in S3 in January and in S1 in May (Tables 1, 5). Densities along coastal transects differed among seasons with greatest densities in January and lowest densities in May (Tables 2–4, 6). At-sea densities for all seabirds combined were greater in 1975–1983 than in 1999–2002 for the entire study area, S2, S4, and S5, but did not differ significantly in S1 and S3 (Tables 7a, 7b).

SPECIES ACCOUNTS

Gaviidae

Loons occurred commonly in southern California and were observed primarily along mainland and island coastlines (Fig. 6). Because it was difficult to distinguish between Common and Pacific loons (*Gavia immer* and *G. pacifica*), and also some Red-throated Loons (*G. stellata*) when in winter plumage, 52% of loons counted were recorded as unidentified (Fig. 7). At-sea densities differed among seasons and the four sub-areas in which loons occurred (S1, S3, S4, and S5; Table 5). Greatest densities occurred in S3 in January and in S1 in May (Tables 1a, 1c). Coastal densities differed among seasons and sub-areas (Table 6). Greatest coastal densities occurred in January along mainland coasts (Tables 2–4). At-sea densities of loons were greater in 1975–1983 than in 1999–2002 for the entire study area, S2, S3, S4, and S5 (Tables 7a, 7b).

Common Loon

Common Loons winter inshore from the western Aleutian Islands, Alaska, to the southwest coast of Mexico (McIntyre and Barr 1997). In 1975–1983, Common Loons occurred in California waters from late March to late May and from late October to December (Briggs et al. 1987). Briggs et al. (1987) estimated several thousand Common Loons off California in April with hundreds occurring <0.5 km from shore. Most large loon concentrations in 1975–1983 were north of our study area (Briggs et al. 1987). In 1999–2002, we observed loons along the coast near Morro Bay, from Point Arguello to Point Dume, near San Diego, and near San Miguel and Santa Rosa islands in January and May (Fig. 8).

At-sea densities of Common Loons did not differ among the two seasons (January and May) or two sub-areas (S1 and S3) in which they were observed (Table 5). Most (82%) Common Loons were observed on coastal transects. Coastal densities differed among seasons and sub-areas and were greatest in January and along the northern portion of the mainland coast (Tables 2–4, 6).

At-sea densities of Common Loons in 1975–1983 were greater than in 1999–2002 for the entire study area and S3 (Tables 7a, 7b); but since Common Loons occurred mainly in coastal transect areas that were not surveyed by Briggs et al. (1987), we cannot determine if reduced densities truly reflect lower population sizes. In other sub-areas, we lacked the data to make statistical comparisons to Briggs et al. (1987).

Pacific Loon

Pacific Loons, the most abundant loons in North America, are strictly marine except when breeding in the Arctic and sub-Arctic (Russell 2002). Pacific Loons winter from Alaska to Mazatlan, Mexico (Russell 2002). Briggs et al. (1987) recorded greatest abundances off southern California in mid-December, especially within the eastern Santa Barbara Channel northeast of Anacapa Island. In our surveys, Pacific Loons were most common within 40 km of the southern California mainland in all seasons. In 1999–2002, we observed loons in January and May near the northern Channel Islands (except Anacapa) from Point Conception to Point Buchon, between Santa Barbara and Point Dume, and on the west side of Santa Catalina Island (Fig. 9). On at-sea transects, 87% of observed Pacific Loons were <5 km from shore.

In 1999–2002, at-sea densities of Pacific Loons did not differ among the two seasons (January and May) or the four sub-areas (S1, S3, S4, and S5) in which they were observed (Table 5). On coastal transects, densities differed among seasons and sub-areas (Table 6). Coastal densities were greatest in January and along the northern mainland and northern Channel Island coastlines (Tables 2–4).

At-sea densities of Pacific Loons were greater in 1975–1983 than in 1999–2002 for the entire study area, S3, S4, and S5 but did not differ significantly in S1 (Tables 7a, 7b). D. Nysewander (unpubl. data) found a 79% decline for loons in Puget Sound over a 20-yr period, indicating that the reduction in loon abundance may extend along the entire Pacific coast.

Western Grebe (*Aechmophorus occidentalis*) and Clark's Grebe (*A. clarkia*)

We were unable to distinguish between Western and Clark's grebes from the air, but because most observations indicate that the overwhelming majority are Western Grebes, we combined both species for analyses and hereafter refer to them as Western Grebes. Western Grebes breed on lakes from northwestern Canada to northern Baja California, Mexico,

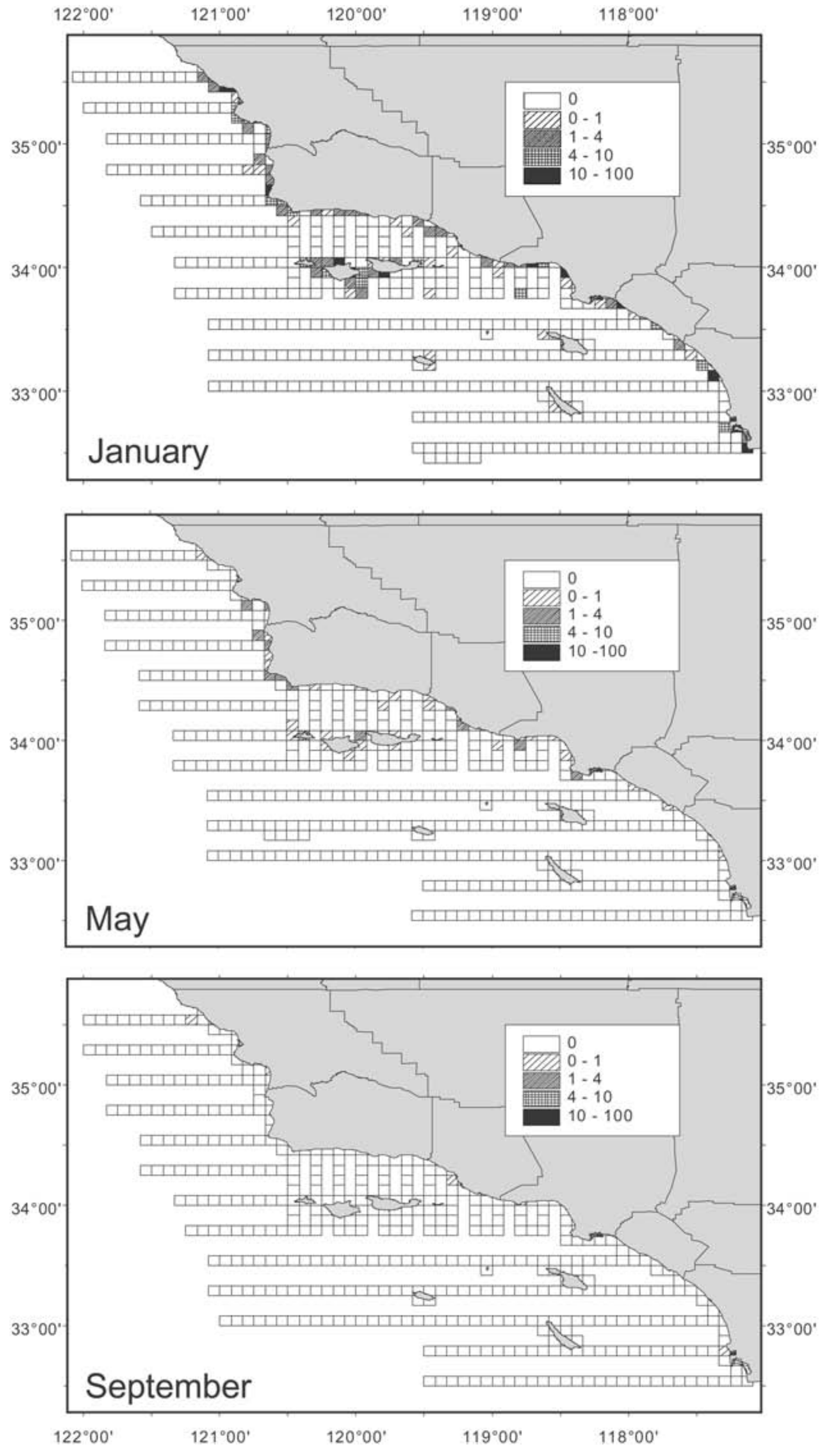

FIGURE 6. Loon densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

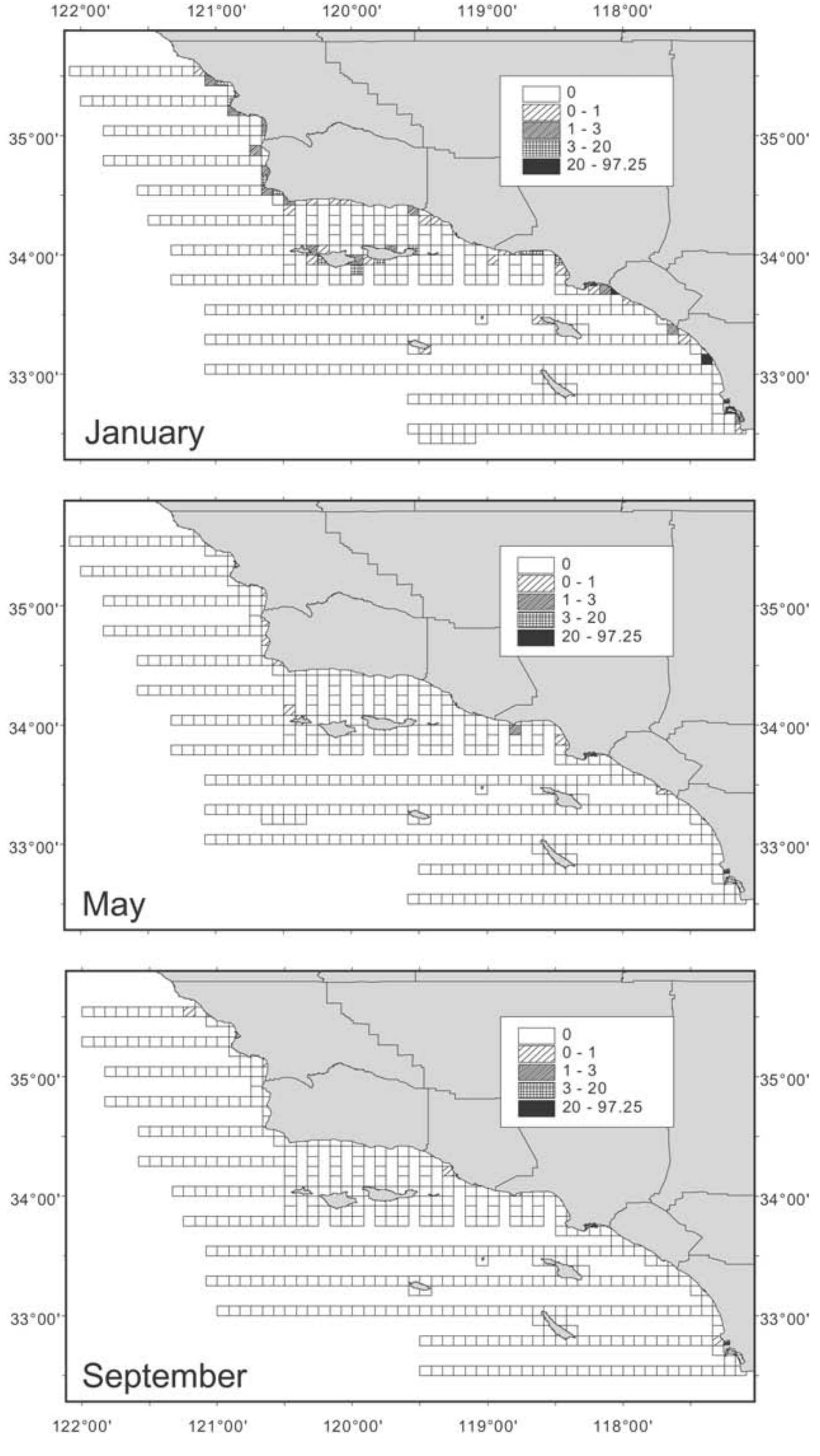

FIGURE 7. Unidentified loon densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

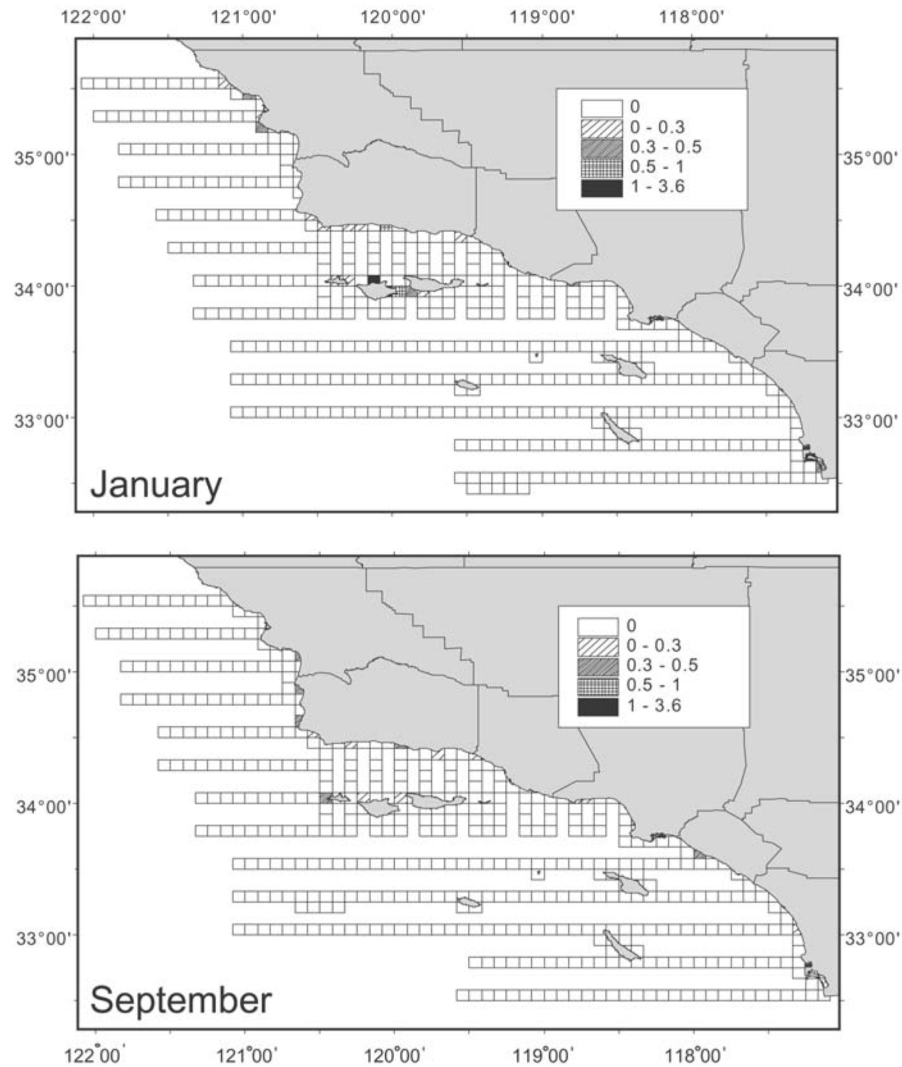

FIGURE 8. Common Loon densities (birds/km²) and distribution off southern California from 1999–2002 during January and September. No Common Loons were observed during May.

and east to Minnesota (Storer and Nuechterlein 1992). Along the Pacific Coast, they winter from southern British Columbia, Canada to southern Baja California, and Sinaloa, Mexico (Storer and Nuechterlein 1992). In the SCB from 1975–1978, Western Grebes were abundant from October through May in the eastern Santa Barbara Channel but rare near the Channel Islands and offshore (Briggs et al. 1987). In 1999–2002, Western Grebes were distributed along mainland and island coasts throughout the study area and we consistently observed aggregations of grebes in all survey months near Morro Bay, Point Sal, and Palos Verdes, and from 75 km north of San Diego to the Mexican border (Fig. 10).

More than 90% of Western Grebes occurred on coastal transects along mainland coasts. At-sea density comparisons were not statistically significant for season or among the three sub-areas where they occurred (S1, S3, and S4; Table 5). In 1999–2002, densities of Western Grebes on coastal transects did not differ among seasons but did differ among sub-areas (Table 6). Greatest densities occurred in NMC in January, SMC in May, and CMC in September (Tables 2–4).

Excluding one aggregation of 1,000 Western Grebes observed 4 km offshore, >70% of Western Grebes observed on at-sea transects occurred <2 km from shore. Therefore, we did

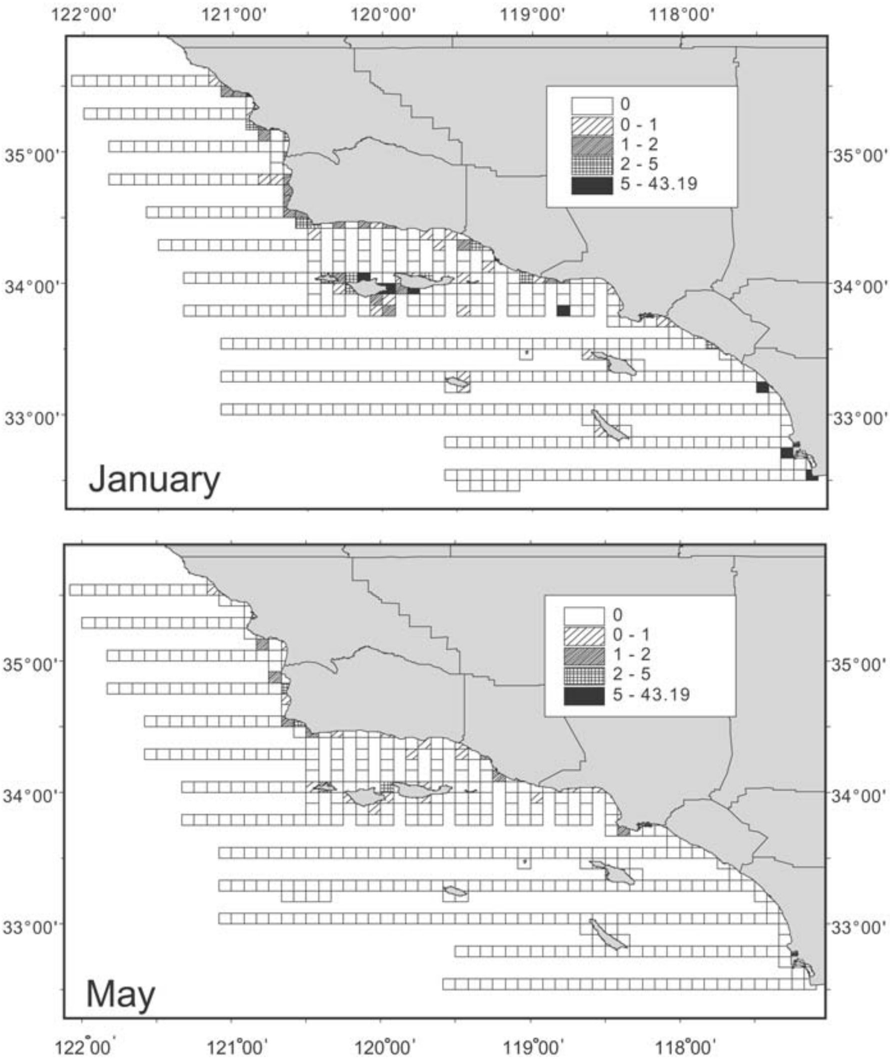

FIGURE 9. Pacific Loon densities (birds/km^2) and distribution off southern California from 1999–2002 during January and May. No Pacific Loons were observed during September.

not compare densities statistically with Briggs et al. (1987) who did not conduct aerial coastal transects in the SCB.

PROCELLARIIDAE

We observed ten species of procellariids in the study area (Fig. 11). At-sea densities differed among seasons and sub-areas with greatest densities occurring in January in S1 and in May in S3 (Tables 1, 5). Coastal densities of procellariids did not differ among seasons or four sub-areas in which they occurred but few occurred in coastal habitats (NMC, CMC, NIC, and SIC; Table 6). At-sea densities were greater in 1975–1983 than in 1999–2002 for the entire study area, S2, S4, and S5; lower in S3; and did not differ significantly in S1 (Tables 7a, 7b).

Black-footed Albatross (Phoebastria nigripes)

The Black-footed Albatross is the most abundant albatross along the eastern Pacific Coast and occurs off California in all months of the year (Briggs et al. 1987). This albatross also breeds in the Hawaiian Archipelago; population numbers were estimated to be 200,000 individuals in the early 1990s (Whittow 1993a) although that number may be decreasing (Brooke 2004). After breeding in June, adults

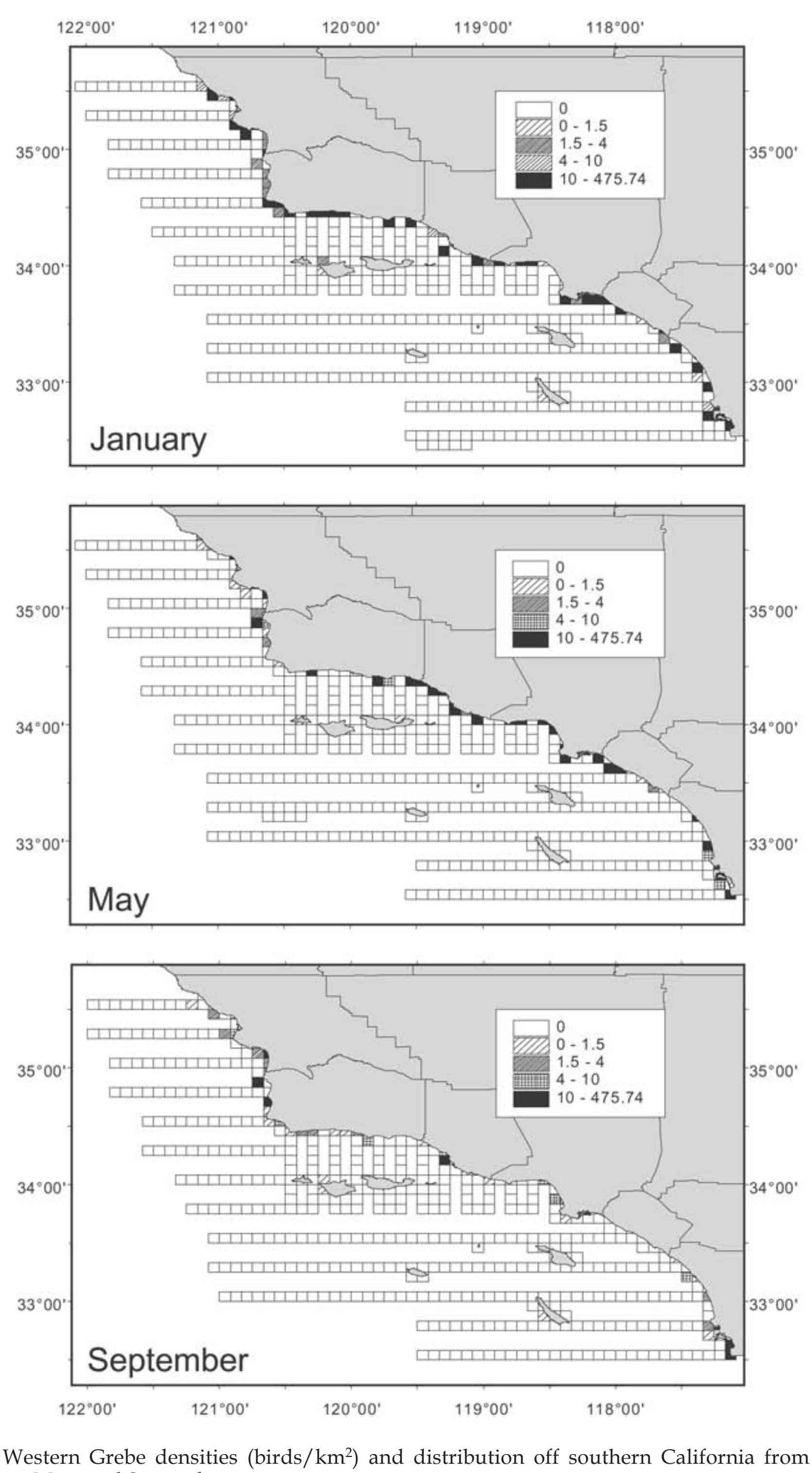

FIGURE 10. Western Grebe densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

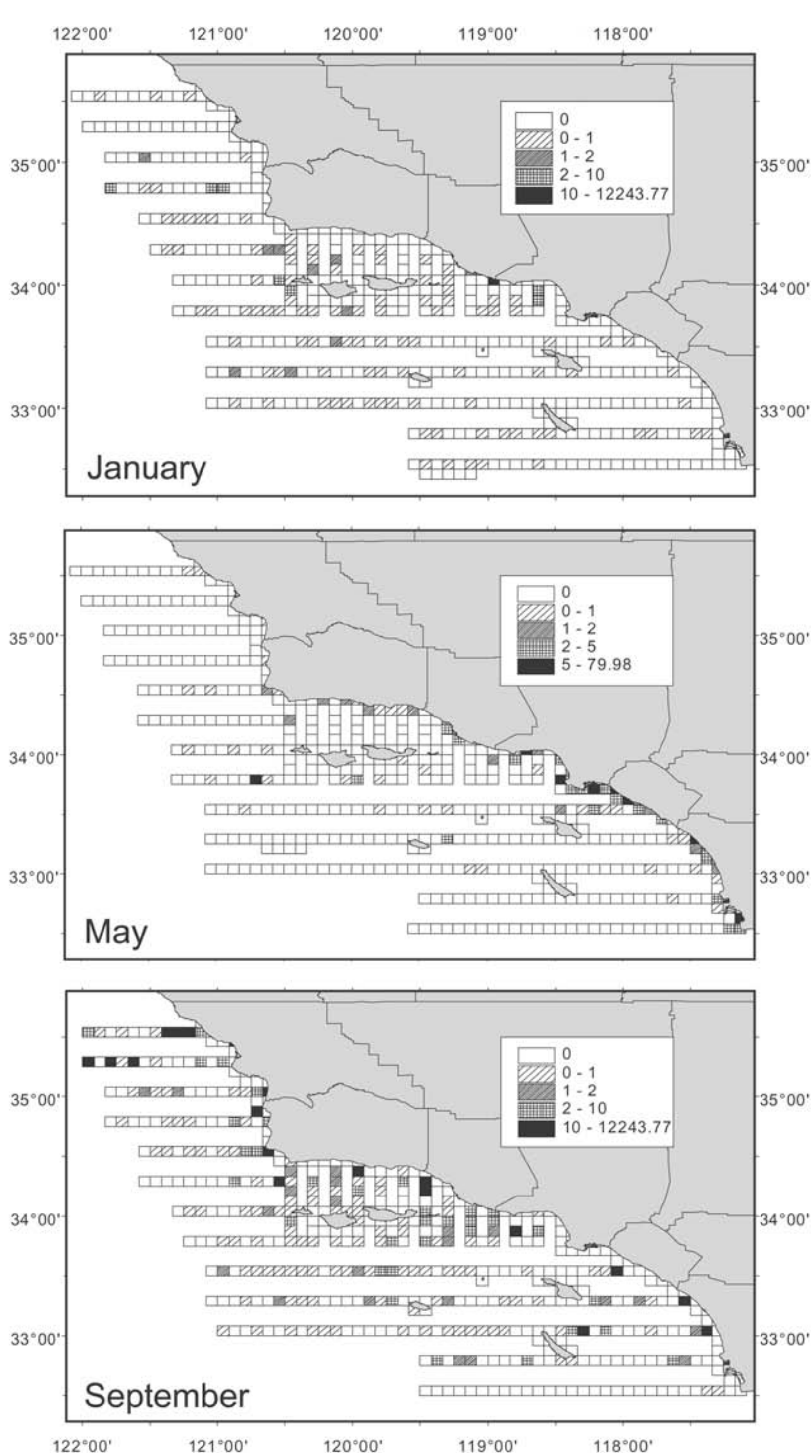

FIGURE 11. Procellariid densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

disperse into the north Pacific Ocean and are most abundant off California from June through August (Stallcup 1990, Whittow 1993a). Briggs et al. (1987) observed maximum numbers of birds off southern California in May or June and within 25 km of the Santa Rosa-Cortes Ridge, especially near San Miguel Island and Tanner and Cortez banks. In 1999–2002, we observed only eight Black-footed Albatrosses with most in May 2000 northwest of the SCB (Fig. 12). On average, sightings occurred <45 km from land (four sightings <20 km from land) and over deep waters (1,260 m; Fig. 12). Low numbers of sightings in both 1975–1978 and 1999–2002 prevented trend analysis.

Laysan Albatross (Phoebastria immutabilis)

Laysan Albatrosses are the most abundant albatrosses in the Northern Hemisphere with an estimated global population of 2,500,000 individuals in the early 1990s (Whittow 1993b). They breed almost entirely in the Hawaiian Archipelago from Kure Atoll to Kauai. In the 1980s, a small breeding colony was discovered on Guadalupe Island off central Baja California, Mexico, and other incipient colonies have developed in the Revillagigedos Islands and Alijos Rock, Mexico (Whittow 1993b). In southern California, Laysan Albatrosses occurred primarily in deeper water and far offshore (Stallcup 1990). In 1975–1978, Briggs et al. (1987) observed only seven birds, most of which were recorded over deep water and seaward of the continental shelf. In 1999–2002, we observed only six birds (Fig. 13); these sightings occurred in January in all years and in May 2001 over waters with an average depth of 1,855 m and 72 km from shore. Two Laysan Albatrosses were recorded together in January 2001 and, in May 2001, a third individual was observed on the same transect line (<2 km away). The few sightings in both 1975–1978 and 1999–2002 prevented examining differences among survey periods.

Northern Fulmar (Fulmarus glacialis)

Northern Fulmars breed at several Alaskan colonies and in the winter are distributed widely across the Pacific Ocean south to Baja California, and Sonora, Mexico (Hatch and Nettleship 1998). Briggs et al. (1987) observed Northern Fulmars off California in all seasons with maximum abundances occurring off southern California in December–January and then again in March, indicating passage south to Mexican waters in winter and return north through the SCB in spring. Northern Fulmars occurred in greatest densities 5–40 km from shore but also were observed 460 km offshore (maximum offshore distance surveyed; Briggs et al. 1987). We observed Northern Fulmars in all survey months and distributed throughout the study area in January (Fig. 14).

In 1999–2002, at-sea densities of Northern Fulmars differed among seasons and sub-areas with greatest densities in January and in S2 (Table 1b). Only four Northern Fulmars were observed on coastal transects, one near Point Mugu (CMC) and three near San Miguel Island. At sea densities in 1975–1983 were greater than densities in 1999–2002 for the entire study area, S3, and S4; were lower in S5; and did not differ significantly in S1 and S2 (Tables 7a, 7b).

Sooty Shearwater and Short-tailed Shearwater

Sooty and Short-tailed shearwaters were difficult to distinguish from the air, so we consider them together here although the vast majority of these birds are assumed to be Sooty Shearwaters. Both shearwaters breed in New Zealand, Chile, and Australia from October–May and migrate to the northern Pacific Ocean from May–September (Everett and Pitman 1993, Warham 1996). Short-tailed Shearwaters are uncommon off California in fall and winter, whereas Sooty Shearwaters are often very abundant. In the 1970s, millions of Sooty Shearwaters were estimated off California (Briggs and Chu 1986). From 1987–1994, Sooty Shearwater numbers decreased by 80–90% coincident with increased sea-surface temperatures throughout the CCS (Veit et al. 1997). Spear and Ainley (1999) suggested that changes in migratory movements may partly explain reduced southern California numbers. From 1975–1983, maximum numbers off southern California occurred in May in the shelf waters off Point Conception (Briggs et al. 1987). In 1999–2002, Sooty and Short-tailed shearwaters were distributed throughout the study area in May with largest concentrations near the northern Channel Islands (Fig. 15).

At-sea densities of Sooty and Short-tailed shearwaters differed among seasons and sub-areas (Table 5). Densities at sea were greatest in May when shearwaters occurred on all at-sea transect lines (Tables 1a–e; Fig. 15). Greatest densities occurred in S3 in May and in S1 in September (Tables 1a, 1c). Densities on coastal transects did not differ among seasons or the four sub-areas in which they occurred (CMC, SMC, NIC, and SIC; Table 6). A single flock of 6,000 Sooty and Short-tailed shearwaters near Point Sal accounted for 40% of shearwaters observed.

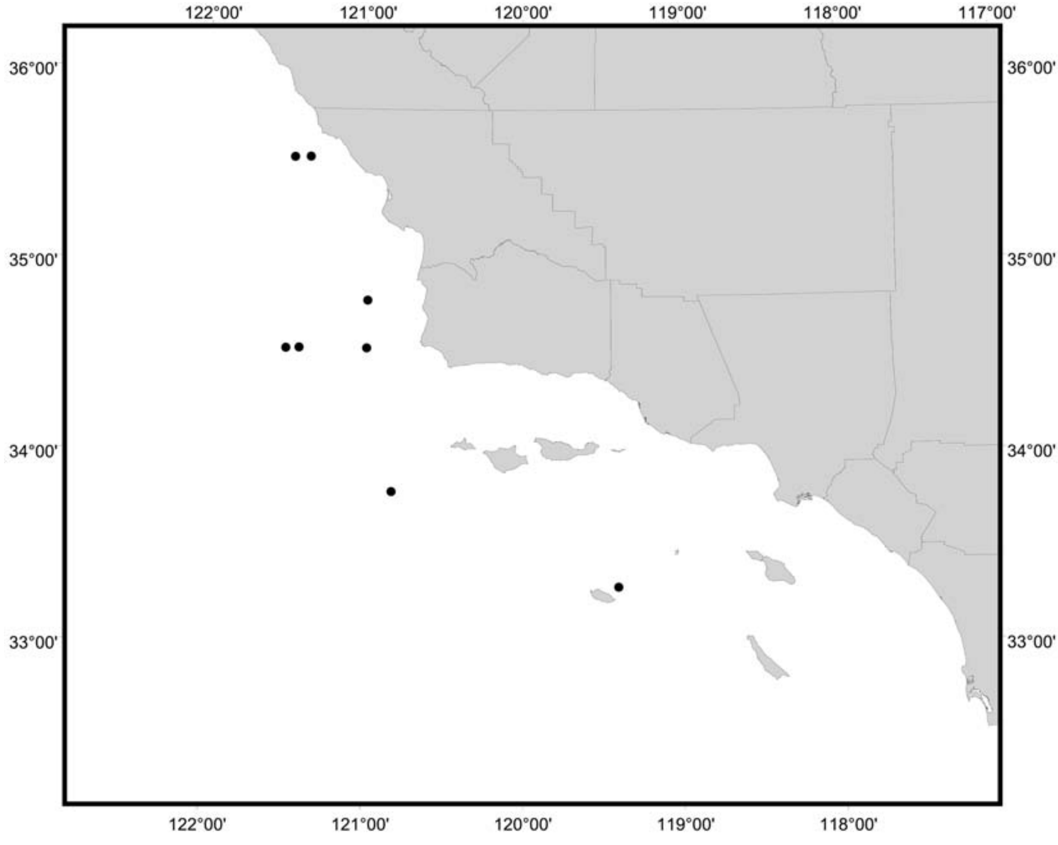

FIGURE 12. Black-footed Albatross sightings off southern California during January and May of 2000 and January and September of 2001.

At-sea densities of Sooty and Short-tailed shearwaters were greater in 1975–1983 than in 1999–2002 in S2, S4, and S5; were lower in S3; and did not differ significantly for the entire study area or S1 (Tables 7a, 7b). These results agree with declining populations reported throughout the range of the Sooty Shearwater, supporting the contention that declines may be an indication of global changes (Veit et al. 1997, Lyver et al. 1999). In addition, our greater sampling effort may have resulted in better estimates of these patchily distributed shearwaters compared with previous surveys; thus, the population decline that we estimated may be conservative.

Pink-footed Shearwater

Pink-footed Shearwaters breed off Chile from November–May and are listed as a threatened species due to a restricted breeding range and population declines (Guicking et al. 2001). About 20,000 breeding pairs nest at their main breeding colony at Mocha Island (Guicking et al. 2001). Briggs et al. (1987) observed Pink-footed Shearwaters in the SCB in almost every month. Greatest densities occurred in May or June and decreased until a second maximum in August to September. In 1975–1978 in the SCB, shearwaters were common near the Santa Rosa-Cortes Ridge in the Santa Barbara Channel and the southern coasts of the northern Channel Islands (Briggs et al. 1987). In 1999–2002, we observed Pink-footed Shearwaters throughout the study area in September, primarily south of Point Conception in May, and near Point Conception in January (Fig. 16).

At-sea densities of Pink-footed Shearwaters differed among seasons but did not differ significantly among sub-areas (Table 5). Densities were greatest in September and lowest in January (Tables 1a–e). Coastal densities did not differ between NMC and NIC but greater densities occurred in September than in May (Table 6). At-sea densities of Pink-footed Shearwaters were greater in 1975–1983 than in 1999–2002 in

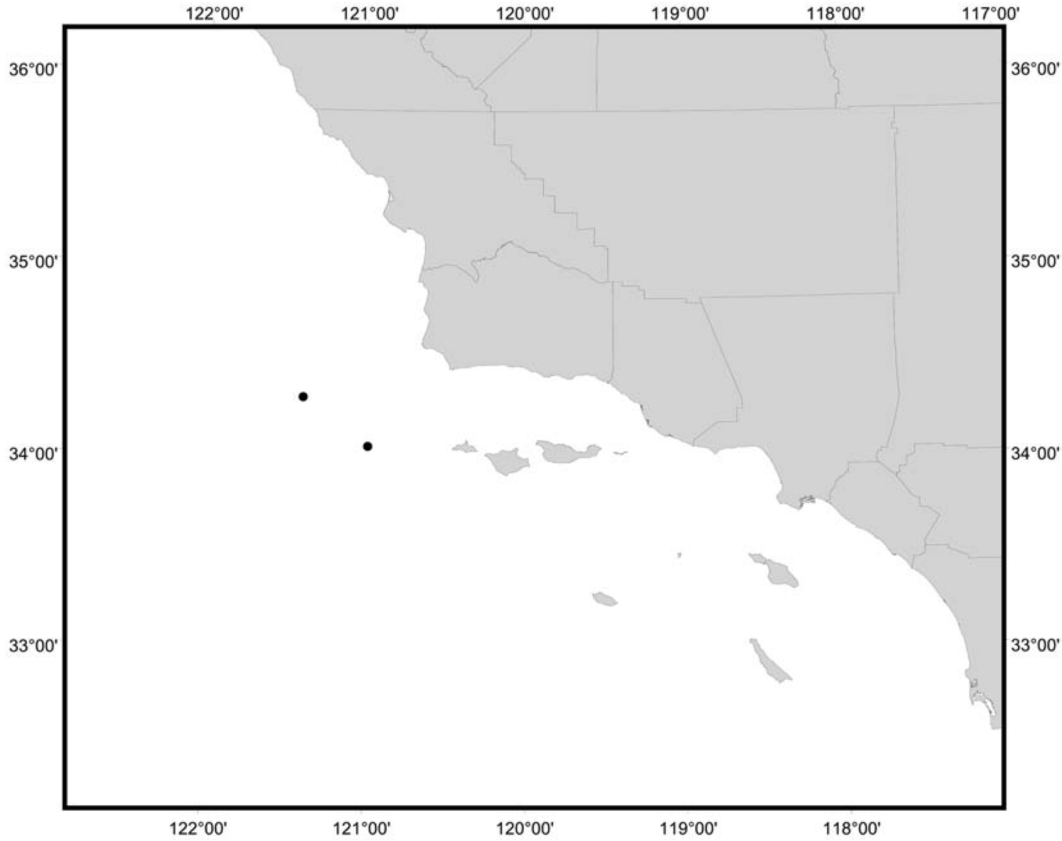

FIGURE 13. Laysan Albatross sightings off southern California during January of 2000 and 2001.

S2 and S5; lower in S4; but did not differ significantly for the entire study area, S1, and S3 (Tables 7a, 7b).

Black-vented Shearwater (Puffinus opisthomelas)

Black-vented Shearwaters breed off the west coast of Baja California, Mexico, with >95% on Natividad Island (Keitt et al. 2000). Black-vented Shearwaters are listed as a Species of Special Concern by the International Union for the Conservation of Nature (Birdlife International 2003). Post-breeding birds disperse northward in July or August and are most abundant off southern California in November, December, and January usually <25 km from shore (Everett 1988, Keitt et al. 2000). Briggs et al. (1987) recorded Black-vented Shearwaters in all months except April with maximum numbers from September–December. Ainley (1976) noted that Black-vented Shearwaters occurred farther northward during years of warm water associated with El Niño events. In September 1977 (an El Niño year), Black-vented Shearwaters occurred throughout the SCB east of the Santa Rosa-Cortes Ridge, in the eastern Santa Barbara Channel, and near Oceanside (Briggs et al. 1987). In 1975–1978, shearwaters were recorded in near-shore waters from south of Dana Point to San Diego (Briggs et al. 1987). In 1999–2002, we primarily observed Black-vented Shearwaters in the eastern Santa Barbara Channel generally <10 km from shore (Fig. 17).

At-sea densities differed among seasons and the four sub-areas where they were observed (S1, S3, S4, and S5; Table 5). In 1999–2002, densities were three times greater in January than in September (Tables 1a–e). Seventy-seven percent of Black-vented Shearwaters recorded at sea occurred in S3. We observed one Black-vented Shearwater in May and one in September 1999. On coastal transects, we observed only two birds between Anacapa and Santa Cruz islands in September 2001. We were not able to obtain Black-vented Shearwater data for the period 1975–1983 and could not compare studies statistically.

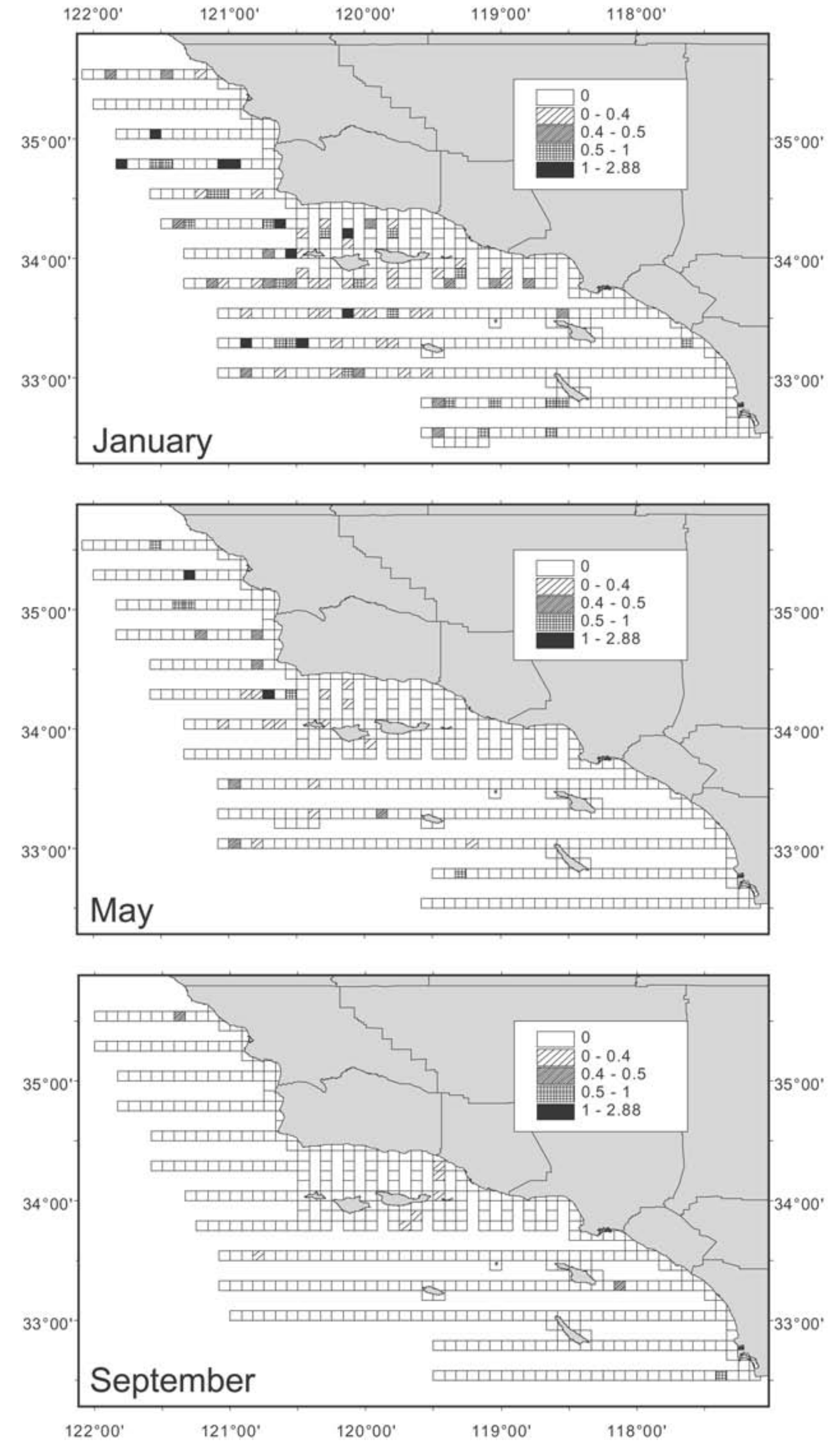

FIGURE 14. Northern Fulmar densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

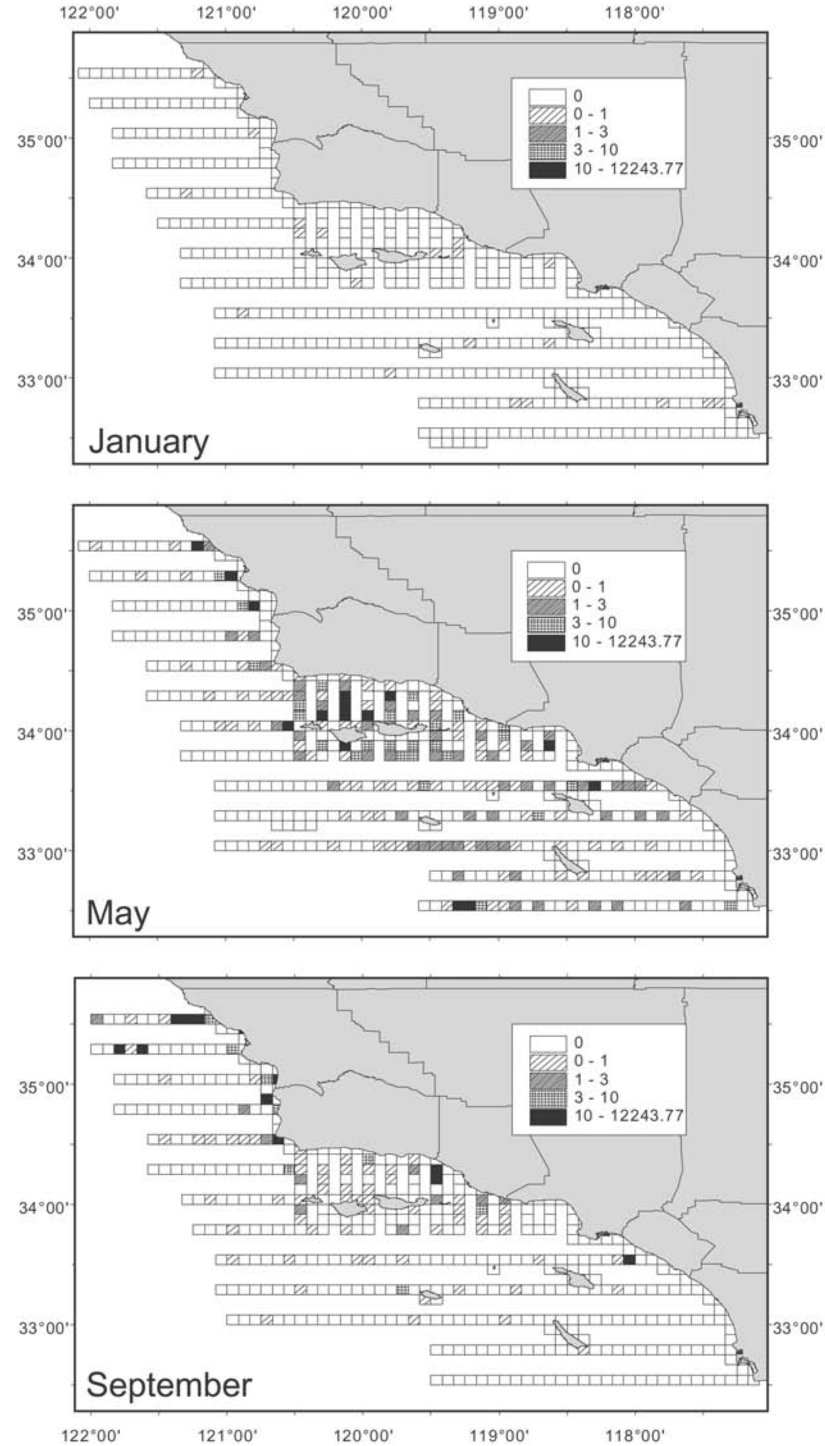

FIGURE 15. Sooty Shearwater densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

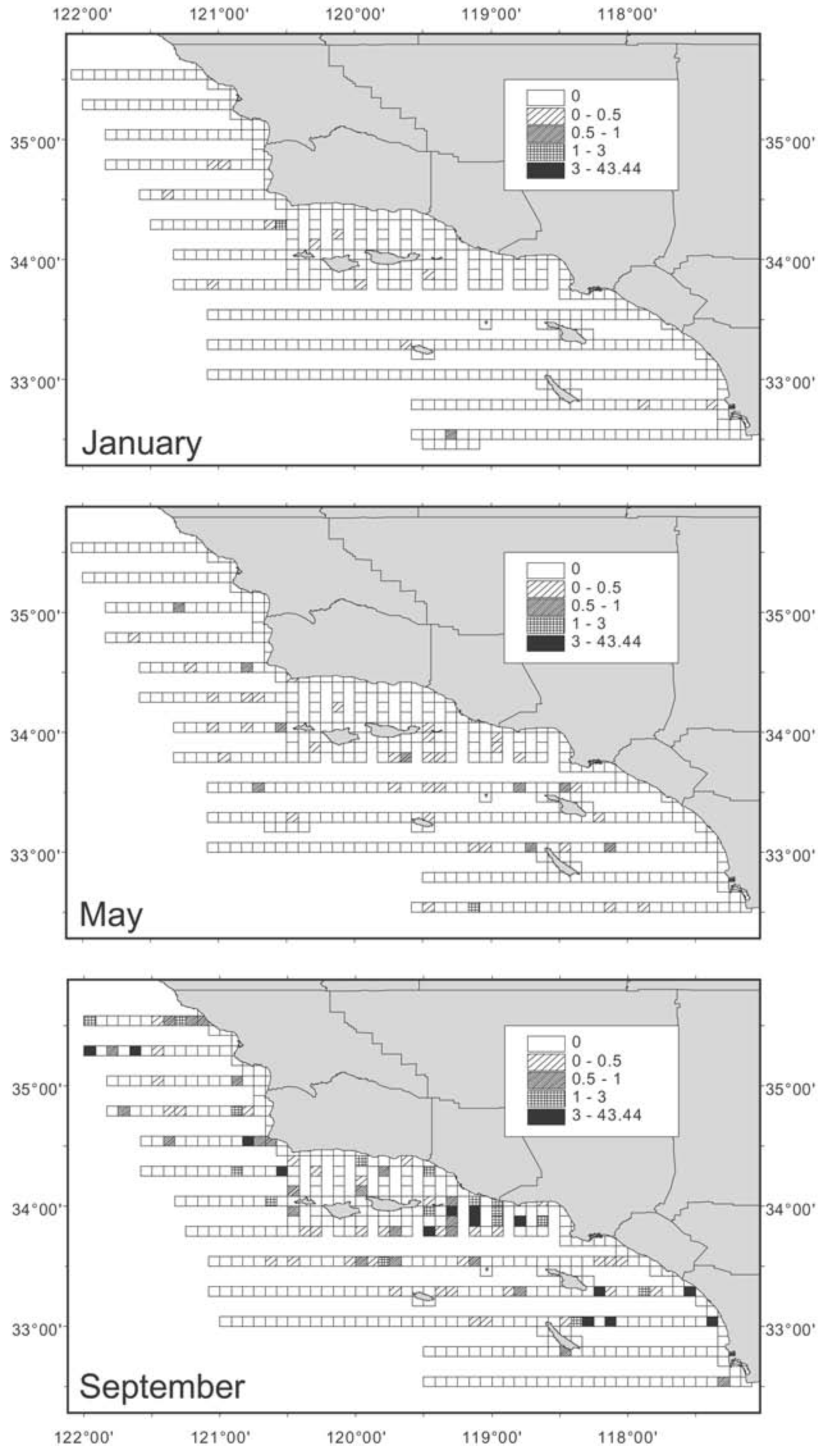

FIGURE 16. Pink-footed Shearwater densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

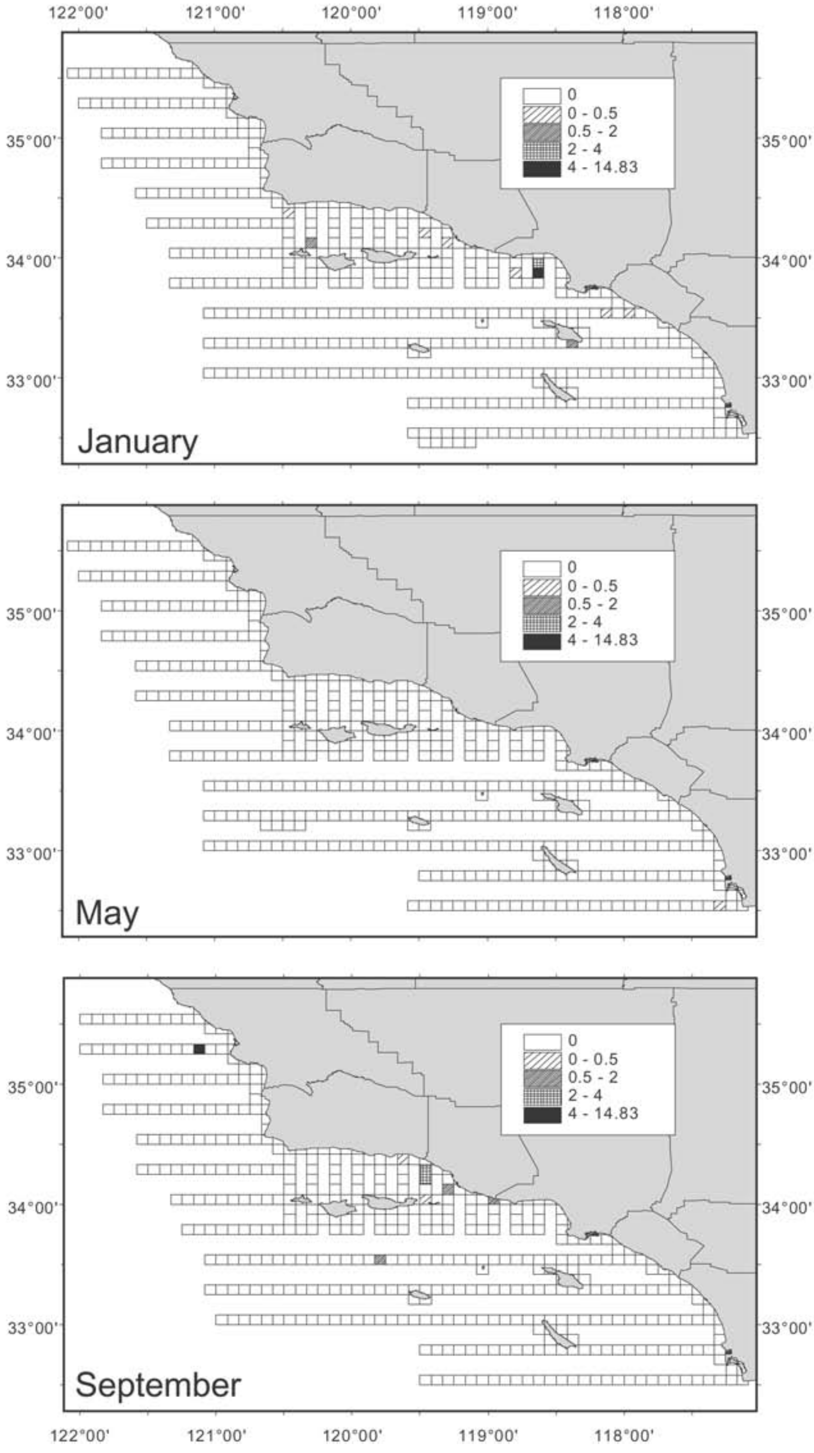

FIGURE 17. Black-vented Shearwater densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

Leach's Storm-Petrel (Oceanodroma leucorhoa)

Leach's Storm-Petrels are the most widespread procellariiform breeding in the Northern Hemisphere and, in the eastern Pacific, breed from the Aleutian Islands, Alaska, to Guadalupe Island, Baja California, Mexico (Huntington et al. 1996). In the SCB, Leach's Storm-Petrels breed on Prince, Sutil, Santa Barbara, and Coronado islands (H. Carter, unpubl. data). Although difficult to census, 314 breeding birds were estimated for the SCB in 1991 (H. Carter, unpubl. data). Briggs et al. (1987) observed Leach's Storm-Petrels in all months of the year with greatest densities off southern California from June through October and lower densities from December through May. In spring 1975–1978, Leach's Storm-Petrels occurred from San Miguel Island to Cortez Bank and eastward to just south of San Clemente Island (Briggs et al. 1987). In late summer, distribution shifted northwestward, seaward of San Nicolas and San Miguel islands (Briggs et al. 1987). In 1999–2002, we found a similar distribution as in 1975–1978 but did not find birds as close to shore in May and found a more northward distribution in September (Fig. 18). For all surveys combined, we observed 64% of birds in the southwest portion of the SCB between 33° and 34° latitude and 120° and 121° longitude and, in January, they occurred only within this area.

At-sea densities of Leach's Storm-Petrels differed among seasons and sub-areas (Table 5). Greatest densities occurred in May and September and very few birds occurred in January (Tables 1a–e). Greatest densities were in S5 and lowest densities in S4. Leach's Storm-Petrels were observed in all sub-areas in all months except for January when they were observed only in S5 (Tables 1a–e). We did not observe Leach's Storm-Petrels on coastal transects. At-sea densities of Leach's Storm-Petrels in 1975–1983 were greater than densities in 1999–2002 for the entire study area, S1, S2, S3, and S4; but lower in S5 (Tables 7a, 7b).

Black Storm-Petrel (Oceanodroma melania)

Black Storm-Petrels breed primarily in the Gulf of California, Mexico, although smaller numbers also breed along the west coast of Baja California, Mexico, and southern California (Pitman and Speich 1976, Sowls et al. 1980, Everett and Anderson 1991). In the SCB, storm-petrels breed on Santa Barbara, Sutil, and Coronado islands, and possibly on Prince (<1 km north of San Miguel Island) and San Clemente islands (H. Carter, unpubl. data). Breeding numbers are difficult to estimate because Black Storm-Petrels nest in inaccessible burrows or crevices and are active at breeding colonies only at night. In 1991, 274 breeding birds were estimated at Santa Barbara and Sutil islands representing >54% increase from 1975–1978 (H. Carter, unpubl. data).

Briggs et al. (1987) observed Black Storm-Petrels in all months with maximum abundances in August and September. In 1975–1978, birds occurred primarily south of Point Conception and <50 km from the mainland, although aggregations of birds also were observed at Forty Mile Bank (30 km southeast of San Clemente Island), near Santa Barbara Island, and along the Santa Rosa-Cortes Ridge (Briggs et al. 1987). In 1999–2001 in September and May, Black Storm-Petrels occurred between Cortez Bank and San Diego, <40 km from the northern Channel Islands, and 50–100 km from Point Buchon in September (Fig. 19).

At-sea densities of Black Storm-Petrels differed among seasons and sub-areas (Table 5). Birds were observed in nearly equal abundance in May and September, but were virtually absent in January (Tables 1a–e). Densities were greatest in S4 and S5 (Tables 1d, 1e). Black Storm-Petrels were not observed on any coastal transect. At-sea densities in 1999–2002 were greater than in 1975–1983 for the entire study area, S3, S4, and S5; but lower in S1 and S2 (Tables 7a, 7b).

Ashy Storm-Petrel (Oceanodroma homochroa)

An estimated 10,000 Ashy Storm-Petrels occur mainly off California, with small numbers off Baja California, Mexico (Ainley 1995; Carter et al., in press). Ashy Storm-Petrels occur year-round in waters of the continental slope and slightly farther to sea and do not disperse far from breeding locations (Ainley 1995). In the SCB, breeding occurs on the Coronado and Todos Santos islands, Baja California, Mexico, and six California Channel Islands (i.e., not Santa Rosa and San Nicolas), and small numbers may breed at Vandenberg Air Force Base (Carter et al., in press). The state of California designated the Ashy Storm-Petrel as a Species of Special Concern (J. Remsen, unpubl. data) and the USDI Fish and Wildlife Service designated it as a bird of conservation concern (USDI Fish and Wildlife Service 2002). In 1991, H. Carter (unpubl. data) estimated 3,135 birds in the SCB but differences in survey protocols and efforts from past studies made trends in population size impossible to assess. However, decline has been noted at the South Farallon Islands in central California (W. Sydeman, unpubl. data). Surveys in 1994–1996 found more widespread breeding in the Channel Islands and higher

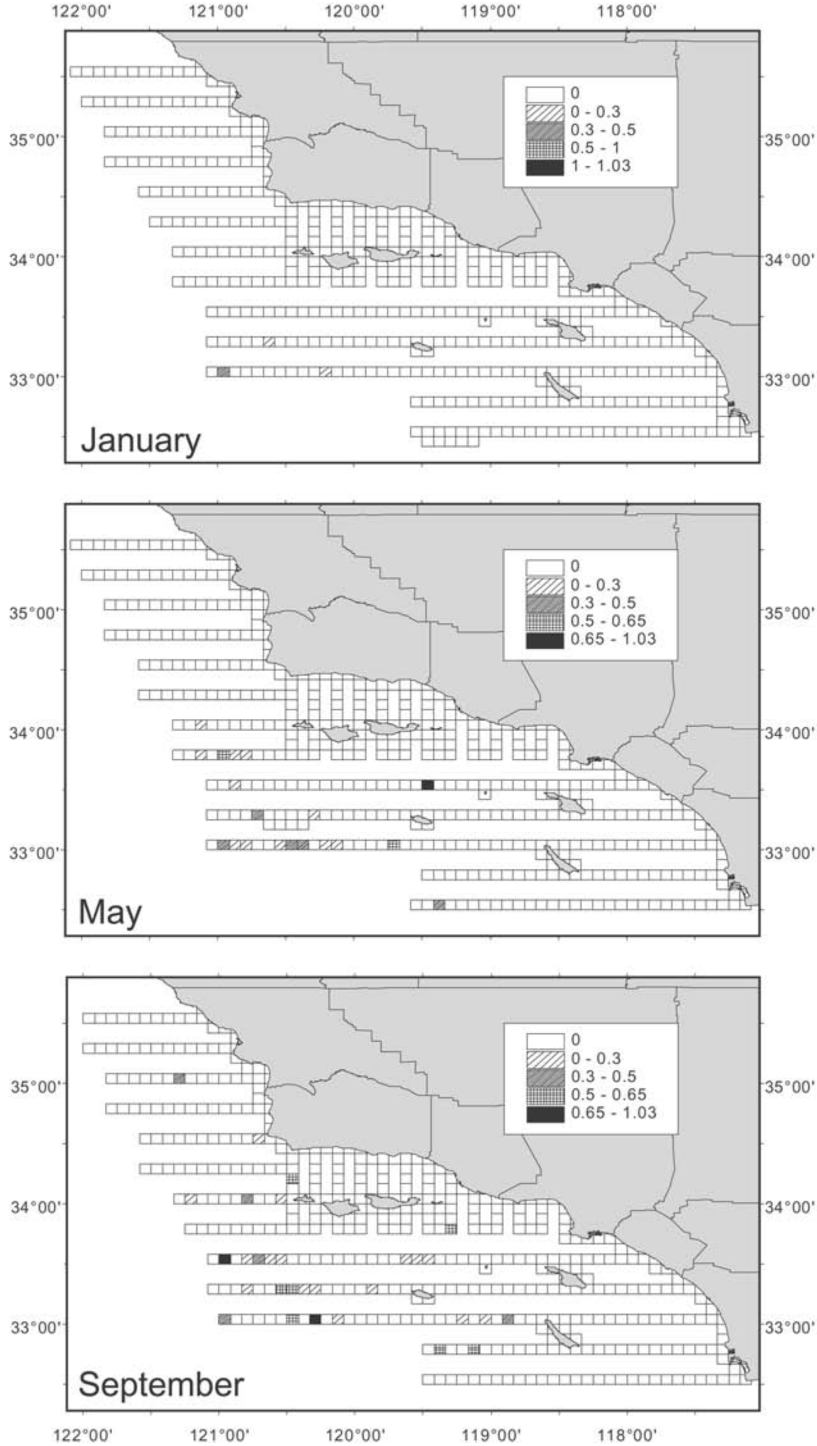

FIGURE 18. Leach's Storm-Petrel densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

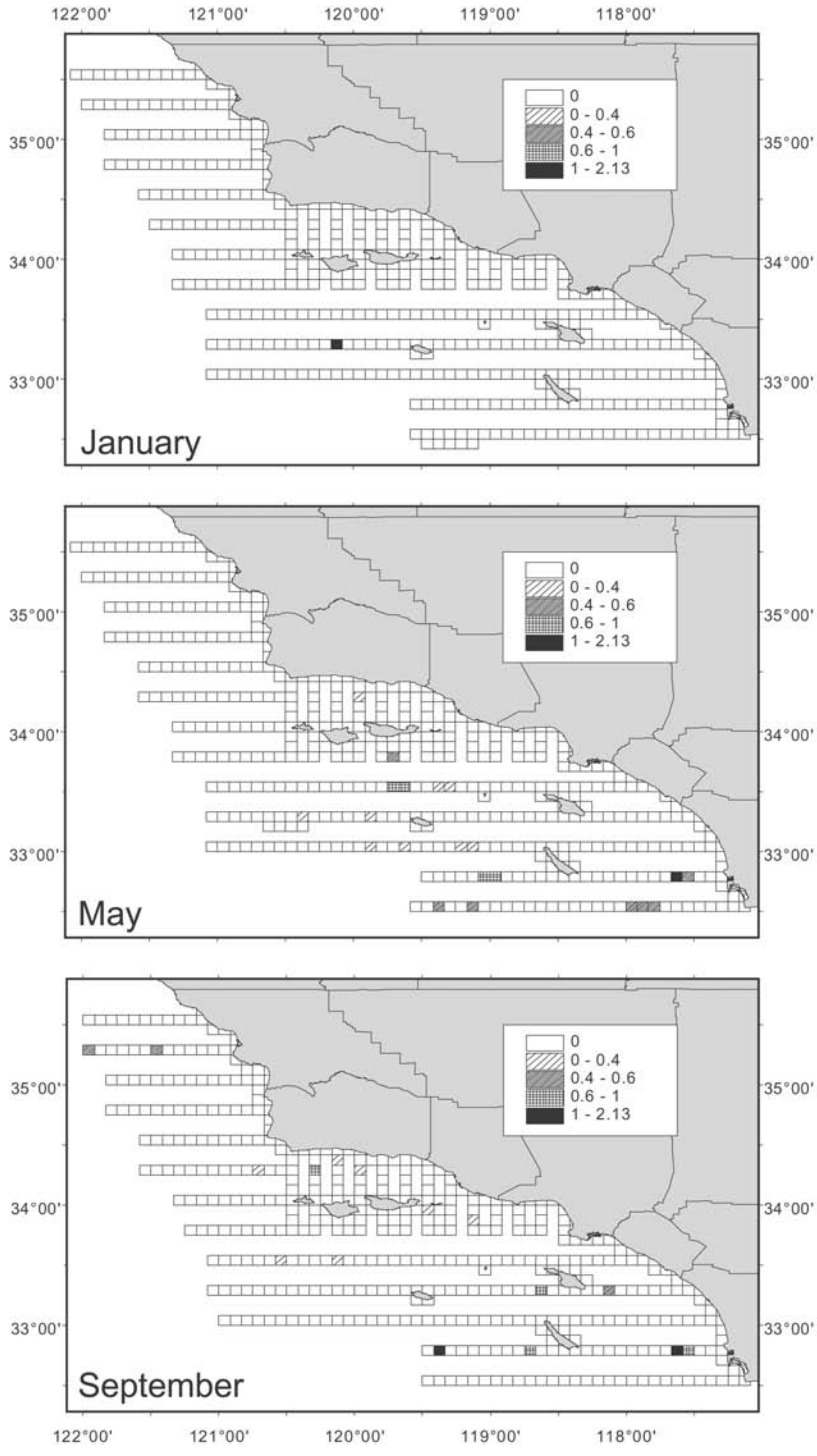

FIGURE 19. Black Storm-Petrel densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

breeding population estimates (Carter et al., in press). From 1995–2003, numbers breeding at study areas on Santa Cruz Island did not change to a great degree (McIver 2002; Carter et al., in press). Off southern California, Briggs et al. (1987) observed Ashy Storm-Petrels in greatest abundance near San Miguel Island from April–June. After October, birds occurred near San Clemente and Santa Catalina islands, over the Santa Rosa-Cortes Ridge, and in the western Santa Barbara Channel to Point Buchon (Briggs et al. 1987). In 1999–2002, we observed Ashy Storm-Petrels throughout the study area with aggregations between Santa Cruz and San Nicolas islands, in the western Santa Barbara Channel, and 10–70 km offshore from San Miguel Island to Point Buchon (Fig. 20).

In 1999–2002, at-sea densities differed among seasons and sub-areas (Table 5). Densities were greatest in May and September, and we observed birds in all sub-areas and in all months except during January in S2 and S3 (Tables 1a–e). We did not observe Ashy Storm-Petrels on coastal transects. At-sea densities of Ashy Storm-Petrels in 1999–2002 were greater than densities in 1975–1983 for the entire study area, S1, S2, S3, and S5 (Table 7). We did not test statistical differences in S5 because Briggs et al. (1987) did not observe birds in S5. However, lower densities in 1999–2002 may reflect undocumented declines at some SCB colonies, decline at the South Farallon Islands, or variation in foraging and wintering areas between years.

Brown Pelican (Pelecanus occidentalis)

The Brown Pelican subspecies, *P. o. californicus,* currently breeds from the California Channel islands south along the Pacific coast of Baja, California, Mexico, throughout the Gulf of California, and south along the Pacific coast of Mexico to Isla Tres Marias and ranges from southern British Columbia, Canada, to Colimas, Mexico (Shields 2002). Greatest pelican abundance in southern California occurs in late summer and early fall coincident with dispersal of birds from breeding colonies in Mexico; abundance is lowest after breeding adults return to breeding colonies in Mexico in early winter (Anderson and Anderson 1976; Briggs et al. 1981, 1983; Jaques 1994; Jaques et al. 1996). In the 1960s and 1970s, Brown Pelicans experienced extremely poor breeding success in southern California due to eggshell thinning caused by DDE contamination (Keith et al. 1971, Risebrough 1972, Jehl 1973, Anderson et al. 1975, Anderson and Gress 1983, Gress and Anderson 1983). Reproductive success did not rebound until the late 1970s (F. Gress, unpubl. data). In 1969–1978, <800 nests were estimated to be on West Anacapa Island. In 1991, about 5,300 pairs were estimated on West Anacapa Island and about 600 breeding pairs were estimated on Santa Barbara Island (H. Carter, unpubl. data).

Briggs et al. (1987) reported lowest densities of Brown Pelicans in California from December through March and greatest densities in September and October with most birds <20 km from shore. Similarly, in 1999–2002 we observed greatest densities in September with 83% observed on at-sea transects <10 km from shore. Brown Pelicans typically roost on land when not feeding at all times of year, leading to relatively low densities at sea, compared to some other seabirds.

In 1999–2002, Brown Pelicans were distributed along coastlines and near roosting sites throughout the study area and occurred in all at-sea sub-areas (Fig. 21). They generally were more abundant along mainland than island coastlines and densities were greatest along the CMC in May (possibly due to breeding activities on Anacapa Island) and NMC and SMC in September (Tables 2–4). In all survey months, Brown Pelicans were most abundant near Point Loma, Palos Verdes, Point Sal, and along the mainland coast of the Santa Barbara Channel and the southern coast of Santa Rosa Island (Fig. 21).

At-sea densities of Brown Pelicans differed significantly among seasons and sub-areas (Table 5) and were greatest in September when breeding birds from Mexico arrived in the SCB. Densities were generally greatest in S3, probably due to the proximity of numerous available roost sites on the northern Channel Islands and on the central mainland coast (Point Conception to Point Dume; Table 1c). We observed only 12 Brown Pelicans in S2. Along coastlines, their densities were greatest in September (Tables 2–4, 6). Densities did not differ significantly among coastal sub-areas (Table 6).

For the entire study area, at-sea densities of Brown Pelicans were greater in 1999–2002 than in 1975–1983 (Tables 7a, 7b), reflecting increased breeding populations in the Gulf of California and in southern California. Pelican densities were lower in S4 and S5; higher in S2 where no pelicans were observed in 1975–1983; and did not differ significantly in S1 and S3 (Tables 7a, 7b).

Cormorants

Densities of all cormorants, including those not identified to species, were combined (Fig. 22) because the three species, Brandt's, Pelagic,

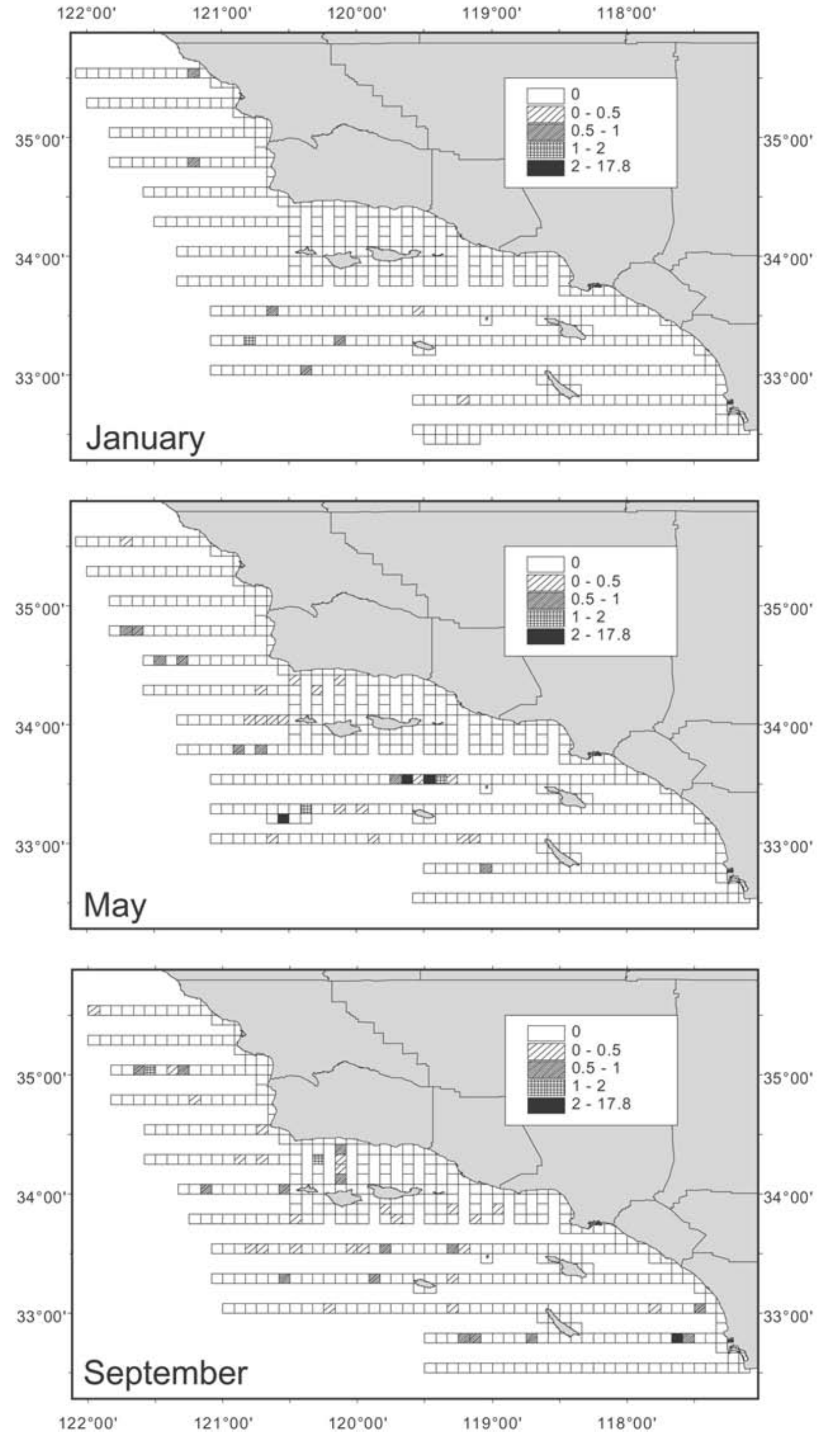

FIGURE 20. Ashy Storm-Petrel densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

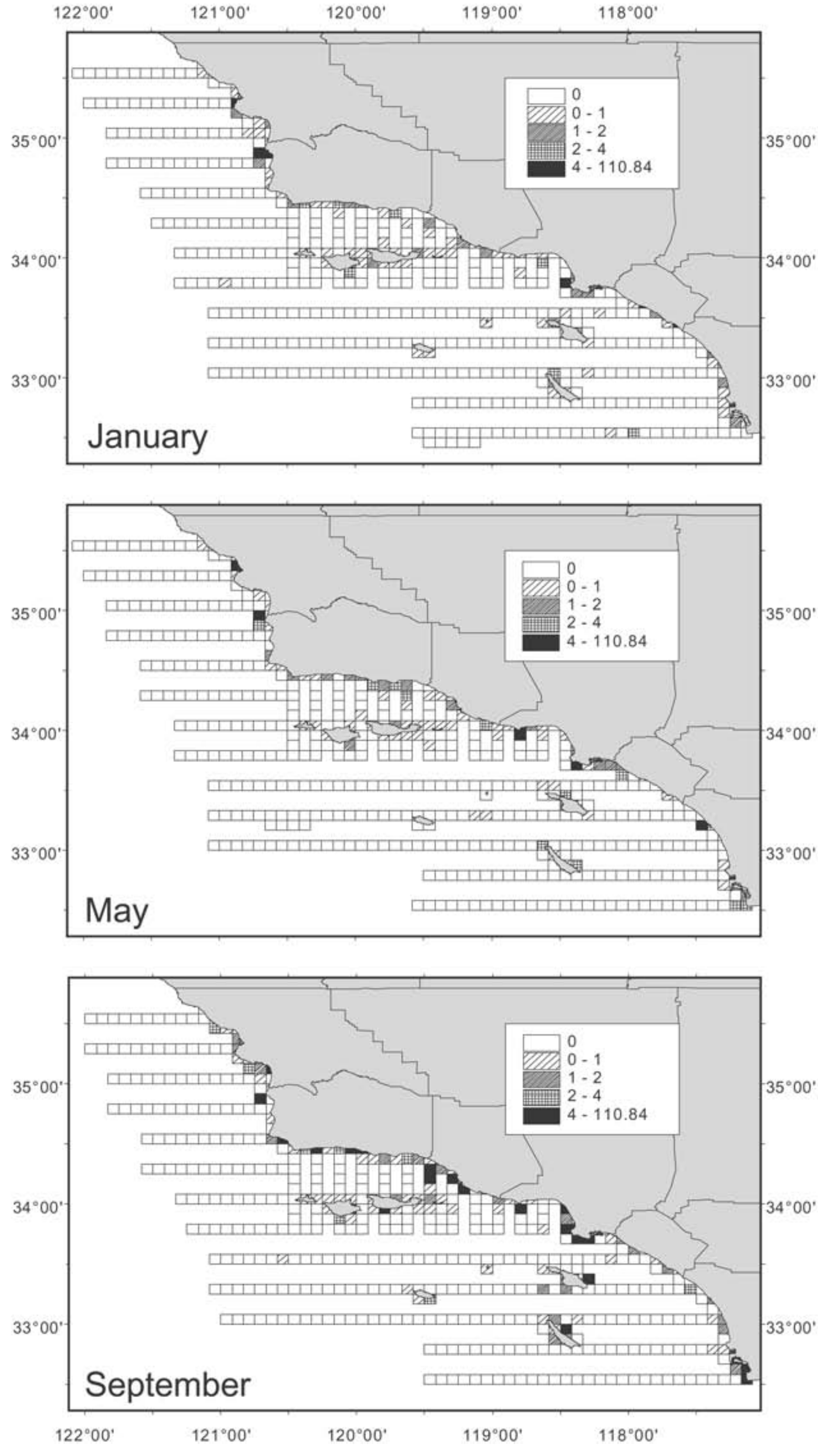

FIGURE 21. Brown Pelican densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

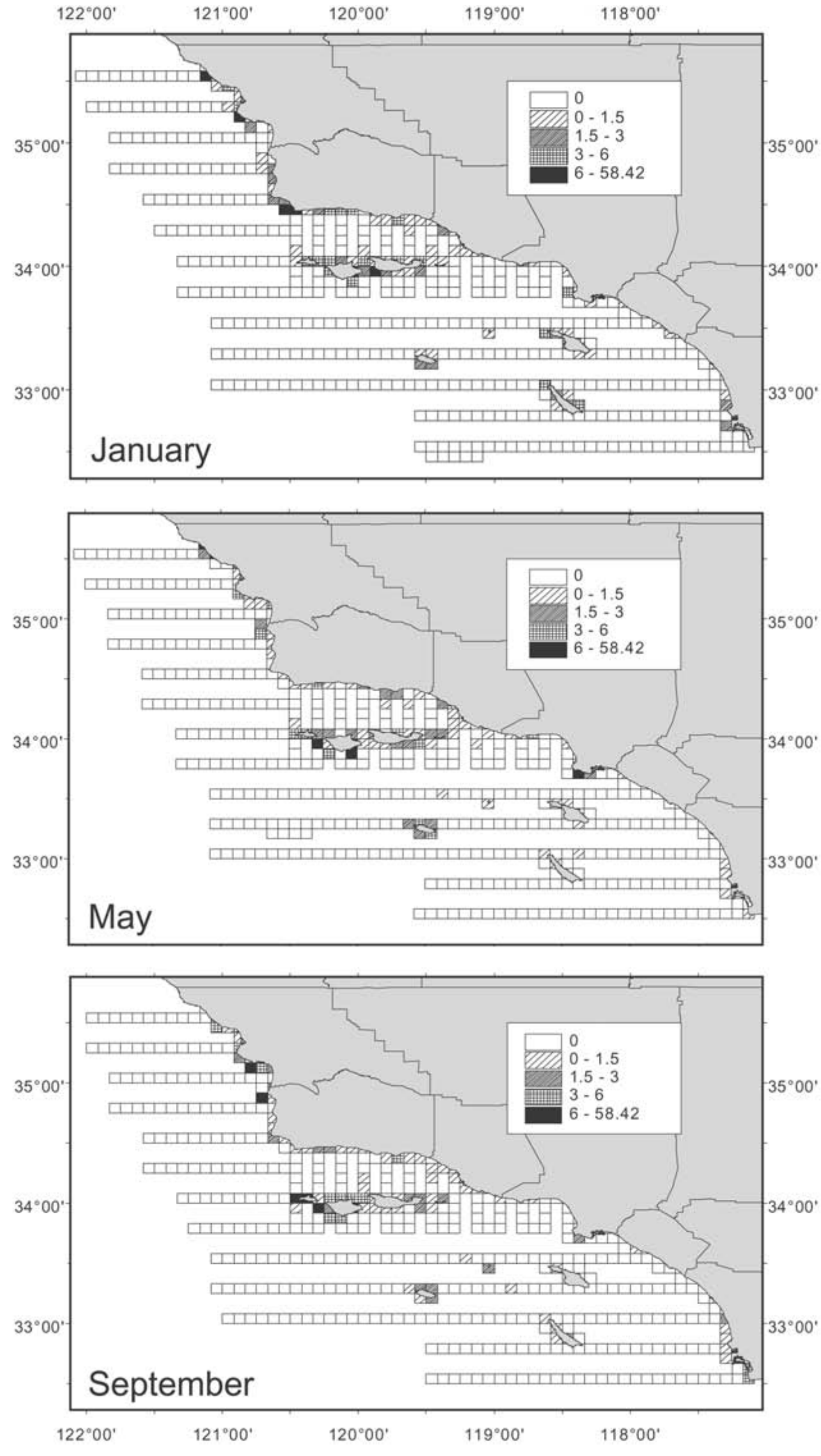

FIGURE 22. Cormorant densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

and Double-crested cormorants (*Phalacrocorax penicillatus*, *P. pelagicus*, and *P. auritus*) were difficult to distinguish from the air and 45% of observed cormorants were unidentified (Fig. 23). Cormorants occurred in every at-sea sub-area except S2 and in every season (Fig. 22). At all times of year, cormorants typically roost on land when they are not feeding, and thus have relatively low densities at sea compared with other seabird families. At-sea densities of cormorants did not differ among seasons, but did differ among sub-areas, with greatest densities occurring in S3 (Tables 1, 5). Coastal densities of cormorants did not differ among seasons, but did differ among sub-areas with greatest densities along the NMC in all months (Tables 2–4, 6). At-sea densities were greater in 1999–2002 than in 1975–1983 for the entire study area, S1, and S5; and were lower in S3 and S4 (Tables 7a, 7b).

Double-crested Cormorant

Double-crested Cormorants are the most numerous and widely distributed of the six North American cormorants but are rarely observed far from land (Hatch and Weseloh 1999). Along the Pacific Coast, the subspecies *P. a. albociliatus* breeds from southern British Columbia, Canada, to the Gulf of California in marine and estuarine habitats (Harrison 1983, Carter et al. 1995). In the SCB Double-crested Cormorants experienced reduced breeding success in the mid-twentieth century due to DDE contamination (Gress et al. 1973; F. Gress, unpubl. data). In 1969, severe eggshell thinning from DDE contamination was discovered in colonies on West Anacapa Island and South Coronado Island, Mexico (Gress et al. 1973, Jehl 1973). Reduced breeding success continued until the early 1970s at the West Anacapa Island colony, but thereafter, breeding success gradually improved (Anderson and Gress 1983; F. Gress, unpubl. data). In 1991, the estimated 5,000 breeding pairs in southern California represented greater than a four-fold increase over 1975–1978 estimates (H. Carter, unpubl. data).

In the SCB, breeding colonies are located on Prince, West Anacapa, and Santa Barbara islands (H. Carter, unpubl. data). Only a few Double-crested Cormorants were observed at sea in 1975–1983 and these were <3 km from breeding colonies (Briggs et al. 1987). In 1999–2002, Double-crested Cormorants were observed consistently near Point Loma and Palos Verdes, south of Point Buchon, north of Morro Bay, along the mainland coast of the Santa Barbara Channel, and near the four northern Channel Islands, and San Nicolas Island (Fig. 24). We observed 86% of Double-crested Cormorants <1 km from shore. In May and September, individuals were occasionally observed 20–30 km northwest of Santa Barbara Island.

We found that at-sea densities of Double-crested Cormorants differed among seasons and the four at-sea sub-areas in which they occurred (S1, S3, S4, and S5; Table 5). At-sea densities were generally greatest in January and in S1 (Table 1a). In May and September, densities were greatest in S3 near breeding colonies (Table 1c). Densities differed among coastal sub-areas, but greatest densities occurred in the CMC in each survey month (Tables 2–4, 6). Double-crested Cormorants occurred in all coastal sub-areas, and coastal densities were up to 40-fold greater than at-sea densities.

Statistical comparisons between 1975–1983 and 1999–2002 surveys were limited to the entire study area, S3, and S4 because of limited observations in other sub-areas during 1975–1983. At-sea densities of Double-crested Cormorants were greater in 1999–2002 than in 1975–1978 for the entire study area and in S3, but were lower in S4 (Tables 7a, 7b). Greater densities were consistent with increased SCB breeding populations. Although continent-wide increases also may have led to increased wintering birds coming from other areas, we could not determine if other breeding populations were represented in the winter.

Brandt's Cormorant

Brandt's Cormorants nest along the Pacific Coast from southwest Vancouver Island, British Columbia, Canada, to southern Baja California, Mexico, including portions of the Gulf of California (Wallace and Wallace 1998). They are one of the most widely distributed and abundant breeding seabirds in southern California and currently breed on all Channel Islands except Santa Catalina Island (H. Carter, unpubl. data). The population size of Brandt's Cormorants decreased in the 1950s and 1960s likely because of breeding failures caused by DDE contamination and human disturbance (McChesney et al. 1997; G. Hunt, unpubl. data). At Santa Barbara and San Nicolas islands, cormorant abundance decreased by 50–90% from the 1950s–1977 (McChesney et al. 1997; G. Hunt, unpubl. data). In 1991, however, about 14,700 breeding pairs were estimated in southern California, a four-fold increase since 1975–1978 (7,600 birds; H. Carter, unpubl. data). In 1975–1983, Brandt's Cormorants occurred primarily in shallow waters <10 km from shore and <25 km from island or mainland roosts or colonies

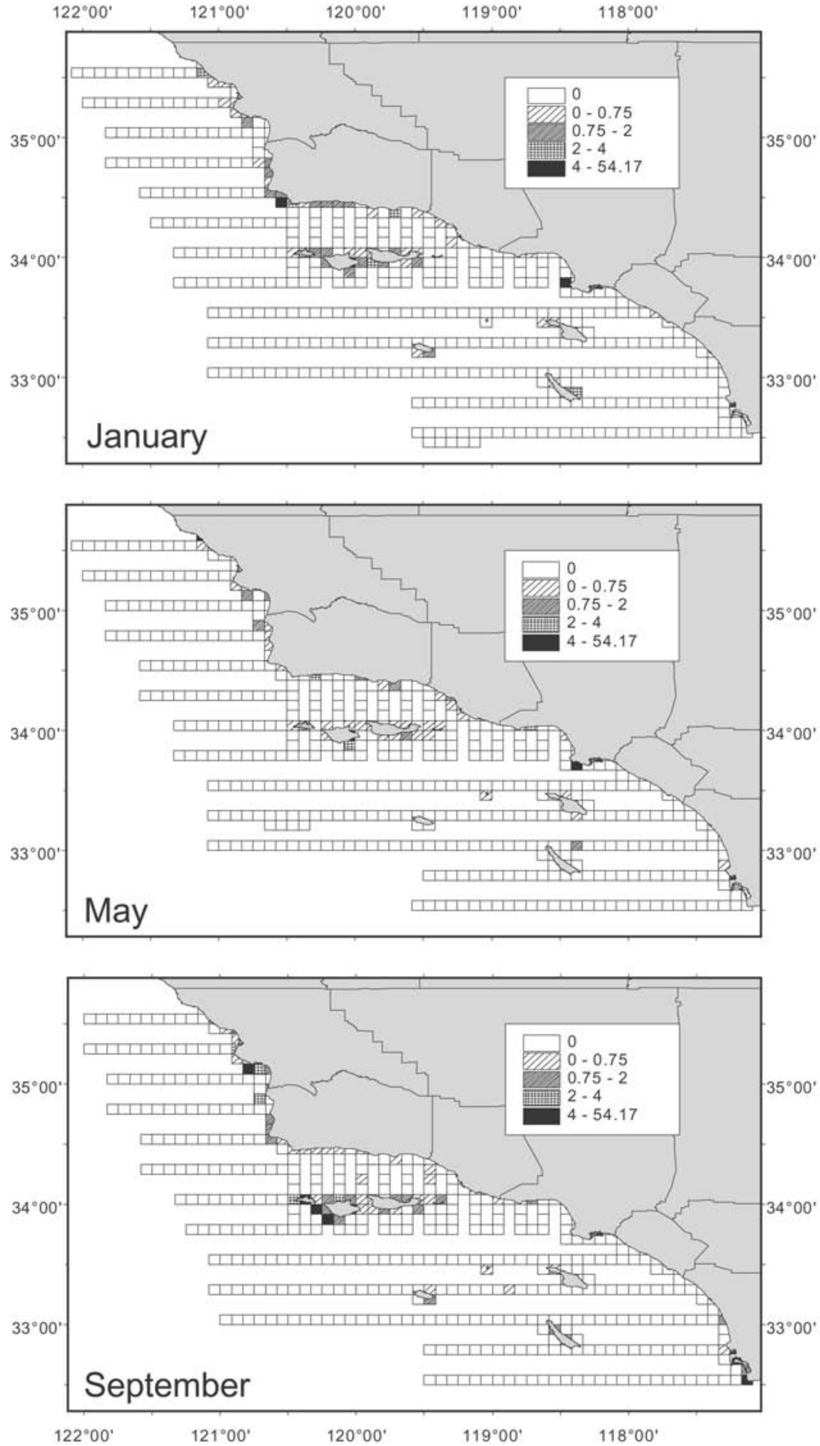

FIGURE 23. Unidentified cormorant densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

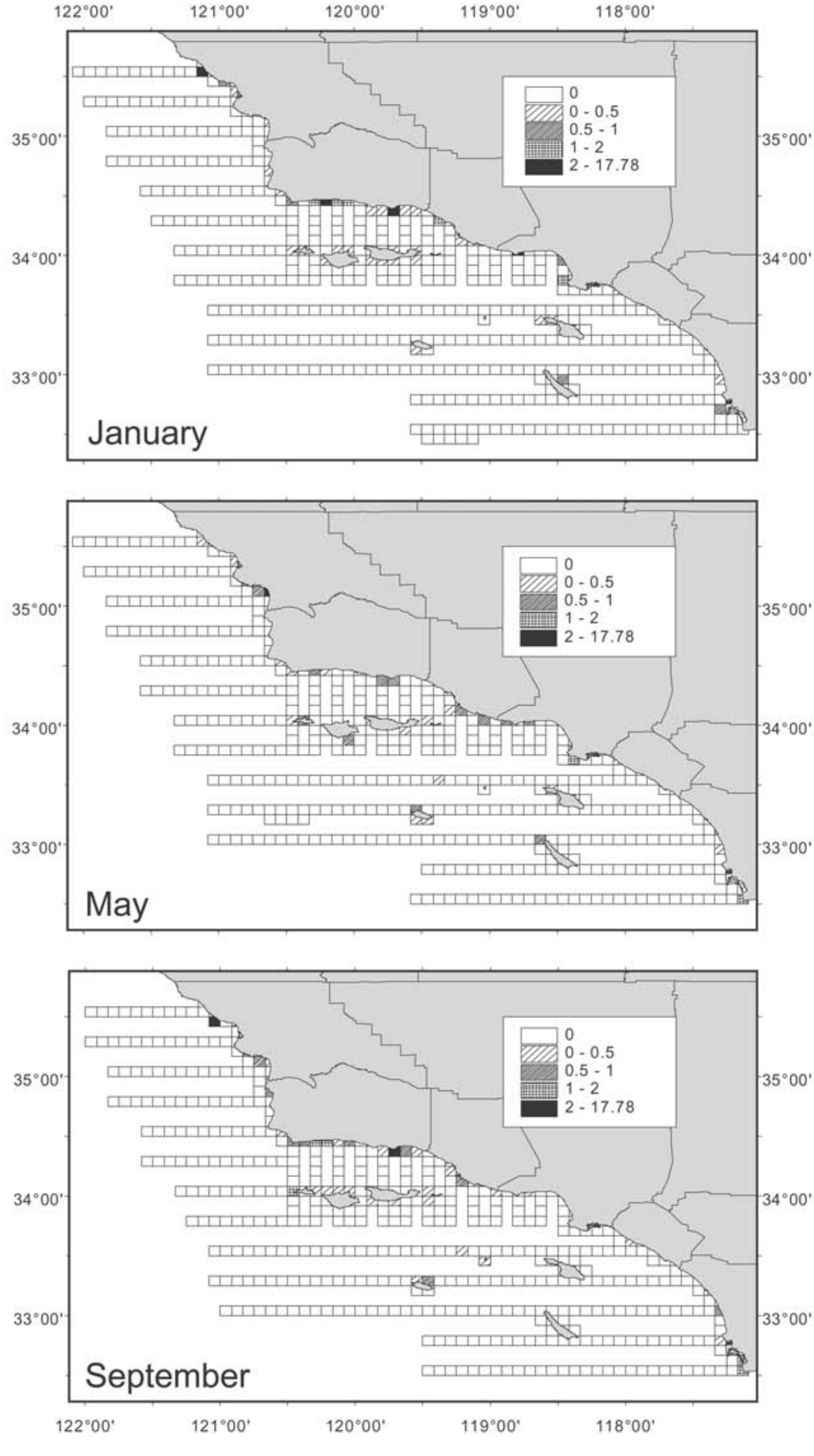

FIGURE 24. Double-crested Cormorant densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

(Briggs et al. 1987). Along mainland coasts, birds consistently occurred near large roosts and near Point Loma, Palos Verdes, Point Sal, and Point Buchon (Fig. 11). Brandt's Cormorants were present at Santa Catalina Island in January and San Clemente Island in January and September. In May, however, reduced densities occurred in the southeastern SCB and increased densities occurred in the northern SCB where most breeding colonies were located.

In 1999–2002, at-sea densities of Brandt's Cormorants did not differ significantly among seasons but did differ among the four sub-areas in which they occurred (S1, S3, S4, and S5; Table 5). We observed greatest densities in S3 and S5 (Tables 1c, 1e). In all seasons, Brandt's Cormorants were concentrated near the northern Channel Islands and near San Nicolas Island (Fig. 25). This distribution corresponds to the presence of large breeding colonies and roost sites on these islands. Coastal densities of Brandt's Cormorants did not differ significantly among seasons, but did differ among sub-areas with greatest densities occurring along Channel Island coastlines, especially along the NIC (Tables 2–4, 6). We observed greater densities of Brandt's Cormorants at sea in 1999–2002 than in 1975–1983 for the entire study area and in each of the four sub-areas in which they occurred (S1, S3, S4, and S5; Tables 7a, 7b), reflecting increased SCB breeding populations between survey periods.

Pelagic Cormorant (Phalacrocorax pelagicus)

Pelagic Cormorants are the most coastal of the southern California cormorants and are rarely observed more than a few kilometers from shore (Sowls et al. 1980, Ainley et al. 1990). Pelagic Cormorants breed from Alaska to the Coronado Islands in northern Baja California, Mexico (Wilbur 1987, Howell and Webb 1995), and occur south to central Baja California, Mexico (Hobson 1997). They breed on five Channel Islands. In 1991, H. Carter (unpubl. data) estimated about 1,400 breeding pairs in the SCB, a three-fold increase over 1975–1978 estimates.

Briggs et al. (1987) observed few Pelagic Cormorants, most north of Point Conception and <10 km from shore. Similarly, we observed most birds <10 km from shore, but unlike the previous study, >80% of the birds occurred south of Point Conception near breeding colonies at San Miguel, Santa Rosa, and Santa Cruz islands. Along the mainland coastline, we consistently observed birds near Point Buchon and Morro Bay in May and September (Fig. 26). Although Pelagic Cormorants breed at Santa Barbara Island (H. Carter, unpubl. data), we did not observe birds near that island in May 1999–2001. The few birds observed in September surveys, however, occurred within 10 km of Santa Barbara Island.

We observed only nine Pelagic Cormorants on at-sea transects and did not have sufficient data to compare at-sea densities among season, sub-area, or to 1975–1983. Most of our sightings occurred in the Santa Barbara Channel, but two birds were seen near Morro Bay.

Along coastlines, densities of Pelagic Cormorants differed among seasons and sub-areas (Table 6). Greatest densities of birds occurred along the CMC and along the NIC (Tables 2–4). Coastal densities were similar in January and May, and few birds were observed in September surveys (Tables 2–4), suggesting little movement of wintering birds from more northern areas into southern California. Pelagic Cormorants were more easily identified to species in May, due to the presence of their conspicuous white flank patches. In January and September surveys, we probably included more Pelagic Cormorants as unidentified cormorants; therefore, our population estimates and distribution maps are probably incomplete in these months.

Surf Scoter and White-winged Scoter

Surf and White-winged scoters can be difficult to distinguish from the air. We identified only three White-winged Scoters in our surveys. Briggs et al. (1987) noted that White-winged Scoters accounted for 5–10% of all scoters observed south of the northern Channel Islands. Therefore, we combined both species for analyses and hereafter refer to them as Surf Scoters. Surf Scoters breed from the western Aleutian Islands, Alaska to British Columbia, Canada, and at several inland sites to eastern Canada (Savard et al. 1998). Scoters primarily winter from the eastern Aleutian Islands and southeast Alaska to central Baja California, Mexico, and the Gulf of California, Mexico (Savard et al. 1998). In 1975–1978, Surf Scoters arrived in the SCB in November and December with maximum abundances from December through March (Briggs et al. 1987). In winter 1975–1978, they most often occurred in near-shore waters in the eastern Santa Barbara Channel, along northern coasts of the northern Channel Islands, in Santa Monica Bay, and from south of Dana Point to San Diego (Briggs et al. 1987). In 1999–2002, Surf Scoters were recorded in all survey months and consistently observed near San Diego and Morro Bay and in the eastern Santa Barbara Channel (Fig. 27).

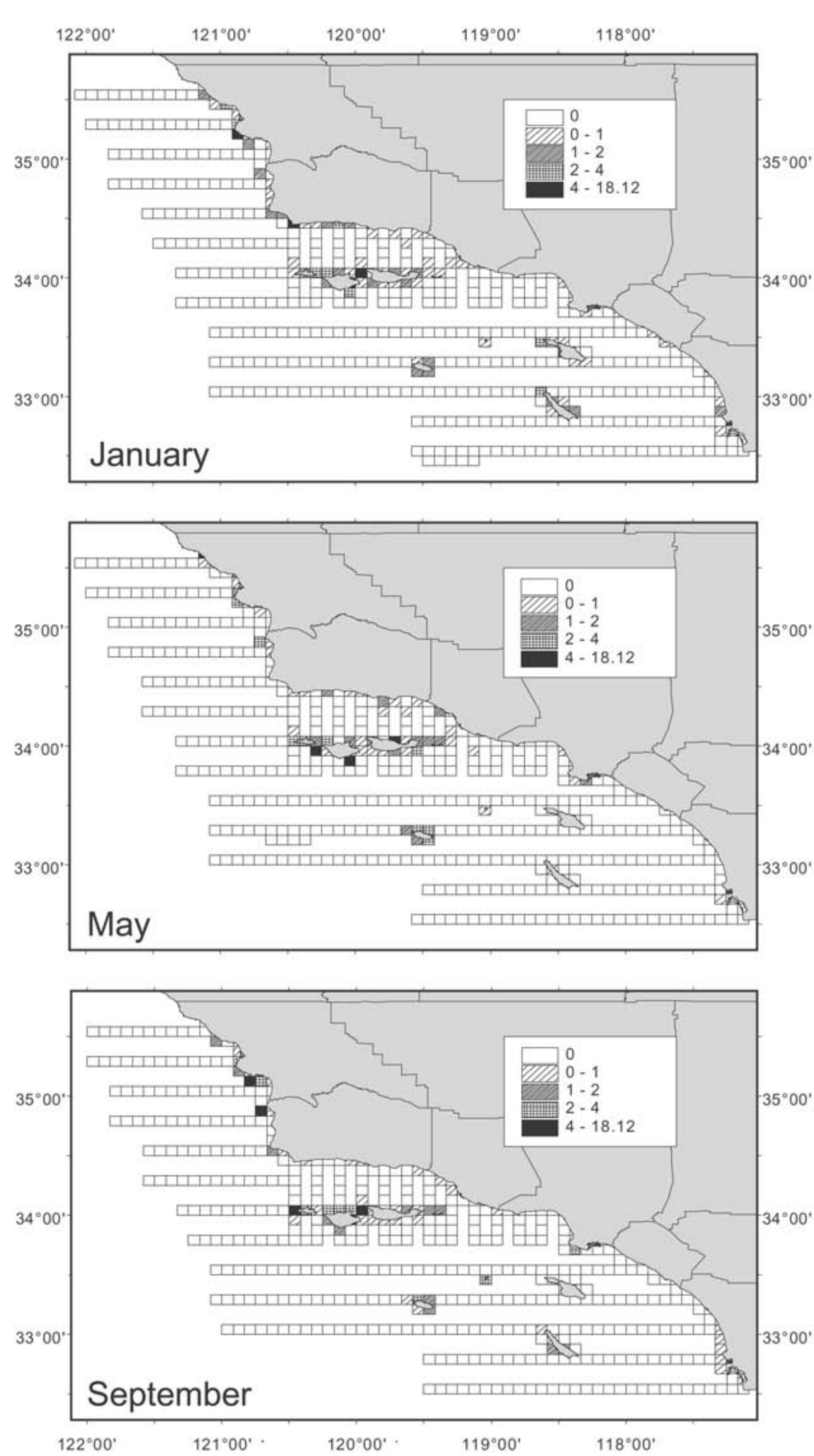

FIGURE 25. Brandt's Cormorant densities (birds/km2) and distribution off southern California from 1999–2002 during January, May, and September.

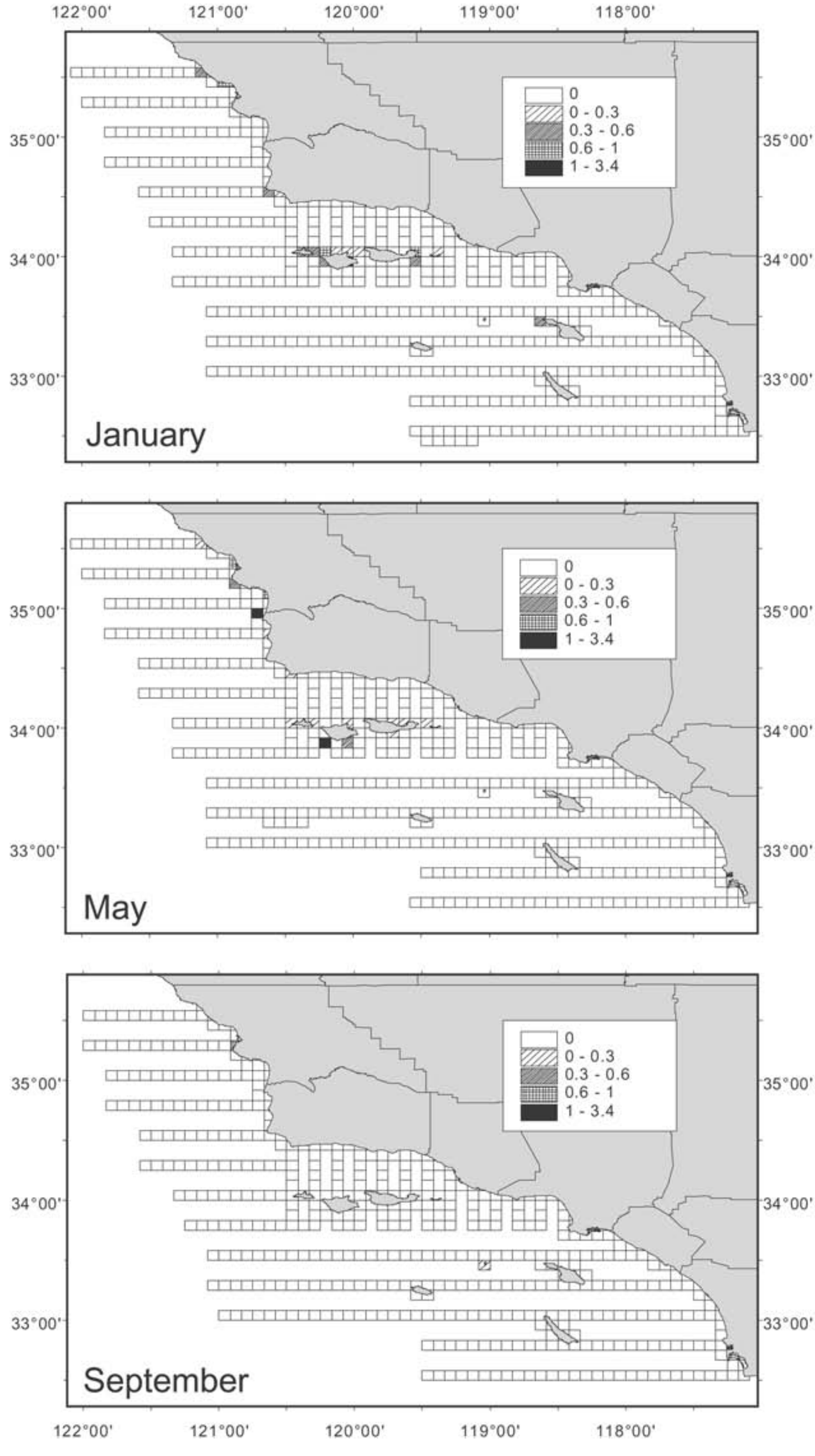

FIGURE 26. Pelagic Cormorant densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

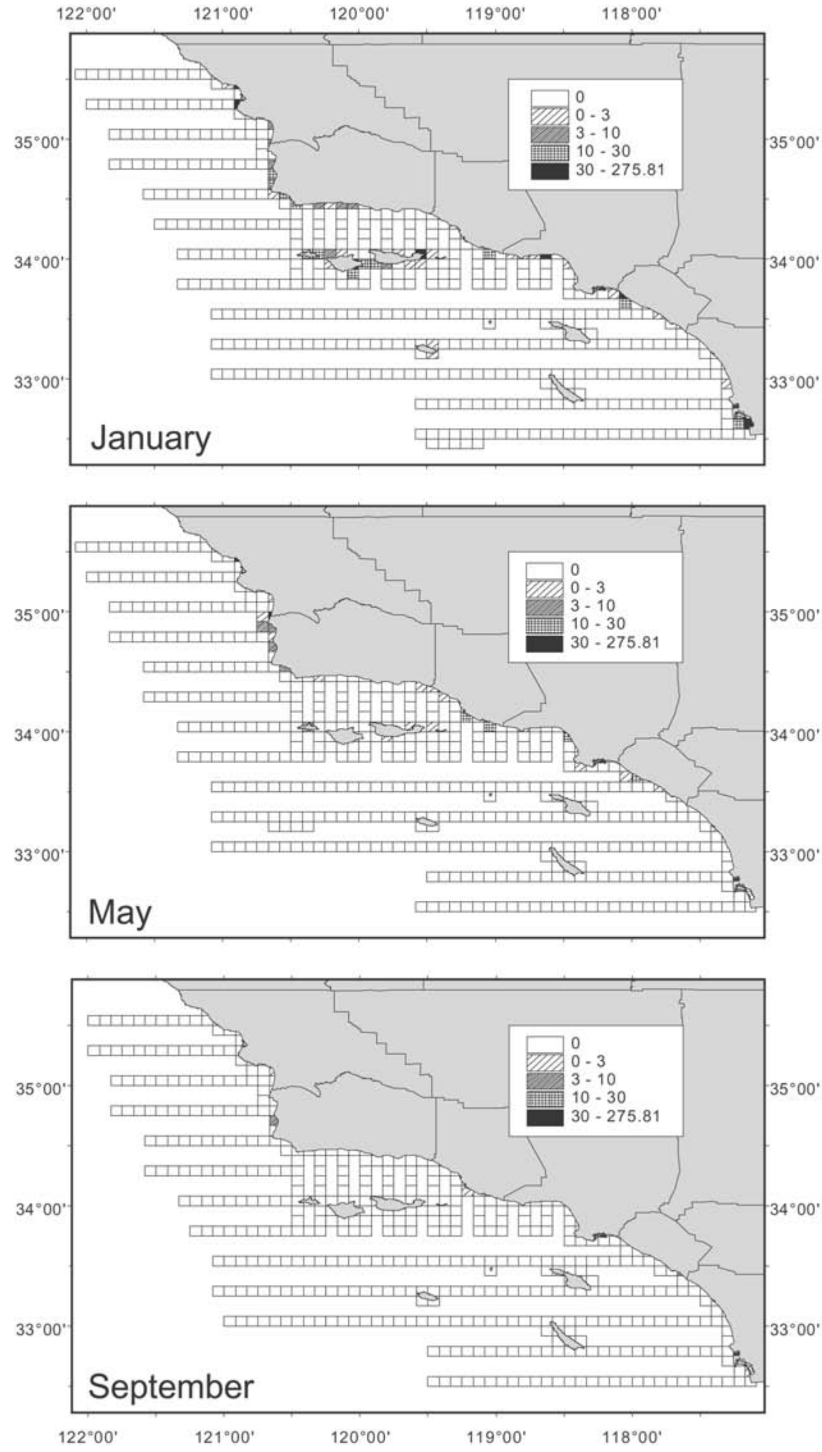

FIGURE 27. Surf Scoter densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

We observed 126 Surf Scoters on at-sea transects in S1 and S3 in January and May and found no difference in densities between S1 and S3 or between January and May (Tables 1, 5). On coastal transects, densities differed among seasons and sub-areas (Table 6). Surf Scoters were most abundant in the SCB in January, least abundant in September, and were equally abundant in NMC and SMC (Tables 2–4).

Because we observed few Surf Scoters on at-sea transects, we did not compare them statistically with Briggs et al. (1987). Reduced numbers of White-winged Scoters has been reported along the Pacific Coast (D. Nysewander, unpubl. data), but we were unable to readily distinguish between Surf and White-winged scoters from the air, and thus could not assess differences in trends between species.

Phalaropodinae

We observed two species of phalaropes within the study area (Fig. 28). Red Phalaropes (*Phalaropus fulicaria*) and Red-necked Phalaropes (*P. lobatus*) were difficult to distinguish from the air. Consequently, 64% of all phalarope sightings were classified as unidentified phalaropes (Fig. 29). Briggs et al. (1987) found both phalarope species distributed throughout California waters from the shoreline to hundreds of kilometers offshore, but that only Red Phalaropes were likely to be observed >50 km from the coast. We also observed phalaropes throughout the SCB and that, when identifiable, Red Phalaropes were distributed farther from shore than Red-necked Phalaropes. Briggs et al. (1987) found spring migration (April–May) to be much more rapid than fall migration (July–October).

In 1992–2002, at-sea densities of phalaropes differed among seasons and sub-areas (Table 5). Greatest at-sea densities generally occurred in May and in S1 and S2 (Tables 1a, 1b). Few phalaropes occurred on coastal transects (Tables 2–4). At-sea densities were greater in 1975–1983 than in 1999–2002 for the entire study area, S3, S4, and S5, but did not differ significantly in S1 and S2 (Tables 7a, 7b). Given the rapid spring migration patterns and the timing of our surveys, we may not have captured periods of peak abundance.

Red-necked Phalarope

Red-necked Phalaropes winter at sea primarily off the coast of Peru and Chile (Rubega et al. 2000). Departure times for southward migration are protracted as Red-necked Phalaropes appear in the SCB from mid-June to late October and again when returning north from mid-April to early June (Lehman 1994).

In 1999–2002, at-sea densities of Red-necked Phalaropes differed among seasons but did not differ significantly among sub-areas (Table 5). Greatest densities occurred in May (Tables 1a–e). We only observed four Red-necked Phalaropes on coastal transects and all occurred on the north side of the northern Channel Islands. Red-necked Phalaropes were distributed throughout the study area in January, aggregated near Point Conception in May, and distributed throughout the western portion of the study area in September (Fig. 30). At-sea densities of Red-necked Phalaropes were greater in 1999–2002 than in 1975–1983 for the entire study area, S1 and S3 (Tables 7a, 7b). We did not compare densities in S2, S4, and S5 across decades because Briggs et al. (1987) did not observe phalaropes in these sub-areas.

Red Phalarope

Red Phalaropes are almost entirely pelagic outside the breeding season, but may occur on bays and coastal estuaries (Johnsgard 1981). Briggs et al. (1987) noted that northbound Red Phalaropes migrated through the SCB in April and May and southbound birds were present from August through November. In 1999–2002, Red Phalaropes were rare in January, scattered throughout the study area in May, and distributed north of the northern Channel Islands and Point Conception in September (Fig. 31).

At-sea densities of Red Phalaropes differed among seasons and sub-areas and were greatest in May and in S1 (Tables 1, 5). We did not observe Red Phalaropes on coastal transects. At-sea densities of Red Phalaropes were greater in 1999–2002 than in 1975–1983 for the entire study area, S1, S2, and S5; but were lower in S3 and S4 (Tables 7a, 7b).

Laridae

We observed 22 species of larids within the study area (Fig. 32). At-sea densities differed among seasons and sub-areas (Table 5). Greatest densities occurred in January and in S3 (Table 1c). Coastal densities were greatest in January primarily due to large numbers of wintering California Gulls (Tables 2–4, 6). At-sea densities of larids were greater in 1975–1983 than in 1999–2002 for the entire study area and in each sub-area except S2 where the difference was not significant (Tables 7a, 7b).

Heermann's Gull (Larus heermanni)

Heermann's Gulls nest almost entirely (>95% of the world breeding population of

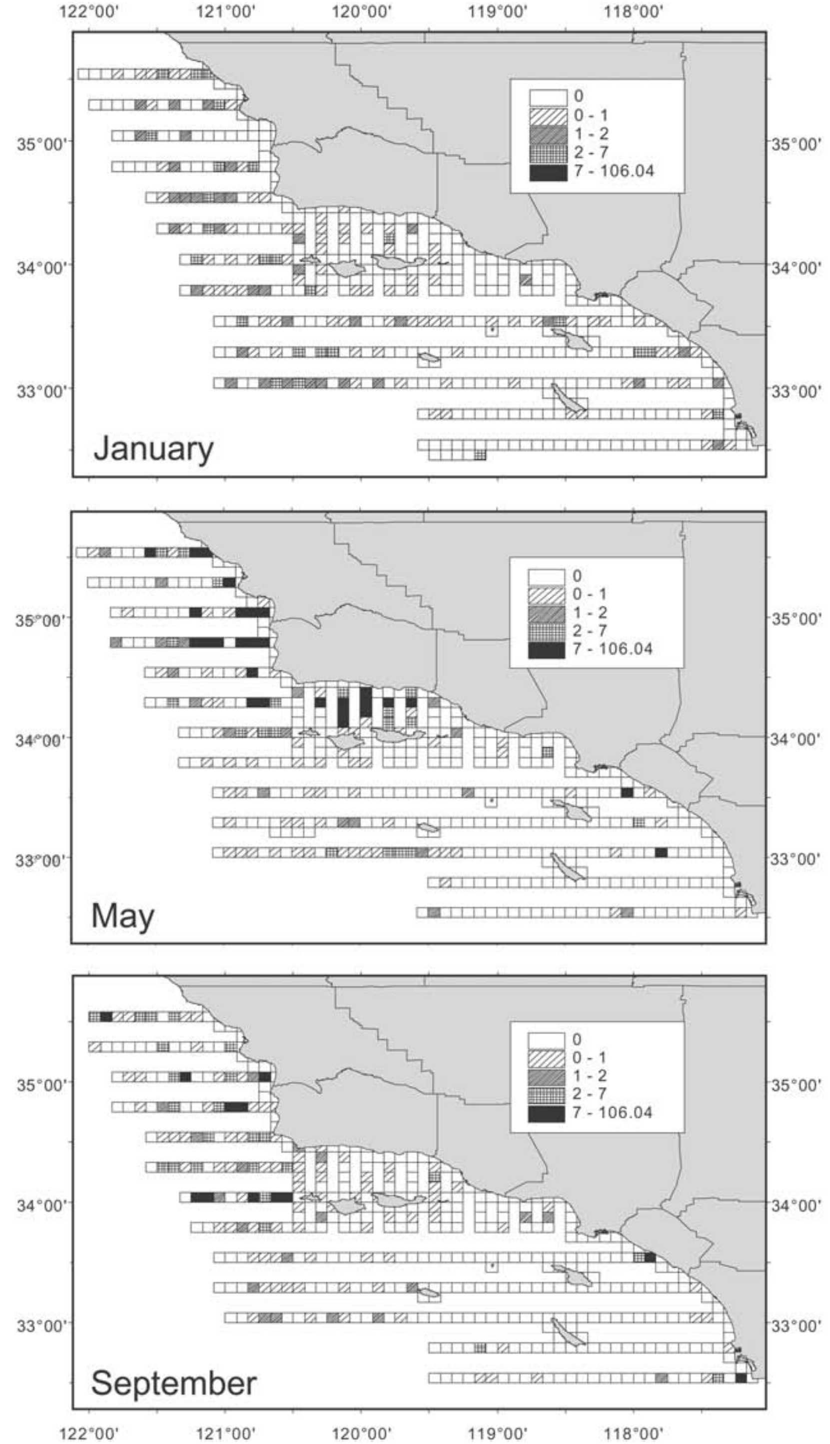

FIGURE 28. Phalarope densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

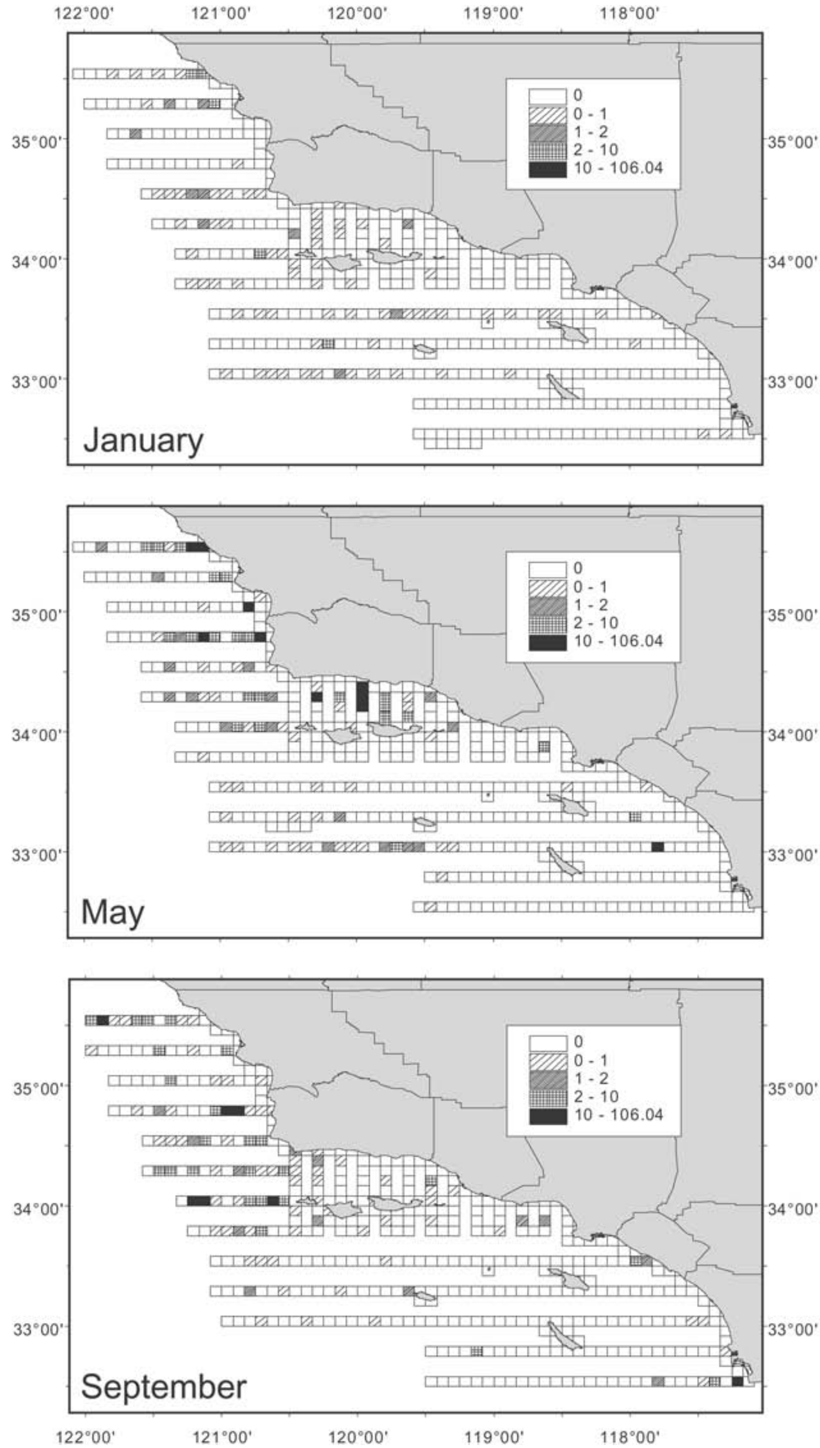

FIGURE 29. Unidentified phalarope densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

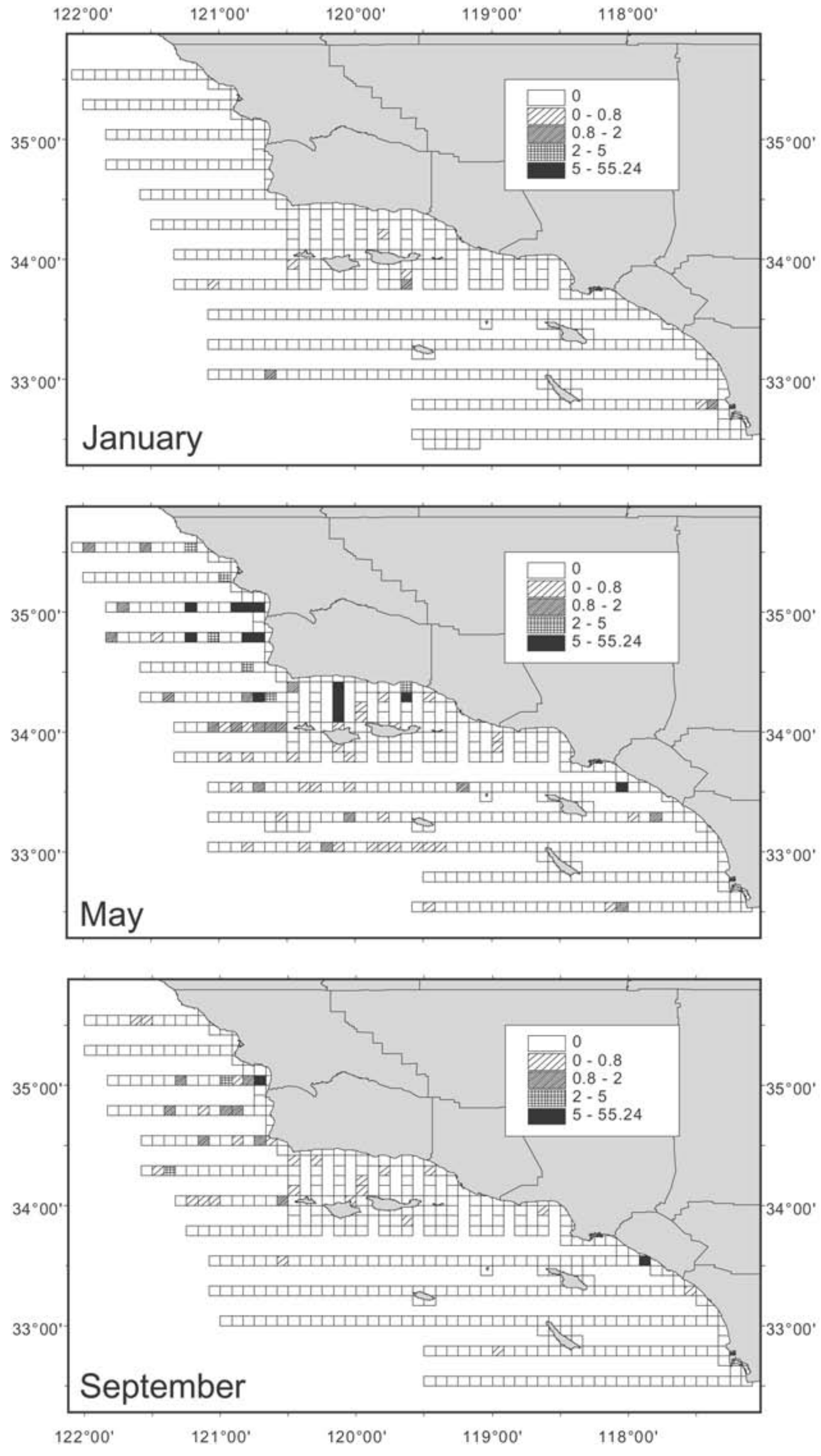

FIGURE 30. Red-necked Phalarope densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

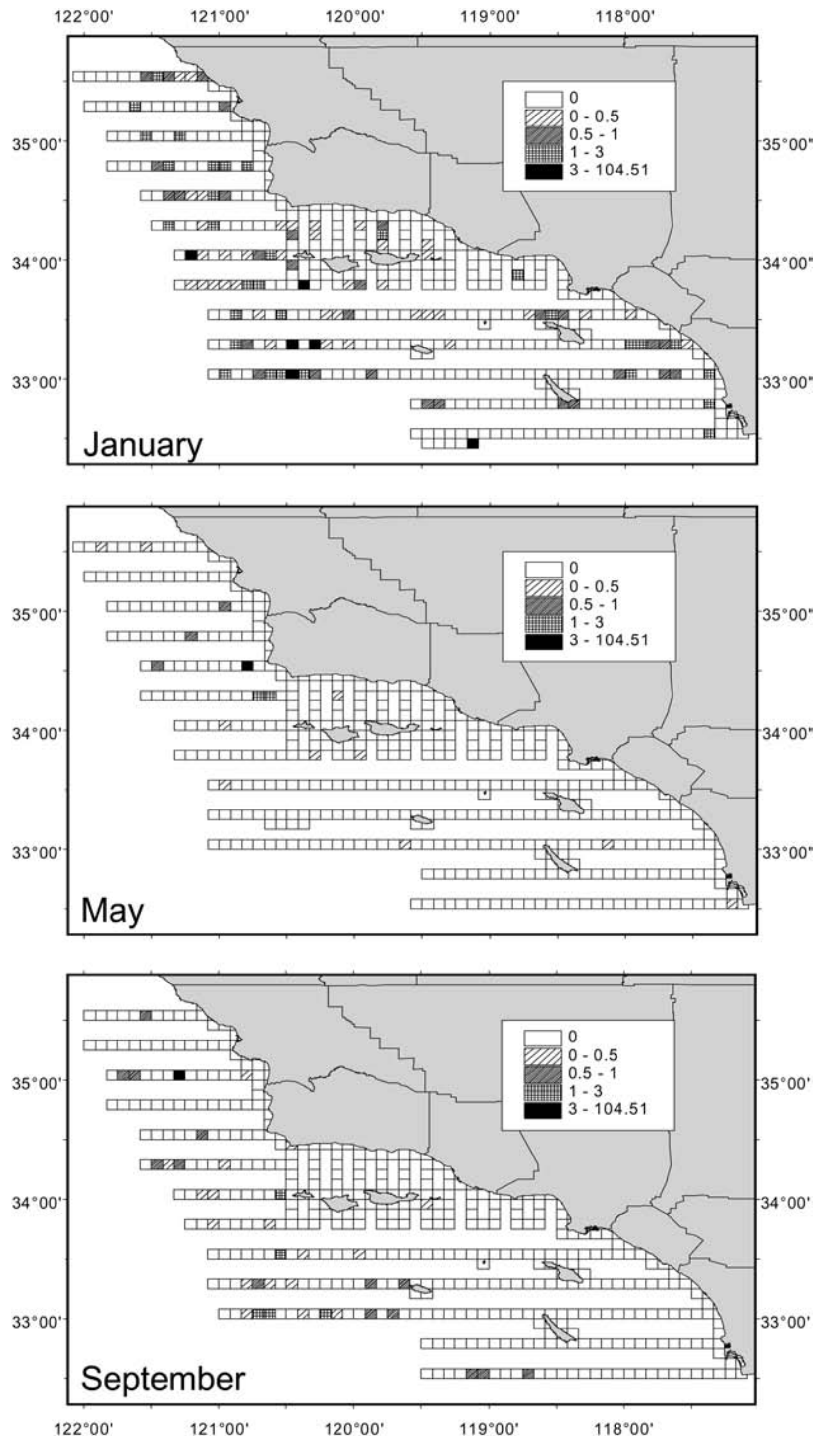

FIGURE 31. Red Phalarope densities (birds/km[2]) and distribution off southern California from 1999–2002 during January, May, and September.

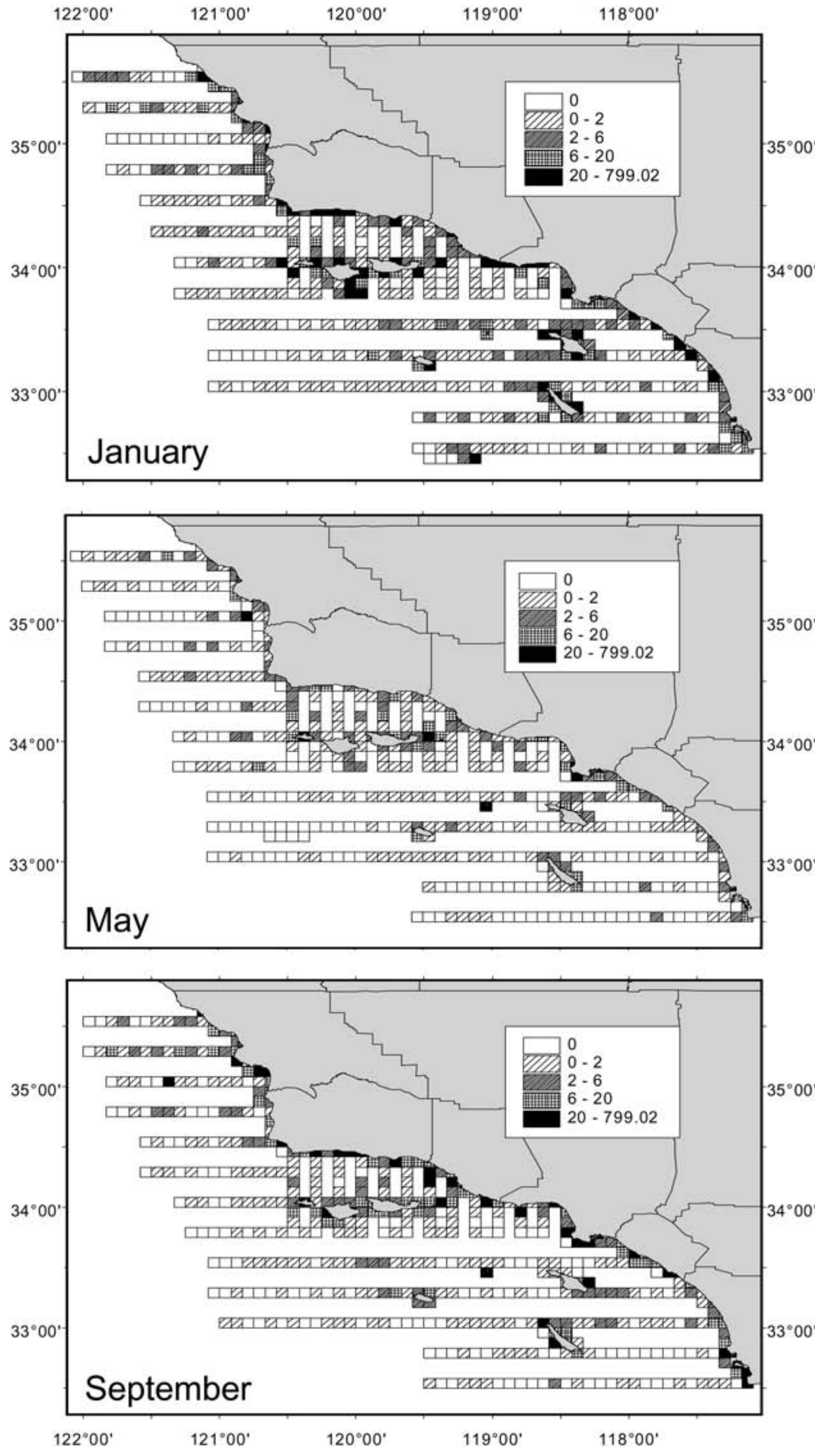

FIGURE 32. Larid densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

130,000 breeding pairs) at Raza Island in the Gulf of California, Mexico (Velarde 1999). Small numbers also have bred on the west coast of Baja California, Mexico and along the U.S. mainland (Sowls et al. 1980, Everett and Anderson 1991). They disperse north to southern British Columbia in late summer and early fall (Campbell et al. 1990).

Briggs et al. (1987) reported post-breeding arrival of Heermann's Gulls off southern California from late April–June and departure to breeding areas in Mexico in early fall. In 1975–1978, they occurred consistently from Morro Bay to the Santa Barbara Channel and near San Diego (Briggs et al. 1987). In 1999–2002 during January and September, we consistently observed birds along the mainland coast from Point Sal to Gaviota, near Palos Verdes, Huntington Beach, and San Diego and along the coastlines of Santa Rosa, Santa Cruz, Anacapa, and San Clemente islands (Fig. 33). In May, we consistently observed Heermann's Gulls only near Palos Verdes. More than 86% of observed Heermann's Gulls occurred <1 km from shore.

In 1999–2002, at-sea densities of Heermann's Gulls did not differ significantly between the two seasons in which they were observed (January and September) but did differ among the four sub-areas in which they occurred (Table 5). At-sea densities were greatest in S3 and Heermann's Gulls were not observed in S2 (Tables 1b, 1c). Coastal densities differed among seasons, with greatest densities along the NMC in September and along the SCI in January (Tables 2–4, 6). At-sea densities in 1975–1983 were greater than densities in 1999–2002 for the entire study area, S1, S4, and S5; but were lower in S3 (Tables 7a, 7b). However we cannot confirm that this represents a decrease in population densities, since Heermann's Gulls occur in coastal areas and roost extensively on shore.

Bonaparte's Gull

Bonaparte's Gulls winter on the Pacific Coast, from southern British Columbia, Canada, to southern Baja California and Nayarit, Mexico (Burger and Gochfeld 2002). Off California, these gulls arrived in September–October and reached maximum numbers in late October–November (Briggs et al. 1987). Numbers declined through the winter and increased again in March–May. Although dispersed widely throughout shelf and slope waters, greatest numbers of birds occurred <40 km from shore (Briggs et al. 1987). In 1999–2002, Bonaparte's Gulls were observed only in January and May; >99% were seen south of Point Conception and >90% of birds occurred <40 km from shore (Fig. 34).

At-sea densities differed between the two seasons in which Bonaparte's Gulls were observed (January and May) and among sub-areas (Table 5). Greatest densities occurred in January and in S4 and S5 (Tables 1d, 1e). Coastal densities of Bonaparte's Gulls did not differ significantly between the two seasons (January and May) or the two sub-areas in which they were observed (CMC and SMCS: Table 6). At-sea densities in 1975–1983 were greater than in 1999–2002 for the entire study area and each of the five sub-areas (Tables 7a, 7b). Since coastal areas were not surveyed by Briggs et al. (1987), comparisons are limited. However, Bonaparte's Gulls do not roost on land as much as many other gulls, and we suspect that lower densities in 1999–2002 reflect a decrease in population numbers.

California Gull (Larus californicus)

California Gulls are one of the most common larids in California waters (Stallcup 1990). They breed at numerous sites on inland lakes from Mono Lake to San Francisco Bay, California, and from southern Colorado to Manitoba, Canada (Winkler 1996). Beginning in late summer, California Gulls winter on the eastern Pacific Coast from southern British Columbia, Canada, to southern Baja California, Mexico, and the Gulf of California (Winkler 1996). They undergo a northward migration in early fall to southern British Columbia coastal waters and move south by late fall reaching maximum abundances off central and southern California and Baja California, in January and February (Porter and Sealy 1981, Chilton and Sealy 1987, Winkler 1996). Breeding adults begin returning to inland colonies in February (Winkler 1996).

Briggs et al. (1987) found that California Gulls were the most abundant gulls in California near-shore waters in the fall and winter with California Gulls arriving in the SCB in late September or October. Shore-based surveys conducted from mainland and island coasts indicated maximum abundances in the SCB from January through March (Briggs et al. 1987). In 1999–2002, we observed California Gulls near mainland and island coastlines in all survey months and throughout southern California in January (Fig. 35). California Gulls were observed on all but two transect lines and 84% occurred <1 km from shore.

In 1999–2002, densities of California Gulls on at-sea transects differed among seasons and sub-areas (Table 5). Densities were greatest in January and lowest in September, indicating that most birds arrived after September

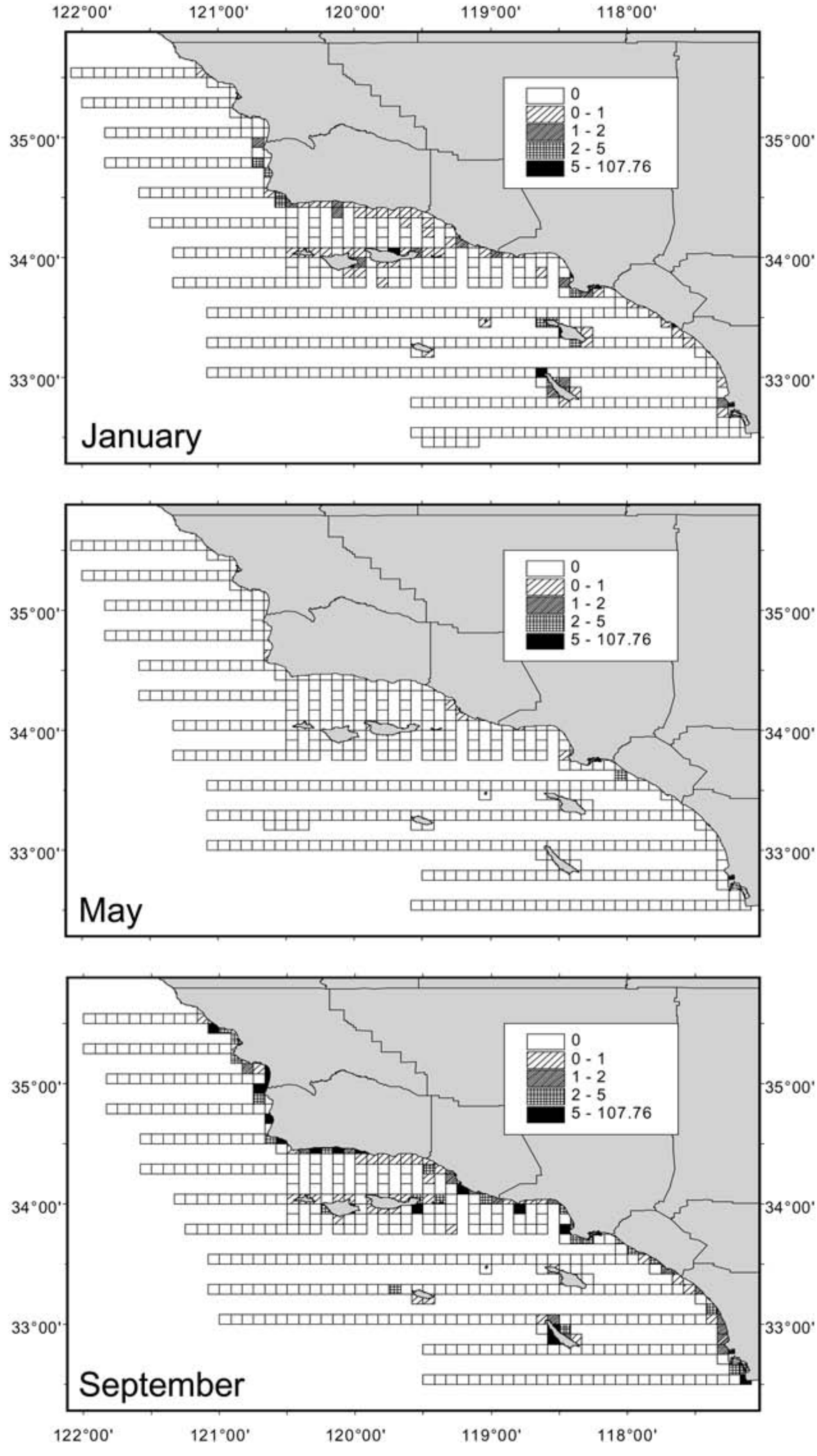

FIGURE 33. Heermann's Gull densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

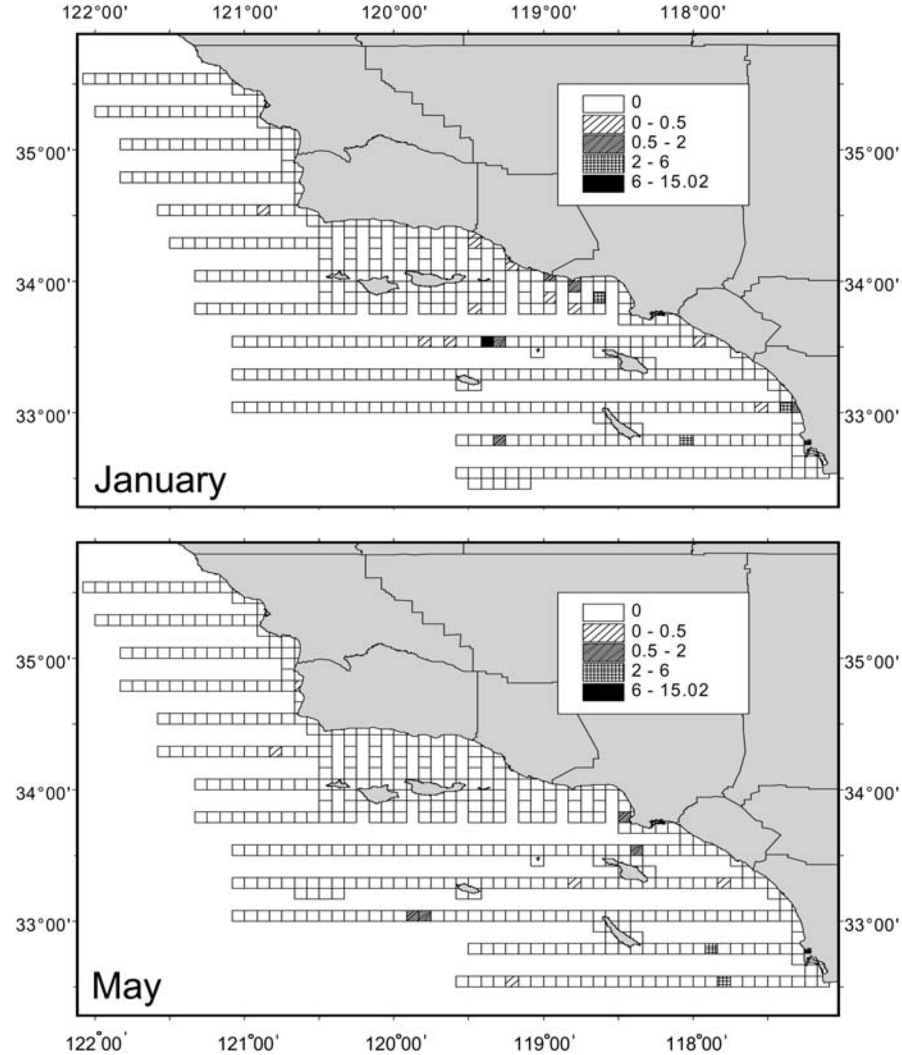

FIGURE 34. Bonaparte's Gull densities (birds/km^2) and distribution off southern California from 1999–2002 during January and May. No Bonaparte's Gulls were observed during September.

(Tables 1a–e). At-sea densities were greatest in S3 in January and September and in S1 and S4 in May (Tables 1a, 1c, 1d). On coastal transects, densities of California Gulls were greatest in January in all sub-areas (Tables 2–4, 6).

At-sea densities of California Gulls were greater in 1975–1983 than in 1999–2002 for the entire study area, S2, and S5; but did not differ significantly in S1, S3, and S4 (Tables 7a, 7b). However, since California Gulls mainly occur in coastal waters and roost extensively along shores, we could not compare densities in their most abundant areas so cannot confirm if this indicates a true decline in abundance or distribution shift.

Western Gull (Larus occidentalis)

Western Gulls breed from central Baja California, Mexico, to southwestern Washington (Speich and Wahl 1989, Penniman et al. 1990), and winter from the southern tip of Baja California, Mexico to Vancouver Island, Canada (Campbell et al.1990, Howell and Webb 1995). The North American population was estimated at 40,000 pairs, making it a relatively rare *Larus* gull (Pierotti and Annett 1995). Western Gulls are the most widely distributed and the second most abundant breeding seabird in southern California; large breeding colonies occur at San Miguel, Santa Barbara, Anacapa, and San

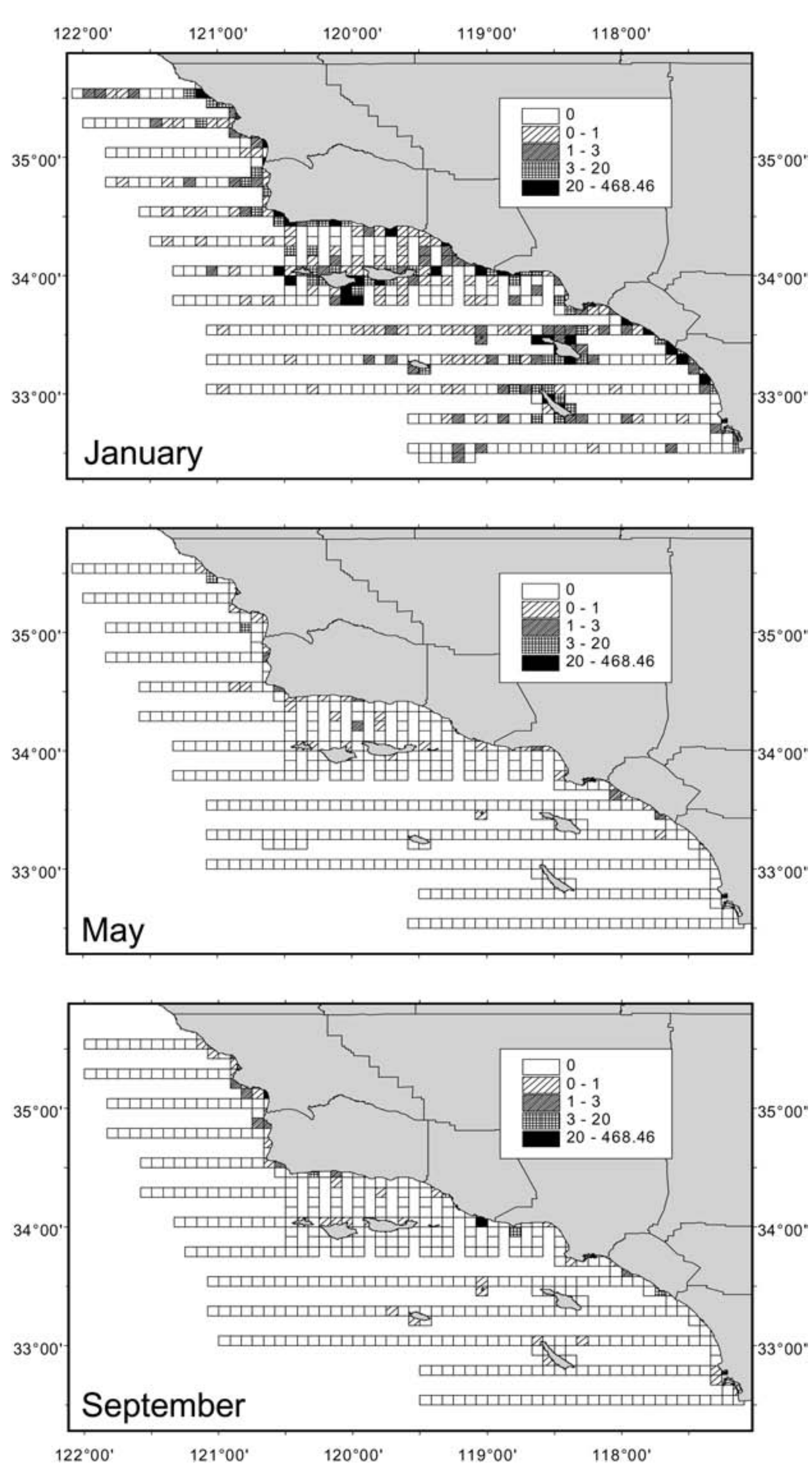

FIGURE 35. California Gull densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

Nicolas islands (H. Carter, unpubl. data). In 1991, 14,000 breeding pairs were estimated to be in the SCB, a more than two-fold increase over the late 1970s (H. Carter, unpubl. data).

Briggs et al. (1987) observed Western Gulls along California coastlines in all months and seldom observed birds farther than 25 km seaward of the shelf break. In the SCB, Western Gulls were mostly restricted to areas near breeding colonies from April–August, but from September–February, they were distributed more evenly throughout the region (Briggs et al. 1987). In contrast, in 1999–2002 we observed Western Gulls throughout southern California in all seasons, on both at-sea and coastal surveys (Fig. 36). More than 96% of observed Western Gulls occurred <20 km from shore.

In 1999–2002, at-sea densities of Western Gulls did not differ among seasons but did differ among sub-areas (Table 5). We observed greatest densities in S3 in all months (Table 1c). Along coastlines, densities did not differ among sub-areas but did differ among seasons (Table 6). Mainland coastal densities were greatest in September and island coastal densities were greatest in January (Tables 2–4).

At-sea densities in 1999–2002 were greater than in 1975–1983 for the entire study area and S3, lower in S2, S4, and S5, and did not differ significantly in S1 (Tables 7a, 7b). Increased numbers apparently reflected increased breeding populations in the SCB, although some Western Gulls from central and northern California also winter in southern California and these populations have also increased (Penniman et al. 1990). Western Gulls also visit coastal lakes in the SCB and forage in garbage dumps, especially in winter, so many birds are not at sea. Western Gulls also roost when not foraging so we only measured actively feeding birds. In the breeding season, a large proportion of the population is at breeding colonies and not at sea. Many birds are seen near shore because they are commuting to colonies and roosting areas or rafting offshore of these areas.

Black-legged Kittiwake (Rissa tridactyla)

In the eastern Pacific, Black-legged Kittiwakes winter offshore from southern Alaska to central Baja California, Mexico (Baird 1994). Kittiwakes migrate south from their Alaskan breeding colonies in September and return north in March (Baird and Gould 1983). In 1975–1983, kittiwakes arrived in California waters in November, reached greatest densities from January through March, and departed in April and May (Briggs et al. 1987). Kittiwakes occurred from the coastline to 200 km from shore and density did not decrease significantly with increasing distance from shore (Briggs et al. 1987). In January 2000–2002, kittiwakes occurred throughout the study area, except in the southeastern portion (S4). Birds were concentrated primarily <15 km from the northern Channel Islands and near San Nicolas Island (Fig. 37).

In 1999–2002, at-sea densities of kittiwakes did not differ significantly among sub-areas (Table 5). Densities were great only in January; we observed only four kittiwakes in May (2000) and none in September (Tables 1a–e). At-sea densities were greatest in S5, S2, and S1 (Tables 1a, 1b, 1e). We observed only 15 Black-legged Kittiwakes on coastal transects, all in January and all but two near the northern Channel Islands.

At-sea densities of Black-legged Kittiwakes were greater in 1975–1983 than in 1999–2002 for the entire study area, S1, S3, and S4, lower in S2, and did not differ significantly in S5 (Tables 7a, 7b). Population trends are difficult to assess because decline has been noted at some Alaskan colonies (Baird 1994) consistent with lower densities in 1999–2002.

Sabine's Gull (Xema sabini)

In the Pacific Ocean, Sabine's Gulls are seen off California during migrations between arctic nesting grounds and wintering areas off northern South America (Day et al. 2001). Briggs et al. (1987) recorded the species statewide from the shoreline to at least 200 km offshore; off southern California, they occurred seaward of the Santa Rosa-Cortes Ridge. In September 1999–2001, we observed Sabine's Gulls near Tanner and Cortez Banks (Fig. 38). In May and September, these gulls were observed north of Point Conception and west of San Miguel Island (Fig. 38).

At-sea densities did not differ significantly between May and September but did differ among sub-areas (Table 5). We observed greatest at-sea densities in S1 and lowest densities in S4 (Tables 1a, 1d). We did not observe Sabine's Gulls on coastal transects.

At-sea densities were greater in 1999–2002 than in 1975–1978 for the entire study area, S1, S2, S4, and S5 (Tables 7a, 7b).

Caspian Tern (Hydroprogne caspia)

Caspian Terns breed in widely dispersed locations on the shores of rivers, lakes, and marshes along the Pacific, Atlantic, and Gulf coasts. On the Pacific Coast, they winter from southern California to Guatemala (Cuthbert

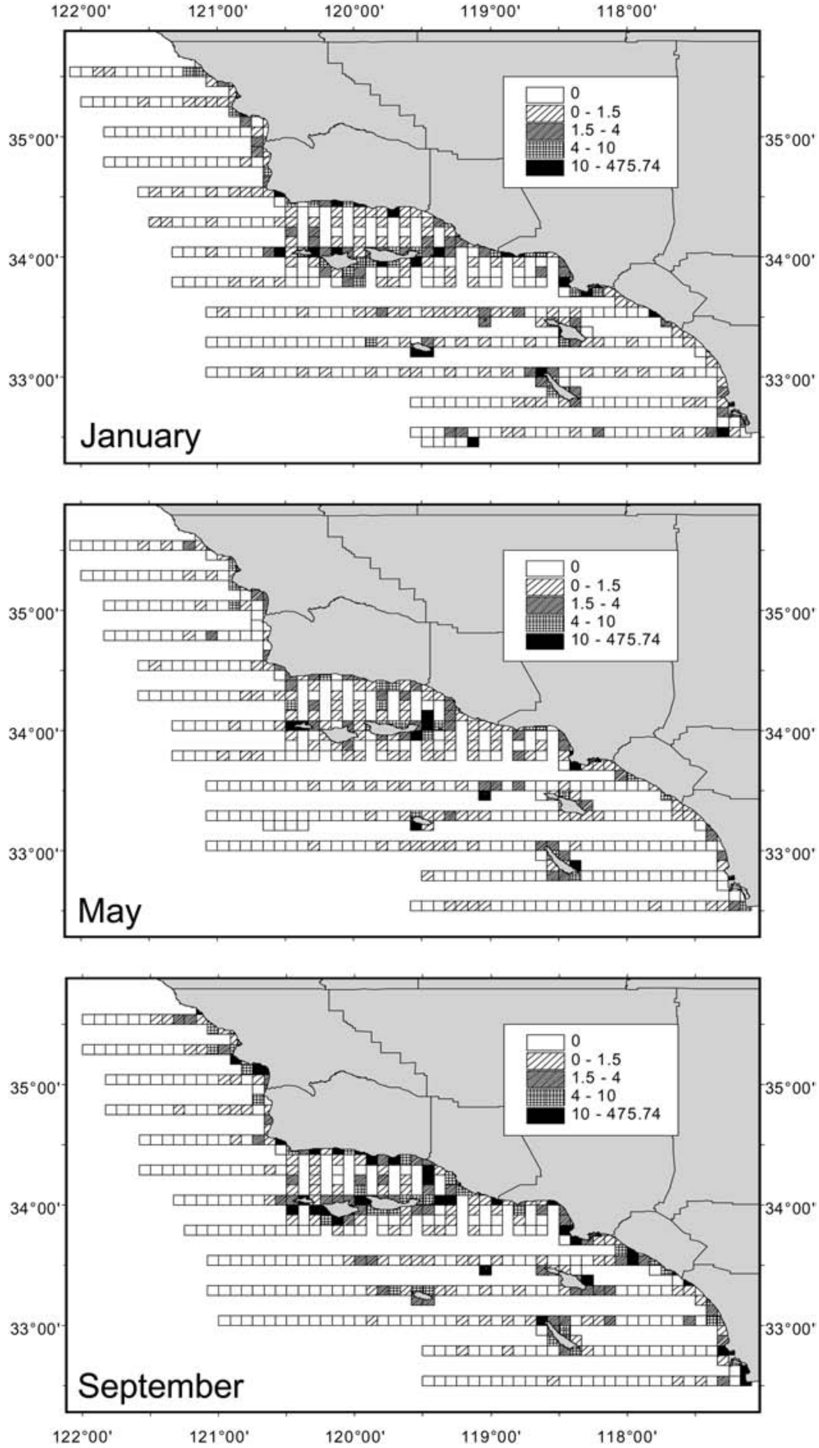

FIGURE 36. Western Gull densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

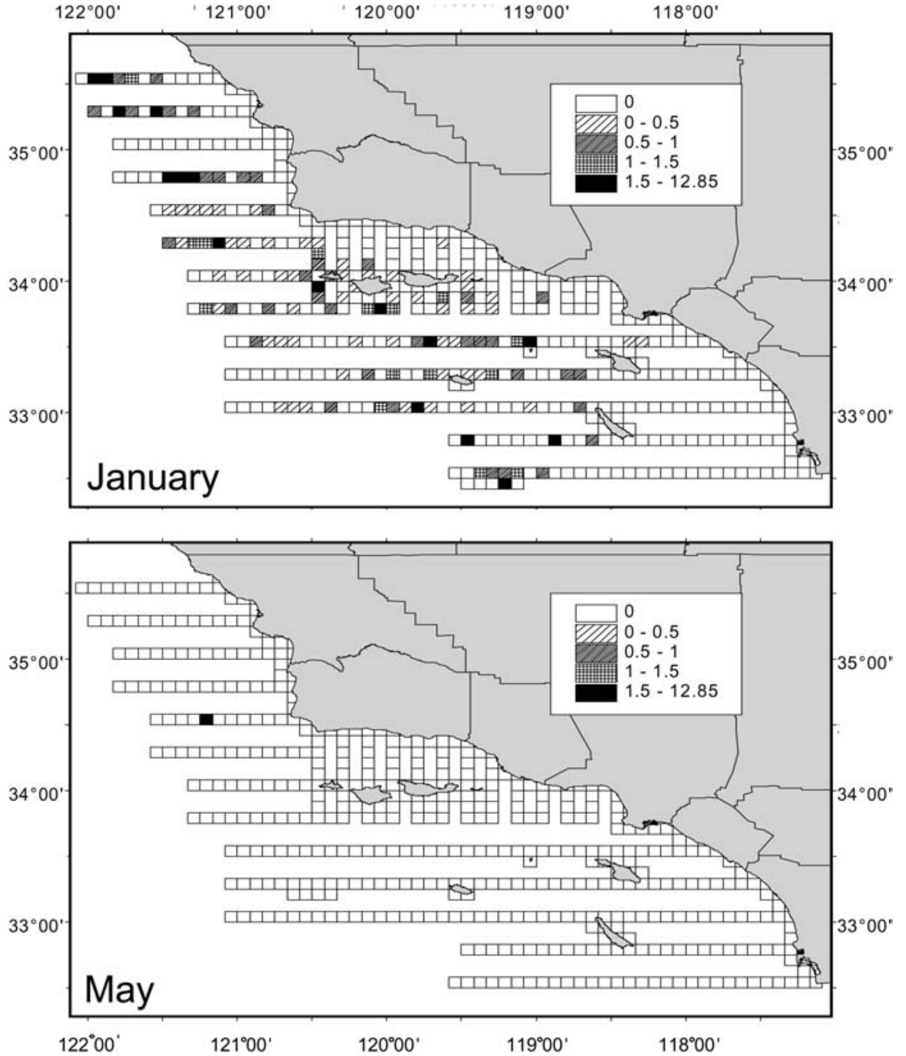

FIGURE 37. Black-legged Kittiwake densities (birds/km^2) and distribution off southern California from 1999–2002 during January and May.

and Wires 1999). In southern California, terns breed on salt pond levees in San Diego Bay (Gill and Mewaldt 1983). Pacific Coast populations have increased by >50% from 1984–1993 (Cuthbert and Wires 1999). In South San Diego Bay National Wildlife Refuge, an estimated 379 pairs of Caspian Terns bred in 2002 (USDI Fish and Wildlife Service 2005).

Briggs et al. (1987) recorded few terns because they did not conduct aerial surveys of coastlines, but they reported that Caspian Terns rarely occurred >1 km from shore. In 1999–2002, we consistently observed Caspian Terns on coastal transects near Point Loma, northern Santa Monica Bay, Santa Cruz Island, and south of Gaviota (Fig. 39). We observed only 16 Caspian Terns on at-sea transects and made no statistical comparisons. Coastal densities of Caspian Terns differed among seasons and sub-areas (Table 6). Greatest densities occurred in September and lowest densities in January (Tables 2–4).

Alcidae

Five alcid species commonly occur in southern California and were recorded throughout the study area except in coastal sub-area SMC (Fig. 40). At-sea densities differed among seasons and sub-areas with greatest densities in January in S1 and in May in S3 (Tables 1, 5). On coastal transects, densities differed among

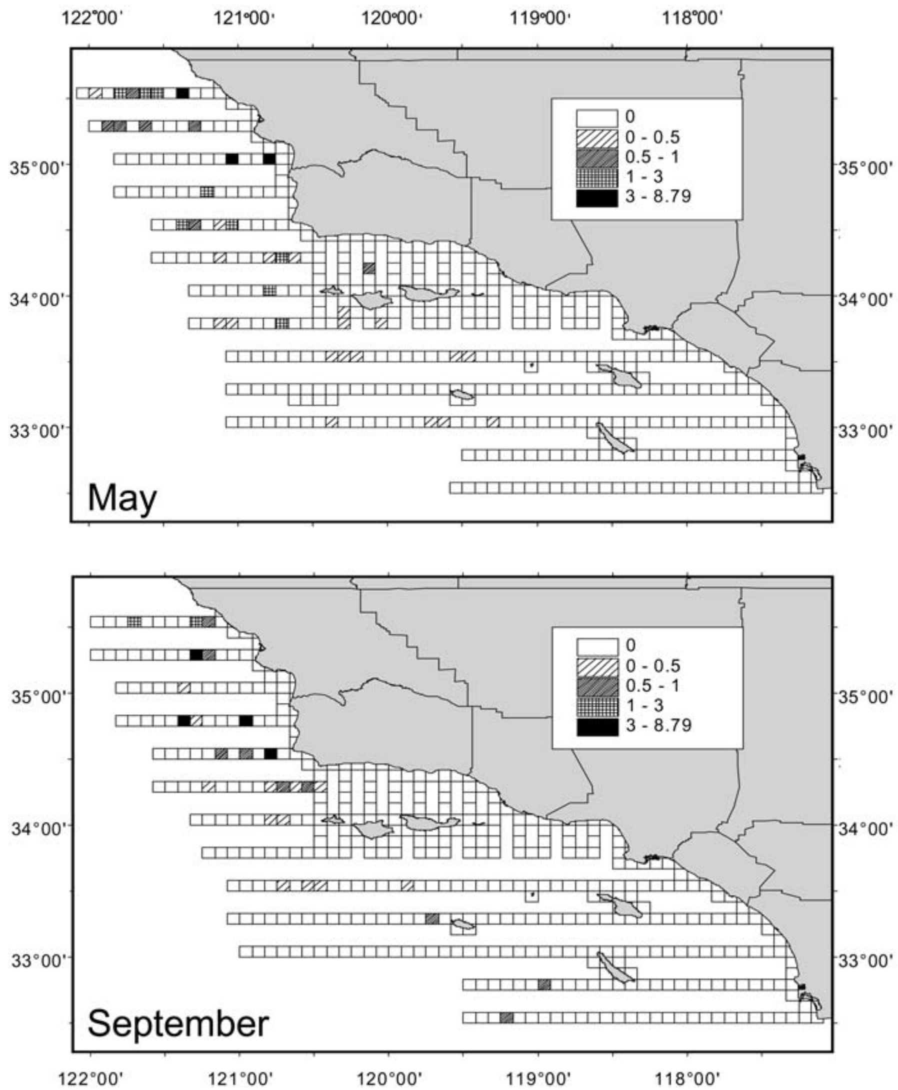

FIGURE 38. Sabine's Gull densities (birds/km^2) and distribution off southern California from 1999–2002 during May and September. No Sabine's Gulls were observed during January.

seasons and four sub-areas where they occurred (NMC, CMC, NIC, and SIC) with greatest densities along the NIC, except in May when greatest densities occurred along the NMC (Tables 2–4, 6). At-sea densities of alcids were greater in 1975–1983 than in 1999–2002 for the entire study area and in each of the five sub-areas, but were not statistically significant for S3 (Tables 7a, 7b).

Common Murre (Uria aalge)

Along the eastern Pacific, Common Murres breed from the Bering Sea, Alaska, to Monterey County in central California (Ainley et al. 2002). Common Murres are the most abundant breeding seabird in California and Oregon (H. Carter, unpubl. data; Carter et al. 2001). Historically, Common Murres bred in the SCB on Prince Island, but as a result of egg gathering for private collections and possibly oil pollution, the colony was extirpated in 1912 (Carter et al. 2001). Common Murres generally winter from southern Alaska to southern California but have been observed as far south as central Baja California, Mexico. Birds occurring in southern California in winter likely originate from breeding populations in central California

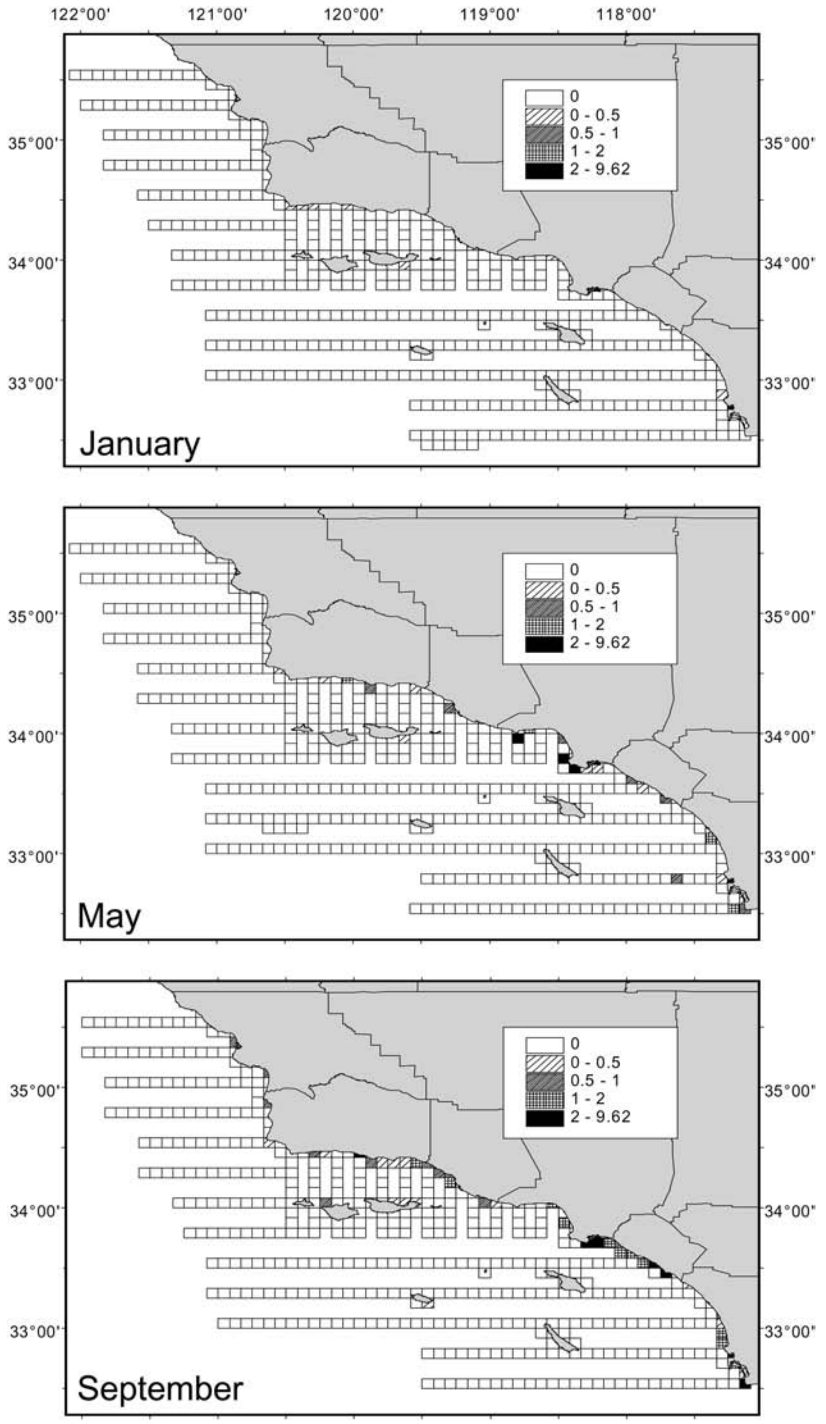

FIGURE 39. Caspian Tern densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

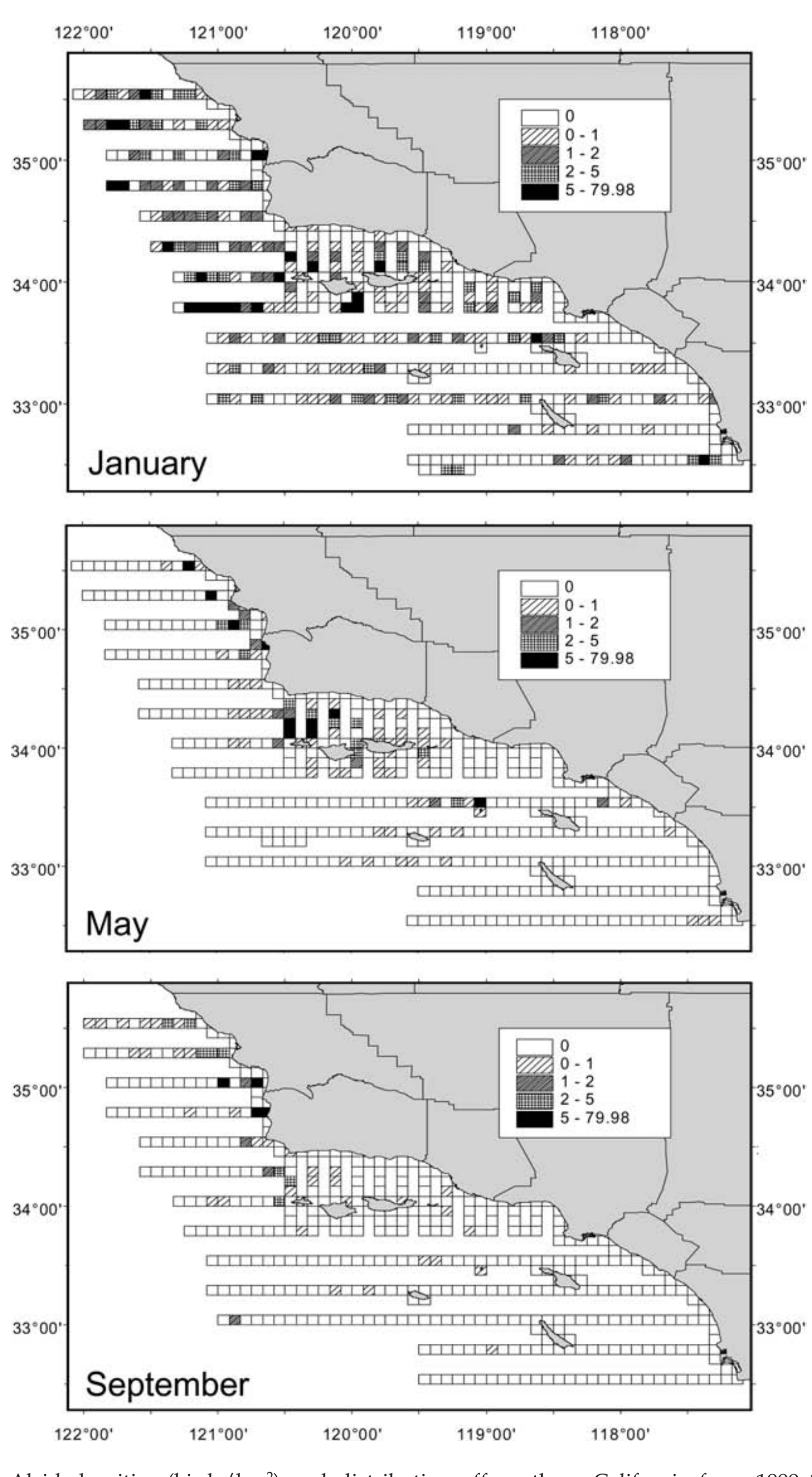

FIGURE 40. Alcid densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

(Manuwal and Carter 2001). Central California breeding populations were increasing rapidly in the late 1970s but declined dramatically from 1982–1986 and continued to decline through 1989 (Takekawa et al. 1990, Carter et al. 2001). Declines in the breeding population were attributed mainly to mortality from gill-net fishing and oil spills, plus lesser impacts from reduced reproductive success associated with the severe 1982–1983 El Niño and human disturbance at breeding colonies (Takekawa et al. 1990; Carter et al. 2001, 2003). Since 1990, population recovery has been underway, reaching levels similar to 1980–1982 in the 1999–2002 period (G. McChesney, unpubl. data)

During the nesting season (April through July), Briggs et al. (1987) observed Common Murres in waters <150 m deep and 75% occurred <40 km from breeding colonies in central and northern California. In 1980–1983, they occurred south of Point Sur only outside of the nesting season, but even in the winter they were most abundant within 50 km of breeding colonies (Briggs et al. 1987). In 1975–1983, tens of thousands were estimated within Santa Barbara Channel and from Morro Bay to Point Arguello in the fall and winter (Briggs et al. 1987). In 1999–2002, we observed only 232 birds, and >85% were north of Point Conception (Fig. 41, Tables 1a–e). More than 90% of birds occurred <20 km from shore in waters <150 m deep.

Densities on at-sea transects in 1999–2002 differed among seasons and three sub-areas where Common Murres occurred (S1, S3, and S4; Table 5). At-sea densities were greatest in January and lowest in May (Tables 1a–e). We observed birds along coastal transects only in January (Tables 2–4). Most coastal sightings occurred near Morro Bay and Point Conception; one bird was observed near Santa Barbara Island (Fig. 41).

Despite substantial population recovery in central California, at-sea densities of Common Murres were statistically much lower in 1999–2002 than in 1975–1983 for the entire study area, S1, S3, and S4 (Tables 7a, 7b). Continued gill-net mortality of several thousand murres per year between Monterey and Morro bays in the late 1990s (Forney et al. 2001) may have reduced populations wintering in our study area, or central California populations may not have yet restored movements to southern California. Birds were observed in S2 and S5 in 1975–1983 but not in 1999–2002. For both studies, Common Murre densities were greatest in January, when partial colony attendance occurs in central California (Manuwal and Carter 2001).

Pigeon Guillemot (Cepphus columba)

Pigeon Guillemots breed on rocky shorelines and forage in nearby near-shore waters from the Bering Sea to Santa Barbara Island and range from northern Alaska to northwestern Mexico (Ewins 1993). In 1991, H. Carter (unpubl. data) estimated 1,600 breeding pairs to be in southern California, doubling the estimates for 1975–1978.

Briggs et al. (1987) observed Pigeon Guillemots mainly in June and July <2 km from shore and distributed from Santa Barbara Island to the Oregon border. We observed birds near Santa Barbara Island, between Santa Rosa and Santa Cruz islands, and along the mainland coast near Point Sal and Point Buchon; >92% occurred <2 km from shore (Fig. 42).

In 1999–2002, we recorded only seven Pigeon Guillemots on at-sea transects, all in May. Densities on coastal transects differed among seasons and the three sub-areas in which guillemots occurred (NMC, NIC, and SIC; Table 6). More than 89% of Pigeon Guillemot sightings occurred in May. We observed most birds along the NMC and NIC (Tables 3, 4). With so few at-sea observations in 1999–2002, we were unable to compare at-sea transect data with data from 1975–1983.

Xantus's Murrelet (Synthliboramphus hypoleucus)

The Xantus's Murrelet is one of the most southerly-distributed alcids with a limited breeding range extending from the SCB to central Baja California, Mexico (Drost and Lewis 1995). Of the two subspecies of Xantus's Murrelets, *S. h. scrippsi* nests in southern California and Baja California and *S. h. hypoleucus* nests primarily at Guadalupe Island, Mexico (Jehl and Bond 1975; Carter et al., in press). Both subspecies were recently listed by the state of California as threatened in 2004 and are listed as threatened in Mexico (E. Burkett, unpubl. data; Keitt, in press); they also have been petitioned for federal listing. Xantus's Murrelets breed on all Channel Islands except Santa Rosa and San Nicolas islands (Drost and Lewis 1995). In 1991, H. Carter (unpubl. data) estimated 700 breeding pairs at the largest known colony in the U.S. at Santa Barbara Island and considered this colony to be stable or declining slightly. Additional evidence of decline at SBI has been noted in later studies (W. Sydeman, unpubl. data; D. Whitworth, unpubl. data). Surveys in 1994–1996 found more widespread breeding in the SCB and higher breeding population estimates (E. Burkett, unpubl. data; H. Carter,

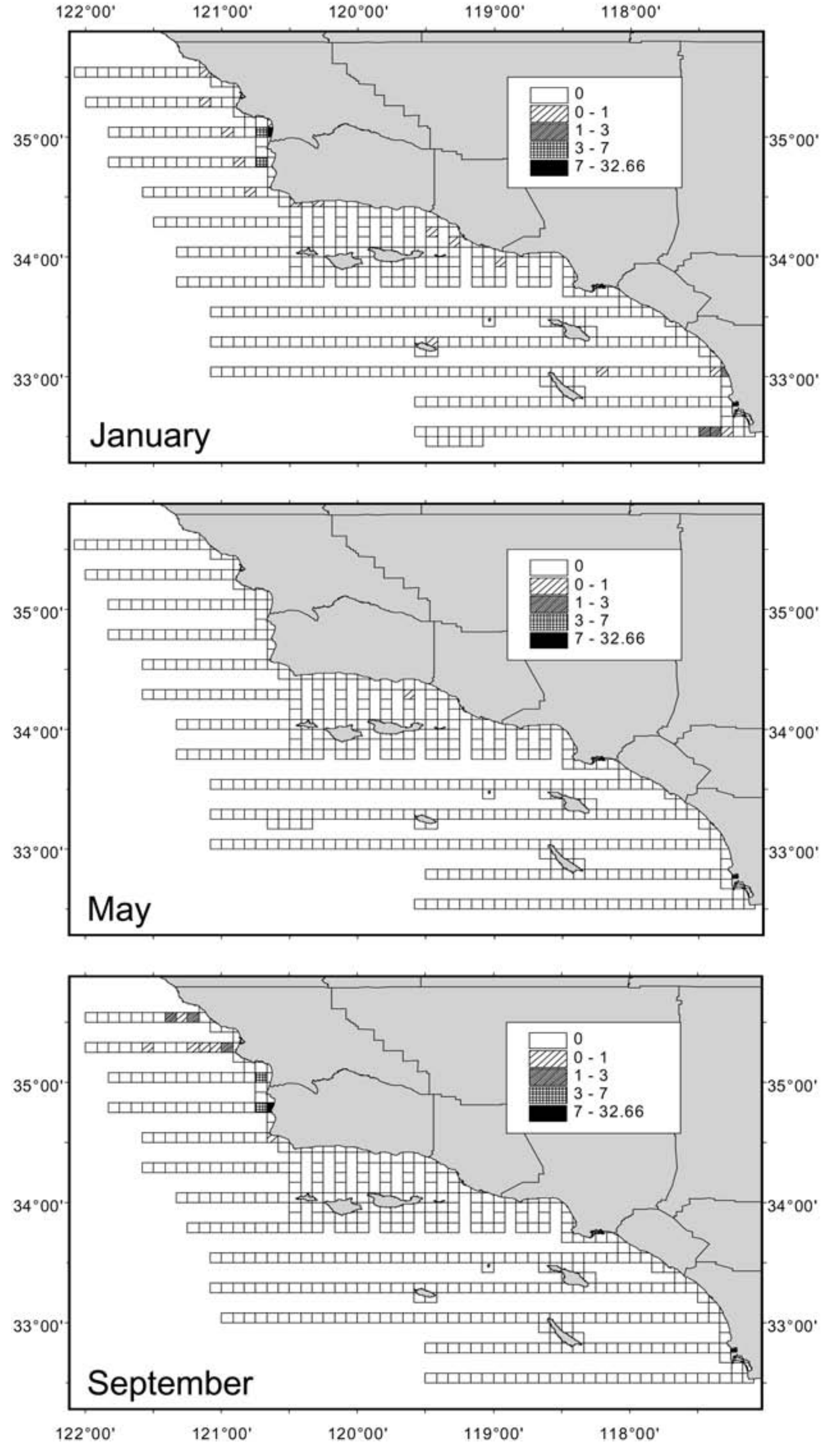

FIGURE 41. Common Murre densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

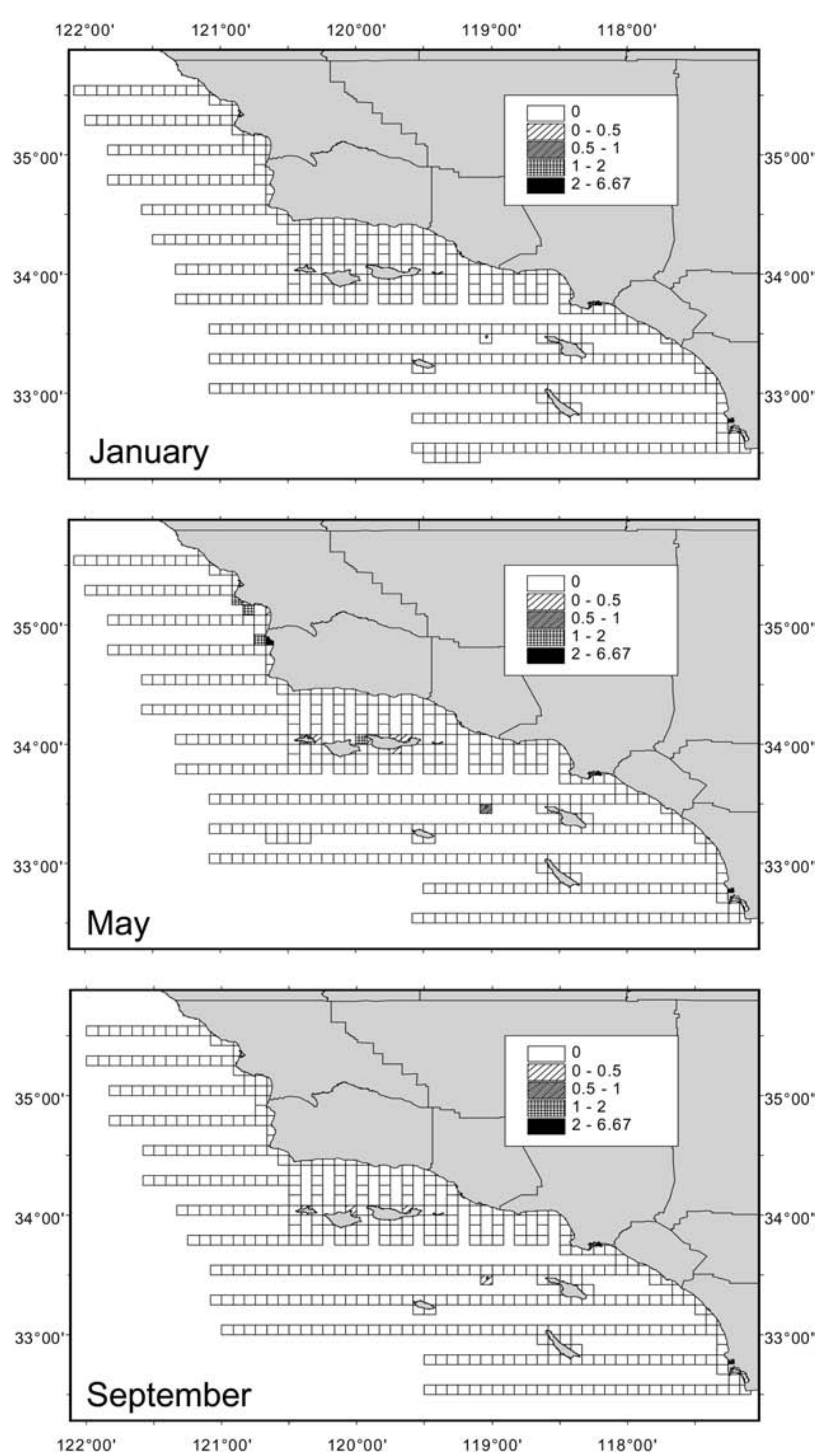

FIGURE 42. Pigeon Guillemot densities (birds/km²) and distribution off southern California from 1999–2002 during January, May, and September.

unpubl. data). Karnovsky et al. (2005) estimated about 8,000–16,000 birds in SCB in spring, corresponding to roughly 2,000–5,000 breeding pairs. Xantus's Murrelets may start attending breeding colonies in December or January (Murray et al. 1983, Gaston and Jones 1998).

Briggs et al. (1987) noted birds concentrated around Santa Barbara Island and off San Diego in the breeding months (March–May) with birds off San Diego presumably from the nearby Coronado Islands, Mexico. They were distributed north of Point Conception from August through October, 20–100 km from shore reflecting northward post-breeding dispersal (D. Whitworth, unpubl. data). In May in 1999–2001, greatest densities were near Santa Barbara and Anacapa islands and north of Point Conception along the coast; 88% of Xantus's Murrelets occurred <40 km from shore and correspondingly 87% occurred in depths <1,400 m (Fig. 43). Foraging near Anacapa Island was also noted during radio-telemetry studies in 1995–1997 and 2002–2003 (Whitworth et al. 2000, Hamilton 2005).

At-sea densities of Xantus's Murrelets did not differ significantly among sub-areas but did differ among seasons (Table 5). Their numbers were greatest in May with few birds observed in January or September (Tables 1a–e), suggesting that few birds had returned to colony areas by January in 2000–2002. Xantus's Murrelets were not observed on coastal transects in any month.

At-sea densities of Xantus's Murrelets were greater in 1999–2002 than in 1975–1983 for the entire study area, S1, and S5 (Tables 7a, 7b). Densities did not differ significantly in S3 or S4 (Tables 7a, 7b). Densities in S2 were not compared because birds were observed there only in 1999–2002. Karnovsky et al. (2005) found no trend between study periods from Point Conception to the Mexico border, although few birds were seen off San Diego. Given infrequent occurrence on surveys, higher densities may have reflected greater sampling effort near Santa Barbara and Anacapa islands.

Cassin's Auklet (Ptychoramphus aleuticus)

Cassin's Auklets are widely distributed in the Pacific Ocean, breeding from the Aleutian Islands, Alaska, to central Baja California, Mexico (Manuwal and Thoresen 1993). Cassin's Auklets are the third most abundant breeding species in southern California (H. Carter, unpubl. data). In 1991, the breeding population of Cassin's Auklets in the SCB was about 6,300 pairs, with >90% at San Miguel Island (Prince Island and Castle Rock) and the remainder at Santa Cruz and Santa Barbara islands (H. Carter, unpubl. data; Whitworth et al., in press). Numbers at Prince Island, the largest colony in the SCB, possibly declined between 1975–1978 and 1991, but differences in colony-based survey protocols and effort prevented assessment of population trends (H. Carter, unpubl. data).

In 1975–1983, Briggs et al. (1987) observed Cassin's Auklets year-round throughout California waters from the mid-continental shelf out to 150 km from shore, but in late spring and summer the species was concentrated near breeding colonies. From August through October, birds were distributed throughout the SCB west of San Clemente Island and over the continental shelf and slope from San Miguel Island to Point Buchon (Briggs et al. 1987). In 1999–2002, Cassin's Auklet distribution varied markedly with survey month, but birds generally were observed >10 km from shore (Fig. 44). In May, birds were concentrated in northwest Santa Barbara Channel and north of Point Conception, reflecting northward dispersal of SCB breeders (Adams et al. 2004). In September, most Cassin's Auklets were observed north of Point Conception. They were widely distributed across the SCB in January primarily west of San Nicolas Island. Limited colony attendance occurs in winter. Higher densities in January than May reflected incubating adults in May, juveniles at sea after the breeding season, and possibly some birds from the Farallon Islands feeding further south before regular colony attendance occurs pre-breeding. Like Briggs et al. (1987), we observed Cassin's Auklets primarily in deeper water seaward of the continental slope in September.

In 1999–2002, at-sea densities differed among seasons and sub-areas (Table 5). Overall, densities were greatest in January, whereas few birds were observed in September (Tables 1a–e). In May, densities were greatest in S3 near northern Channel Island breeding colonies (Table 1c). In January, densities were greatest in S2 (west of San Miguel Island) in waters averaging 1,450 m in depth (Table 1b). On coastline surveys, Cassin's Auklets only occurred near the northern Channel Islands where densities were greatest in January (Tables 2–4).

At-sea densities of Cassin's Auklets were greater in 1975–1983 than in 1999–2002 for the entire study area and S1, but lower in S3, S4, consistent with possible decline at the largest breeding colony at Prince Island (Tables 7a, 7b). Numbers of breeding birds at colonies at Santa Cruz and Santa Barbara islands declined since 1991 (J. Adams, unpubl. data). At-sea densities did not differ significantly in S2 (Tables 7a).

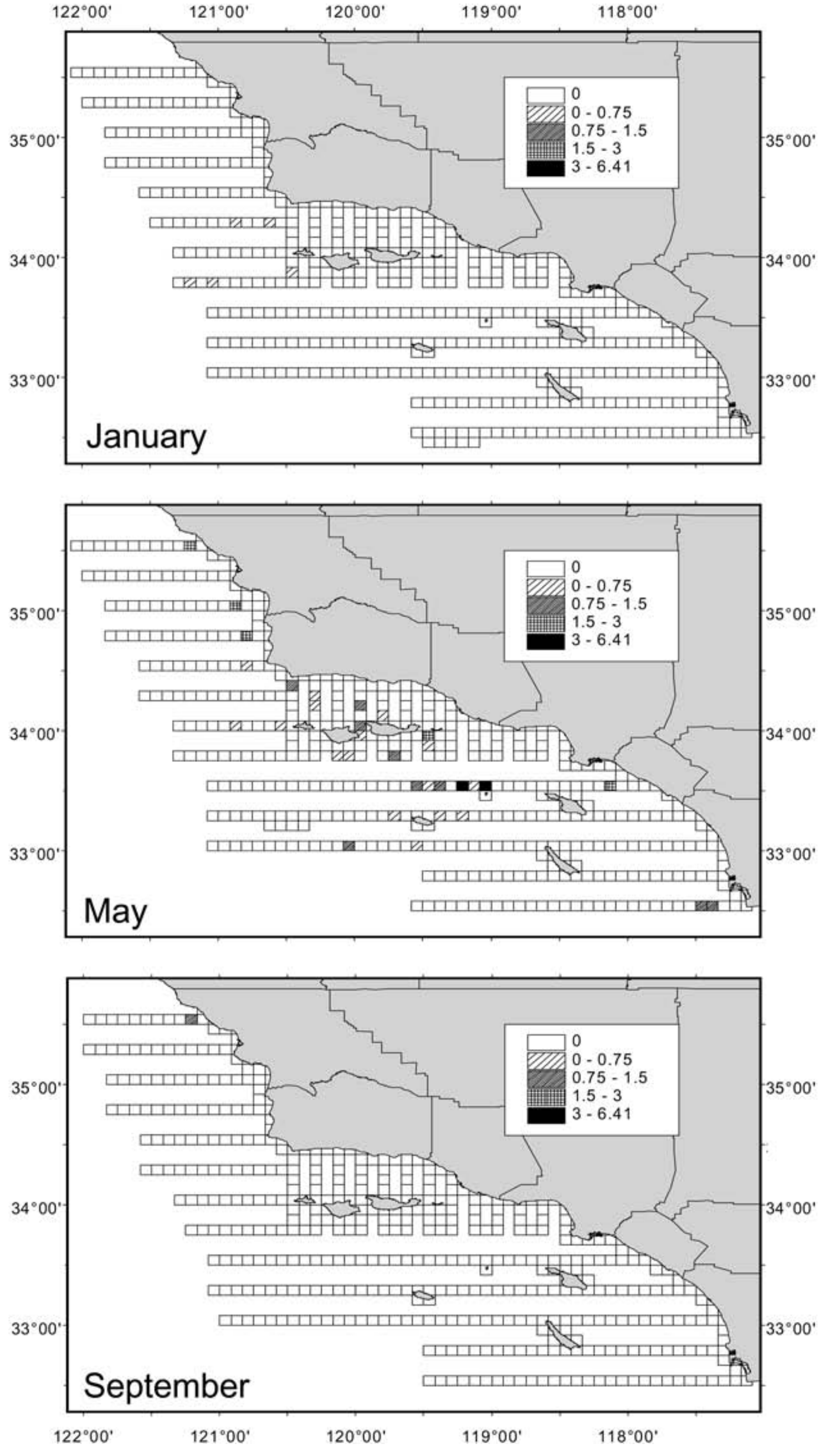

FIGURE 43. Xantus's Murrelet densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

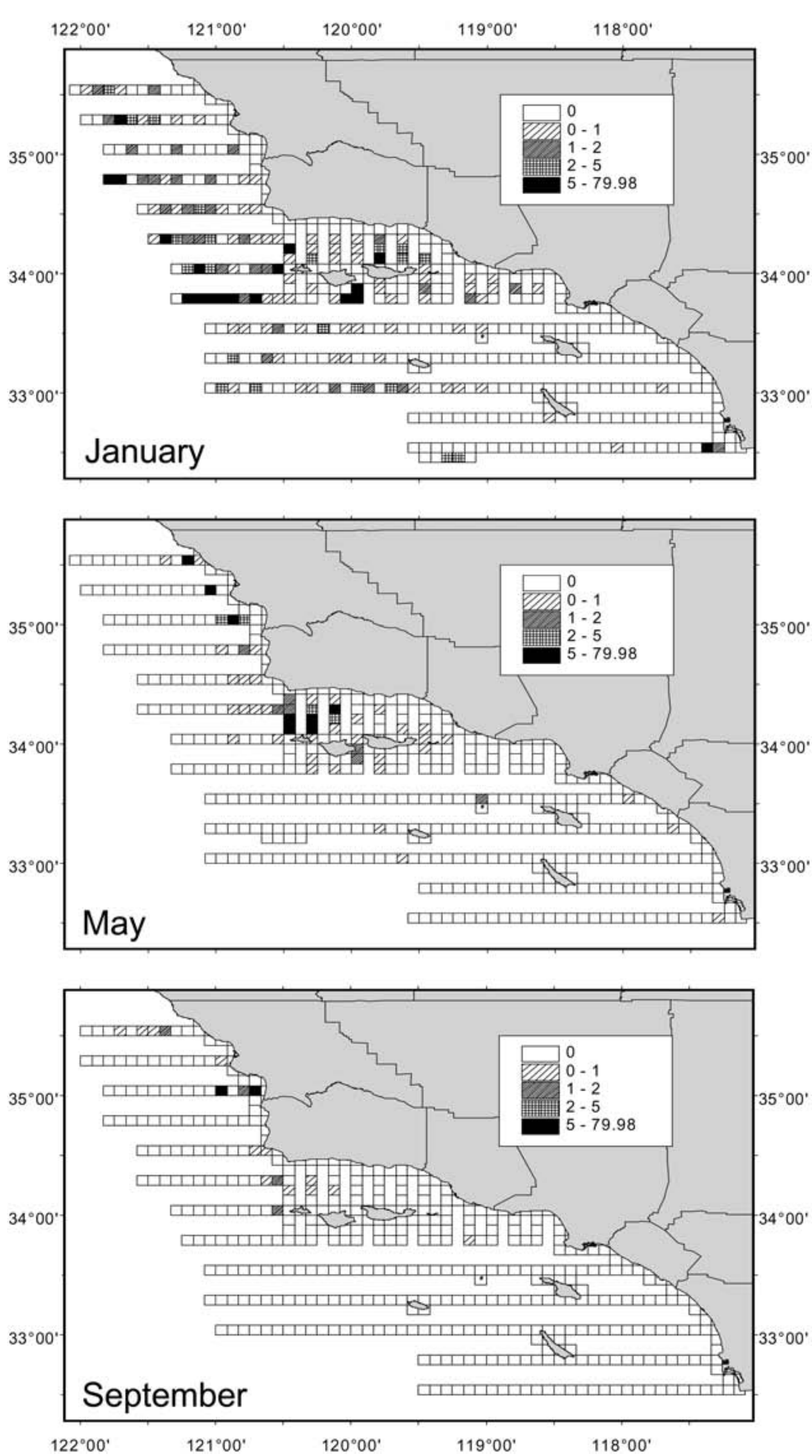

FIGURE 44. Cassin's Auklet densities (birds/km^2) and distribution off southern California from 1999–2002 during January, May, and September.

Rhinoceros Auklet (Cerorhinca monocerata)

Rhinoceros Auklets breed from the Aleutian Islands, Alaska to San Miguel Island. Birds winter from southeast Alaska to southern Baja California, Mexico (Gaston and Dechesne 1996). In 1991, small numbers of Rhinoceros Auklets were found to breed at San Miguel Island and north of Point Conception, six small breeding colonies also were observed (H. Carter, unpubl. data; McChesney et al. 1995). The California breeding population was estimated to be 900 breeding pairs representing a five-fold increase over 1979–1980 (H. Carter, unpubl. data).

In 1975–1978, Rhinoceros Auklet densities in the SCB were lowest in the summer and greatest in January, February, and March (Briggs et al. 1987). In spring, birds occurred along the western margin of the SCB, in the passages between the northern Channel Islands, and along the shelfbreak from Point Arguello to Oregon (Briggs et al. 1987). In 1999–2002 in January, we observed Rhinoceros Auklets throughout southern California <100 km from shore (Fig. 45). Small numbers observed in May and September occurred near breeding colonies in the northern Channel Islands or north of Point Conception.

At-sea densities differed among seasons and sub-areas (Table 5). Rhinoceros Auklet densities were greatest in January and much lower in May and September (Tables 1a–e). In all months, at-sea densities were greatest in S1, lowest in S2, and intermediate in S3, S4, and S5 (Tables 1a–e). We observed only five Rhinoceros Auklets on coastal transects in 1999–2002, all near the northern Channel Islands. At-sea densities of Rhinoceros Auklets in 1975–1983 were greater than densities in 1999–2002 in the entire study area, S2, and S3, but were lower in S1 (Tables 7a, 7b). At-sea densities did not differ significantly in S4 or S5 (Tables 7b). Not consistent with lower densities in 1999–2002, populations on the west coast of North America have increased in recent years (Ainley et al. 1994, Gaston and Dechesne 1996).

Tufted Puffin (Fratercula cirrhata)

Tufted Puffins breed from California to the Bering and Chukchi seas, extending to Japan (Gaston and Jones 1998). Tufted Puffins did not breed in the SCB from 1912–1991, but small numbers were found breeding at Prince Island in 1991 and 1994 (H. Carter, unpubl. data; McChesney et al. 1995). At the Farallon Islands off San Francisco, California, puffins experienced a population decline from 1,000s of birds in the late 1800s to an estimated 100 breeders in 1982. Although their winter distribution is not well known, Tufted Puffins generally spend the winter well offshore and Briggs et al. (1987) found puffins most abundant off California in January, April, and May. During periods of annual maximum abundance in the winter and spring in 1975–1978, low thousands were estimated in the SCB (Briggs et al. 1987). Since few puffins breed south of British Columbia, these birds must have originated from British Columbia or Alaska.

We did not observe Tufted Puffins during our study. In the winter, we may have misidentified small numbers of Tufted Puffins as Rhinoceros Auklets but our population estimates still would be much lower than found by Briggs et al. (1987). We suggest that puffins were not migrating to southern California in 1999–2002, consistent with major declines in populations from southeast Alaska to California (Piatt and Kitaysky 2002).

DISCUSSION

In 1999–2002, we examined distribution and abundance of seabirds off southern California from Cambria to the Mexican border with the first comprehensive aerial surveys in two decades. Earlier surveys in 1975–1983 (Briggs et al. 1987) focused on describing temporal patterns of seabird abundance in at-sea habitats, with monthly surveys limited to a relatively small area that excluded coastal habitats in the SCB. In 1999–2002, we focused on completing: (1) better assessment of seabird abundance in five at-sea and five coastal sub-areas during 3 mo (May, September, and January); and (2) comparison of seabird abundance in these 3 mo for at-sea sub-areas between 1999–2002 and 1975–1983 to assess general trends.

While our study design was directed at reducing variability between our study and Briggs et al. (1987), we flew similar, but not identical, transect lines. Our effort within the SCB was greater than Briggs et al. (1987), and we concentrated effort around the northern Channel Islands. Aircraft type and observers differed between the two studies, and we sampled intensively during 3 mo of the year, whereas Briggs et al. (1987) sampled year-round. Thus, although they were more likely to record annual peaks in abundance, we averaged their survey data across months (April–June) to reduce variation in peak abundance between studies. However, we used the same analytical approach to estimate densities from both datasets to derive comparable estimates.

While direct comparisons are complicated by these differences in survey coverage, our