

23 December 2005

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Dear Mr. Hagen:

Enclosed is a copy of our manuscript "Wintering seabird in the northern Gulf of Alaska," which we have submitted for review and possible publication by *Western Birds*. This completes the final task to complete this project for the Exxon Valdez Oil Spill Trustee Council

Thank you for managing this project.

Happy holidays.

Sincerely yours,

Robert H. Day, Ph.D.
Senior Scientist



WINTERING SEABIRDS IN THE NORTHERN GULF OF ALASKA

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23 December 2005

ABSTRACT.—I studied the distribution and abundance of marine-oriented birds in the northern Gulf of Alaska in winter (October–May, 1997–2001) during 16 research cruises. I recorded 58 species of seabirds on transect, plus one off transect. The avifauna was dominated numerically by tubenoses, which represented 50% of all birds; alcids represented 29%, larids represented 3%, waterfowl represented 2%, cormorants represented 1%, and loons represented <1% of the wintering avifauna. Five species each represented $\geq 5\%$, and collectively represented 74% of the wintering avifauna: Common Murre (21%), Northern Fulmar (19%), Fork-tailed Storm-Petrel (16%), Sooty Shearwater (11%), and Black-legged Kittiwake (7%). Another nine species collectively represented ~19% of all birds, whereas the other 44 species collectively represented ~7% of all birds. Across all data, species-richness varied from 10 to 37 species/cruise; both richness and total densities of all birds combined decreased from October to March, then rapidly increased in April and (especially) May. I describe the seasonal occurrence of the 58 species seen during surveys and the one species seen off transect.

The Gulf of Alaska supports enormous numbers of marine-oriented birds on an annual basis (Gould et al. 1982, DeGange and Sanger 1986). Over 9×10^6 seabirds nest in the Gulf (DeGange and Sanger 1986), suggesting that this region is important foraging seabirds. There is seasonal variation in seabird abundance, with up to 40×10^6 feeding in the Gulf as a whole during the summer and lower numbers in winter (Gould et al. 1982).

This study investigated some aspects of the ecology of marine birds during a period (winter) that may strongly affect their ecology and populations (Bailey and Davenport 1972, Harrington-Tweit 1979, Blake 1984, Harris 1984, Hope Jones et al. 1984). (In this study, the term "winter" refers to that period in a general sense, to differentiate it in a general sense from "summer," which is when birds are breeding. In a strict sense, this study occurred from oceanographic fall to spring.) I studied variation in the abundance of seabirds in the northern Gulf of Alaska during October–May over four consecutive winters (1997–2001). These data on the distribution and abundance of seabirds during winter represent the first step in understanding the wintering ecology of these predators at this high latitude.

Although seabirds have been studied in the Gulf of Alaska for >30 years, few data actually are available for comparison with this study. For example, Gould et al. (1982) presented data by season, but few are available for this region for most months and for particular locations. In addition, one of three interannual studies of wintering seabird abundance in this region was conducted within protected bays on Kodiak Island since the late 1970s (Forsell and Gould 1981; D. Zwiefelhofer, USFWS, Kodiak, AK, pers. comm.). The other two studies comparing interannual abundance, including winter, were conducted after the *Exxon Valdez* oil spill and are concentrated in Prince William Sound (Day et al. 1995, 1997a, 1997b; Wiens et al. 1996; Murphy et al. 1997; Agler et al. 1999, Lance et al. 1999, Irons et al. 2000). However, none of

these studies collected data on the wintering ecology of seabirds in the open northern Gulf of Alaska, and only one (Day et al. 1997a) examined birds in the Gulf, and that was only within bays during the summer. A final project studied birds in lower Cook Inlet in February–March of one winter (Agler et al. 1995).

STUDY AREA

The study area encompassed the northern Gulf of Alaska, including both neritic and oceanic areas, and nearby Prince William Sound (Fig. 1). It included the 220-km-long Seward Line, a large oceanographic survey line that extends across the shelf and continental slope, and several other oceanographic lines that sampled the shelf and the Alaska Coastal Current in the Gulf and within Prince William Sound. Although the Seward Line was sampled every cruise, I was able to sample the other lines only sporadically.

The physical oceanography of the region is dominated by several structures and water masses. Going from inshore to offshore, these are the Alaska Coastal Current, the mid-shelf region, the shelf-break front, and the Alaska Current/Alaska Stream (Fig. 1). In winter, storms enter the Gulf, are blocked by the coastal mountains, and drop large amounts of precipitation that forms an enormous freshwater "river" (The Alaska Coastal Current) that flows northwestward along the coast (Royer 1979, 1982). These storms also generate a cyclonic circulation over the Gulf's shelf and continental slope and drive surface water onshore, resulting in downwelling most of the time (Reed and Schumacher 1986).

The Alaska Coastal Current (ACC) is the most prominent circulation feature of the shelf (Fig. 1); it is a fast, low-salinity current that typically occurs within 35 km of the coast and varies in width seasonally, being wider in the fall and winter and narrower in late winter and spring

(Royer 1981a, 1981b; Johnson et al. 1988). Part of the ACC loops through southern Prince William Sound (Niebauer et al. 1994); occasionally, jets of ACC water (indicated by dashed lines in Fig. 1) are forced offshore at coastal promontories. In the mid-shelf region, current flow is much weaker than in both the inshore ACC and the offshore Alaska Stream, both of which exhibit strong westward flow (Niebauer et al. 1981, Royer 1981a, Lagerloef 1983). The shelf-break region is an area of complex physics, and the dynamics of the shelf-break front in this region are poorly understood. Hydrographic data collected by the GLOBEC study indicate that a front may be present at the bottom, at the surface, at both, in neither location, or extending throughout the water column as one large front. Along the continental slope, flow consists of the broad, diffuse Alaska Current in the northeastern Gulf of Alaska that becomes transformed into the narrow, rapidly flowing Alaska Stream in the northern Gulf.

METHODS

Data collection

I collected data on the at-sea distribution and abundance of seabirds during 16 oceanographic cruises in the northern Gulf of Alaska from October 1997 through March 2001. During this period, there was no cruise in December 1997, and I was unable to participate in the October 1998 cruise. Hence, I collected data on three October, three December, four March, three April, and three May cruises; I collected data on all except the October 2000 cruise, when another trained observer replaced me.

I sampled seabirds on time and space scales similar to those sampled by the Gulf of Alaska GLOBEC Program. The Seward Line, which was sampled on every cruise, extended across the shelf to the Alaska Stream, including Alaska Coastal Current water, mid-shelf water,

the shelf-break, and oceanic water in the Alaska Stream. Ship's speed averaged ~18.5 km/h and varied between 10.3 km/h and 22.6 km/h. I recorded data on sea-surface temperatures (SST's) and sea-surface salinities (SSS's) for as many transect samples as possible with an automatic system aboard the ship's sea chest; however, this system broke down on a few cruises. I rounded SSTs to the nearest 0.1°C and SSSs to the nearest 0.1 psu (Practical Salinity Units).

I collected data on the at-sea distribution and abundance of seabirds with a series of strip-transects, following the methodology of Tasker et al. (1984) and Gould and Forsell (1989). In essence, data are collected in a zone 300 m off one side of the ship (i.e., from directly forward to 90° starboard) while it moves forward in a straight line at a known and fixed speed. Data on flying seabirds were collected with the "snapshot method" to avoid inflation of density estimates caused by the movement of birds through the transect (Tasker et al. 1984, Gould et al. 1989), whereas birds on the water were recorded continuously because they often were difficult to locate with one visual scan and because they were not moving through the transect. Although some authors (e.g., Becker et al. 1997) have argued for the use of line-transects in sampling birds at sea, line-transect data are so cumbersome to collect in locations with even moderate numbers of birds that the resulting data are of questionable accuracy.

I collected data in transects of fixed time length. Transects almost always were 5 min long, although a few were 4 min long if we were arriving at an oceanographic station. Within transects, we recorded data by the minute, allowing calculation of exact location and allowing clumping of data for analyses. For each record of a bird, I recorded time, species, number of individuals; location, and activity.

Data analysis

I pooled all data from the 16 cruises to enumerate the total numbers of each species of seabird seen altogether. For each species and species-group, I calculated the percentage of the total number seen. To examine species-richness (Magurran 1988), I calculated the number of species seen during each cruise, both for the Seward Line (sampled every cruise) and for all transect samples on a cruise (variable among cruises, although some areas were sampled most or all cruises). I then plotted these numbers and visually interpreted the resulting patterns.

I pooled transects into 10-min transects when possible because of clumping at different scales (Day and Prichard, unpubl. data). The total number of adjusted (5- or 10-min) transects available for analysis was 2,437 across all research cruises combined. For each transect, I divided the total count of birds by the total area sampled to generate a standardized estimate of density (birds/km²). For each species, I calculated mean \pm 1 SE density by month and year.

RESULTS

The environment

Along the Seward Line, sea-surface temperatures (SST's) varied seasonally; mean SST's were highest in October ($10.1 \pm \text{SE} < 0.1^\circ\text{C}$), decreased in December ($7.4 \pm < 0.1^\circ\text{C}$), were at a minimum in March ($5.5 \pm < 0.1^\circ\text{C}$) and April ($5.6 \pm < 0.1^\circ\text{C}$), and increased slowly in May ($6.9 \pm < 0.1^\circ\text{C}$; Fig. 2). The winter of 1997–1998, immediately after the large El Niño of 1997, was the warmest year (mean $7.8 \pm 0.1^\circ\text{C}$), followed closely by 1999–2000 and 2000–2001 ($7.6 \pm 0.1^\circ\text{C}$ for both); only the winter of 1998–1999 was cold ($6.0 \pm < 0.1^\circ\text{C}$; Fig. 2). I believe, however, that the estimate for 2000–2001 was inflated because I had a large sample from the warm fall (the warmest since the El Niño of 1997) but did not sample during the other cold months that winter

(April, May). Hence, I suspect that the mean SST for 2000–2001 would have been between those for 1998–1999 and 1997–1998. Sea-surface salinities (SSSs) along the Seward Line also varied seasonally and interannually, being lowest in the winter of 2000–2001 (mean 30.9 ± 0.1 psu), intermediate in 1997–1998 and 1999–2000 ($31.7 \pm <0.1$ psu for both), and highest in 1998–1999 ($32.0 \pm <0.1$ psu). Again, however, I had an incomplete sample for 2000–2001.

Seabirds

During the 16 cruises, I recorded 15,896 marine-oriented birds of at least 58 species, plus another species not seen on transect (Table 1). Species represented five orders and nine families: Anseriformes (Anatidae); Gaviiformes (Gaviidae); Procellariiformes (Diomedidae, Procellariidae, and Hydrobatidae); Pelecaniformes (Phalacrocoracidae); and Charadriiformes (Scolopacidae [the only shorebirds studied were phalaropes], Laridae, and Alcidae).

The avifauna was dominated numerically by tubenoses, which collectively represented 50% of all birds (Fig. 3); that group was dominated by petrels and shearwaters (31.0% of all birds) and storm-petrels (16.4%), with much smaller numbers of albatrosses (2.9%). Alcids were second in abundance, at 29%, and larids were third in abundance, at 13%; phalaropes (shorebirds) represented 3%, waterfowl represented 2%, cormorants represented 1%, and loons represented <1% of the total avifauna. Surprisingly, I recorded no grebes (Podicipediformes) of any kind.

Five species each represented $\geq 5.0\%$ of the total avifauna and collectively represented ~74% of all birds recorded across all cruises: Common Murre (21.3%), Northern Fulmar (18.5%), Fork-tailed Storm-Petrel (16.3%), Sooty Shearwater (10.7%), and Black-legged Kittiwake (7.0%). Another nine species each represented 1.0–4.9% of the total avifauna and collectively represented ~19% of all birds: Tufted Puffin (3.9%), Glaucous-winged Gull (3.6%),

Red Phalarope (3.1%), Black-footed Albatross (1.9%), Short-tailed Shearwater (1.6%), Kittlitz's Murrelet (1.4%), Marbled Murrelet (1.3%), Double-crested Cormorant (1.1%), and Laysan Albatross (1.0%). Finally, the other 44 of the 58 total species each represented <1% of the total avifauna and collectively represented ~7% of all birds.

Species-richness and overall densities.—For the Seward Line, species-richness varied between 8 and 26 species/cruise, with an overall mean of 16.1 species/cruise (Fig. 4). Species-richness decreased seasonally from October (mean 18.0 species/cruise) to December (mean 13.0) and March (mean 11.0), then increased rapidly in April (mean 16.7) and May (mean 23.7), when wintering species are leaving, breeding species are arriving, and migrant species are present. Across all data, species-richness varied between 10 and 37 species/cruise, with an overall mean of 20.9 species/cruise (Fig. 4). Similar to the pattern seen for the Seward Line, species-richness across all data decreased seasonally from October (mean 24.3 species/cruise) to December (mean 18.7) and March (mean 14.8), then increased rapidly in April (mean 19.7) and May (mean 29.3).

Total densities of all species combined exhibited a seasonal pattern similar to that for species-richness, in that overall densities decreased from October (6.4 birds/km²) to December and March (mean 5.2 birds/km²), then increased from March to April (mean 7.6 birds/km²; Fig. 5). Total densities peaked in May with a mean of 12.9 birds/km².

Species accounts.—In these accounts, I discuss abundance for most species in general terms and discuss details of habitat use and seasonal, interannual, and/or geographic variation in abundance for only the more common species. This difference in detail occurs because 44 of the 58 species of birds seen on transect were recorded in trace numbers (i.e., each was <1% of the total number seen). In addition to the 58 species recorded on transect, I saw one species (Black-headed Gull) only off transect.

I follow Kessel and Gibson (1978) in classifying each species in terms of abundance (abundant, common, fairly common, uncommon, rare, casual, and accidental). "Casual" implies not annual, and "accidental" implies that the species is so far from its normal range that further records are unlikely. I modified their status categories, however, because I did not have year-round information on whether they were resident and did not know the breeding status; hence, I use the terms "migrant" and "winter visitor." Taxonomy follows the American Ornithologists' Union's *Check-list of North American Birds* (AOU 1998) and supplements (AOU 2000; Banks et al. 2003, 2004). Months are expressed as two-letter abbreviations (JA, FE, MR, AP, MY, JN, JL, AU, SE, OC, NO, DE). Prince William Sound is abbreviated as PWS, and the Alaska Coastal Current is abbreviated as ACC.

Cackling/Canada Goose *Branta hutchinsii/canadensis* (rare migrant): I saw a flock of four flying north in the mid-shelf area, ~35 km offshore, on 6 MY 1999; they represented 0.1% of all birds seen during surveys (Table 1). In addition, I saw off transect a flock of 40 sitting on the ocean ~9 km south of Cape Fairfield on 10 OC 1999; three flying off outer Montague Island on 17 AP 1999; and a flock of 18 flying in the mid-shelf area, ~35 km offshore, on 7 MY 1998. During this work, I did not differentiate the two species because they had not yet been split by the AOU; however, both occur in the Gulf of Alaska during migration. The species is an uncommon winter resident and an abundant migrant in the region, with migration occurring SE to mid-NO and late MR–late MY (Isleib and Kessel 1973). It has been recorded once in winter at Kodiak Island, a flock in late FE (Forsell and Gould 1981), but has not been recorded wintering in PWS (Lance et al. 1999) or in Lower Cook Inlet (Agler et al. 1995).

Brant *Branta bernicla* (rare–uncommon spring migrant): I saw a flock of four flying north (presumably coming in from the deep North Pacific) near the shelf-break on 6 MY 1999

and saw a flock of four flying east (not west) off the mouth of Resurrection Bay on 17 MY 2000; they represented 0.1% of all birds (Table 1). In addition, I saw off transect a flock of six sitting on the ocean at 58°51'N 148°32'W, one bird flying northwest, and ~20 flying west-northwest, all over the outer part of the mid-shelf and all on 8 MY 1999. Thus, it appears that this species migrates through the region primarily far offshore in the spring. The species is a rare fall and fairly common spring migrant, primarily in offshore waters; migration occurs mid-AU to OC and early AP to mid-MY (Isleib and Kessel 1973). It does not winter in the northern Gulf of Alaska (Zwiefelhofer and Forsell 1989, Lance et al. 1999, Agler et al. 1995).

Mallard *Anas platyrhynchos* (rare migrant): I saw a flock of 21 flying to the southeast over the mid-shelf on 4 OC 2000; they represented 0.1% of all birds (Table 1). The species is a common winter visitor and an abundant migrant, with migration occurring late AU to mid-OC and late AP to mid-MY (Isleib and Kessel 1973). It winters in protected bays of Kodiak Island (Forsell and Gould 1981), in PWS (Day et al. 1995, 1997b; Lance et al. 1999), and in Lower Cook Inlet (Agler et al. 1995), so our lack of later winter records probably reflects the fact that these birds winter primarily in protected waters and on shorelines, where I did not sample.

Northern Shoveler *Anas clypeata* (rare–uncommon migrant): I saw a flock of three flying east ~20 km offshore on 7 OC 1999 and a flock of four flying west ~110 km offshore on 17 MY 2000; they represented <0.1% of all birds (Table 1). In addition, I saw off transect a flock of three flying east ~150 km offshore on 7 OC 1999; two flying to the northwest ~260 km offshore and clearly migrating over the deep North Pacific on 7 MY 1999; and a flock of 17 sitting on the ocean at 58°33'N 148°13'W (~165 km offshore) on 8 MY 1999. The species is a fairly common migrant in the region, migrating from mid-AU to early OC and late AP–early JN (Isleib and Kessel 1973). It occasionally winters in protected bays of Kodiak Island (Forsell and

Gould 1981) and in PWS (Day et al. 1995, 1997b; Lance et al. 1999).

Green-winged Teal *Anas crecca* (rare migrant): I saw a flock of seven sitting on the ocean at 59°40'N 147°53'W (just south of Montague Island) on 17 AP 1999 and saw one flying north (and, presumably, coming inshore from the deep North Pacific) over the mid-shelf on 12 MY 1999; they represented 0.1% of all birds (Table 1). The species is a rare winter visitor and an abundant migrant in the region, with migration late AU–late NO and mid-AP to late MY (Isleib and Kessel 1973). It winters in low numbers in protected bays of Kodiak Island (Forsell and Gould 1981) and in PWS (Day et al. 1995, 1997b).

Greater Scaup *Aythya marila* (rare–uncommon migrant): I saw nine flying east, high over the ocean on 13 OC 1997 and saw 17 sitting on the ocean at 58°33'N 148°12'W on 8 MY 1999, both near the shelf-break, ~160 km offshore. They represented 0.1% of all birds (Table 1). In addition, I saw off transect 20 birds ~37 km offshore and 5 birds ~160 km offshore, near the shelf-break, both on 6 MY 1999; and 1 pair flying inshore from the deep North Pacific ~200 km offshore on 18 MY 2000. The species is a common winter visitor and abundant migrant, with migration occurring early SE–early NO and late AP to mid-MY (Isleib and Kessel 1973). It winters in low–moderate numbers in protected bays of Kodiak Island (Forsell and Gould 1981), in PWS (Lance et al. 1999), and in Lower Cook Inlet (Agler et al. 1995).

Common Eider *Somateria mollissima* (rare migrant): I saw a flock of 26 flying southwest over the mid-shelf on 7 MY 1998; they represented 0.2% of all birds (Table 1). The species is a rare visitor to the region, being more common in winter and occurring primarily along the open coast (Isleib and Kessel 1973). The species winters in low numbers in protected bays of Kodiak Island (Forsell and Gould 1981) and winters in Lower Cook Inlet in the low thousands (Agler et al. 1995) but has not been recorded in PWS in winter (Lance et al. 1999).

Harlequin Duck *Histrionicus histrionicus* (rare winter visitor): I recorded only six during surveys, scattered between OC and MR; they represented <0.1% of all birds (Table 1). All except two were in ACC water, and the two exceptions were slightly farther offshore, in the inner part of the mid-shelf, on 15 OC 1997. They occurred in both the Gulf and PWS. In addition, I occasionally saw them off transect in scattered nearshore locations, especially in protected waters. The species is an abundant resident in nearshore waters, being especially common in winter (Isleib and Kessel 1973). It winters at Kodiak Island, being more common in fall than in winter (Zwiefelhofer and Forsell 1989), in PWS in the low tens of thousands (Lance et al. 1999), and in Lower Cook Inlet in the low thousands (Agler et al. 1995).

Surf Scoter *Melanitta perspicillata* (probably rare winter visitor, rare migrant): I saw a pair in Knight Island Passage (PWS) on 5 OC 2000, five just south of Cape Fairfield on 10 OC 2000, and a pair in southern PWS on 11 MR 2000; they represented 0.1% of all birds (Table 1). In addition, I saw off transect a flock of five at Macleod Harbor on 5 MR 2001; 90–100 in Icy Bay on 18 AP 1999; and two off eastern Knight Island (all PWS) on 10 MY 1999. The species is an abundant resident and is the most abundant seaduck in inshore waters at all seasons; migration occurs SE–NO and AP–late MY (Isleib and Kessel 1973, Gould et al. 1982). It winters in low numbers at Kodiak Island (Zwiefelhofer and Forsell 1989), and in the thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

White-winged Scoter *Melanitta fusca* (rare winter visitor, rare–uncommon migrant): I recorded a total of 52 in 7 groups during surveys; they represented 0.1% of all birds (Table 1). They were most common in OC, when I recorded them every year, but occurred sparingly from DE to AP. They also occurred everywhere, from PWS to ~185 km offshore; this latter group (15 birds) was seen migrating over the deep North Pacific on 6 OC 1999. In addition, I saw birds off

transect southwest of Montague Island on 16 OC 1997; one in Knight Island Passage (PWS) on 9 OC 1999; five at Naked Island (PWS) on 5 DE 1998; four near Cape Suckling on 5 DE 1999; two near Chenega Island (PWS) on 18 AP 1999; and seven flying northwest ~45 km offshore on 20 MY 2000. The species is an abundant resident, especially in protected waters; migration in fall has not been described and in spring occurs AP–MY (Isleib and Kessel 1973). It winters in substantial numbers at Kodiak Island (Zwiefelhofer and Forsell 1989) and in the thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995), where it is the most common seaduck.

Black Scoter *Melanitta nigra* (very rare migrant): I saw single Black Scoters flying west of Kayak Island on 5 DE 1999 and ~55 km offshore, in the mid-shelf, on 16 AP 1999; they represented <0.1% of all birds (Table 1). The species is a common winter visitor, especially in protected waters, and a fairly common migrant in the region; migration occurs late SE onward and early AP–late MY (Isleib and Kessel 1973). It winters in large numbers in bays at Kodiak Island, with numbers increasing at least until NO (Zwiefelhofer and Forsell 1989), and in the low thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

Long-tailed Duck *Clangula hyemalis* (rare winter visitor, rare–uncommon migrant): I saw 70 total, two in DE and the rest in MY; they represented 0.4% of all birds (Table 1). I saw single birds in Blying Sound on 3 and 6 DE 2000; flocks of six and two flying west ~18 and ~37 km south of Cape Fairfield on 11 MY 1999 and 20 MY 2000, respectively; and flocks of 45 and 15 flying east (not west) over the mid-shelf ~45 km offshore on 19 MY 2000. In addition, I saw off transect one bird ~150 km offshore, over the shelf-break, on 2 DE 1999; 25–30 in Icy Bay (PWS) on 18 AP 1999; a flock of 16 flying west over the mid-shelf on 8 MY 1998; and ~200 birds in 5 groups flying northeast or east (not west) over the mid-shelf on 19 MY 2000. The

species is a common winter visitor and a common migrant, with migration occurring SE–NO and late AP to mid-MY (Isleib and Kessel 1973, Gould et al. 1982). This is the most common waterfowl wintering in bays of Kodiak Island (Zwiefelhofer and Forsell 1989), and it winters in the thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

Common Goldeneye *Bucephala clangula* (uncommon migrant): I saw flocks of 79 and 17 in Bainbridge Passage (PWS) on 6 OC 2000; they represented 0.6% of all birds (Table 1). The species is an abundant winter visitor, especially in protected waters, and common migrant in the region, with migration occurring mid-SE to mid-NO and late MR to mid-MY (Isleib and Kessel 1973). It winters in low numbers in protected bays at Kodiak Island (Zwiefelhofer and Forsell 1989) and in the hundreds to low thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995)

Common Merganser *Mergus merganser* (rare winter visitor): I saw one in Port Bainbridge, Blying Sound, on 3 DE 2000; it represented <0.1% of all birds (Table 1). In addition, I occasionally saw birds off transect near shore, especially in PWS. The species is a common resident of the region, especially in protected waters; migration occurs mid-SE to NO and late MR–early MY (Isleib and Kessel 1973). It winters in low numbers in protected bays of Kodiak Island (Zwiefelhofer and Forsell 1989) and in the several thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

Red-throated Loon *Gavia stellata* (rare winter visitor): I saw only eight total, representing 0.1% of all birds (Table 1). I saw a single bird in lower Resurrection Bay on 1 DE 1998 and saw scattered single birds and groups totaling seven, mostly migrating west in the inner and middle shelf, on 6–11 MY 1999. The species is an uncommon winter visitor and common migrant in the region, with wintering numbers varying greatly among years; migration occurs

early SE–early NO and mid-AP to late MY (Isleib and Kessel 1973). It is seen only as a fall migrant at Kodiak Island (Zwiefelhofer and Forsell 1989) and has not been recorded in Lower Cook Inlet in winter (Agler et al. 1995), but a few tens of birds occur in PWS during most (not all) late winters (Lance et al. 1999).

Pacific Loon *Gavia pacifica* (uncommon migrant): I saw 45 total during surveys, representing 0.3% of all birds: a flock of four migrating west ~14 km south of Cape Fairfield on 10 OC 1999; two single birds in southern PWS on 12 MR 2001; five single birds migrating west in Blying Sound in AP 1999 and 2000; and the remaining 34 birds, mostly migrating west, spread across the shelf in MY of every year (Table 1). In addition, I saw off transect six birds flying west in southern PWS on 12 MR 2001 and two near Knight Island (PWS) on 10 MY 1999. The species is a common winter visitor and common migrant in the region; migration occurs late SE–early NO and late AP through mid-MY (Isleib and Kessel 1973). It is an uncommon fall and spring migrant in protected bays at Kodiak Island (Zwiefelhofer and Forsell 1989) and the Gulf of Alaska in general (Gould et al. 1982) and occurs in the low tens or hundreds in PWS and Lower Cook Inlet in most winters (Agler et al. 1995, Lance et al. 1999).

Common Loon *Gavia immer* (rare winter visitor): I saw single birds ~18 km south of Cape Fairfield on 6 OC 2000 and east of Kayak Island on 5 DE 1999; they represented <0.1% of all birds (Table 1). The species is a common resident of the region, wintering in protected waters in low numbers; migration occurs early SE–early NO and mid-AP to mid-MY (Isleib and Kessel 1973). It winters regularly at Kodiak Island (Zwiefelhofer and Forsell 1989) and in the several hundreds in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1999).

Yellow-billed Loon *Gavia adamsii* (rare winter visitor, rare migrant): I saw four single birds, representing <0.1% of all birds seen during surveys: one in western PWS on 17 AP 1999,

one south of Montague Island on 13 MY 1998, and two south of the outflow of the Copper River on 23 MY 2000 (Table 1). In addition, I saw one off transect near Naked Island (PWS) on 5 DE 1998. The species is a fairly common winter visitor and a rare migrant, wintering in protected waters; migration occurs late SE to mid-NO and probably late MR–JL (Isleib and Kessel 1973). In the Gulf of Alaska, it is recorded primarily OC–MY (Gould et al. 1982). At Kodiak Island, it is a regular winter visitor and, with Common Loon, forms the bulk of the wintering loon population (Zwiefelhofer and Forsell 1989). Tens to low hundreds of birds winter in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

Laysan Albatross *Phoebastria immutabilis* (uncommon–fairly common winter visitor): I saw Laysan Albatrosses on 14 of the 16 cruises and in every month; they were most common in DE and least common in MR and AP (Fig. 5, Table 1). They represented 1.0% of all birds and constituted up to 3.4% of all birds on some cruises. They occurred only in the Gulf, especially the western Gulf. Although most occurred primarily at the shelf-break and in oceanic water of the Alaska Stream, they regularly occurred inshore as far as the outer part of the mid-shelf, and one even was seen in the ACC. The species is a rare visitor to oceanic waters of the Gulf of Alaska (Isleib and Kessel 1973, Kessel and Gibson 1978); although Gould et al. (1982) suggested that the species occurs only from MR to NO, our data suggest that the species is resident. It was not recorded in winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995) because those surveys all were conducted in protected waters.

Black-footed Albatross *Phoebastria nigripes* (uncommon–common winter visitor): I saw Black-footed Albatrosses on every cruise, although they were least common in DE and MR (Fig. 5, Table 1). They represented 1.9% of all birds (the ninth-most-abundant species), constituting

up to 5.7% of all birds on some cruises. They occurred only in the Gulf, especially the Western Gulf. Although most occurred at the shelf-break and in the Alaska Stream, they regularly occurred as far inshore as the outer part of the mid-shelf (especially during the warmer months), and several were seen inshore in the ACC. The species is a fairly common visitor, probably being less common (perhaps irregular) from OC to MY (Isleib and Kessel 1973, Gould et al. 1982). It was not recorded in winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995) because those surveys all were conducted in protected waters.

Short-tailed Albatross *Phoebastria albatrus* (rare winter visitor): I recorded two juveniles during surveys, one at 58°46'N 148°27'W on 2 DE 1998 and one at 58°35'N 148°14'W on 13 AP 1999 (both near the shelf-break); they represented <0.1% of all birds (Table 1). In addition, I saw off transect one adult while on station at 58°06'N 147°48'W (in the Alaska Stream) on 18 MY 2000. Essentially nothing was known about this highly endangered species in the region when Isleib and Kessel (1973) wrote their monograph; numbers are increasing, however, and recently exceeded 1,000 birds (Hasegawa 2001). It was not recorded in winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995) because those surveys all were conducted in protected waters.

Northern Fulmar *Fulmarus glacialis* (uncommon–abundant winter visitor, uncommon–abundant migrant?): I saw Northern Fulmars during every cruise (Table 1); they represented 18.5% of all birds seen during surveys (the second-most-abundant species) and constituted up to 43.7% of all birds on some cruises. They were most abundant in AP (Fig. 5), suggesting possible migration through the area. They occurred across the entire Gulf but not in PWS; they were most abundant at the shelf-break and were least common in the ACC. The

species is a common visitor and common migrant, occurring primarily in the Gulf and only occasionally entering PWS; no information is available on the timing of migration (Isleib and Kessel 1973, Lance et al. 1999), although higher densities occur during fall and spring, as I saw (Gould et al. 1982). It winters in offshore and oceanic waters at Kodiak Island (Forsell and Gould 1981) and even in Lower Cook Inlet (Agler et al. 1995).

Mottled Petrel *Pterodroma inexpectata* (rare–uncommon winter visitor): I recorded a total of 20 birds on 3 of the 16 cruises; they represented 0.1% of all birds (Table 1). I saw 12 at the shelf-break and in oceanic water (150–200 km offshore) on 6–7 OC 1999; one at the shelf-break (~150 km offshore) on 4 AP 1998; and a total of seven scattered from the mid-shelf to the Alaska Stream (70–200 km offshore) on 18–19 AP 2000. On the latter survey, single birds seen at 58°11'N 148°47'W and 58°11'N 148°48'W are the farthest inshore I have seen this oceanic species, which concentrates in the deep waters of the Alaska Gyre (Day 1992). The species is a casual to uncommon summer visitor to oceanic waters of the region (Isleib and Kessel 1973, Kessel and Gibson 1978) and previously has been recorded in winter only during OC (Gould et al 1982). It was not recorded in winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995) because those surveys all were conducted in protected waters.

Buller's Shearwater *Puffinus bulleri* (casual winter visitor): I recorded four on transect and two off transect, all in the middle shelf, in OC 1997; they represented <0.1% of all birds (Table 1). On 13 OC 1997 (during the large El Niño that year), I saw single birds at 58°47'N 148°30'W, 58°36'N 148°16'W, and 58°35'N 148°15'W; on 15 OC, I saw one at 59°35'N 148°53'W, plus I saw off transect one at 58°43'N 148°25'W and one at 59°27'N 148°52'W. The species is a rare summer visitor to oceanic waters of the Gulf of Alaska (Kessel and Gibson

1978, Isleib and Kessel 1989), occurring only from AP to OC (Gould et al 1982). In winter, it has not been recorded at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Sooty Shearwater *Puffinus griseus* (rare–common winter visitor): I saw Sooty Shearwaters regularly during the warmer months of OC and AP–MY; they were rarer in DE, and I never saw them in MR (Fig. 5, Table 1). They represented 10.7% of all birds (the fourth-most-abundant species) and constituted up to 36.2% of all birds on some cruises. They essentially occurred only in the Gulf, and I saw only one in PWS, on 3 DE 2000. They moved onto the shelf and into the ACC during the warmer months of OC and MY but occurred farther offshore in AP, suggesting an inshore–offshore seasonal movement. I also saw several flocks that appeared to have just finished feeding; one of these flocks (~125 birds) was seen in what appeared to be a cyclonic eddy southwest of Cape Cleare, Montague Island, in OC 1997. The species is an abundant summer visitor (Isleib and Kessel 1973) and is believed to be absent in winter (Gould et al. 1982). In winter, it occurs at Kodiak Island over oceanic waters (Forsell and Gould 1981), but it has not been recorded in PWS (Lance et al. 1999) or Lower Cook Inlet (Agler et al. 1995).

Short-tailed Shearwater *Puffinus tenuirostris* (rare–uncommon winter visitor): I saw Short-tailed Shearwaters during 12 of the 16 cruises and during all months, although they were common only during MY (Fig. 5, Table 1). They represented 1.6% of all birds (the tenth-most-abundant species) and constituted as much as 6.0.% of all birds on some cruises. They occurred only in the Gulf, usually in small groups associated with or near Sooty Shearwaters, and ranged from the ACC to the Alaska Stream, being most abundant at the shelf-break and in the Alaska Stream. The species is an uncommon summer visitor, occurring in low numbers during winter

(Isleib and Kessel 1973), but is greatly outnumbered by Sooty Shearwaters in the northeastern Gulf of Alaska (Gould et al. 1982). In winter, it occurs at Kodiak Island over oceanic waters (Forsell and Gould 1981), but it has not been recorded in PWS (Lance et al. 1999) or Lower Cook Inlet (Agler et al. 1995).

Little Shearwater *Puffinus assimilis* (accidental visitor): I recorded one bird at 59°24'N 149°03'W on 12 OC 1997, in the mid-shelf, during the El Niño of 1997 (Table 1). This very small shearwater was seen closely: the underwing was nearly completely white, with a narrow black border on the forward edge of the wing and white out into the undersides of the primaries; the axillaries also were white, as were the undertail-coverts; I believe that the dark cap extended below the eye (nominate *assimilis* from the southwestern Pacific has a white face to above the eye, whereas *elegans* from the southern Pacific near New Zealand has a dark cap extending down below the eye; Harrison 1985). These characters separate it from the Audubon's Shearwater, which is slightly larger, has more black on the underwing, and has black in the axillaries. The only other record of this species in Alaska is a sight record by Jeff B. Allen of a bird seen closely near Ugak Bay, Kodiak Island, on 26 AU 1996 (drawing and details at the University of Alaska Museum). He also noted that the underwing was almost all white with a narrow black border on the leading and trailing edges and a small black tip; the dark cap extended below the eye, also suggesting that this bird was not nominate *assimilis*. The only other record from western North America is a single bird photographed in Monterey County, CA, on 29 OC 1993 (San Miguel and McGrath 2005); that bird also had a dark cap extending below the eye, suggesting that it also was not *assimilis*. One final record in the North Pacific comes from the Leeward Hawaiian Islands, where Reginald E. David (in litt.) pulled a bird from a burrow on Midway Island in December 1991; this bird had the dark cap ending above the eye,

suggesting that it was *assimilis*.

Fork-tailed Storm-Petrel *Oceanodroma furcata* (rare–abundant winter visitor): I saw Fork-tailed Storm-Petrels on all cruises and in all months, although they were least abundant from DE to AP (Fig. 5, Table 1); they represented 16.3% of all birds (the third-most-abundant species) and constituted up to 43.9% of all birds on some cruises. They occurred in both the Gulf and PWS, nearly completely abandoned nearshore waters in DE and MR, suggesting an inshore–offshore seasonal movement, and occurred in highest densities in the mid-shelf and at the shelf-break front. The species is considered a rare or irregular winter visitor and abundant migrant, with the winter population in the entire region previously estimated at a few hundreds; migration occurs mid-SE to mid-NO and in spring allegedly occurs far offshore, with birds supposedly not seen inshore until MY (Isleib and Kessel 1973, Forsell and Gould 1981, Gould et al. 1982), in contrast to our observations. In PWS, the winter population size fluctuates wildly among years, between 0 and >10,000 birds (Lance et al. 1999).

Perhaps the most interesting record was of an enormous feeding flock of this species in the mid-shelf part of the Seward Line in MY 2000. This feeding flock was concentrated in an area ~18 km north–south and ≥ 9 km east–west, for a minimal area of ~162 km²; I suspected that the flock was even larger than this. Associated with this enormous feeding flock were large numbers of Red and Red-necked phalaropes, the only Leach's Storm-Petrels recorded during any winter survey, and Humpback Whales (*Megaptera novaeangliae*). At an estimated average density of ~146 birds/km² in this area, this feeding flock probably contained >25,000 feeding Fork-tailed Storm-Petrels, plus large numbers of Red Phalaropes and small numbers of Leach's Storm-Petrels and Red-necked Phalaropes.

Leach's Storm-Petrel *Oceanodroma leucorhoa* (casual, possibly annual, winter visitor): I

recorded a total of 17, all in MY 2000; they represented 0.1% of all birds (Table 1). I saw one bird ~65 km offshore on 19 MY 2000 and saw the other 16 feeding in the mid-shelf with Fork-tailed Storm-Petrels and phalaropes on 18 MY 2000 (see above). The species is a probable uncommon summer visitor in oceanic waters of the region (Isleib and Kessel 1973) and is recorded only from MY to OC (Gould et al. 1982). At Kodiak Island, it has been recorded twice in winter, with both records occurring in FE and in shelf-break/oceanic waters (Forsell and Gould 1981). The species has not been recorded in winter in PWS (Lance et al. 1999) or Lower Cook Inlet (Agler et al. 1995).

Double-crested Cormorant *Phalacrocorax auritus* (rare winter visitor, rare–abundant migrant): I recorded a total of 169 birds, although 4 of the 5 records were represented by single birds; they represented 1.1% of all birds and constituted up to 15.9% of all birds on some cruises (Table 1). I saw single birds in Blying Sound on 6 OC 2000, at the mouth of Resurrection Bay on 8 OC 2000, and in the ACC in Knight Island Passage (PWS) on 5 MR 2001 and 25 MY 2000. The largest group, a flock of 165 birds, was seen migrating to the east at 58°50'N 148°32'W (~120 km offshore, just inshore of the shelf-break) on 8 OC 2000. The species is a resident, being an uncommon winter visitor (highly variable in numbers) and a common migrant; migration occurs AU–NO and late MR–MY (Isleib and Kessel 1973). Gould et al. (1982) suggest that there is a pronounced coastal migration of this species in the Gulf, in contrast to what I saw. It winters in low numbers in protected bays at Kodiak Island (Zwiefelhofer and Forsell 1989), in the several hundreds to low thousands in PWS (Lance et al. 1999), and as a few birds in Lower Cook Inlet (Agler et al. 1995).

Red-faced Cormorant *Phalacrocorax urile* (rare migrant): I recorded a total of 14 over 4 cruises during the warmer months; only one was seen in the fall (lower Resurrection Bay, 10 OC

2000), and the rest were seen in AP–MY (Table 1). They represented 0.1% of all birds. In addition, I saw two off transect in Bainbridge Passage (PWS) on 18 AP 1999 and saw one ~9 km offshore on 9 MY 1999. All birds except one were in the ACC, with a single bird occurring in mid-shelf water, and they were most common in AP and less common in MY. The species is an uncommon resident, with evidence that the population expanded dramatically in the 1960s (Isleib and Kessel 1973). First recorded in the region in 1959, it was the most common breeding cormorant in the Gulf by 1976 (Kessel and Gibson 1978), but it clearly is greatly outnumbered by Pelagic Cormorants in recent years (Day, unpubl. data), suggesting a major decline since then. In winter, it is seen at Kodiak Island (Zwiefelhofer and Forsell 1989), in the low tens in PWS during some years (Lance et al. 1999), and in a few tens in Lower Cook Inlet (Agler et al. 1995).

Pelagic Cormorant *Phalacrocorax pelagicus* (rare–uncommon winter visitor): I recorded a total of 51 during 11 cruises and all months; although they were recorded in low numbers at all times, they were rare but consistent in occurrence, representing 0.3% of all birds (Table 1). In addition, I saw birds off transect DE–AP, in both the Gulf and PWS. They were least common in DE and most common in AP and were most common in the Gulf and rare in PWS. Most occurred in the ACC, but a few strayed into the inner part of the mid-shelf; I also saw one bird ~160 km offshore, at the shelf-break, on 2 DE 1998. The species is an abundant resident in inshore waters; migration occurs SE–OC and primarily in AP, with the movement consisting of population shifts between wintering and nearby breeding areas (Isleib and Kessel 1973) it primarily is coastal but occasionally is seen in oceanic waters (Gould et al. 1982). It winters at Kodiak Island (Zwiefelhofer and Forsell 1989) and in several thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

Red-necked Phalarope *Phalaropus lobatus* (probably rare migrant): I recorded 60 in MY 2000, the only cruise on which I saw this species; they represented 0.4% of all birds (Table 1). They occurred in both the ACC (most common) and mid-shelf water, only in the Gulf. Many were seen feeding in surface "slicks" or wrack lines indicative of surface convergences and divergences. The species is an abundant migrant from late JL to late OC and from early MY to early JN (Isleib and Kessel 1973); it is a primarily coastal migrant and, like the Red Phalarope, appears to be less common in fall than in spring (Gould et al. 1982). There are two winter records at Kodiak Island, both in NO (Forsell and Gould 1981), whereas it has not been recorded in PWS (Lance et al. 1999) or Lower Cook Inlet (Agler et al. 1995) in winter.

Red Phalarope *Phalaropus fulicarius* (rare–common migrant): I saw Red Phalaropes only during migration, recording one in OC and many in MY, although not annually (Fig. 5, Table 1). They represented 3.1% of all birds (the eighth-most-abundant species), even though they really occurred only during MY, and constituted up to 11.4% of all birds seen on some cruises. They occurred from the ACC to the Alaska Stream but were most common in the mid-shelf. The species is an abundant migrant from late AU to late OC (it is more oceanic at this time) and mid-MY to mid-JN (Isleib and Kessel 1973, Gould et al. 1982). The species does not winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Pomarine Jaeger *Stercorarius pomarinus* (rare migrant): I recorded a total of 52, seeing them every OC, once in AP, and in two of three MY cruises; they represented 0.3% of all birds (Table 1). They were equally common in OC and MY; an early migrant was seen at 58°17'N 147°58'W, over oceanic water of the Alaska Stream, on 19 AP 2000; otherwise, all birds occurred over the mid-shelf and, less commonly, over the ACC. In addition, I saw one off

transect near Cape Fairfield on 11 MY 1999. They occurred primarily in the Gulf and were rare in PWS. The species is a fairly common migrant from late JL to mid-NO and mid-AP to mid-JN (Isleib and Kessel 1973, Gould et al 1982); this is the most abundant jaeger migrating in the Gulf of Alaska (Gould et al. 1982). The species does not winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Parasitic Jaeger *Stercorarius parasiticus* (rare migrant): I saw only six total; they represented <0.1% of all birds (Table 1). I saw them every fall but saw only one in the spring (a single bird ~35 km south of Cape Fairfield on 20 MY 2000). They occurred only in the Gulf and only in mid-shelf water; in addition, I saw one off transect south of Montague Island on 17 AP 1999. The species is a common fall migrant and uncommon spring migrant from late JL to mid-NO and from late AP to mid-MY (Isleib and Kessel 1973, Gould et al. 1982). The species does not winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Long-tailed Jaeger *Stercorarius longicaudus* (rare migrant): I saw only 12 total, all during MY (1 in 1999 and 11 in 2000); they represented 0.1% of all birds (Table 1). All occurred in the Gulf, and most were migrating west. Four occurred in the ACC, and eight occurred in mid-shelf water, up to ~55 km offshore. The species is a rare migrant from late JL to mid-SE (with one very late record in DE) and during MY (Isleib and Kessel 1973). The species does not winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Black-headed Gull *Larus ridibundus* (casual visitor): I saw one off transect, a Basic-plumaged bird visiting the ship on station at 59°25'N 149°04'W on 3 MR 2001. Observed closely, it was substantially larger than a Bonaparte's Gull and had dark underwing-coverts near

the primaries. The species must be considered casual in this region because the only other record in the Gulf is of one bird in late summer–fall 1977 (Isleib and Kessel 1989).

Bonaparte's Gull *Larus philadelphia* (rare migrant): I recorded only ten total, five each in OC 2000 and MY 2000; they represented 0.1% of all birds (Table 1). They occurred in both PWS and the western Gulf and primarily in the ACC, with a few seen in mid-shelf water to ~45 km offshore. The species is a common migrant from late JL through mid-NO and from late AP to mid-MY (Isleib and Kessel 1973, Forsell and Gould 1981); it apparently is a coastal migrant in the Gulf, for it rarely is seen offshore (Gould et al. 1982). It is an uncommon migrant at Kodiak Island (Forsell and Gould 1981) and has been seen in PWS in one winter (Lance et al. 1999) but has not been recorded wintering in Lower Cook Inlet (Agler et al. 1995).

Mew Gull *Larus canus* (rare–uncommon winter visitor): I recorded only 79 total, representing 0.5% of all birds (Table 1). They occurred every month but were considerably more common OC–MR, becoming much rarer in AP and MY, presumably as they moved to coastal and inland sites to breed. They were highly coastal, with all records except three in ACC water; two records occurred in the mid-shelf, and one (a single bird on 13 OC 1997) occurred ~150 km offshore, at the shelf-break. I also saw them regularly off transect in nearshore waters and protected bays throughout the region, in both the Gulf and PWS. The species is an abundant resident, being common in winter (allegedly in both protected and offshore waters); migration occurs AU–NO and mid-MR to MY (Isleib and Kessel 1973). It actually appears to be more common in the Gulf in winter (Gould et al. 1982), when it is common at Kodiak Island (Zwiefelhofer and Forsell 1989), occurs in thousands to tens of thousands in PWS (Lance et al. 1999), and in thousands in Lower Cook Inlet (Agler et al. (1995).

Herring Gull *Larus argentatus* (rare–uncommon winter visitor): I recorded a total of 114

on 13 of 16 cruises; they represented 0.7% of all birds (Table 1). Although I saw them every month, they were most common in OC and DE and least common in MR and AP, increasing in abundance again in MY. They were widespread, occurring in both the Gulf and PWS. They also occurred in decreasing abundance from the ACC and the mid-shelf (most common) to the shelf-break (three birds) and oceanic water (two birds; to ~220 km offshore). In addition, I saw birds off transect from OC to MY and in both the Gulf and PWS. The species is a fairly common winter visitor and a common migrant from mid-SE to mid-OC and from mid-AP to early MY (Isleib and Kessel 1973), in the Gulf, it actually is more common in winter than in summer (Gould et al. 1982), when birds move inland to breed. In winter, it is regular but rare at Kodiak Island (Forsell and Gould 1981) and occurs in highly variable numbers in PWS (Lance et al. 1999) and in the low hundreds in Lower Cook Inlet (Agler et al. 1995).

Thayer's Gull *Larus thayeri* (casual winter visitor): I recorded only two during surveys, single birds in Knight Island Passage (PWS) on 4 DE 2000; they represented <0.1% of all birds (Table 1). In addition, I saw four off transect in Harriman Fjord (PWS) on 5 DE 2000. The species is a resident, actually being most common from OC through AP (Isleib and Kessel 1973); however, Gould et al. (1982) recorded it only three times, and it has not been recorded in winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995), so it either is much rarer than Isleib and Kessel (1973) suggested or has declined in abundance dramatically in recent years.

Glaucous-winged Gull *Larus glaucescens* (common winter visitor): I recorded Glaucous-winged Gulls during every cruise, although they were most common in OC, AP, and MY (Fig.6, Table 1). They represented 3.6% of all birds (the seventh-most-abundant species), constituting as much as 10.2% of all birds on some cruises. They occurred from the ACC to the

Alaska Stream and in both the Gulf and PWS; in the Gulf, they were primarily a neritic species, being most abundant in the ACC. The species is an abundant resident, wintering in substantial numbers; migration occurs mid-SE to mid-OC and mid-AP to mid-MY (Isleib and Kessel 1973). It winters at Kodiak Island in moderate numbers (Zwiefelhofer and Forsell 1989), in PWS in the low tens of thousands (Lance et al. 1999), and in Lower Cook Inlet in the low thousands (Agler et al. (1995).

Glaucous Gull *Larus hyperboreus* (rare winter visitor): I recorded a total of six, representing <0.1% of all birds; I saw one in OC, one in AP, and four in MY, all in 2000 (Table 1). In addition, I saw off transect one juvenile at Macleod Harbor (PWS) on 5 MR 2001; several subadults around PWS on 10 MY 1999; single birds in the mid-shelf and shelf-break on 8 MY 1999; and three birds ~35 km south of Cape Fairfield on 11 MY 1999. They occurred in the Gulf and PWS and in ACC and mid-shelf water. The species is an uncommon resident, occurring as scattered individuals (Isleib and Kessel 1973, Gould et al. 1982). It is an uncommon wintering visitor to protected bays of Kodiak Island (Forsell and Gould 1981), is very rare in winter in PWS (Day, unpubl. data), but has not been recorded wintering in Lower Cook Inlet (Agler et al. 1995).

Sabine's Gull *Xema sabini* (rare migrant; timing probably incorrect for determining true abundance): I recorded a total of 12 during surveys, all in the period 22–25 MY 2000; I suspect that the other MY cruises occurred too early to detect these migrants, which represented 0.1% of all birds (Table 1). I recorded them south of Montague Island, south of Hinchinbrook Entrance, and west of Kayak Island, in both ACC and mid-shelf water. Although all of these birds were in Alternate plumage, the lateness of the records suggests either that they were not going to breed that year or that they were destined for remote locations where they could arrive late and still

breed (e.g., Taimyr Peninsula of Russia; Day et al. 2001). The species is an uncommon fall migrant and rare spring migrant from mid-JL to early NO and from early MR–early JN (Isleib and Kessel 1973, Gould et al. 1982). The species has not been recorded in winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Black-legged Kittiwake *Rissa tridactyla* (uncommon–common winter visitor): I recorded Black-legged Kittiwakes during every cruise; they were most common in MR and AP, when they returned prior to breeding (Fig. 6, Table 1). They represented 7.0% of all birds (the fifth-most-abundant species) and constituted up to 18.5% of all birds on some cruises. They occurred primarily on the shelf, although they were less common inshore in DE and MR, suggesting movement offshore during the colder months; they had moved inshore by MY, however. The species is an uncommon winter visitor and abundant migrant, from mid-AU to NO and from mid-MR to early MY (Isleib and Kessel 1973); it moves offshore in winter (Gould et al. 1982). It is common in fall but rare in winter at Kodiak Island (Zwiefelhofer and Forsell 1989). In PWS, hundreds to >10,000 birds occur in late winter (Lance et al. 1999), whereas the species is absent until sometime in early MR (Day, unpubl. data); the species does not winter in Lower Cook Inlet (Agler et al. 1995).

Arctic Tern *Sterna paradisaea* (rare migrant): I recorded a total of 81, all in MY and all presumably arriving from wintering grounds; they represented 0.5% of all birds (Table 1). All but one were seen in the Gulf, and many were migrating to the west, although some were migrating to the east or northeast. They occurred primarily in mid-shelf water and occasionally in the ACC; three were seen in oceanic water, up to ~220 km offshore, on 7 MY 1999. The species is an abundant migrant from late JL to mid-OC and late AP to mid-MY (Isleib and

Kessel 1973, Gould et al. 1982). The species does not winter at Kodiak Island (Zwiefelhofer and Forsell 1989), in PWS (Lance et al. 1999), or in Lower Cook Inlet (Agler et al. 1995).

Common Murre *Uria aalge* (abundant winter visitor): I saw Common Murres during every cruise, although they were most abundant in MR and AP (Fig. 6, Table 1); they represented 21.3% of all birds (the most-abundant species), constituting as much as 45.4% of all birds on some cruises. They occurred in both the Gulf and PWS but were rare in PWS in OC and DE, suggesting an inshore seasonal movement. They occurred primarily on the shelf, especially in the mid-shelf, being rare at the shelf-break or in the Alaska Stream. Hence, they appear to winter entirely in this area, and almost entirely on the shelf. There does appear to be a seasonal movement, however, as indicated by the coastward movement in MY, prior to breeding; many of the murres were flying inshore as early as MR. Most of the birds seen in OC appeared to be unwilling or unable to fly, suggesting that they were flightless at that time. The species is an abundant resident and wintering bird, with possibly hundreds of thousands wintering; migration in fall is not described and in spring occurs at least in AP (Isleib and Kessel 1973). It winters in protected bays at Kodiak Island, also increasing in numbers throughout the winter (Zwiefelhofer and Forsell 1989). Gould et al. (1982) suggested that Common Murres in the Gulf prefer shelf waters in winter, which I also saw. In PWS, tens to hundreds of thousands winter during most years (Lance et al. 1999), and approximately 25,000 birds winter in Lower Cook Inlet (Agler et al. (1995).

Thick-billed Murre *Uria lomvia* (rare winter visitor): I recorded a total of 15 birds, representing 0.1% of all birds (Table 1). Records ranged between DE and MY, with most occurring in MR and AP. They occurred only in the Gulf, where they ranged widely, from the ACC to the shelf-break (one bird) and oceanic water ~165 km offshore (three birds); however,

they were most common in the mid-shelf. They occurred sporadically among the large numbers of Common Murres. The species is a rare resident (Isleib and Kessel 1973). Although Gould et al. (1982) suggested that the Thick-billed Murre wintering in the Gulf of Alaska prefer deeper waters than the Common Murre, I saw no evidence for this claim. The species winters in protected bays of Kodiak Island in low numbers (Zwiefelhofer and Forsell 1989), is absent from PWS during nearly all winters (Lance et al. 1999), and occurs in a few tens of birds in Lower Cook Inlet (Agler et al. 1995).

Pigeon Guillemot *Cepphus columba* (probably rare migrant, probably very rare winter visitor): I recorded a total of six during surveys, all in MR and MY 1998; they represented <0.1% of all birds (Table 1). In addition, I saw off transect one in Harriman Fjord (PWS) on 5 DE 2000 and 15 in Icy Bay (PWS) on 18 AP 1999, suggesting that the species is resident in protected bays in low numbers. They occurred in both the Gulf and PWS, although all occurred in ACC water. The species is a resident in protected waters, although few data on wintering numbers are available (Isleib and Kessel 1973, Gould et al. 1982). It winters in protected waters at Kodiak Island in low–moderate numbers (Zwiefelhofer and Forsell 1989) and in low thousands in PWS (Lance et al. 1999) and Lower Cook Inlet (Agler et al. 1995).

Marbled Murrelet *Brachyramphus marmoratus* (rare winter visitor, rare migrant): I saw Marbled Murrelets during 12 of the 16 cruises and in all months; they were more common in spring than in fall (Fig. 6, Table 1). They represented 1.3% of all birds, constituting as much as 6.1% of all birds on some cruises. They occurred in both PWS and the Gulf, where they occurred primarily in the ACC and mid-shelf. In addition, I saw off transect two at Naked Island (PWS) on 5 DE 1998 and 15–20 in Harriman Fjord (PWS) on 5 DE 2000. The species is rare in the Gulf of Alaska in winter (Isleib and Kessel 1973, Gould et al. 1982). It winters in moderate

numbers at Kodiak Island and actually is more common in winter than in fall (Zwiefelhofer and Forsell 1989); it is very rare in PWS in winter (Day, unpubl. data), although several thousand allegedly occur there in MR (Lance et al. 1999). Several thousand also winter in Lower Cook Inlet (Agler et al. 1995).

Kittlitz's Murrelet *Brachyramphus brevirostris* (rare–uncommon winter visitor): I saw Kittlitz's Murrelets during 15 of the 16 cruises and in all months; they were most abundant in MR and AP (Fig. 6, Table 1). They represented 1.4% of all birds, constituting as much as 7.0% of all birds on some cruises. They occurred in both PWS and the Gulf, being more common in the Gulf. In the latter location, they occurred primarily in the ACC and mid-shelf; I saw one bird at the shelf-break front, ~180 km offshore, on 9 MR 1998, but saw none in the Alaska Stream. In addition, I saw off transect three Basic-plumaged birds flying east just south of Montague Island on 16 OC 1997; 12–15 at Naked Island (PWS) on 5 DE 1998; two off the dock in Seward on 2 MR 2001; one south of Montague Island on 14 MR 1998; and four (two obvious pairs) near the ice edge in Icy Bay (PWS) on 18 AP 1999. I did not, however, see any in Harriman Fjord (PWS) on 5 DE 2000. Interestingly, the mean temperature recorded for this species in winter (6.2°C overall) was essentially identical to the mean temperature in which this species occurs in PWS in summer (6.1°C overall; Day et al. 1999, 2003). The species is a common resident, wintering in both protected and exposed waters (Isleib and Kessel 1973, Gould et al. 1982). It winters in very low numbers at Kodiak Island (Zwiefelhofer and Forsell 1989) and in PWS (Lance et al. 1999) but has not been recorded in Lower Cook Inlet (Agler et al. 1995).

Ancient Murrelet *Synthliboramphus antiquus* (rare migrant): I recorded 52 during surveys, 3 in OC 1997 and the remainder spread across the three MY cruises; they represented 0.3% of all birds (Table 1). All records were from the Gulf, primarily in mid-shelf water and

secondarily in the ACC; one bird was seen ~140 km offshore, just inshore of the shelf-break. Many of the MY records were from near the Kenai Peninsula, suggesting breeding in this area. The species was considered by Isleib and Kessel (1973) to be an uncommon resident, although there were no records in the deep winter; it is recorded as late as mid-NO and as early as late FE (Forsell and Gould 1981, Gould et al. 1982). The species is absent from PWS in winter during most years but was recorded there once (Lance et al. 1999); it has not been recorded wintering in Lower Cook Inlet (Agler et al. 1995).

Cassin's Auklet *Ptychoramphus aleuticus* (rare winter visitor, rare migrant): I recorded 42 during surveys, represented 0.3% of all birds (Table 1). They occurred on 11 of 16 cruises and in all months, being least common in DE and MR and most common in MY. They occurred only in the Gulf, from the ACC to oceanic water in the Alaska Stream, and were most common from the outer part of the mid-shelf to oceanic water; I saw them up to ~220 km offshore. They appear to exhibit an inshore–offshore seasonal pattern of movement, moving off the shelf in fall (although the one DE record was inshore) and back onto the shelf in spring. The species was considered by Isleib and Kessel (1973) to be a casual visitor but was suspected to be more common than known at that time. In the Gulf of Alaska, it is recorded as late as NO and as early as late FE (Gould et al. 1982). There is one wintering record from Kodiak Island, a single bird in late NO (Forsell and Gould 1981). The species is absent from PWS during most years but has been recorded there once (Lance et al. 1999); it has not been recorded wintering in Lower Cook Inlet (Agler et al. 1995).

Parakeet Auklet *Aethia psittacula* (rare migrant): I recorded only 17 during surveys, in OC, MR, and MY; they represented 0.1% of all birds (Table 1). They occurred only in the Gulf but ranged from the ACC to oceanic water in the Alaska Stream. They were least common in the

ACC and were equally common from the mid-shelf to the Alaska Stream, where they occurred to ~185 km offshore. They appear to exhibit an inshore–offshore seasonal pattern of movement, with birds seen farther offshore in OC, the species absent in DE, and then bird moving back inshore in spring. The species is an uncommon breeder in the northern Gulf, but there are no other winter records in recent years (Isleib and Kessel 1973, Forsell and Gould 1981, Gould et al. 1982, Zwiefelhofer and Forsell 1989, Lance et al. 1999, Agler et al. 1995).

Crested Auklet *Aethia cristatella* (rare winter visitor): I recorded a total of six during surveys: single birds at 58°54'N 148°03'W and 58°56'N 148°07'W on 3 DE 1998 (both near the shelf-break), one at 59°24'N 149°05'W (~55 km offshore) on 5 DE 1999, one at 58°55'N 148°35'W (near the shelf-break) on 7 MR 2001, and two at 58°52'N 148°30'W (near the shelf-break) on 9 MR 2001. They represented <0.1% of all birds seen during surveys (Table 1). Off transect, I saw one at 59°51'N 149°28'W (~15 km offshore) on 30 NO 1999 and saw one off the dock at Seward on 30 NO 1998. This latter bird was seen closely; the crest was partially regrown, but the bill still was dark gray, with no sign of new growth of the orange bill plates; the white ocular stripe was still small and short. In contrast to our data that suggest that the species is annual in the northern Gulf, this species previously has been considered a casual winter visitor to the region (Isleib and Kessel 1973, Gould et al. 1982). It regularly winters as far east as the Kodiak Archipelago, occasionally occurring in large flocks (Forsell and Gould 1981, Zwiefelhofer and Forsell 1989); however, it has not been recorded wintering recently in PWS (Lance et al. 1999) or in Lower Cook Inlet (Agler et al. 1995).

Rhinoceros Auklet *Cerorhinca monocerata* (rare migrant): I recorded 22 during surveys, representing 0.1% of all birds (Table 1). They were rare in OC, absent in DE and MR, and most common in AP and MY. They were most common in the mid-shelf and less common in the

ACC and the Alaska Stream; I saw them up to ~200 km offshore. They also appeared to undergo an inshore–offshore seasonal movement; in spring, they were common near the Kenai Peninsula, where they nest. The species breeds at scattered locations along the Gulf coast (Isleib and Kessel 1973), and is recorded from early MR to early NO (Gould et al. 1982). It has been recorded wintering at Kodiak Island only twice, in NO and FE (Forsell and Gould 1981), and has not been recorded wintering in PWS (Lance et al. 1999) or Lower Cook Inlet (Agler et al. 1995).

Horned Puffin *Fratercula corniculata* (rare winter visitor, uncommon migrant): I recorded 59 during surveys, representing 0.4% of all birds (Table 1). I saw four in OC (1997), three in DE (2000), and the rest in MY (2000). They occurred only in the Gulf, where they ranged from the ACC to the Alaska Stream; I saw them up to ~210 km offshore. They also appeared to exhibit an inshore–offshore seasonal movement, leaving the shelf in the deep winter. There was a noticeable inshore movement in MY 2000, with birds even seen copulating on the water, in preparation for breeding; because this was the latest MY survey, I suspect that this inshore migration from the deep North Pacific, begins at that time. The species becomes oceanic in winter, with very few records in the northern Gulf (Isleib and Kessel 1973, Gould et al. 1982); it is recorded in protected bays of Kodiak Island as late as NO (Forsell and Gould 1981). The species has been recorded wintering in PWS in low numbers once (Lance et al. 1999) but has not been recorded wintering in Lower Cook Inlet (Agler et al. 1995).

Tufted Puffin *Fratercula cirrhata* (rare winter visitor, rare–abundant migrant): I recorded Tufted Puffins during 11 of 16 cruises and in all months, although they were abundant only in MY (Fig. 6, Table 1). They represented 3.9% of all birds seen during surveys (the sixth-most-abundant species), even though they were not present all winter; they constituted up to 15.3% of all birds on a cruise. All records except one were in the Gulf. They exhibited a

seasonal inshore–offshore movement, moving into the deep North Pacific to winter and back onto the shelf in the spring. The species is considered a resident of the region, being rare in winter; like the Horned Puffin, it disperses into oceanic waters during the winter, leaving the northern Gulf (Isleib and Kessel 1973, Gould et al. 1982). Early spring migrants have been recorded at Kodiak Island as early as FE, however (Forsell and Gould 1981). The species has been recorded wintering in PWS once (Lance et al. 1999) but has not been recorded wintering in Lower Cook Inlet (Agler et al. 1995).

DISCUSSION

The avian fauna was dominated by tubenoses, which collectively represented 50% of all marine-oriented birds seen. Alcids and larids brought the total percent to 92% overall, indicating that only three species-groups dominate this fauna. Dominance also was high, in that five species each represented $\geq 5\%$ of the total avifauna (Common Murre, Northern Fulmar, Fork-tailed Storm-Petrel, Sooty Shearwater, and Black-legged Kittiwake) and collectively represented nearly 74% of all birds seen on all cruises. Another 9 species each represented 1.0–4.9% and collectively represented 19% of the total avifauna, and the remaining 44 species could be considered trace elements and collectively represented 7% of the wintering avifauna.

Species-richness

For all transects combined, species-richness varied between 10 and 37 species/cruise, with an overall mean of 20.9 species/cruise. Richness exhibited a strong seasonal pattern, decreasing from October to March, then rapidly increasing again to May, when wintering species are still present, breeding species are arriving, and migrant species are crossing the region. Both of the months with the fewest number of species are dominated numerically by just a few

species, indicating that only a few are able to thrive at this high a latitude during the coldest months of the year. The avifauna during both months is dominated numerically by Northern Fulmars, Black-legged Kittiwakes, and Common Murres, with Laysan and Black-footed Albatrosses, Glaucous-winged Gulls, and Kittlitz's Murrelets forming a small but regular part of the avifauna.

Species accounts

A diverse community of seabirds occurs in the northern Gulf of Alaska in winter, from October to May. I recorded 58 species during transect sampling and saw another species off transect. Of these, most (44 of the 58 species seen on transect) occurred in trace amounts. These rare species fell into several categories. Some winter in the Gulf, and sometimes in numbers, but only within protected bays; the seaducks are prominent members of this group. Some winter in the Gulf in substantial numbers but are so coastal that I rarely saw them during our open-ocean oceanographic sampling; cormorants fall into this group. Some winter elsewhere and only pass through the northern Gulf in fall and/or spring; numerous species, such as Red-necked Phalarope and Sabine's Gull, fall into this category, which probably is the largest component of these rare species. Some winter in the Gulf but generally are rare everywhere; the Yellow-billed Loon falls into this group. Finally, a few species are accidental to casual, and few or no further records are predicted; Little Shearwater and Black-headed Gull fall into this group.

The other 14 species form the core of the wintering avifauna, forming 93% of all wintering birds. Most occurred all winter, although some (e.g., Sooty Shearwater, Red Phalarope, Tufted and Horned puffins) are absent during one or more of the seasons. Several other species were present all winter but clearly were more abundant during some seasons (usually May, April, and/or October). For example, species such as Tufted Puffins move off the

shelf to winter in the deep North Pacific, returning to the shelf again only in April and May; Black-legged Kittiwakes also mostly leave the northern Gulf to winter farther out at sea and down the West Coast of the US, although they return in numbers in March, earlier than the puffins; consequently, they were detected continuously during these surveys and appeared to be present all winter. Only a few species were present in numbers during most or all of the winter: Common Murres, Northern Fulmars, and Glaucous-winged Gulls.

This work suggests that the shelf of the northern Gulf of Alaska is an important wintering area for Kittlitz's Murrelets, which has not been known previously (Day et al. 1999). These birds clearly wintered in numbers over the open shelf of the Gulf and secondarily in Prince William Sound. Given the substantial area of continental shelf in the study area and the mean densities I recorded in this study, it is possible that several thousand winter here.

I recorded two very rare species in this study (Buller's and Little shearwaters), the latter of which was the second sight record for the state. The fact that both species occurred during the strong El Niño of 1997 suggests a northward movement with the very warm water found in the Gulf of Alaska that fall. In addition, a sea turtle was recorded at Montague Island that fall, suggesting that seabirds were not the only species moving north with the El Niño.

There was a surprising absence or rarity of records of some species. For example, I did not record Aleutian Terns (*Sterna aleutica*), which are not coastal migrants but instead come inshore from the deep ocean (D. D. Gibson, University of Alaska Museum, pers. comm.). I also saw surprisingly few migrating Arctic Terns. As indicated earlier, the few records of Sabine's Gulls probably resulted from incorrect timing of the sampling, rather than from low numbers migrating through the area.

ACKNOWLEDGMENTS

I thank the *Exxon Valdez* Oil Spill Trustee Council for funding this project; I especially thank Stan Senner of the Trustee Council and Bruce Wright of NOAA. The crew of the R/V *Alpha Helix*, especially Capt. William Rook, were greatly helpful. The ship time was provided by the National Science Foundation to the Institute of Marine Sciences, University of Alaska, Fairbanks. Tom Weingartner of IMS provided the original stimulus for RHD to conduct this research and was a great companion and friend at sea; this project could not have been done without his incredible support, interest, and enthusiasm. Other colleagues who helped make this research successful include Ken Coyle, Dean Stockwell, and Seth Danielson, all from IMS, and Tom Royer of Old Dominion University, Norfolk, VA. At ABR, Randy Mullen collected data on one of the cruises, Robert Ritchie provided travel funds and salary for some of the data collection, Adrian Gall helped with figures, and Allison Zusi-Cobb generated the maps.

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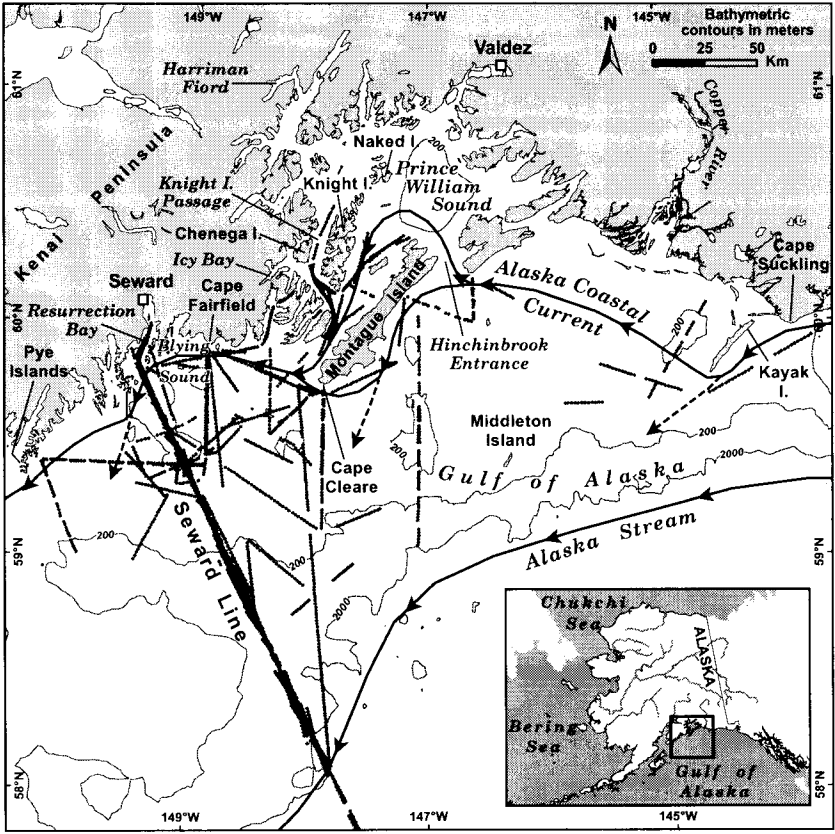


Figure 1

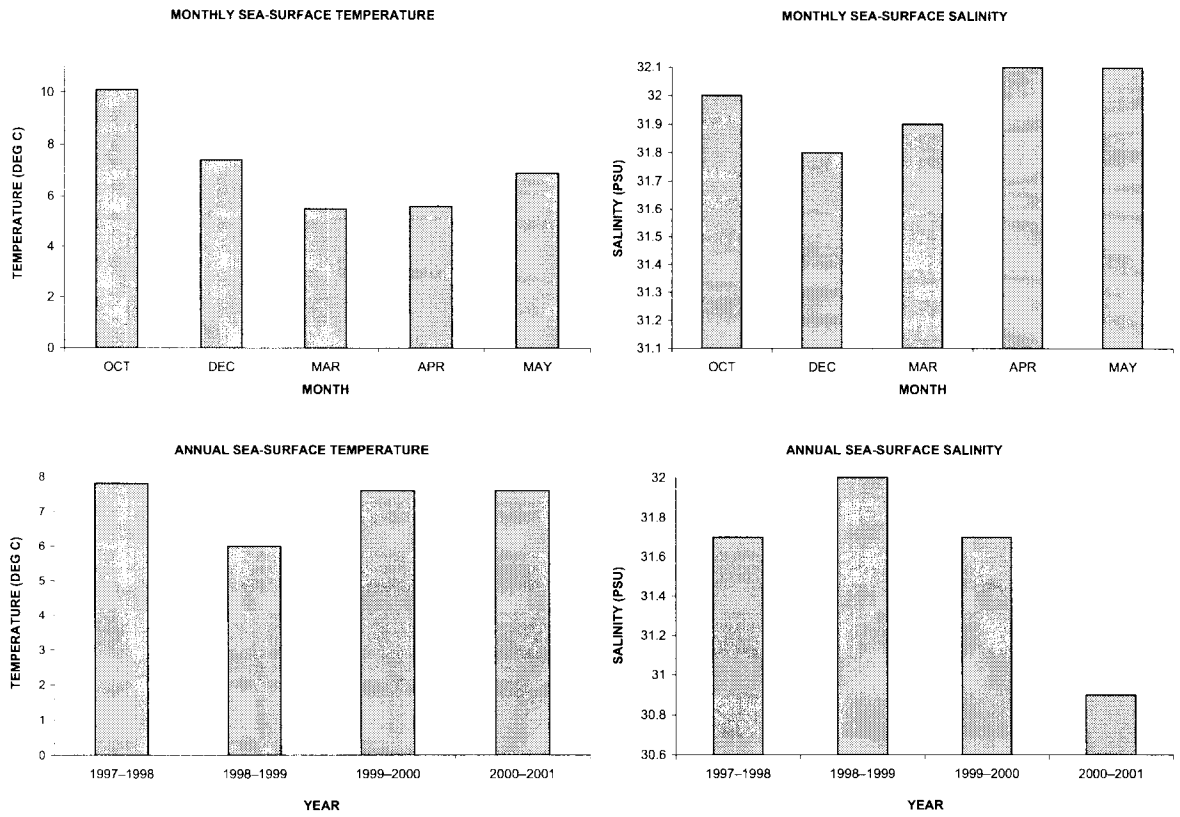


Figure 2

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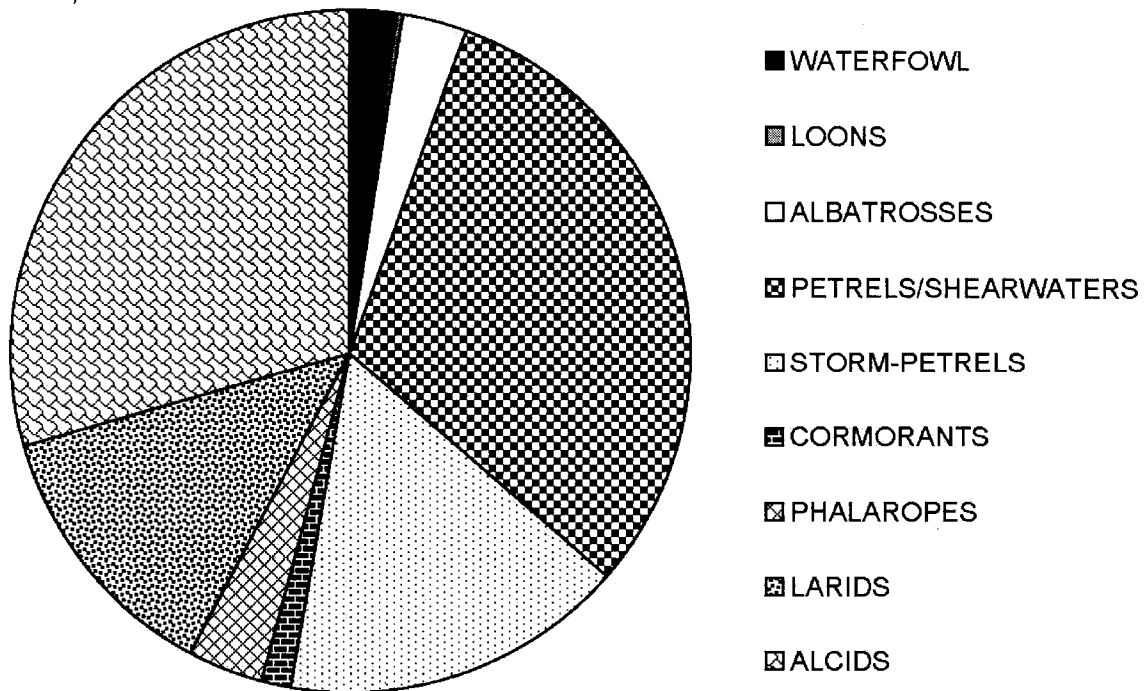


Figure 3

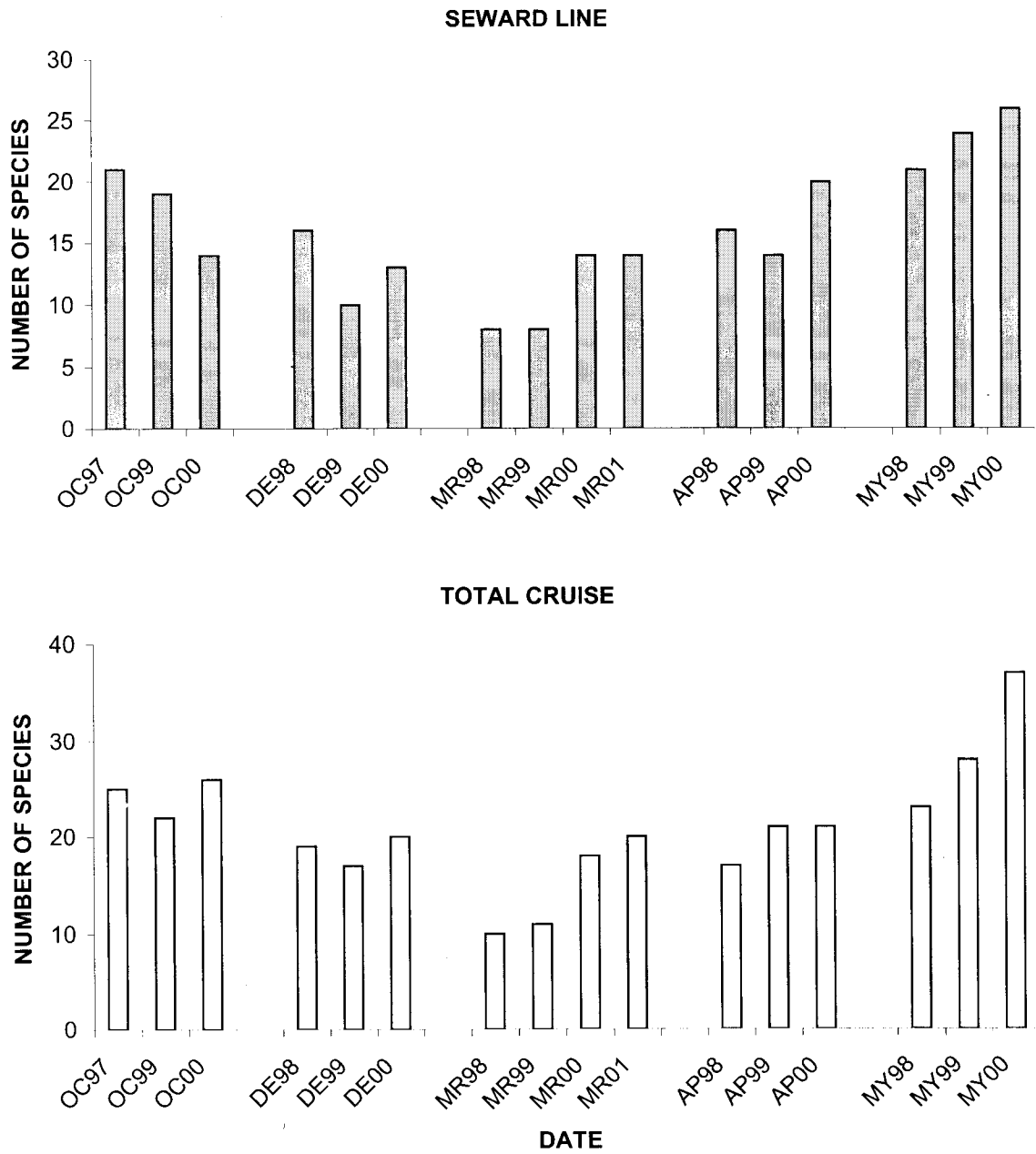


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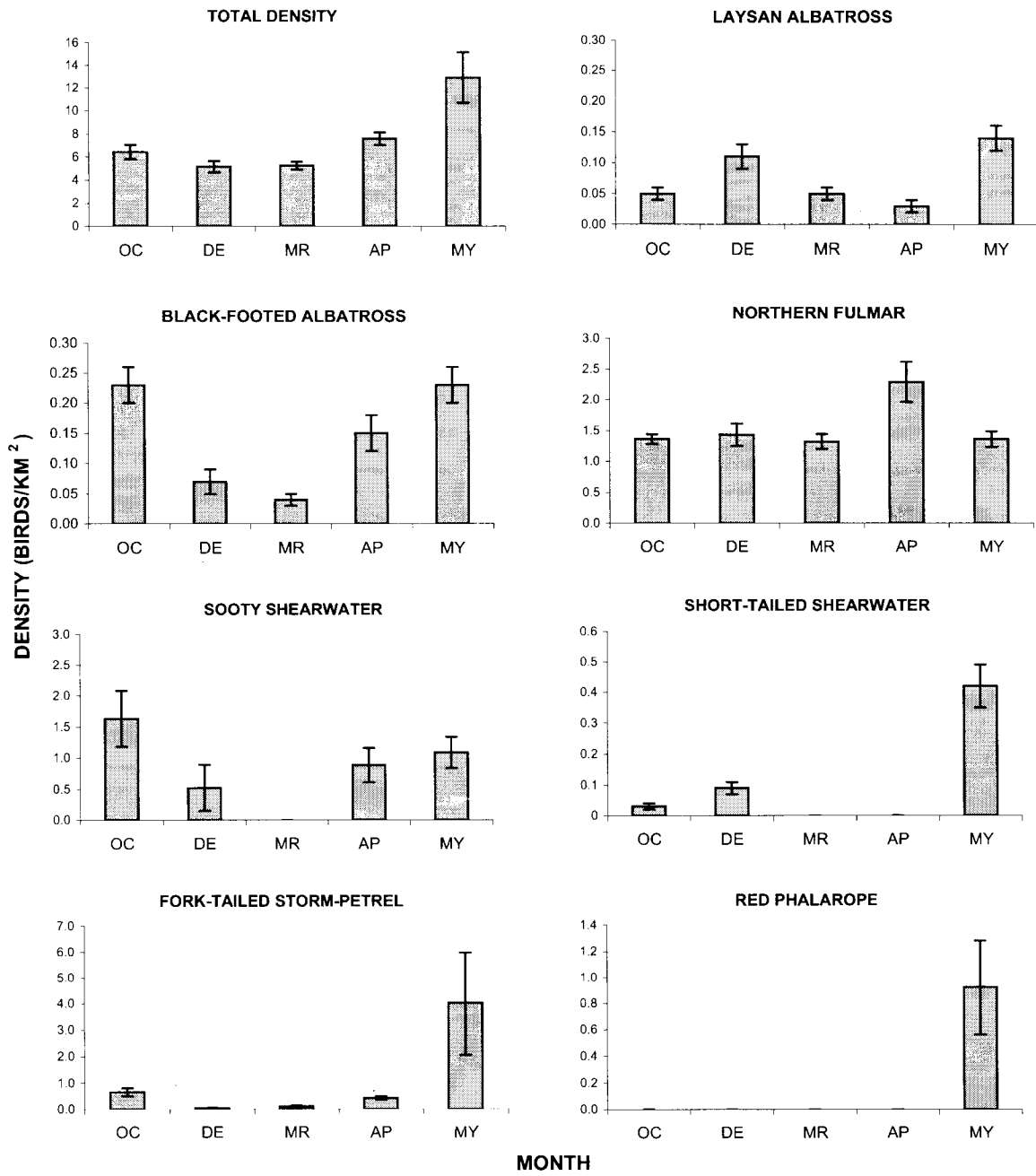


Figure 5

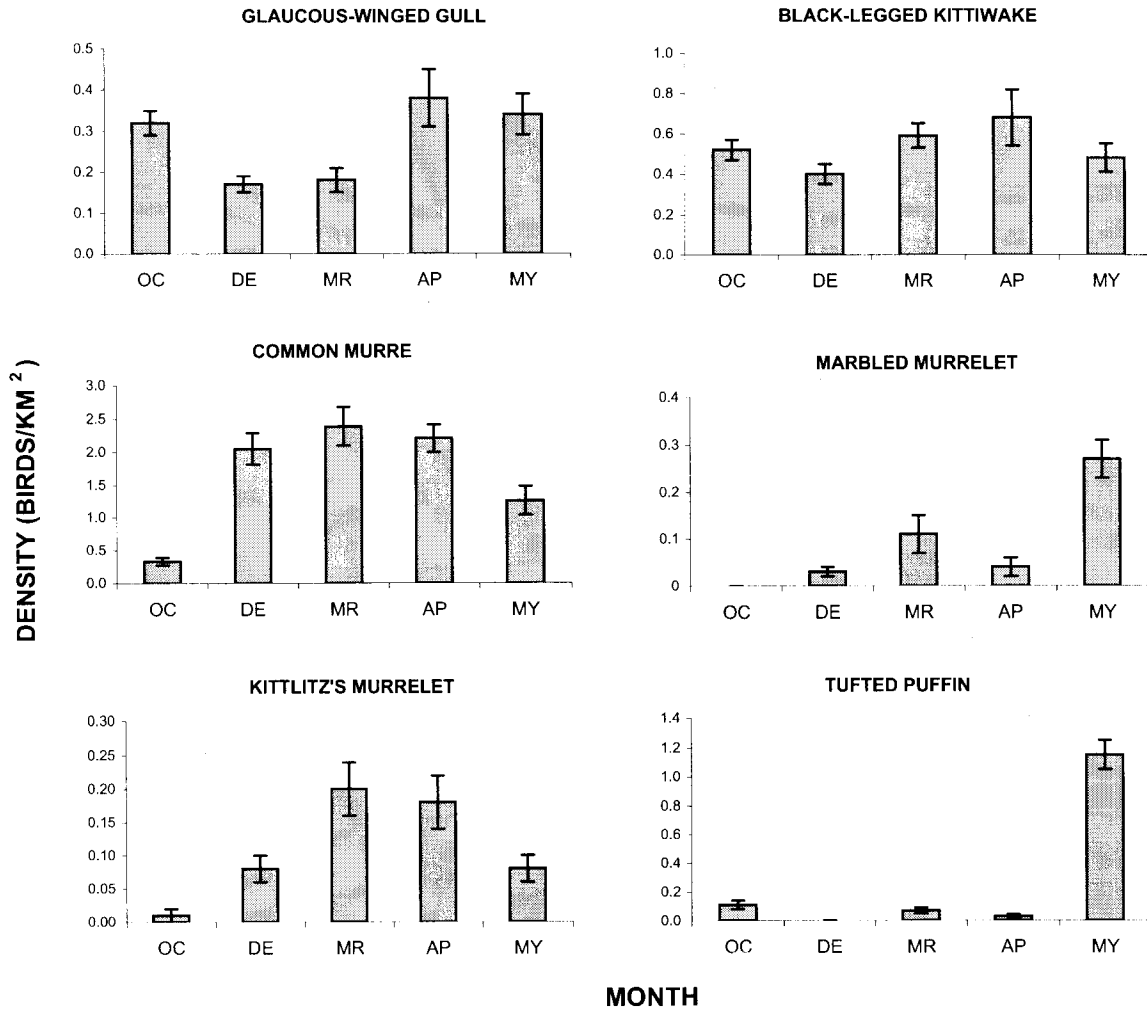


Figure 6

Table 1 Mean and SE density (birds/km²) of seabirds in the northern Gulf of Alaska, 1997–2001, by date; *n* is number of transect samples.

Sample size/species/guild	Date											
	OC97		OC99		OC00		DE98		DE99		DE00	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
<i>n</i>	143		147		215		137		133		151	
Total density	8.36	1.59	5.37	0.40	5.93	0.97	6.06	0.57	4.46	0.63	4.96	1.19
Cackling/Canada Goose	0	0	0	0	0	0	0	0	0	0	0	0
Brant	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	0	0	0	0	0.10	0.10	0	0	0	0	0	0
Northern Shoveler	0	0	0.02	0.02	0	0	0	0	0	0	0	0
Green-winged Teal	0	0	0	0	0	0	0	0	0	0	0	0
Greater Scaup	0.07	0.07	0	0	0	0	0	0	0	0	0	0
Common Eider	0	0	0	0	0	0	0	0	0	0	0	0
Harlequin Duck	0.01	0.01	0	0	0	0	0	0	0	0	0.01	0.01
Surf Scoter	0	0	0	0	0.05	0.04	0	0	0	0	0	0
White-winged Scoter	0.19	0.19	0.11	0.11	0.02	0.02	0	0	0	0	0.01	0.01
Black Scoter	0	0	0	0	0	0	0	0	0.01	0.01	0	0
Long-tailed Duck	0	0	0	0	0	0	0	0	0	0	0.01	0.01
Common Goldeneye	0	0	0	0	0.49	0.41	0	0	0	0	0	0
Common Merganser	0	0	0	0	0	0	0	0	0	0	0.01	0.01
Unidentified merganser	0	0	0	0	0.02	0.02	0	0	0	0	0	0
Unidentified diver	0	0	0.01	0.01	0	0	0	0	0	0	0	0
Red-throated Loon	0	0	0	0	0	0	0.01	0.01	0	0	0	0
Pacific Loon	0	0	0.03	0.03	0	0	0	0	0	0	0	0
Common Loon	0	0	0	0	0.01	0.01	0	0	0.01	0.01	0	0
Yellow-billed Loon	0	0	0	0	0	0	0	0	0	0	0	0
Laysan Albatross	0.04	0.02	0.13	0.03	0	0	0.14	0.04	0.15	0.06	0.04	0.02
Black-footed Albatross	0.10	0.03	0.30	0.05	0.26	0.04	0.14	0.04	0.07	0.03	0.02	0.01
Short-tailed Albatross	0	0	0	0	0	0	0.01	0.01	0	0	0	0
Northern Fulmar	1.32	0.14	1.79	0.19	1.08	0.10	1.78	0.19	1.93	0.53	0.67	0.10

Table 1 Continued.

Sample size/species/guild	Date																	
	OC97			OC99			OC00			DE98			DE99			DE00		
	Mean	SE		Mean	SE		Mean	SE		Mean	SE		Mean	SE		Mean	SE	
Mottled Petrel	0	0		0.10	0.04		0	0		0	0		0	0		0	0	
Buller's Shearwater	0.03	0.01		0	0		0	0		0	0		0	0		0	0	
Sooty Shearwater	3.07	1.53		1.13	0.29		1.01	0.24		0.02	0.02		0	0		1.42	1.02	
Short-tailed Shearwater	0.01	0.01		0.06	0.02		0.04	0.02		0.24	0.05		0.01	0.01		0.03	0.02	
Little Shearwater	0.01	0.01		0	0		0	0		0	0		0	0		0	0	
Fork-tailed Storm-Petrel	1.37	0.48		0.71	0.14		0.12	0.03		0.05	0.02		0.02	0.02		0.03	0.02	
Leach's Storm-Petrel	0	0		0	0		0	0		0	0		0	0		0	0	
Double-crested Cormorant	0	0		0	0		0.81	0.80		0	0		0	0		0	0	
Red-faced Cormorant	0	0		0	0		<0.01	<0.01		0	0		0	0		0	0	
Pelagic Cormorant	0.02	0.02		0	0		0.04	0.03		0.01	0.01		0	0		0.02	0.01	
Unidentified cormorant	0	0		0	0		<0.01	<0.01		0	0		0	0		0	0	
Red-necked Phalarope	0	0		0	0		0	0		0	0		0	0		0	0	
Red Phalarope	0	0		0	0		0.01	0.01		0	0		0	0		0	0	
Pomarine Jaeger	0.08	0.03		0.05	0.02		0.05	0.02		0	0		0	0		0	0	
Parasitic Jaeger	0.02	0.01		0.01	0.01		0.01	0.01		0	0		0	0		0	0	
Long-tailed Jaeger	0	0		0	0		0	0		0	0		0	0		0	0	
Bonaparte's Gull	0	0		0	0		0.03	0.01		0	0		0	0		0	0	
Mew Gull	0.01	0.01		0.02	0.01		0.06	0.03		0.01	0.01		0.07	0.03		0.13	0.09	
Herring Gull	0.04	0.02		0.05	0.02		0.41	0.06		0.01	0.01		0.03	0.02		0.05	0.02	
Thayer's Gull	0	0		0	0		0	0		0	0		0	0		0.01	0.01	
Glaucous-winged Gull	0.25	0.05		0.11	0.03		0.52	0.06		0.16	0.03		0.17	0.05		0.19	0.04	
Glaucous Gull	0	0		0	0		<0.01	<0.01		0	0		0	0		0	0	
Sabine's Gull	0	0		0	0		0	0		0	0		0	0		0	0	
Black-legged Kittiwake	0.51	0.09		0.23	0.05		0.73	0.10		0.44	0.07		0.30	0.10		0.44	0.08	
Arctic Tern	0	0		0	0		0	0		0	0		0	0		0	0	

Table 1 Continued.

Sample size/species/guild	Date											
	OC97		OC99		OC00		DE98		DE99		DE00	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Common Murre	0.86	0.17	0.19	0.07	0.06	0.02	2.95	0.54	1.44	0.27	1.76	0.38
Thick-billed Murre	0	0	0	0	0	0	0.01	0.01	0.01	0.01	0	0
Unidentified murre	0	0	0	0	0	0	0	0	0	0	0	0
Pigeon Guillemot	0	0	0	0	0	0	0	0	0	0	0	0
Marbled Murrelet	0	0	0	0	0.01	0.01	0.01	0.01	0.07	0.04	0.01	0.01
Kittlitz's Murrelet	0.02	0.02	0.01	0.01	0	0	0.04	0.02	0.15	0.06	0.06	0.04
Unidentified <i>Brachyramphus</i>	0	0	0	0	0	0	0	0	0	0	0	0
Ancient Murrelet	0.02	0.02	0	0	0	0	0	0	0	0	0	0
Cassin's Auklet	0.07	0.04	0.01	0.01	0	0	0	0	0.02	0.02	0	0
Parakeet Auklet	0	0	0.10	0.04	0	0	0	0	0	0	0	0
Crested Auklet	0	0	0	0	0	0	0.01	0.01	0.01	0.01	0	0
Rhinoceros Auklet	0.02	0.01	0.01	0.01	0	0	0	0	0	0	0	0
Horned Puffin	0.04	0.03	0	0	0	0	0	0	0	0	0.02	0.01
Tufted Puffin	0.18	0.05	0.17	0.09	0.01	0.01	0.02	0.01	0	0	0	0

Table 1 Continued.

Sample size/species/guild	Date											
	MR98			MR99			MR00			MR01		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Total density	4.77	0.51	128	3.90	0.43	140	5.98	0.67	143	6.18	0.95	148
Cackling/Canada Goose	0	0		0	0		0	0		0	0	
Brant	0	0		0	0		0	0		0	0	
Mallard	0	0		0	0		0	0		0	0	
Northern Shoveler	0	0		0	0		0	0		0	0	
Green-winged Teal	0	0		0	0		0	0		0	0	
Greater Scaup	0	0		0	0		0	0		0	0	
Common Eider	0	0		0	0		0	0		0	0	
Harlequin Duck	0	0		0	0.03		0.03	0.03		0.01	0.01	
Surf Scoter	0	0		0	0.02		0.02	0.02		0	0	
White-winged Scoter	0	0		0	0		0	0		0.01	0.01	
Black Scoter	0	0		0	0		0	0		0	0	
Long-tailed Duck	0	0		0	0		0	0		0	0	
Common Goldeneye	0	0		0	0		0	0		0	0	
Common Merganser	0	0		0	0		0	0		0	0	
Unidentified merganser	0	0		0	0		0	0		0	0	
Unidentified diver	0	0		0	0		0	0		0	0	
Red-throated Loon	0	0		0	0		0	0		0	0	
Pacific Loon	0	0		0	0		0	0		0.01	0.01	
Common Loon	0	0		0	0		0	0		0	0	
Yellow-billed Loon	0	0		0	0		0	0		0	0	
Laysan Albatross	0	0		0.02	0.01		0.06	0.02		0.12	0.05	
Black-footed Albatross	0.03	0.02		0.03	0.02		0.03	0.02		0.07	0.04	
Short-tailed Albatross	0	0		0	0		0	0		0	0	
Northern Fulmar	1.40	0.28		1.53	0.25		1.17	0.20		1.22	0.19	

Table 1 Continued.

Sample size/species/guild	Date											
	MR98			MR99			MR00			MR01		
	Mean	SE		Mean	SE		Mean	SE		Mean	SE	
Mottled Petrel	0	0		0	0		0	0		0	0	
Buller's Shearwater	0	0		0	0		0	0		0	0	
Sooty Shearwater	0	0		0	0		0	0		0	0	
Short-tailed Shearwater	0	0		0.01	0.01		0.01	0.01		0	0	
Little Shearwater	0	0		0	0		0	0		0	0	
Fork-tailed Storm-Petrel	0.15	0.08		0.12	0.04		0.06	0.02		0.09	0.03	
Leach's Storm-Petrel	0	0		0	0		0	0		0	0	
Double-crested Cormorant	0	0		0	0		0	0		0.01	0.01	
Red-faced Cormorant	0	0		0	0		0	0		0	0	
Pelagic Cormorant	0.02	0.02		0.02	0.02		0.03	0.02		0	0	
Unidentified cormorant	0	0		0	0		0	0		0	0	
Red-necked Phalarope	0	0		0	0		0	0		0	0	
Red Phalarope	0	0		0	0		0	0		0	0	
Pomarine Jaeger	0	0		0	0		0	0		0	0	
Parasitic Jaeger	0	0		0	0		0	0		0	0	
Long-tailed Jaeger	0	0		0	0		0	0		0	0	
Bonaparte's Gull	0	0		0	0		0	0		0	0	
Mew Gull	0	0		0	0		0.03	0.01		0.18	0.11	
Herring Gull	0	0		0	0		0.01	0.01		0.01	0.01	
Thayer's Gull	0	0		0	0		0	0		0	0	
Glaucous-winged Gull	0.18	0.04		0.15	0.04		0.16	0.06		0.24	0.05	
Glaucous Gull	0	0		0	0		0	0		0	0	
Sabine's Gull	0	0		0	0		0	0		0	0	
Black-legged Kittiwake	0.52	0.08		0.37	0.07		0.64	0.10		0.82	0.16	
Arctic Tern	0	0		0	0		0	0		0	0	

Table 1 Continued.

Sample size/species/guild	Date											
	MR98			MR99			MR00			MR01		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	SE	
Common Murre	2.13	0.37	1.38	0.31	3.35	0.62	2.65	0.80				
Thick-billed Murre	0.05	0.02	0	0	0.01	0.01	0.01	0.01				
Unidentified murre	0.01	0.01	0	0	0	0	0	0				
Pigeon Guillemot	0.05	0.03	0	0	0	0	0	0				
Marbled Murrelet	0	0	0.02	0.02	0.06	0.03	0.33	0.14				
Kittlitz's Murrelet	0.24	0.07	0.27	0.12	0.10	0.04	0.22	0.09				
Unidentified <i>Brachyramphus</i>	0	0	0	0	0	0	0	0				
Ancient Murrelet	0	0	0	0	0	0	0	0				
Cassin's Auklet	0	0	0	0	0.09	0.06	0.03	0.03				
Parakeet Auklet	0	0	0	0	0	0	0.01	0.01				
Crested Auklet	0	0	0	0	0	0	0.02	0.02				
Rhinoceros Auklet	0	0	0	0	0	0	0	0				
Horned Puffin	0	0	0	0	0	0	0	0				
Tufted Puffin	0	0	0	0	0.14	0.06	0.12	0.06				

Table 1 Continued.

Sample size/species/guild	Date																	
	AP98			AP99			AP00			MY98			MY99			MY00		
	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Total density	10.11	1.04	133	4.74	0.74	161	8.79	1.09	104	11.17	0.89	128	6.38	0.53	173	18.28	4.81	253
Cackling/Canada Goose	0	0		0	0		0	0		0	0		0.06	0.06		0	0	
Brant	0	0		0	0		0	0		0	0		0.02	0.02		0.03	0.03	
Mallard	0	0		0	0		0	0		0	0		0	0		0	0	
Northern Shoveler	0	0		0	0		0	0		0	0		0	0		0.02	0.02	
Green-winged Teal	0	0		0.09	0.09		0	0		0	0		0.01	0.01		0	0	
Greater Scaup	0	0		0	0		0	0		0	0		0.11	0.11		0	0	
Common Eider	0	0		0	0		0	0		0.22	0.22		0	0		0	0	
Harlequin Duck	0	0		0	0		0	0		0	0		0	0		0	0	
Surf Scoter	0	0		0	0		0	0		0	0		0	0		0	0	
White-winged Scoter	0	0		0.01	0.01		0	0		0	0		0	0		0	0	
Black Scoter	0	0		0.01	0.01		0	0		0	0		0	0		0	0	
Long-tailed Duck	0	0		0	0		0	0		0	0		0.04	0.04		0.24	0.18	
Common Goldeneye	0	0		0	0		0	0		0	0		0	0		0	0	
Common Merganser	0	0		0	0		0	0		0	0		0	0		0	0	
Unidentified merganser	0	0		0	0		0	0		0	0		0	0		0	0	
Unidentified diver	0	0		0	0		0	0		0	0		0	0		0	0	
Red-throated Loon	0	0		0	0		0	0		0	0		0.04	0.02		0	0	
Pacific Loon	0	0		0.02	0.01		0.02	0.02		0.14	0.12		0.10	0.03		0.01	0.01	
Common Loon	0	0		0	0		0	0		0	0		0	0		0	0	
Yellow-billed Loon	0	0		0.01	0.01		0	0		0.01	0.01		0	0		0.01	0.01	
Laysan Albatross	0.03	0.02		0.02	0.02		0.04	0.02		0.25	0.05		0.06	0.02		0.14	0.03	
Black-footed Albatross	0.10	0.04		0.06	0.03		0.35	0.11		0.18	0.06		0.30	0.07		0.20	0.04	
Short-tailed Albatross	0	0		0.01	0.01		0	0		0	0		0	0		0	0	
Northern Fulmar	4.06	0.91		0.84	0.17		2.28	0.30		2.40	0.35		0.93	0.11		1.12	0.21	

Table 1 Continued.

Sample size/species/guild	Date											
	AP98		AP99		AP00		MY98		MY99		MY00	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Mottled Petrel	0.01	0.01	0	0	0.09	0.04	0	0	0	0	0	0
Buller's Shearwater	0	0	0	0	0	0	0	0	0	0	0	0
Sooty Shearwater	0.05	0.04	0.61	0.24	2.35	0.96	0.34	0.08	0.77	0.35	1.66	0.49
Short-tailed Shearwater	0	0	0	0	0.01	0.01	0.62	0.12	0.28	0.10	0.41	0.11
Little Shearwater	0	0	0	0	0	0	0	0	0	0	0	0
Fork-tailed Storm-Petrel	0.21	0.07	0.21	0.09	1.02	0.18	1.38	0.26	0.65	0.15	7.64	4.28
Leach's Storm-Petrel	0	0	0	0	0	0	0	0	0	0	0.09	0.04
Double-crested Cormorant	0	0	0	0	0	0	0	0	0	0	<0.01	<0.01
Red-faced Cormorant	0.09	0.06	0	0	0.01	0.01	0	0	0	0	0.01	0.01
Pelagic Cormorant	0.14	0.09	0.05	0.04	0	0	0.02	0.01	0	0	0.02	0.02
Unidentified cormorant	0	0	0	0	0	0	0	0	0	0	0	0
Red-necked Phalarope	0	0	0	0	0	0	0	0	0	0	0.31	0.11
Red Phalarope	0	0	0	0	0	0	0.04	0.04	0	0	2.00	0.79
Pomarine Jaeger	0	0	0	0	0.01	0.01	0	0	0.05	0.02	0.10	0.03
Parasitic Jaeger	0	0	0	0	0	0	0	0	0	0	<0.01	<0.01
Long-tailed Jaeger	0	0	0	0	0	0	0	0	0.01	0.01	0.04	0.02
Bonaparte's Gull	0	0	0	0	0	0	0	0	0	0	0.02	0.01
Mew Gull	0.03	0.03	0.02	0.01	0	0	0	0	0.01	0.01	<0.01	<0.01
Herring Gull	0.02	0.01	0	0	0.04	0.03	0.02	0.02	0.04	0.02	0.04	0.01
Thayer's Gull	0	0	0	0	0	0	0	0	0	0	0	0
Glaucous-winged Gull	0.49	0.10	0.48	0.14	0.07	0.03	0.27	0.07	0.38	0.08	0.35	0.08
Glaucous Gull	0	0	0	0	0.01	0.01	0	0	0.02	0.01	0	0
Sabine's Gull	0	0	0	0	0	0	0	0	0	0	0.05	0.02
Black-legged Kittiwake	0.59	0.10	0.82	0.33	0.56	0.11	0.25	0.06	0.40	0.11	0.64	0.12
Arctic Tern	0	0	0	0	0	0	0	0.02	0.24	0.08	0.17	0.10

Table 1 Continued.

Sample size/species/guild	Date											
	AP98		AP99		AP00		MY98		MY99		MY00	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Common Murre	3.92	0.51	1.28	0.19	1.45	0.30	2.76	0.69	0.64	0.15	0.93	0.32
Thick-billed Murre	0.02	0.01	0	0	0.02	0.02	0	0	0	0	0.01	0.01
Unidentified murre	0	0	0	0	0	0	0	0	0	0	0	0
Pigeon Guillemot	0	0	0	0	0	0	0.02	0.01	0	0	0	0
Marbled Murrelet	0	0	0.02	0.02	0.11	0.07	0.17	0.07	0.11	0.04	0.43	0.08
Kittlitz's Murrelet	0.31	0.08	0.08	0.04	0.18	0.08	0.19	0.07	0.02	0.01	0.07	0.02
Unidentified <i>Brachyramphus</i>	0.01	0.01	0	0	0	0	0	0	0	0	0	0
Ancient Murrelet	0	0	0	0	0	0	0.16	0.16	0.04	0.02	0.16	0.05
Cassin's Auklet	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.02	0.04	0.02
Parakeet Auklet	0	0	0	0	0	0	0	0	0	0	0.02	0.01
Crested Auklet	0	0	0	0	0	0	0	0	0	0	0	0
Rhinoceros Auklet	0.02	0.02	0.07	0.04	0.04	0.03	0.03	0.02	0.01	0.01	<0.01	<0.01
Horned Puffin	0	0	0	0	0	0	0	0	0	0	0.28	0.08
Tufted Puffin	0	0	0.01	0.01	0.09	0.04	1.67	0.30	0.99	0.12	1.00	0.12