Populations and productivity of seabirds at South Marble Island, Glacier Bay, Alaska, during May – July, 1999

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Abstract

In the course of directed research on glaucous-winged gulls, we investigated the numbers and activities of all breeding and non-breeding seabirds associated with South Marble Island in Glacier Bay, Alaska, during mid-May to late July, 1999. Most observations were made from the island; additional observations were made during transportation to and from the island. Data were collected on the presence and numbers of all seabirds observed. Detailed information on breeding chronology and productivity were also collected for glaucous-winged gulls (*Larus glaucescens*), pigeon guillemots (*Cepphus columba*), black-legged kittiwakes (*Rissa tridactyla*), and black oystercatchers (*Haemantopus bachmani*).

Introduction

South Marble Island is an important seabird colony and Steller sea lion (*Eumetopias jubatus*) haul-out located in central Glacier Bay, Alaska (58°39'N, 136°0'W)(Fig. 1). The island has been closed to foot traffic for over 25 years to reduce disturbance to the breeding seabirds and the federally-protected Steller sea lion. Here we report data that were collected on all seabirds at South Marble Island during the course of a study on the effects of egg-harvesting on glaucous-winged gulls.

Little historical information is available on the seabirds of South Marble Island (see Appendix 1). The earliest published record of bird counts conducted on South Marble Island is from 1907. Additional data are available in publications, unpublished records, and logs of anecdotal information recorded by park rangers. Most records consist of observations made from the water. The island has also been visited several times in the mid-late 1990's by sea lion researchers and visited annually by Tlingit peoples to collect glaucous-winged gull eggs for personal consumption (D. Neal, pers. comm).

Glaucous-winged gull colonies in Glacier Bay are a traditional source of eggs for the local Tlingit population (D. Neal, pers. comm). Egg harvesting is currently not permitted within the Glacier Bay National Park boundaries. The National Park Service is interested in documenting Tlingit egging practices, assessing the status of the gull colony on South Marble Island, and understanding the effects of timing and intensity of egg-harvesting on the gulls. The main goal of this study is to assess the effects of egg-harvesting on the gull population at South Marble Island.

We established a small field camp on South Marble Island from May to July 1999. During this period, we recorded observations of seabirds and one shorebird (black oystercatcher) that were nesting or likely nesting on the island. We also recorded the presence of non-breeding seabirds at or near the island. Population and productivity information for all species, including glaucous-winged gulls, are included in this report. Detailed findings of the experimental study of gull egg-harvesting will be reported after data have been analyzed.

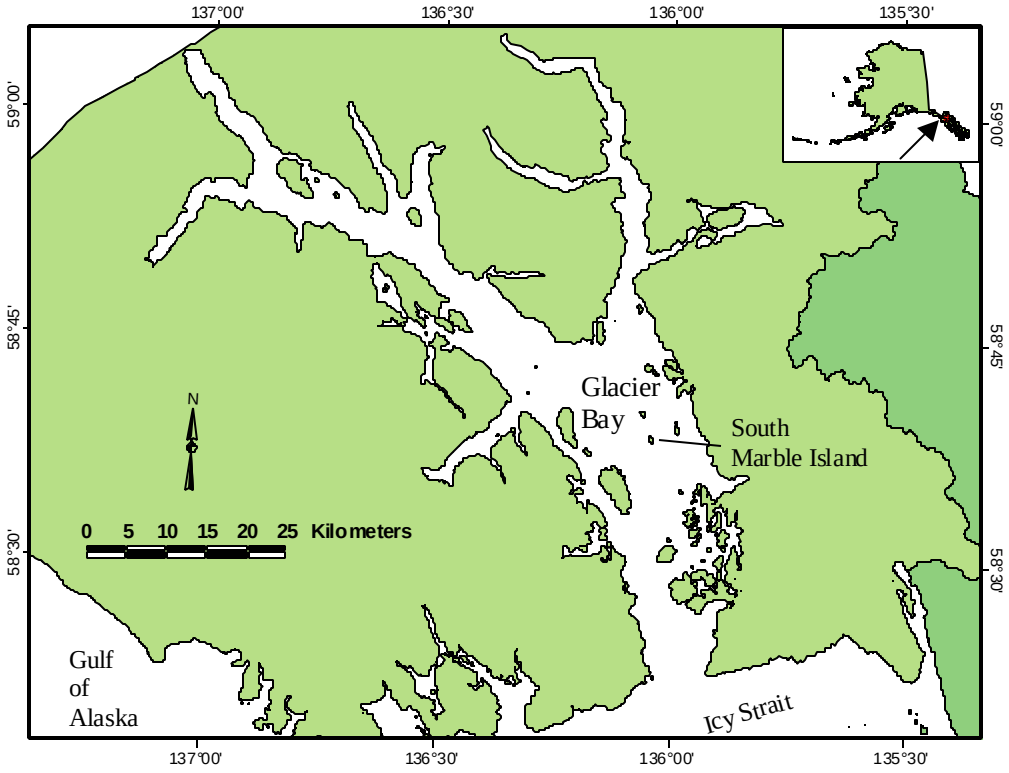


Fig. 1. The location of South Marble Island in Glacier Bay, Alaska

Methods

Study Area

Glacier Bay is a recently deglaciated fiord about 100 km long and 20 km wide at the northern end of southeast Alaska. South Marble is a 9.7 square km island located in the central portion of the bay. Water depth reaches 250 meters within 100 meters of the island. The island itself has been deglaciated for approximately 170 years. It is composed of partially metamorphosed limestone that forms smooth slopes visible in unvegetated portions of the island (Fig. 2). A central rift bisects the island. Low cliffs and dense spruce forest dominate the western half of the island. Grassy rounded hilltops that rise to 49 m and steeply sloped cliffs characterize the eastern half. A small partially vegetated islet connected only at low tide extends from the southern end of the island. Coves at the northern and southern end contain small cobble beaches.

Fig. 2. South Marble Island as viewed from the south. North Marble Island is in the background.

Data collection

Two researchers were present on the island for a total of 48 days between May 14 and July 21 during visits of 1 to 7 days duration. Most observations were made from the island. Additional observations were made opportunistically from the water while travelling to and from the island by boat. We observed standard seabird data collection protocol as described in Byrd (1989). The types of data collected varied among species. Details of methods are given in the individual species accounts. All means are reported ± 1 standard error.

Results

Glaucous-winged Gulls

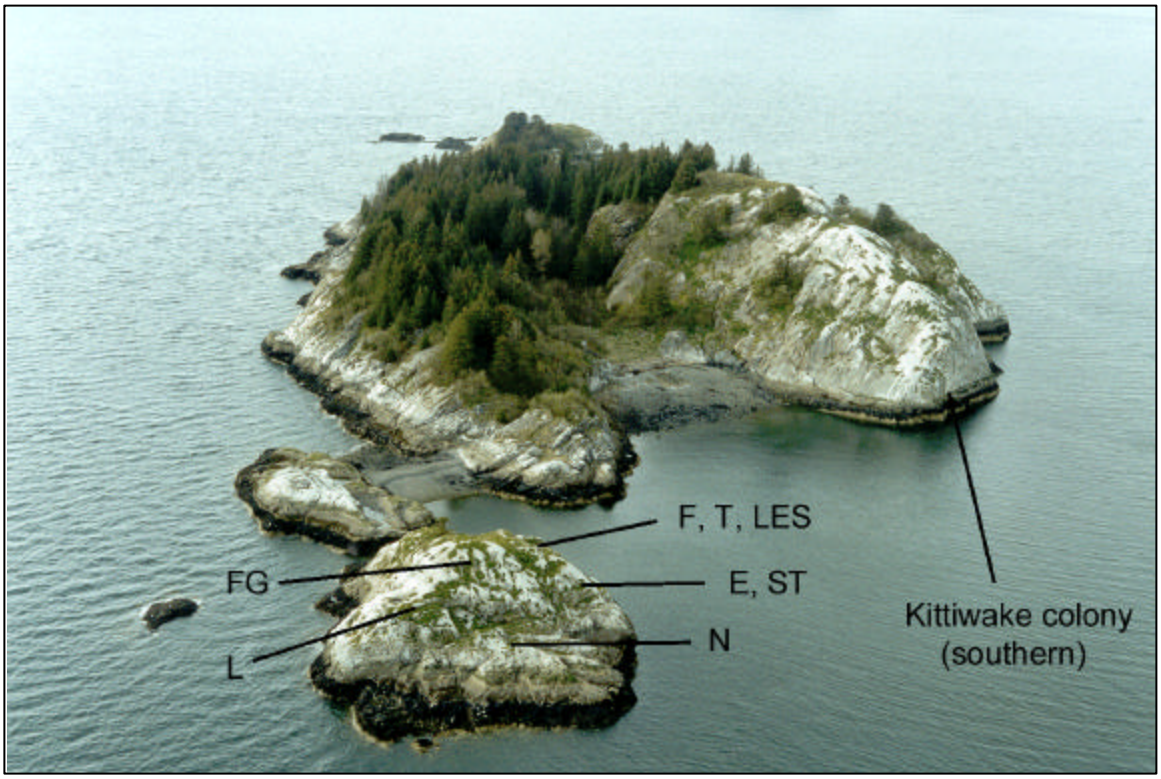
We censused glaucous-winged gulls while circumnavigating the island on May 14 and May 24. Repeated counts were made in consecutive sections of the island by 1 to 3 observers until the difference in replicates was less than 10% of the counts. These counts were taken before the gulls began laying eggs and during high tide. We counted 730 gulls on the first census and 829 on the second census. During the mid-incubation stage, two observers counted all nests that could be seen from the island. Nests without eggs, and with 1, 2, or 3 eggs were tallied separately. The total number of nests with eggs on June 18-19 was 285. Assuming all breeding pairs had eggs in nests on those days, the minimum breeding population was 570 birds.

Gulls nested on all but the forested portion of the peninsula at the north end, along the cliffs and cliff tops on the east side, and on the islet on the southern end of South Marble Island. The nesting areas covered most of the open areas of the island with low annual and perennial vegetation. Gulls did not nest on the low cliffs on the west side nor in any forested portions of the island.

Gulls were attending territories and had constructed some nest bowls when we first visited the island on May 14. The numbers of gulls attending territories before the onset of egg-laying increased at high tide; many areas were empty during low tide (data not included in this report). We monitored a minimum of 214 nests in 18 plots (Fig. 3) with 7 to 27 nests in each. We checked the status of nests every 1 to 4 days in most plots. In two plots we did not check nests between June 30 and July 19. An average of 35 ± 5% (n = 18 plots) of nests never contained eggs during our checks. The first eggs were laid on May 26 (± 1 day). The median lay date of the first eggs in clutches was June 9 (n = 18 plots). Egg-laying continued throughout the duration of our study. The last new egg we observed was laid July 18. Gulls incubated 1 to 3 eggs at a time. Clutch sizes changed when eggs were lost during incubation.

The first gull chick hatched June 25. The mean hatching success (chicks hatched per eggs laid) among nests with known fates was 32.4 ± 5.2 % (n = 18 plots; range = 0.0 – 76.9%)(Table 1). Forty-one eggs failed to hatch (7.7 ± 2.1% of eggs laid; n = 18 plots). Forty nests still contained eggs on July 19, our last check.

We found many depredated eggs in nests and near nests (Fig. 4). An average of 43.1 ± 7.9% (n = 18 plots) of eggs laid were depredated or likely depredated (i.e. they disappeared before they could have hatched). On two occasions, we observed bald eagles (*Haliaeetus leucocephalus*) landing in gull nests and eating eggs. We did not observe any other eggs predators, nor did we see gulls abandon their nests in the presence of potential avian predators such as the northwestern crow or the common raven (*Corvus corax*).



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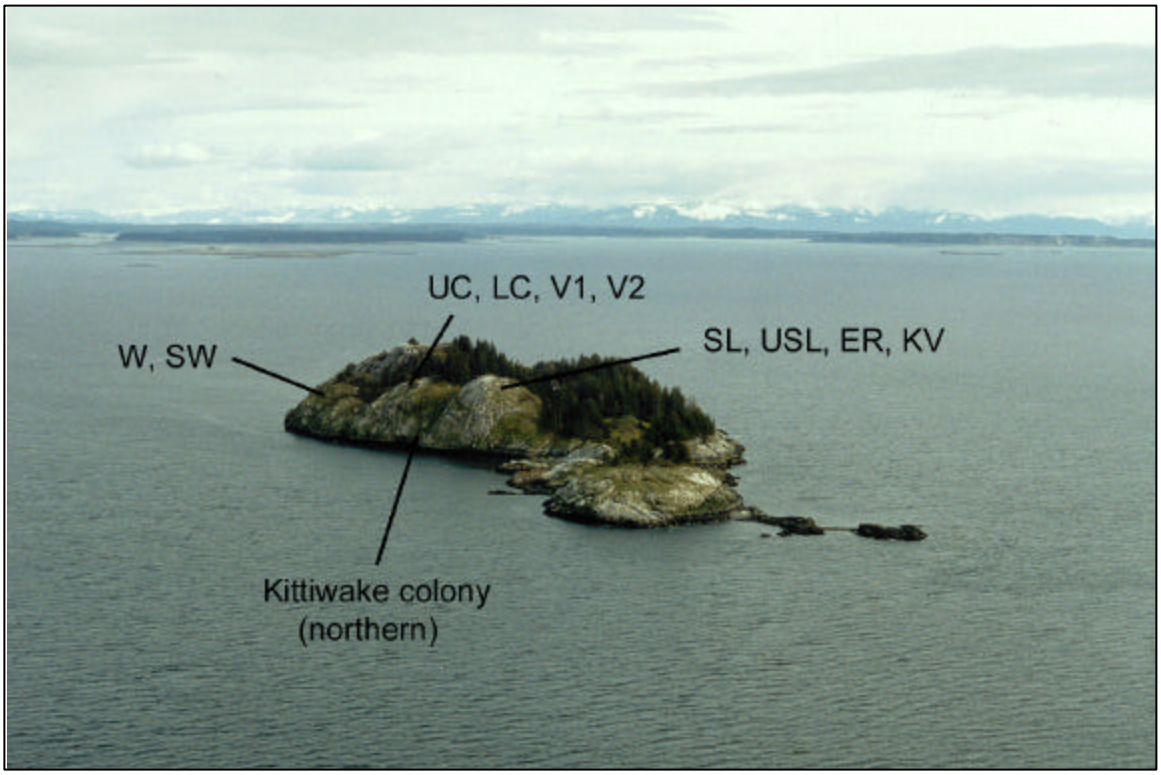

b.

Fig. 3. Plots of glaucous-winged gull nests that were monitored on South Marble Island; viewed from the south (a) and north (b).

Table 1. Mean hatching success (± 1 s.e.) and median lay date in plots of glaucous-winged gull nests at South Marble Island, Glacier Bay, Alaska, 1999.

Plot	Hatching Success[1]	# Nests	Median Lay Date
SL	65.5 ± 16.7	7	June 3
USL	30.0 ± 15.3	10	June 8
ER	25.0 ± 13.1	12	June 10
KV	76.9 ± 10.9	13	June 7
UC	14.3 ± 14.3	7	June 11
LC	8.3 ± 8.3	12	June 10
V1	10.0 ± 10.0	10	June 12
V2	0.0 ± 0.0	12	June 22
W	0.0 ± 0.0	9	June 14
SW	10.4 ± 7.3	16	June 9
F	40.9 ± 4.8	11	June 10
T	49.2 ± 12.8	13	June 13
LES	38.1 ± 12.5	14	June 7
E	44.8 ± 12.8	14	June 10
ST	31.7 ± 15.0	10	June 7
N	45.2 ± 17.3	7	June 5
FG	41.7 ± 13.5	12	June 4
L	51.6 ± 9.3	26	June 6

[1] Percent of chicks hatched per eggs laid

Gulls frequently abandoned their nests when bald eagles either flew over or landed in or near the colony. We observed these interactions on a daily basis throughout our stay on the island. We conducted three 2 hour watches to quantify the disturbance rates in the colony. (Data will be analyzed later)

We collected pellets regurgitated by adult gulls to determine diet composition. We collected samples from a plot monitored specifically for this purpose, as well as pellets encountered opportunistically while collecting data elsewhere. We removed all pellets found in the diet plot every 1 to 5 days to ensure that we were collecting only fresh samples. The number of pellets found decreased seasonally. Mussels were the most common item in the pellets. We also found fish bones, urchins, and at least two types of gastropods. (Samples will be analyzed in the laboratory and reported later)

Fig. 4. Depredated glaucous-winged gull egg found near a nest on South Marble Island.

For the egg-harvesting study, we manipulated 35 nests. All other monitored nests will serve as controls, grouped by hatching success, area, timing of egg loss, and lay date. Eggs were re-laid in 43.8% of nests with the first egg of the clutches removed (n = 16 nests), and eggs were re-laid in 31.6% of nests with the entire clutch removed (n = 19). To assess physiological costs of re-laying eggs, we banded, weighed, and measured 42 adult gulls (9 from nests that were manipulated and 33 from control nests). We took blood samples from 31 of these (including the 9 birds from manipulated nests) for examination of stress hormones. (Data will be analyzed and reported later)

Pigeon Guillemots

We censused pigeon guillemots (*Cepphus columba*) while circumnavigating the island on May 14, 17, and 24. We counted all guillemots seen on land and on the water. All counts were taken before the guillemots began laying eggs. The counts were 122, 155, and 171, respectively.

We followed 33 likely guillemot nest sites. These sites are documented in "A guide to pigeon guillemot nest sites on South Marble Island" (Zador 1999). Guillemots are sensitive to disturbance at their nest sites during the incubation stage. Accordingly, we checked nests no more than once per week during the incubation stage and nests with chicks no more than once every 2 days. Guillemots laid eggs in and/or were seen occupying 28 of these sites. The first egg was laid June 8 (± 2 days). Six nests still

contained eggs when last checked on July 20. The guillemots laid an average of 1.8 ± 0.1 eggs in 26 nests. Eggs disappeared in 6 nests before they could have hatched. One egg failed to hatch. The first chick hatched on or before July 6. Mean hatching success was 1.3 ± 0.2 (n = 26 nests) chicks per nest. We could not determine fledging success in those nests because we left the island before chicks fledged.

We measured growth rates of chicks in 11 nests (Fig. 5). Each chick was measured 1 to 3 times. We recorded weight in grams and tarsus, culmen, and wing chord in mm. Alpha chicks gained an average of 14.2 ± 2.7 grams per day (n = 5 chicks); beta chicks gained an average of 15.5 ± 2.5 grams per day (n = 5 chicks); and singletons gained an average of 14.4 ± 2.1 grams per day (n = 2 chicks).

We made 6 observations of guillemots carrying fish in their bills. We presume these fish were intended as chick meals and observed one delivered to a nest site. Four of these fish appeared to be gunnels (one likely a crescent gunnel *Pholis laeta*). The other two appeared to be a gadid and a sand lance.

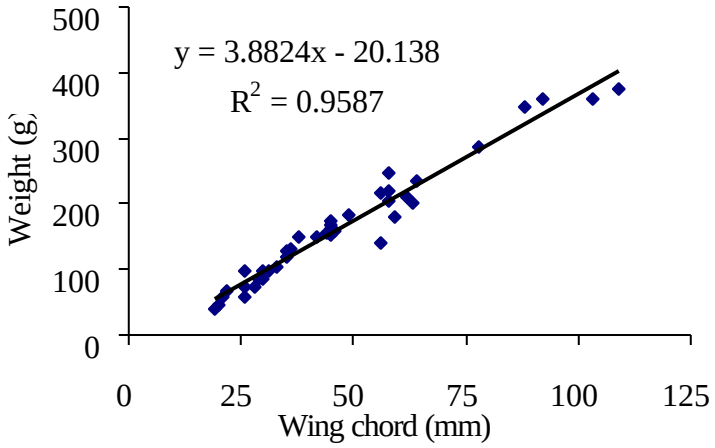

Figure 5. Pigeon guillemot chick weight versus wing chord for 18 chicks measured 1 to 3 times (n = 39 measurements).

Black-legged Kittiwakes

We censused black-legged kittiwakes (*Rissa tridactyla*) while circumnavigating the island on May 14 and 24. Counts of adults were taken before the kittiwakes began laying eggs. In order to obtain an index of productivity (Byrd 1989), the two kittiwake colonies were surveyed for chicks twice during the chick-rearing stage.

Observations at the southern colony were limited to surveys taken from boats. On May 14, 45 adults occupied old nesting sites on the cliff. On May 24, 96 adults were present,

and 17 nest sites had fresh nesting material. On July 24, at least 13 nests contained ≥ 1 chick, and 2 nests contained 2 chicks. Most of the chicks were downy. On August 12, 74 feathered chicks and 2 fledged chicks were present in the colony. From this count we can estimate that 38 to 76 pairs successfully raised 1 to 2 chicks.

We monitored the northern colony from a land-based observation site on the island as well as from the water. We counted 59 adults occupying sites on May 14 and 63 on May 24. No chicks were seen in this colony during the counts on July 24 and August 12. We monitored 38 nests from a viewing area above the colony (Fig. 6). From this vantage point we could see the nest contents when adults moved or were not present. We checked nests opportunistically every 2 to 7 days. We recorded when birds appeared to be in incubation posture and we could not see the nest contents. We saw eggs in two nests, once on June 18 and once on June 27. We recorded adults in incubating posture for ≥ 3 consecutive checks in 20 nests. The number of nests with adults in incubating posture dropped substantially in early July, indicating nests contents were lost at this time (Fig. 7).

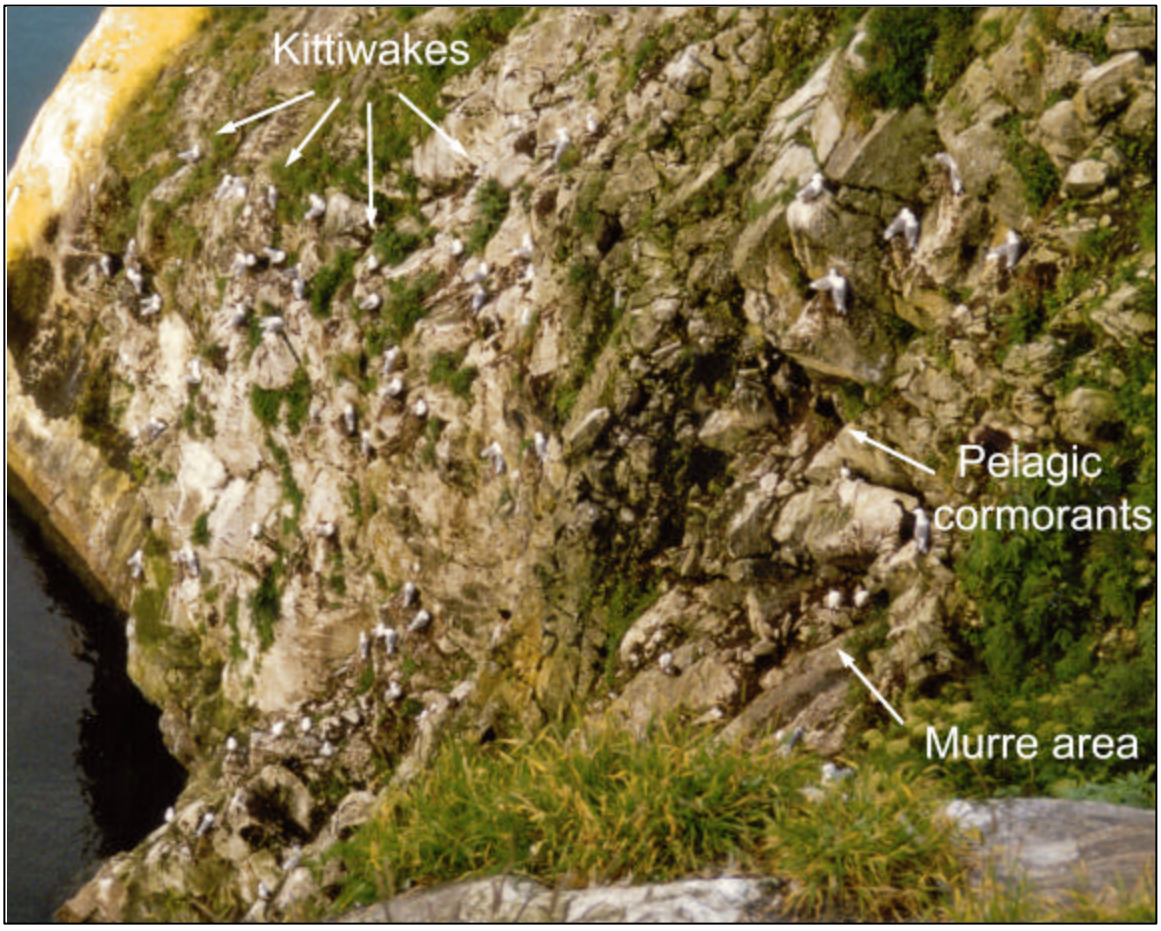

Fig. 6. The black-legged kittiwake colony at the north end of South Marble Island. The location of cormorant nests and murres are also indicated.

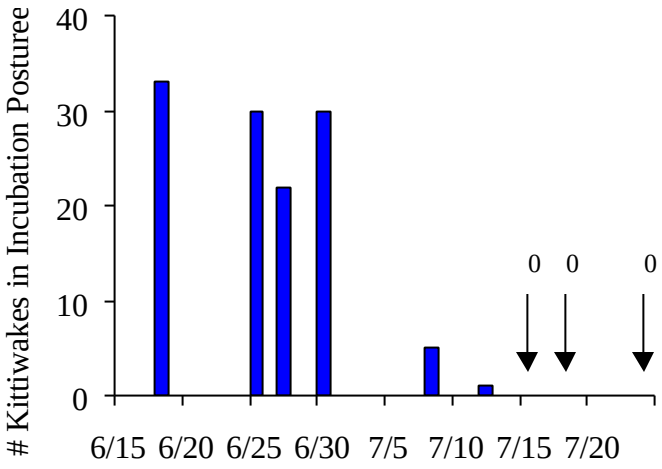

Fig. 7. The number of kittiwakes in incubation posture during nest checks at the northern colony on South Marble Island in 1999.

Black Oystercatchers

We monitored 10 pairs of oystercatchers that occupied territories on South Marble Island. There were at least 2 pairs that occupied territories at the base of steep cliffs on the east side of the island, but we could not monitor these. We saw eggs at 9 of the monitored sites. At least 5 of these nests hatched ≥ 1 chick. We checked nests opportunistically during the course of other work. We approached all but one nest at least once to check the contents. Eggs were laid between May 19 and June 19. We followed closely one nest near the camp site. Three eggs were laid in this nest. Two chicks hatched, but one chick disappeared between 12 to 18 days after hatching. At least 2 chicks hatched from a nest we observed only through binoculars from a distance. One of these chicks disappeared between 2 to 8 days after hatching.

Common Murres

We observed common murres (*Uria aalge*) infrequently around the island in rafts of up to 17 birds. We observed murres repeatedly on one section of cliff just above the northern kittiwake colony (Fig. 6). On one occasion we observed 12 murres on the cliff and 17 on the water below the cliff. Up to 12 murres were seen attending the cliff on 7 different occasions from May 24 to July 24, although the area was often empty. Some murres attended in pairs, but no eggs were seen. Five to eleven murres were seen on three consecutive checks from July 19 to 24, which suggests murres attempted to breed.

Thick-billed Murres

We made two observations of single thick-billed murres (*Uria lomvia*). On July 26, we saw one rafting alone on the water approximately 10 meters off the west end of the island. On July 20, we observed a single thick-billed murre roosting among 11 common murres just above the northern kittiwake colony.

Tufted Puffins

We observed up to 18 tufted puffins (*Fratercula cirrhata*) flying or rafting within the vicinity of South Marble Island from May 14 to July 20. Puffins likely nested in burrows visible in the vegetated portions of the cliffs on the east side of the island, but we were not able to approach these burrows. We did not observe any puffins carrying fish in their bills.

Horned Puffins

We observed a horned puffin (*Fratercula corniculata*) once at South Marble Island. On July 19, a single horned puffin circled with three tufted puffins below the cliffs on the east side of the island. The puffins appeared to be attempting to land on the island, but we did not see them do so.

Pelagic Cormorants

Pelagic cormorants (*Phalocrocorax pelagicus*) roosted in flocks of up to 192 birds on the cliffs on the east side and the wash rocks south of the island. The maximum number of cormorants counted in one day was 201. Flocks consisted of juveniles and adults in breeding plumage. Two pairs constructed nests on the cliff above the northern kittiwake colony, but these nests were not attended regularly, nor did we see any eggs in the nests (Fig. 6).

Double-crested Cormorants

We observed double-crested cormorants (*Phalocrocorax auritus*) roosting among pelagic cormorants on the wash rocks south of the island. We counted 3 on May 24 and 2 on May 31.

Discussion

Glaucous-winged Gulls

The earliest documentation of the glaucous-winged gull population on South Marble Island is from 1941when Jewett (1942) estimated that about 100 pairs nested on the

island. Estimates from the 1970's suggest a population of 500-1000 birds (see Appendix 1).

The absolute size of the current breeding population on South Marble Island is difficult to determine for three reasons: (1) Counts of birds taken from the water reflected only the birds present and visible at the colony at the time of the census. We found that attendance at the colony was influenced by the tide cycle, which presumably influenced foraging activity. Also, counts may have included non-breeding birds, which cannot be distinguished visually from breeding birds. (2) Counts of nests included only those visible to observers on the day of the census. Nests were constructed throughout our stay on the island, whereas some abandoned nests deteriorated completely. Also, not all nesting areas could be surveyed. (3) Gulls are known to build more than one nest within their nesting territories (O'Connell et al. 1977). Consequently, calculating one breeding pair per nest may overestimate the numbers of breeding pairs. Patten (1974) found glaucous-winged gulls on North Marble Island constructed 2.3 extra nests for every one final nest used. We saw evidence of gulls sequentially using more than one nest. As we could not distinguish unmarked individuals, we could not confirm nest-movement among pairs. We recorded distances between nests potentially belonging to the same pair and nests belonging to neighboring pairs. These data will be analyzed and reported later.

Bald eagles appear to be the primary predators of nesting glaucous-winged gulls on South Marble Island. In addition to observing eagles take eggs from nests, we found remains of 2 gulls and 1 kittiwake in the trees and on the forest floor. These were found below known eagle roosting sites. Crows appear to cause little predation threat. We observed crows picking up items, presumably egg shells and dead chick parts, within the gull colonies, but never from actively attended gull nests. Crows nested within some gull colonies and were present constantly in these areas. River otters (*Lontra canadensis*) are known predators of glaucous-winged gull adults and chicks (Verbeek 1993). We did not see any river otters on the island. However, trails likely left by otters were visible in the forested areas when we arrived in May. In 1998, sea lion researchers noted one otter moving through a gull nesting area which caused the birds to give alarm cries and flush (L. Dzinich, pers. comm.). They also found remains of depredated gull chicks that they attributed to river otters.

Nest loss from depredation was not evenly distributed on the island. Pairs nesting along the central portion of the eastern cliffs fared worst. Surprisingly, many of the plots with the highest hatching success were only a few hundred meters further north on the east cliffs, above the northern kittiwake colony. As the nests on the islet south of the island fared similarly, location may explain part of the difference in nest loss among plots. These plots differ in gull nesting density and topographic features, important factors in the ability of a gull colony to respond to potential predators.

Plots with the lowest hatching success also had the latest median lay dates. Nests in areas of high predation may have contained eggs that we did not see before they disappeared. In addition, higher predation rates may have caused birds to lay later in these areas than in other areas.

Mussels (*Mytilus* sp.) appeared to be the primary prey of adult gulls at South Marble Island before and during incubation. Using pellets to describe diet composition can bias analyses against soft-bodied prey (Irons 1987). However, mussel beds dominate the rocky intertidal at South Marble Island, and we frequently observed gulls there (Fig. 8). Gulls most often consumed mussels, but we also observed gulls swallowing small urchins, a sea star, and a gastropod that was dropped from the air to the rocks repeatedly until broken and consumed. Murphy et al. (1984) found glaucous-winged gull reproductive success to be reduced when mussels were the primary prey. The seasonal drop in the overall number of pellets we found suggest that the gulls may have shifted their foraging strategy as the breeding season progressed.

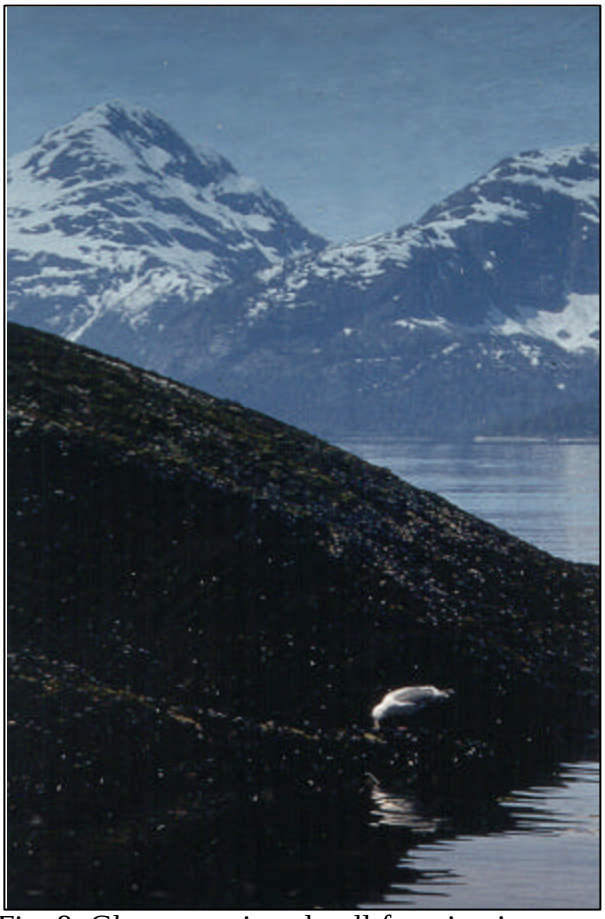

Fig. 8. Glaucous-winged gull foraging in mussel (*Mytilis* sp) bed on South Marble Island.

Future work

Further analysis of data collected during this pilot year of the egg-harvesting study will highlight portions of the project which need to be expanded or improved in the second year. We kept our experimental sample sizes at a minimum this year. Statistical power

analyses done this winter will show whether we need to increase our sample sizes of nest manipulations and/or blood sampling. Banding activities were minimal and need to be continued next year. Marked birds will help us to document nest-switching. This is very important for accurately assessing re-laying. Because capturing adults is difficult and time-intensive, using temporary markers, such as small dye-soaked sponges placed in nests to mark birds, may be necessary.

Other Species

Pigeon guillemots may be the second most abundant seabird breeding in Glacier Bay (J. Piatt, unpubl. data.), but little is known about the status of the population. Guillemots were first documented breeding on South Marble Island in 1907. Records suggest that during the 1970's the population was 100 to 150+ birds (Appendix 1), similar to our current estimate.

We found no evidence of predation in or near the guillemot nests that lost eggs. Guillemot chicks gained approximately 2 grams per day less than chicks in Kachemak Bay (Litzow 1996). However, chick growth rates on South Marble Island were similar to those of guillemot chicks fed unrestricted diets in a controlled environment (G. Divoky, pers. comm.). Guillemot chick growth rates are influenced by chick diets (Litzow 1996, G. Divoky, pers. comm.). Guillemots are nearshore foragers and provision chicks primarily with benthic and schooling fish captured within a few kilometers of their nests (Drent 1965). Robards et al. (1999) found potential guillemot prey species widely distributed and abundant in beach seines conducted in Glacier Bay during June 1999.

Kittiwakes have produced few or no chicks in Glacier Bay during the past 5 years (E. Hooge, unpub. data., Hooge 1995.). The eggs we observed confirm that kittiwakes in the northern colony attempted to nest, and the chicks at the southern colony showed that the colony can be productive. Kittiwakes will forgo breeding in years of poor food supply. If food availability was similar for birds nesting in the successful and unsuccessful colonies on South Marble Island, then the difference in reproductive performance between the two colonies may have due to differences in predation. We did not observe any direct predation in the northern colony, but did find one probable eagle-kill carcass in the forest (see above). Because the northern colony is in a recessed portion of the cliff, it appears that it would be more protected from aerial predators than the successful colony on the exposed cliff face to the south. Our presence in the viewing area did not appear to cause the birds to flush. Variable reproductive success among neighboring kittiwakes colonies is not unusual (Zador et al. 1996).

Kittiwakes first nested at the southern colony in 1989, but did not produce chicks (Streveler 1989). The earliest record of chicks at this colony was in 1994. The kittiwakes began nesting at the northern colony in 1996 (E. Hooge, pers. comm.). It is unclear whether the birds at this colony have ever produced chicks.

Glacier Bay has been documented to have the highest concentration of breeding oystercatchers in southeast Alaska (Nelson and Lenhausen 1983). Lentfer and Maier

(1995) found high nesting density and productivity in the Beardslee Islands, approximately 15 km south of South Marble Island. Despite the oystercatcher egg and chick loss we documented, we did not observe any predation or evidence of predation. We observed aggression between crows and oystercatchers, and oystercatchers responded and joined the alarm calls of the gulls when eagles were present. Common ravens (*Corvus corax*) and northwestern crows were considered the primary predators of oystercatcher eggs in the Beardslee Islands, where ≥ 26% of eggs laid in 1989 were depredated (Lentfer and Maier, 1995).

Breeding of common murres has not been documented on South Marble Island. The earliest record of murres on South Marble Island is from 1978 (Appendix 1). Anecdotal information suggests murres have been attending the same cliff since this time. It is possible that murres laid eggs in 1999, but we did not observe any. Records indicate murres nested on North Marble Island from at least 1967 through 1974 (Appendix 2). Murres were last documented there in 1975. To the best of our knowledge, thick-billed murres are not known to occur in Glacier Bay during summer. Our sightings confirm that at least one thick-billed murre was present in 1999.

Horned puffins have been documented nesting on South Marble Island since 1907. The breeding population has remained relatively constant at 2 to 6 birds since that time. Eleven were seen in 1972, but it is unclear whether these were all breeding birds. Tufted puffins have been seen at or near the island in numbers of 17 to 50+ birds since 1920. We could not confirm that horned or tufted puffins nested on South Marble Island this year because the cliffs where they likely nest were inaccessible. Boat-based monitoring efforts are needed to confirm nesting.

South Marble Island appears to be an important roosting area for non-breeding and breeding pelagic cormorants. Cormorants have been seen at the island in numbers of 50 to 300 since 1907. South Marble Island may have had more cormorant nesting activity in past years. We know that the area is capable of supporting a breeding population because cormorant nests in Spokane Cove, about 7 km east of South Marble Island, contained 13 chicks on August 12.

Acknowledgements

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Appendix 1. Historical information on seabirds breeding on South Marble Island, Glacier Bay.

Year	Date	Number	Comments	Source
Pelagic Cormorants				
1907	?	250-300	100 breeding, 150-200 non-breeding	Grinnell 1909
1970	May 17	200	Flew off island	Ranger logs
	July 8	175	No details	Ranger logs
1972	June 13	80	Unidentified cormorants	Ranger logs
1973	?	200	Data from S. Patten	Sowls et al. 1978
1975	July 29	50	Unidentified cormorants	Ranger logs
1976	May 26	~150	Unidentified cormorants	Ranger logs
1999	June 7	201	Maximum count	This study
Glaucous-winged Gulls				
1941	July 14	200	With eggs and young	Jewett 1942
1973	?	550	Data from S. Patten?	Sowls et al. 1978
1975	?	?	~1000 nests on N and S Marble Is, breeding failure	Ranger logs
1999	May 24	829	Maximum count	This study
Black-legged Kittiwakes				
1989	?	6	First time nests built, no young	G. Streveler, unpub. data
1991	?	0	None nesting in 1991	Climo and Duncan 1991
	June	+	Present on cliffs	
1994	July 6	24	10 nests, ≥ 2 chicks	E. Hooge, unpub. data
1995	June	~70	~30 nests	R. Yerxa, unpub. data
1996	July 2	199	135 nests	E. Hooge, unpub. data
1996	July 17	135	97 nests. North colony appears.	E. Hooge, unpub. data
1997	June 25	171	96 nests	E. Hooge, unpub. data
1998	June 19	261	131 nests	M. Kralovec, unpub. data
1999	May 24	159	July 24: 76 chicks at southern colony, 0 chicks at northern colony	This study
Common Murres				
1978	July 2	15	-	Ranger logs
1991	June	+	Present on cliffs	J. Piatt, pers. obs.
1999	May-July	29	Max. count: 12 on cliff, 17 on water	This study
Pigeon Guillemots				
1907	?	+	Breeding	Grinnell 1909
1970	May 20	150	NW end of island	Ranger logs
1973	?	100	S. Patten data?	Sowls et al. 1978
1975	July 29	27	No details	Ranger logs
1999	May 24	171	Maximum count, whole island	This study
Tufted Puffins				
1920	?	+	100+ around “Marble”, Drake, and Willoughby Islands	Bailey 1927
1970	July 17	50	“off S. Marble”	Ranger logs
1971	July 24	40	No details	Ranger logs
1972	Sept 1	23	No details	Ranger logs
1973	?	40	Data from S. Patten?	Sowls et al. 1978
1975	July 29	17	No details	Ranger logs
1979	June 7	30	No details	Ranger logs
1999	May-July	18	Maximum on the water	This study
Horned Puffins				
1907	?	2+	Nesting, 2 adults collected	Grinnell 1909
1969	June 9	3	2 in crevice	Ranger logs
1970	July16	6	On island, maximum summer count	Ranger logs
1972	Aug 17	11	Maximum summer count	Ranger logs
1972	Summer	6	Breeding population	Patten 1974
1973	Summer	6	Breeding population	Patten 1974
1975	July 29	5	No details	Ranger logs
1985	July 30	1	No details	Ranger logs
1999	July 19	1	Flying around island	This study

Appendix 2. Historical information on seabirds breeding on North Marble Island, Glacier Bay.

Year	Date	Number	Comments	Source
Pelagic Cormorants				
1969	July 18	+	"Numerous", 4 nests with 3,3,4,5 eggs	Ranger logs
1970	July 27	150	Survey of all seabirds	Ranger logs
1972	Sept 14	47	No details	Ranger logs
1972	Summer	6	Breeding population	Patten 1974
1973	Summer	60	Breeding population	Patten 1974
1999	May 24	0	Entire island surveyed from water	This study
Glaucous-winged Gulls				
1941	July 14	200	"100 pairs" with eggs and young	Jewett 1942
1972	Summer	1000	Breeding population estimate	Patten 1974
1973	Summer	1000	Breeding population estimate	Patten 1974
1975	?	+	~1000 nests on N and S Marble Is, breeding failure	Ranger logs
1999	May 24	25	On grassy slope on sw corner	This study
Common Murres				
1967	?	20	"Breeding confirmed"	Wik and Streveler 1968
1969	July 22	33	3 breeding ledges with 20, 5, and 8.	Ranger logs
	Aug 1	15	On ledges, eggs observed	Ranger logs
1970	May 29	120	Off island in 2 flocks	Ranger logs
	July 14	25	6 on ledge, 19 in water	Ranger logs
1971	June 15	46	Summer max count, 14 on ledges	Ranger logs
1972	June 12	61	Summer max count, on 3 ledges	Ranger logs
1972	Summer	16	Breeding population	Patten 1974
1973	Summer	36	Breeding population	Patten 1974
1975	July 29	12	No details	Ranger logs
1999	May 24	0	Entire island surveyed from water	This study
Pigeon Guillemots				
1970	July 27	350	Summer max count	Ranger logs
1971	June 15	200	No details	Ranger logs
1972	Summer	100	Breeding population	Patten 1974
1973	Summer	120	Breeding population	Patten 1974
1975	July 23	50	No details	Ranger logs
1999	May 24	127	Many in caves on west side	This study
1999	July 24	115	Surveyed east side only	This study
Tufted Puffins				
1920	?	+	100+ around "Marble", Drake, and Willoughby Islands	Bailey 1927
1970	July 26	75	East side of island	Ranger logs
1971	July 24	56	Summer max count	Ranger logs
1972	June 21	19	No details	Ranger logs
1972	Summer	50	Breeding population	Patten 1974
1973	Summer	60	Breeding population	Patten 1974
1975	July 23	30	No details	Ranger logs
1999	May 24	0	Entire island surveyed from water	This study
Horned Puffins				
1970	Aug 19	1	No details	Ranger logs
1973	Summer	2	Breeding population	Patten 1974
1975	July 29	2	No details	Ranger logs
1999	May 24	0	Entire island surveyed from water	This study
1999	July 24	4	Surveyed east side only	This study