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SPRING DISTRIBUTION OF MARINE BIRDS IN THE GULF OF ALASKA

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ABSTRACT.—Aerial surveys of marine birds were conducted in the Gulf of Alaska from March through June 1977. The surveys provide synoptic information on the relative seasonal abundance of seabirds and their use of the continental shelf and slope and deep oceanic areas. Northern Fulmars (*Fulmarus glacialis*), Sooty and Short-tailed shearwaters (*Puffinus griseus* and *P. tenuirostris*), Fork-tailed Storm-Petrels (*Oceanodroma furcata*), sea ducks, Black-legged Kittiwakes (*Rissa tridactyla*), murres (*Uria* spp.), and Tufted Puffins (*Lunda cirrhata*) were the most common of the 35 species observed in the Gulf. Most seabirds were found over the continental slope and oceanic waters in March. Densities, especially of shearwaters, increased as birds moved into waters over the continental shelf from April to June. Most species were associated with at least one other, and 11 statistically significant associations ($P < 0.05$) were found between the eight most common species. Tufted Puffins, Arctic Terns, and shearwaters were highly associated.

General studies of seabirds exist for large portions of the North Pacific (Kuroda 1955, Sanger 1972, Shuntov 1972), but little detailed information exists for the Gulf of Alaska. My colleagues and I conducted aerial surveys in the Gulf of Alaska (Fig. 1) from March to June 1977 to determine seasonal distribution and abundance of marine birds there. We included some coastline in the surveys, but concentrated on offshore waters as far as 180 km from shore and as deep as 3,000 fm. Our results provide information about the relative seasonal abundance and movements of seabirds, and their use of the Gulf of Alaska. This paper illustrates the value of aerial surveys for solving problems in marine ornithology.

METHODS

Aerial surveys were conducted along the tracklines shown in Figure 1 between 10:00 and 16:00 GMT+10 on 8–9 March, 20 April, 19 May, and 17 June 1977. The specific date of each survey depended upon the availability of aircraft and personnel, and on the weather over the Gulf of Alaska. The surveys included segments of three oceanographic habitats: continental shelf (water depth < 100 fathoms [fm] = 180 m), continental slope (water depth 100–1,000 fm = 180–1,800 m), and deep ocean (water depth > 1,000 fm = 1,800 m). The trackline of each survey had approximately 580 km of continental shelf, 220 km of continental slope, and 270 km of deep ocean. All water depths were taken from National Oceanic and Atmospheric Administration Charts 531 and 16580.

The survey aircraft was a modified Grumann turbo-goose equipped with a Global VLF Navigation System (Karant 1976), which provided a continuous readout of longitude and latitude and could maintain tracklines to within 200 m. We flew at an altitude of 30 m and a ground speed of 200 km/h. Three biologists participated in each survey. One sat on each side of the aircraft and made direct observations of birds, recording this information on cassette tapes. The third biologist monitored the navigation system and recorded positions. Since we made strip censuses of 50 m on each side of the aircraft, there was a shadow of noncensused area beneath the plane along the flight line (Fig. 2). The width of the transect on each side of the aircraft was estimated to be 50 m, using a clinometer, aircraft altitude, and elementary trigonometric functions. The quality of the observations varied somewhat owing to occasional glare and the turbulence of the water, but LeResche and Rausch (1974) have dem-

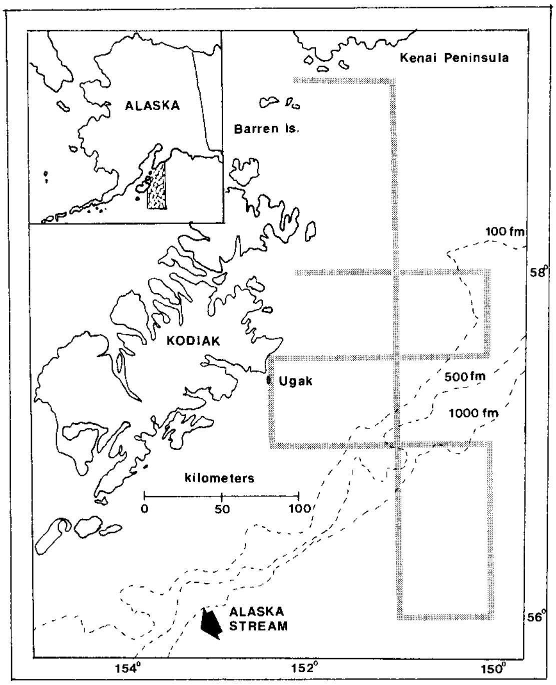


FIGURE 1. Northwest Gulf of Alaska. The study area is shaded in the inset, and stippling shows the trackline used in the aerial surveys.

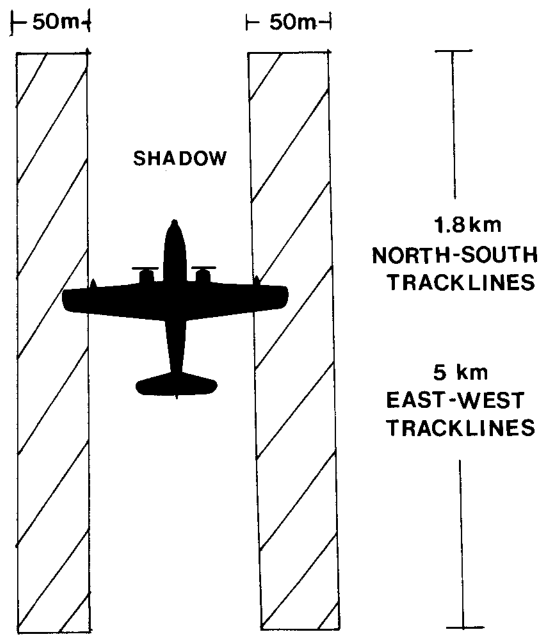


FIGURE 2. Aerial survey technique depicting the 50-m strips that were censused on each side of the airplane and the shadow along the flight line, which was not censused. The plane's positions were logged each minute of longitude (1.8 km) for north–south tracklines and at each 5 min of latitude (5 km) for east–west tracklines.

onstrated that this is unimportant if the observers are experienced with aerial surveys.

RESULTS

I have plotted the distribution and estimated densities of the eight most commonly observed species by month in Figure 3 and present estimated densities of all observed species by area and month in Table 1. Using the weights of seabirds given by Palmer (1962–1976) and Dement'ev et al. (1951), I estimate that the total avian biomass within the study area was 7.5, 13, 56, and 28 kg/km^2 in March, April, May, and June, respectively.

In March, wintering populations of murres (*Uria* spp.), Black-legged Kittiwakes (*Rissa tridactyla*), Crested Auklets (*Aethia cristatella*), and sea ducks predominated (Fig. 4). By April, auklets had left the area, and kittiwakes were more numerous, many probably en route to colonies from wintering areas at sea. Shearwaters (*Puffinus* spp.) were also present in April, a month earlier than reported by Gabrielson and Lincoln (1959). In addition, Tufted Puffins (*Lunda cirrhata*) and Fork-tailed Storm-Petrels (*Oceanodroma furcata*) had moved into waters over the continental shelf. Northern Fulmars (*Fulmarus glacialis*) were most numerous in April. In May, ducks were gone, but huge flocks of shearwaters were present. Numbers of Fork-tailed Storm-Petrels peaked; the migration of Arctic Terns (*Sterna paradisaea*) was highest; Glaucous-winged Gulls (*Larus glaucescens*) moved inshore; but the density of murres and Tufted Puffins was almost unchanged. In June, the densities of many species were low (Fig. 3, Table 1). Breeding activities certainly contributed to this decline for species other than shearwaters. Many Scaled Petrels (*Pterodroma inexpectata*) were found in deep water at this time.

Coefficients to express associations between species (Cole 1949), based on pooled data for the eight most common species, are listed in Table 2. Most species were associated with at least one other, and 11 of 28 potential associations were statistically significant ($P < 0.05$). Arctic Terns, Tufted Puffins, and shearwaters were highly associated with one another. No species avoided another. What follow are detailed accounts of the species portrayed in Figure 3.

Fulmarus glacialis. Northern Fulmar. This species occurred in all three oceanographic habitats throughout the study period. The number of fulmars over deep oceanic waters was relatively constant from March until June, as were numbers over the continental shelf and slope during all months except April. We saw large numbers of "light phase" birds during April. The ratio of dark to light phase birds

TABLE 1. Estimated density (birds/km²) of seabirds over the Gulf of Alaska during aerial surveys, March–June 1977.

Species	March water depth (fm)			April water depth (fm)			May water depth (fm)			June water depth (fm)		
	<100	100–1,000	>1,000	<100	100–1,000	>1,000	<100	100–1,000	>1,000	<100	100–1,000	>1,000
Gavia spp.	+	–	–	–	–	–	–	–	–	–	–	–
Diomedia nigripes	–	–	–	–	–	+	–	–	–	–	–	–
Fulmarus glacialis	0.2	0.4	0.7	1.0	2.6	0.6	0.1	0.5	0.9	0.4	0.3	0.5
Puffinus creatopus	–	–	–	–	–	–	+	+	–	+	+	–
P. bulleri	–	–	–	0.1	–	–	–	–	+	–	0.1	0.1
P. griseus/tenuirostris	–	–	+	4.6	2.5	0.4	110	2.8	0.5	55	+	0.2
Pterodroma inexpectata	–	–	–	–	–	–	–	–	+	–	+	1.6
Oceanodroma furcata	–	–	2.8	3.2	0.6	0.4	5.8	9.7	1.1	1.4	3.3	1.3
O. leucorhoa	–	–	–	–	–	–	–	–	–	+	0.2	–
Phalacrocorax spp.	0.3	–	–	0.1	–	–	+	–	–	–	–	–
Anas platyrhynchos	–	–	–	–	+	–	–	–	–	–	–	–
Clangula hyemalis	0.8	–	–	0.3	–	–	–	–	–	–	–	–
Histrionicus histrionicus	0.1	–	–	–	–	–	–	–	–	–	–	–
Somateria spp.	+	–	–	–	–	–	–	–	–	–	–	–
S. spectabilis	0.1	–	–	–	–	–	–	–	–	–	–	–
Melanitta spp.	0.8	–	–	0.4	–	–	–	–	–	–	–	–
M. deglandi	+	–	–	2.2	–	–	–	–	–	–	–	–
M. perspicillata	0.1	–	–	–	–	–	–	–	–	–	–	–
M. nigra	–	–	–	0.1	–	–	–	–	–	–	–	–
Lobipes lobatus	–	–	–	+	–	–	–	–	–	–	–	–
Stercorarius spp.	–	–	–	+	–	+	0.1	+	0.1	–	–	–
S. pomarinus	–	–	–	–	–	–	+	–	–	–	–	–
S. parasiticus	–	–	–	–	+	–	0.1	+	0.1	–	–	–
S. longicaudus	–	–	–	–	–	–	–	+	–	–	–	–
Catharacta skua	–	–	–	–	–	–	–	–	+	–	–	–
Larus hyperboreus	–	–	–	–	–	–	–	+	–	–	–	–
L. glaucescens	0.4	1.1	+	0.6	0.1	0.1	0.1	–	–	0.2	+	–
L. canus	–	–	–	+	–	–	+	–	–	–	–	–
Rissa tridactyla	0.3	6.0	0.9	6.8	15	4.4	3.6	0.5	0.1	1.2	–	–
Sterna paradisaea	–	–	–	–	0.2	–	0.8	0.5	–	+	–	–
Uria aalge/lomvia	3.2	6.9	2.2	3.3	–	0.1	4.1	+	–	2.9	–	–
Brachyramphus marmoratus/ brevirostris	–	–	–	–	–	–	+	–	–	0.3	–	–
Cyclorrhynchus psittacula	–	–	–	+	–	–	+	–	–	+	–	–
Aethia cristatella	–	–	5.9	–	–	–	–	–	–	–	–	–
Cerorhinca monocerata	–	–	–	–	–	–	–	–	–	+	–	–
Fratercula corniculata	0.1	0.2	–	0.1	–	–	+	–	–	+	–	–
Lunda cirrhata	–	+	+	2.0	1.1	0.6	2.7	0.3	+	1.5	–	–
Unidentified alcids	+	0.2	1.7	0.3	+	–	+	–	–	0.1	–	–
TOTAL	6.4	15	14	25	22	6.6	130	15	3.0	63	4.1	3.7

+ Indicates that a species was present, but that its estimated density was <0.1.

was 1:1 in April, but 2:1 during other months in the survey (Table 3). The difference is statistically significant ($\chi^2 = 22.9$, $P < 0.005$). Fulmars occurred singly and in flocks of up to 25. Birds in flocks were usually all light or all dark, although mixed groups were occasionally seen. We did not find fulmars closer than 7 km from land nor in waters shallower than 25 fm.

Puffinus griseus. Sooty Shearwater.

Puffinus tenuirostris. Short-tailed Shearwater. These congeners, which breed in the Southern Hemisphere and spend the austral winter in the North Pacific (Palmer 1962–1976, Shuntov 1972), were the dominant seabirds in the Gulf of Alaska (Table 1, Fig. 4). Since it is difficult to distinguish them in the field, I pooled all sightings for purposes of analysis. Few shearwaters were seen in March, but large flocks (Sooty Shearwaters) had arrived by 20 April. In May, shearwaters sighted over the continental shelf numbered approximately 110 birds/km². Flocks appeared to include both species, and many birds were molting. They clearly preferred the continental shelf (Fig. 3). By June, their estimated density had dropped to half of that in May (Table 1).

Oceanodroma furcata. Fork-tailed Storm-

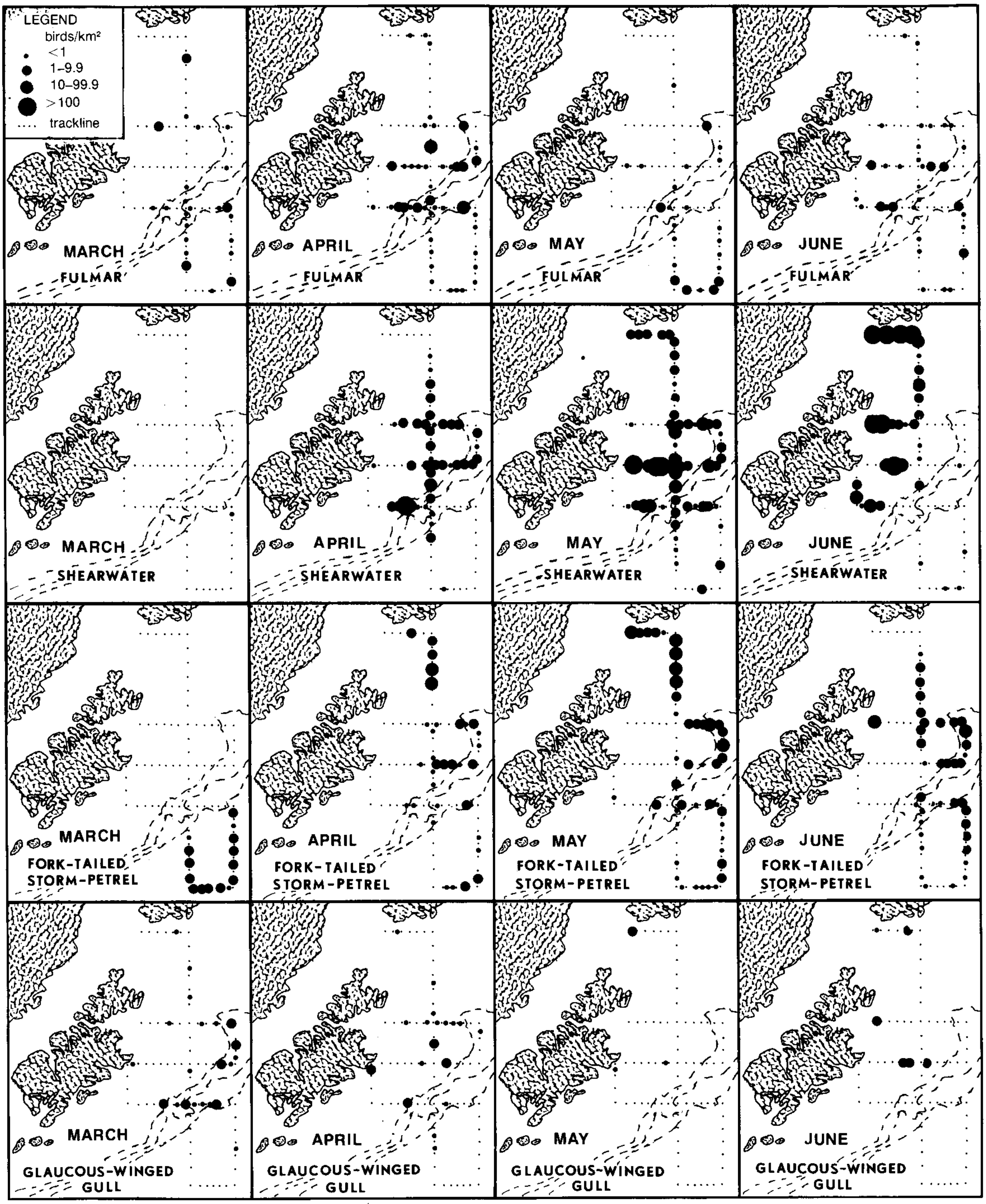
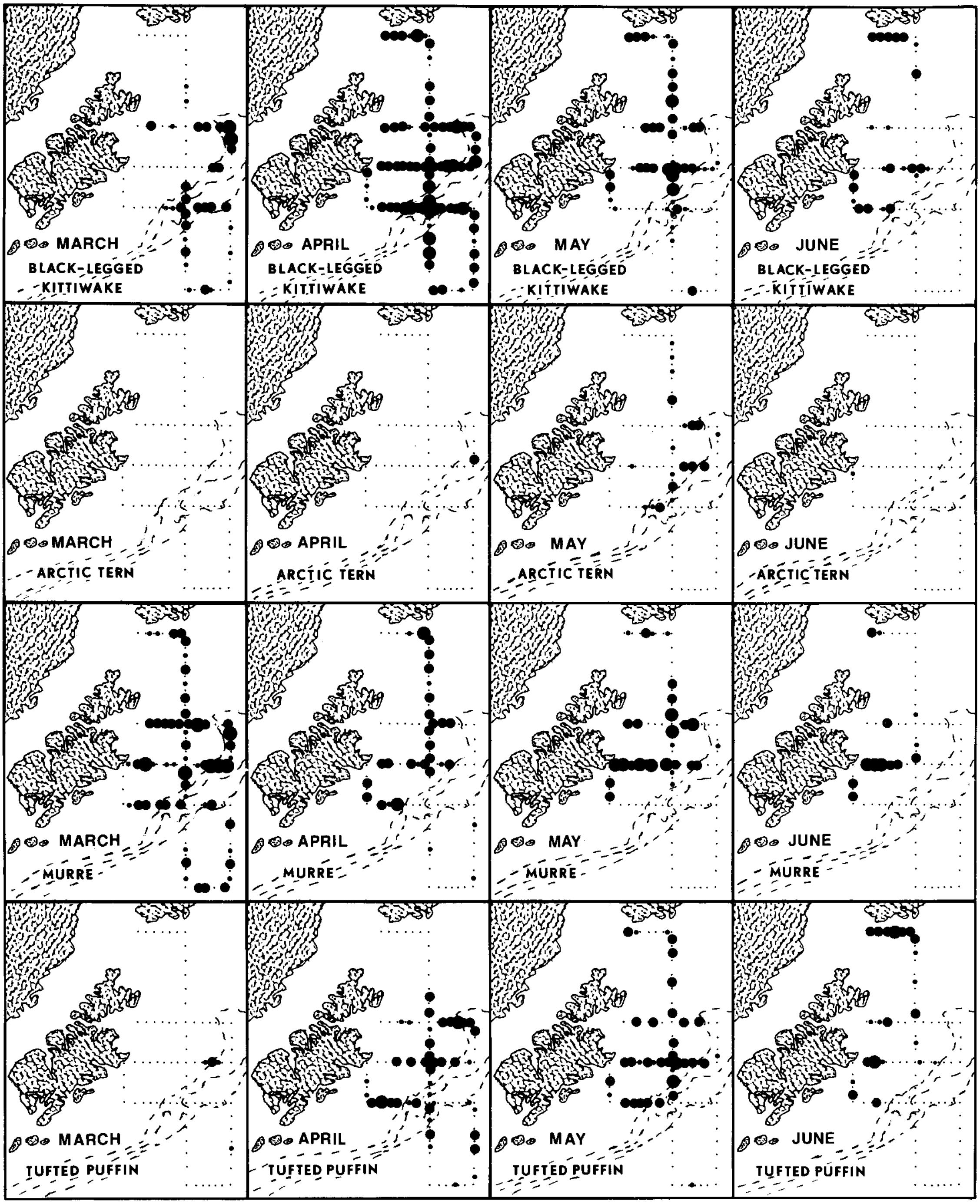


FIGURE 3. Monthly distribution and abundance of eight common seabirds over the Gulf of Alaska. Density estimates are plotted by 10-min increments of longitude or latitude. Dashed lines are 100-, 500-, and 1000-fm contours (see Fig. 1).

Petrel. During March, storm-petrels were frequently sighted in deep oceanic waters but not over the continental slope or shelf. Between April and June, they appeared in all three marine habitats, but those over the continental shelf and slope were generally above 57°30′N (Fig. 3), i.e., within 150 km of colonies on the Barren Islands and Kenai Peninsula (Sowls et al. 1978). This was especially true during April when storm-petrels congregated in large numbers over the continental shelf, most within 75 km of known colonies. Birds were usually alone or in small, loosely aggregated flocks.

Larus glaucescens. Glaucous-winged Gull.



Glaucous-winged Gulls are year-round residents in the study area and breed in numerous relatively small colonies throughout the Kodiak Archipelago and Kenai Peninsula (Sowls et al. 1978). In coastal areas, they form large flocks on sand spits and near canneries where they feed on offal. Individuals and small flocks were found as far as 140 km from land in March and April (Fig. 3) and were associated with kittiwakes and murres (Table 2). The number of birds sighted at sea decreased progressively from March through June (Table 1), which is similar to results reported by Shuntov (1961) in the Bering Sea.

Rissa tridactyla. Black-legged Kittiwake. Since the Red-legged Kittiwake (*R. breviros-*

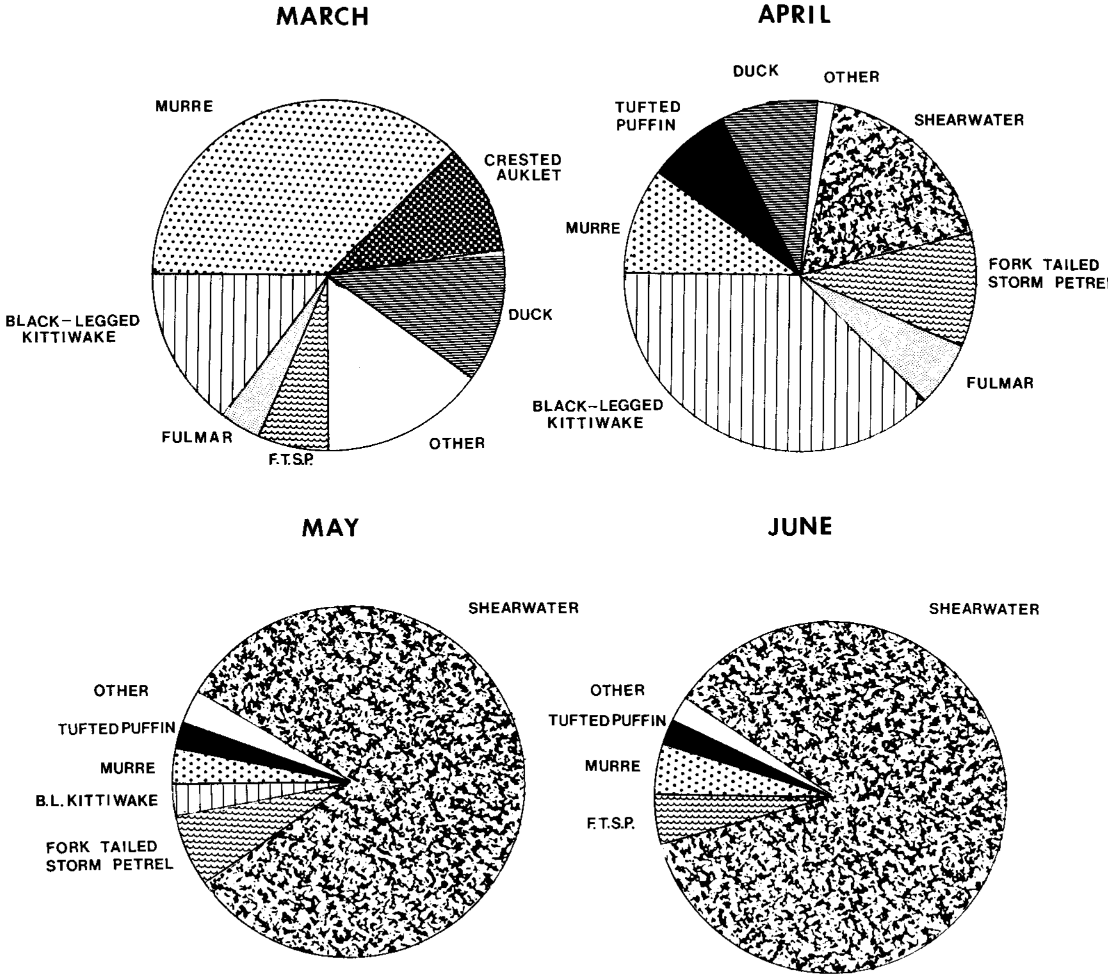


FIGURE 4. Relative proportions of species composing the avifauna over the northwestern Gulf of Alaska between March and June. Proportions were derived from the estimated density of each group and areas of each habitat within the study area occupied by it.

tris) is a rare winter visitor within the study area, I assumed that all of the kittiwakes sighted were the black-legged form (*R. tridactyla*) whose breeding colonies extend from the Kodiak Archipelago to the Kenai Peninsula (Sowls et al. 1978). Kittiwakes occurred in all three marine habitats during March, with highest concentrations over the continental slope (Table 1). Peak numbers occurred simultaneously on the continental shelf and slope and in deep water during April (Fig. 3), a finding consistent with the migratory peak reported by Shuntov (1963) in the Bering Sea. As in March, the highest densities were along the continental slope. There were many airborne flocks of at least 50 birds in April, suggesting that birds were migrating. Densities declined sharply in May and June, and no kittiwakes were observed over the continental slope or deep waters in June (Fig. 3). This species tended to associate with Glaucous-winged Gulls, Arctic Terns, and Tufted Puffins (Table 2).

Sterna paradisaea. Arctic Tern. We saw no Arctic Terns until 20 April. Individual birds and small flocks were over waters on the continental shelf and slope in May, but very few were seen in June (Table 1). This suggests that most birds passed through the study area between 20 April and 19 May, and consequently numbers in Table 1 are not maximum estimates of the density of this species. Arctic Terns were highly associated with shearwaters and Tufted Puffins; and moderately, but significantly associated with kittiwakes (Table 2). (The Aleutian Tern, *S. aleutica,* occurs in small numbers in the Gulf of Alaska [Sowls et al. 1978], but we did not see any.)

Uria aalge. Common Murre.

Uria lomvia. Thick-billed Murre. Both murres occur within the study area and are

TABLE 2. Coefficients of interspecific association (Cole 1949) for seabirds commonly found in the Gulf of Alaska during spring. C = 1.00 if both species are completely associated; C = 0.00 if two species are distributed independently of one another; C = −1.00 if they are completely dissociated. Coefficients that are significant ($P < 0.05$; chi-square test for a 2 × 2 contingency table; df = 1) are designated with asterisks.

	Shearwater	FM	FTSP	GWG	AT	BLKW	MR
Fulmar (FM)	−0.02						
Fork-tailed Storm-Petrel (FTSP)	0.23*	0.11					
Glaucous-winged Gull (GWG)	0.02	−0.01	−0.05				
Arctic Tern (AT)	0.96*	−0.01	0.39	−0.01			
Black-legged Kittiwake (BLKW)	0.19*	0.12	−0.07	0.44*	0.40*		
Murre (MR)	−0.02	−0.06	−0.13	0.50*	0.00	0.15*	
Tufted Puffin (TP)	0.78*	−0.01	−0.04	0.16	0.91*	0.41*	0.30*

difficult to distinguish in the field (Shuntov 1972). Consequently, I pooled all sight records as *Uria* spp. As Table 1 shows, the density of murres in water over the continental shelf was relatively constant between March and June. Birds occurred as individuals, in small flocks, and occasionally in large rafts. During March, we also saw murres along the continental slope and in waters 3,000 fm deep and 180 km from land, but these areas were scarcely used between April and June (Fig. 3). Most murres were still in winter plumage on 8–9 March, but in breeding plumage on 20 April. Ninety-one percent of those observed in June were within 30 km of land. Murres at sea were associated with Glaucous-winged Gulls, Tufted Puffins, and Black-legged Kittiwakes (Table 2).

Lunda cirrhata. Tufted Puffin. We saw few Tufted Puffins near the continental shelf in early March (Fig. 3). Density increased in all three habitats during April, and numbers observed over the continental slope and deep water were highest at this time. In contrast, density over the continental shelf peaked in May. Of the Tufted Puffins seen in June, 83% were within 30 km of land when concentrations were especially high near Ugak Island (central Kodiak) and the Kenai Peninsula (Fig. 3). Although we saw individuals or small groups at sea, pairs were more common. The birds observed on 20 April were molting, with orange bills and partially formed white tufts. Those seen on 19 May were in full breeding plumage. Tufted Puffins were highly associated with shearwaters, Arctic Terns, Black-legged Kittiwakes, and murres (Table 2).

DISCUSSION

Data in Table 1, Figure 3 and Figure 4 show that large-scale changes occur in the distribution of marine birds over the Gulf of Alaska during spring. This is especially true of shearwaters, Black-legged Kittiwakes, murres, and Tufted Puffins. Aerial surveys, in contrast to those conducted from ships, provide information about the distribution of seabirds over large areas of ocean on an hourly, rather than daily basis, eliminating problems associated with long sampling periods. Not only does this technique provide information about the *hourly* movements of birds, but if combined with radiotelemetry, it could be used to locate feeding grounds (Harrison and Stoneburner 1981). Inherent problems, however, limit its usefulness. First, it is difficult to estimate the density of highly aggregated species such as shearwaters from an airplane. For example, one large flock of shearwaters covered 11 km of trackline on the May survey 55 km east of Kodiak, largely accounting for the two-fold difference in the density of this species over the continental shelf between May and June (Table 1). Second, aerial surveys cannot be used to determine the absolute size of a population of breeding seabirds, since this is the instantaneous sum of birds at sea and at colonies. Even if one could accurately determine the density of a species at sea, it would be difficult to use this information to estimate the number of birds ashore. Furthermore, *relative* density estimates between species exaggerate the importance of the non-breeding shearwaters since all of them are at sea.

Several environmental and biological factors influence the dispersion of birds at sea and probably bias estimates of their density. Feeding rhythms of colonially nesting birds are undoubtedly important, as are the patchy dis-

TABLE 3. Color phase of Northern Fulmars in the Gulf of Alaska, March–June 1977. Values in the table are percentages.

Month	*n*	Color phase		
		Dark	Intermediate	Light
March	34	74	3	23
April	134	47	2	51
May	44	68	7	25
June	44	50	11	39

tribution of foraging areas at sea (Ashmole 1971), the diel nature of the vertical migrations of squid and plankton (Clarke 1966, Vinogradov 1968), tidal influences on the spawning activity of fish (Hart 1973), and weather-related changes in water masses. Any or all of these may profoundly influence the foraging behavior and consequent distribution of seabirds. My data indicate that daily changes can occur in the distribution of seabirds, probably as a result of concurrent changes in the distribution of prey and in local oceanographic conditions. During May, for example, murres congregated over different areas of the continental shelf on two consecutive days. Similar inconsistencies occurred in the location of the large flock of shearwaters mentioned above from one day to the next.

Most results of these surveys confirm published land-based observations concerning the chronology of seabird movements in the Gulf of Alaska. Fork-tailed Storm-Petrels did not appear over the continental shelf until April, which is consistent with the observation that this species lays eggs on the Barren Islands from mid-April to June, peak laying occurring in late May (Boersma et al. 1980). During April and May, storm-petrels congregated near a colony of 300,000 birds on this island (Fig. 3).

I observed Sooty Shearwaters on the 20 April survey (and saw a flock of 500 from a boat on 11 April 1976). (Chronologies given by Richdale [1963] for this species indicate that the earliest arrivals in Alaskan waters are nonbreeders and birds whose reproductive efforts failed.) However, we found no shearwaters south of the Aleutian Islands and in the southern Bering Sea during aerial surveys on 21–26 April 1977. Since Short-tailed Shearwaters are the predominant form in the Aleutian Islands and the Bering Sea (Gabrielson and Lincoln 1959, Shuntov 1972), they apparently arrived in Alaskan waters later than the Sooty Shearwaters in 1977.

Isleib and Kessel (1973) reported that Black-legged Kittiwakes arrived at colonies in the Gulf of Alaska in mid- or late March. This coincides with my observations that kittiwakes began to congregate along the continental slope in early March and were most highly concentrated there in mid-April (Table 1). Large numbers of Arctic Terns migrate through the Gulf of Alaska, but only from late April until mid-May (Isleib and Kessel 1973). This probably explains why I saw so few of them on the surveys (Table 1). The 20 April survey was apparently too early, and the May survey was at the end of the migration. The absence of terns in June suggests that breeding birds feed in coastal or fresh-water habitats.

I noted very few Northern Phalaropes (*Lobipes lobatus*) during these surveys although Isleib and Kessel (1973:91) reported that "immense numbers pass through the region during the second and third weeks of May." This indicates that my surveys did not occur during the peak of migration. I have seen phalaropes on aerial surveys elsewhere, and I do not believe that they went undetected.

Common Murres remain in the Gulf of Alaska during winter, but substantial numbers migrate through offshore waters during late April (Isleib and Kessel 1973). However, peak numbers occurred during the March survey (Table 1). Because I saw murres rafting near breeding cliffs during late March, I attribute the decline in their numbers over the continental slope and deep ocean during April to colony attendance. Migrating birds may have passed through the study area between surveys, or may have followed the coastline, in which case it would be more difficult to detect them on an aerial survey. Tufted Puffins winter in oceanic waters (Shuntov 1972) and arrive at colonies in Alaska from mid-April to mid-June (Gabrielson and Lincoln 1959). This timetable is confirmed by my aerial surveys in which the greatest numbers appeared at sea during April and May. Gould et al. (1978) found that this species moves into bays around Kodiak Island during the summer.

My data are generally too limited to establish migration routes for seabirds in the Gulf of Alaska. However, the large number of light-phase Northern Fulmars in the study area during April (Table 3) may indicate something about the migratory routes and wintering areas of this species since the major breeding stations of light-phase birds are in the Bering Sea (Fisher 1952, Sowls et al. 1978) rather than the Gulf of Alaska. The surveys (Fig. 3) disclose that the Fork-tailed Storm-Petrel and the Tufted Puffin winter in deep oceanic waters and move onto the continental shelf and slope during spring. Nevertheless, since their precise wintering areas are unknown, attempts to delineate their migratory routes on the basis of my data would be speculative.

The density of seabirds over the Gulf of Alaska tends to increase from March through May (Table 1), largely because of changes in the number of shearwaters. The decline in June can be attributed to difficulties in censusing shearwaters, as well as the nesting activities of Northern Fulmars, Black-legged Kittiwakes, Common Murres, Fork-tailed Storm-Petrels, Arctic Terns, and Tufted Puffins, since these species generally lay eggs between mid-May and mid-June (Gabrielson and Lincoln 1959; Harrison, pers. observ.). The spawning of capelin (*Mallotus villosus*) and herring (*Clupea harengus pallasi*; I. Warner, pers. comm.) may also induce birds to forage near shore at this time.

Sowls et al. (1978) mapped the breeding colonies of all seabirds that nest in the Gulf of Alaska. The Northern Fulmar colony closest to my trackline is in the Semidi Islands, 250 km away. The largest colony of Fork-tailed Storm-Petrels is in the Barren Islands, just northeast of Kodiak Island. Colonies of Glaucous-winged Gulls, Black-legged Kittiwakes, Arctic Terns, Common Murres, and Tufted Puffins are scattered along the east coast of Kodiak Island and the southern coast of the Kenai Peninsula. I do not know if the distribution of birds along my tracklines is related to their movements between colonies and feeding areas because the published daily flight distances for these species are based largely on conjecture. For example, Pearson (1968) listed 20 km for the Arctic Tern and 55 km for the Black-legged Kittiwake in the North Sea, but Billings (1968) showed that Leach's Storm-Petrel (*Oceanodroma leucorhoa*) can fly 65 to 359 km/day. However, some seabirds, e.g., kittiwakes (Coulson and White 1956, 1959), do not breed until they are several years of age, although they probably occur in large numbers in the population. Furthermore, it is possible that breeding and non-breeding birds feed in different areas. Therefore, one should not assume a priori that concentrations of birds at sea are breeding individuals from the nearest colony. I suspect that birds who are foraging far from known colonies are non-breeders. Many fundamental questions, including the identity of birds at sea, can only be answered with techniques, such as radiotelemetry, that permit one to find the feeding grounds and flight paths of individuals on specific colonies (Harrison and Stoneburner 1981).

The large number of statistically significant interspecific associations that I found among these seabirds (Table 2) suggests that these birds either form feeding associations or simply forage in the same areas when prey density is high. The continental shelf had the highest densities of birds from April to June (Table 1), perhaps because it is a productive area in terms of photosynthesis (Raymont 1966). In summer, the primary productivity in this part of the Gulf of Alaska is an estimated 10 to 100 mg C/$m^3 \cdot$day (Koblentz-Mishke et al. 1970); I have been unable to find published monthly differences in productivity. The continental slope had highest densities in April, and the decrease here in May may indicate the movement of birds to the continental shelf. Deep oceanic waters had the fewest birds throughout the study; their number declined here from late winter to summer.

Aerial surveys illustrate the dynamic use that seabirds make of the waters in the Gulf of Alaska during spring. The most dramatic changes in species composition and density occurred in April and May. The continental shelf supported more birds per unit area than the continental slope or deep oceanic waters.

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RECENT PUBLICATIONS

The Question of Animal Awareness/Evolutionary Continuity of Mental Experience. Revised and enlarged edition.—Donald R. Griffin. 1981. Rockefeller University Press, New York. 209 p. $13.95. This book challenges the long-held assumption that no other animals share the human capacity "for conscious thinking, planning of future actions, or any of those mental experiences which are known under the general term 'awareness.'" Drawing widely on studies in neurology, psychology, linguistics, behavior and cognate fields, Griffin builds a sober and well-reasoned argument. In this edition, he replies to the criticism levelled at the first (1976) edition. He concludes "that there may be no qualitative dichotomy, but rather a large quantitative difference in complexity of signals and range of intentions that separates animal communication from human language." This in turn opens the possibility that animals have mental experiences and communicate with conscious intent. These ideas have profound implications for research and understanding of animal behavior—and our own. At a time when most scientific books are references, monographs, collections of papers, or texts, it is a rare pleasure to find an intellectual yet readable treatise such as this, a book to be read straight through. An important book for all behaviorists, it also deserves to be read and pondered by those who believe in the uniqueness of the human mind. References, indexes.

Instinctive Navigation of Birds.—Edward Gerrard. 1981. The Scottish Research Group, Skye, Scotland. 185 p. Paper cover. $12.00. Source: Scottish Research Group, Pabay, Broadford, Skye, Scotland IV49 9BP. This book offers a new explanation for navigation/homing abilities of birds and rejects theories hitherto proposed. Gerrard argues that birds have an instinctive, enforced urge to fly tangentially at a light source when encountering low-angle glare, and directly toward bright lights that do not produce glare at low angles and toward all high-angle bright lights regardless of any glare. Such behavior, maintained by natural selection and coupled with attraction toward recognizable features, is claimed to be able to account *generally* for nearly all avian navigational performances. The author has "not attempted to offer any experimental evidence of [his] own in support of [his] ideas although [he has] made considerable use of the experimental errors of others." The last portion of the book is devoted to a sharply worded critique of the experiments conducted by several of the most notable researchers in this field. While Gerrard may have some valid points, his imprecise writing, lack of his own data, and harsh tone make his polemic at times difficult to follow. Maps, diagrams, references.

Birds of the North Solomons.—Don Hadden. 1981. Handbook No. 8, Wau Ecology Institute, Papua New Guinea. 107 p. Paper cover. $9.50. Source: Bishop Museum Press, Box 19000-A, Honolulu, Hawaii 96819. Bougainville and Buba islands are the easternmost province of Papua New Guinea, about 725 km northeast of the main island. Ornithologically, the first has received much attention, whereas the second hardly any. This book compiles present knowledge of the avifauna, including the author's own observations, and serves as a guide for field identification. Covering 155 species, it treats sea- and shorebirds (including numerous migrants) as well as land and freshwater birds. The species accounts each concisely give the appearance, voice, habitat, habits, and distribution—so far as known. Color photographs of many species are shown in 24 plates. Appendices summarize the entire list and give lists of species for certain localities. References, index.