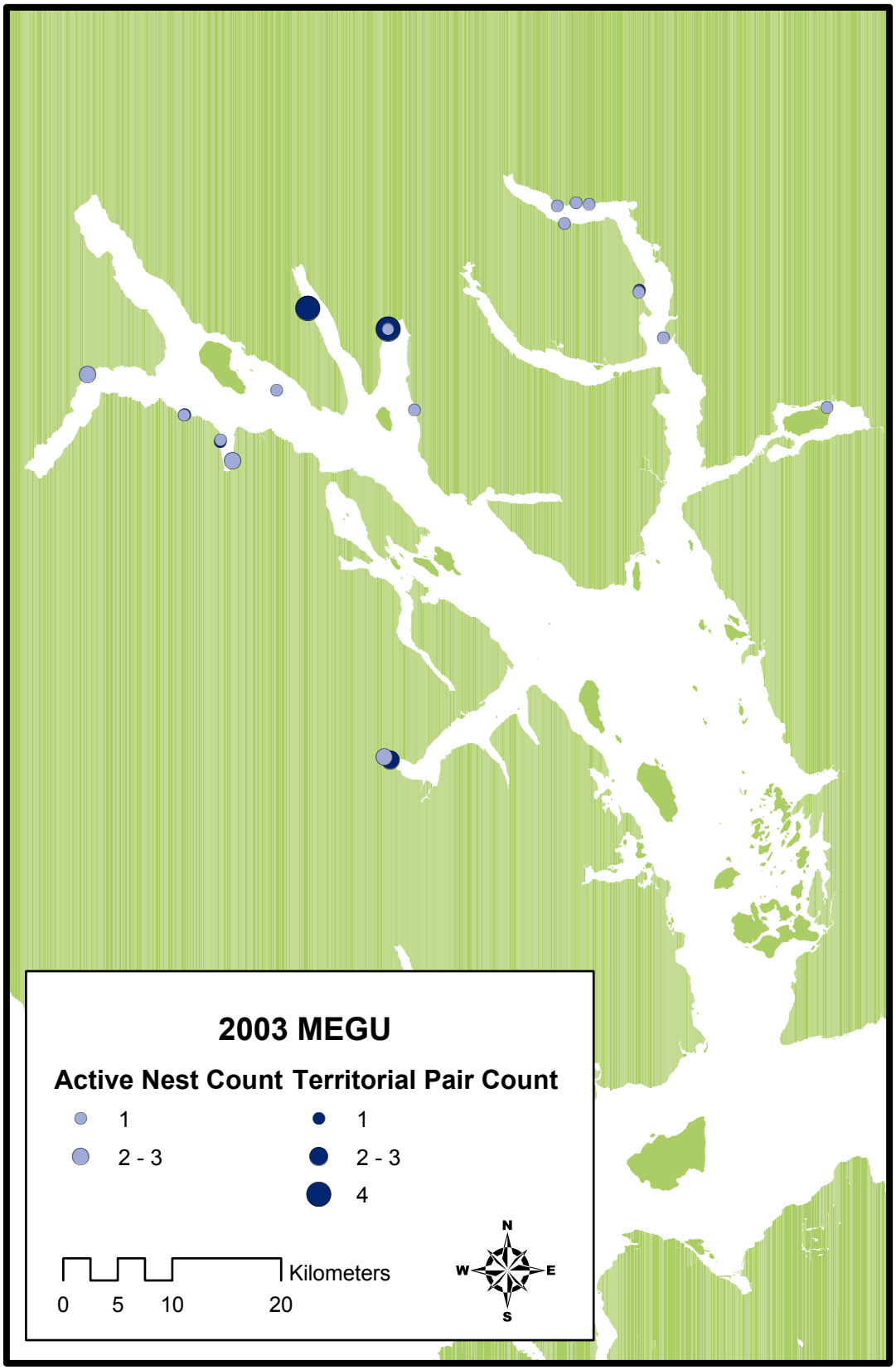


Figure 5. Mew Gull (MEGU) active nest and territorial pair distribution during the 2003 survey.

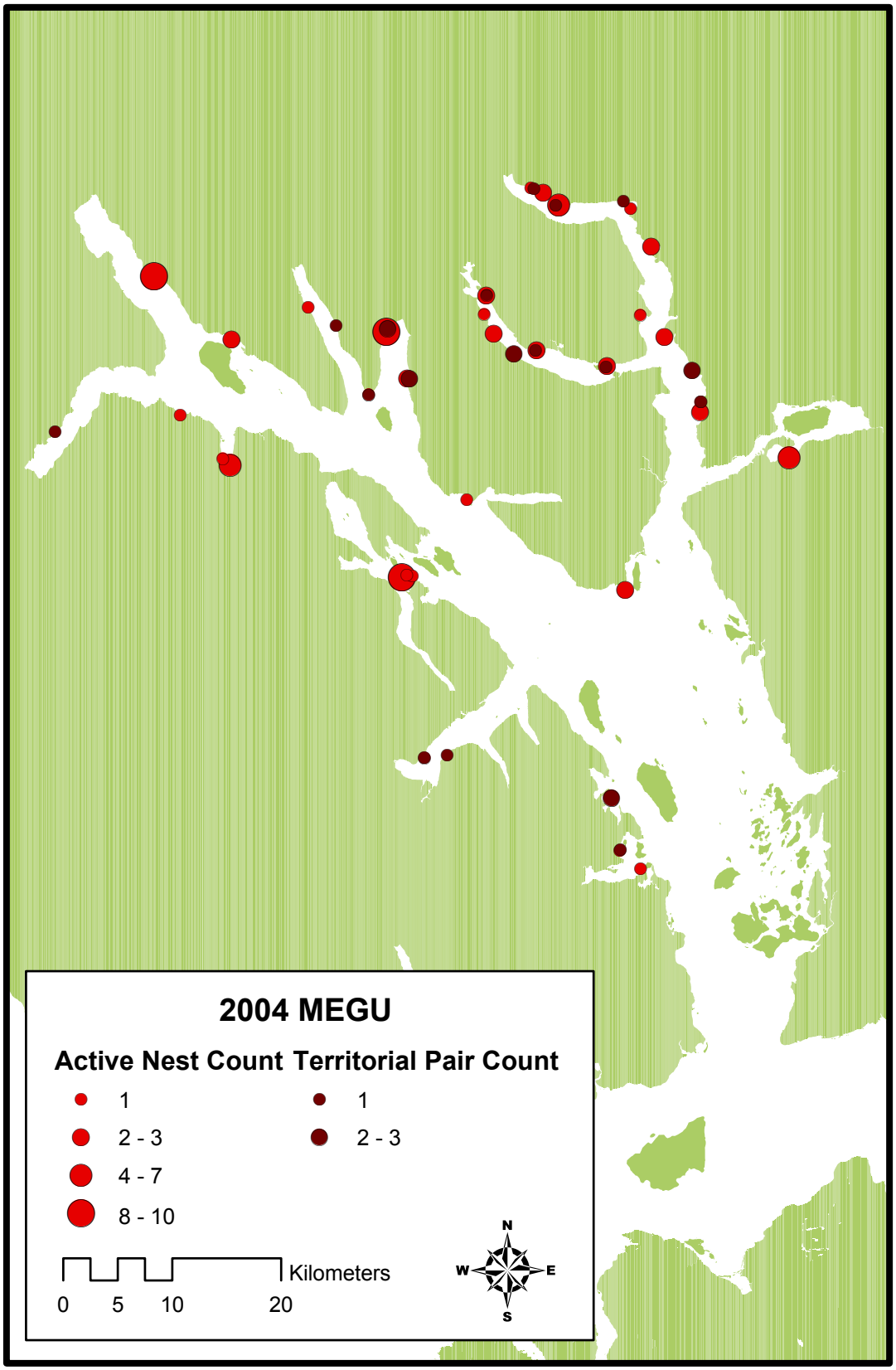


Figure 6. Mew Gull (MEGU) active nest and territorial pair distribution during the 2004 survey.

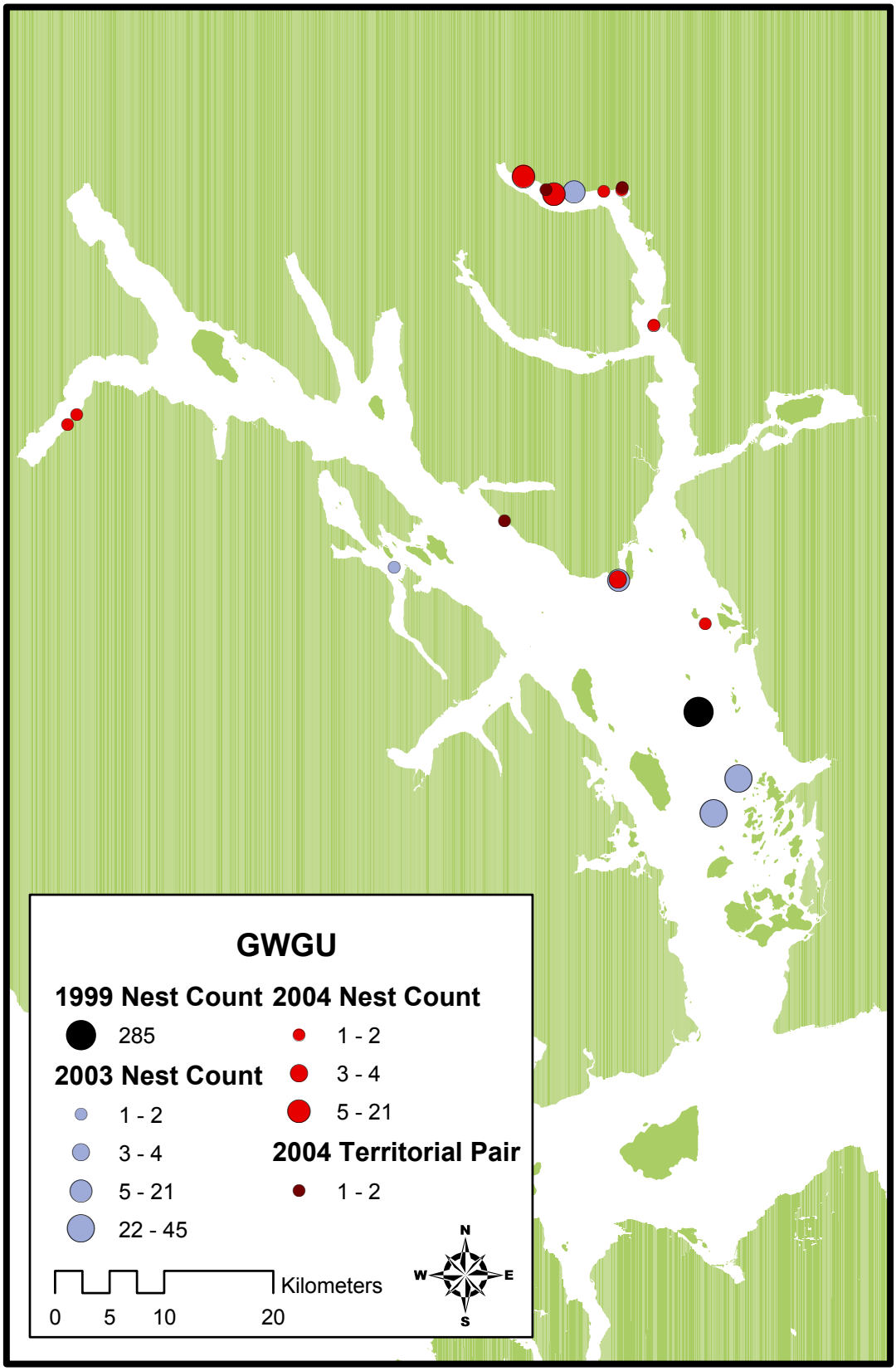


Figure 7. Glaucous-wing gull (GWGU) nest and territorial pair distribution during the 1999 (Zador et al.), 2003 and 2004 surveys.

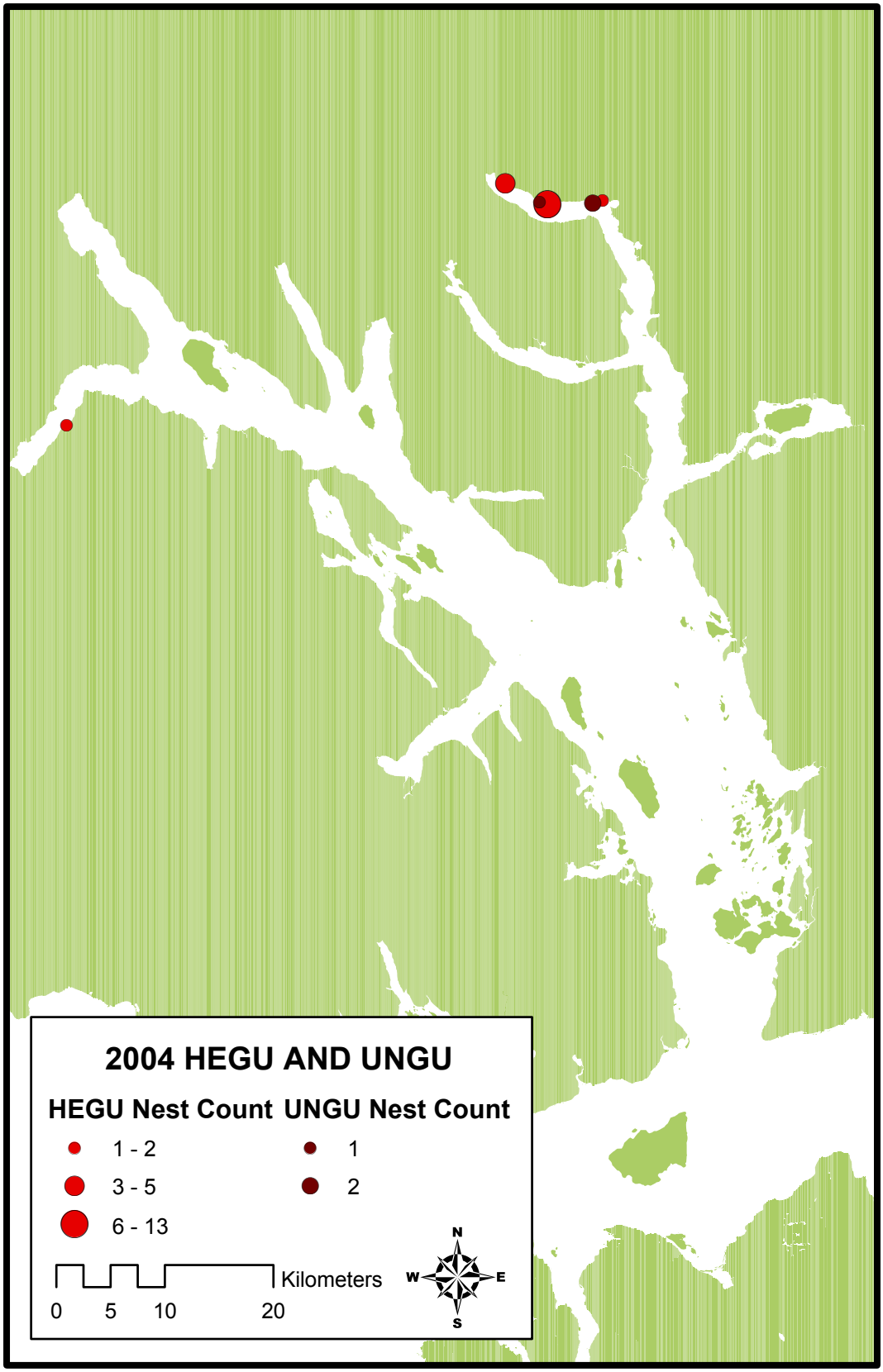


Figure 8. Herring Gull (HEGU) and Unidentified Gull (UNGU) nest distribution during the 2004 survey. Unidentified Gull nests belonged to either Herring Gulls or Glaucous-wing Gulls.

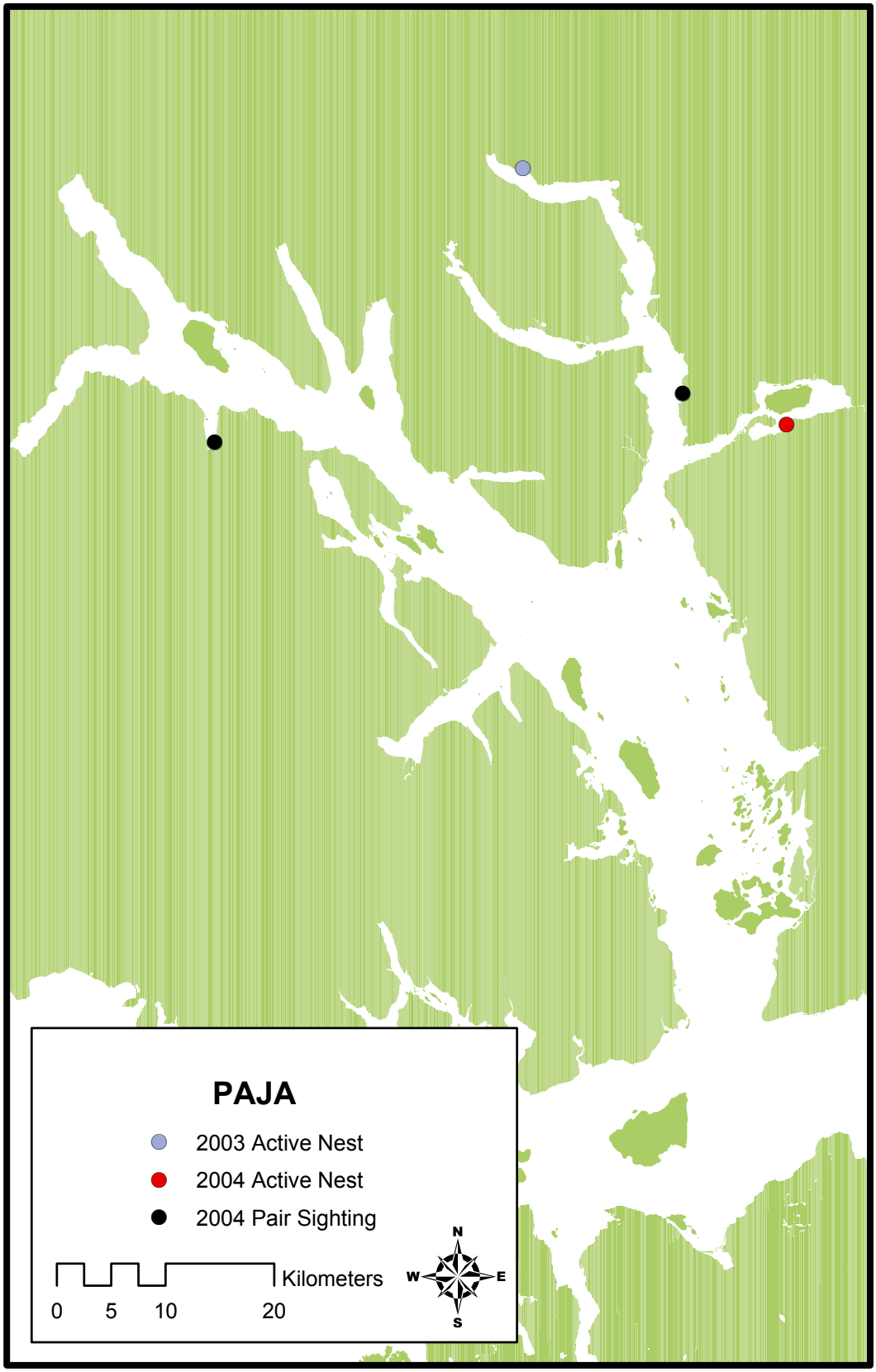


Figure 9. Parasitic Jaeger (PAJA) nest and pair observations during the 2003 and 2004 surveys.

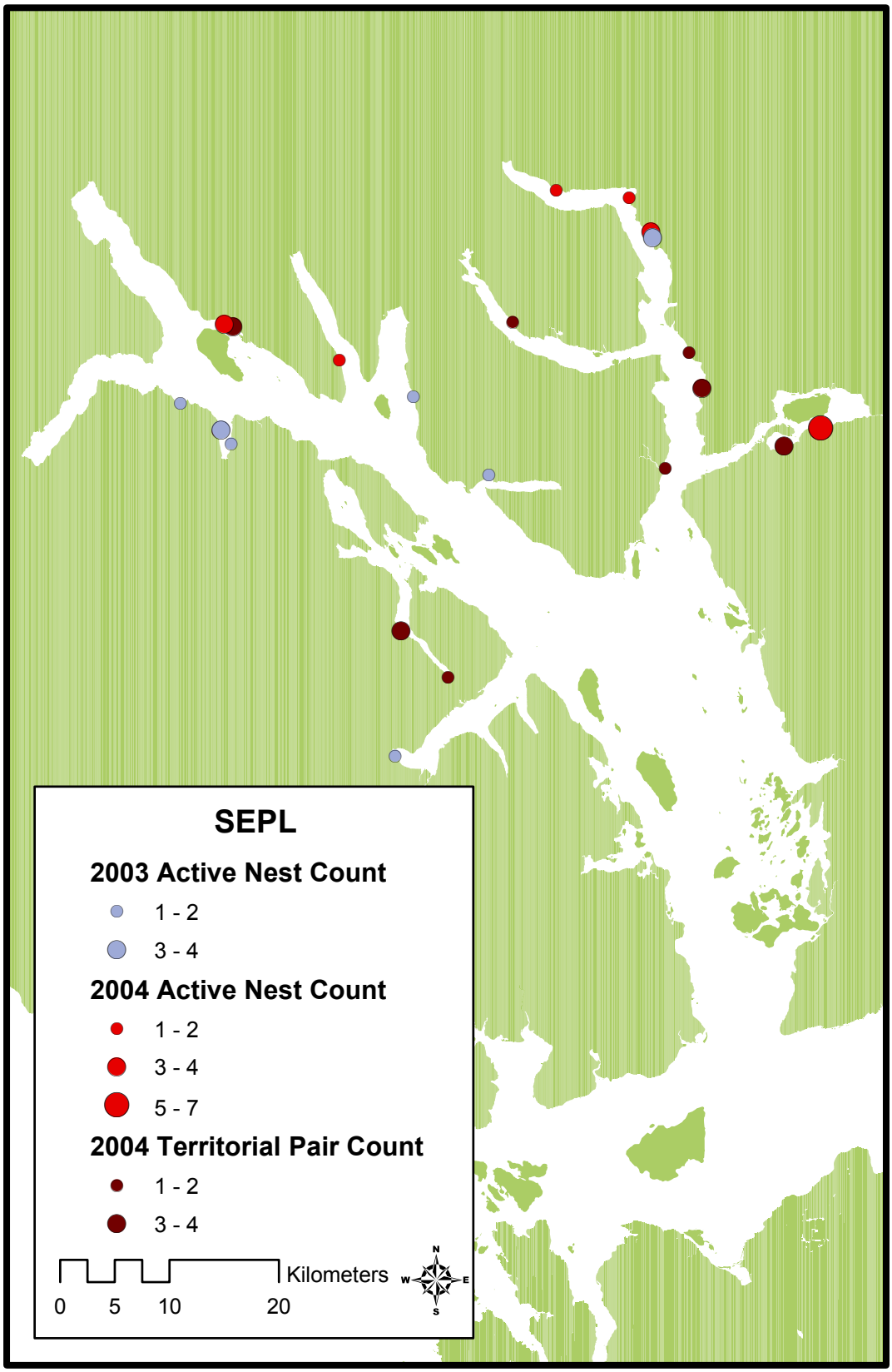


Figure 10. Semipalmated Plover (SEPL) nest and pair observations during the 2003 and 2004 surveys.

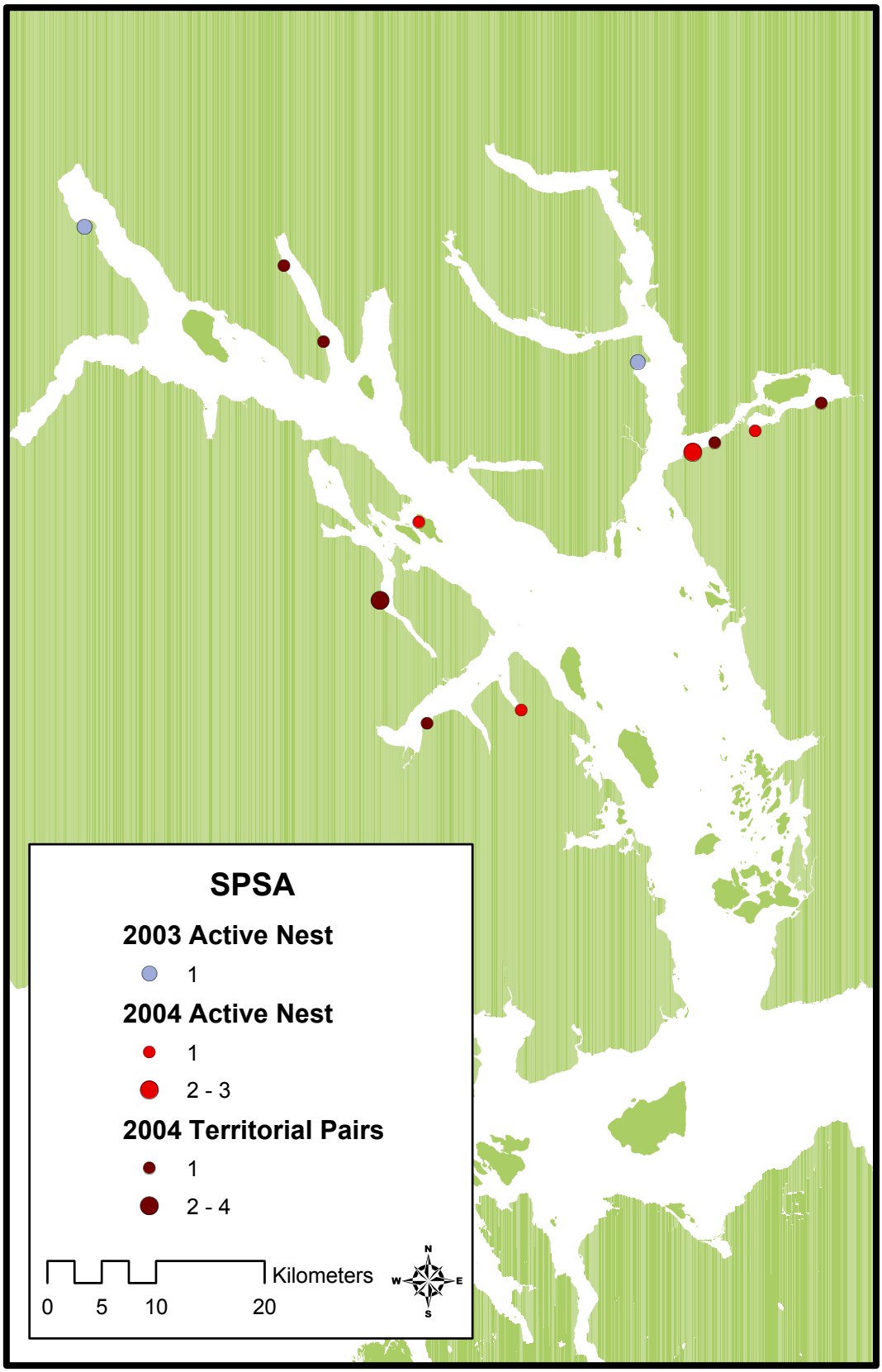
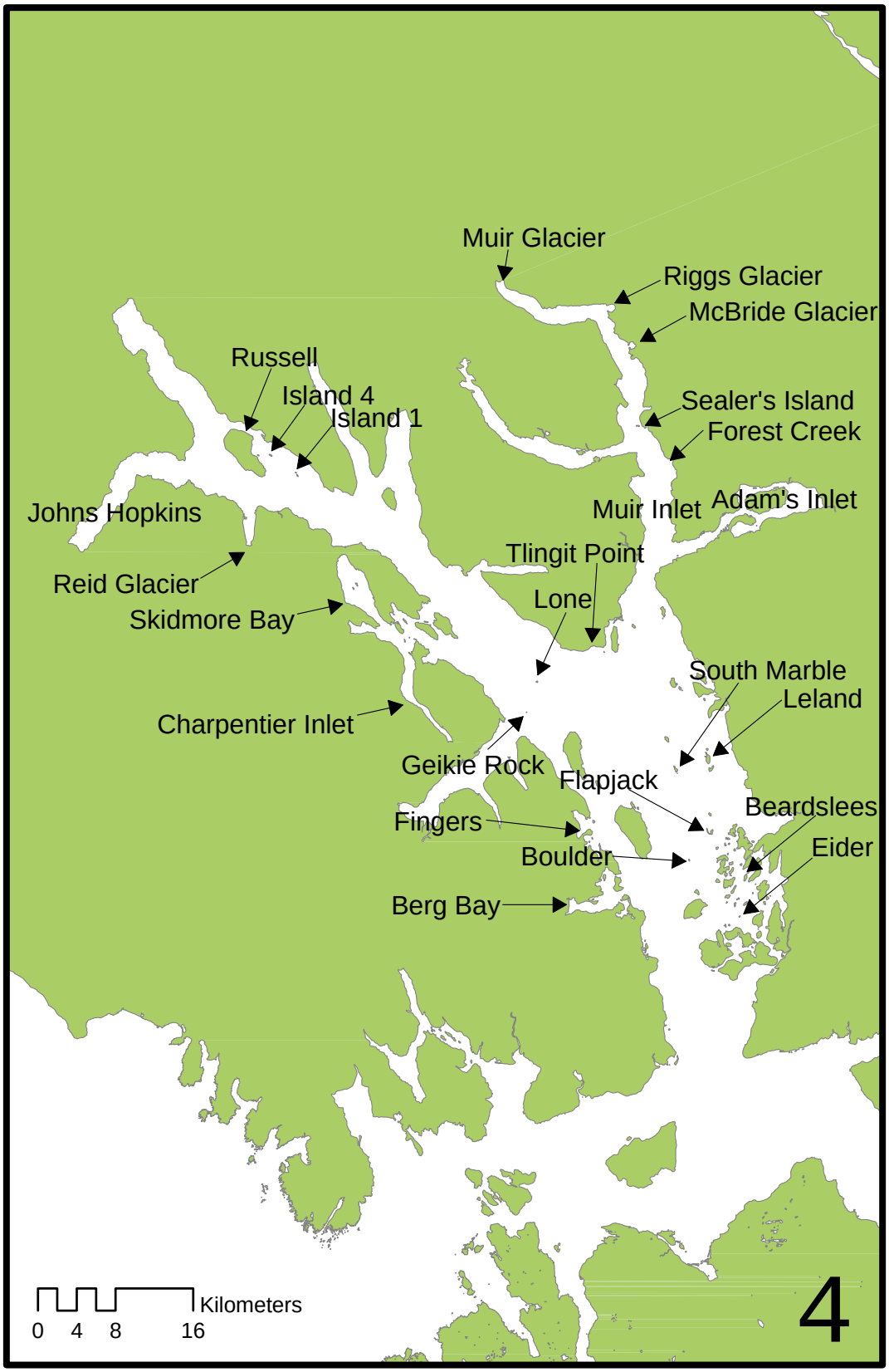


Figure 11. Spotted Sandpiper (SPSA) nest and pair observations during the 2003 and 2004 surveys.



Appendix 1. Place names in Glacier Bay National Park mentioned in this report.

Appendix 2. Photos of nests in Glacier Bay

a. Arctic Tern

b. Black Oystercatcher

c. Glaucous-wing Gull

d. Herring Gull

e. Mew Gull

f. Parasitic Jaeger

g. Semipalmated Plover

h. Spotted Sandpiper