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**SEABIRDS OF
CENTRAL AND NORTHERN CALIFORNIA,
1980-1983:
STATUS, ABUNDANCE
AND DISTRIBUTION.**

Volume III, Book 3

**Kenneth T. Briggs, W. Breck Tyler,
David B. Lewis, Kathleen F. Dettman**

**Center for Marine Studies
University of California, Santa Cruz**

**Prepared for
Pacific OCS Region
Minerals Management Service
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by

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and Kathleen F. Dettman**

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University of California, Santa Cruz**

**Part of Investigator's Final Report
Marine Mammal and Seabird Study,
Central and Northern California
Principal Investigator: Thomas P. Dohl**

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ABSTRACT

We present the results of a three-year survey (1980-1983) of seabird populations inhabiting the coastline and waters to 185 km offshore of central and northern California. Surveys were mainly conducted from aircraft flying at low altitudes (60 m) employing strip transect methodology. About 120,000 linear km of tracklines were surveyed during monthly flights, resulting in about 71,000 sightings of 1.2 million seabirds. Quarterly counts of nearshore populations resulted in records of almost 3.0 million birds,

The seabird fauna comprises 102 species of which 30-35 are relatively numerous in a given month. Mean density of seabirds ranged from about 8 to 38 birds/km² and biomass density from 3 to 26 kg/km². Annual lows in both measures usually occurred in mid-winter and in early summer. Birds were most abundant in 1980 and least so in 1982 during the onset of an intense El Niño event in the eastern Pacific. At this time waters were unusually warm, flow of currents to the north over the continental shelf was unusually strong, and seabird foods may have been less abundant or located deep in the water column. Species composition and diversity varied seasonally and geographically; the fauna of waters seaward of the continental slope was relatively depauperate compared to that of the adjacent shelf. While the majority of all birds in the study area at all times was visitors and migrants, the nesting fauna, comprising seventeen species and 13.8 million birds, was large and diverse. Visiting phalaropes and Shearwaters attained the greatest mean densities of all taxa, at times completely dominating the fauna. Among nesting species murrelets, auklets, cormorants and gulls were prominent both at sea and ashore.

Large concentrations of birds occur at times almost everywhere over the continental shelf, but three areas were notable for consistently supporting the largest numbers of nesting, roosting, and

ABSTRACT

foraging birds: a) the continental shelf and shoreline from Cape Mendocino to the California-Oregon border, where almost half the state's resident seabirds nest and where largest numbers of grebes, scoters, and murre fed at sea; b) the shelf waters and shoreline from Monterey to Point Reyes, including the Farallon Islands and Cordell Bank, where almost half the state's nesting seabirds reside and huge numbers of murre, cormorants, auklets, scoters, grebes, gulls, and a wide variety of migrants fed at sea; and c) the shelf and shoreline south of Point Piedras Blancas, which supported relatively few nesting birds but great numbers of migrants, winter residents (including birds nesting elsewhere in central and northern California), and thousands of Brown Pelicans in summer and fall.

The status, distribution and demography of the fauna as a whole and of the several numerically-predominant species are discussed in relation to geography, seasonality, and prevailing hydrographic conditions. An annotated species list and distributional graphics document the occurrence of species not treated in detail.

Seabirds of Central and Northern California

1980-1983

Status, Abundance, and Distribution

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frequently used in the text:

AB	<i>American Birds</i>
AFN	<i>Audubon Field Notes</i>
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CBC	Christmas Bird Count
MMS	Minerals Management Service
MT	Metric Tons
OCS	outer Continental Shelf
NOAA	National oceanic and Atmospheric Administration
POBSP	Pacific ocean Biological Survey Program
se.	standard error of the mean
SCB	Southern California Bight

1. INTRODUCTION

This report presents the results of a three-year study (January 1980-January 1983), designed to characterize the numbers, distribution, and species composition of the seabird fauna of the region extending 185 km seaward of the central and northern California coast. The surveys, conducted mostly from an airplane, have yielded a vast amount of information of potential use to scientists and managers concerned with identifying, mitigating, and monitoring possible impacts to seabirds that might be associated with development of offshore oil and gas resources in the region. Our three-year study has resulted in the first comprehensive perspective on the seabird fauna of central and northern California. It provides a framework for integrating and interpreting earlier studies and adds greatly to the understanding of the status and distribution of these organisms, in addition to identifying seasons and locations upon which the birds depend for their livelihood (such as feeding areas, migration routes, loafing sites), we have investigated some specific environmental features that promote seabird concentrations.

Prior to our study the published scientific literature provided a limited base to assess general characteristics of the fauna, and a substantial amount of data concerning reproductive biology, and to some degree diet, of several species nesting on the Farallon Islands, off San Francisco (Fig. 1). The early literature concerning seabirds in central and northern California focused specifically on the species nesting on the Farallones (e.g. Loomis 1895, Emerson 1904, reviewed in Ainley and Lewis 1974), and on the fauna of Monterey Bay (e.g. Beck 1910). The general status and seasonality in California waters of many numerically important seabirds was reviewed by Ainley (1976), who identified some broad geographic (latitudinal), seasonal, and interannual trends in bird occurrence. Using primarily data from *Audubon Field Notes/American Birds* (AFN/AB), Ainley derived indices

1. INTRODUCTION

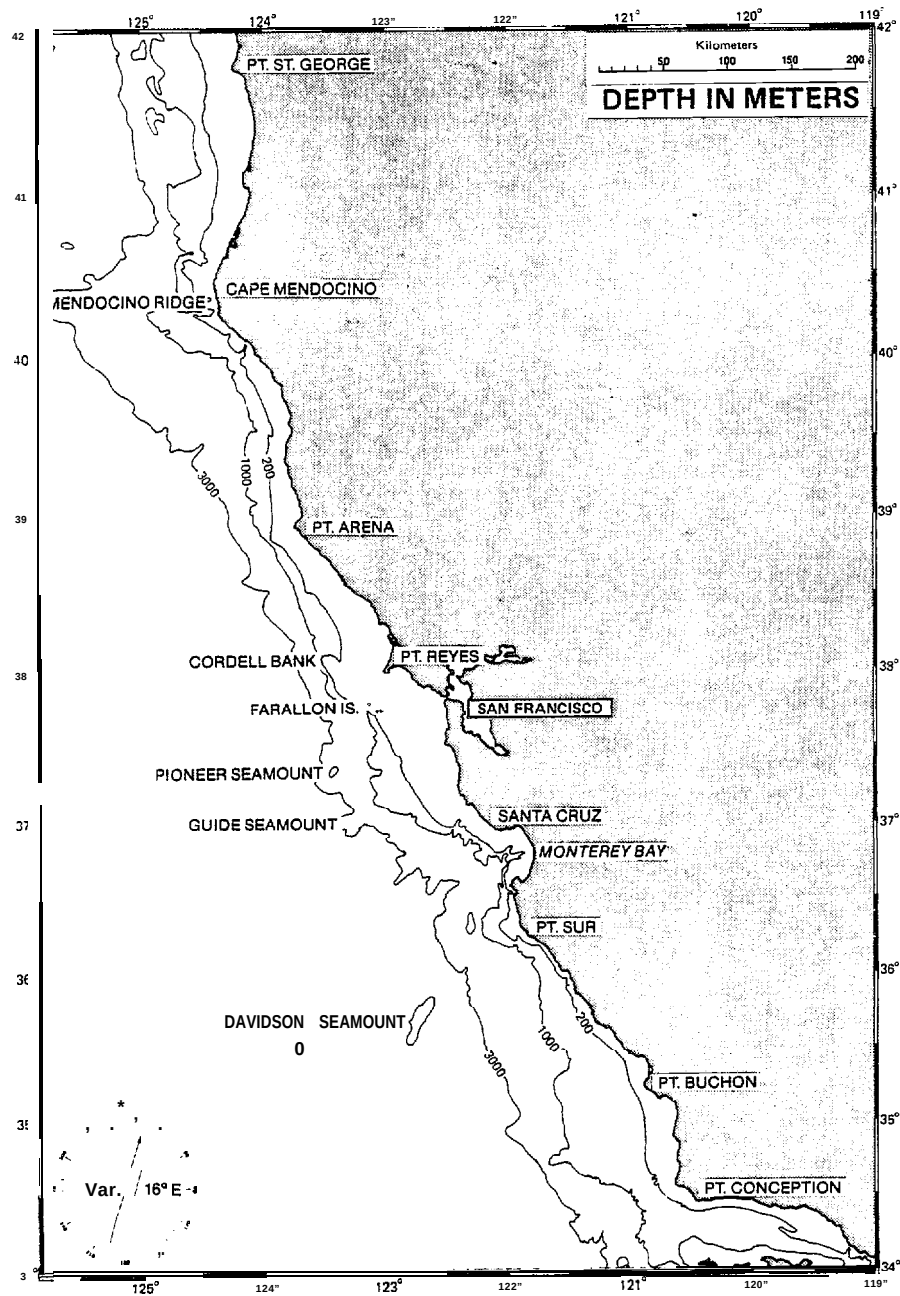


Figure 1. Map of the central and northern California study area showing major coastal features and general bathymetry.

1. INTRODUCTION

of relative abundance and discussed some hydrographic correlates of distribution. Several common species were omitted from consideration because the observers focused on unusual species rather than familiar ones. Most of the AFN/AB data were gathered during day-trips on boats near major coastal cities (especially San Francisco, Monterey, Los Angeles, and San Diego). A similar treatment of birds in Monterey Bay, based on numerous short boat trips, is presented by Stallcup (1976). Published and unpublished reports by personnel of the Pacific Ocean Biological Survey Program (P.O.B.S.P.) provide some details of seasonal occurrence of birds south and west of Point Conception (Harrington 1975, DeLong and Crossin ms) as do papers by Jehl (1973) and Briggs et al. (1981a). Page et al. (1977) reviewed general distribution, diet, and seasonality of all important seabirds in the region.

As they occur off central and northern California, individual species that have received detailed study include the Black-footed Albatross (Sanger 1974a), Laysan Albatross (Sanger 1974b), Leach's Storm-Petrel (Crossin 1974, Ainley 1980 and 1983), Ashy Storm-Petrel (Ainley et al. 1974, Crossin 1974), Fork-tailed Storm-Petrel (nesting only; Harris 1974), Mottled Petrel (Ainley and Manolis 1979), Brown Pelican (Ainley 1972, Baldrige 1973, Anderson and Anderson 1976), Brandt's, Pelagic, and Double-crested Cormorants (Bartholomew 1942, Ainley et al. 1981), Western Gull (Coulter 1973 and 1975, Ainley and Lewis 1974, Briggs 1977, Pierotti 1981), Common Murre (Ainley and Lewis 1974), Pigeon Guillemot (Drent 1965), Cassin's Auklet (Thoresen 1964, Manuwal 1974), and Horned Puffin (Hoffman et al. 1975; scientific names of species appear in Section 3d., Annotated Species List). Hundreds of other citations of narrower scope could be mentioned.

Diet and foraging strategies of seabirds in the region have received relatively little attention with the exception of the important works of Manuwal (1974), Baltz and Morejohn (1977), Morejohn

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et al, (1978), Ainley and Sanger (1979), Ainley et al. (1981), Hunt et al. (1981), and Chu (1984 in press). A thorough synthesis of existing data and much new work concerning the numbers, distribution and nesting phenology of California's breeding resident seabirds appears in Sowers et al. (1980).

Our study ties together many of the works mentioned above and provides, for the first time, quantitative data on geographic and seasonal patterns of habitat occupancy. Working both near the coast and well offshore each month, we have gained new perspectives on movements of some bird populations and have resolved to some extent the most important feeding and migration areas. As in other aerial surveys carried out to date (Briggs et al. 1981a, Orr et al. 1982, Harrison 1982), we have sampled the area rapidly, providing a series of "snapshots" of the fauna in short time periods (4-5 days). Our data are most complete concerning species that occur in relatively large numbers and are less complete for rarely-occurring species, particularly where they occur near the coast (where rare and inconspicuous birds may be missed among the thousands present) or far at sea (where observation conditions often are most difficult).

We do not attempt here to evaluate the behavior or vulnerability of birds when in contact with spilled oil. This subject has been reviewed recently by contractors for MMS (Nero Associates 1982), and is an area of active research. The interested reader may consult the Nero Associates' report and the Environmental Statement prepared by MMS for OCS Sale 53 (1981) for summaries of the published literature. We do provide pertinent life history, behavioral and demographic information where applicable, and in Volume II, Detailed Synthesis, identify locations and populations that should receive priority attention in the event of an oil spill.

1. INTRODUCTION

la. Plan of Presentation, The remainder of this book is organized into six sections. Following a section concerning Methods (which includes survey rationale, field protocols, and data analysis procedures) is found a description of the Hydrographic Conditions encountered during our study, as they relate to distribution and numbers of birds. Our data on seabirds are presented in three parts: a section dealing with Faunal Characteristics, including the numbers and biomass of all seabirds, areas of concentration, and species composition; a section containing seasonal and annual population profiles of the Numerically Predominant Species; and an Annotated Species List providing details pertinent to each species occurring in the region; this is followed by an Appendix comprising a collection of distributional graphics referred to in the text.

2. METHODS

2a. Survey Rationale. Our study included primarily aerial surveys, supplemented in 1981 by five geographically-restricted cruises aboard UCSC's 40' vessel RV Scammon. Aerial surveys are relatively new in studies of seabirds at sea; their merits and weaknesses relative to traditional shipboard sampling have been evaluated only incompletely. The principal features of all aerial surveys of seabirds reported to date are: rapid coverage of large geographic areas, use of low altitude strip censuses; absolute, rather than relative density estimation schemes. Speeds, altitudes, corridor widths and protocols have varied among aerial surveys as have reported levels of confidence in density estimation and identification of inconspicuous targets such as small alcids (Hunt and Briggs 1975; Bradstreet 1979; Briggs et al. 1981a, 1981b; Orr et al. 1982; Harrison 1982) .

We decided at the outset of our study to employ a sampling scheme based on four main features: 1) survey lines would be oriented east-west, approximately perpendicular to the coast, would extend 185 km (100 nm) seaward, and would be fixed; 2) sampling would occur in all regions systematically, not randomly; 3) samples would be concentrated in shelf and slope waters, where our previous experience had indicated birds would be concentrated (Briggs et al. 1981a); 4) samples would be spaced apart evenly with latitude, with additional transects employed in five areas designated by MMS as potential lease areas for OCS Sale 53. The sampling regimen actually attained included monthly surveys of about half of the potential 92 transects located at 5' latitude intervals with 40% of effort devoted each to shelf and slope waters, respectively.

2a. Survey Rationale

No effort was made to sample individual lines repetitively in order to reduce within-sample variance. Our work in southern California (Briggs et al, 1981a) indicated that even 4 to 7 immediate replicates of a line yielded a coefficient of variation in density estimates of $\pm 20\%$. This irreducible variance results from clumping of birds at sea, movements of birds, narrow transect corridors, and error introduced by observer bias and fatigue, and observation conditions.

2b. Survey Aircraft. All aerial surveys were conducted in a specially equipped Hunting Pembroke, a large high-wing, twin-engine aircraft, well suited to relatively slow, low altitude operations. The aircraft was equipped with four large viewing ports on each side, and four photo ports (one each in the belly and nose, and one on each side) which made it an excellent platform for both visual and photographic censuses. The usual flight crew consisted of a pilot, co-pilot, and four or more scientists. The position of the aircraft (accurate to 0.1' of latitude and 0.1' of longitude), was known through the use of an onboard navigational computer (GNS-500) with a display panel visible to the flight crew and a repeater for the scientific personnel,

2c. Open-Ocean Survey Protocol. Surveys were flown at 60 m (200 ft) above sea level; as determined by barometric and radar altimeters. Flight speed averaged 165 km/hr. The width of the transect corridor was 50 m, estimated by sighting angle measured with a hand-held inclinometer. Collection of seabird data proceeded in the following manner: *single* observers on one or both sides of the aircraft continuously searched the 50 m corridor and recorded observations orally on tape. Sighting records included the time, location, species and number of all birds sighted; behavior, direction of travel, and interspecific associations were also noted. In addition to seabird data, observers also noted environmental phenomena

such as slicks, water color boundaries, and changes in sea state, in practice, observers searched only the side of the aircraft free from sun glare. Data for *seabirds* observed beyond the survey corridor were also noted and recorded as "off-transect"* sightings.

The combination of flight speed, altitude, and corridor width were optimal for identification of seabirds (see Briggs and Hunt 1981), but surveys were affected by environmental conditions. Identifications were made to species whenever possible. If a bird could not be identified confidently to species, it was recorded at the genus or family level. In practice, the proportion of specific to generic identifications was highest among large or conspicuous birds and lowest for inconspicuous individuals whose plumage or flight characteristics were not clearly diagnostic. For example, similarities among some terns, storm-petrels, small alcids, and immature gulls made specific identification difficult. When birds were spotted in flocks so large that direct counts were not possible, observers first estimated number, then species composition, and finally noted behavior, direction of travel, etc.

Off-duty observers were engaged in the collection of oceanographic data. Sea surface temperature was measured by means of a radiation thermometer (Barnes PRT-5) mounted through the aircraft floor. On a few flights chlorophyll concentration was measured by using a differential radiometer (Briggs et al, [1984 in press] describe the collection and application of oceanographic data in a study of phalaropes off central California), Both instruments were connected to a strip chart recorder to provide continuous data along each transect line. Table 1 presents dates and level of coverage attained for all open water and coastal surveys.

Table 1. Summary of field effort on low-altitude aerial surveys of seabirds.

<u>Offshore Surveys</u>			<u>Coastal Surveys</u>		
<u>Date</u>	<u>Trip#</u>	<u># of Tran- sects</u>	<u>Date</u>	<u>Flight hours</u>	<u>Photos taken</u>
25 February- 1 March 1980	2-01	48	28-30 January 1980	18.5	1,403
24-28 March	2-02	40	5-7 May	20.5	1,791
21-25 April	2-03	40	1-3 July	15.7	1,924
26-30 May	2-04	40	28-30 October	17.0	1,494
23-28 June	2-05	40	28-30 January 1981	18.0	978
21-25 July	2-06	40	19-21 May	15.25	1,282
25-28 August	2-07	40	30 June - 2 July	18.0	1,575
23-27 September	2-08	40	28-30 September	19.5	1,562
20-24 October	2-09	43			
17-21 November	2-10	41	25-30 January 1982	15.0	538
15-19 December	2-11	38	3-5 and 19 May	15.25	1,106
			28-30 June	13.5	1,456
19-24 January 1981	2-12	34	27-28 October	12.75	1,218
23-27 February	2-13	41			
22-25 March,			TOTAL : 12 surveys	198.95	16,327
27-28 March	2-14	39	Average	16.58	1,360
20-24 April	2-15	42			
25-29 May	2-16	42			
22-26 June	2-17	43			
20-24 July 1981	2-18	42			
24-28 August	2-19	42			
21-25 September	2-20	42			
19-23 October	2-21	42			
16-20 November	2-22	41			
7-11 December	2-23	42			
18-22 January 1982	2-24	32			
22-26 February	2-25	32			
22-26 March	2-26	34			
19-23 April	2-27	42			
24-28 May	2-28	40			
21-25 June	2-29	36			
19-23 July	2-30	42			
23-26 August	2-31	35			
20-24 September	2-32	36			
18-22 October	2-33	38			
15-19 November	2-34	40			
13-17 December	2-35	36			
24, 25 January 1983,					
27-29 January	2-36	38			
TOTAL : 36 trips		1,423			
Average		39.5			

2d. Coastal Surveys. Visual and photographic surveys of seabirds were conducted quarterly each year along the mainland coast from Point Conception to the Oregon border, including adjacent islands. These surveys were flown at 100 - 200 m (325-650 ft) altitudes along most of the central and northern California coast, and as high as 300-400 m (975-1,300 ft) over especially sensitive habitats (e.g., Farallon Island murre colonies). The survey track of the aircraft was approximately 100 m seaward of the shoreline during most surveys. On coastal surveys, seabirds were censused by observers on both sides of the aircraft taking in the zone from the shoreline to 200 m offshore; all sightings were recorded orally on tapes. Frequent input of time and location was included on the tape commentary. Virtually all aggregations of birds greater than 25 individuals were photographed with 80-200 mm or 300 mm lenses on hand-held, motor-driven, 35 mm cameras. Photographic logs and tape entries keyed the photos to specific features of the coastline,

We refer occasionally to Audubon Society Christmas Bird Counts (CBC's). These volunteer counts can be used to assess general population trends for unmistakable species occurring almost exclusively along the coast. Where we refer to CBC's, care was taken to tabulate counts from the same spots and with comparable party-hours each year. Unlike our aerial counts, complete coastal coverage is not achieved by CBC's. However, counter-balancing this incomplete coverage is the fact that shore or boat counts can record numbers of birds that may fortuitously dive during passage of an airplane. The two kinds of coverage are loosely complementary but have not been subjected to rigorous quantitative comparisons,

2e. vessel Surveys. In addition to the aerial surveys, five vessel surveys were conducted in the waters from Monterey Bay to Bodega Bay, extending approximately 100 km offshore. The purpose of vessel surveys was to determine species composition of dense flocks

2e. Vessel Surveys

(especially of the smaller species), which is not possible from an airplane. A secondary task was to evaluate seabird occurrence and feeding in relation to the autumnal upwelling that occurred in these waters. Surveys were conducted by one or two observers who, using 7x binoculars, counted and identified birds within an 800 m Corridor (400 m to either side of the ship), and recorded sighting distance, interspecific associations, feeding, and other behavior. Observations were generally made from the flying bridge (4 m elevation) of the vessel moving at 10-18 km/hr.

The maximum distance at which various seabirds may reliably be identified varies with observation conditions, plumage characteristics, body size, and behavior. We used two transect widths (300 and 800 m) when calculating densities for inconspicuous and conspicuous birds, respectively. Small, inconspicuous birds were reliably counted only out to 150 m laterally under most environmental conditions. Comparison of surface and aerial survey techniques and documentation of the effect of corridor width on density estimation is provided in detail in Briggs and Hunt (1981).

2f. Data Analyses. Upon transcription, editing and error-checking of tapes made in the field, all data were entered into computer files by trip. First level manipulations included error-checking at multiple stages, rostering of total sightings and individuals by trip, and computation of bird density within transect corridors. Density was calculated as: number of birds seen within searched corridors divided by total area searched. We present densities in terms of birds/km². In some statistical analyses relating bird density to environmental characteristics, we have used log density instead of untransformed density. This procedure is useful in reducing the influence of within-sample variance (primarily geographic, Sokal and Rohlf 1969), thus facilitating use of parametric procedures such as correlation and regression. Two different density

2f. Data Analyses

estimates were made, corresponding to length of sampling unit and level of subsequent analyses: 1) density was calculated for each transect segment of 10' longitude length (segments were shorter where truncated by the coast or fog) for multivariate statistical treatments including regression, correlation and principal components analyses; 2) density was calculated for segments of variable length encompassing the area along each line within each of three water depth strata: shelf (0-199 m), slope (200-1,999 m), and offshore (>2,000 m). These stratified density estimates were combined with samples from similar strata on all other lines to provide gross estimates for all shelf waters, all slope waters, all southern offshore waters, etc.

The type of open-ocean survey we employed almost always underestimates the density of diving birds (e.g. loons, alcids), and overestimates that of species that occur in large flocks very close to shore. Divers are underrepresented because they spend a finite period of each day submerged, where they are undetectable from an airplane. Correction factors appropriate to the diving time and frequency of each group of diving birds are unavailable, so we chose to acknowledge the bias in the data, rather than to arbitrarily alter the numbers. For birds like scoters, grebes, some gulls and occasionally pelicans and cormorants, transect segments that are truncated at the coast often contribute to overestimates of mean density over the shelf. This occurs because large flocks of these species may occur within scant meters of the beach, leading to extremely high density values in the entire segment. During data analysis one has the option of selectively eliminating such short segments or of devaluing their associated densities by some fraction. Alternatively, we chose to recognize the inherent potential for overestimating density, and rely instead on our periodic longshore censuses for estimates of population size. Since almost the entire population of scoters, grebes and cormorants can be found within a few hundred meters of the shore at certain times, it is not likely that the coastal counts seriously

2f. Data Analyses

underestimate their numbers. Density averages, then, serve as a monthly index to population size and distribution.

2g. Size of the Data Base. During our three-year study we covered 123,488 linear km of aerial trackline as follows: 38,371 km in 1980, 41,394 km in 1981, 40,282 km in 1982, and 3,441 km in January 1983. We amassed 70,516 sightings of 1,221,289 birds during open-water surveys and counted 2,914,626 birds during twelve coastal counts. Five vessel surveys covered 954 km of trackline, resulting in 4,947 sightings of 20,654 birds. In all, 25,919 observations of SST were logged during aerial surveys.

3. RESULTS

3a. Hydrographic Conditions

Many studies of **seabirds** have attempted to relate various aspects of bird life history, reproduction, and occurrence at sea to measurable characteristics of surface waters. Frequently, bird numbers have been compared with temperature and salinity, and less often with chlorophyll content, turbidity, primary production, water depth, and distance to shore or to nesting sites. A relatively new perspective on oceanic habitats was introduced by **Ashmole** 1971, and later amplified by several other authors: birds may seek out habitat gradients such as **thermo-haline** fronts, in preference to adjacent waters having low horizontal variability in surface water chemistry or temperature (e.g., Iverson et al. 1979, Brown 1980, Powers and **Backus** 1982). It has been assumed, but **seldom** *rigorously* tested, that such fronts serve to concentrate seabird prey above **levels** encountered in adjacent waters.

To facilitate interpretation of our data on bird distribution at sea, we present here a general description of hydrographic conditions encountered during our study. The oceanography of the central and northern California study area is reviewed by **Hickey** (1979]. In addition to measurements made by us, we have utilized several main data sources: *Oceanographic Monthly Summary* (Auer [ed.] monthly, 1981-83), numerous *CalCOFI Reports*, **upwelling** indices provided by A. **Bakun** of the Pacific Environmental Group, satellite images of SST and chlorophyll provided by L. Breaker, R. **Gilliland**, and R. Austin, and data from the NOAA meteorological buoy network provided by R. **Gilliland** and compiled by **Piltz** (1982). It should be borne in mind that this discussion relates primarily to birds that spend considerable time offshore. **For** some coastal species including loons,

3a. Hydrographic Conditions

grebes, **scoters**, and some gulls and terns, features such as availability of roosts close to preferred nearshore feeding areas are of more importance than the hydrographic conditions to be described.

The California coastline from Point Conception to the Oregon border is oriented approximately north-south with a prominent westward bulge at Cape Mendocino. The continental shelf (<200 m water depths) varies in width from about 5 to 75 km. Important topographic highs exist at the **Mendocino** Escarpment and at Guide, Pioneer and Davidson **Seamounts**, while major canyons are found off Trinidad Head, Cape **Vizcaino**, and in **Monterey Bay** (Fig. 1). Beyond the shelfbreak the seabed slopes away fairly rapidly to **abyssal** plain exceeding 3,000 m in depth.

The hydrography of the area is dominated by the southward-flowing California Current. It is broad (perhaps 1,000 km), generally slow (averaging 10-30 cm/sec), and cool (10-16°C north of Cape **Mendocino**, 2-30 warmer off Point Conception), with the region of maximum flow at 250 to 500 km offshore. A northward countercurrent, the California Undercurrent, flows year-round at depth near the edge of the shelf. During November through February flow is northward throughout the water column everywhere over the shelf. It is thought that the undercurrent surfaces at this time of year, and this nearshore flow is termed the Davidson Current (**Bolin** and Abbott 1963). Flow of the California Current is strongest, with the region of maximum flow closest to the coast, during spring and **summer**. Later in the year, flow weakens, moves offshore, and frequently resolves into eddies of about 100-300 km in diameter (Reid et al. 1958, Bernstein et al. 1977, Hickey 1979, Broenkow 1982).

Studies conducted recently by Mooers and Robinson (1984) have shown that current filaments or 'jets', having speeds in the range of 50 cm/sec or more, may form between prominent counter-rotating eddies of the California Current. These jets have dimensions of tens to

3a. Hydrographic Conditions

hundreds of kilometers, durations of days to weeks, and may flow in a direction opposite to the long-term southward flow of the California Current. The prevalence and predictability of these features is unknown, but it is certain that high-speed current jets contribute importantly to offshore movement of coastal water, and are associated with sharp surface thermal fronts (where temperature changes dramatically over relatively short horizontal distances). The ecological implications of this new perspective on flow in the California Current are not presently understood, but may be significant.

Upwelling is a process of great importance in promoting high productivity in California coastal waters. **Upwelling** occurs in any season where winds are favorable (relatively strong, from the north or northwest). An index of the strength of **upwelling**, calculated from regional wind patterns by A. Bakun and his colleagues, can be used to examine the seasonal and geographic prevalence of **upwelling** during our study. In the area south of Point Sur, Bakun's index shows that winds were favorable for **upwelling** during almost every month of our study (Fig. 2a), whereas winds conducive to coastal convergence, or **downwelling**, occurred north of Cape Mendocino through almost half of 1980 and 1981 (Fig. 2d). The coolest, most saline surface waters in central and northern California are found north of Point Reyes during periods of intense **upwelling** (occasionally as cool as 7-8°C). Prominent centers of **upwelling** include Cape Mendocino, Point Arena, Point Reyes, Point Sur, and Point Conception; almost the entire remainder of the coastline features **upwelling** to a lesser degree. In midsummer through autumn, cool 'plumes' of water extend seaward out to 400 km from a few coastal promontories (Tragant et al. 1980). Though supporting data are few, it is generally thought that the highest standing stocks of plankton are reached downstream of **upwelling** centers, several weeks to months after the onset of **upwelling**.

3a. Hydrographic Conditions

A feature of **upwelling** systems that is potentially of great importance to birds is convergence and sinking of waters within and at the seaward edges of **upwellings** (Laurs et al. 1977, Brown 1979 and 1980, Lasker et al. 1981, Briggs et al. 1984 in press). Here, physical mechanisms may promote a passive concentration of biological materials that in turn enhances standing stocks of motile plankton, squid, fish, and other predators. The outer edges of **upwellings** are often observed in satellite imagery of surface temperature as scalloped features located primarily **over** the continental slope (e.g., Bernstein et al. 1977, Breaker and Gilliland 1981). Until archived satellite images have received detailed future study, it will not be **possible** to predict with confidence the presence of these features in space and time.

Chelton (1981) and Bernal and McGowan (1981) have analyzed long time-series **CalCOFI** data and found that annual productivity of California Current waters correlates more with transport in the California Current than to local enrichment through **upwelling**. Plant and zooplankton stocks are higher in northern California, near the source of California Current water, than farther to the south. Additionally, when California Current transport decreases, water warms and productivity drops. These features probably act in combination to influence bird concentrations. Birds may be expected to be more abundant in northern California than in the south, should be concentrated at convergence bordering and within **upwellings**, and should respond on annual time scales to periodic declines in California **Current** transport. Evidence for these phenomena is discussed in various sections that follow.

The three-year patterns of SST averaged within four latitudinal sectors of our study area are compared in Figures 2a-d to the departures from climatic mean conditions and to the **upwelling** index derived from winds data for each area by A. Bakun. SST and temperature anomaly data are from Auer (1981, 1982) and represent a

3a. Hydrographic Conditions

slightly broader longitudinal section than the waters we sampled. As such, the SST curves represent conditions in the California Current in general, and are less responsive to the local effects of coastal upwelling. Our sampling of SST, occurring primarily within the upwelling zone, reflected variations in upwelling to a greater degree, producing lower means in spring and summer, and higher means in autumn.

In each latitudinal sector, mean temperatures were lowest in spring and highest in August-October. Due to flow of cool water in the California Current, temperatures north of Cape Mendocino were 1-3°C lower throughout the year than off Point Sur to Point Conception. Temperatures were warmer at the fall maximum during 1981 and 1982 than in 1980, and we experienced four consecutive winters of anomalously warm SST's. During autumn 1982 and winter 1983, warm coastal waters were seen everywhere in the tropical and temperate eastern Pacific as intense "El Niño" conditions (Wyrtki et al. 1976, Cushing 1981, Auer 1982) burgeoned along the equator (Fig. 3). In comparison with the other years, upwelling generally was least prominent in 1982.

Figure 2. (facing page) Comparison of monthly mean sea surface temperatures (SST), deviation of SST from climatic (20 year) seasonal means, and upwelling index for four sectors of central and northern California waters, 1980-1983. a) Point Conception to Point Sur; b) Point Sur to Russian River; c) Russian River to Cape Mendocino; d) Cape Mendocino to the California-Oregon border. The highest positive values of Bakun's index correspond to months in which average southward wind velocity is greatest, therefore favoring upwelling. Negative values indicate coastal downwelling. Data are modified from Auer (cd., 1981-1983), A. Bakun (pers. comm.), and this study.

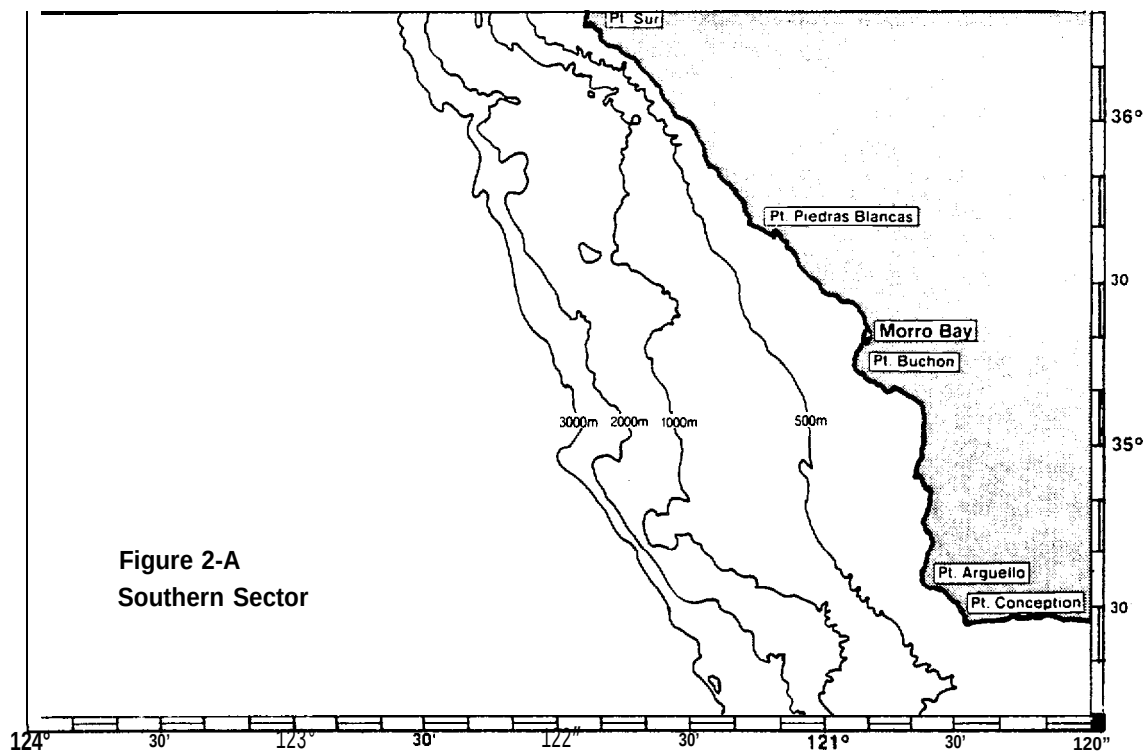
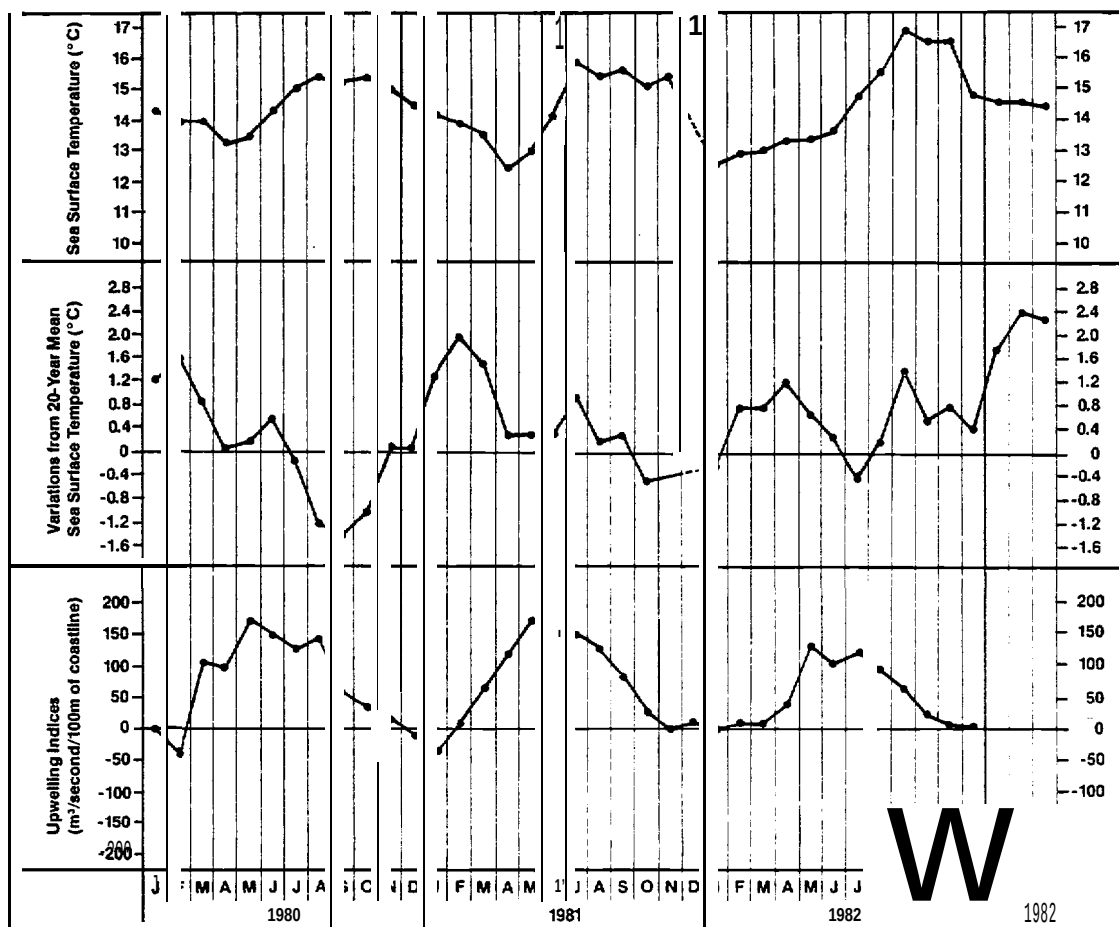
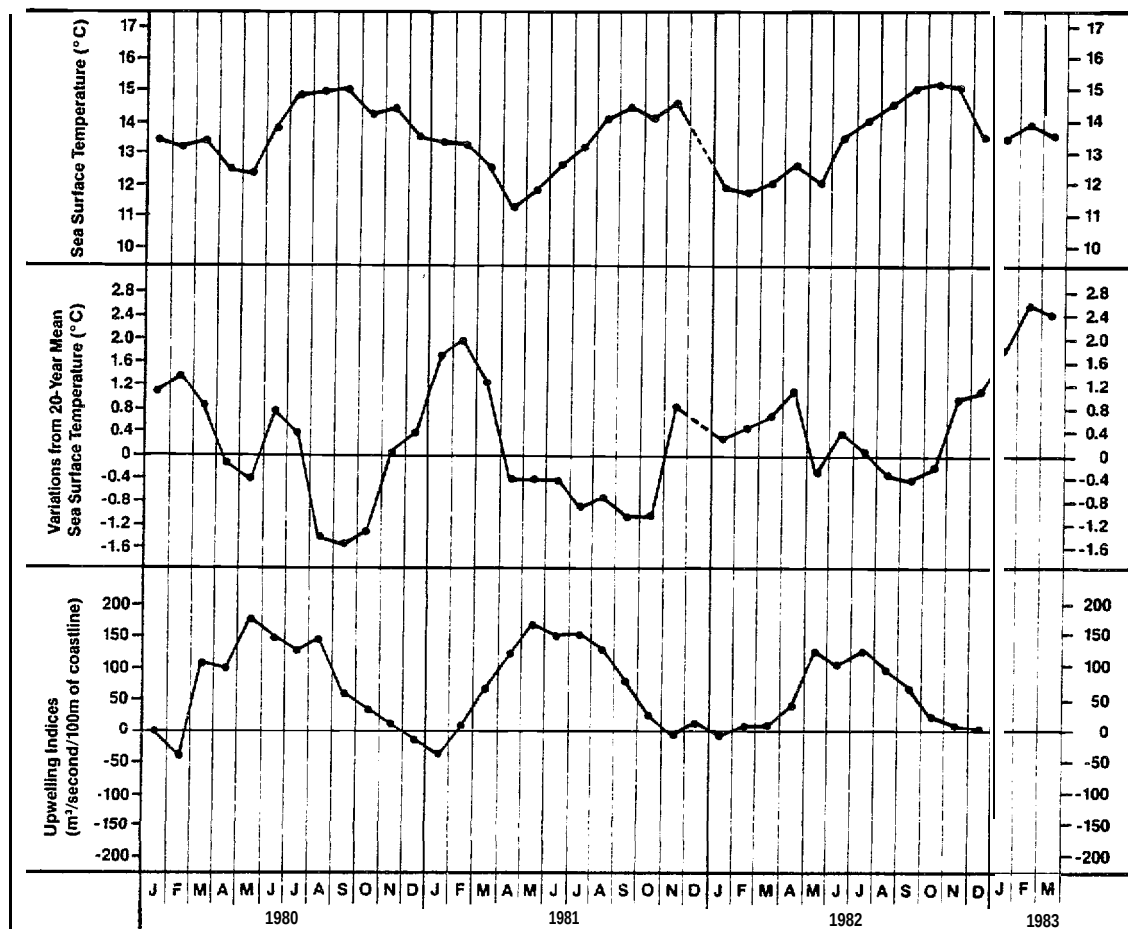
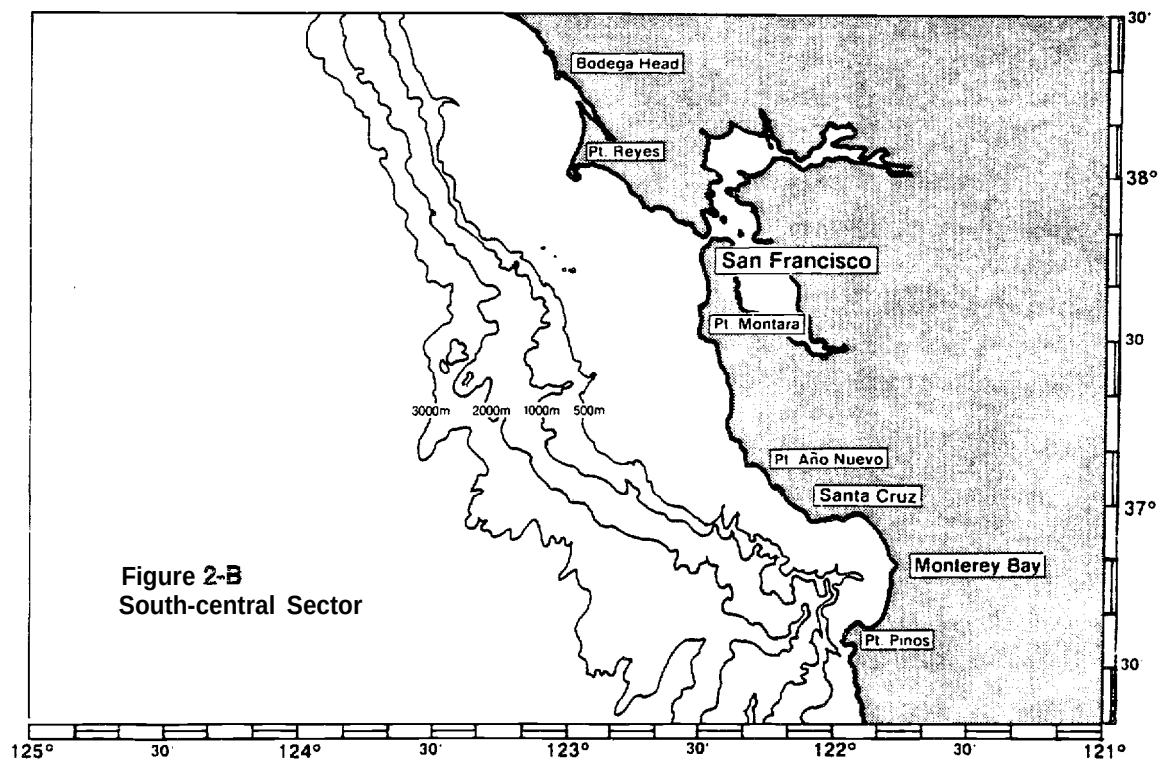


Figure 2-A
Southern Sector





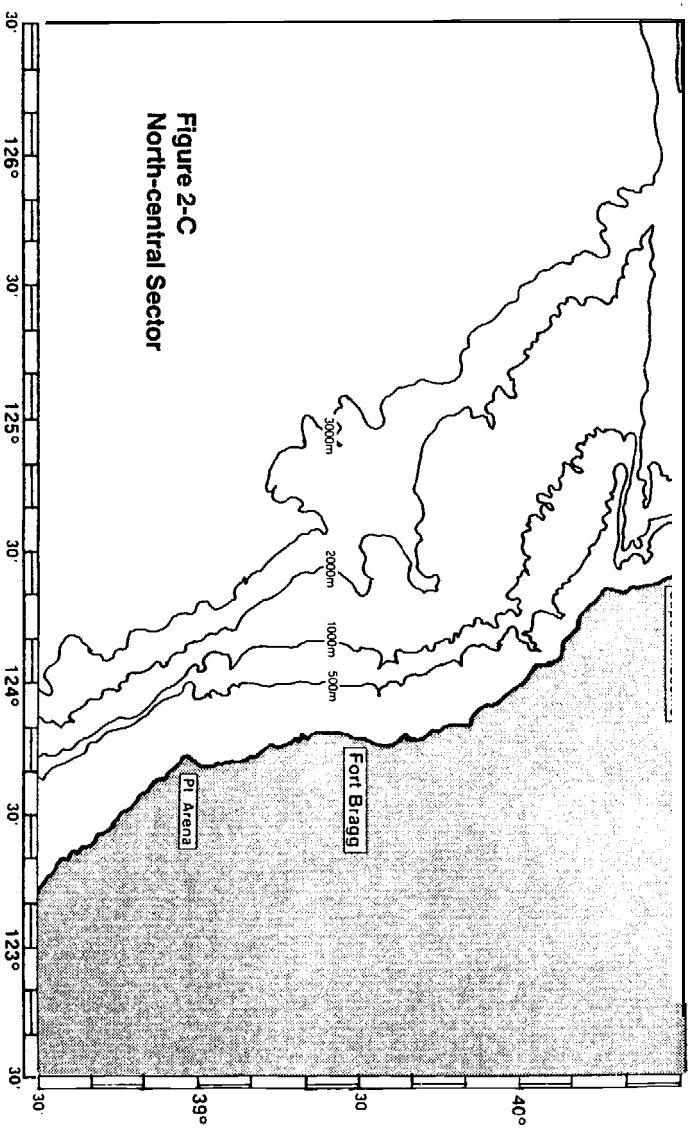
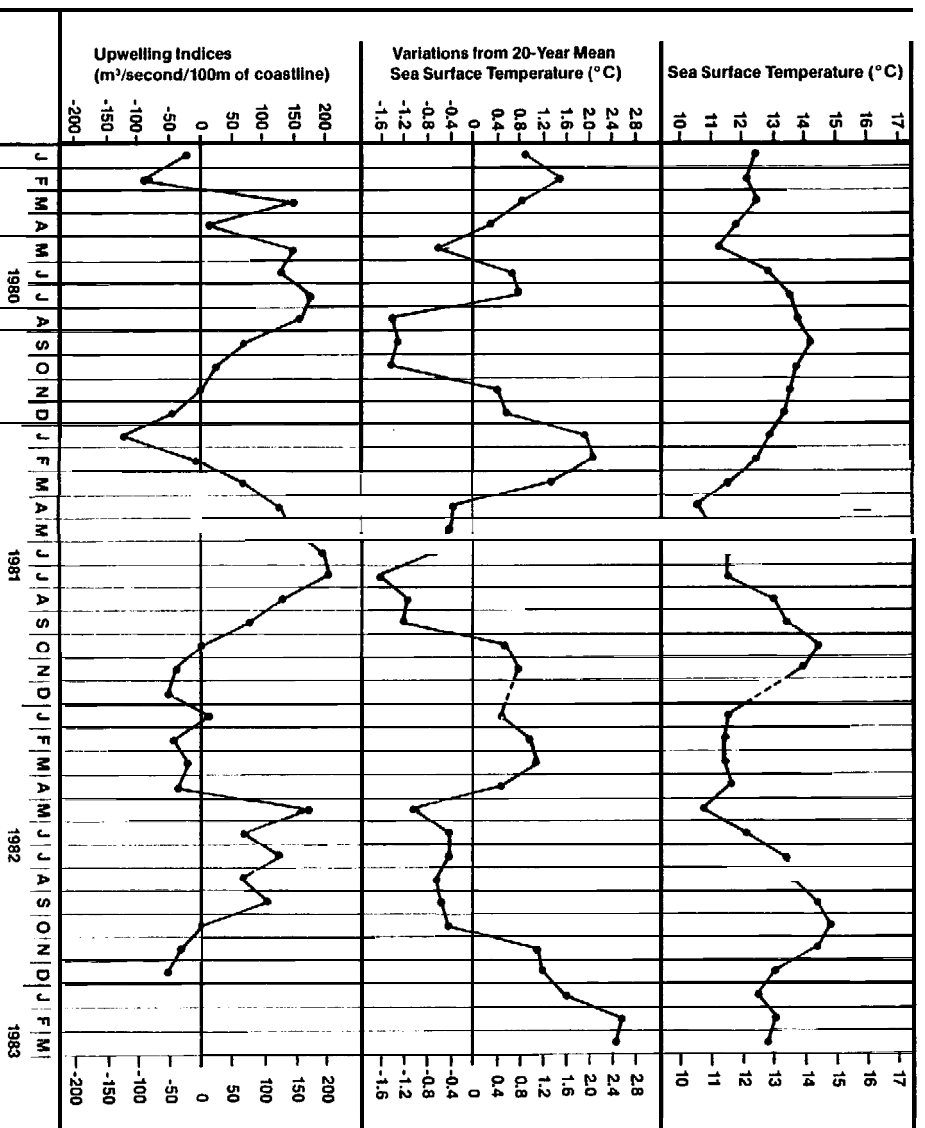
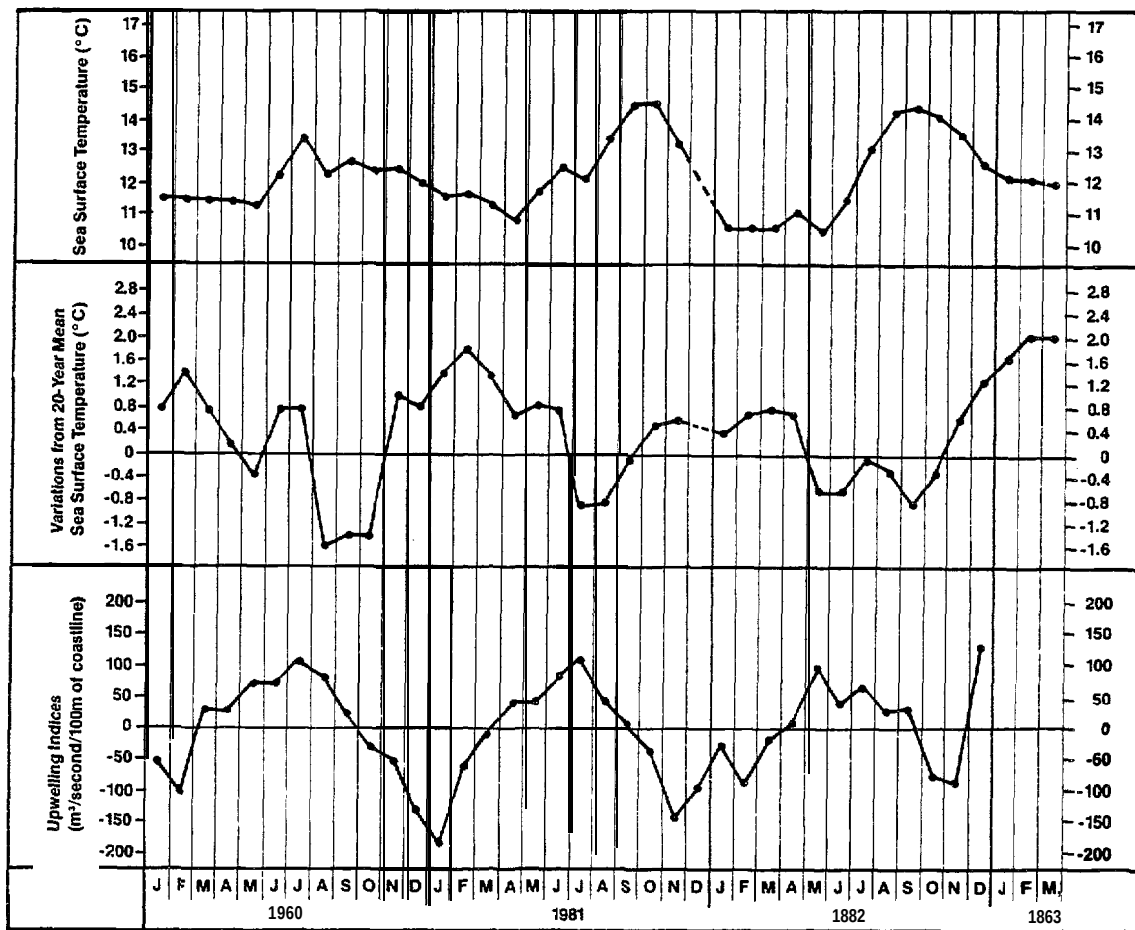
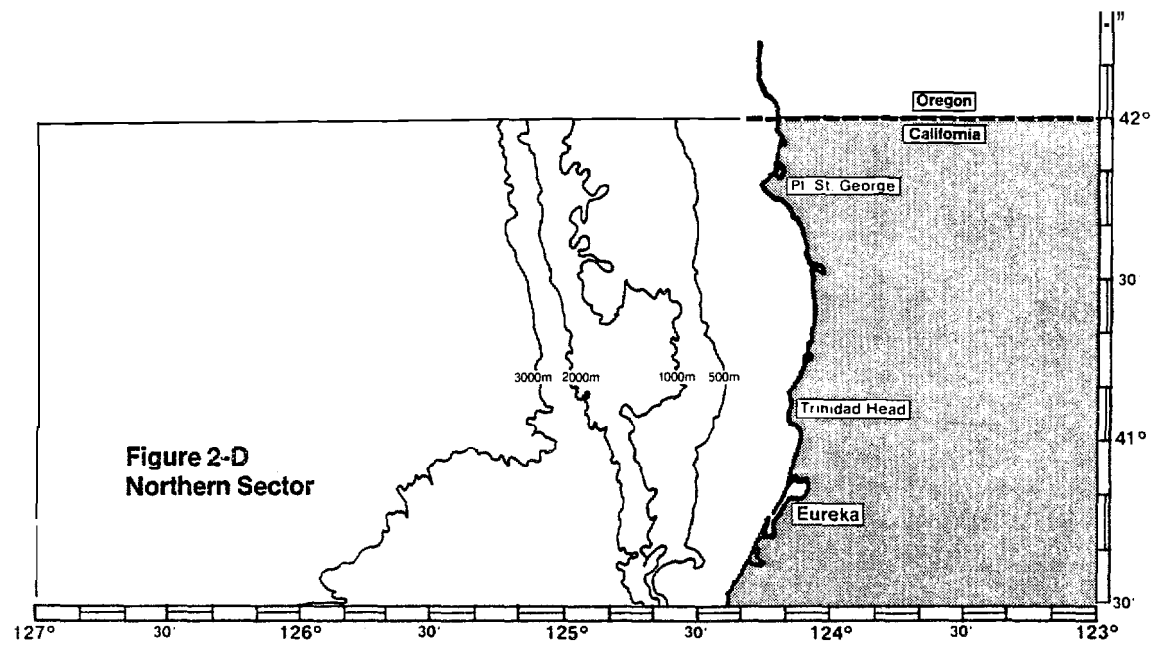


Figure 2-C
North-central Sector





3a. Hydrographic Conditions

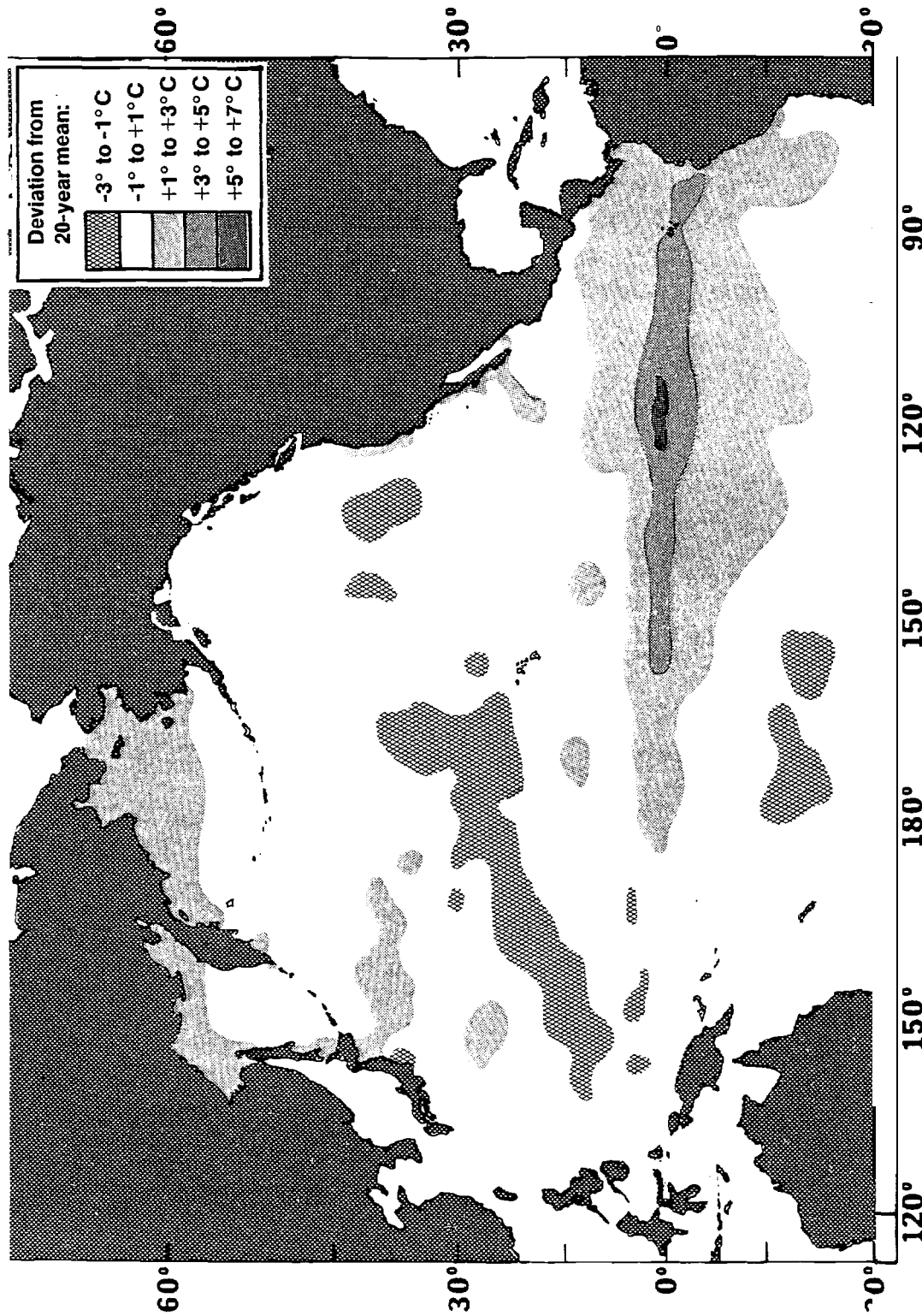


Figure 3. The pattern of SST anomaly (deviation from 20-year seasonal mean conditions) in the Pacific Basin during December 1982. Data are modified from Auer (1982). A few months later, the region of 5° - 7° C warm anomaly encompassed most of northwestern South American waters, westward to the Galapagos.

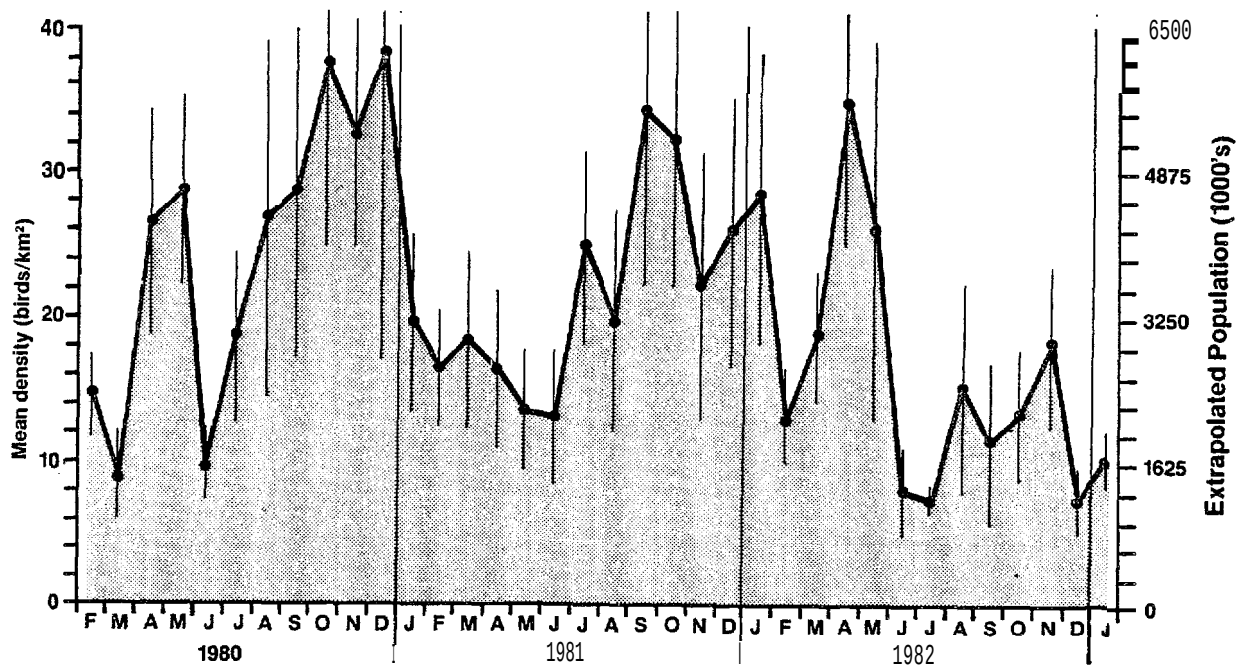


Figure 4. Monthly mean density of all seabirds in waters of central and northern California, 1980-1983. Scale for converting individual density to extrapolated total population appears at right. Vertical bars depict ± 1 se. for bird density in all density figures in this report.

3b . Faunal Characteristics

We describe the general abundance, composition, feeding habits, and geographic patterns of the seabird fauna in the following six subsections: Seabird Numbers and Biomass at Sea; Species Composition and Diversity at Sea; Foraging Methods; Geographic Patterns; Distribution and Abundance on The Coast; and Important Areas of Seabird Concentration.

1. Seabird Numbers and Biomass at Sea. The mean density of all seabird species in aggregate is presented for each month of our study in Fig. 4. Mean density fluctuated between 7.83 birds/km² (Dec. 1982) and 38.19 birds/km² (Dec. 1980), with vacillations as great as 300%

3b.1. Seabird Numbers and Biomass at sea

between adjacent months. With some annual variation, bird density was low each year in June-July (the season when nesting species accounted for about half the total, and when migrants often were present only in small numbers), and high during spring (April-May) and fall (September/October-December). Density increased to annual maxima in autumn in 1980 and 1981, while in 1982 the autumn peak was lower than that in spring. In winter, density was quite variable: values for February and March are lower than in the preceding two months or in the following spring, but January figures ranged from about 10.4 to more than 28.5 birds/km². It is likely that poor observation conditions resulting from storms contributed to the lows in March 1980, February 1981 and 1982, and December 1982.

During April-May total density fluctuated according to whether our field work coincided with the main passage of phalaropes, loons and gulls, and the annual influx of shearwaters. Densities were quite high (>26 birds/km²) in these months during 1980 and 1982, but were much lower in 1981. Both phalaropes and shearwaters occurred in large numbers during spring surveys in 1980 and 1982, while in 1981 phalaropes probably moved through central and northern California between our April and May flights, and shearwaters reached maximum densities a bit later in the year.

The average densities of locally-nesting species and of visitors are compared for each month in Fig. 5. On average, visitors contributed a much larger fraction to the total than did breeders, especially in spring and late autumn. Species diversity, assessed by means of the Shannon-Wiener index:

$$H^* = -\sum (P_i \cdot \ln P_i)$$

(where n is the number of species recorded and P_i is the proportion of total density contributed by species i , [Shannon and Weaver 1963]) was

3b.1. Seabird Numbers and Biomass at Sea

highest from November through February, and lowest from May through August (Fig. 5).

A rough conversion of monthly mean density to total "instantaneous" population in the area is presented in Fig. 4. Estimated numbers vary in direct proportion to density from 1.3 to 6.2 million birds. Since we cannot estimate turnover rates of migrants or the proportion of summer resident versus migrant shearwaters, we are not able to estimate accurately the total numbers of birds that use central and northern California waters throughout the year.

Conversion of monthly mean density for each species to biomass density (kg/km^2) was accomplished routinely by computer according to values of body weight derived from literature sources. Added together, these figures produce the curve of biomass density for the seabird fauna depicted in Fig. 6. For the most part, biomass density follows as a function of bird density, but is lower. Large differences between individual density and biomass density occurred during spring and autumn months while differences between the curves are minimal in mid-nesting season (June-July). These differences emphasize the contrast between the large numbers of small-bodied phalaropes, alcids and other species during migration with the predominance of heavier gulls, cormorants, pelicans, and shearwaters in the nesting season.

From a practical standpoint, we can consider the density of birds at sea to be an index to the numbers of birds at risk in a given area should an oil spill occur, while biomass density reflects the general importance of the fauna in energy cycling. It is beyond the scope of this report to attempt to detail energy flow patterns, trophic interactions, or seabird impact on prey populations, but some feeling for consumption by seabirds can be obtained by a simple conversion of biomass to daily food intake (Fig. 6). The literature provides

3b.2. Seabird Numbers and Biomass at Sea

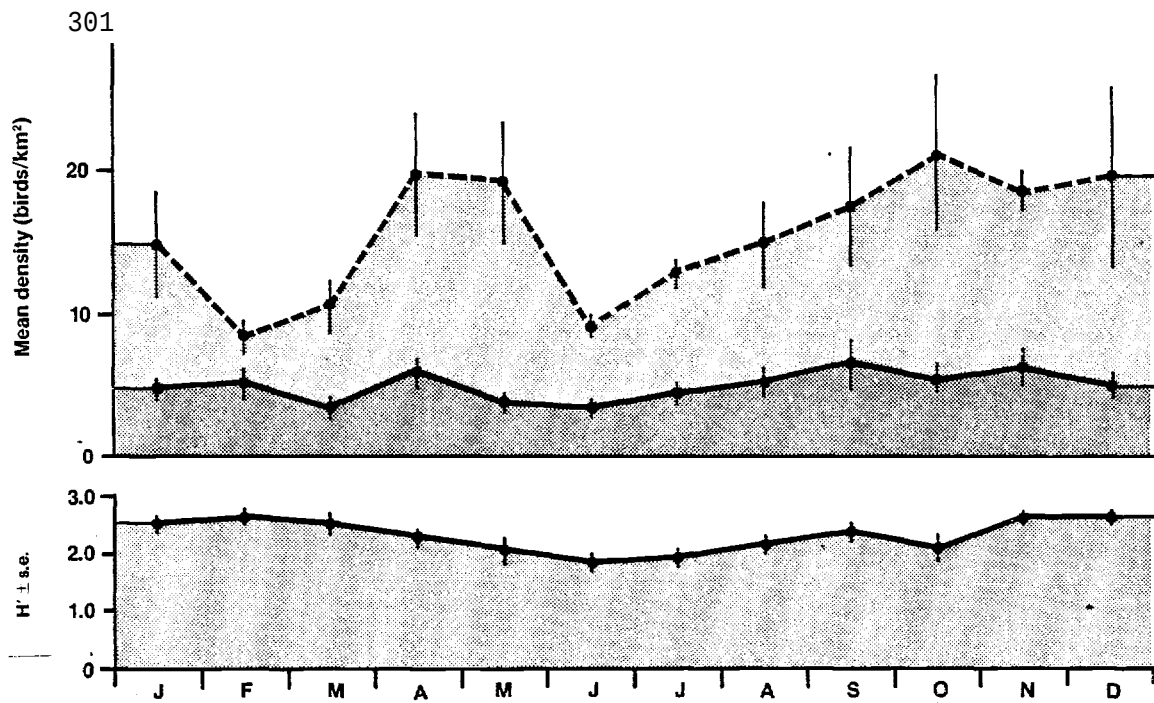


Figure 5. Average monthly densities (+s.e.) of visiting (top curve) and of locally-breeding seabirds (middle curve) compared to values of species diversity index (H').

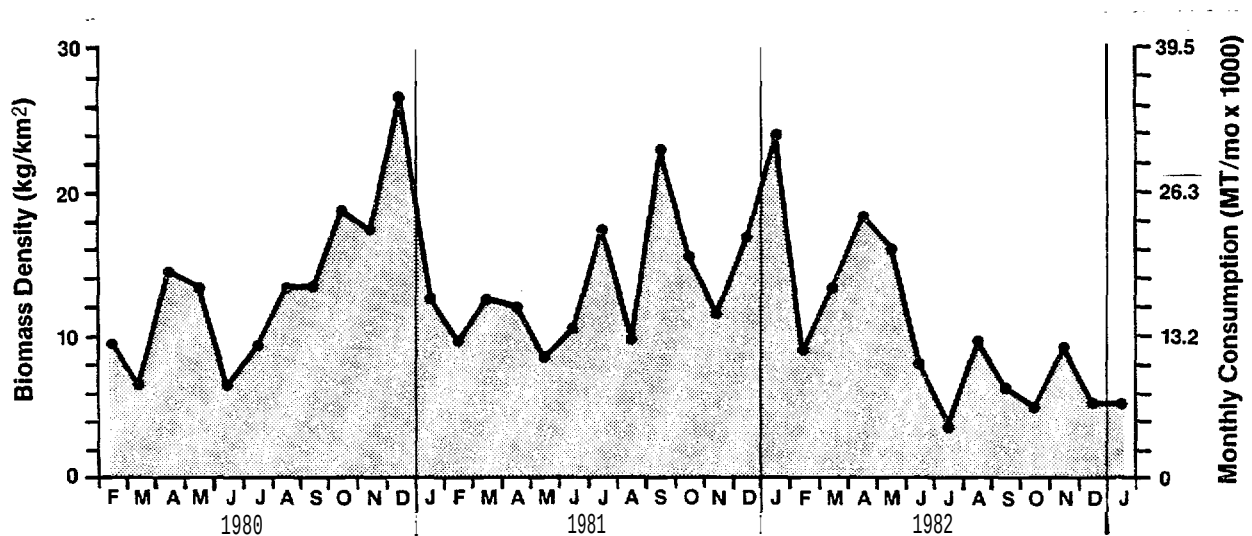


Figure 6. Monthly mean density of all seabird biomass in waters of central and northern California, 1980-1983. Scale for converting biomass density to approximate monthly consumption appears at right.

3b.1 Seabird Numbers and Biomass at Sea

several indirect means for estimating daily intake by seabirds, (Wiens and Scott 1975, Kendeigh et al. 1977; Furness 1978; Wiens et al. 1978a; Schneider 1982; Schneider and Hunt 1982). We chose a daily consumption value of 27% of mass as a reasonable estimate for the latitude and temperatures of the study area; our detailed calculations show that phalaropes, small alcids and storm-petrels may consume twice this percentage each day while large birds consume much less (12-15% of mass). Fig. 6 provides a scale for converting biomass density to consumption per month for all birds at sea in the study area. On this crude basis, seabirds are estimated to have consumed about 200,000 MT of prey during 1980 and somewhat less in the other years.

The average biomass density we found in central and northern California is approximately twice that reported by Briggs et al. (1981a) for the Southern California Bight, but is similar to the 11.6 to 22.5 kg/km² figures reported for open waters of the southeastern Bering Sea by Schneider and Hunt (1982). Wiens and Scott (1975) analyzed individual density for a four-species "community" of Oregon seabirds, reporting monthly densities that were considerably lower and considerably higher than the averages we found. Wiens and Scott's values for consumption (100-600 MT/day) are fairly similar to ours if we delete from our figures the large seasonal contribution by species (such as wintering gulls) that were excluded from their Oregon analysis.

There is a noteworthy correspondence between low seabird density and biomass and oceanic warming in autumn-winter 1982-1983. For unknown reasons, the expression in California waters of the intense El Niño event coincided with comparatively low visitation by northern migrants and winter residents (e.g. gulls and alcids). This somewhat corroborates the statement by Ainley (1976) that seabird occurrence off California relates more closely to temperature than to salinity, We would expect ambiguity in the response to salinity since similar,

3b.1 Seabird Numbers and Biomass at Sea

elevated salinities are seen in different water types, e.g. cold water presumably upwelled from the undercurrent and warm, subtropical water advected northward during the El Niño. It remains to be seen whether feeding conditions were exceptionally good north of our study area, perhaps obviating the need for birds to move as far south as central and northern California, or whether plankton and fish here were especially unavailable, leading migrants to pass by quickly and wintering species to move farther south. As fisheries, plankton, and seabird data from other regions become available we may gain a better perspective on this phenomenon.

3b.2. Species Composition and Diversity at Sea. According to a recently published list of accepted records (Jones et al. 1981), the marine avifauna of central and northern California comprises 102 species. Each of these is listed and discussed separately in Section 3c, Predominant Species, or Section 3d, Annotated Species List. In this and the following two subsections, we analyze faunal composition and diversity in several ways, categorizing the species in terms of seasonal status and foraging method, and presenting data on each of four latitudinal sectors according to water depth. Comparisons with other Pacific Coast areas are made where suitable data exist.

The seabirds of central and northern California may be grouped according to seasonal status into five main elements: 1) the species that nest in the area; 2) those that visit or reside primarily in winter but that also are present in the other seasons; 3) species that occur almost exclusively during spring and fall migration; 4) those that nest south of central California and occur here during summer and autumn; and 5) species that occur rarely and in very low numbers (Table 2).

3b.2. Species Composition and Diversity at Sea

Table 2. Seasonal status of marine birds of the central and northern California OCS. In some species more than one category may be applicable. All shorebirds except phalaropes and most anseriforms are excluded. Status is defined by season of maximum numbers. Pacific breeding range center for locally occurring form is identified following scientific name (after Palmer 1962).

Breeding species (18)

Fork-tailed Storm-Petrel (*Oceanodroma furcata*); Alaskan marine
 Leach's Storm-Petrel (*Oceanodroma leucorhoa*); Alaskan marine
 Ashy Storm-Petrel (*Oceanodroma homochroa*); California Current
 Double-crested Cormorant (*Phalacrocorax auritus*);
 eastern North Pacific
 Brandt's Cormorant (*Phalacrocorax penicillatus*);
 California Current
 Pelagic Cormorant (*Phalacrocorax pelagicus*); Alaskan marine
 Heermann's Gull (*Larus heermanni*); Gulf of California
 Western Gull (*Larus occidentalis*); California Current
 Caspian Tern (*Sterna caspia*); Temperate inland
 Forster's Tern (*Sterna forsteri*); Temperate inland
 Least Tern (*Sterna antillarum*); coastal California
 Common Murre (*Uria aalge*); Alaskan marine
 Pigeon Guillemot (*Cephus columba*); Alaskan marine
 Marbled Murrelet (*Brachyramphus marmoratus*); Alaskan marine
 Cassin's Auklet (*Ptychoramphus aleuticus*); Pacific northwest
 Rhinoceros Auklet (*Cerorhinca monocerata*);
 southeast Alaskan marine
 Tufted Puffin (*Lunda cirrhata*); Alaskan marine
 Brown Pelican (*Pelecanus occidentalis*), (nested until 1959,
 not thereafter; now mostly a summer resident); Gulf of California

Winter residents/visitors (26)

Common Loon (*Gavia immer*); Temperate inland
 Arctic Loon (*Gavia arctica*); Arctic inland
 Red-throated Loon (*Gavia stellata*); Arctic inland
 Western Grebe (*Aechmophorus occidentalis*); Temperate inland
 Red-necked Grebe (*Podiceps grisegena*); Temperate inland
 Eared Grebe (*Podiceps nigricollis*); Temperate inland
 Horned Grebe (*Podiceps auritus*); Temperate inland
 Laysan Albatross (*Diomedea immutabilis*); Hawaii
 Northern Fulmar (*Fulmarus glacialis*); Alaskan marine
 Short-tailed Shearwater (*Puffinus tenuirostris*); southwest Pacific
 American White Pelican (*Pelecanus erythrorhynchos*); Temperate inland
 Black Scoter (*Melanitta nigra*); Arctic coast
 Surf Scoter (*Melanitta perspicillata*); Arctic coast
 White-winged Scoter (*Melanitta fusca*); Arctic coast
 Red-breasted Merganser (*Mergus serrator*); Temperate inland
 Harlequin Duck (*Histrionics histrionicus*);
 Temperate-Arctic inland

3b.2. Species Composition and Diversity at Sea

Table 2. Continued.
Winter residents/visitors

Oldsquaw (*Clangula hyemalis*); Arctic-Subarctic coast
Mew Gull (*Larus canus*); Alaskan inland
Ring-billed Gull (*Larus delawarensis*); Temperate inland
California Gull (*Larus californicus*); Temperate inland
Glaucous-winged Gull (*Larus glaucescens*); Subarctic coast
Herring Gull (*Larus argentatus*); Alaskan inland
Thayer's Gull (*Larus thayeri*); eastern North America
Glaucous Gull (*Larus hyperboreus*); Alaska coast
Black-legged Kittiwake (*Rissa tridactyla*); Alaskan marine
Ancient Murrelet (*Synthliboramphus antiquus*); Alaskan marine

Spring/autumn migrants (15)

Flesh-footed Shearwater (*Puffinus carneipes*); Southwestern Pacific
Mottled Petrel (*Pterodroma inexpectata*); Southwestern Pacific
Brant (*Branta bernicla*); Arctic coast
Red Phalarope (*Phalaropus fulicarius*); Arctic-subarctic coast
Red-necked Phalarope (*Phalaropus lobatus*); Subarctic inland
Pomarine Jaeger (*Stercorarius pomarinus*); Arctic inland
Parasitic Jaeger (*Stercorarius parasiticus*); Arctic inland
Long-tailed Jaeger (*Stercorarius longicaudus*); Arctic inland
South Polar Skua (*Catharacta maccormicki*); Antarctic
Laughing Gull (*Larus atricilla*); Temperate inland
Bonaparte's Gull (*Larus philadelphia*); Arctic inland
Sabine's Gull (*Xema sabini*); Arctic inland
Common Tern (*Sterna hirundo*); Temperate inland
Arctic Tern (*Sterna paradisaea*); Arctic inland
Horned Puffin (*Fratercula corniculata*); Alaskan marine

Summer/autumn (nonbreeding) residents\visitors (9)

Buller's Shearwater (*Puffinus bulleri*);
southwestern Pacific
Black-footed Albatross (*Diomedea nigripes*); Hawaii
Pink-footed Shearwater (*Puffinus creatopus*); south Pacific
Sooty Shearwater (*Puffinus griseus*); south Pacific
Black-vented Shearwater (*Puffinus opisthomelas*);
Baja California marine
Black Storm-Petrel (*Oceanodroma melania*); Baja California marine
Royal Tern (*Sterna maxima*); Gulf of California
Elegant Tern (*Sterna elegans*); Gulf of California
Xantus * Murrelet (*Synthliboramphus hypoleucus*); southern California

Rarities (33)

Yellow-billed Loon (*Gavia adamsii*); Alaskan inland
Short-tailed Albatross (*Diomedea albatrus*); northwestern Pacific
Wandering Albatross (*Diomedea exulans*); Antarctic marine
Cape Petrel (*Daption capense*); Antarctic marine

3b.2. Species Composition and Diversity at Sea

Table 2, Continued.

Rarities

Cook's Petrel (*Pterodroma cookii*); south Pacific
 Stejneger's Petrel (*Pterodroma longirostris*); southeast Pacific
 Solander's Petrel (*Pterodroma solandri*); southwest Pacific
 Streaked Shearwater (*Calonectris leucomelas*); Japan marine
 Greater Shearwater (*Puffinus gravis*); Atlantic
 Manx Shearwater (*Puffinus puffinus*); Atlantic
 Townsend's Shearwater (*Puffinus auricularis*);
 Pacific Mexico marine
 Wedge-rumped (Galapagos) Storm-Petrel (*Oceanodroma ethys*);
 Tropical marine
 Least Storm-Petrel (*Halocrypta microsomis*);
 Gulf of California marine
 Wilson's Storm-Petrel (*Oceanites oceanicus*);
 southern oceans, Antarctica
 White-tailed Tropicbird (*Phaethon lepturus*); southwest Pacific
 Red-billed Tropicbird (*Phaethon aethereus*);
 eastern tropical marine
 Red-tailed Tropicbird (*Phaethon rubricauda*); Hawaii
 Blue-footed Booby (*Sula nebouxi*); Gulf of California marine
 Brown Booby (*Sula leucogaster*); tropical marine
 Red-footed Booby (*Sula sula*); Central American marine
 Magnificent Frigatebird (*Fregata magnificens*);
 Central America marine
 King Eider (*Somateria spectabilis*); Alaskan coastal
 Franklin's Gull (*Larus pipixcan*); Temperate inland
 Little Gull (*Larus minutus*); eastern North American
 Common Black-headed Gull (*Larus ridibundus*); eastern north Atlantic
 Lesser Black-backed Gull (*Larus fuscus*); eastern North America
 Black Tern (*Chlidonias niger*); Temperate inland
 Black Skimmer (*Rynchops niger*); Gulf of California coastal
 Thick-billed Murre (*Uria lomvia*); Alaskan marine
 Craveri's Murrelet (*Synthliboramphus craveri*);
 Gulf of California marine
 Parakeet Auklet (*Cyclorhynchus psittacula*); Alaskan marine
 Least Auklet (*Aethia pusilla*); Alaskan marine
 Crested Auklet (*Aethia cristatella*); Alaskan marine

Aside from the substantial number of rare or accidental species, most are either winter residents (26 species) or local nesters (17 species, 18 if Brown Pelicans are included). Of these two large groups, only a few species' nesting ranges are centered south of the study area: Heermann's Gull, Least Tern and Brown Pelican in southern California or Mexico; Laysan Albatross in the central Pacific and Short-tailed Shearwater in the southwestern Pacific. The great

3b.2. Species Composition and Diversity at Sea

majority of winter visitors and breeders has a breeding range center north or inland from central and northern California. Among the locally-breeding species, nine nest both north and south of the study area; Ashy Storm-Petrels, Brandt's Cormorants, and Western Gulls are essentially endemic to the California Current. For the most part, the locally-nesting species contribute their largest relative fraction to the total fauna during June, while winter residents constitute the bulk of the fauna from November through March (discussed further below).

The shearwaters and the phalaropes are the most abundant of the 24 species that visit central and northern California primarily during migration, or that visit during summer and autumn after concluding nesting activities in Mexico or in the central or southwestern Pacific. Among the rare and accidental species are birds from all corners of the Pacific, the Bering and Arctic seas, all the North American land mass, and the North Atlantic,

To a large extent the seabird fauna of central and northern California is one that is shared with Oregon-Washington, southern California, and Mexico; a good deal of mixing of tropical and boreal faunas occurs on either side of Point Conception. Moving north from there, one encounters fewer tropical species (e.g. boobies, frigatebirds, some petrels, some terns) and more boreal species (e.g. alcids, gulls). The number of individuals of tropical or sub-tropical species that invade central and northern California in late summer and fall is, however, greatly overshadowed by the hundreds of thousands of birds that move southward into the area during winter. The long term data analyzed by Ainley (1976) reveal that movements of tropical and subtropical birds north of Point Conception are tied to overall oceanographic conditions. During years of abnormally warm temperatures and enhanced northward flow of the Davidson Current, these southern forms are more numerous and press farther to the north.

3b.2. Species Composition and Diversity at sea

Compared to the nesting fauna of regions to the north and south, (Table 3), that of central and northern California is relatively diverse and contains moderate numbers of birds. The extensive colony data presented by **Sowls** et al. (1980) reveal that about 0.7 million seabirds nest in the study area, with highest numbers in the Gulf of the **Farallones** and on about a dozen coastal rocks scattered from cape **Mendocino** north. Common Murres (59.6%), **Cassin's Auklets** (17.9%), **Brandt's** Cormorants (9.6%), and Western Gulls (6.5%), account for the bulk of the nesting total (Table 3).

3b.3. Foraging Methods. A large proportion of the seabird species common off central and northern California obtain food *either* by pursuing their prey underwater or by seizing food on or just below the surface (Table 4). Comparison of monthly aggregate density curves for surface-seizers and divers (Fig. 7a, b) reveals annual lows for both groups during summer and **variable**, high densities in fall and winter. It appears that numbers of surface feeders, mostly reflecting gull and **phalarope** populations, peak a **bit** earlier during autumn than is the case for divers, which largely comprise **alcid** populations. Populations of both surface feeders and divers attained highest autumn densities in 1980, were most variable from August 1981 through the following **April**, and were relatively low during the onset of El **Niño** conditions in fall 1992.

Populations of shearwaters, the only pursuit plungers frequenting our area, peaked each year during May through July. Later in summer, numbers of aerial plungers (pelicans and terns) increased markedly, coincident with the seasonal reduction in **upwelling**. Cessation of **upwelling** leads to general decreases in standing stocks of **phytoplankton** and concomitant clarification of surface waters (**Ainley** 1977), Relatively clear waters enable flying birds to locate, track, and presumably capture schooling prey most effectively. storm-Petrels, which use a feeding method termed "dipping" (picking up

Table 3. Numbers of seabirds (1,000s) nesting in California compared with totals for contiguous regions. Species nesting exclusively in Alaska are not listed!

Species	Alaska Total	British Columbia	Washington	Oregon	California	
					Central- Northern	Southern
Fork-tailed Storm-Petrel	5,000.0	98.2	3.8	< 1	0.3	0
Leach's Storm-Petrel	4,000.0	12.7	7.3	136.0	18.3	Present
Ashy Storm-Petrel	0	0	0	0	4.0	1.2
Black Storm-Petrel	0	0	0	0	0	0.2
Double-crested Cormorant	7+	2.1	0.1	1.7	1.5	0.4
Brandt's Cormorant	<0.1	0.4	0.3	16.2	58.4	5.8
Pelagic Cormorant ²	90.0	10.0	2.8	6.6	15.4	0.5
Brown Pelican	0	0	0	0	0	2.7
Glaucous-winged Gull	500.0	29.5	20.9	0	0	0
Herring Gull	0.3+	?	Present	0	0	0
Western Gull	0	0	1.9	9.9	39.7	11.2
Common Murre	5,000.0	3.0	23.9	255.0	363.1 ³	0
Pigeon Guillemot	200.0	6.0	0.7	2.1	12.5	2.2
Marbled Murrelet	Present	Present	Present	Present	2.0	0
Ancient Murrelet	400.0	42.3	0	0	0	0
Xantus' Murrelet	0	0	0	0	0	3.5
Cassin's Auklet	600.0	1,063.0	0.2	0.2	108.9	22.3
Rhinoceros Auklet	200.0	22.5	42.4	0.2	0.4	0
Tufted Puffin	4,000.0	324.1	119.8	6.6	0.3	0

1. Sources include Heath (1915), Manuwal and Campbell (1979), SOWLS et al. (1978), SOWLS et al. (1980), Varoujean and Pitman (1980), and Willett (1915).
2. Includes Red-faced Cormorant (*P. urile*) in Alaska.
3. Current estimate (this study) is 518.8.

3b.3. Foraging Methods

Table 4. Classification of the numerically important seabird species groups of central and northern California, according to feeding method (after Ashmole 1971, Ainley 1977, Ainley and Sanger 1979).

1. Pursuit Divers - submerge from surface to capture prey, using wings or feet for propulsion.

loons	scoters	
grebes	Red-breasted Merganser	
cormorants	alcids	Total 17 species
2. Pursuit Plungers - actively pursue prey beneath surface after aerial plunging.

Sooty Shearwater		
Pink-footed Shearwater		
Short-tailed Shearwater		
Buller's Shearwater		Total 4 species
3. Aerial Plungers - obtain prey within 1-3 m of surface after aerial plunge.

Brown Pelican		
toms		Total 6 species
4. Surface Seizers - capture prey in upper few cm of water (to perhaps 1 m) while swimming on the surface.

Black-footed Albatross		
Northern Fulmar	jaegers	
phalaropes	gulls	Total 15 species
5. Contact Dippers - capture minute prey while fluttering just above the surface.

Storm-Petrels		Total 4 species
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3b.3. Foraging Methods

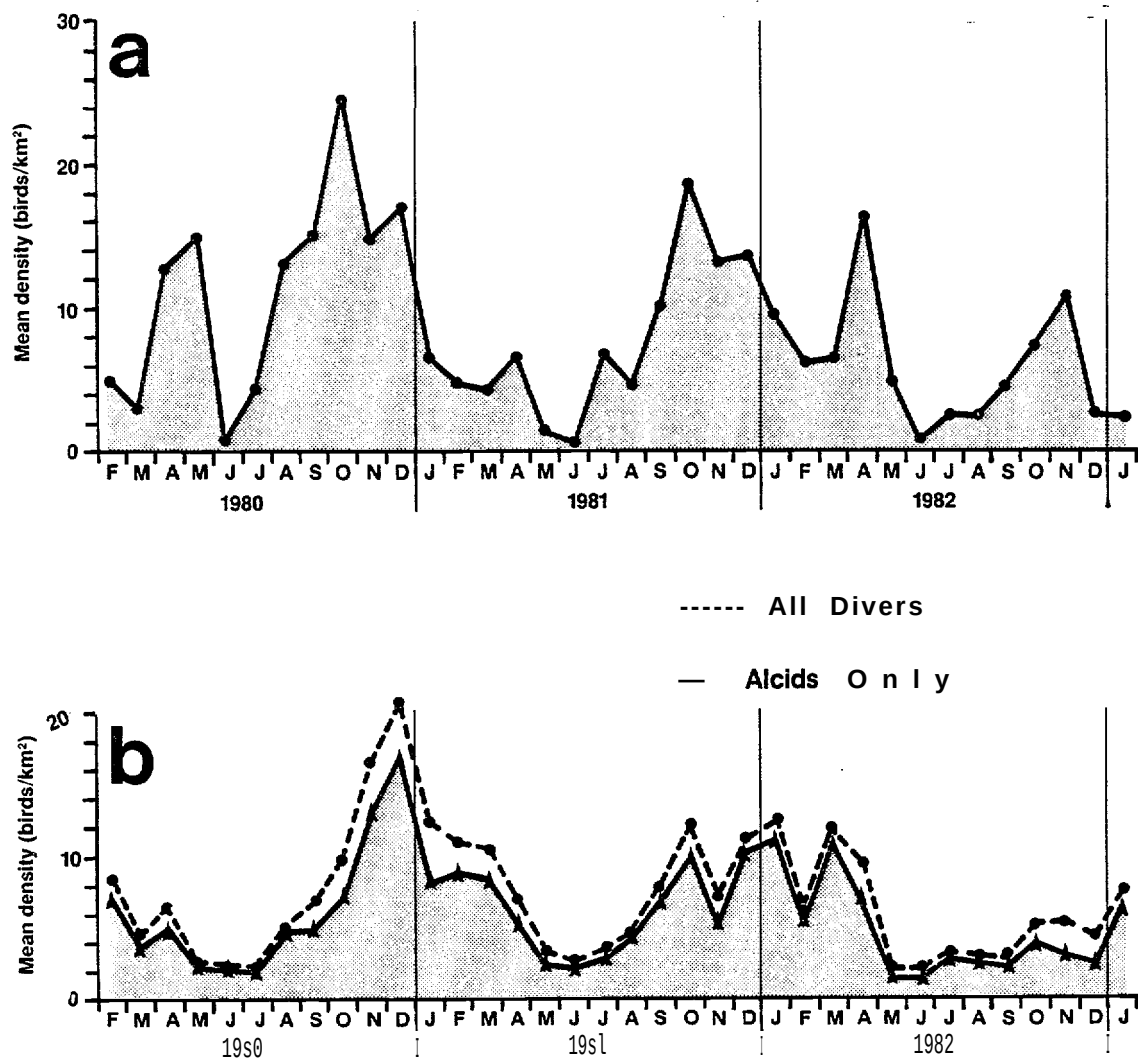


Figure 7. (a) Monthly mean density of all surface seizers in central and northern California, 1980-1983; (b) monthly mean density of all divers and of all alcids.

3b.3. Foraging Methods

minute prey while flying or fluttering just above the water), are present year-round, peaking in abundance during the nesting season and early fall.

3b.4. Geographic Patterns, The patterns of species composition, diversity, and numbers at sea vary annually, with latitude, and according to water depth. To facilitate discussion of these **faunal** patterns, we divided the study area into four approximately-equal latitudinal sectors. Each sector, described in terms of three water depth strata, encompasses an oceanographic regime somewhat distinct from neighboring sectors and a unique **faunal** mix. In the discussions that follow we consider total **abundance** and two measures of **faunal** diversity:

- 1) the total number of taxa identified, and
- 2) the Shannon-Wiener Index (see page 25) which combines the effects of abundance (numbers of individuals), and diversity (number of taxa), and is designated H' .

The sectors are discussed from south to north and from the coast to the offshore region. We distinguish between shelf, slope, and offshore waters on the basis of water depth (Fig. 8a,b,c).

Southern Sector (Pt. Conception-Pt. Sur). In this and all other sectors, the total density, species diversity and number of taxa observed on the shelf exceeded these measures from waters over the slope and farther offshore (Fig. 8a,b,c). Typically, highest densities were found in cool waters indicative of **upwelling**.

Throughout the year, ~~the~~ fauna of the Southern Sector was clearly **dominated** by non-breeding species; the area of greatest importance was the shoreline and shelf waters south of Point **Buchon**. Density peaks were attained in shelf waters during August through November 1980, January and July 1981, and January and April 1982; each peak exceeded

3b.4. Geographic Patterns

Figure 8-a.

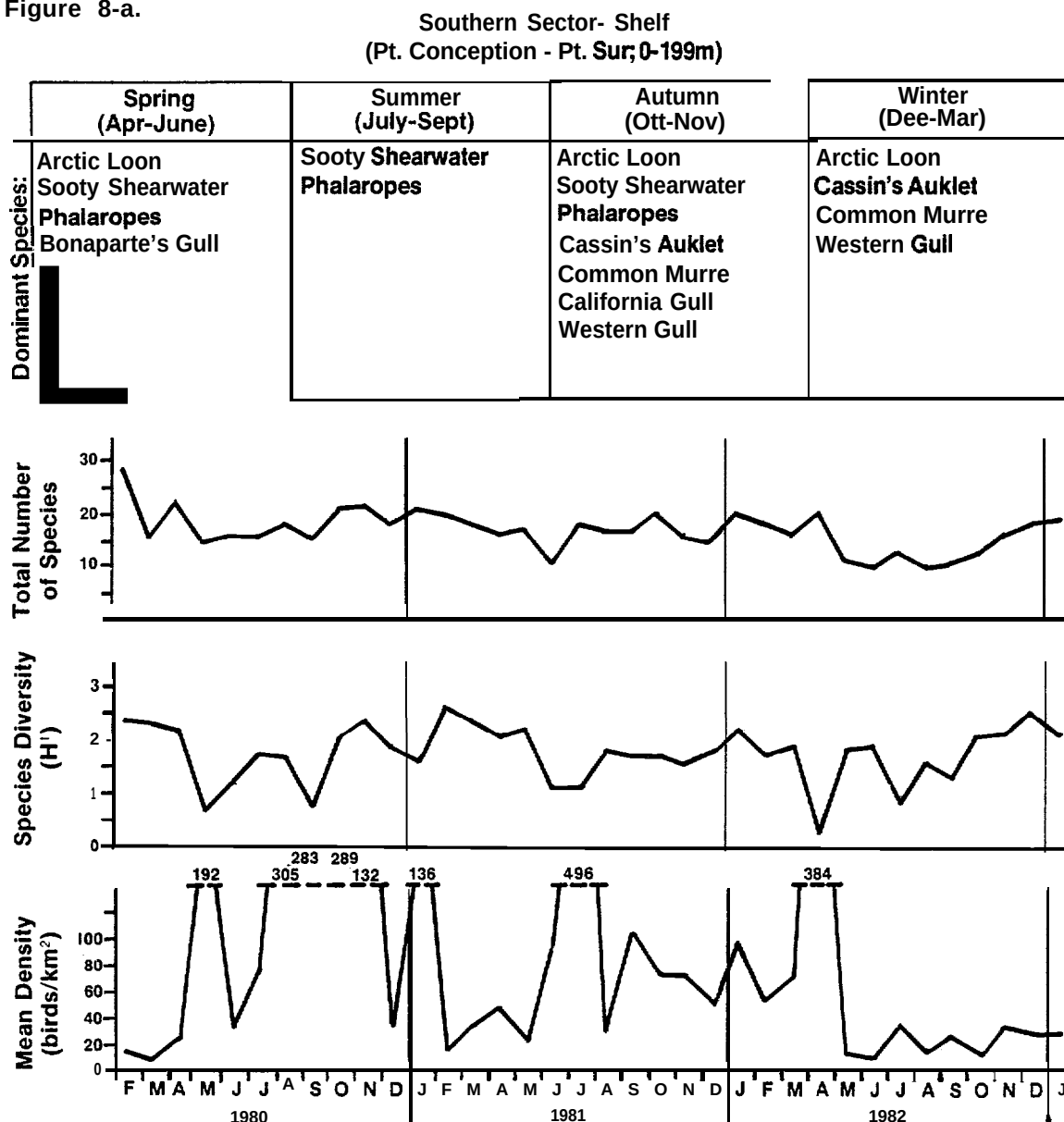
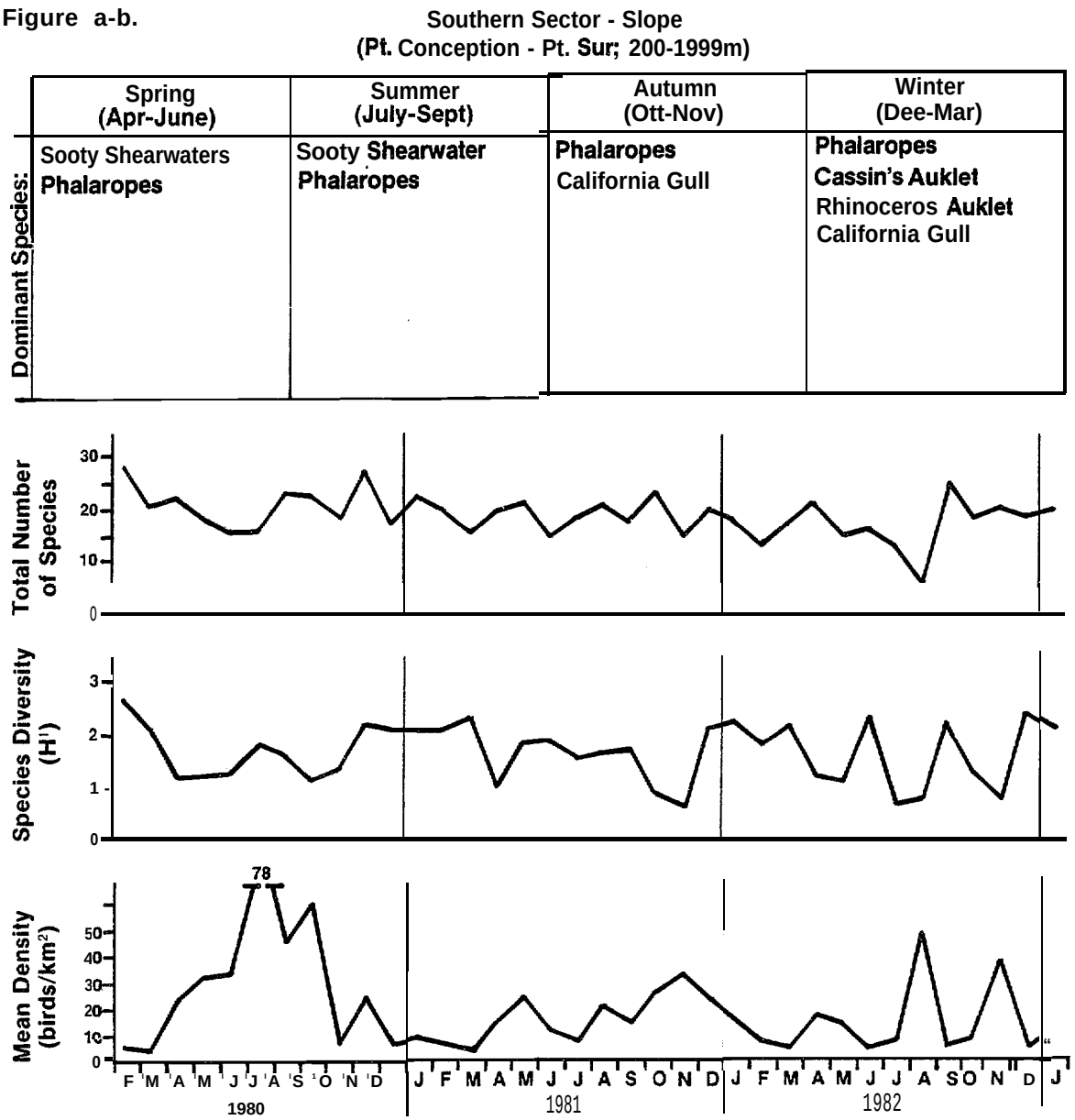


Figure 8. Comparison of monthly mean bird density, species diversity (H'), and species richness (number of taxa) in waters of central and northern California, 1980-1983. Four latitudinal sectors are subdivided by depth. Species accounting for more than 25% of the total fauna on at least three surveys during a season are considered numerically dominant. a-c Southern Sector (Pt. Conception-Pt. Sur); d-f South-central Sector (Pt. Sur-Russian River); g-i North-central Sector (Russian River-Cape Mendocino); j-i Northern Sector (Cape Mendocino-Oregon border).

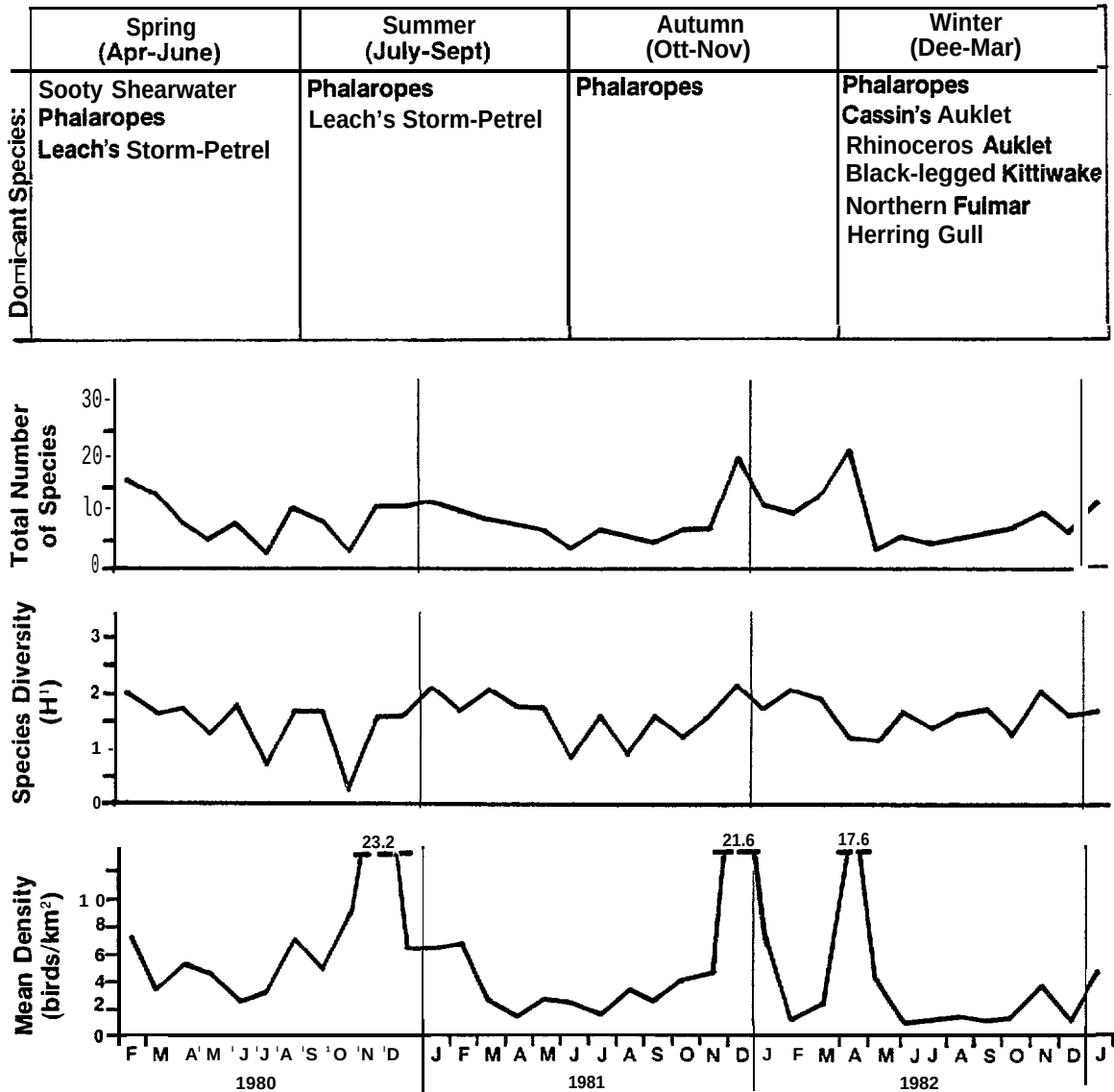
Figure a-b.



3b.4. Geographic Patterns

Figure 8- c

Southern Sector - Offshore
(Pt. Conception - Pt. Sur; $\geq 2000\text{m}$)



3b.4. Geographic Patterns

130 birds/km². Density over the slope was generally about one-third to two-thirds lower than over the shelf, reaching peaks in late summer, fall and (to a much lesser extent) spring. Densities seaward of the slope were even lower, dropping to less than 3 birds/km² each summer, and peaking at up to 23 birds/km² in fall and spring. Throughout the sector numbers were generally highest in 1980 and lowest in 1982.

Generally, during the periods of peak abundance of Shearwaters (May-July) and phalaropes (May and October-November), the values of H' declined appreciably. Peak values of the diversity index were attained in late fall through winter (December through February). In shelf waters we saw fifteen or more taxa during 30 surveys, while over the slope we observed that many species during 35 surveys. Offshore, however, we usually saw only five to ten species (occasionally only three or four), and counted fifteen species only on three occasions.

The composition of the fauna over the shelf during winter was heavily weighted toward loons, murre, gulls and Cassin's Auklets. The auklets plus phalaropes and kittiwakes dominated numbers over the slope and offshore. Spring migration was seen at all distances from shore with Sooty Shearwaters and phalaropes predominating far offshore and the same species plus loons, Leach's Storm-Petrels and Bonaparte's Gulls predominating on shallower waters. Sooty Shearwaters, phalaropes, and Leach's Storm-Petrels were the most abundant species at all distances from shore in the summer, while in fall the spring migrants reappeared and were augmented near shore by pelicans, gulls and murre.

South-central Sector (pt. Sur-Russian River). Compared with the sector south of Point Sur, this sector supported a large component of locally-nesting species on shelf and slope waters. Including, as it does, a little under half the state's total nesting fauna, the area from Point Sur to Point Reyes often harbors at least one-quarter

3b.4. Geographic Patterns

million cormorants, Western Gulls, Common Murres and Cassin's Auklets, and thousands of individuals of other nesting species.

Over the shelf, waves of spring and fall migrants and of over-summering shearwaters sometimes swamped numbers of breeding residents, producing density peaks exceeding 150 birds/km² on eight surveys (Fig, 8d,e,f). Somewhat lower numbers of essentially the same species (excluding scoters, grebes and a few coastal gulls) inhabited slope waters; aggregate numbers over the slope were highest in fall, winter and spring. The overall impact of phalaropes was relatively greatest seaward of the slope, where they predominated during spring through fall. Migrations of Arctic Terns and Buller's Shearwaters were also quite evident seaward of the slope. This was the sector of the study area where bird densities offshore were highest.

Over the shelf and slope, passage of massive numbers of shearwaters and phalaropes in spring, summer, and fall temporarily depressed species diversity (H') to below 1.0, though at these times, the total numbers of species present often exceeded 20. Seaward of the slope, numbers of species and species diversity were lower than in areas closer to shore, both peaked in October through March. In winter, Northern Fulmars replaced common Murres, Western Gulls and California Gulls as a predominant species offshore, while at all distances from shore, kittiwakes and auklets were abundant.

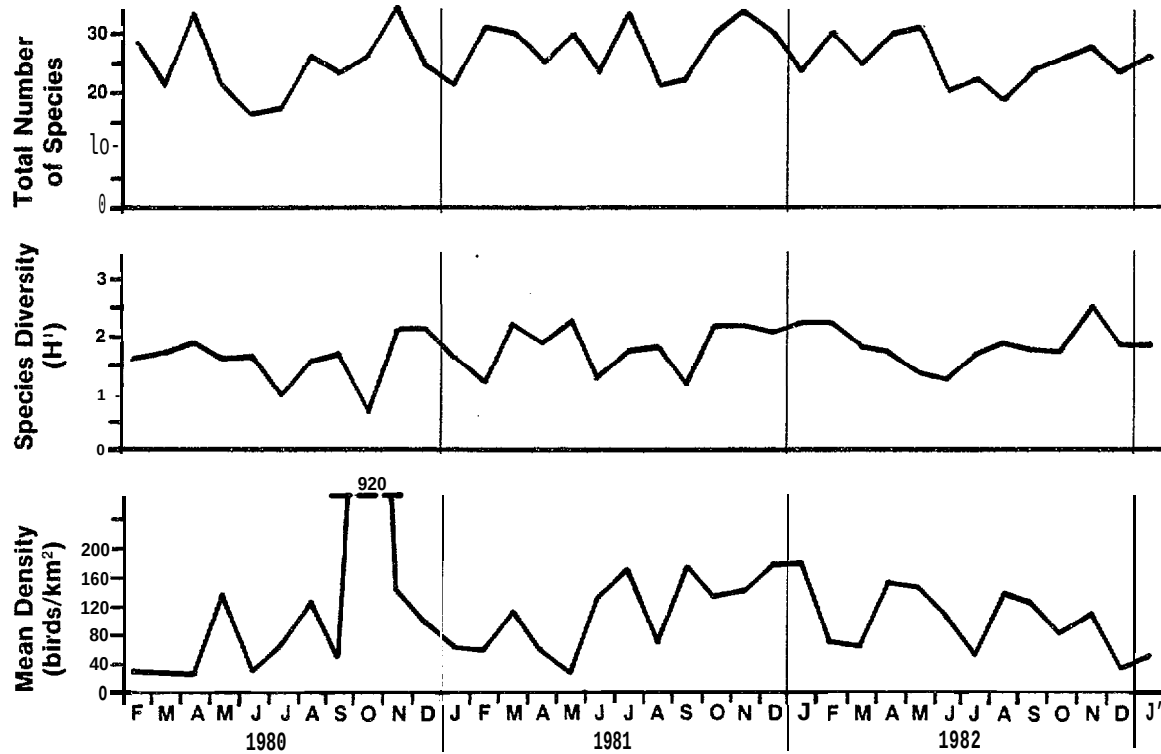
It was obvious at all times that two areas within this sector were of great biological significance to seabirds on a state-wide scale. These were the waters of Monterey Bay and the shelf waters and shoreline from Point Año Nuevo to Point Reyes, including the Farallon Islands and Cordell Bank. Besides harboring almost half the resident seabirds nesting in California, these areas supported literally millions of individuals of the nesting species, migrants and winter visitors during late summer through spring. Both these areas lie south of upwelling centers (Point Arena to Point Reyes, Point Montara

3b.4. Geographic Patterns

Figure 8-d.

South-Central Sector - Shelf
(Pt. Sur - Russian River; 0-199m)

	Spring (Apr-June)	Summer (July-Sept)	Autumn (Oct-Nov)	Winter (Dec-Mar)
Dominant Species:	Sooty Shearwater Phalaropes Common Murre Bonaparte's Gull Western Gull	Sooty Shearwater Phalaropes Common Murre	Phalaropes Common Murre Cassin's Auklet Western Gull	Western Grebe Common Murre California Gull



3b.4. Geographic Patterns

Figure 8-e.

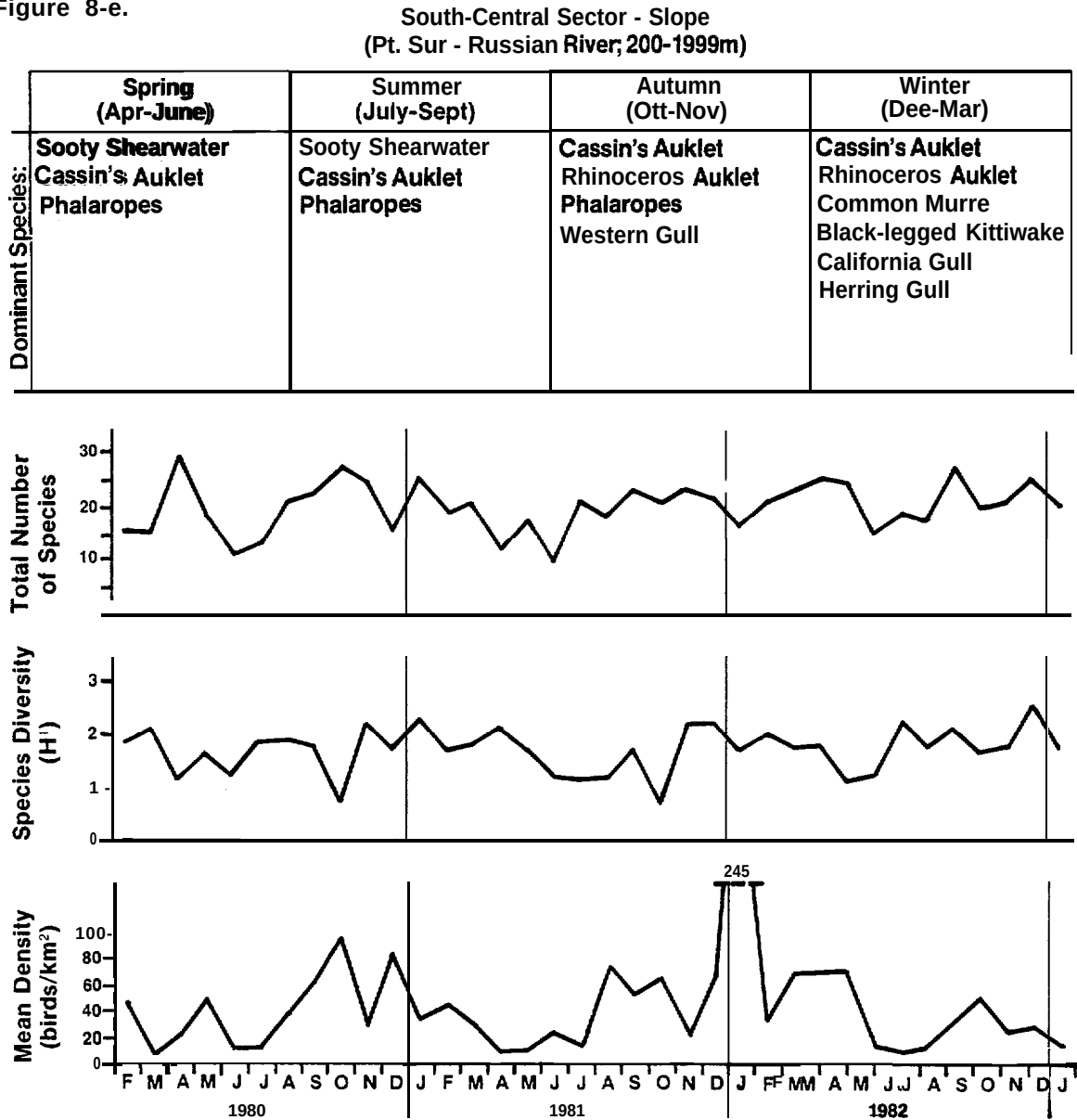
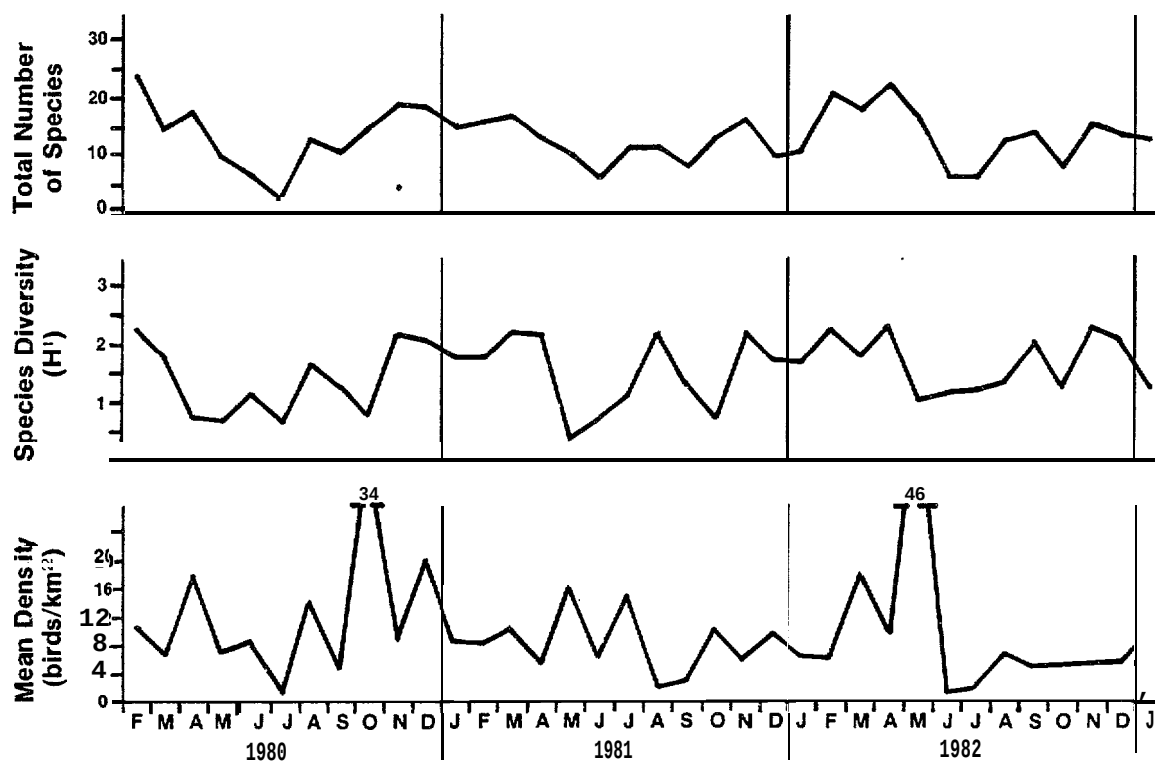


Figure 8 -f.

South-Central Sector - Offshore
(Pt. Sur - Russian River; $\geq 2000\text{m}$)

	Spring (Apr-June)	Summer (July-Sept)	Autumn (Oct-Nov)	Winter (Dec-Mar)
Dominant Species:	Sooty Shearwater Phalaropes Cassin's Auklet	Sooty Shearwater Phalaropes Common/Arctic Terns	Buller's Shearwater Cassin's Auklet Phalaropes Bonaparte's Gull Western Gull	Northern Fulmar Cassin's Auklet Rhinoceros Auklet Black-legged Kittiwake Herring Gull



3b.4. Geographic Patterns

to Point Año Nuevo), suggesting that food webs are enhanced by productivity ultimately generated just upstream. Additionally, sharp thermal fronts, probably indicating convergence, are frequently encountered south and southwest of Point Reyes and in northern Monterey Bay.

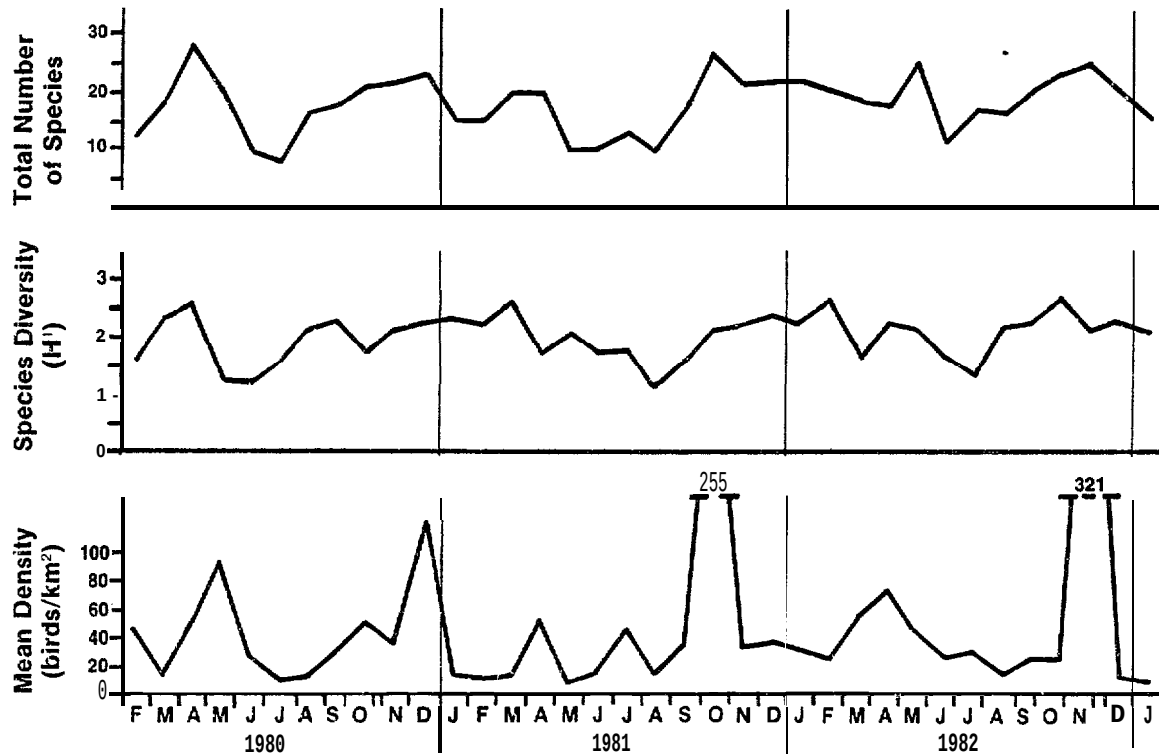
North-central Sector (Russian River-Cape Mendocino). In this sector --the area of the state with highest average summer wind energy, deepest mixed layer, greatest wind-induced turbulence, coolest waters and narrowest continental shelf --total bird numbers generally were lower than in adjacent sectors, and species diversity was depressed. Density peaks exceeding 50 birds/km² were recorded over shelf waters during spring and fall each year as scoters, gulls and murrees passed through the area, but summer and winter densities generally were much lower (Fig. 8g,h,i). Annual density curves for waters over the slope show yearly highs during spring and fall and lows at other times. The spring peaks resulted from aggregations (probably mostly migrants) of Sooty Shearwaters, phalaropes, and to a lesser extent Arctic Loons, murrees and auklets. offshore, total bird densities were fairly low (2-8 birds/km²) through most of 1980, half of 1981 and half of 1982. Relatively large numbers of auklets, fulmars, kittiwakes and phalaropes appeared offshore here from August 1981 through April 1982.

The contribution to the fauna of the shelf by local nesters was substantial in summer and winter due to high densities of Common Murrees and Cassin's Auklets. The same was true of slope waters. Among local breeders, only the auklet contributed heavily to the offshore fauna. It appears that this area supports thousands of Cassin's Auklets during post-nesting dispersal from the Farallones colonies; probably these birds are joined in fall and winter by birds nesting north of the study area.

Figure 8 - g.

North-Central Sector- Shelf
(Russian River - Cape Mendocino; 0-199m)

	Spring (Apr-June)	Summer (July-Sept)	Autumn (Oct-Nov)	Winter (Dec-Mar)
Dominant Species:	Arctic Loon Sooty Shearwater Common Murre Surf Scoter Bonaparte's Gull	Sooty Shearwater Phalaropes Common Murre Western Gull	Phalaropes Cassin's Auklet Common Murre Bonaparte's Gull California Gull Herring Gull Western Gull	Cassin's Auklet Common Murre California Gull Herring Gull Western Gull



3b.4. Geographic Patterns

Figure 8-h.

North-Central Sector - Slope
(Russian River - Cape Mendocino; 200-1999m)

	Spring (Apr-June)	Summer (July-Sept)	Autumn (Oct-Nov)	Winter (Dec-Mar)
Dominant Species:	Sooty Shearwater Phalaropes Cassin's Auklet Common Murre	Sooty Shearwater Phalaropes Cassin's Auklet	Phalaropes Cassin's Auklet California Gull Western Gull	Phalaropes Northern Fulmar Cassin's Auklet Rhinoceros Auklet Common Murre Black-legged Kittiwake California Gull

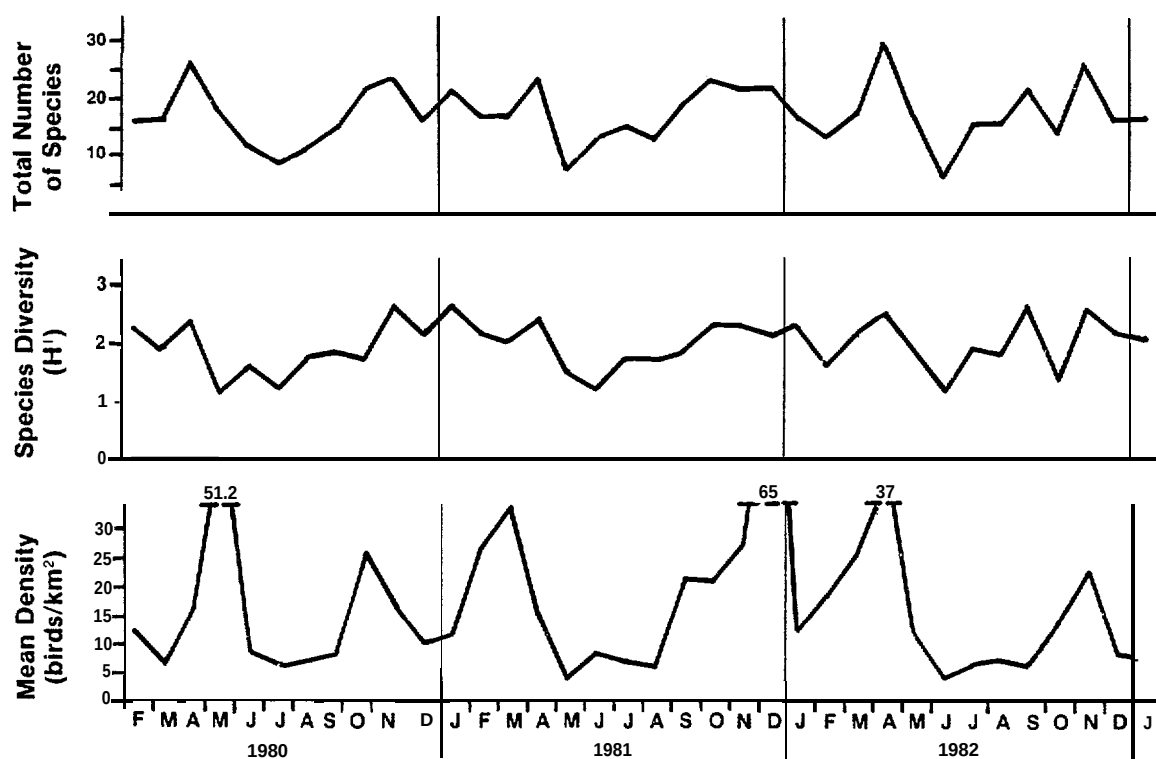
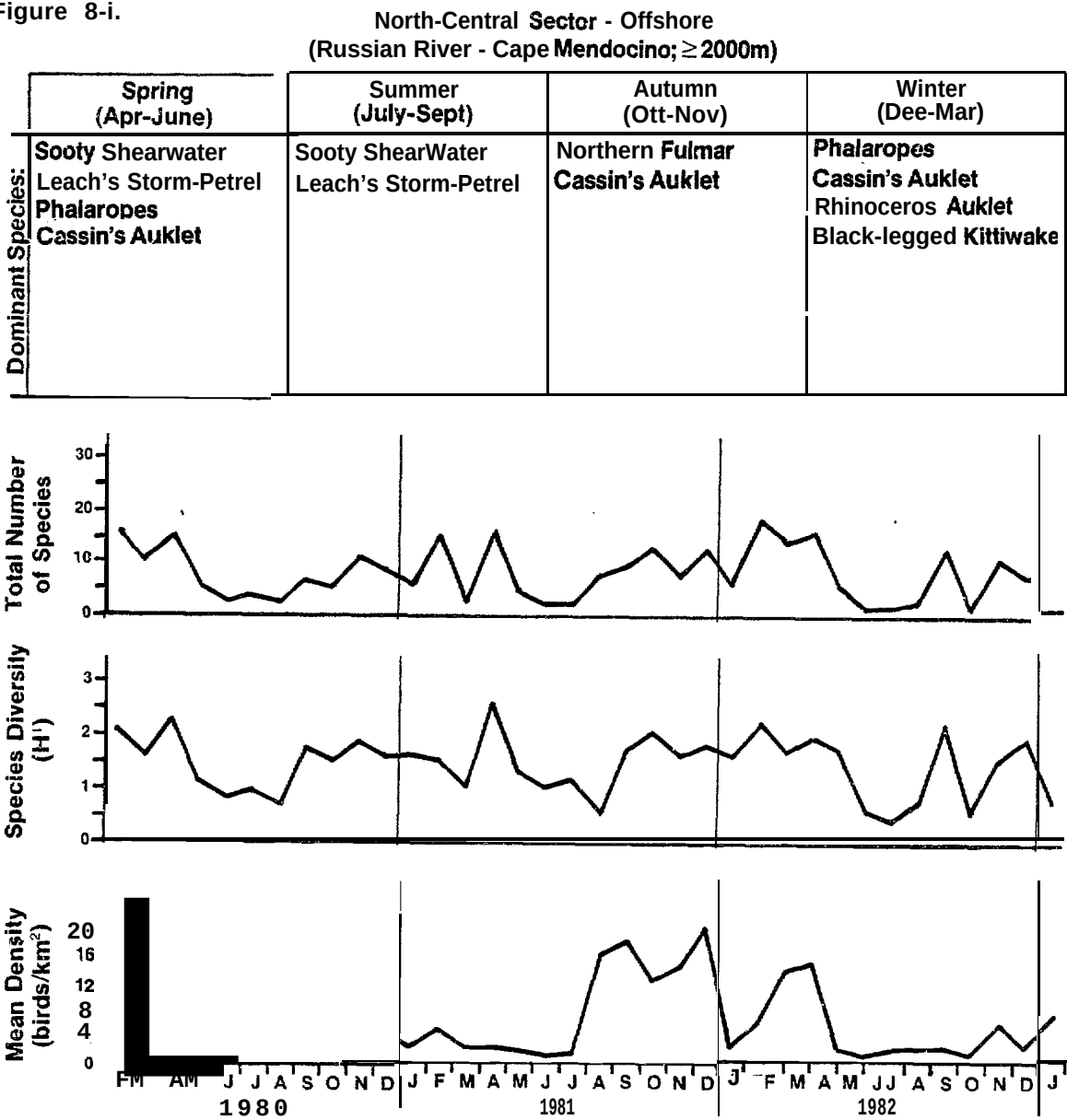


Figure 8-i.



3b.4. Geographic Patterns

Northern sector (Cape Mendocino-Oregon). The continental shelf waters and shoreline of this sector were of very great significance to the nesting and winter-resident seabirds of California. About half of the seabirds nesting in California attend colonies north of Cape Mendocino. Common Murres, Cassin's Auklets and both Leach's and Fork-tailed Storm-Petrels all constitute important elements of the fauna (Fig. 8j,k,l). In addition to locally-nesting species, bird populations on shelf waters were dominated in summer by phalaropes and Western Gulls, and in fall, winter, and spring by loons, grebes, scoters and a variety of gulls. Total bird densities over the shelf peaked at over 100 birds/km² in September-December 1980, April and autumn 1981, and autumn 1982. Both species numbers and diversity were lowest in summer and reached maxima in fall and spring.

It is not obvious which hydrographic features contribute most heavily to this high bird abundance. coastal upwelling, which here appears to be a fairly linear feature, occurring all along the shelf, probably contributes to food web productivity in April-September. The presence offshore of a (submerged) Columbia River plume may also act as a concentration area for some fish species, e.g., anchovy and salmon Smelt (D. Varoujean pers. comm., L. Breaker pers. comm.). It is noteworthy that bird density declined during winter when coastal downwelling and northward currents prevailed over the shelf (Bakun upwelling indices in Fig. 2; Parrish et al. 1981). This pattern would be expected if coastal downwelling led to lower overall productivity and concomitant absence of potential prey-concentrating features, such as might be found at the seaward edges of upwellings.

Over the slope, bird density vacillated greatly through the year, reflecting passage of migrant gulls, phalaropes, and shearwaters, and occasional heavy concentrations of foraging murres (January-April 1982). Peaks in species diversity occurred in all seasons, but numbers of species over the slope were highest during spring and fall.

3b.4. Geographic Patterns

Figure 8-j.

Northern Sector- Shelf
(Cape Mendocino - Oregon Border; 0-199m)

	Spring (Apr-June)	Summer (July-Sept)	Autumn (Oct-Nov)	Winter (Dec-Feb)
Dominant Species:	Phalaropes Common Murre Surf Scoter Bonaparte's Gull	Cassin's Auklet Phalaropes Common Murre Western Gull	Arctic Loon Western Grebe Cassin's Auklet Common Murre Surf Scoter White-winged Scoter Bonaparte's Gull California Gull Western Gull	Western Grebe Common Murre White-winged Scoter Herring Gull

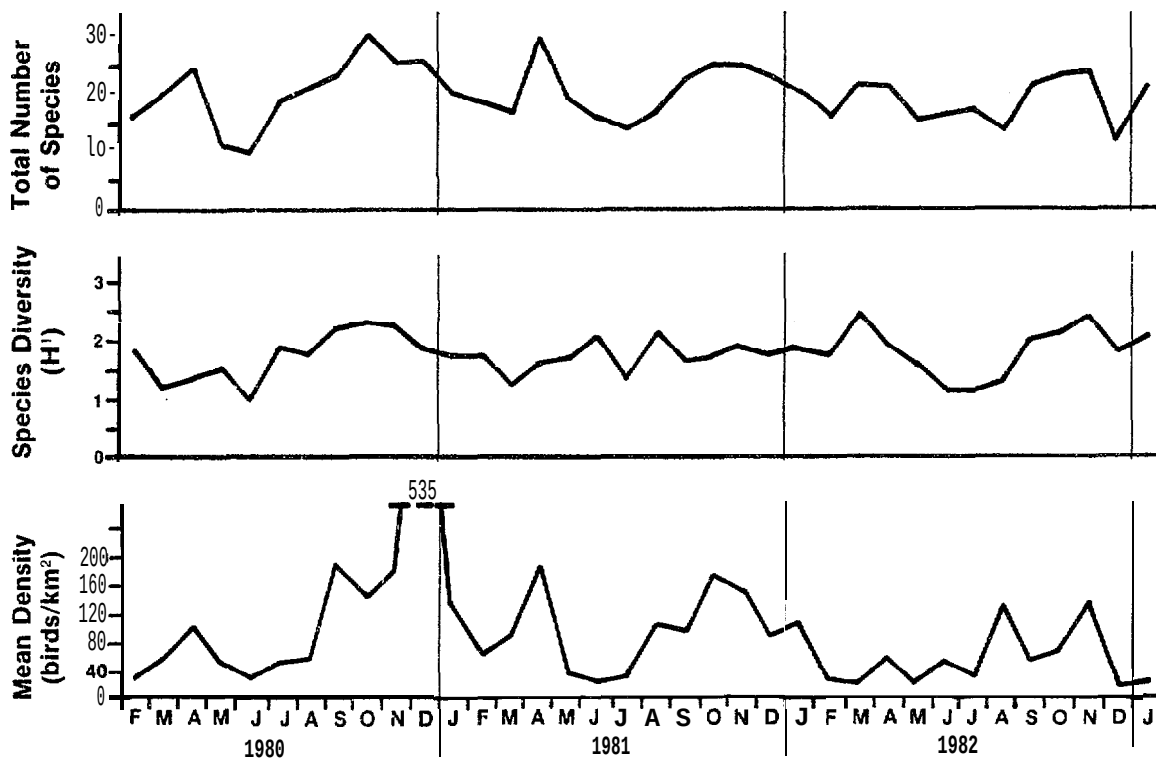


Figure 8-k.

Northern Sector- Slope
(Cape Mendocino - Oregon Border; 200-1999m)

	Spring (Apr-June)	Summer (July-Sept)	Autumn (Oct-Nov)	Winter (Dec-Mar)
Dominant Species:	Phalaropes Cassin's Auklet Leach's Storm-Petrel Common Murre	Phalaropes Sooty Shearwater Leach's Storm-Petrel Black-footed Albatross	Phalaropes Northern Fulmar Cassin's Auklet Rhinoceros Auklet Black-legged Kittiwake Bonaparte's Gull California Gull	Northern Fulmar Cassin's Auklet Rhinoceros Auklet Common Murre Black-legged Kittiwake Herring Gull

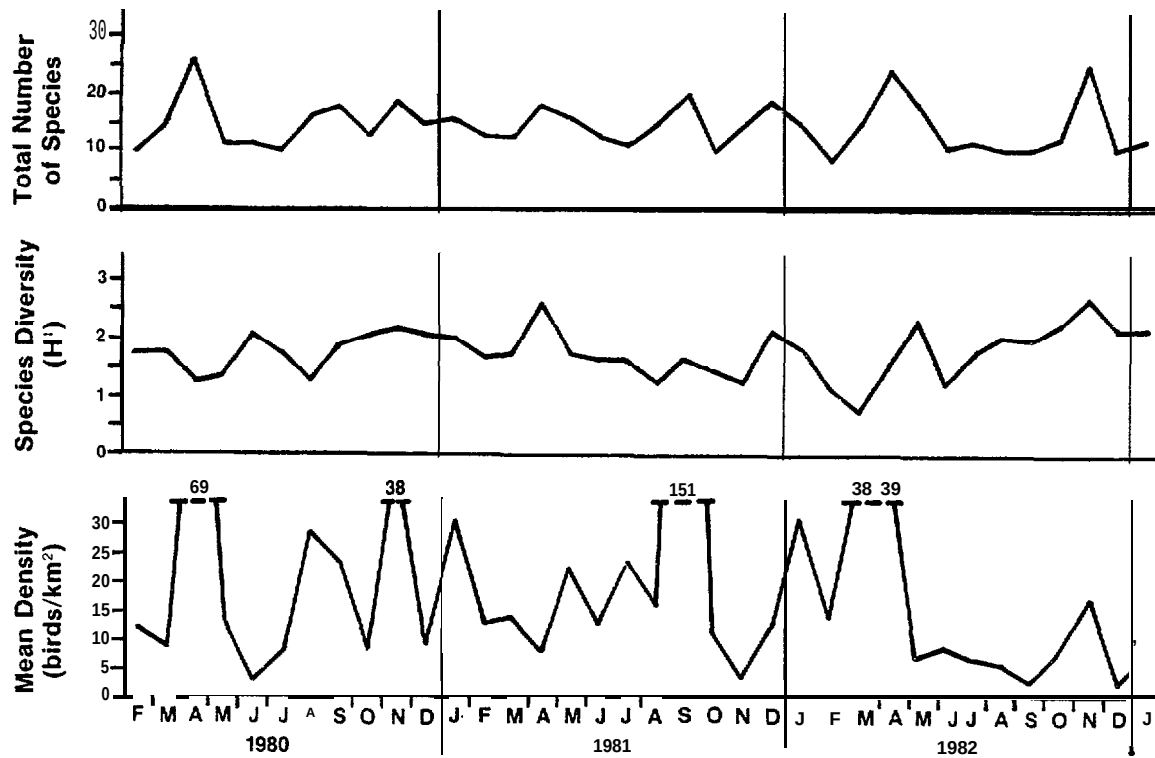
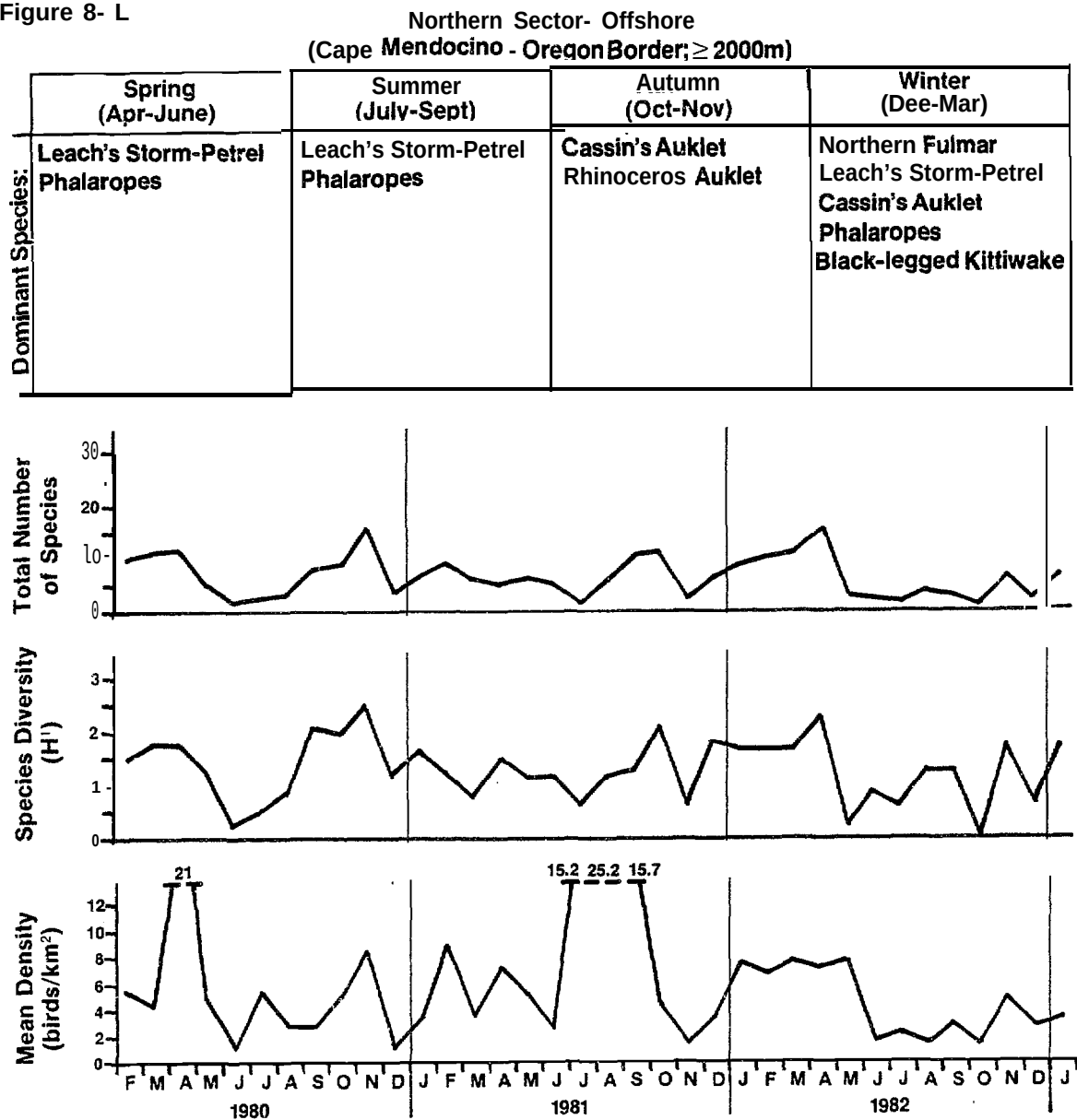


Figure 8- L



3b.4. Geographic Patterns

As in other offshore areas, total bird density here was an order of magnitude lower than that on the adjacent shelf, generally ranging from 2 to 8 birds/km². This was the area where storm-petrels were most in evidence, due to foraging activities from colonies at castle Rock and in Oregon. **Auklets**, kittiwakes, and **fulmars** also **contributed** heavily to the fauna here in fall and winter. Of all the waters of the study area, species numbers and diversity reached their *lowest* values offshore in this sector, primarily during mid-summer.

3b.5. Distribution and Abundance on the Coast. Because the coastline **habitat** is linear, the patterns of bird abundance along **the coast** are simpler than those occurring at sea. In all seasons the coastal areas of greatest concentrations were those bordering areas of broad continental shelf: north of Cape **Mendocino**, Monterey Bay to **Bodega**, and south of Point **Buchon**. Total numbers of birds along the coast during our twelve counts varied from **about 81,000** to 432,000 and species numbers from 23 to 30 (Table 5). Numbers of birds *were* usually dominated by those of **murres**, cormorants and **gulls** during spring and summer and by gulls, cormorants, scoters and grebes during fall and winter.

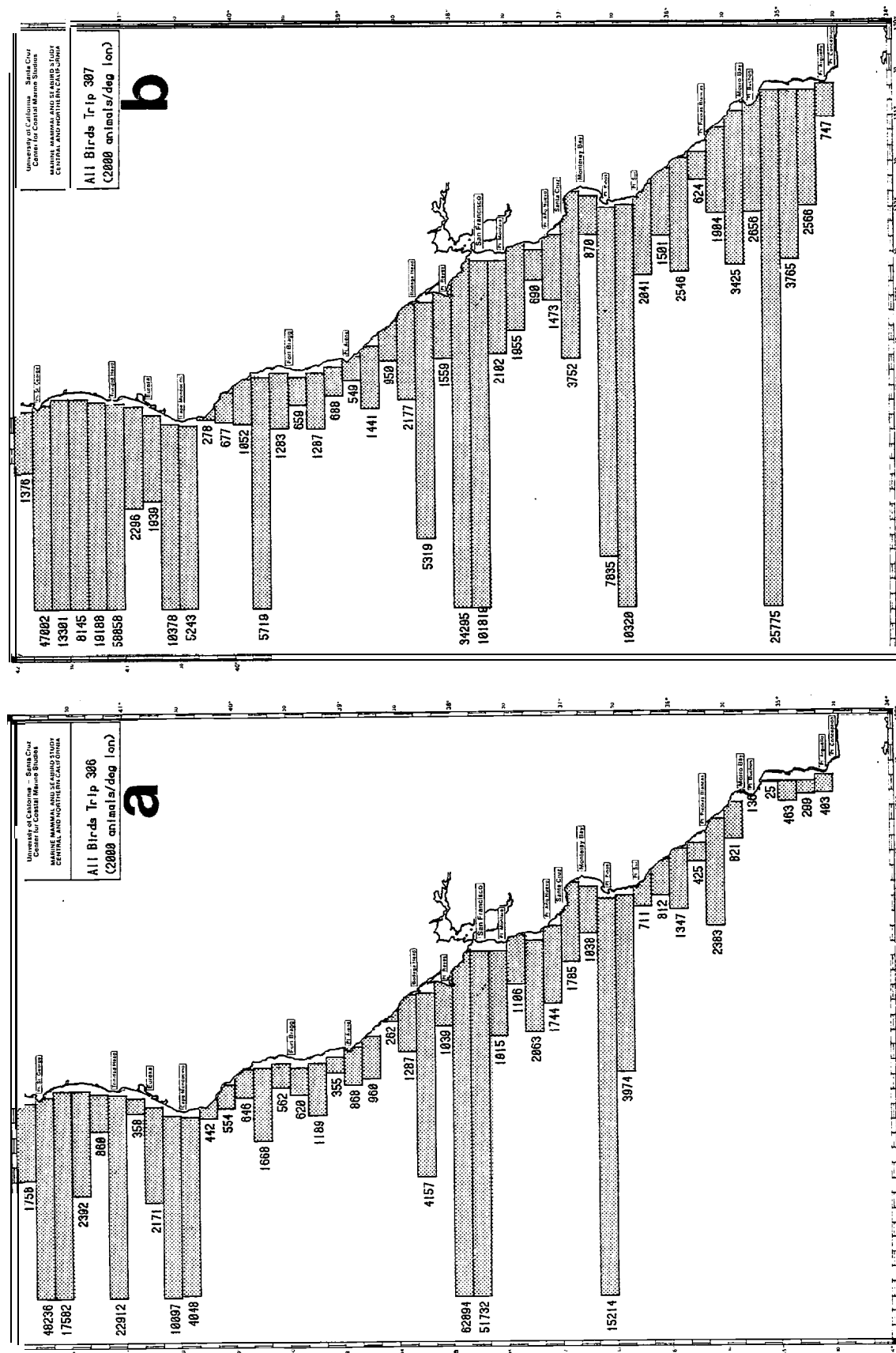
During May and early July counts, we found that nesting species constituted the great majority of birds near the coast. (The size, diversity and distribution of the nesting fauna are discussed thoroughly by **Sowls** et al. (1980) and will not be repeated here in detail, but population profiles for both breeders and for non-breeders appear in Sections 3c, Predominant Species, and 3d, Annotated Species List). Among the non-breeders, flocks of up to several thousand shearwaters, **phalaropes** and migrant gulls (especially California and Bonaparte's) occasionally appeared along the coast during spring and summer counts. Total bird numbers for May and July 1981 coastal counts appear according to latitude *in* Fig. 9. Great concentrations in the Gulf of the **Farallones** and north of Cape **Mendocino** are evident,

Table 5. Total counts of the major groups of birds seen along the coast during twelve censuses. January 1980 to October 1982.

Species	Group	1980				1981				1982			
		Jan	May	July	Ott	Jan	May	July	Sept	Jan	May	July	Ott
Loons and Grebes		26,791	7,532	1,921	5,780	4,009	7,240	4,300	4,510	5,67(3	7,146	2,246	3,649
Procellariiforms				27,309	1	-	500	20,012	25,000	112	24,998	451	96
Cormorants and Pelicans		16,156	34,756	58,862	31,960	14,890	27,752	73,976	59,682	6,913	18,444	54,555	33,651
Ducks and Geese		8,677	4,619	3,902	22,674	17,995	3,308	7,163	8,709	8,947	3,556	2,427	13,358
Phalaropes			1,319	21	9,042	17	9,041		707	1	19,299		724
Jaegers, Gulls and Terns		61,319	38,948	43,307	40,320	49,581	23,392	51,322	65,364	51,791	30,838	43,327	37,233
Alcids		31,321	138,503	268,133	14,096	38	202,056	242,233	789	5,025	224,106	314,664	393
TOTAL ¹		198,517	230,123	407,177	131,673	89,080	276,354	404,274	167,450	81,150	329,821	420,222	125,984

1. Includes shorebirds other than phalaropes, ducks, egrets, and landbirds.

Figure 9. Counts of all seabirds along the central and northern California coast during (a) May and (b) July, 1981. Counts are clustered by 10' of latitude; each degree of longitude corresponds to 2,000 birds. These patterns are typical of all counts made during these months in 1980-1982.



3b.5. Distribution and Abundance on the Coast

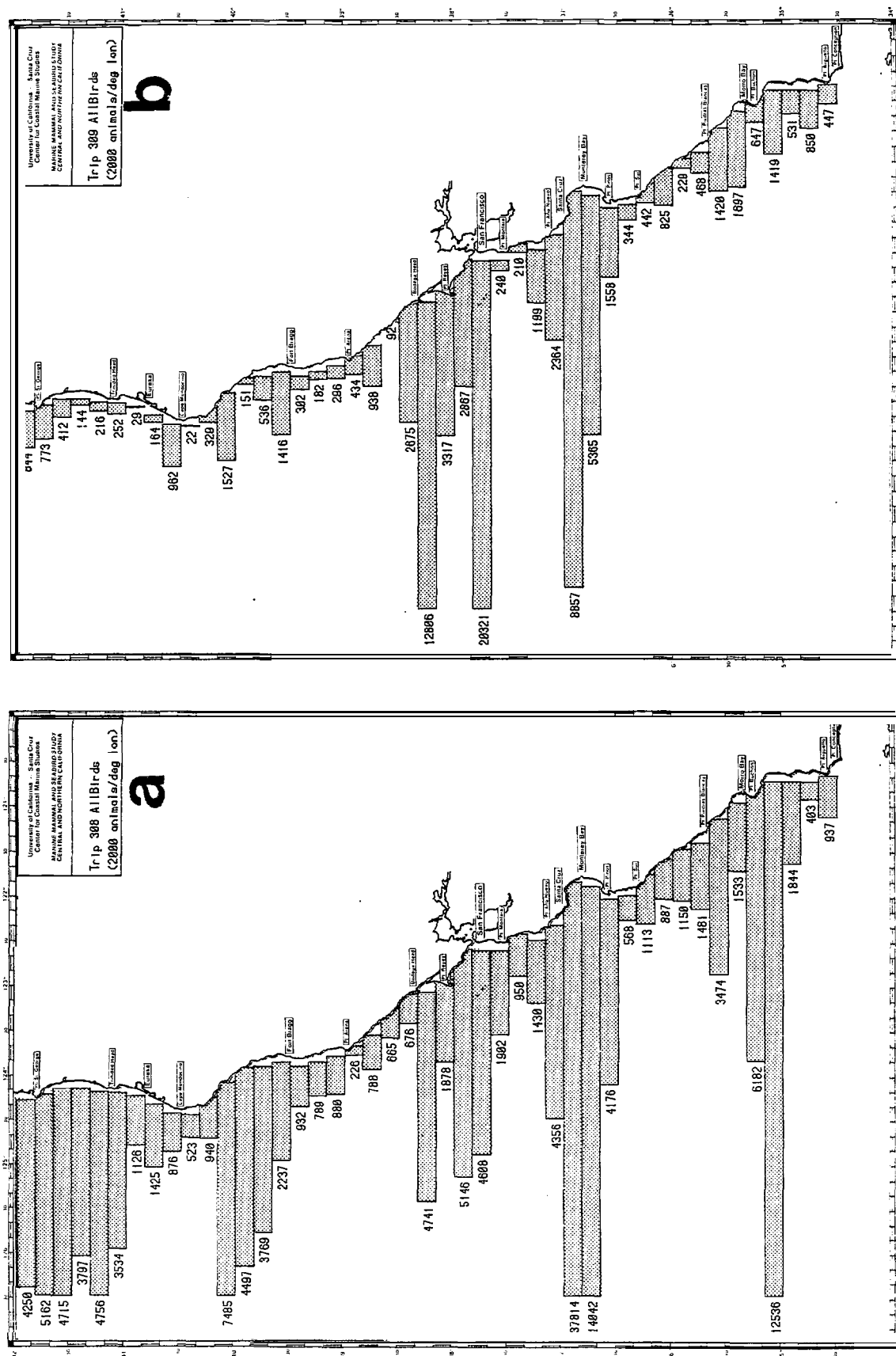
corresponding to locations of the state's major colonies of murre, auklets, Western Gulls and cormorants (Sowls et al. 1980). Large populations off Carmel Bay and south of Point Buchon in July were composed of shearwaters, phalaropes, and smaller numbers of nesting cormorants, murre and gulls. These distributional patterns closely resemble those seen during spring and summer counts in 1980 and 1982.

Numbers of birds near the coast were much lower in fall and winter than in the other seasons (Fig. 10). Arrival of wintering gulls, grebes and scoters did not offset the movement offshore of murre or the southward movement of cormorants and pelicans. At these times of the year gulls always constituted the largest fraction of the total count {31% to 63%}, while cormorants and pelicans accounted for about 30% in fall and 8% to 16% in winter.

3b.6. Important Areas of Seabird Concentration. It is our supposition that the areas in which seabirds reach their greatest concentrations during feeding, breeding, migration and loafing are the areas of greatest overall importance to the bird populations as a whole. To arrive at a description of these important areas we identify the most heavily used sites for each of these activities and synthesize the information geographically.

The nature of aerial surveys makes it quite difficult to assess the importance of feeding areas. In many cases feeding birds are submerged when the aircraft passes, or have recently disbanded from feeding flocks. In some cases conditions such as heavy winds or seas mask the activities of birds. Some birds, such as small alcids, some gulls, and pelicans, startle when approached from the air during feeding. Further, feeding probably includes rhythms endogenous to the prey and the predator. For example, because many macrozooplankton

Figure 10. Counts of all seabirds along the central and northern California coast during (a) October 1981 and (b) January 1982. Counts are clustered by 10' of latitude; each degree of longitude corresponds to 2,000 birds.



3b.6. Important Areas of Seabird Concentration

migrate vertically near sunset and sunrise, their availability to diurnal ~~surface-siezing~~ seabirds may be limited to dawn and dusk--hours when ~~we~~ made no observations.

Nevertheless, we directly observed flocks of seabirds feeding during 854 individual sightings, and we can further infer feeding areas from the distributional patterns of several seabird groups. Locations of feeding flocks and numbers of birds involved are depicted in Fig. 11. During the spring months the largest number of flocks and largest aggregations were noted from Point Sur north to about Fort Bragg. Very large flocks noted off Point Sur, Point Año Nuevo, and the Farallones were composed of gulls, shearwaters and auklets, while a large flock near Eureka consisted of murre and gulls. overall, fewer feeding flocks were noted during July through September (Fig. 11b); these consisted of sooty Shearwaters, murre, auklets, and gulls. Relatively many feeding flocks were seen north of Cape Mendocino; the large numbers of birds nesting there indicates traditional heavy use of the area (see below), The apparent lack of feeding flocks off Bodega-Point Arena and over the shelf off Point Buchon may reflect low prey levels, relatively low numbers of breeding birds in those areas, or may be artifact.

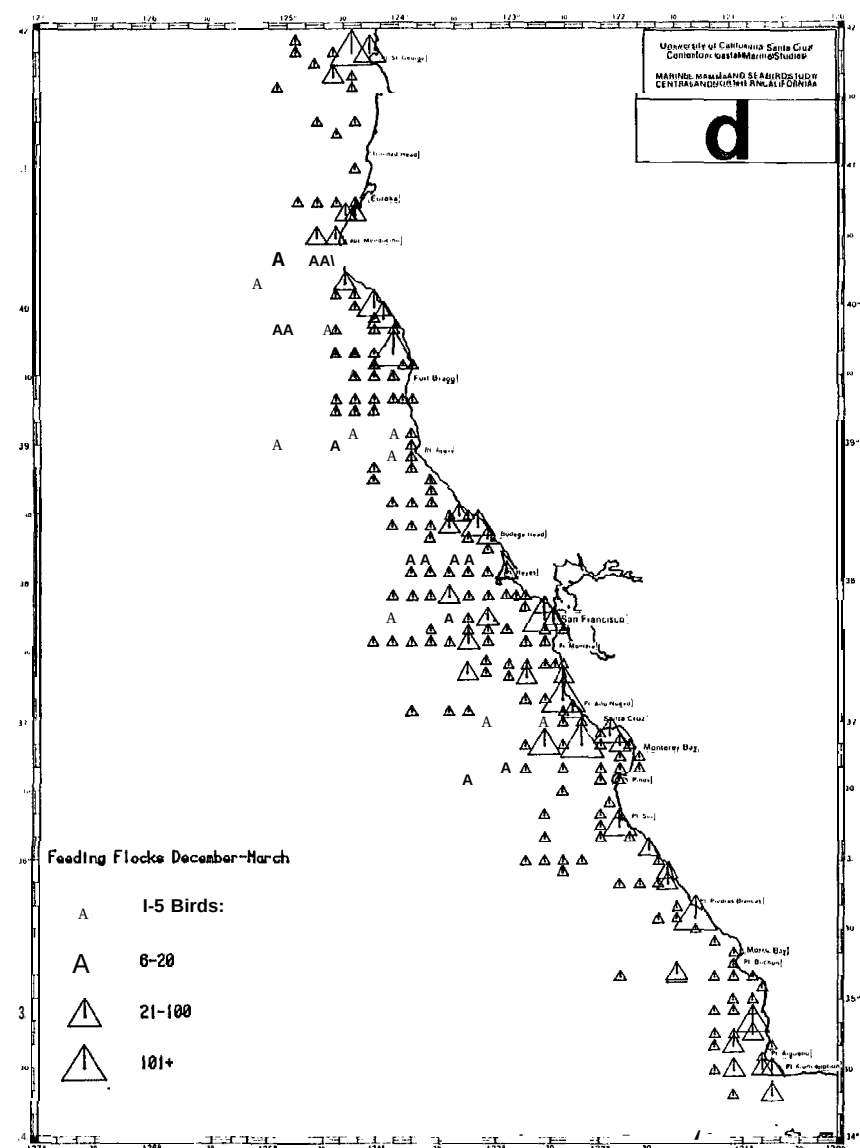
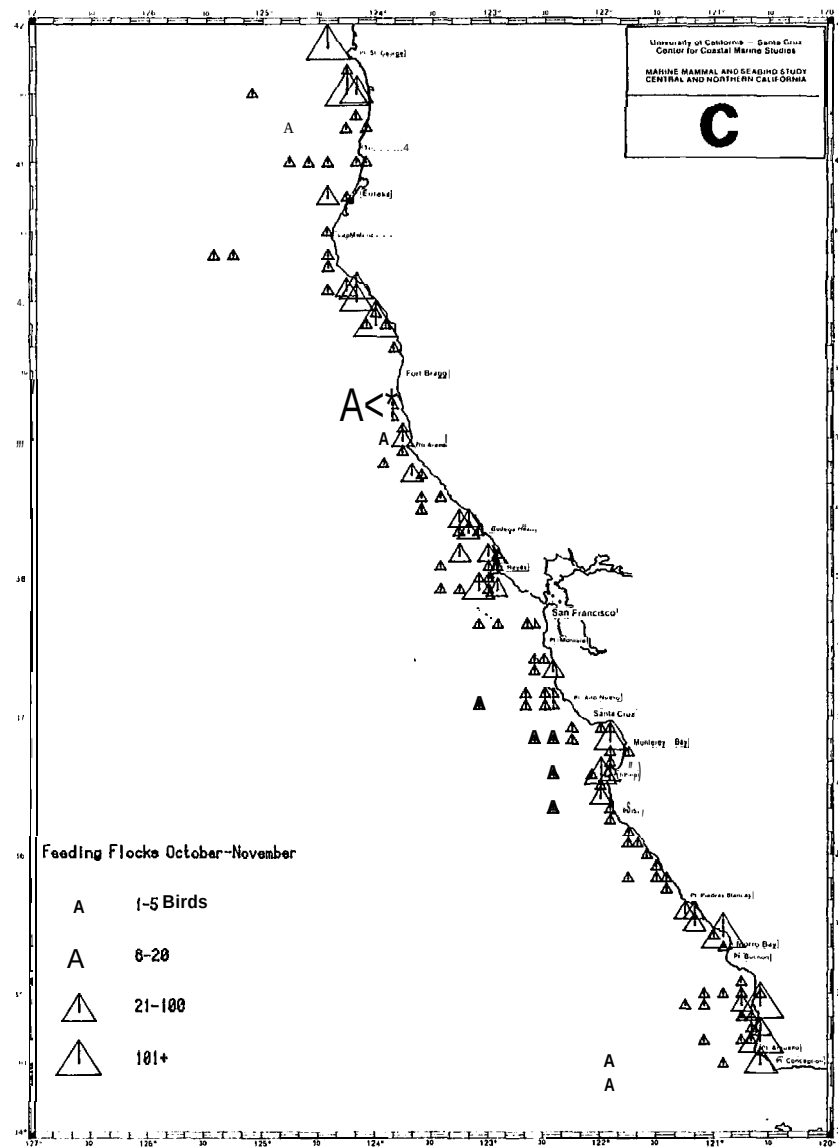
Many more feeding flocks were seen in October-November than in the preceding period (Fig. 11c). In large measure, this resulted from considerably greater bird populations at this time and from the fact that observation conditions, typically, were best in fall. Two relatively distinct clusters of sightings are evident: over the shelf near Point Arguello and also over the shelf and slope from Monterey to Bodega; flocks were scattered along the shelf from just north of Fort Bragg to Oregon. Many of these flocks comprised gulls, phalaropes, murre, Western Grebes and scoters near shore, and gulls, phalaropes, auklets, murre and pelicans farther out (from 5 to 50 km offshore).

3b.6. Important Areas of Seabird Concentration

During winter, our sightings of feeding flocks were numerous, taking in all sections of the study area (Fig. 11d). The greatest number of sightings occurred roughly from Point Arena to Monterey, including many records of large flocks southwest of Santa Cruz. Feeding flocks were less evident north of Cape Mendocino, though here, rough observation conditions prevailing in winter may be largely to blame. A cluster of sightings of feeding flocks, including several large flocks, is evident over shelf waters south of Point Buchon. Generally, the composition of feeding flocks reflected the overall winter populations over the shelf and slope. Predominant near the coast were scoters, grebes, cormorants, gulls, and murre. Farther at sea, gulls, murre, auklets, and fulmars were the major constituents.

Less direct evidence pertaining to feeding areas, can be obtained from inspection of average seasonal distributions of each of several groups of birds. The groups selected for this presentation are important elements of the coastal and shelf fauna and, by reason of limited daily flight activity, seasonal status, or ties to colonies, are assumed to be relatively dependent on local resources.

The loons, grebes and scoters are among the most numerous birds near the coast in fall and winter. Their feeding activities are concentrated within 2-3 km of the shore, often over sandy substrates, and often south (leeward) of major headlands (Fig. 12). In both these seasons, the largest numbers of these birds seen on coastal surveys were located north of Fort Bragg and from Monterey to Bodega (especially Tomales Bay and the Gulf of the Farallones). Numbers of loons, grebes, and scoters were considerably reduced in spring (Fig. 12c) and were concentrated from Point Montara to Bodega. Of great importance from winter through early spring was spawning of herring (Clupea) in the shallow waters of Tomales Bay and San Francisco Bay. Scoters were quite concentrated in these areas and appear to rely heavily on spawning of herring throughout the Pacific Coast at this time (Vermeer 1981a).



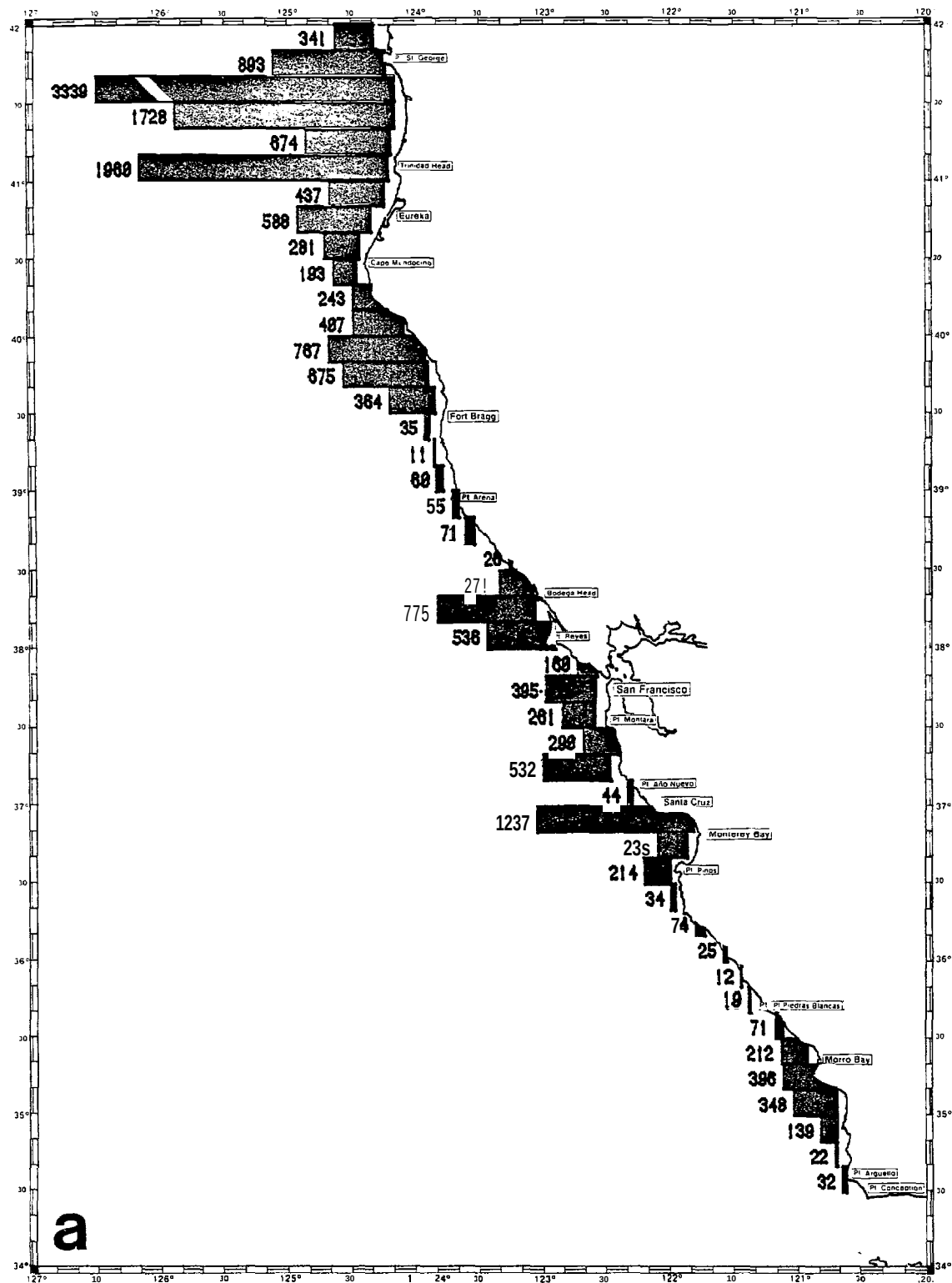
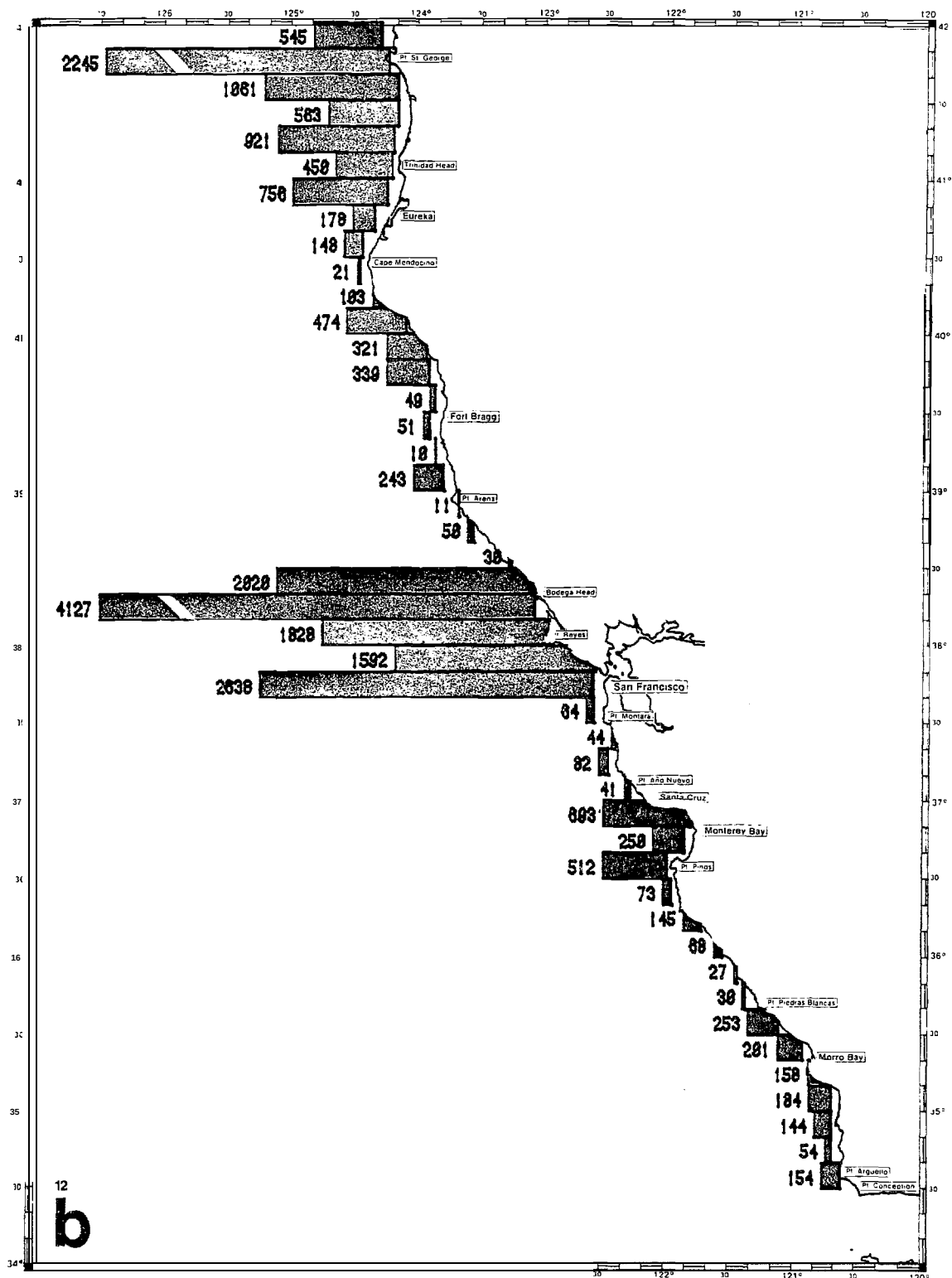
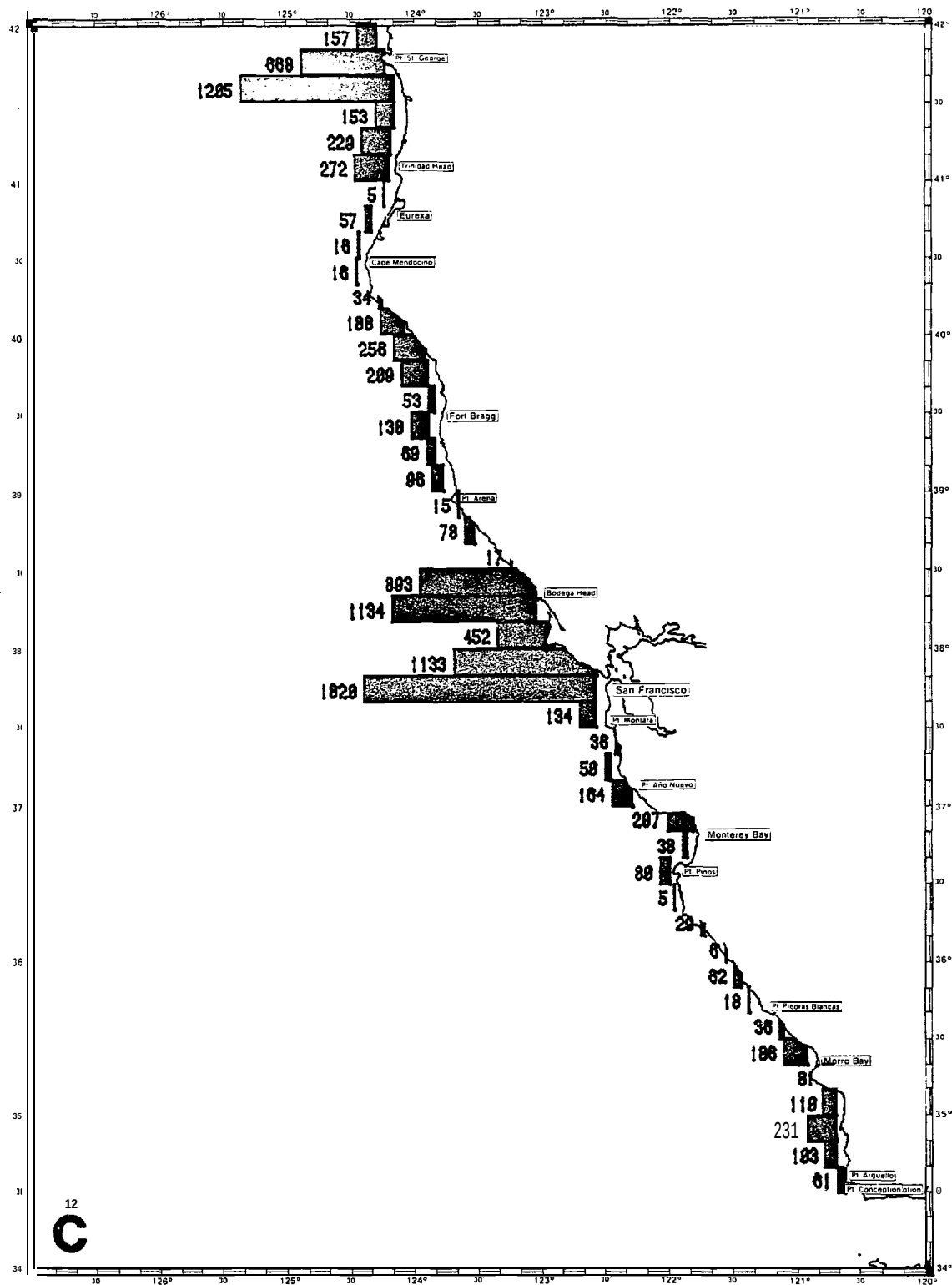


Figure 12. Average coastal counts of combined loons, grebes, and scoters during three seasons. Counts are clustered by 10' of latitude; each degree of longitude corresponds to 1,000 birds. (a) 3 September and October surveys; (b) 3 January surveys; (c) 3 May surveys.





3b.6. Important Areas of Seabird Concentration

Coastal counts of cormorants and pelicans during fall and winter revealed largest numbers south of Bodega, particularly from Point Reyes to Point Piños and near Point Buchon (Fig. 13a,b). Although pelicans do forage as far out as 88 km from shore and in waters as deep as 3,100 m (Briggs et al. 1983), the great majority of sightings of cormorants and pelicans occurred within 15 km of the mainland.

From numbers exceeding 59,000 birds in fall, cormorant and pelican populations along the coast declined to as low as 7,000 in winter. The great majority of pelicans returned to southern California and Mexican waters to resume nesting activities, while many Brandt's Cormorants apparently moved south of Point Conception from September until the following spring. The heavy concentration of cormorants and pelicans in the Gulf of The Farallones, Monterey Bay area and near Point Buchon, so evident in fall was not as apparent in winter; numbers remained high off San Francisco but diminished elsewhere. Areas of primary importance to nesting cormorants and roosting and foraging pelicans are described more fully in Section 3c, Predominant Species, and in SOWLS et al. (1980).

Feeding activities of breeding seabirds must be located within a certain range of their colonies that is defined by a combination of flight capabilities, foraging and prey capture strategies, energy requirements of the young, and local oceanic productivity. During May through August, the heart of the aggregate nesting season, nesting residents were most heavily concentrated at sea north of Cape Mendocino, from Bodega to Monterey, and in narrow bands near the coast from Cape Mendocino to Bodega and Point Sur to Point Buchon (Fig. 14). The two areas of greatest concentration and broadest offshore extent of high densities were, naturally, the areas containing the most important colonies--Trinidad to Castle Rock, and the Gulf of the Farallones. Because of their numerical predominance in the nesting fauna, this distributional pattern is weighted toward those of Common Murres and Cassin's Auklets. Less substantial contributions to the

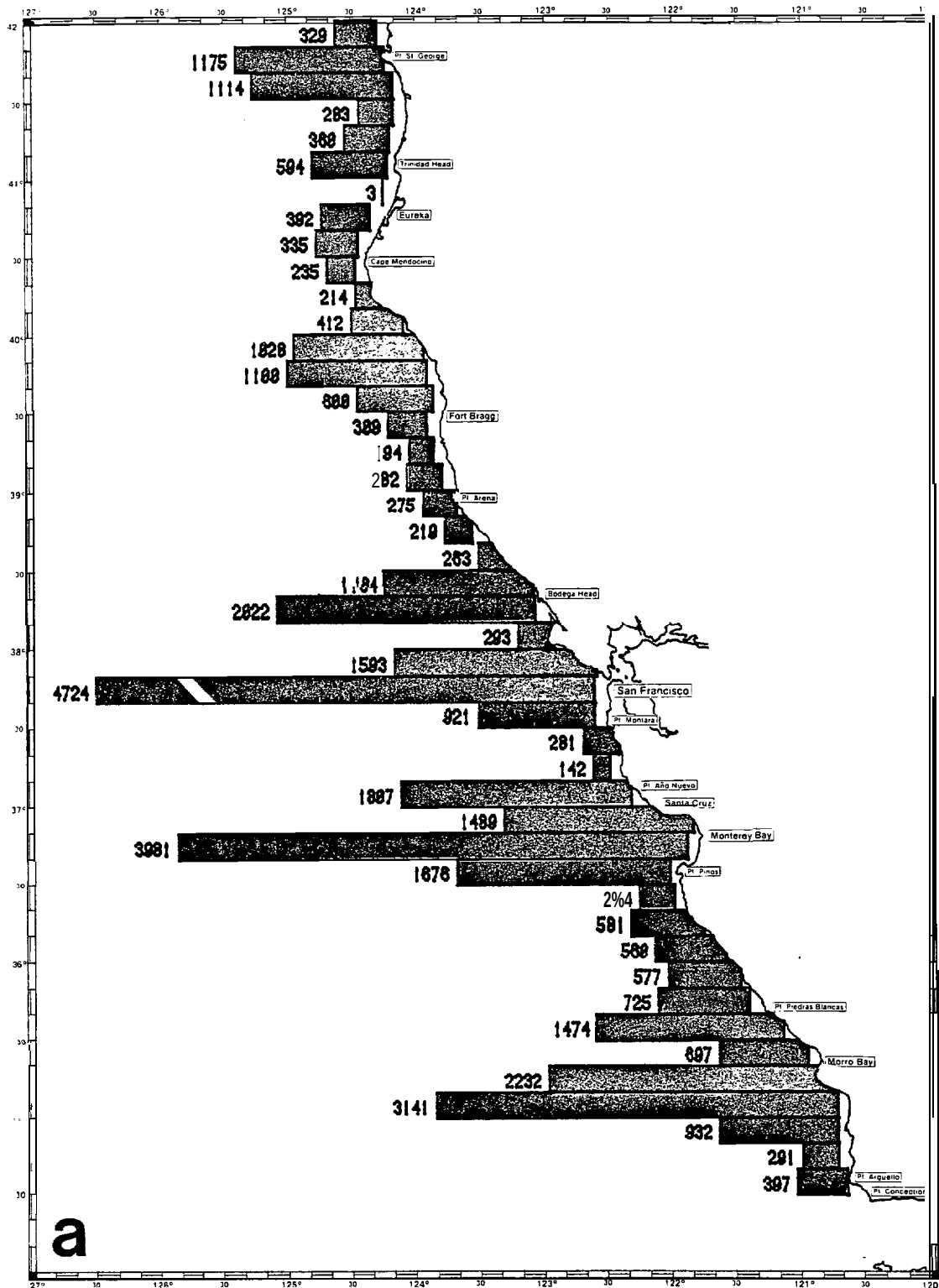
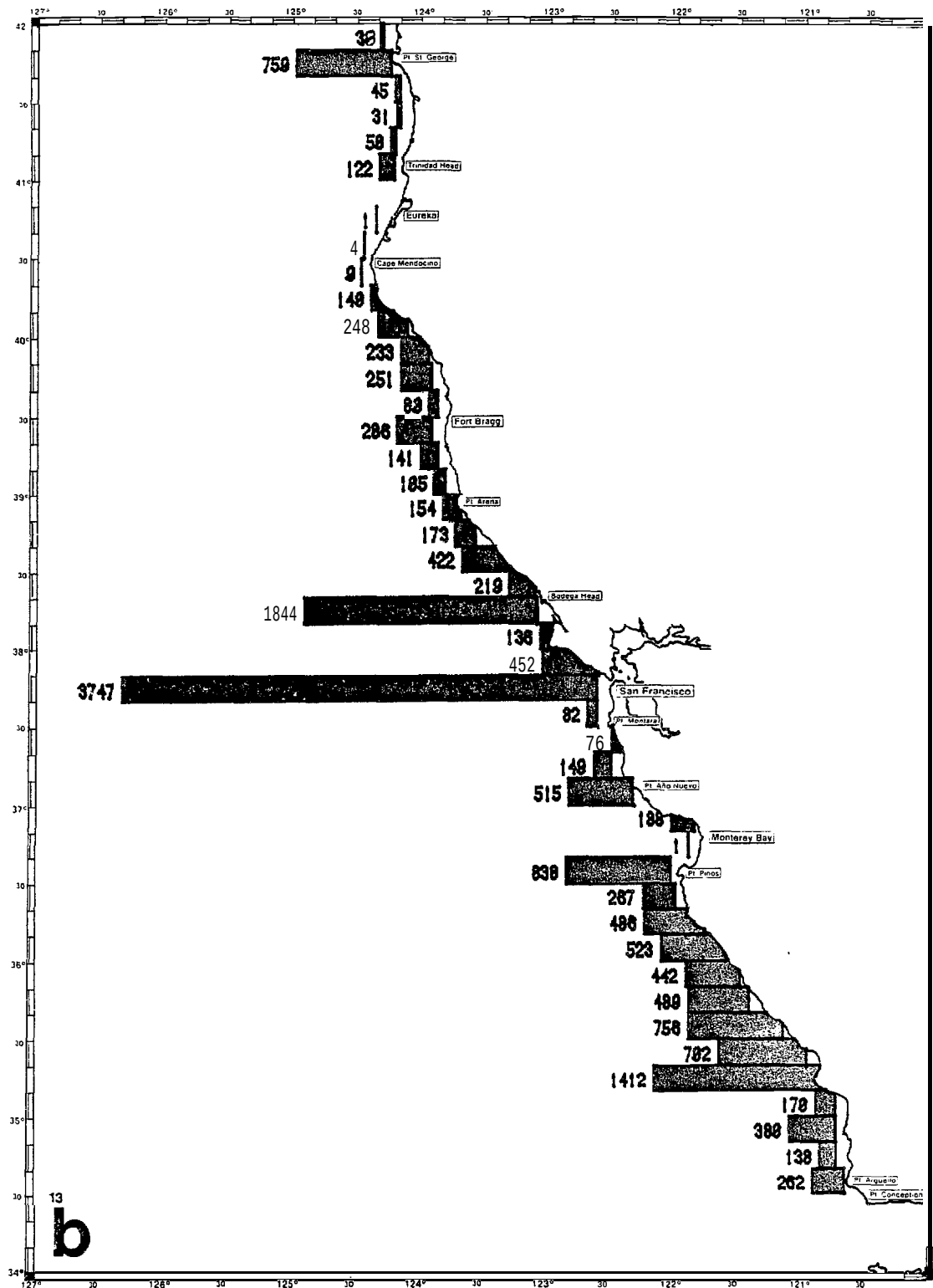


Figure 13. Average coastal counts of combined cormorants and pelicans during autumn and winter. Counts are clustered by 10' of latitude; each degree of longitude corresponds to 1,000 birds. (a) 3 September-October surveys; (b) 3 January surveys.



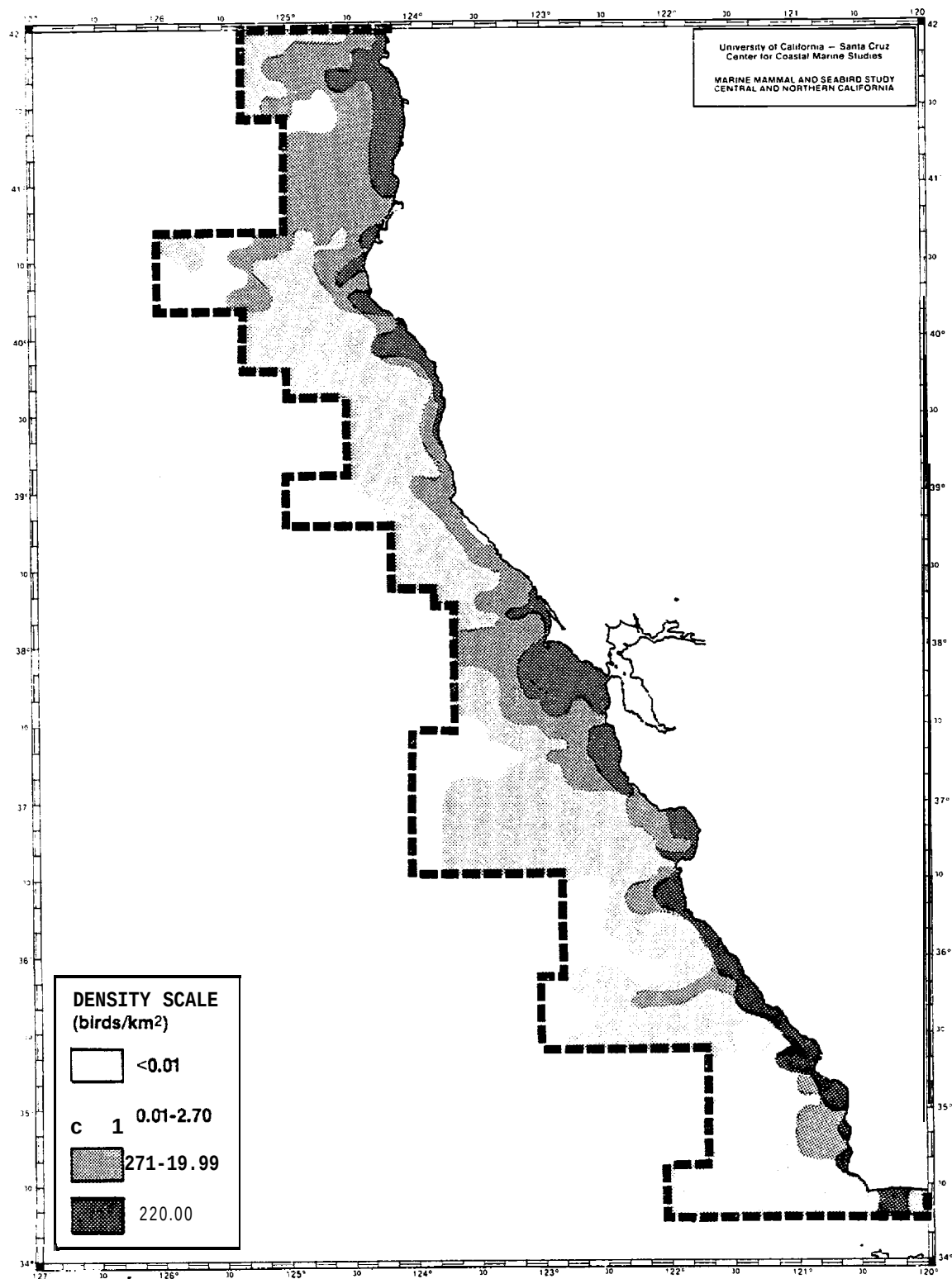


Figure 14. Average distribution of density of all breeding species at sea on central and northern California. Data from twelve surveys during May through July are compiled.

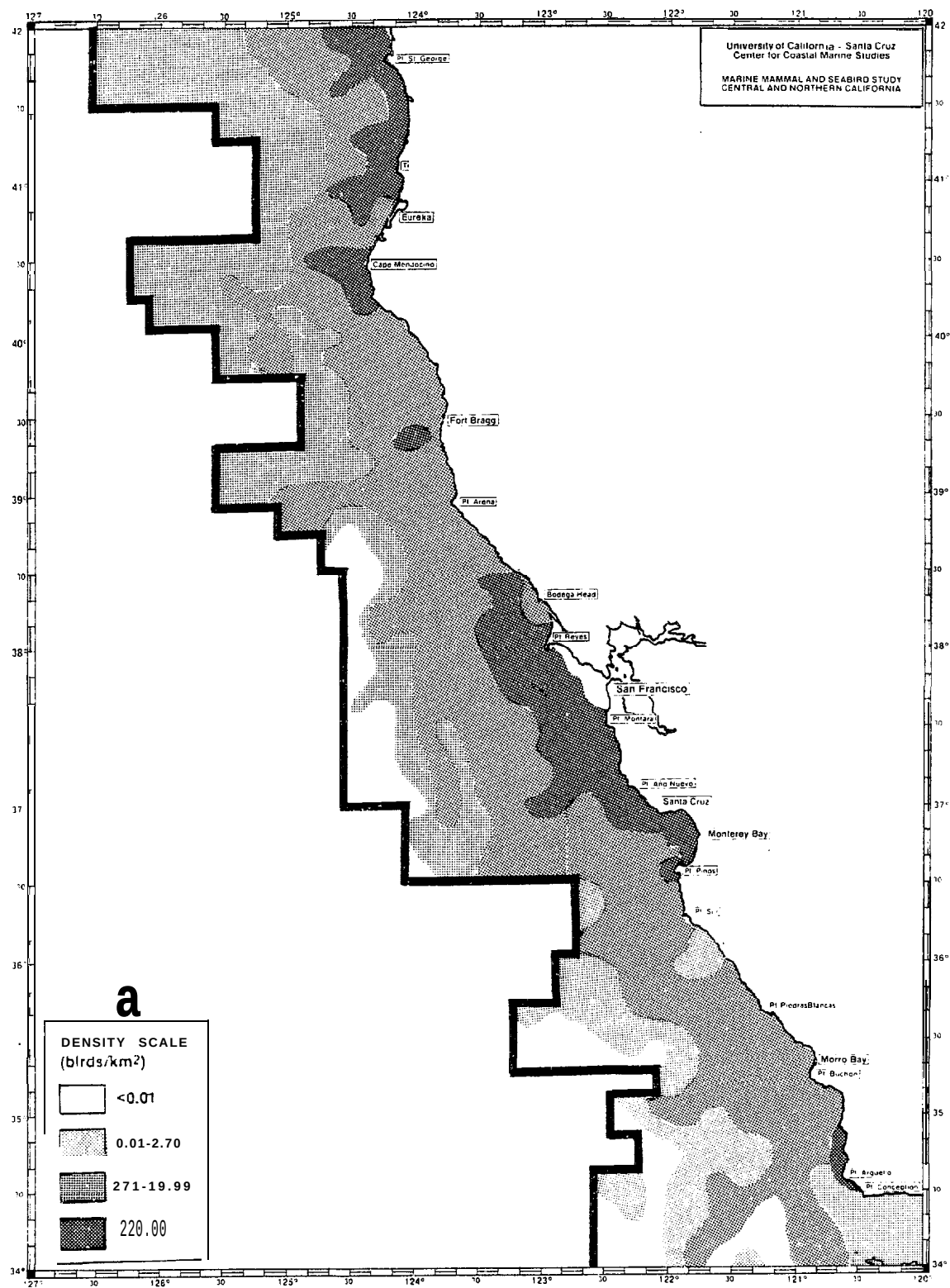
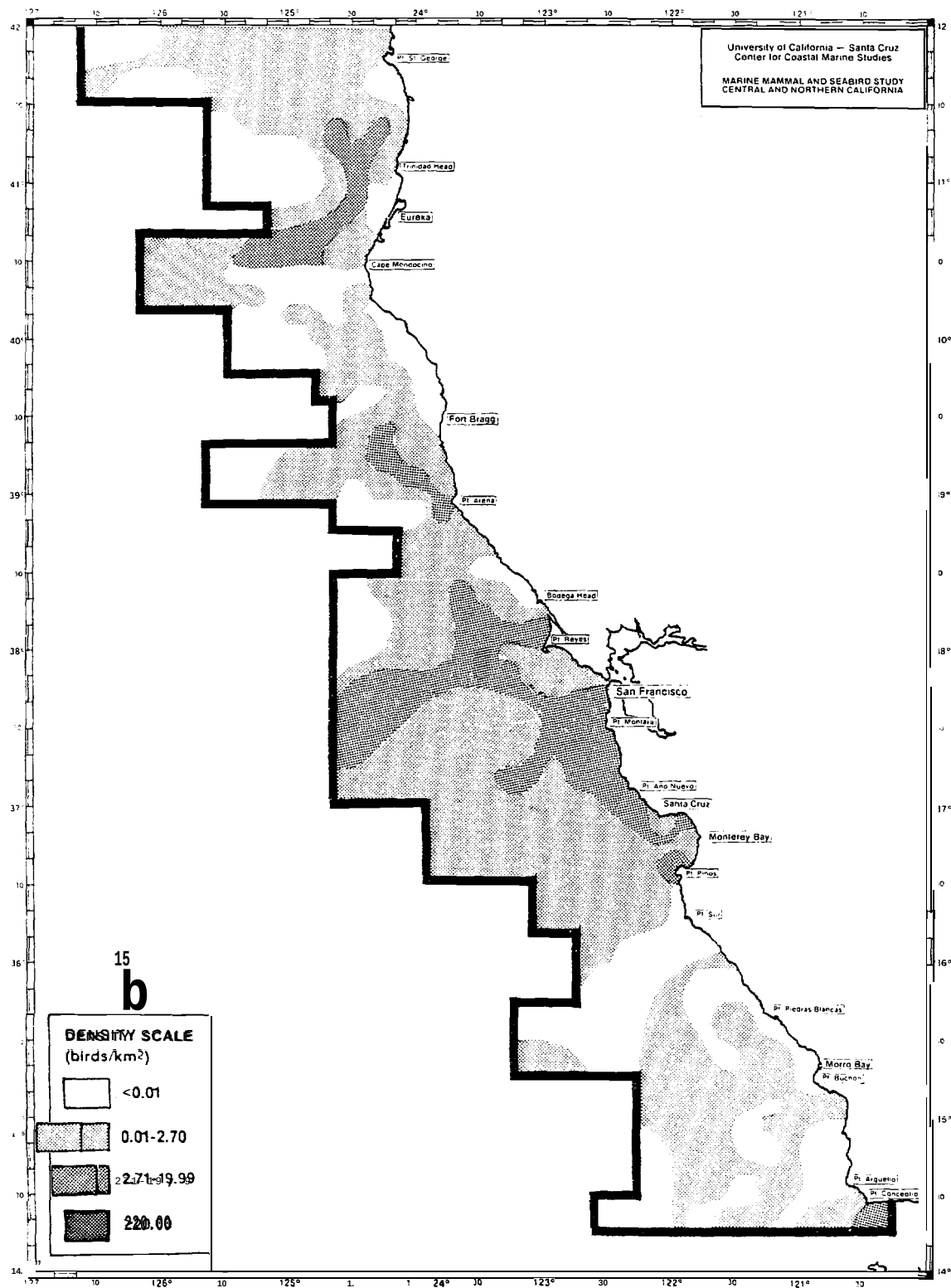


Figure 15. Average distribution of density of (a) all alcids and (b) all tubenoses (primarily fulmars) at sea off central and northern California during winter. Data from all nine surveys in December-March 1980-1983 are compiled.



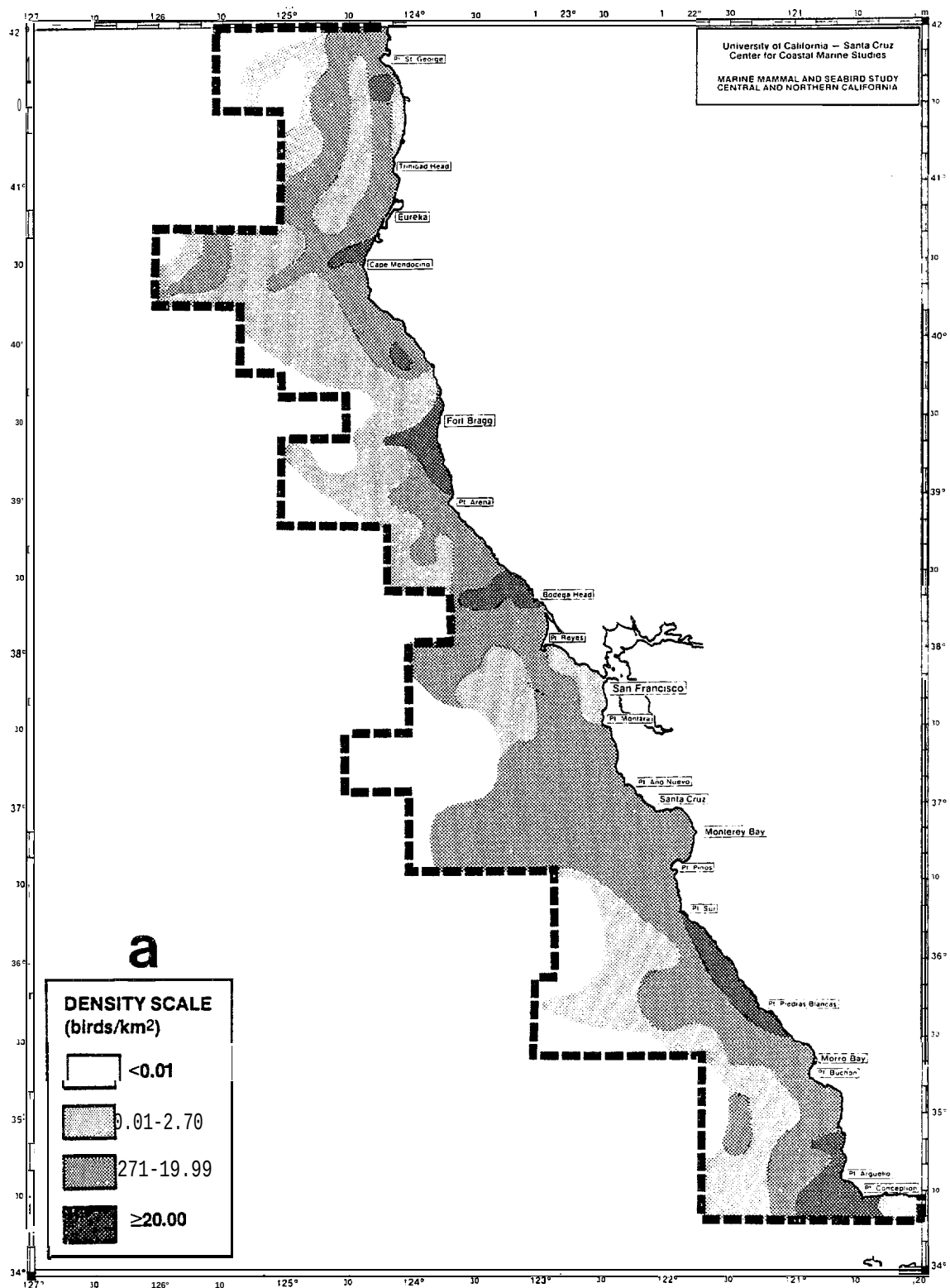
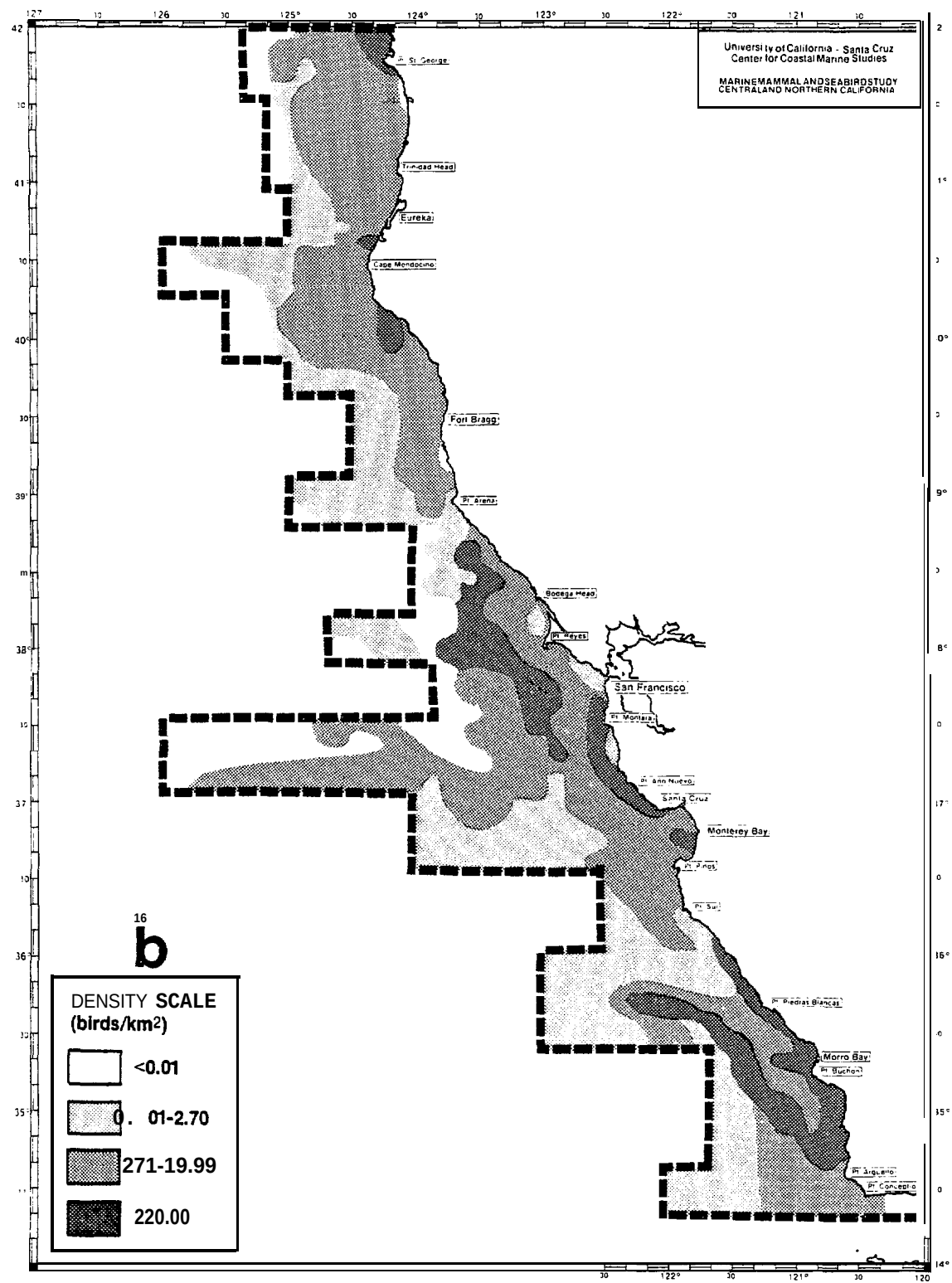


Figure 16. Average distributions of density of all migrant species during (a) spring and (b) autumn. Data from nine surveys in April-June and twelve surveys in July-October are compiled.



3b.6. Important Areas of Seabird concentration

pattern derive from sightings of Brandt's Cormorants and Western Gulls ,

Owing to the potential for daily or seasonal movements of birds during migration, the link between feeding and distribution is less direct and assessment of the relative importance of different areas is correspondingly tenuous; phalaropes or shearwaters seen off Point Reyes in spring, for example, may be merely passing through the area and not feeding there at all. Nevertheless, the distributions of alcids and of tubenoses (primarily fulmars) in winter (Fig. 15a,b), probably do reflect the areas of concentrated feeding activity, since population movements at this time are assumed to be minimal. Apparent in both distributions are major concentration areas north of Cape Mendocino and from Bodega to Monterey. The average distributions of density of migrant species in spring and fall (particularly phalaropes, shearwaters, loons, and several species of gulls and terns) may or may not reflect the distribution of feeding, although by definition it defines the route of migration. Since we can assume that feeding will take place anywhere along the migration route it is instructive to note the heavy concentrations over the shelf, broad concentrations of migrants off the coast at 37°N, and the suggestion of generally low numbers farther seaward than about 100 km in both seasons (Fig. 16a,b).

In summary, the above information concerning specific feeding activities, locations of major coastal concentrations and distributions of density at sea, provide a somewhat complex, but consistent picture of the areas of most importance to seabirds; these are the three areas of relatively broad shelf--north of Cape Mendocino, Bodega to Monterey, and south of Point Piedras Blancas. The central and southernmost of these three areas, lie downstream (south) of promontories from which dramatic upwelling plumes extend. This is particularly true of the extremely intense upwellings off

3b.6. Important Areas of Seabird Concentration

Point Arena/Point Reyes. It is likely that Farallon Island seabirds rely on food webs enriched by upstream upwelling. The same is likely in northern Monterey Bay, where huge migrant populations are? found within sharp thermal gradients associated with the southeastern edge of Point Año Nuevo upwellings. Finally, the locations of major colonies and traditional roosts along the shoreline give a clear indication of portions of the available habitat where the combination of feeding conditions, substrate, and lack of predation/disturbance are optimal over the span of years.

3c. The Predominant Species

The numbers and biomass of the seabird fauna of central and northern California are dominated by the populations of nineteen species. Among these are the four most numerous nesting species, the five most numerous winter residents, several summer (non-breeding) residents and several "pure" migrants. In this section we present demographic, distributional and ecological details pertinent to each species. The large number of species not treated here, some of which are quite numerous at times, are listed and discussed in less detail in the following section, Annotated Species List. We have drawn liberally from the regional accounts and Christmas Bird Counts found in American Birds (AB). Many different regional accounts involving many regional editors were consulted each year. we make no attempt to cite these individually, but refer to AB and the year of publication.

Arctic Loon (*Gavia arctica*). The North American population of Arctic Loons (*G. a. pacifica*) breeds on freshwater lakes along the Arctic Circle in Alaska and Canada, and winters on salt water along the Pacific coast from southeast Alaska to southern Baja California (Palmer 1962). Arctic Loons are found on California waters throughout the year, but large numbers occur only during migration; the

population is smallest during summer when *only* non-breeders are present. The size of the North American population is unknown; data from California during migration suggest that the Alaskan population may range into the hundreds of thousands. They are most conspicuous during migration when large flocks travel near the coast during daylight hours. In winter the birds tend to be more sedentary, when scattered individuals and small groups inhabit protected inshore areas. Arctic Loons are the most abundant gaviiformes in California waters, and the most pelagic in distribution (Small 1974); they may be outnumbered by Red-throated Loons (*Gavia stellata*) within 0,5 km of shore (Briggs et al. 1981a). Loons obtain all of their small fish prey by diving and underwater pursuit; their diet on marine waters is very poorly known.

Due to plumage similarities it can be difficult to distinguish Arctic Loons from other loon species during some seasons, As such, the species composition of the gaviiform population is difficult to assess; however, a few studies have presented data on this subject. In a land-based census of migrating loons at Pigeon Point (San Mateo County) over 432,000 northbound birds were counted during 11 weeks of daylight observations, with the peak count of 46,770 birds on April 22, Arctic Loons comprised over 98% of all loons identified to species (AE 1977). Unfortunately, it is not possible to determine the total number of loons migrating past this point since an unknown, possibly variable proportion of the population passed seaward of the maximum viewing distance, The mid-winter population has been examined during Audubon Society Christmas Bird Counts; these indicate that Arctics constitute a lower percentage during winter, especially on protected waters away from the open coast.

Arctic Loon occupation-of study area waters was seasonally consistent through three annual cycles (Fig. 17), Each year we observed the first southbound birds in October, with the peak of migration in November. Population size declined through December and

reached mid-winter lows during January and February. Northbound migration began in March, peaked in April, and tapered off in May. Arctic Loons were scarce on California waters through summer (June-September).

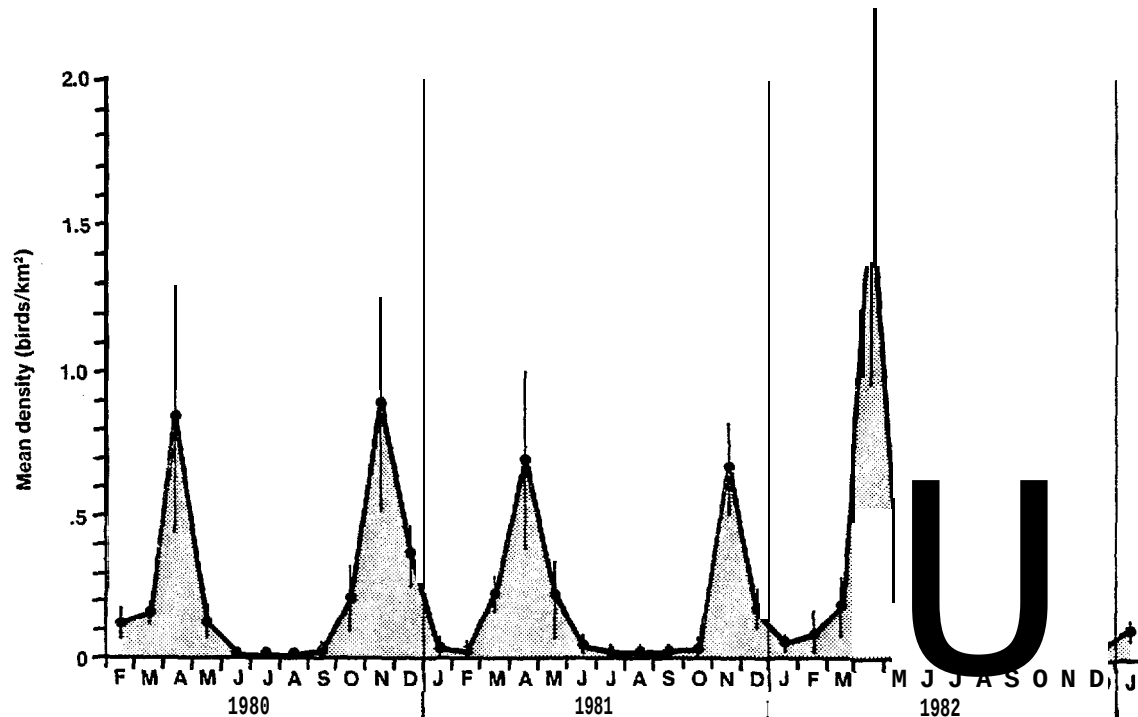


Figure 17. Monthly mean density of Arctic and unidentified Loons in waters of central and northern California, 1980-1983.

Each year we recorded the largest numbers of loons during migrations. Instantaneous population estimates ranged from about 112,000 to 257,000 loons (Arctic and unidentified) for spring (April) and from 75,000 to 137,000 birds during fall (November); since turnover rates during migration are unknown, we cannot determine the total number of loons migrating through the study area. Population estimates based on density projections for three winter (January) transect surveys ranged from about 5,000 to 19,000 birds, while January coastal survey counts ranged from 174 to 399 birds. The actual number of loons present in central and northern California at

the mid-winter low is probably between 1,000 and 5,000 birds. Counts from three July coastal surveys ranged from 47 to 276 Arctic and unidentified loons.

The annual differences we noted in seasonal highs and lows may reflect actual population fluctuation, but more likely indicate the temporal proximity of our survey to the precise peak or lull of the season in question. For species such as Arctic Loons which migrate rapidly through the area, the degree to which our survey hits or misses the peak, may dramatically affect our population estimate. For example, although estimates from the April 1982 survey put the population at 239,000 birds, (over three times the estimate for April 1980) we believe that in 1982 migration was probably just somewhat later, since no evidence of inflated numbers was seen on the preceding survey (March 1982) or during the preceding migration (November 1981). The coastal survey in early May 1982 counted 1,044 birds (over half in the far north), 2 to 8 times higher than previous May counts; however, by the time of the late May transect survey, numbers had returned to "normal" (equivalent to previous late-May surveys).

In addition, the magnitude of peaks may be affected by the duration of migratory movement through the area. For example, migration appears to have been more protracted in spring 1981 than in either 1980 or 1982: the April 1981 estimate was the lowest spring "peak" we recorded, but density projections for the subsequent May and June surveys exceed those of the other survey years. Furthermore, the count from the July (1981) coastal survey was 5-6 times that of other July counts, and most of the birds were found in the far north.

Despite their pelagic reputation, we found Arctic Loons to be most numerous on waters of the continental shelf in all seasons. They were most widely distributed during migration, (Fig. 18}, but even then average density was 3 to 40 times higher on shelf waters than

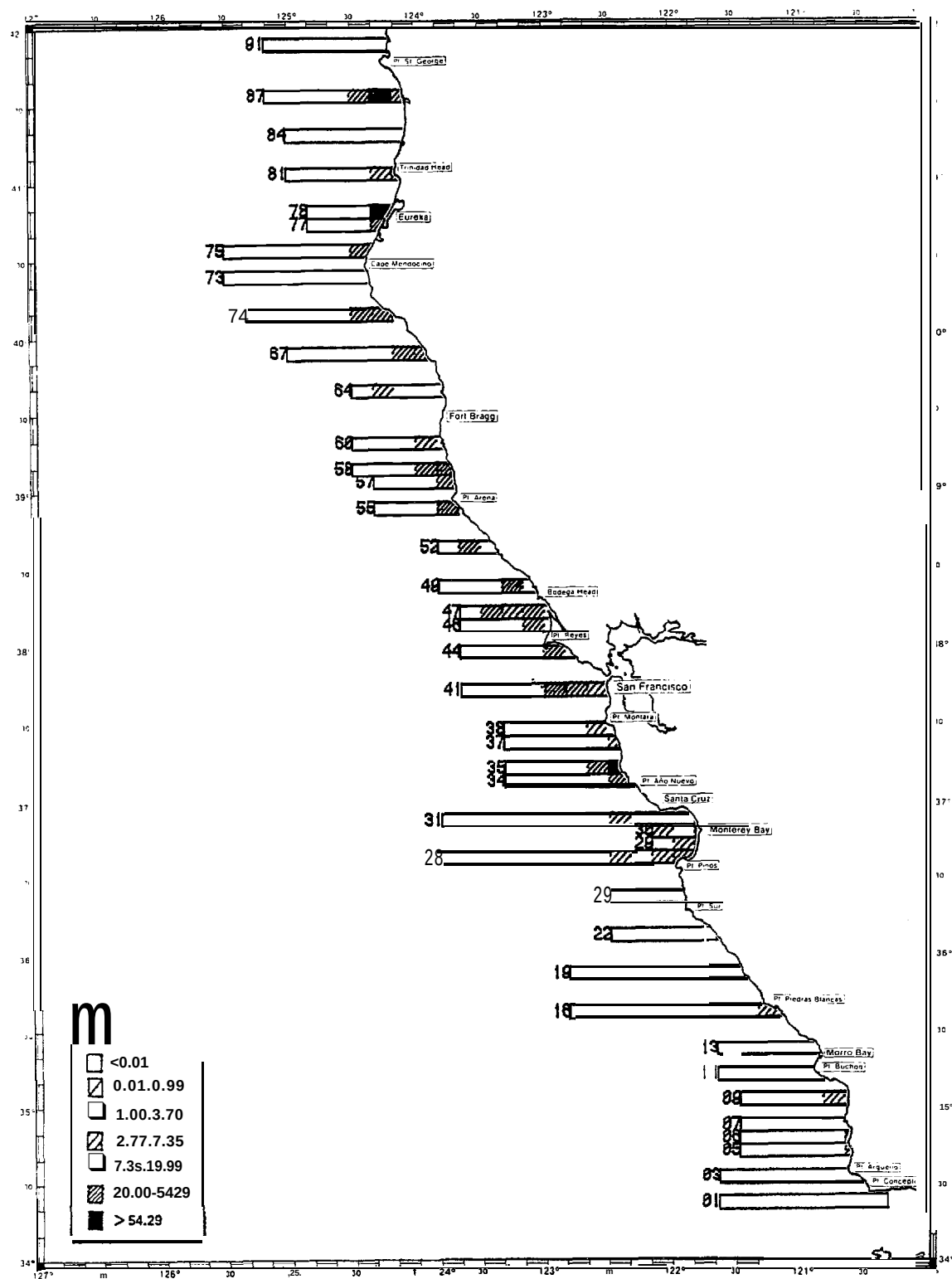


Figure 18. Density of unidentified and Arctic Loons observed on central and northern California waters in November 1981.

over the slope (average for November surveys was 4.69 birds/km² on Shelf versus 0.32/km² on slope). Small numbers of Arctic Loons were also observed traveling over waters seaward of the slope. Our farthest offshore record was of a single bird about 110 km west of Monterey in November 1982.

During the winter, Arctic Loons were even more restricted to protected coastal waters; none were observed beyond the slope. Areas preferred by wintering loons included the following: Point Montara to Bodega (including Tomales Bay) accounted for 35.9% of all wintering loons on average; Monterey Bay averaged 17.3%; and Point Buchon to Point Piedras Blancas averaged 10.5%. In contrast, the 300+ km stretch of coast from Point Arena to Oregon accounted for only 15% of the total (Fig. 19).

We found it difficult for aerial surveyors to distinguish between different loon species in winter plumage. Consequently, a large proportion of loons were categorized as unidentified during most months. However, during spring migration the majority of birds had molted into breeding plumage, facilitating identification and enabling more accurate assessment of loon species composition. Over shelf waters Arctic Loons accounted for 86% of all loons identified on April transect surveys and 76% on May transect surveys; beyond the shelf break they comprised 95% on April surveys and 90% on May surveys. On three May coastal censuses Arctic Loons averaged 74% of all loons identified.

Western Grebe (*Aechmophorus occidentals*), Western Grebes breed on inland lakes and ponds of the continental U.S. and Canada; their total population numbers are unknown. Colony areas are located from northern California northeastward through the Rocky Mountains into central Canada; small local breeding sites are known from farther east and south as far as central Mexico. These birds winter along the

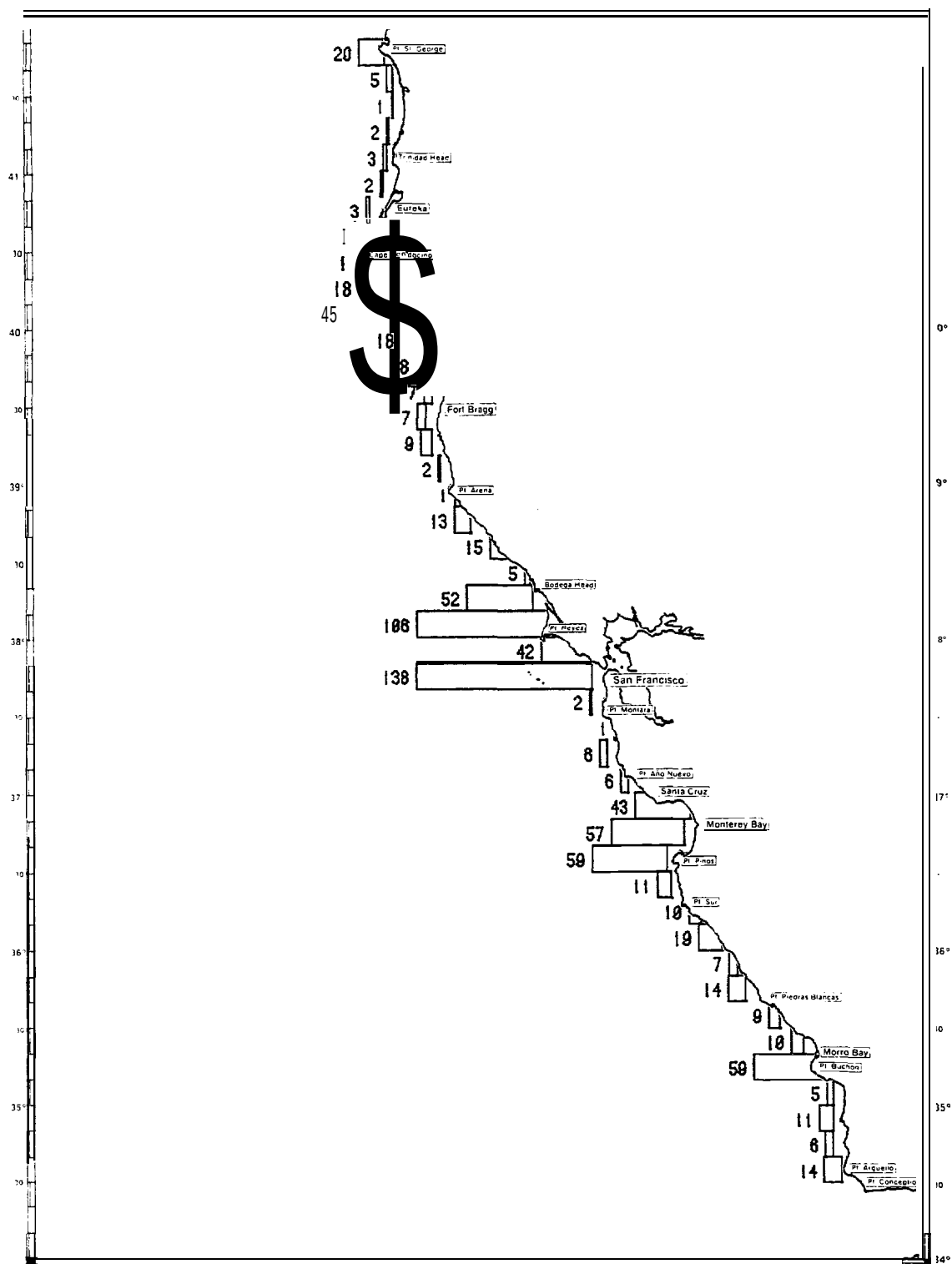


Figure 19. Distribution of unidentified and Arctic Loons on inshore waters of central and northern California during January 1981. Numbers are aggregated by 10' of latitude.

Pacific coast from ~~southeast~~ Alaska to Mexico (Palmer 1962). The diet consists primarily of small fish captured above sandy or rocky substrate.

Migration dates vary annually, but the first migrants reach salt water by late September, and by December Western Grebes are well distributed from British Columbia to Baja California. Distribution during winter is variable; annual highs among the Audubon Society Christmas Bird Counts (CBC) have been reported as far south as San Diego and as far north as Seattle or Vancouver. In late March and April the southernmost birds begin to move north, and the majority depart the ocean and move inland in late April and May. Passage of Western Grebes during northbound flight is usually of short duration; large numbers of birds may arrive and depart abruptly. They seem to be gregarious throughout the year (Palmer 1962).

The general latitudinal pattern of Western Grebe distribution throughout much of their range during winter can be obtained from CBC's. Similar coverage and party-hours were tabulated for each year, though coastal coverage was only partial, some CBC counts included bays, estuaries, or coastal lakes. They thus provide an index to latitudinal distribution, but not coastal population. Table 6 shows how variable the population can be. In 1980 the population was centered in Washington, but in 1981 more birds were seen in British Columbia. In 1982 central and northern California had numbers comparable to both northern regions. These counts are not conducted with sufficient attention to methods of quantification to permit more than cursory comparison with our coastal censuses.

Western Grebes were present on California waters throughout the 36 months of our study. They occupied a narrow band of shelf water, usually within 3 km of the mainland coast and showed a marked

preference for shallow water (75 m or less) over sandy bottom.

Table 6. Summary of counts of Western Grebes on Audubon Christmas Bird Counts, 1979-1982. Percent of Pacific Coast total in parentheses.

	<u>1979-80</u>	<u>1980-81</u>	<u>1981-82</u>
1) British Columbia (18 sites)	15,419 (21%)	20,586 (36%)	22,335 (29%)
2) Washington (14 sites)	27,503 (37%)	13,716 (24%)	21,396 (28%)
3) Oregon (16 sites)	941 (1%)	574 (1%)	1,032 (1%)
4) California central & northern (45 sites)	22,038 (29%)	17,619 (31%)	23,351 (30%)
5) California southern (19 sites)	8,944 (12%)	4,771 (8%)	8,586 (11%)
TOTAL (112 sites)	74,845	57,266	76,700

According to our surveys, population size fluctuated widely between months and varied greatly between years. Some of this variability reflects the abrupt **re-locations** of which this species is capable. But, in addition, the pattern of distribution exhibited by Western Grebes was difficult to assess by our survey techniques. The band occupied by these birds was too narrow for valid sampling by our standard transect methods. Coastal censuses sometimes provided more believable numbers but were probably influenced by environmental conditions: during moderate winds the band occupied by Western Grebes was narrow, so that most could be counted by nearshore surveys; but during mild weather, the birds were dispersed and occupied a band wider than the survey corridor. Additionally, during stormy weather many birds probably left coastal waters entirely, preferring the safety of freshwater lakes and protected bays.

Western Grebe

Despite these methodological difficulties we believe the general annual pattern was as follows: Western Grebes began to return to salt water from breeding lakes during September. Numbers rose through autumn and reached annual peaks during the period November through January. Population size was variable during winter and spring months but it generally decreased after the peak through May. Numbers were lowest on salt water during nesting season, June through August (Fig. 20).

Our coastal counts generally followed this seasonal pattern but with substantial variability between years. The highest single count was of 24,580 birds from a fair-weather coastal survey in January 1980. Counts from subsequent coastal surveys during 1980 were 7,328 birds in May, 1,862 birds in July, and 5,145 birds in October.

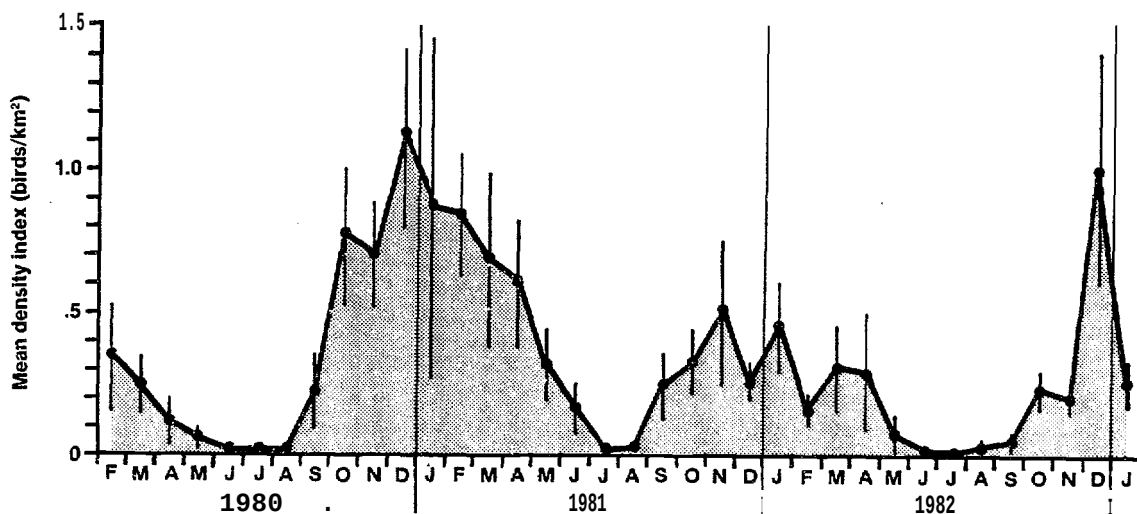


Figure 20. Monthly mean density index for Western Grebes in waters of central and northern California, 1980-1983. See text for discussion of estimated population size.

Our January 1981 coastal survey was conducted in stormy conditions, and we counted only 3,558 birds. Summertime coastal surveys counted 4,024 in July and 4,469 in September; distribution was somewhat more northerly during the later survey, indicating the birds

probably moved north after winds began to ease, We counted 5,406 Western Grebes during our January 1982 **coastal survey**. Our transect surveys recorded generally low densities at sea following a November **peak**. Our mid-summer count was 2,175 birds. Relatively low numbers (3,348 birds) in October may have been the result of a later than usual nesting season (**AB** 1983).

Despite the variability in apparent size of the wintering Western Grebe population, those birds observed on salt water (whatever their number) **exhibited** fairly consistent patterns of distribution. In general, we found largest numbers of Western Grebes on coastal waters from Point **Montara** to **Bodega** (Fig. 21); this stretch of coastline accounted for nearly 45% of all birds observed on average, and up to 75% on a single survey (May 1981). Peak **numbers** were usually found in the vicinity of the mouth of San Francisco Bay. The second most important region, Trinidad Head to Point St. George, accounted for over 20% of the birds on average, and up to 40% on a single survey (May 1980). Waters in the south generally harbored fewer birds, though Monterey Bay and Point Sal to Point Piedras **Blancas** each accounted for about 7% of all birds on average.

Western Grebes typically were concentrated in the above mentioned areas during January, May, and July surveys. During autumn surveys the birds were more evenly and widely distributed. We found largest numbers in Monterey Bay, in the vicinity of Point **Buchon**, and near **Bodega** (Fig. 22). At this time, the coast below Cape **Mendocino** (south to Fort **Bragg**) harbored more birds than did any more northerly stretch,

Northern Fulmar (*Fulmarus glacialis*). The natural history and distribution of the Northern **Fulmar** are the best known of any of the northern hemisphere **Procellariidae**. This species nests on cliff ledges in colonies in the far northern Atlantic and Pacific Oceans.

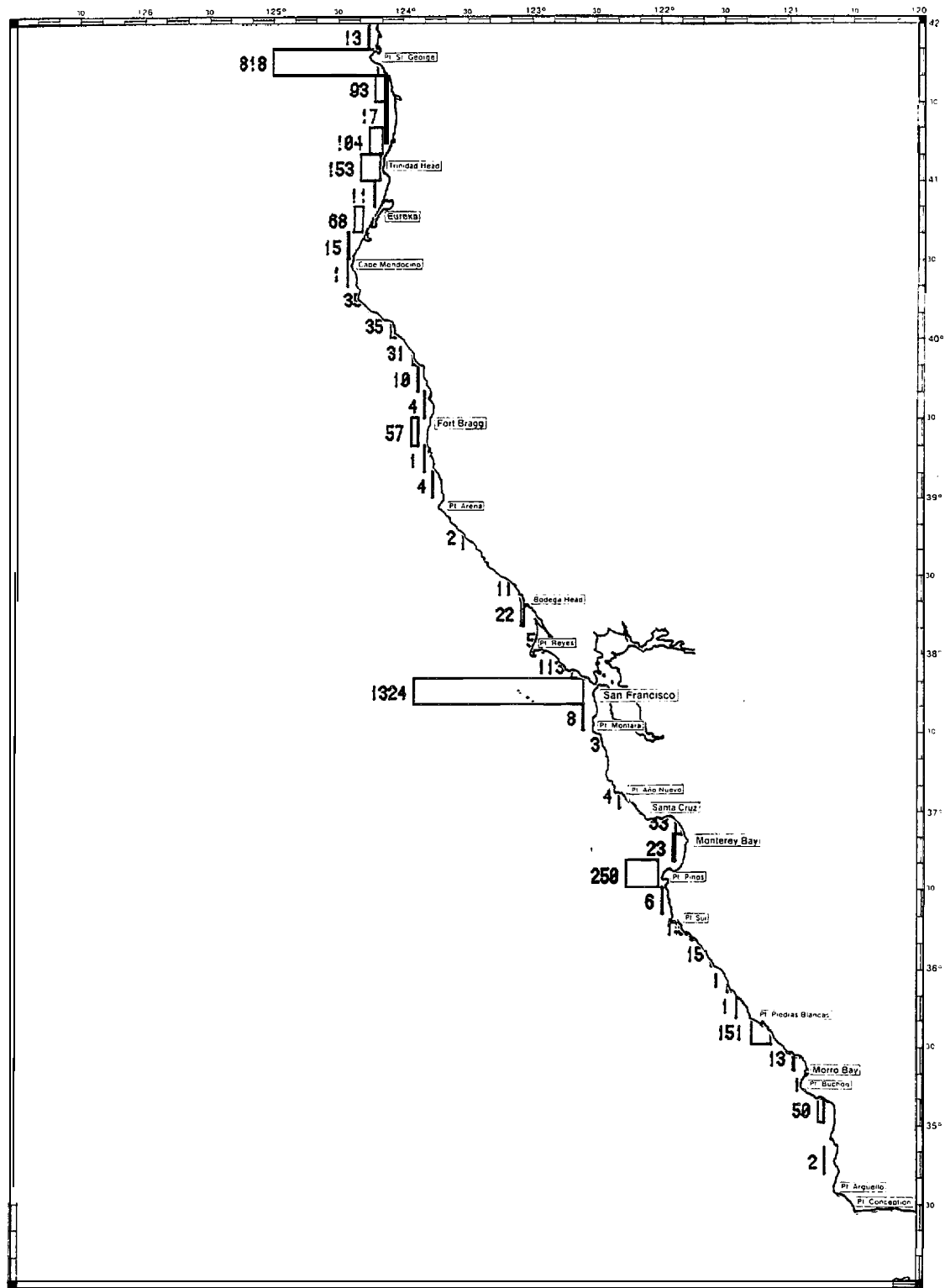


Figure 21. Distribution of Western Grebes on inshore waters during January 1981. Numbers are aggregated by 10° of latitude.

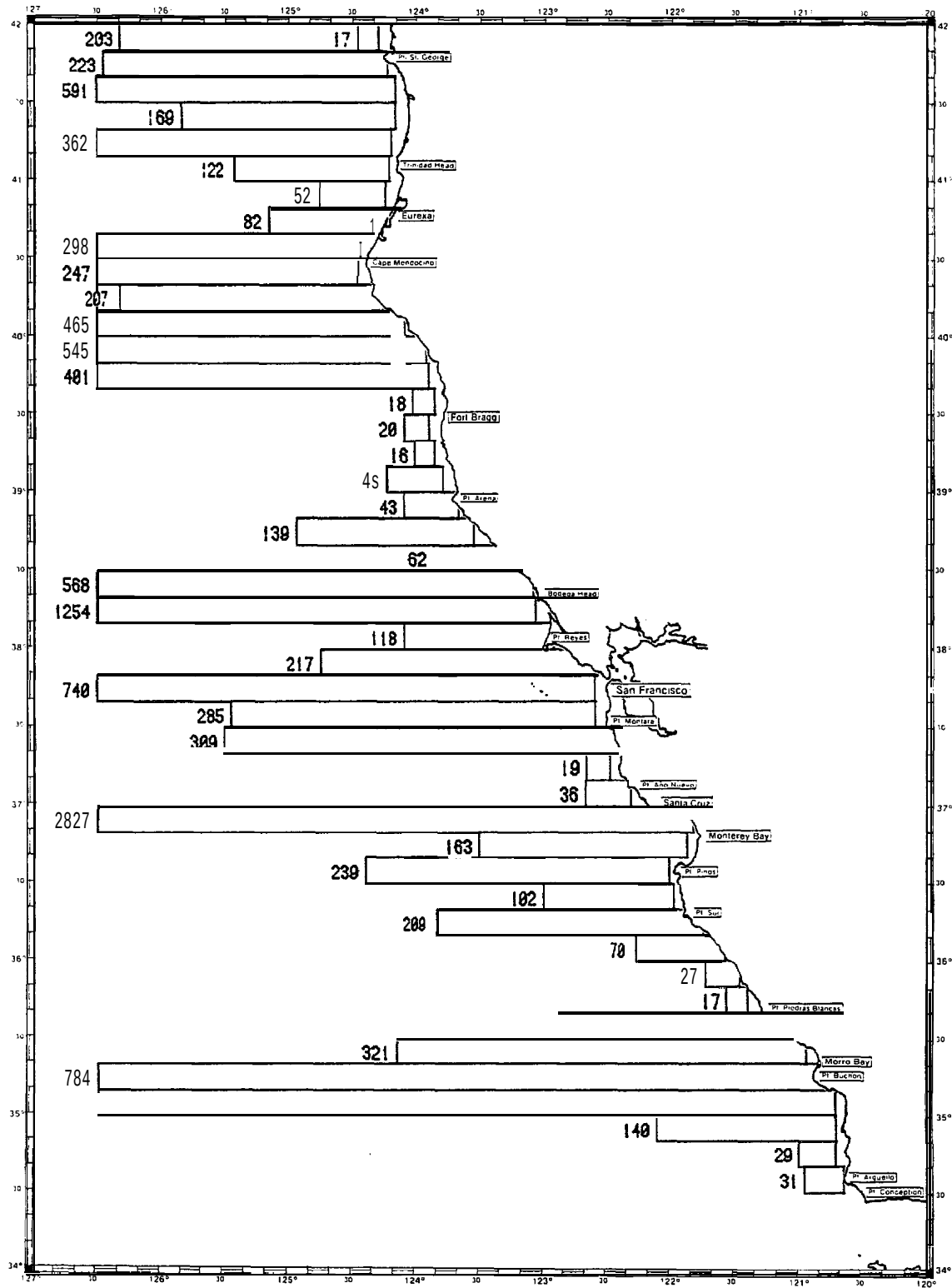


Figure 22. Distribution of Western Grebes on inshore waters during September 1981 and October 1980 and 1982. Numbers are aggregated by 10' of latitude.

Northern Fulmar

In the Atlantic, fulmar populations have increased rapidly and expanded southward into warmer subarctic waters during the last century. The Pacific population (*F. g. rogersii*) breeds on islands in the Bering Sea and Gulf of Alaska. Light-morph birds predominate at more northerly colonies, dark-morph birds at southern colonies. Population size is estimated to be about 2 million birds, of which 38% are non-breeders (Sowls et al. 1978). During the winter (October through April) the birds are dispersed; many remain in Alaska waters, but others roam as far south as Japan and Baja California (Palmer 1962; our unpubl. data). Squid appear to be the mainstay of the diet in Alaska and Monterey Bay (Sanger 1983, Baltz and Morejohn 1977), with small contributions from fish, crustaceans, and jellyfish.

Northern Fulmars occur in California waters in all months, but peak numbers and widest distribution occur from October through April. In other months, fulmars may be scarce at southern latitudes. Most recent authors have reported that fulmars vary greatly in number from year to year, Ainley (1976) reported a preference by fulmars for cool waters of high salinity. His index of annual fulmar abundance differed by an order of magnitude between the warm water period of the late 1950's and the cooler years in the 1960's and 1970's,

We found low numbers of fulmars in central and northern California during winter 1980, and they were virtually absent that year from April through September. Moderate numbers of Fulmars were present during the 1980-81 winter (October-April), but once again, they were virtually absent from California waters during May through September. Fulmar numbers were largest in winter 1981-82 and low densities remained through the summer on slope waters north of Monterey. In general, when December-January populations were low, fulmars disappeared from California waters by May. Populations that remained through mid-summer, were apparently remnants of above average influxes of birds in the preceding winters. This pattern was also

observed by us in the Southern California Bight in 1975-1978 (Briggs et al. 1981a).

Annual peak densities were recorded in December 1980 and 1981, and in November 1982. In the the Southern California Bight, peaks also occurred in December in two of three winters (Briggs et al. 1981a). During the 1981-82 winter in central and northern California, (and all three winters in the SCB), density curves were bimodal; minima occurred each February with higher mean densities earlier in the winter and in March. The peak population estimate in central and northern California was 291,000 birds in December 1981, whereas maxima in other winters were about 50% lower; during mid-winter the fulmar population here numbered about 33,000 to 73,000 birds. Combining these estimates with similar ones from our studies in the SCB, it appears that statewide annual maxima for December-January range from about 228,000 to 361,000, while the mid-winter population may vary from 35,000 to 93,000 birds.

During the autumn (October-December) influx of fulmars, densities were highest on shelf and slope waters, though large numbers of birds also were present offshore (Fig. 23). During this season the coolest waters generally occur off California only over the shelf. That fulmars are widespread in all habitats during autumn, indicates that migration occurs over a broad front, and that birds in transit are less attracted to cool waters.

By the end of January, densities and total numbers of birds were higher over slope and offshore waters than on the shelf (Fig. 24). The percentage of birds on waters beyond the slope remained high through May (or until the birds departed the area) although during the March pulse of migration densities were higher over slope waters, This offshore distribution during the period encompassing winter and early spring, may be due to lower surface salinity near the coast, caused by discharge of rivers. In 1982, Fulmars were present in large

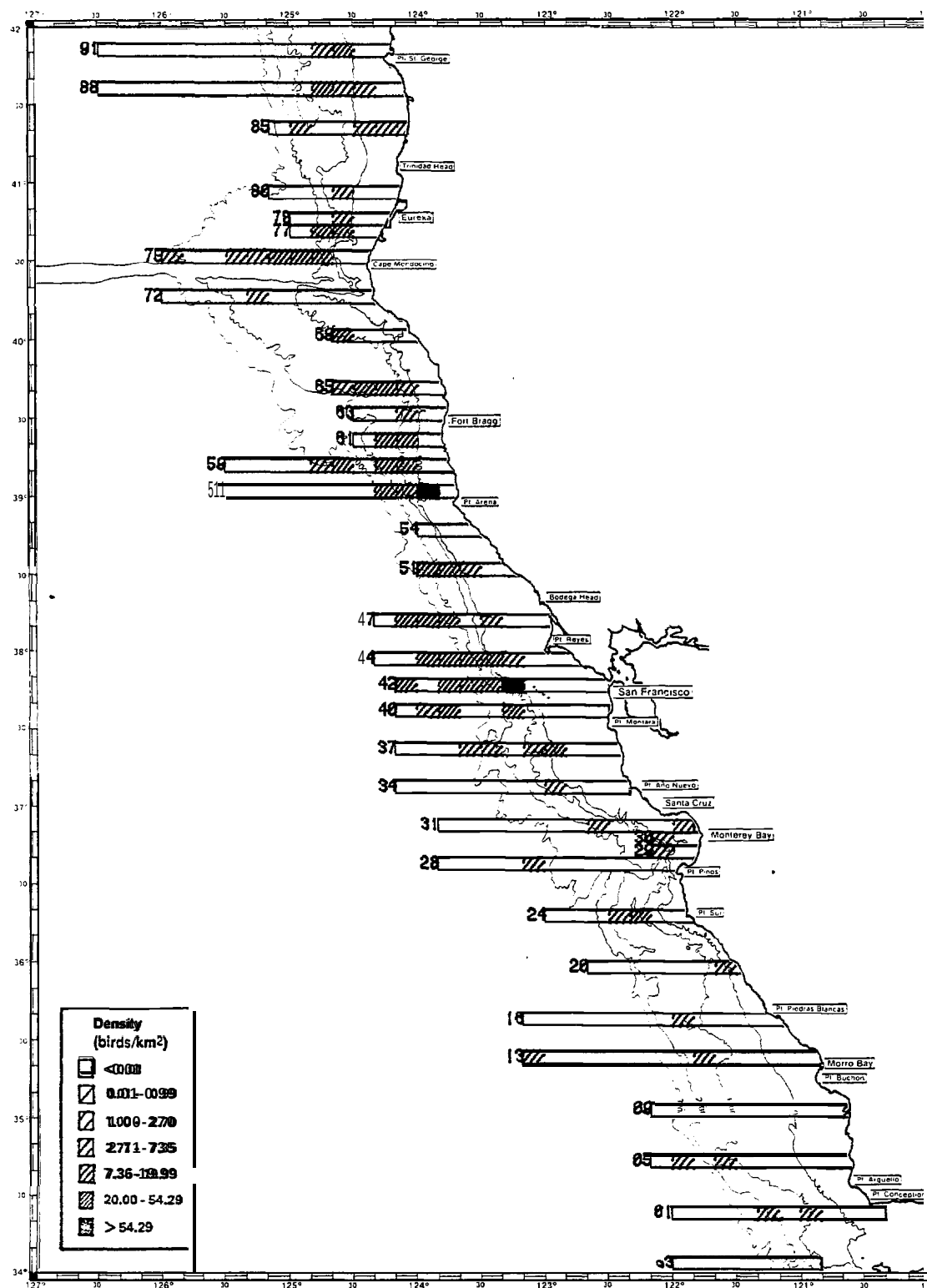


Figure 24. Density of Northern Fulmars in central and northern California waters, March 1982.

numbers during June through September on shelf and slope waters, but they were absent offshore. During this period, upwelling maintains higher salinity and lower SST over shelf waters than farther offshore.

During the months of maximum abundance (October through March), fulmar numbers generally were highest on waters from Point Piños to Bodega and lowest on waters south of Point Sur. An exception was the midwinter lull in migratory movement (about February), when relatively more fulmars were seen on southern waters.

The wide variation in abundance previously reported for this species may require reinterpretation. Although numbers (at peak) did actually vary up to 50% annually in our study, the preference for offshore waters exhibited by these birds would preclude determination of even relative numbers by near-shore observers (the source of almost all previously published information). More likely, during certain years, oceanographic conditions cause birds to be nearer the coast, and therefore more detectable. "Low" fulmar years may be those when the birds remain farther offshore.

Sooty Shearwater (*Puffinus griseus*). Sooty Shearwaters are distributed widely in the world's oceans during April-October, reaching the coasts of Asia, Alaska and the rest of western North America in late March and attaining peak abundance in May-July (Kuroda 1955, Briggs et al. 1981a, Gould et al. 1982, Chu and Briggs ms, D.W. Anderson pers. comm.). Though precise estimates of nesting population size from the colonies near Australia and New Zealand are lacking, several authors have estimated populations at sea in the North Pacific, Bering Sea and North Atlantic (Table 7).

In California, sooty Shearwaters are present in all months, and during the peak of summer visitation, they are among the most numerous of all seabirds in the eastern Pacific (Sanger 1972, Ainley 1976).

Sooty Shearwater

Table 7. Estimated peak populations of Sooty Shearwaters at sea in several north-temperate and subpolar regions. Peak numbers may occur at different times in different locations.

<u>Area</u>	<u>Estimate</u>	<u>Source</u>
Bering Sea	0.3 million	Gould et al. (1982)
Gulf of Alaska	>8.5 million	Gould et al. (1982)
Oregon	2.2 million	Wiens and Scott (1975)
Central & Northern California	2.7 million	this study
Southern California	1.2 million	Briggs et al. (1981a)
Gulf of California	>10,000	D.W.Anderson (pers. comm.)
Southeastern Canada	>100,000	Brown et al. (1981)

The monthly mean density curve for Sooty Shearwaters in central and northern California (Fig. 25) reveals peak densities between 9.5 and 13.6 birds/km² in May, June, or July and winter densities below 0.01 birds/km². When matched with similar data taken in southern California during 1975-78, the total California population is about 2.7 to 3.7 million in May, decreases by one-third in June and falls away to about 1.0 million by late September (Chu and Briggs ins).

Sooty Shearwaters occur in southern California primarily in the coolest waters: those of the major upwelling center stretching along the Santa Rosa-tortes Ridge south of Point Conception, shallow island shelves, and western Santa Barbara Channel (Briggs et al. 1981a). In central and northern California, Sooty Shearwaters were found primarily over the shelf, especially where it is broad. They did not frequent waters off Point Arena-Cape Mendocino in great numbers, so the correlation of high-density with the coolest temperatures does not hold for the data from this study. Instead, like Kuroda (1955), we found them most abundant in 11-14°C waters,

Sooty Shearwater

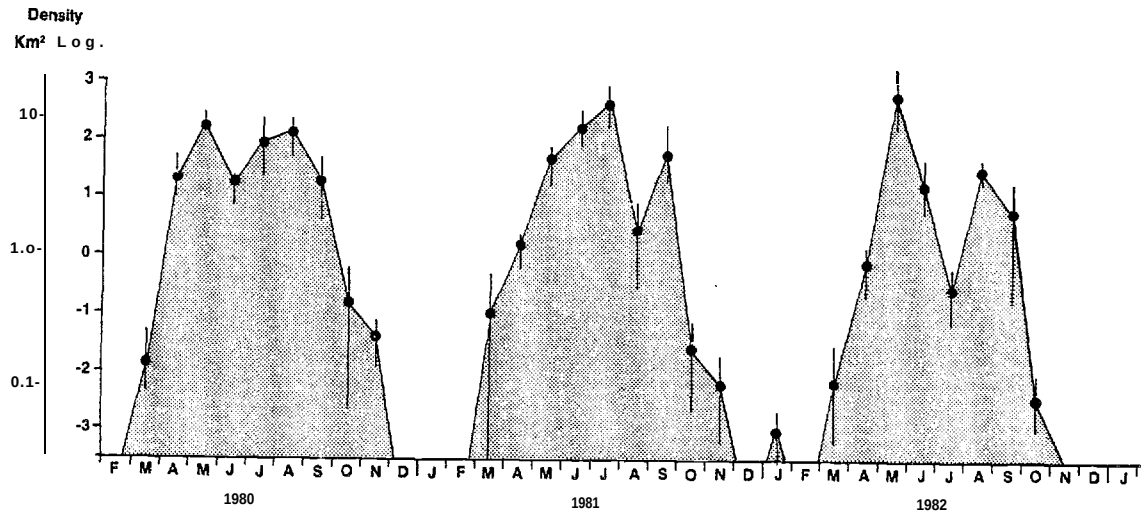


Figure 25. Monthly mean density of Sooty Shearwaters ($\pm$ se.) in waters of central and northern California, 1980-1983.

The major concentration areas of this species in central and northern California appear to be the shelf waters from Point Arguello to Point Piedras Blancas, Monterey Bay, the shelf and slope from Point Año Nuevo to Bodega, and the shelf north of Trinidad (Fig. 26). The latter area was not used consistently in spring and early summer, perhaps only supporting rapidly-moving migrant flocks, but had sizeable shearwater concentrations in August and September.

Monterey Bay, the site that has contributed most heavily to earlier accounts of seabird occurrence in central California may well be the focus of the largest shearwater flocks in the state. In June 1981 we photographed two flocks in northern Monterey Bay that together comprised over 630,000 birds. At that time, perhaps one-third of all Sooty Shearwaters in California were present in Monterey Bay. Flocks of >5,000 birds also occurred elsewhere (Table 8). Although frequently outnumbered at sea by phalaropes (even when sooty

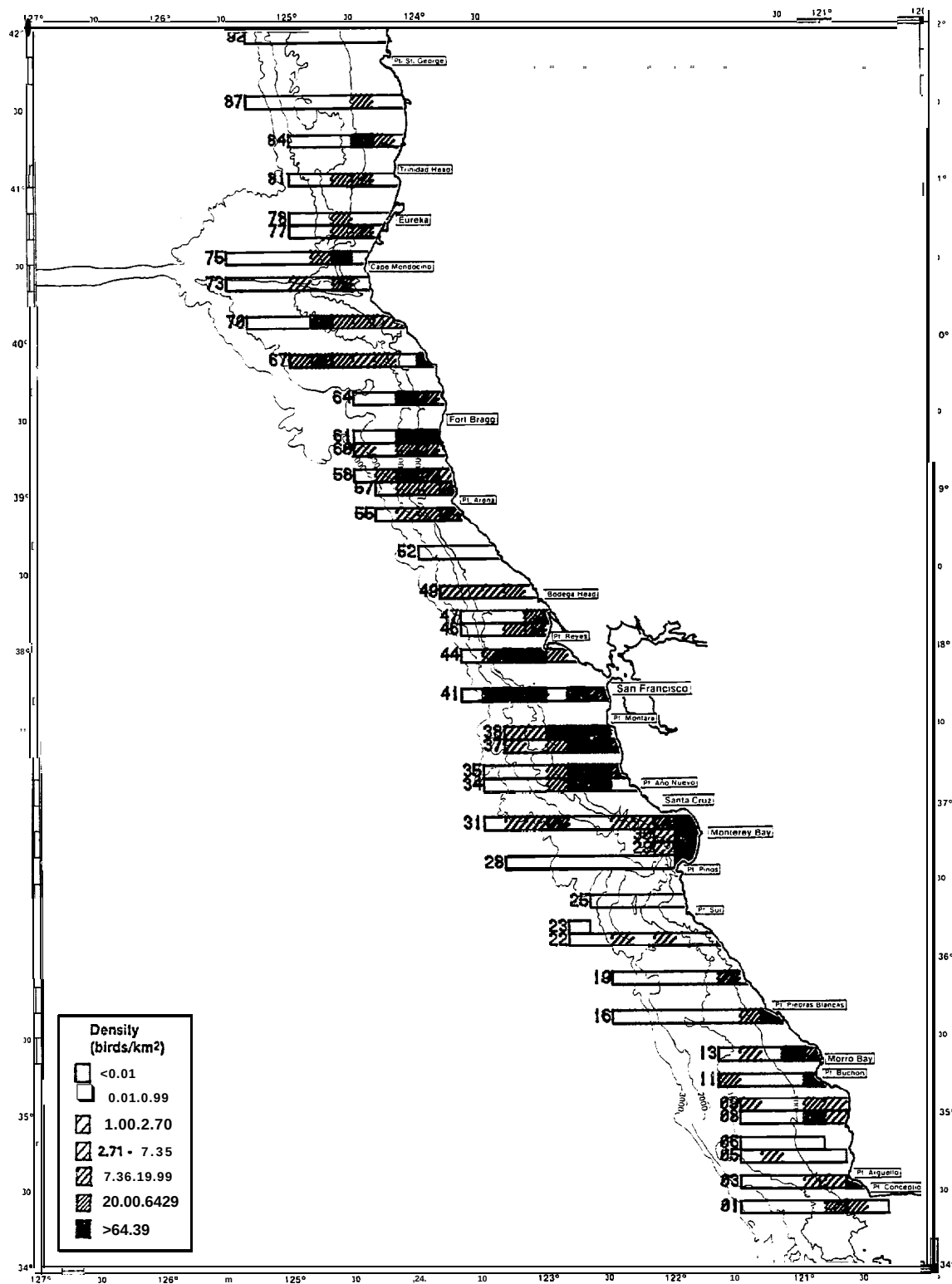


Figure 26. Density of Sooty Shearwaters in central and northern California waters, June 1981.

Shearwaters reached maximum annual densities), Sooty Shearwaters contributed as much as 59.6% of the total biomass of all seabirds in the study area in May-July.

Table 8. Location and dates of shearwater flocks in which numbers exceeded 1,000 birds.

	<u>Date</u>	<u>North Latitude</u>	<u>West Longitude</u>	<u>Approximate Numbers</u>
1980	27 May	36°35'	121°50'	15,000
	28 May	38°15'	123°10'	17,500
	26 June	38°50'	123°40'	1,000
	21 July	34°55'	121°20'	1,000
	22 July	35°35'	120°20'	2,250
	24 July	41°15'	124°00''	7,500
	25 August	34°30'	121°00'	1,500
	25 August	35°25'	120°50'	30,000
	26 September	37°20'	123°20'	15,000
	26 September	37°55'	123°20'	6,000
	26 September	37°55'	123°30'	2,000
1981	21 June	36°55'	121°55'	630,000
	22 June	35°10'	120°50'	2,000
	25 September	36°50'	122°00'	1,000
1982	21 April	38°35'	123°50'	1,000
	23 June	37°40'	122°30'	5,500
	23 June	37°40'	122°40'	1,000
	23 June	37°55'	123°20'	5,000
	24 June	38°30'	123°30'	3,000
	20 July	36°45'	121°50'	20,000
	23 August	34°40'	120°50'	3,980

We investigated the relationship of shearwater density to environmental features by means of correlation analysis, and linear

Sooty Shearwater

regression of density against uncorrelated environmental variables. Significant negative correlations ($p > .05$, df 139-239) were found between $\log_n$ density of Shearwaters and depth, distance from shore, temperature, and latitude. For the most part Sooty Shearwater density was greatest in shallow, cool water south of Point Reyes. Correlation coefficients as high as $r = -.35$ were attained between $\log_n$ density and distance to shore, $r = -.41$ between density and latitude, and $r = -.45$ between density and depth. The best simple regressions explained 15 to 21% of variance in $\log_n$ density (vs. depth; July 1980 and June 1982) while regression equations with two uncorrelated variables (depth and latitude) explained up to 31% of variance in $\log_n$ density of shearwaters. These correlations and regressions are similar to those obtained by us in southern California (Briggs et al. 1981a).

The diet and fat accumulation work of Chu (1984 in press) suggests that shearwaters rely on euphausiids and juvenile *Sebastes* in late spring. Shearwaters migrate to the concentration areas off central California by early summer, forming immense flocks and feeding upon market squid (*Loligo opalescent*), which spawn in the area during summer, and anchovy (*Engraulis mordax*), which migrate to the area from winter-spring spawning areas in southern California. Anchovy also spawn north of California, though later in the year (Parrish et al. 1981); perhaps large aggregations of Sooty Shearwaters in northern California during August and September are exploiting this food source prior to the long transequatorial migration in autumn. Briggs and Chu (ins) have found that throughout California, Sooty Shearwaters concentrate where gradients in SST exceed $0.08^\circ\text{C}/\text{km}$. It is likely that many thermal fronts exploited by this species are sites of convergence and sinking of recently upwelled surface water; the huge Monterey Bay flocks clearly concentrate in such features.

Leach's Storm-Petrel (*Oceanodroma leucorhoa*). This species is one of the most wide-ranging and abundant storm-petrels of the Pacific. Nesting populations exist from southeastern Alaska to central Baja California, Mexico. The migration patterns and pelagic distribution of Leach's Storm-Petrels are not well known. They are generally considered to be cool-water birds in the breeding season, but are widespread in tropical areas during winter (Palmer 1962, Crossin 1974, Scott 1974). The diet of Leach's Storm-Petrel is very incompletely known; small fish and crustaceans probably are the main prey items (Ainley and Sanger 1979).

Palmer (1962) states that the race of Leach's Storm-Petrels breeding along the western coast of North America is *O. l. beali*, while Ainley (1980, 1983) incorporates these birds into *O. l. leucorhoa*. Sowers et al. (1980) estimate the California breeding population at about 18,000 birds, 90% of which nest on nearshore rocks north of Trinidad Head. Varoujean and Pitman (1980) estimate that 68,000 pairs nesting in Oregon; world populations are unknown. Nesting season is approximately May through October (Sowers et al. 1980), and may be quite protracted at any given colony (Palmer 1962).

Palmer describes the winter range for the species as centered near the equator, but says the birds are widespread in tropical seas in that season. POBSP cruises found that large numbers of *O. l. beali* winter far offshore of south-central California.

We observed Leach's Storm-Petrels within the central and northern California study area throughout the year. Average area-wide densities were highest (0.25 to 1.26 birds km²) in March through August, when these were the most abundant storm-petrels in the area. Numbers were much lower during autumn and winter when densities never exceeded 0.15 birds km².

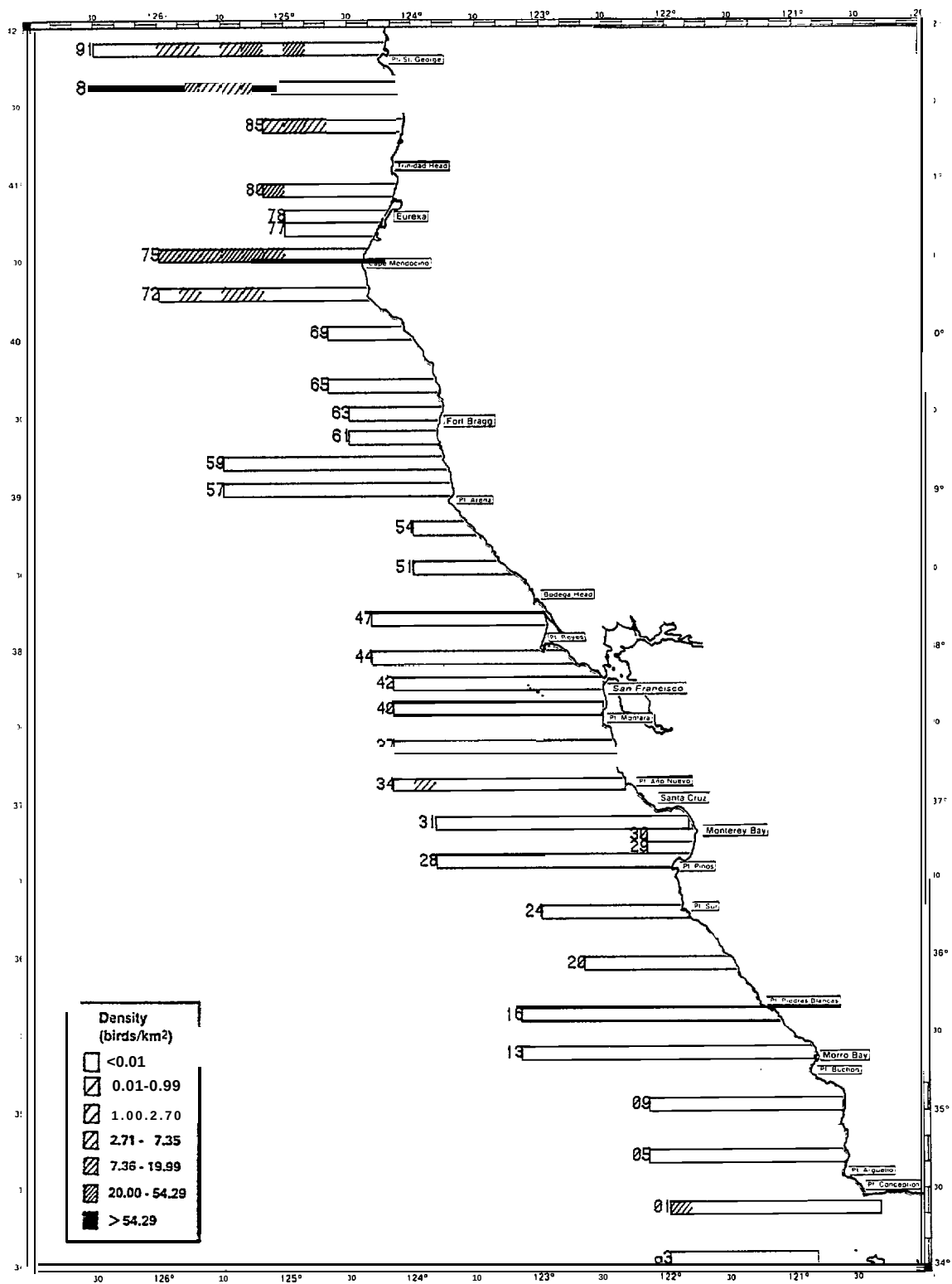


Figure 27. Density of Leach's Storm-Petrel in waters of central and northern California, March 1982.

During the spring, densities were highest at northern latitudes on offshore waters adjacent to breeding colonies (Fig. 27). By midsummer the birds were widely distributed on offshore waters at all latitudes, At this time densities were highest north of Cape Mendocino, but also high south of Monterey Bay (Fig. 28). This abundance of birds away from colony areas during the breeding season suggests that many Leach's Storm-Petrels seen on California waters during the summer are probably non-breeders. Densities declined abruptly after August in the north and after September in the south and quickly reached the low levels that persisted through winter.

This corresponds well with the pattern we observed in the Southern California Bight during 1975-78, Densities there increased in September-October (as the birds presumably departed south out of central and northern California) and the birds increasingly inhabited waters well offshore.

In most cases Leach's Storm-Petrels were more abundant over deep offshore waters than over the continental slope; few were ever seen over the continental shelf, Densities over slope waters were, however, noticeably higher during mid-summer upwelling peaks than at other times, and were significantly lower south of Point Arena than north of there. Leach's Storm-Petrels appear to exploit relatively clear, thermally stratified waters of the California Current, reaching a shoreward distributional limit just outside the thermal fronts marking the outer margins of upwellings. Nearly all winter sightings were of birds seaward of the slope.

Brown Pelican (*Pelecanus occidentalis*), As recently as 1959, Brown Pelicans nested successfully in central California, though probably only during periods of prolonged oceanic warming (Baldrige 1973, Anderson and Gress 1983). Presently, they nest as far north as Santa Barbara Channel and, following the nesting season

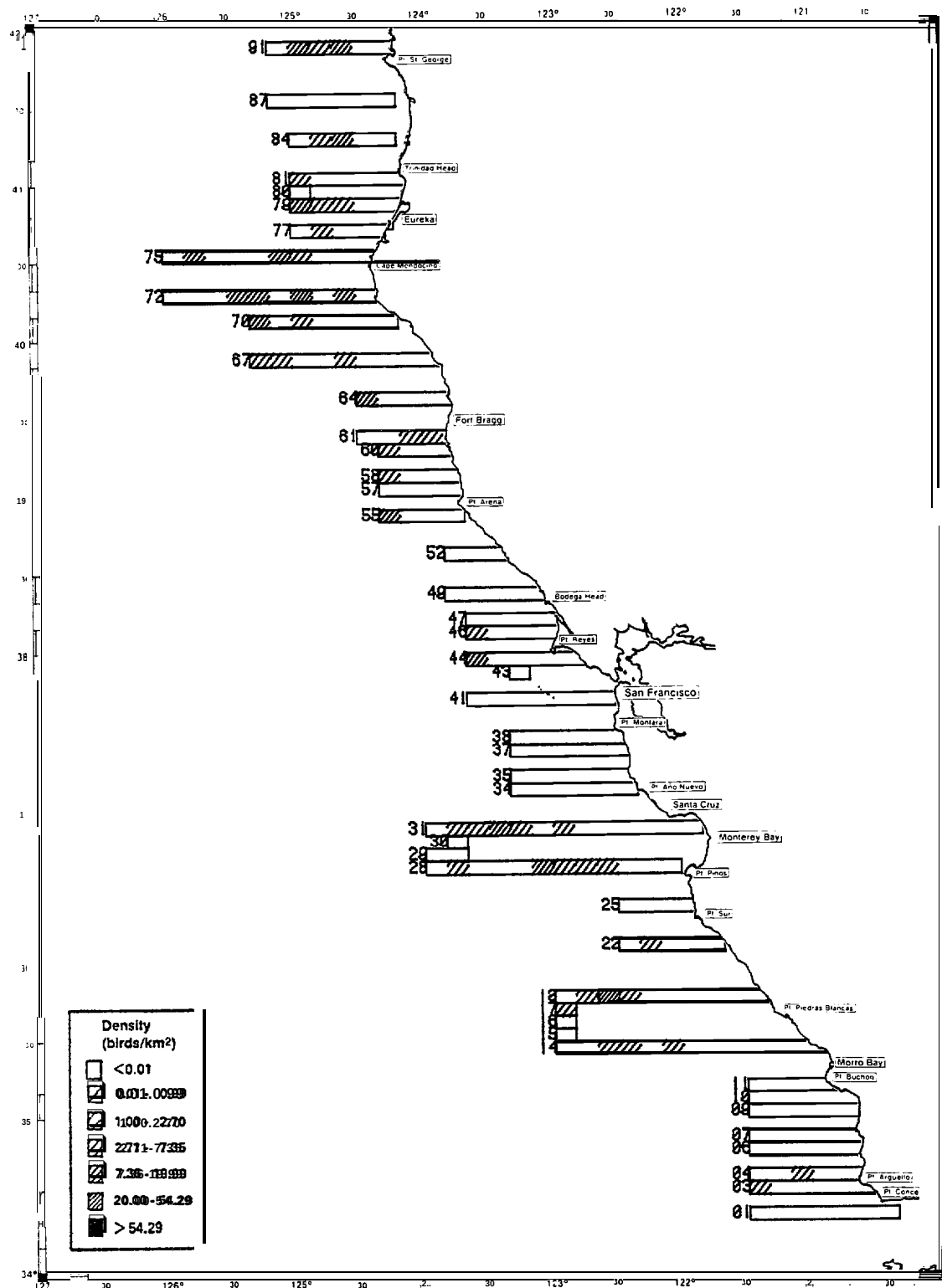


Figure 28. Density of Leach's Storm-Petrel in waters of central and northern California, June 1980.

in southern California and Mexico, they disperse along the coast throughout California and Oregon. Prior to our study the only published information concerning pelican occurrence in central and northern California came from Ainley (1972), Baldridge (1973) and Anderson and Anderson (1976); the first two were limited in geographic scope while the third source contains general information about seasonality, phenology and demography throughout the range. Population size of the Pacific coast subspecies is unknown; Briggs et al. (1981b), Anderson and Gress (1983), and Briggs et al. (1983) discuss regional populations. Pelicans feed upon a wide variety of schooling, epipelagic fish when attending nesting colonies in the Gulf of California, but birds nesting in southern California take about 90% northern anchovy (D.W. Anderson pers. comm., Anderson et al. 1980).

We found that Brown Pelicans occupy the coast from about Point Conception to Bodega throughout the year but are present farther north generally from April through November. They are least numerous in central California from January through April, corresponding to nesting activities at colonies to the south. January coastal surveys in 1980 and 1981 revealed fewer than 50 birds, all south of Point Sur, and about 400 in 1982, with up to 45 birds at roosts as far north as Tomales Bay.

Larger numbers of pelicans appeared on the coast by early May each year, probably comprising very early, successful nesting birds, failed early breeders, and perhaps non-breeders. As during winter, few pelicans were seen offshore, all of these near coastal roosts. The main influx of pelicans to central and northern California occurred during July through September. About 4,700 and 7,700 birds were counted along the coast in July 1980 and 1982, respectively, while almost 15,500 birds were on the coast at that time in 1981 (Fig. 29). Population peaks were attained in September-October each year, with almost 34,000 birds ashore and at sea in 1981 (Fig. 30).

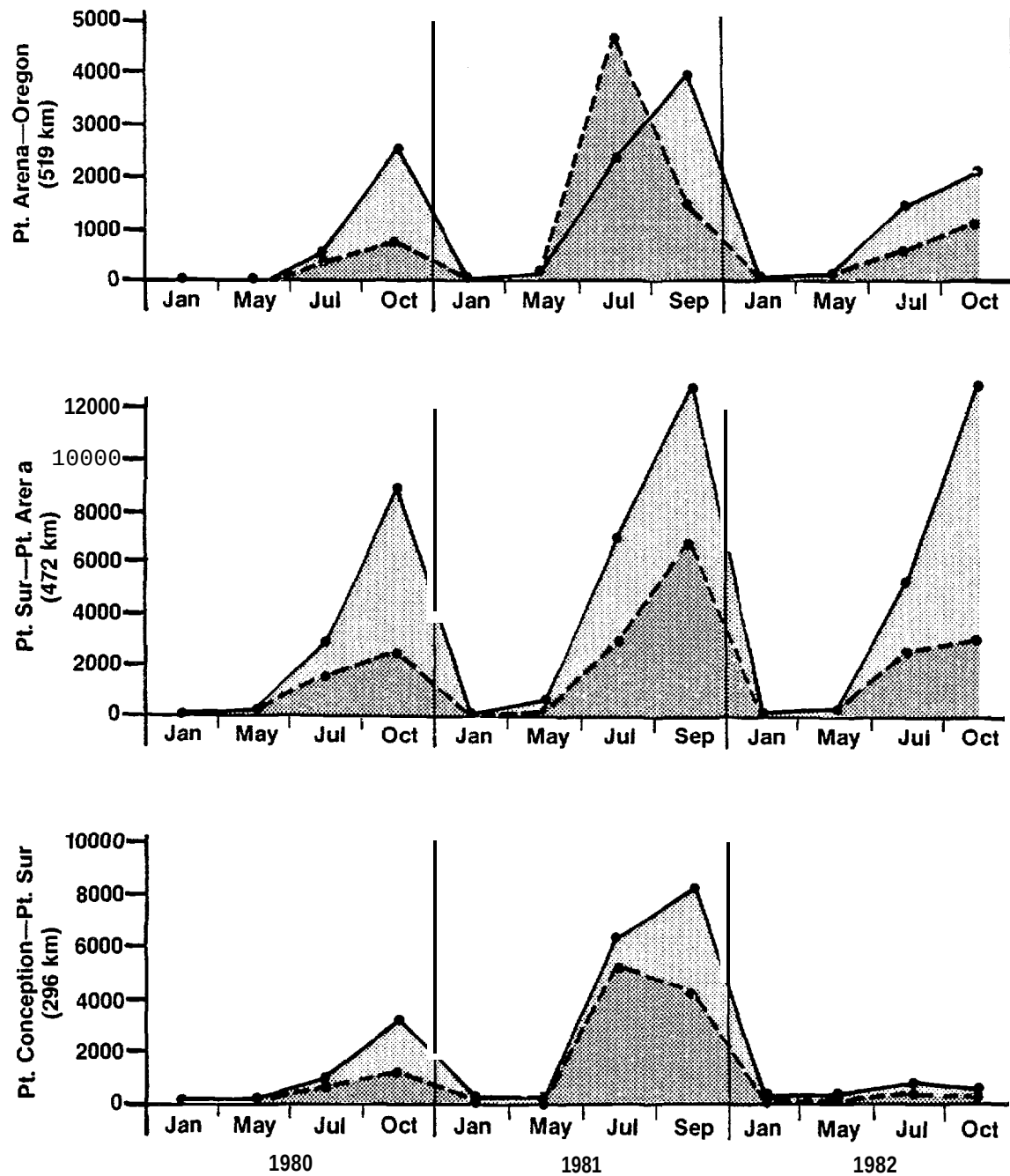


Figure 29. Censuses of Brown Pelicans (solid line) and Heerman's Gulls (dashed line) along the central and northern California coast, 1980-1982. The Heerman's Gull is another Gulf of California nesting species that visits central California after the nesting season. General correspondence between the curves for both species indicates that dispersal to California in large numbers during 1981 was triggered by environmental conditions affecting all seabirds in the Gulf.

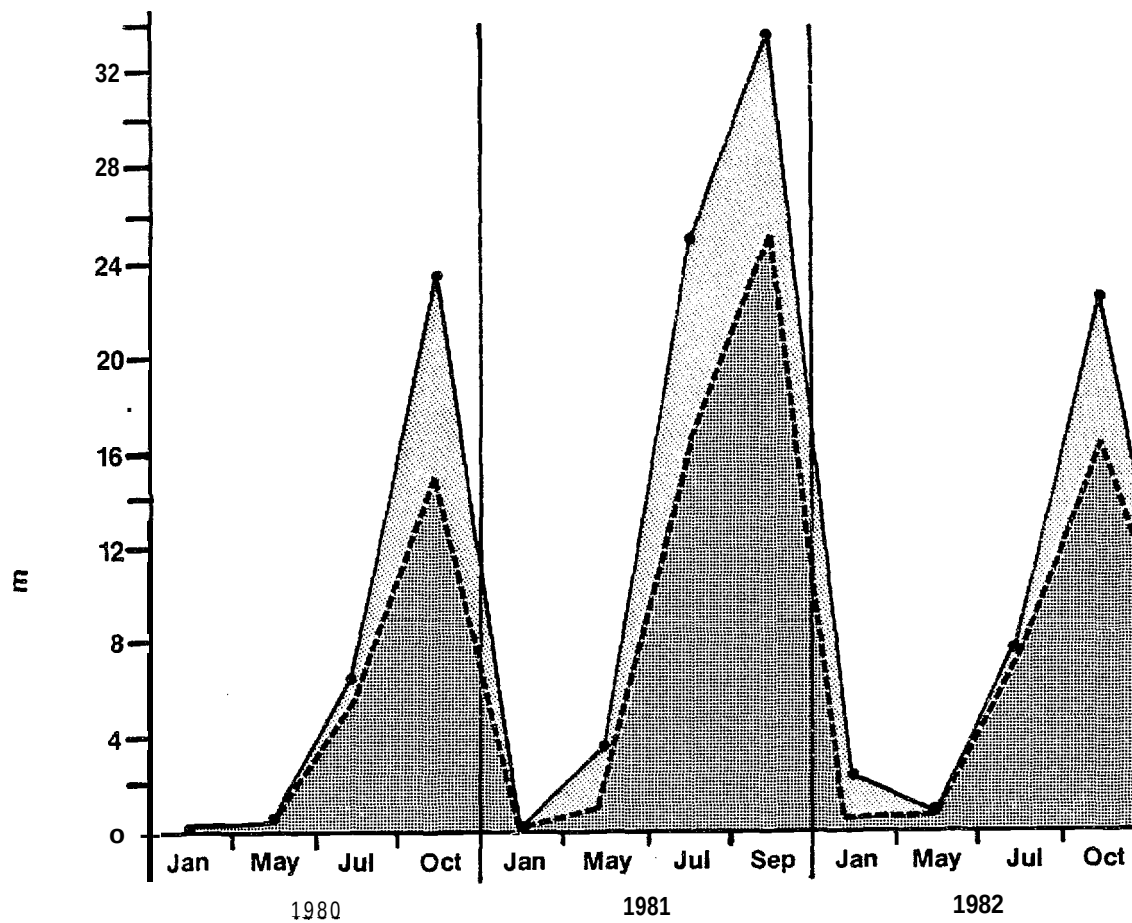


Figure 30. Estimated total population of Brown Pelicans in central and northern California, 1980-1982.

At times of high pelican abundance, coastal roosts in the Point Conception-Morro Bay region and from Moss Landing to Bodega harbored the greatest numbers of birds (Fig. 31). Use of these roosts was quite variable from year to year. Sixteen roosts harbored more than 500 birds on at least one occasion while 27 roosts had more than 100. Yet only nine of these had more than 100 birds during three of our surveys, and only six roosts had more than 100 birds four or more times. The roosts having consistently large numbers of birds, (Table 9), served as sites where pelicans roosted at night. The large nocturnal roosts attracted birds from many kilometers of adjacent shoreline.

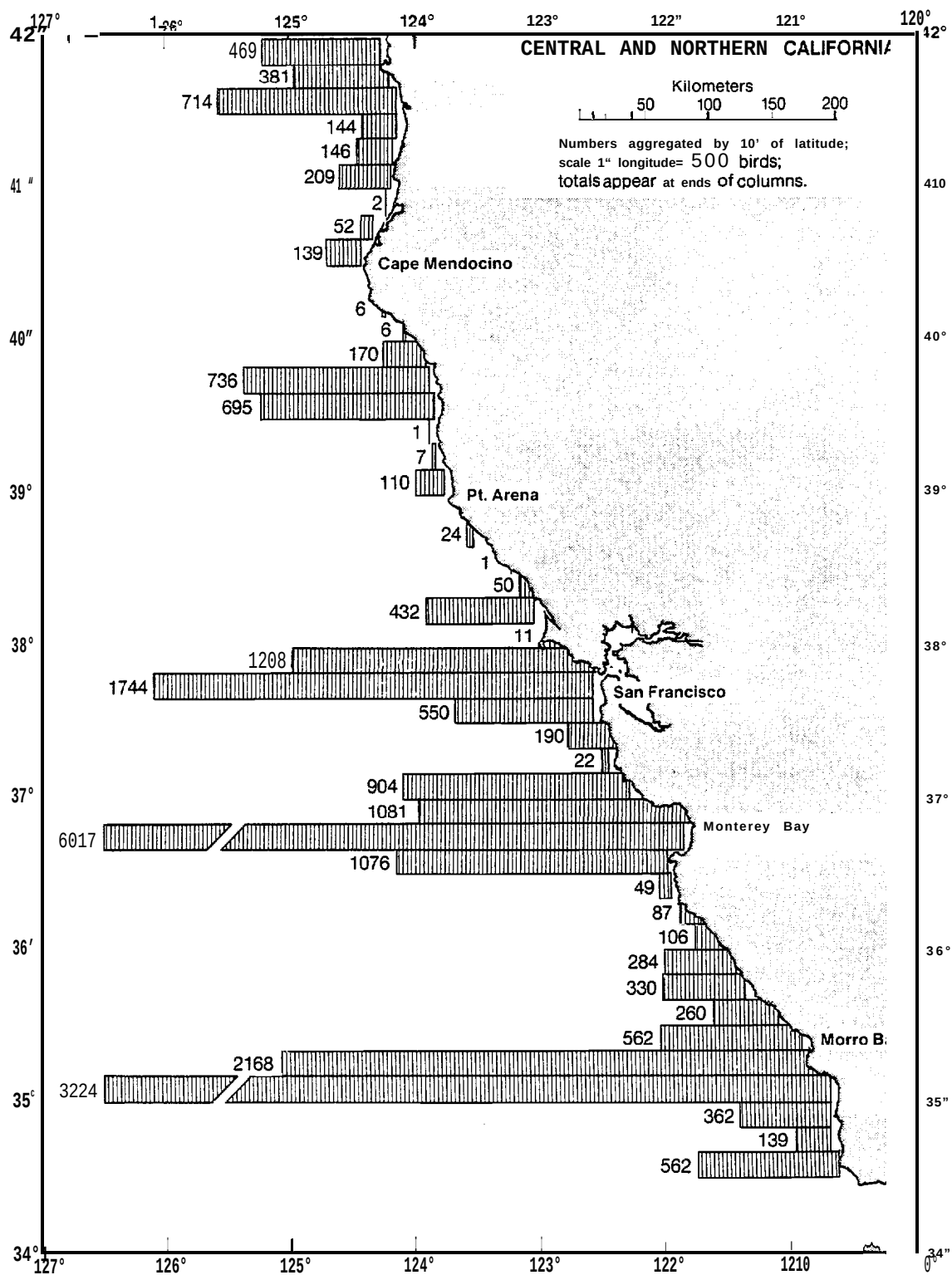


Figure 31. Distribution of Brown Pelicans at coastal roosts, 28-30 September 1981.

Brown Pelican

Table 9. Counts of Brown Pelicans at 27 important roosts in California.

<u>Site</u>	<u>North Latitude</u>	<u>$\bar{X}_j$</u>	<u>$\bar{X}_{s/o}$</u>	<u>N>100</u>	<u>N>500</u>	<u>Maximum Count (month)</u>
Castle Rock	41°45'	0	207	2	0	314(9/81)
False Klamath Rock	41°35'	1	264	1	1	657(10/80)
Klamath River	41°32'	2	180	2	0	293(9/81)
White Rock*	41°30'	101	124	3	0	396(9/81)
Redding Rock	41°20'	92	24	2	0	155(7/81)
Big Lagoon	41°10'	244	1	1	1	731(7/81)
Flatiron Rock	41°03'	130	46	2	0	221(7/82)
Soldier Frank Point	39°45'	31	150	2	0	304(9/81)
Kibesillah Rock*	39°34'	0	249	1	1	674(9/81)
Arched Rock	38°26'	276	206	5	0	430(7/81)
Bird Rock	38°13'	526	362	3	2	1265(7/82)
Double Point Rocks	37°50'	348	369	5	1	562(7/81)
Bolinas Lagoon	37°55'	485	38	1	1	992(7/81)
Bird Island	37°49'	533	145	4	1	1026(7/81)
southeast Farallon Island	37°41'	105	2856	3	3	3967(10/82)
Point San Pedro	37°35'	118	311	3	1	533(10/82)
Año Nuevo Island	37°06'	201	1148	4	1	2328(10/82)
Elkhorn Slough	36°48'	142	2555	3	3	5288(9/81)
Salinas River*	36°44'	124	25	1	0	200(7/81)
Bird Island	36°30'	68	797	2	2	1538(10/82)
Islay Creek*	35°16'	3	301	1	1	855(9/81)

Table 9. (continued)

<u>Site</u>	<u>North Latitude</u>	$\bar{X}_j$	$\bar{X}_{s/o}$	<u>N>100</u>	<u>N>500</u>	<u>Maximum Count (month)</u>
Lion Rock*	35°13'	150	358	4	1	743(10/80)
Pecho Rock	35°10'	140	13	1	0	370(7/80)
Point San Luis	35°09'	209	149	4	0	328(9/81)
Shell Beach Rocks	35°09'	631	575	2	2	1683(7/81)
North Pismo Beach	35°07'	167	133	1	1	500(7/81)
South Point Sal Rocks	34°53'	94	59	2	0	170(1/82)

* Includes adjacent mainland.

$\bar{X}_j$ Average for three July surveys.

$\bar{X}_{s/o}$ Average for three September and October surveys.

N>100 Number of surveys with greater than 100 birds (12 total surveys).

N>500 Number of surveys with greater than 500 birds (12 total surveys).

Age ratios on coastal roosts and at sea were heavily skewed towards adults: the average coastal count had 2.4 adults per immature, with many birds of undeterminable age. The overall ratio of adults seen along the coast was substantially higher than that reported for southern California (Briggs et al. 1981b).

Pelicans occurred at sea throughout the study area; not surprisingly, their relative numbers and latitudinal distribution paralleled patterns of occupancy ashore. The curve of monthly mean densities (>2 km from shore) is bimodal each year (Fig. 32). The peaks probably represent the period of maximum numbers of dispersing birds (July-September) and return migration to the south (December). Though few birds occurred more than a few km offshore in December,

Brown Pelican

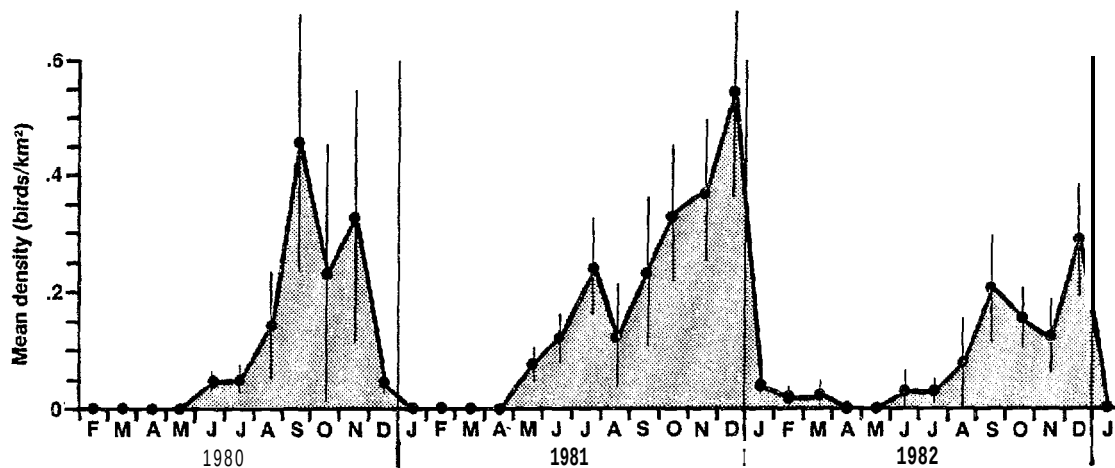


Figure 32. Mean pelican density at sea in central and northern California, 1980-1983. Birds seen within 2 km of the coastline are excluded and are tallied with coastal populations.

they ranged as far out as 88 km off Monterey Bay during the earlier population peak. Sightings offshore were heavily concentrated within 20 km of shore in all seasons (451 of 587 pelicans [76.8%] seen offshore were within 16 km of the coast) and in waters of ≤ 150 m depth. Those pelicans that foraged as far out as the continental slope were concentrated primarily west of Bodega to Monterey and Point Piedras Blancas to Point Conception. Briggs et al. (1983) have found that Brown Pelicans off central California typically frequent waters having moderate or high gradients in surface temperature. Foraging seaward to about the middle of the continental slope, pelicans often associated with the outer margins of upwellings, apparently seeking schooling fish drawn there to concentrations of their own prey.

Brandt's Cormorant (*Phalacrocorax pennicillatus*). Ranking as the third most abundant of California's nesting seabirds, Brandt's Cormorants are one of the most familiar birds to coastal birdwatchers. The world population, which numbers perhaps 85,000 breeders, is centered on the Farallones (Varoujean and Pitman 1980; Sowls

Brandt's Cormorant

et al. 1980; K.T. Briggs unpubl. notes from Mexico). In central and northern California, there are at least thirteen colonies with more than 1,000 individuals (Sowls et al. 1980). Occupying primarily flat or sloping nesting grounds, Brandt's Cormorants appear to shift colony sites between adjacent islets and ledges in an unpredictable fashion (Hunt et al. 1981).

Though formerly considered to be resident throughout their southern Alaska to central Baja California nesting range (Palmer 1962), it now appears that Brandt's Cormorants concentrate in winter from southern British Columbia through Washington, and in California, south of Cape Vizcaino. Varoujean and Pitman (1980), and DeGange and Sowls (1981) have noted the absence of large numbers of Brandt's Cormorants from southern Oregon and northern California at this time; in the latter area Double-crested Cormorants (*P. auritus*) replace Brandt's as the predominant large cormorant.

use of coastal and offshore roosts by Brandt's Cormorants appears to be variable: DeGange and Sowls (1981) have shown that a relatively small number of sites serve as nocturnal roosts, attracting hundreds of birds from contiguous coastline, while a large number of sites serve as diurnal roosts where cormorants rest, preen, and dry their wettable feathers. Some colony sites serve as roosts in fall and winter while others, like the Farallon Islands, support relatively few birds for 3-6 months after the conclusion of the nesting season. Brandt's Cormorants frequently roost on sandy beaches in the non-breeding seasons, an activity seldom seen when the birds are nesting. Use of sheltered inlets and brackish bay waters, such as near San Francisco, increases greatly during fall and winter (DeGange and Sowls 1981) 0

Usually found within a few kilometers of land, Brandt's Cormorants may dive to relatively great depths, They are recorded as retrieving algae for nests from the seabed in 150 feet (46 m) of water

(Bent 1922) and they have been recovered from nets set as deep as 30 fathoms (55 m) (Palmer 1962). They frequently occurred over deep waters (>1000 m) east of San Clemente Island during our studies in 1975-78, but we did not ascertain whether cormorants fished in the upper water column there or merely passed over the area on route to the mainland (Briggs et al. 1981a). The diet of this species comprises fish and squid taken both from above the bottom and from mid- or top-water shoals (Palmer 1962; Baltz and Morejohn 1977; Ainley et al. 1981). Among the most important prey are anchovies, small rockfish (*Sebastes*), market squid (in Monterey Bay), and a variety of demersal fish. The overlap in diet between Brandt's and Pelagic (*P. pelagicus*) Cormorants is pronounced, while that between the Double-crested and the other species is relatively slight (Baltz and Morejohn 1977; Ainley et al. 1981).

To a large extent, it is not possible to distinguish among the cormorant species during aerial surveys. There is, however, some basis for assigning sightings to one or another species. In California the nesting population of the Brandt's exceeds that of the Pelagic by about 4:1, and Double-crested's are relatively rare on the coast (DeGange and SOWLS 1981). In autumn and winter, Brandt's are scarce north of Cape Vizcaino and abundant to the south. In late winter, when Brandt's might be expected to reoccupy northern California colonies, Pelagic Cormorants begin to show distinctive white rump patches and Double-crested's begin to depart the coast for interior nesting sites. On the basis of this information, during March through October, we assigned 80% of all 'unidentified' cormorants seen along the coast to Brandt's throughout central and northern California, while in the remainder of the year, no 'unidentified' were assigned to Brandt's north of Cape Vizcaino, and 90% of 'unidentifieds' were considered Brandt's south of there. At all times, the great majority of unidentified cormorants recorded at

Brandt's Cormorant

sea were south of Cape Vizcaino and few birds were of small size (probably Pelagic). Accordingly, all unidentified cormorants at sea were referred to Brandt's.

During 1980-83, we found large numbers of Brandt's Cormorants along the coast in all seasons; on each of twelve surveys more than 200 individual sites harbored 25 or more birds. Peak coastal counts occurred in nesting season: total numbers varied from about 62,000 in 1980 to 38,000 in 1982 (Table 10). Coastal counts were lowest in winter each year, probably indicating some movement southward, into the Southern California Bight (Briggs et al. 1981a) and perhaps into San Francisco Bay, where we did not survey. Brandt's Cormorants concentrated along the coast from Bodega to Point Lobos throughout the year, with counts as high as 28,000 on the Farallon Islands in early July. The anticipated shift of cormorants away from northern California occurred in fall and winter each year, notwithstanding our procedures for assigning of unidentified birds to the various species (Table 10). Counts of Brandt's and unidentified Cormorants at each of 42 important coastal and offshore roosts are presented in Table 11.

In May through November each year, Brandt's Cormorants were common along the entire coast within 20 km of the shoreline; more than 90% of the sightings occurred within 15 km of a colony or roost having more than 100 birds. In late fall through winter, we saw Brandt's Cormorants more than 10 km offshore only infrequently and then primarily from Bodega to Point Sur and south of Morro Bay. The curve of monthly mean density (Fig. 33) shows wide variations between months with a general tendency to peak in late summer through autumn.

By adding the total coastal counts to corresponding extrapolations of density at sea, we estimate that the total Brandt's Cormorant population in central and northern California is approximately 65,000 to 100,000 in mid- to late-summer and may fall as

Table 10. Counts of cormorants on land by degree of latitude during twelve coastal censuses, 1980-1982. Nesting totals (Individuals) are from SOWLS et al. (1980) for the years 1979 and 1980.

Latitude	Nesting Totals		Aerial Counts:				May 1980		July 1980		Oct 1980	
	Brandt's	Pelagic	Jan 1980		Brandt's Pelagic		Brandt's Pelagic		Brandt's Pelagic		Brandt's Pelagic	
			Brandt's	Unit	Brandt's	Unit	Brandt's	Unit	Brandt's	Unit	Brandt's	Unit
41°-42°	5,300	1,900	0	1,293	10	2,653	0	6,079	0	0	0	1,990
40°-41°	1,300	800	0	421	16	57	0	1,531	0	0	0	0
39°-40°	5,800	3,800	50	1,083	375	80	1	6,251	0	0	0	2,346
38°-39°	3,900	3,700	99	2,721	380	90	25	4,803	2	0	0	2,91
37°-38	31,500	3,800	2	3,652	53	113	0	24,168	0	0	0	2,060
36°-37°	7,800	800	88	2,254			0	6,199	9	0	0	2,740
35°-36°	2,600	600	31	3,134	11	24	0	4,221	56	0	0	3,080
34°-35°	5,300		16	1,134		0	1	651	0	0	0	1,422
TOTALS	64	15	286	15,698	859	373	6	53,903	67	0	0	16,729

Table 10. Continued

Counts of cormorants on land by degree of latitude during twelve coastal censuses, **1980-1982**.
Nesting totals (individuals) are from *Sowls et al. (1980)* for the years **1979** and **1980**.

Aerial Counts:

Latitude	Jan 1981			May 1981			July 1981			Sept 1981		
	Brandt's	Pelagic	Unid	Brandt's	Pelagic	Unid	Brandt's	Pelagic	Unid	Brandt's	Pelagic	Unid
41°-42°	0	2	292	824	89	5,516	39	100	8,489	15	0	3,012
40°-41°	1	1	278	50	47	1,787	8	13	2,687	2	0	1,242
39°-40°	6	5	528	18	149	2,098	26	22	5,172	4	5	3,201
38°-39°	15	35	1,705	43	123	1,967	83	134	4,777	15	0	2,687
37°-38°	13	6	5,179	1	16	3,936	0	310	18,317	6	3	4,337
36°-37°	8	21	1,375	3	14	6,122	1	35	9,881	1	0	8,214
35°-36°	48	6	4,333	0	20	3,487	450	4	6,616	55	0	10,316
34°-35°	1	0	985	0	0	62	11	0	1,460	3	1	751
TOTALS	92	76	14,675	939	458	24,975	618	618	57,399	101	9	33,760

Latitude	Jan 1982			May 1982			July 1982			Oct 1982		
	Brandt's	Pelagic	Unid	Brandt's	Pelagic	Unid	Brandt's	Pelagic	Unid	Brandt's	Pelagic	Unid
41°-42°	19	0	222	682	43	2,404	49	8	5,479	0	0	1,785
40°-41°	0	0	87	94	71	189	5	0	2,702	1	0	1,729
39°-40°	0	0	442	608	64	817	125	22	5,856	0	1	1,884
38°-39°	50	0	1,240	1,019	55	775	0	0	5,100	0	0	2,727
37°-38°	0	0	2,549	3,137	78	630	347	36	17,050	3	0	3,617
36°-37°	0	0	761	2,281	4	1,313	246	8	4,278	0	0	3,497
35°-36°	0	0	918	1,424	23	1,655	51	63	3,896	0	0	1,814
34°-35°	0	0	133	0	0	284	49	2	1,268	1	0	1,161
TOTALS	69	0	6,352	9,245	338	8,067	872	139	45,629	5	1	18,214

Brandt's Cormorant

Table 11. Counts of Brandt's plus unidentified Cormorants at colonies and roosts in central and northern California, 1980-1982. Colony totals are from SOWLS et al. (1980) for the years 1979 and 1980. Dash indicates fewer than 50 birds.

Location	Colony Totals			Jan 1980	May 1980	July 1980	Oct 1980	Jan 1981	May 1981	July 1981	Sept 1981	Jan 1982	May 1982	July 1982	Oct 1982
	Brandt's	Double- crested	Pelagic												
Hunter Rock	680	0	122			620			404	420	0	0	147	218	66
Prince Is.	0	450	146			446			395	305			217	271	
St. George Reef	0	0	0	231	372	-	253	0	404	720	37	27	139	142	437
Castle Rock	2,200	0	340	550	885	3,267			2,122	1,500	225	71	691	1,978	63
Klamath Rock & False Klamath Rock	356	84	110		129	438			328	392	148		265	472	
White Rock	240	60	12		176	417			742	580	132		155		
Green Rock	216		48			363			47	226					71
Flatiron Rock	1,540		4		244	1,551			770	1,221	204		500	724	
Eel River	0	0	0			300			174	122	616			207	483
False Cape	400	0	170		474	500			245	779				778	296
Steamboat Rock	494	0	0		170	388			237	234				416	
Cape Vizcaino	3,080	0	120	141	892	3,825			499	2,308	208		299	2,139	
Bruhel Pt. / Kibesillah Rk.	350	0	92			1,567			597	510				1,221	
Goat Is.	1,240	0	134		800	1,607				510			335	1,221	
Caskett Rock	330	0	0		245	395				334				429	
Gualala, Fish Rock	1,640	0	400		518	1,505				250	581		291	1,081	84
Gull Rock	650	0	16			613	226							77	
Arched Rock	0	0	0		349	-				251	426		205	704	
Bodega, Bird Rk, & Tomales Pt.	1,350	0	134	573	1,063	1,647	343	269	618	2,067	1,040	865	664	1,490	751
Pt. Reyes	2,400	0	808		5,000	1,136			593	2,143		50	145	1,601	
Double Pt.	258		16	272	191	530			148	248			65	603	58

Brandt's Cormorant

Table 11. Continued.

Location	Colony Totals			Jan 1980	May 1980	July 1980	Oct 1980	Jan 1981	May 1981	July 1981	Sept 1981	Jan 1982	May 1982	July 1982	Oct 1982
	Brandt's	Double- crested	Pelagic												
Bird Is., Pt. Bonita	0	0	60	223	3,998	651	300	719	633	54		118	41	60	
Seal Rocks				635	-	566		2,150	382	737	255	62	184	245	
North Farallones								202	150	305	318	82	22	336	73
South Farallon Is.	28,000	180	2,000		505	13,688	131			7,971	230		1,822	8,690	1,174
- Sugarloaf					532	622				159	224			50	395
- Maintop					4,831	13,908			800	5,052			939	4,100	120
Año Nuevo Is. & Point	0	0	220	509	172	609		158		69	539	88		160	254
Davenport	236	0	50		170	302	150		163	226		71	118	170	130
Pt. Santa Cruz to Soquel Pt.	0	0	28			306	334				1,279	60	249	208	569
Bird Rock (Cypress Pt.)	1,340	0	0	124	1,618	1,755	475		950	2,500	272	82	834	1,238	154
Carmel Bay	200	0	22	234				113	300	140	350	65	84		138
Bird Is. (Pt. Lobos)	4,200	0	16		2,431	3,038	150		2,582	3,137	328		960	1,455	
Pt. Sur & Big Sur Rock	0	0	54	112	281	-	229			138			158	195	139
Lopez Rock	0	0	0				194			402	141		275	92	89
Cape San Martin	680	0	26	104	503	939			605	1,219	130	50	235	127	51
Pt. Piedras Blancas	1,200	0	0			1,013	474	608	1,956	1,281	345	98	784	378	110
Lion Rock	0	0	0		1,057	350		451	-	99	135				
Pecho Rock	148	0	0	175	205	394	508			212	121	84	115	158	814
Shell Beach	0	0	4							1,445	2,879		384	642	
Pt. Sal	0	0	0		150	-	459	482	-	1,073	556		51	766	915
Pt. Conception	0	0	6		116	-		310	-	-			195	240	51

Brandt's Cormorant

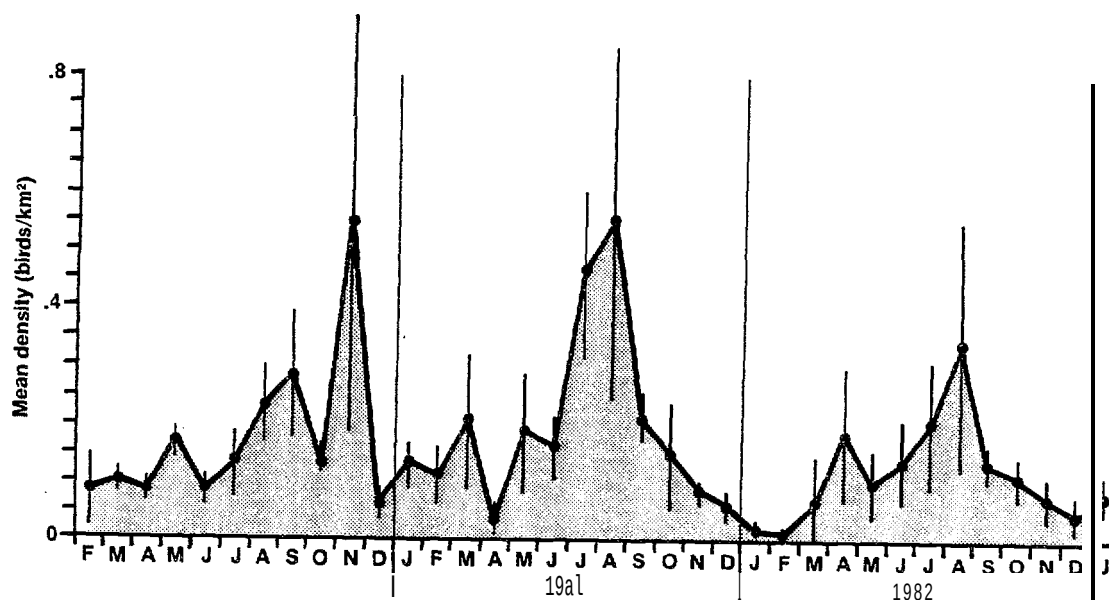


Figure 33. Monthly mean density index for Brandt's and unidentified Cormorants in waters of central and northern California, 1980-1983.

low as 15,000 to 30,000 in winter. Compared to data gathered in 1975-78, the present study shows that peak populations are about five times larger in central and northern California than in southern California, and are attained in the nesting season, not in autumn. We surmise that half or more of the central and northern California population moves northward into Oregon, Washington or British Columbia, or southward into southern California, after the conclusion of nesting activities.

White-winged Scoter (*Melanitta fusca*).

Surf Scoter (*M. perspicillata*). The most abundant of the waterfowl (*Anseriformes*) in Pacific coastal waters during migration and winter are the scoters. Though at times indistinguishable by aerial observers, it appears that the Surf Scoter outnumbers the White-winged scoter throughout California at all times. The same holds true as far north as British Columbia, but in Alaska, the White-winged ranks as the more numerous (Phillips 1926, Johnsgard

White-winged & Surf Scoters

1975, Wahl et al. 1981, Vermeer 1981a, Gould et al. 1982). The North American population of the Surf scoter, estimated to be at least 257,000 by Bellrose (1976), may only be one-quarter the size of that of the White-winged. However, Vermeer (1981a) estimates that 650,000 Surf Scoters occurred in British Columbian waters alone in March 1978. In contrast to the ~~circum-Arctic~~ (and sub-Arctic) nesting range of the White-winged, all nesting by Surf Scoters is confined to Alaska and Canada.

Both species winter primarily on open-ocean waters and shallow coastal bays, on the Pacific coast from Baja California to the Aleutians. They are reported as frequenting waters 15 to 20 km offshore when migrating, but they winter primarily within 1 or 2 km of shore. They dive for benthic prey (primarily mollusks) just outside the surfzone during daylight hours and may 'raft' together a bit farther offshore at night. Exceptional concentrations of scoters have been noted in March in British Columbia, and in April and May in Puget Sound, where they feed on the eggs of herring (Vermeer 1981a, Wahl et al. 1981).

After the conclusion of nesting in Alaska, many scoters migrate to California, reaching the Southern California Bight mainly in November and December (Briggs et al. 1981a). The Surf Scoter was quite abundant throughout mainland and island coastal waters of the SCB during 1975-78, while the much less abundant White-winged was mostly confined to the cool waters of Santa Barbara Channel and the northern Channel Islands.

During the present study, we encountered scoters in every month, recording maximum numbers on October and January coastal surveys, and October through December or January offshore surveys (Table 12, Fig. 34). Scoters were found only very infrequently more than 3 km from the coast; hence, the great majority of birds seen on east-west transects would also have been seen during longshore counts. Because

Table 12. Counts of scoters by degree of latitude during 12 coastal censuses. Surf scoter is abbreviated by S; White-winged by WW, and Unidentified by UI.

Latitude	Jan 1980			May 1980			July 1980			Oct 1980		
	S	WW	UI	S	WW	UI	S	WW	UI	S	WW	UI
41"-42"	329	15	3,755	16	6	840	1	72	2,071	323	356	10,496
40°-41°	75	0	268	2	9	52	0	3	33	113	42	3,241
39"-40°	9	3	365	1	0	77	121	0	207	31	17	2,038
38"-39°	333	9	1,135	2	1	716	3	0	393	8	181	1,529
37°-38°	27	42	101	284	9	1,486	5	0	273	94	38	1,472
36°-37°	468	6	216	1	0	74	8	0	86	80	1	1,693
35°-36°	301	2	431	72	0	568	9	0	370	14	1	608
34°-35°	114	30	616	3	0	409	20	0	230	32	1	250
TOTALS	1,656	107	6,887	381	25	4,222	167	75	3,663	695	637	21,327

White-winged & Surf Scoters

Table 12. Continued

Counts of **scoters** by degree of latitude during 12 coastal censuses. Surf **scoter** is abbreviated by S; White-winged by **WW**, and Unidentified by **UI**.

Latitude	Jan 1981			May 1981			July 1981			Sept 1981		
	S	WW	UI	S	WW	UI	S	WW	UI	S	WW	UI
41°-42°	8	4	5,049	178	2	332	554	0	3,456	655	25	4,629
40°-410	0	9	3,006	0	0	341	0	3	148	30	4	387
39"-40"	3	1	478	8	0	872	10	0	295	27	6	1,923
38°-390	10	3	6,288	15	1	1,008	73	30	768	4	4	282
37"-38"	10	5	934	3	5	362	1	0	912	0	3	633
36°-370	489	4	1,338	1	0	3	0	53	112	2	0	0
35"-36°	20	4	278	0	4	54	0	0	630	1	7	29
34"-35°	0	0	15	2	0	117	5	7	206	0	0	56
TOTALS	540	30	17,386	207	12	3,089	643	93	6,527	719	49	7,939
Latitude	Jan 1982			May 1982			July 1982			Ott 1982		
	S	WW	UI	S	WW	UI	S	WW	UI	S	WW	UI
41"-42"	3	1	284	50	4	513	4	81	499	48	16	8,185
40°-410	7	1	211	6	6	119	37	17	69	5	3	1,153
39"-40"	12	0	239	2	7	112	3	1	659	59	13	479
38"-39°	106	1,126	4,963	20	3	1,632	111	35	336	204	0	713
37"-38°	43	5	783	19	11	427	33	8	131	125	9	834
36°-370	52	0	591	17	1	114	13	1	6	167	2	487
35"-36°	89	1	380	0	0	224	20	28	202	122	2	268
34°-350	37	5	222	0	0	141	14	0	119	6	1	25
TOTALS	349	1,139	7,673	114	32	3,282	235	171	2,021	736	46	12,144

White-winged & Surf Scoters

of the sensitivity of 'mean density' figures to the occasional occurrence of **large** flocks near the shoreline and the typical occurrence of scoters in flocks, we consider our density figures to be an index to the population count and rely on coastal surveys to document total numbers. On this basis, we estimate that up to 30,000 **scoters** were found in open-coastal waters of the study area, with the maximum in October 1980 (Table 12). Counts in autumn 1981 and 1982 and in January 1980-83 were no more than about 60% of this figure.

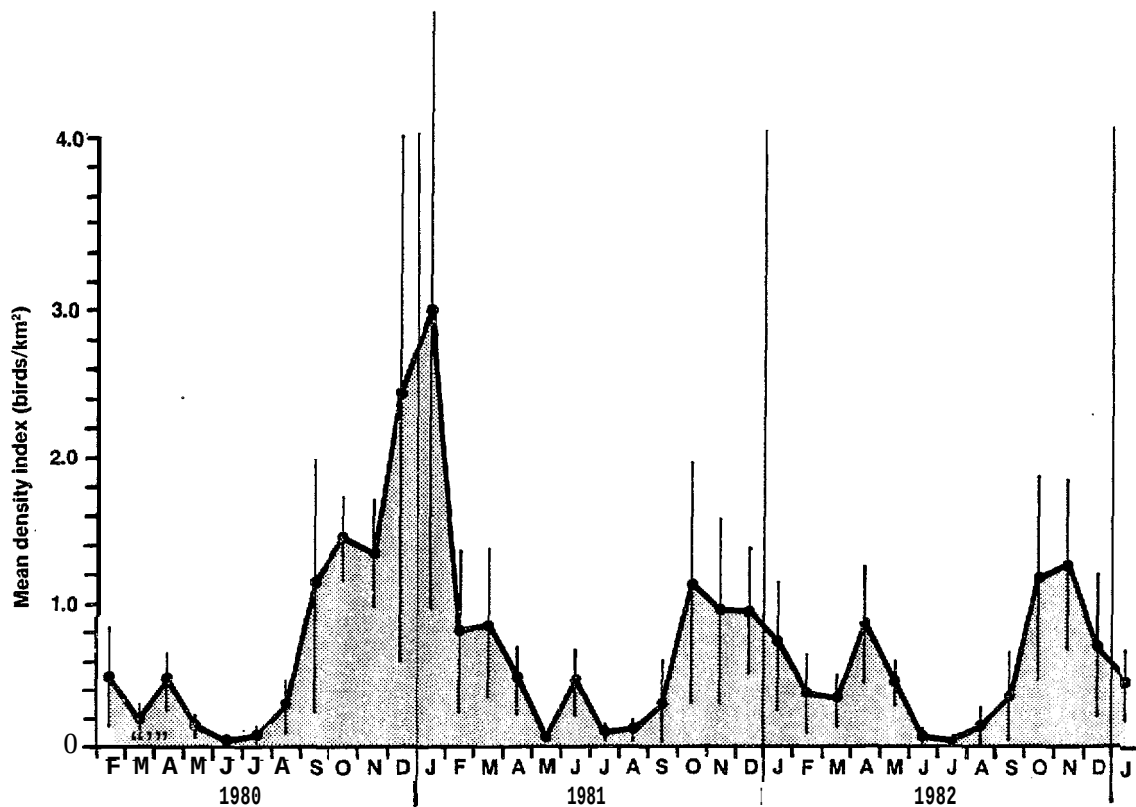


Figure 34. Monthly mean density index for all scoters in waters of central and northern California, 1980-1983: See text for discussion of estimated population size.

Scoters were distinctly most abundant in two areas: from Trinidad to the Oregon border, and in the vicinity of Bodega and Tomales bays. During the high count of October 1980, more than 15,000 scoters were in the northern area, and we found more than 4,000 in the Tomales Bay area on several occasions. The appearance of large numbers of scoters

in the early stages of fall migration always occurred first north of Trinidad. Many thousands of birds massed here in late summer through fall while to the south only the few hundreds of over-summering birds were seen. It may be that water temperature played a role in the further southward dispersal of **scoters**: while thousands inhabited 10-13°C waters in the north, the sparsely-inhabited waters of the central California coast ranged from 14.5°C to more than 16.5°C. By November each year, density indices sprang upward and we found **scoters** to be numerous as far south as **Morro Bay** (Fig. 35).

Numbers of **scoters** seen during January coastal counts ranged from 6,887 in 1980 to 17,386 in 1981 (Table 12); density indices declined rapidly at this time. January and February probably mark the time when only winter residents are present in central and northern California; southbound migrants have passed beyond Point Conception and return migration is still several months off. Wintering **scoters** concentrated wherever sandy substrate occurred, particularly in the lees of major promontories (Fig. 36). In addition to the Del Norte County coast and the **Bodega-Tomales** region, we also found hundreds or thousands of **scoters** from Trinidad to the Eel River, in the northern Gulf of the **Farallones**, in Monterey Bay, and near **Morro Bay**.

The spring migration repeated what we saw in autumn with three notable exceptions: 1) numbers of birds in the far north were an order of magnitude lower; 2) **scoters** occasionally numbered in the thousands in **Tomales Bay** early in the period, perhaps partaking of late herring spawning; and 3) we usually saw many hundreds of **scoters** south of Point Sur in April and May, but not in October. By midsummer **scoters** were more evenly distributed with latitude (Fig. 37) and numbers declined to as few as 3,076 in 1982; 1,000 to 3,000 birds remained through summer from the **Klamath River** to Crescent City.

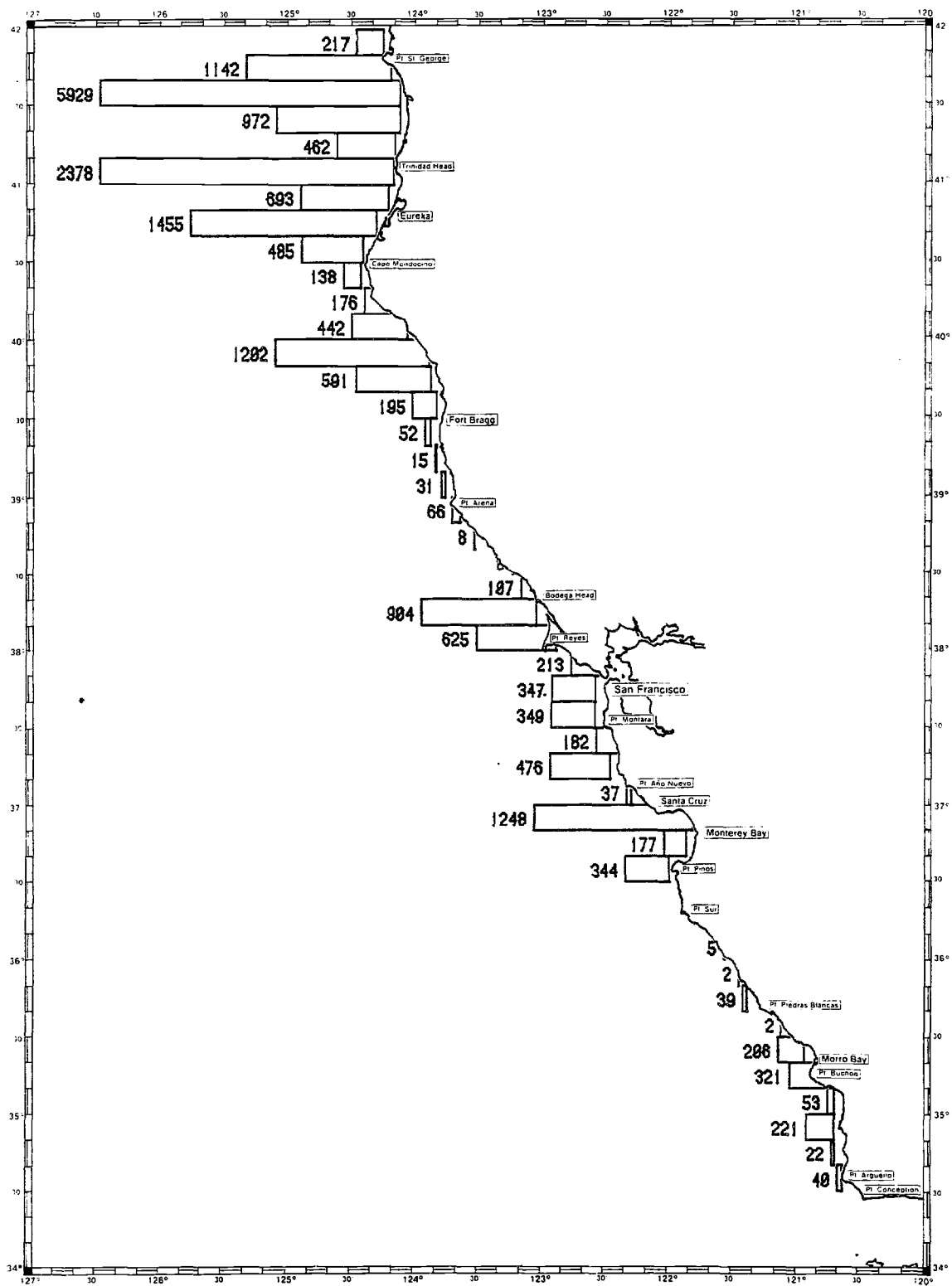


Figure 35. Distribution of all scoters in waters of central and northern California, October 1930.

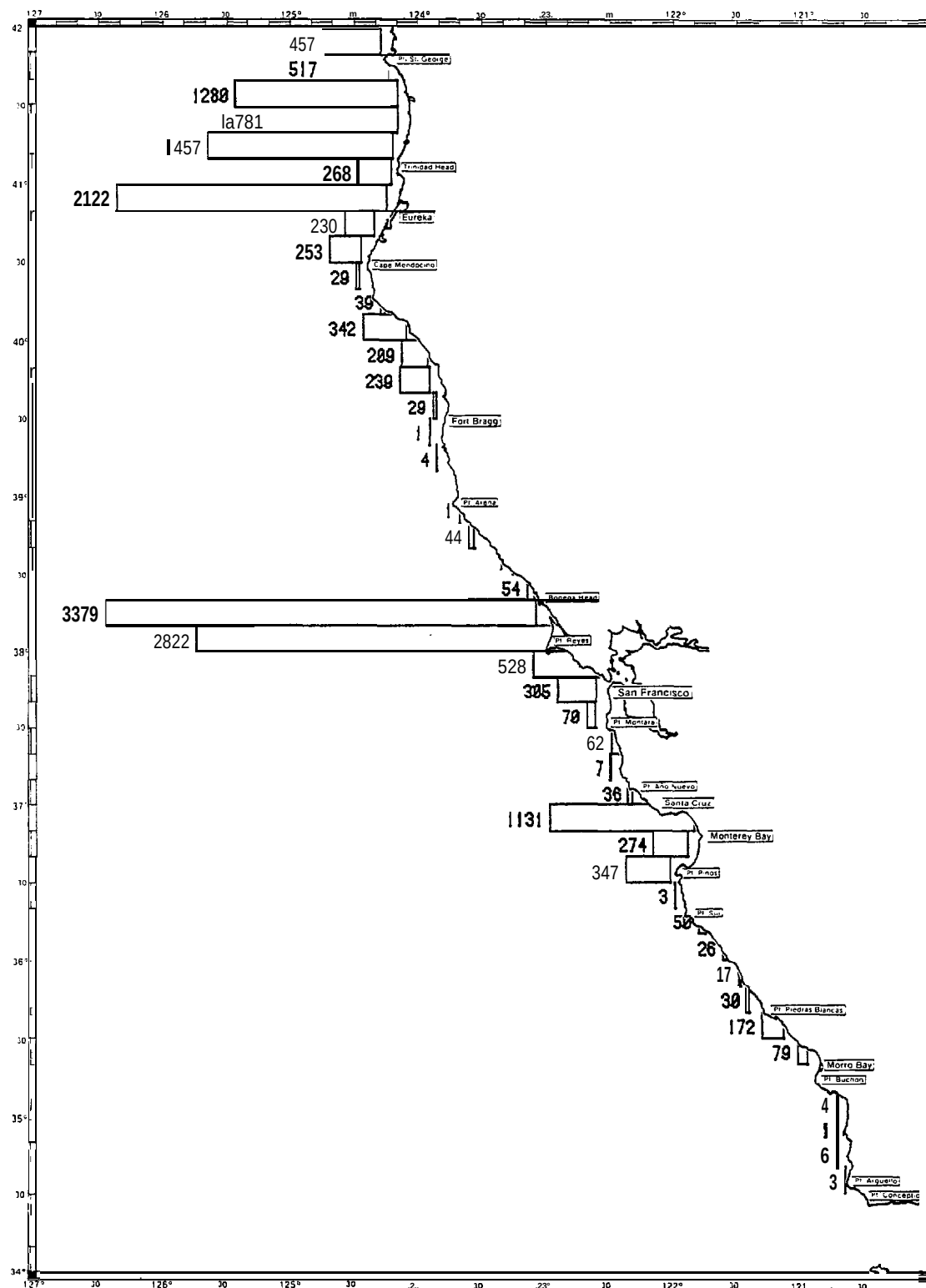


Figure 36. Distribution of allscoters in waters of central and northern California, January 1981.

White-winged & Surf Scoters

In comparison to the data from southern California, (Briggs et al. 1981a), the present information indicates arrival of fall migrants about two months earlier, with apparent great concentration in far northern California. Numbers of **scoters** on open coastal waters reached a maximum **about** three times that recorded in the Southern California Bight (SCB). **we** did not survey San Francisco Bay in the present study and so have no figures with which to compare Jehl's (pers. comm.) estimate of up to 30,000 **scoters** in the San Diego Bay area. White-winged **Scoters** appear to account for a decreasing portion of the **scoter** population with decreasing latitude; only a few hundred birds winter in the SCB, principally in the cool waters bordering Santa **Barbara** Channel.

Red Phalarope (*Phalaropus fulicarius*).

Red-necked Phalarope (*P. lobatus*). **Phalaropes** nest in large but undocumented numbers throughout Arctic North America and migrate through and winter off California. Present in all months of our study, **phalaropes** were the most abundant birds in central and northern California waters during April, **May**, and August-October 1980, October 1981, and April and November 1982. They eclipsed shearwaters in number in mid-spring, and departed northward toward Alaskan nesting areas before shearwater numbers peaked (after mid-May). Return migration was evident in late-July each year and lasted until late fall (Fig. 38). The lowest densities were recorded in February and March, indicating the absence of migrants of either species and winter residency of small numbers of Red **Phalaropes**.

With few exceptions, the two **phalarope** species are indistinguishable by airborne observers. Other workers have noted that the Red-necked **Phalarope** migrates somewhat earlier than the Red (April **vs.** May; July-August **vs.** August-November) and perhaps somewhat closer to shore (Howell 1917, Scott 1974, Wahl 1975, Briggs et al. 1981a), The spring migration of both species appears to be of **short**

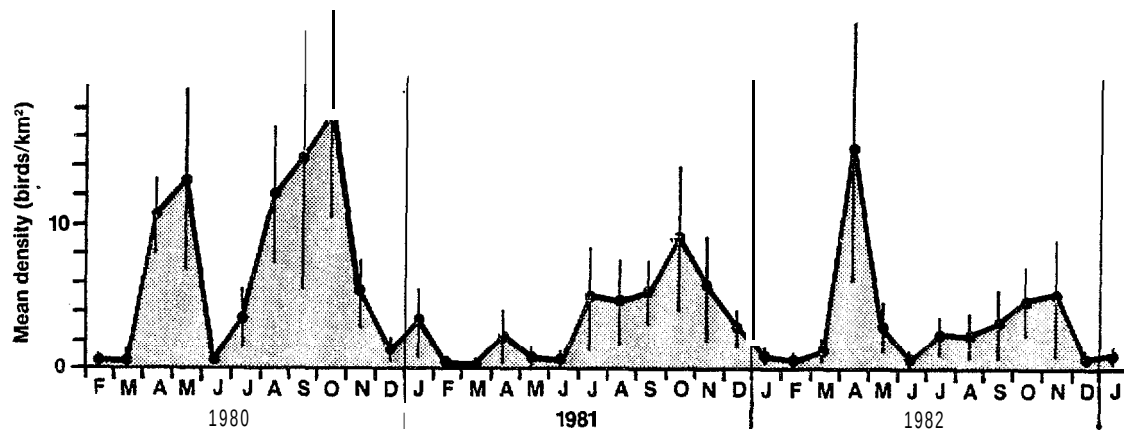


Figure 38. Monthly mean density of phalaropes in waters of central and northern California, 1980-1983.

duration relative to that in fall, perhaps because southbound birds linger longer to feed.

The curve of monthly mean density off central and northern California shows a six-fold difference between years in the *magnitude* of the spring peak and a three-year, 350% decline in peak *fall* densities. The low densities in spring 1981 might have resulted from very rapid passage of the population between our April and May surveys. However, conversations with other ornithologists at the time indicated that **phalaropes** were also scarce off southern California and Oregon, leading to the possibility that substantially fewer birds flew north or they did so either farther west in the California Current, inland, or both. The somewhat **bimodal** curves for July-November 1981 and 1982 suggest early passage of Red-necked **Phalaropes** followed by larger numbers of Reds. Compared to similar data from southern California in 1975-78 (Briggs et al. 1981a), we see that a) the magnitude of spring and fall density peaks is 50%-100% higher in central California, b) migrating **phalaropes** are present in the north by July but not until August in the south, and c) populations wintering in central and northern California out-number those to the south by an order of magnitude.

Red Phalarope & Red-necked Phalarope

While we found phalaropes everywhere in the study area, they were primarily concentrated a) near the coast in spring (where up to several thousand birds flocked as close in as the kelp beds off Santa Cruz to Morro Bay), b) over the outer shelf and slope in spring and fall (Fig. 39), and, c) seaward of the shelf in winter. An intensive field study in September 1931 revealed several additional features of the habitat affinities of phalaropes. Birds occurred primarily as flocks inhabiting slicks embedded within zones of moderate or strong SST gradient ($>0.08^{\circ}\text{C}/\text{km}$). They were not especially numerous where chlorophyll concentrations were high (near the coast) but, on three ship transects off central California, birds concentrated where populations of *Galanus copepods* and of euphausiids were high. Phalaropes primarily fed upon these crustaceans plus eggs of two species of pelagic fish (*Ichichthys lockingtoni* and *Trachipterus altivelus*). Our data support the notion espoused by Brown (1980) that phalaropes require physical features such as convergence to concentrate their minute prey to exploitable levels (Briggs et al. 1984 in press). off California, phalaropes appear to depend on the convergence bordering and within upwellings.

Western Gull (*Larus occidentals*). Aside from a few isolated nesting attempts by Heermann's Gulls (*L. heermanni*) in recent years, the Western Gull is the only gull that nests on the coast of California. It is the state's most ubiquitous nesting seabird, with forty-four colonies of 50 or more birds and more than one-hundred smaller colonies; it ranks fourth in nesting population size with almost 51,000 birds (Sowls et al. 1980). More than 60% of the population nests on the Farallon Islands, the site of many studies of nesting biology, "d-i-et, and other aspects of life history. Sowls et al. (1980) have concluded that the Western Gull population probably is growing in response to the high availability of foods in human fishing ports and garbage dumps. Hunt et al. (1981) and spear (pers. comm.)

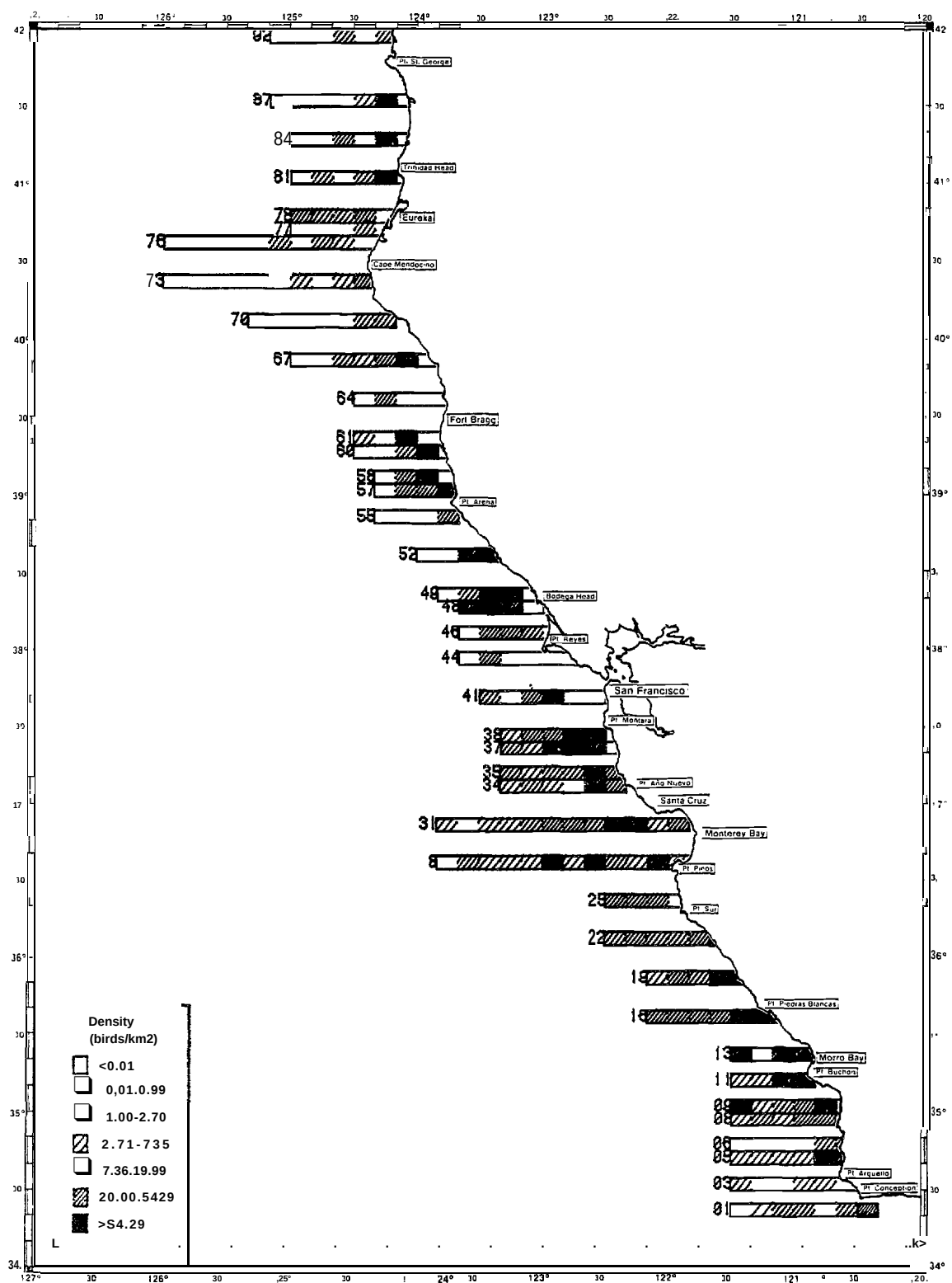


Figure 39. Density of phalaropes in waters of central and northern California, May 1980.

both have found that many, if not most breeding adults subsist largely on garbage in the months prior to nesting. On the colonies, they eat many naturally-occurring foods and prey heavily upon small seabirds including Cassin's Auklets (Manuwal 1974).

Populations of Western Gulls in Oregon have been documented by Varoujean and Pitman (1980); they number about 9,900 individuals. In Washington, where Western's hybridize extensively with Glaucous-winged Gulls (*L. glaucescens*; Hoffman et al. 1978), the size of the population is not well documented, but is probably about 2,000 (Manuwal and Campbell, 1979). The southern periphery of the nesting range is the Pacific coast of Baja California; populations there have not been assessed in detail.

The distribution of Western Gulls at sea in all seasons has received modest attention. Barrington (1975), Wahl (1975) and Briggs et al. (1981a) have found that Westerns primarily remain in neritic waters. They are most restricted to the vicinity of their colonies during the period of hatching of chicks and are most widespread at sea in autumn and early winter. Frequently, Western Gulls occur in mixed-species feeding flocks with murrees, pelicans, shearwaters and other gulls, and they often associate with marine mammals. Their association with pinnipeds extends to land as well; Briggs (1977) found that pinniped carcasses and placentae, and even elephant seal milk are consumed in quantity by Western Gulls in central and southern California.

During 1980-83 we found Western Gull density at sea off central and northern California to be highest in autumn and early winter (averaging about 0.5 to 1.0 birds/km² and lowest in the nesting season (0.25 to 0.6 birds/km²). Very large numbers of gulls went unidentified in all seasons except early summer, so the precise size of the Western Gull population of central and northern California is difficult to determine. It appears that peak densities of this

species were about one-third to one-half lower in autumn 1982 than in the preceding years. It ~~may~~ be that unusually stormy weather caused large a segment of the population to remain ashore. Alternatively, ocean warming associated with the El Niño phenomenon may have driven birds northward, or caused unusually heavy mortality of ~~young-of-the-~~year, or contributed in other ways to the observed reduction in densities.

In all seasons Western Gulls attained highest densities at sea and were most ubiquitous in the three areas of broad shelf: Cape Mendocino to the Oregon border, Bodega to Carmel Bay, and south of Point Piedras Blancas. Their occurrence was most restricted to neritic waters during April through July (April-October south of Point Sur). In late summer through early winter, they occurred seaward to the middle or outer continental slope (75 to 95 km offshore), with largest numbers off Point Montara to Bodega and off Eureka to the Klamath River (Fig. 40), Later in winter, we seldom saw Western Gulls more than 25 km offshore north of Point Arena, probably due to the prevalence of stormy conditions in that region, while we frequently found them 50-60 km at sea off central California. In all seasons, the neritic waters from Bodega to Monterey harbored the highest numbers of birds. Western Gull density was inversely correlated with distance from land and water depth in all seasons, corroborating our impression of their preference for neritic waters.

Along the shoreline, Western Gulls accounted for 50 to 95% of the large gulls identified to species; on occasion almost 90% of all gulls were unidentified (Table 13). We found Western Gulls to be most numerous south of Bodega at all times with about 90% of 29,146 birds counted in July 1980 in the general vicinity of the Gulf of the Farallones (Fig. 41). Spear (1982) has found that Farallon nesting birds constitute about 80% of all large gulls from Monterey to Fort

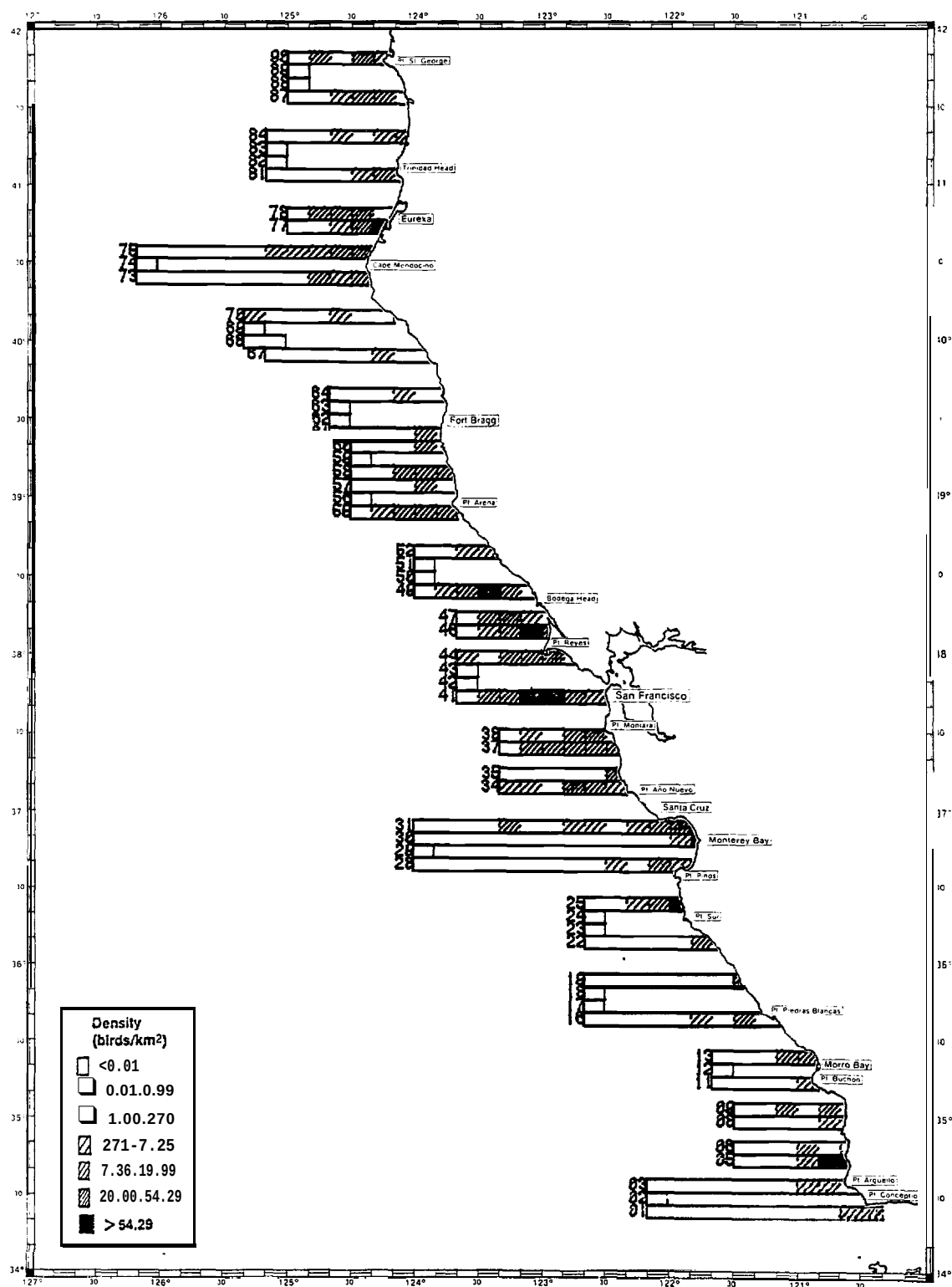


Figure 40. Density of Western Gulls in waters of central and northern California, November 1980.

Table 13. Counts of selected gull species during coastal surveys of central and northern California, 1980-1982.

Date: Species	1980				1981				1982			
	Jan.	May	July	Oct.	Jan.	May	July	Sept.	Jan.	May	July	Oct.
Glaucous-winged	1,439	63	11	260	953	53	17	39	718	124	55	154
Western	14,890	22,274	29,142	2,663	3,655	5,613	13,878	5,991	6,887	9,631	19,772	6,562
Herring	7,153	19	5	583	1,365	1	81	104	324	121	5	318
California	4,594	310	72	3,168	1,146	295	185	4,910	727	146	489	3,807
Bonaparte's	42	871	0	199	3	728	78	4	10	4,574	2	68
Unidentified	32,928	15,284	9,283	28,188	42,407	16,390	23,195	39,779	42,811	15,771	19,082	21,157

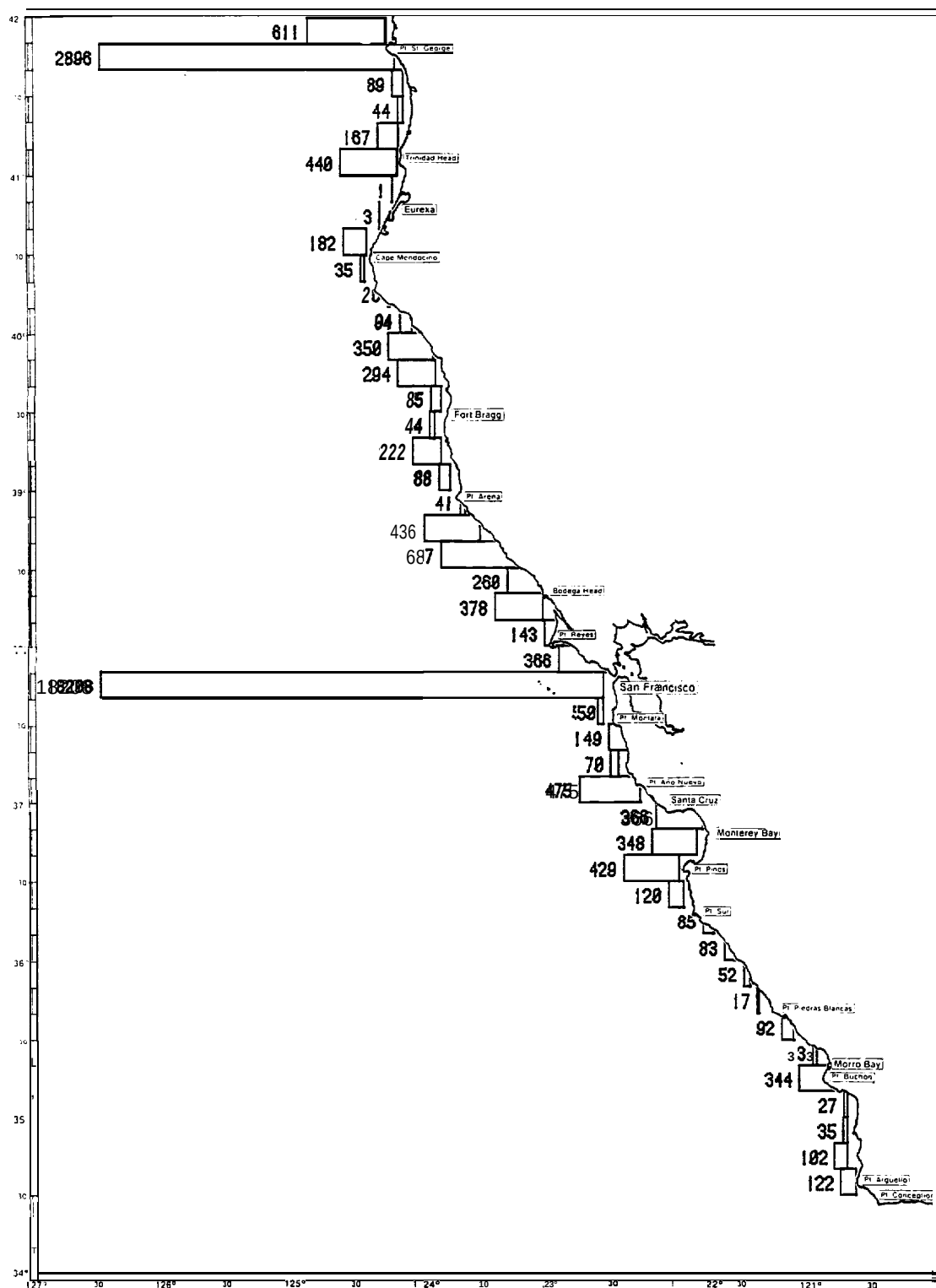


Figure 41. Distribution of Western Gulls on inshore waters and coastal roosts during July 1980. Numbers are aggregated by 10' of latitude.

Bragg during late summer and that most **return** to the **San Francisco area** by late **fall**. Western Gulls occurred almost everywhere along the shoreline during September/October surveys.

California Gull (*Larus californicus*). The California Gull occurs along the Pacific coast throughout the year, but population *numbers* **are** low in May-July when only non-breeders are present. They nest throughout the western states east of the Sierra Nevada, and **small** numbers of these gulls have colonized south San Francisco Bay in the **last few** years. This colonization may have been in response to disturbance by predators due to falling water levels at their previously large and isolated *colonies* at Mono Lake, California. **Total** nesting populations are unknown, but may be *on* the order of 200,000 to 500,000 birds (Conover and Conover 1981; this report). After departing their colonies in the *interior*, California Gulls pass rapidly to the Pacific Coast, where they overwinter; they arrive in September and October. ' **They** are apparently rare in the Gulf of **Alaska** (Gould et al. 1982, Harrison 1982), but are among the most abundant of coastal **gulls** from southern British Columbia to the Gulf of California (Wahl 1975, Barrington 1975, **Briggs** et al. 1981a, Porter and Scaly 1981, unpublished data from Baja California). In southern California numbers increase first at sea, then near **island** and mainland shores; a peak estimated population of 150,000 to 200,000 birds is reached in December and January (**Briggs** et al. 1981a).

As one of 'several large, opportunistic gull species that winter in the study area, California Gulls probably take whatever food is locally abundant, On Monterey Bay their diet *in* winter consists largely of squid and anchovy, overlapping considerably with the diets of Western, Glaucous-winged and Mew Gulls, and Black-legged **Kittiwakes** (Baltz and Morejohn 1977).

Data from central and northern California gathered during the present study complement those of Briggs et al. (1981a) for the Southern California Bight. Substantial numbers of California Gulls appeared on the coast throughout the state by late September, and a rapid upturn in mean density at sea occurred in October (Fig. 42, and Fig. III-56 of Briggs et al. 1981a). In central and northern California we encountered local densities up to 75 birds/km² throughout shelf and slope waters, with a suggestion of concentration in autumn off Eureka and off Point Arena to Monterey (Fig. 43). As the density maximum was reached in November-December, California Gulls were found as far as about 125 km off the central coast, and numbers increased over the shelf south of Point Sur. Compared to southern California, central and northern California hosts about the same number of birds at sea in autumn (200,000 to 300,000 in November 1980-82), but overall densities are lower (fall peaks of 1.35 to 2.50 birds/km² in central and northern California versus about twice that in the south). Because timing of migration appears to be similar throughout California, it is unlikely that the majority of birds migrate southward along the coast to arrive in southern California. Rather, it appears that many birds use overland routes directly to coastal wintering areas, then drift southward into Mexico or take up residence near the shore, in coastal garbage dumps, harbors, etc.

Following the autumn peak in density at sea, California Gull density declined abruptly in winter to about 15 to 40% of the previous maxima (Fig. 42). At this time, we saw some concentration of California Gulls south of Point Reyes and a decline in numbers farther north (Fig. 44), as well as a general withdrawal towards nearshore waters. As pointed out by Barrington (1975) and Briggs et al. (1981a), California Gulls are rarely seen seaward of the shelfbreak during winter (although, except in local concentrations, we have never found them to be an order of magnitude more numerous than all other gulls near the coast, as contended by Barrington). We identified up to 4,600 California Gulls among the 50,000 to 60,000 gulls recorded

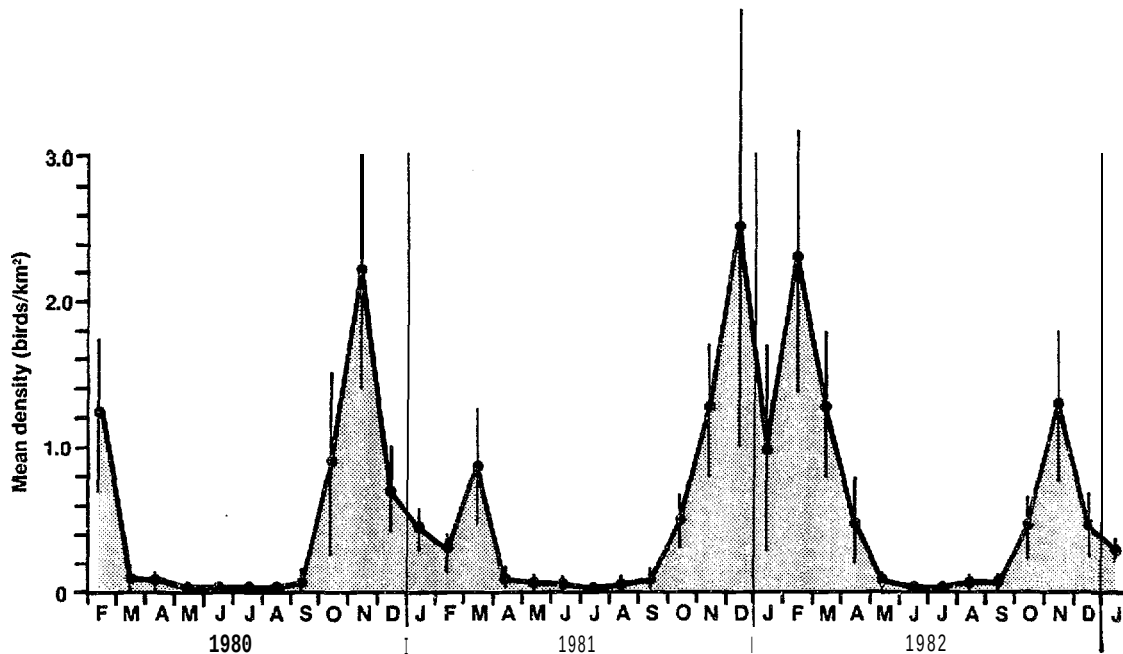


Figure 42. Monthly mean density of California Gulls in waters of central and northern California, 1980-1983.

during winter coastal surveys in central and northern California, but a substantial portion of the 30,000 to 40,000 unidentified gulls present on these surveys may have been of this species (Table 13),

An increase in California Gull numbers occurred over open waters during late winter, probably indicating some northward movement of birds wintering in southern California, Mexico and perhaps central America. During 1981 and 1982, the late-winter density peak was about one-third to one-half lower than that of the preceding autumn, suggesting either that fewer birds were involved or that movement was more rapid, with less feeding offshore.

Black-legged Kittiwake (*Rissa tridactyla*). Kittiwakes are a dominant component of the pelagic fauna off California every winter, but have previously been reported to vary greatly in abundance. Nesting in arctic and subarctic Alaska, the Pacific Ocean-Bering Sea

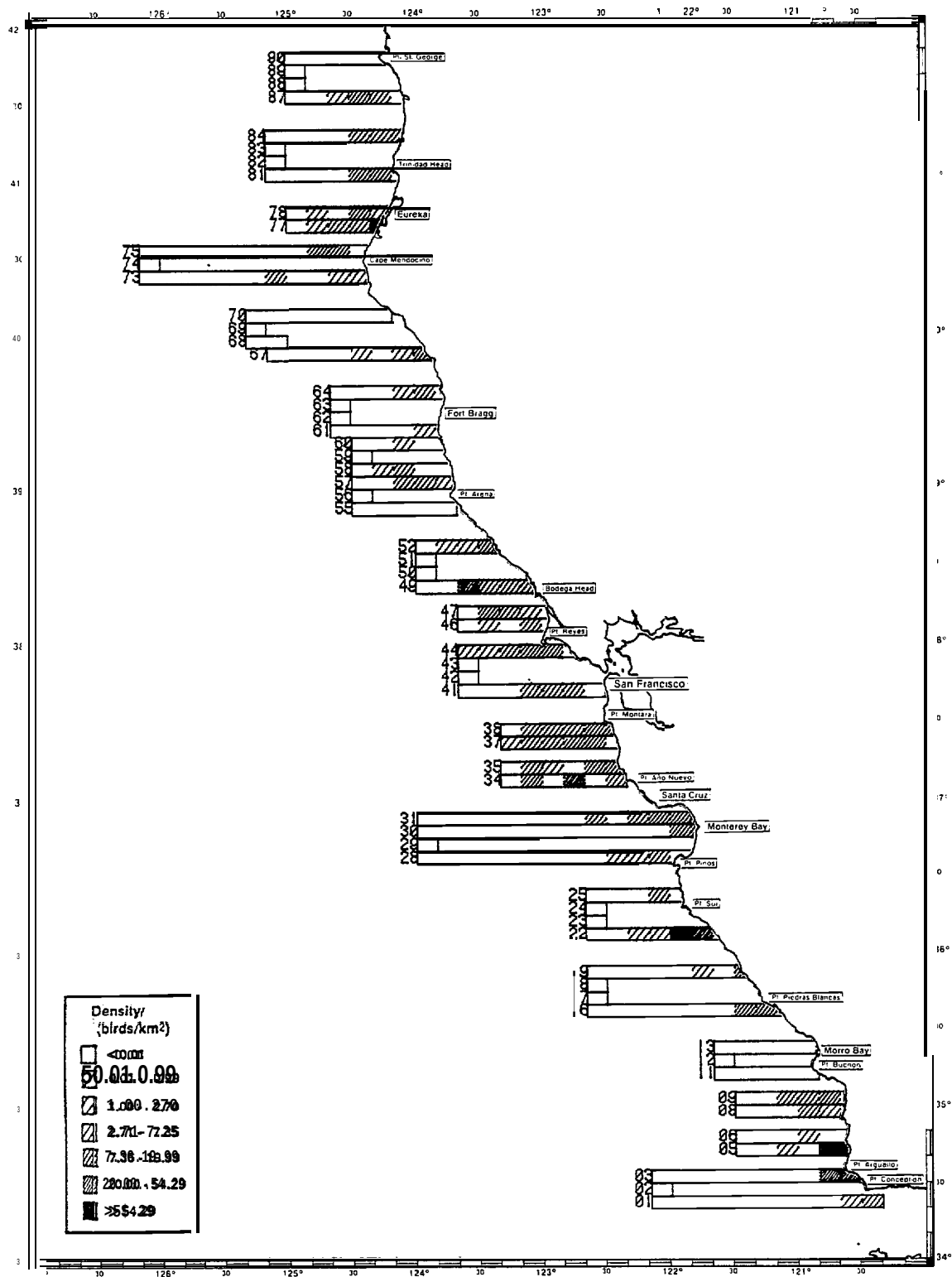


Figure 43. Density of California Gulls in waters of central and northern California, November 1980.

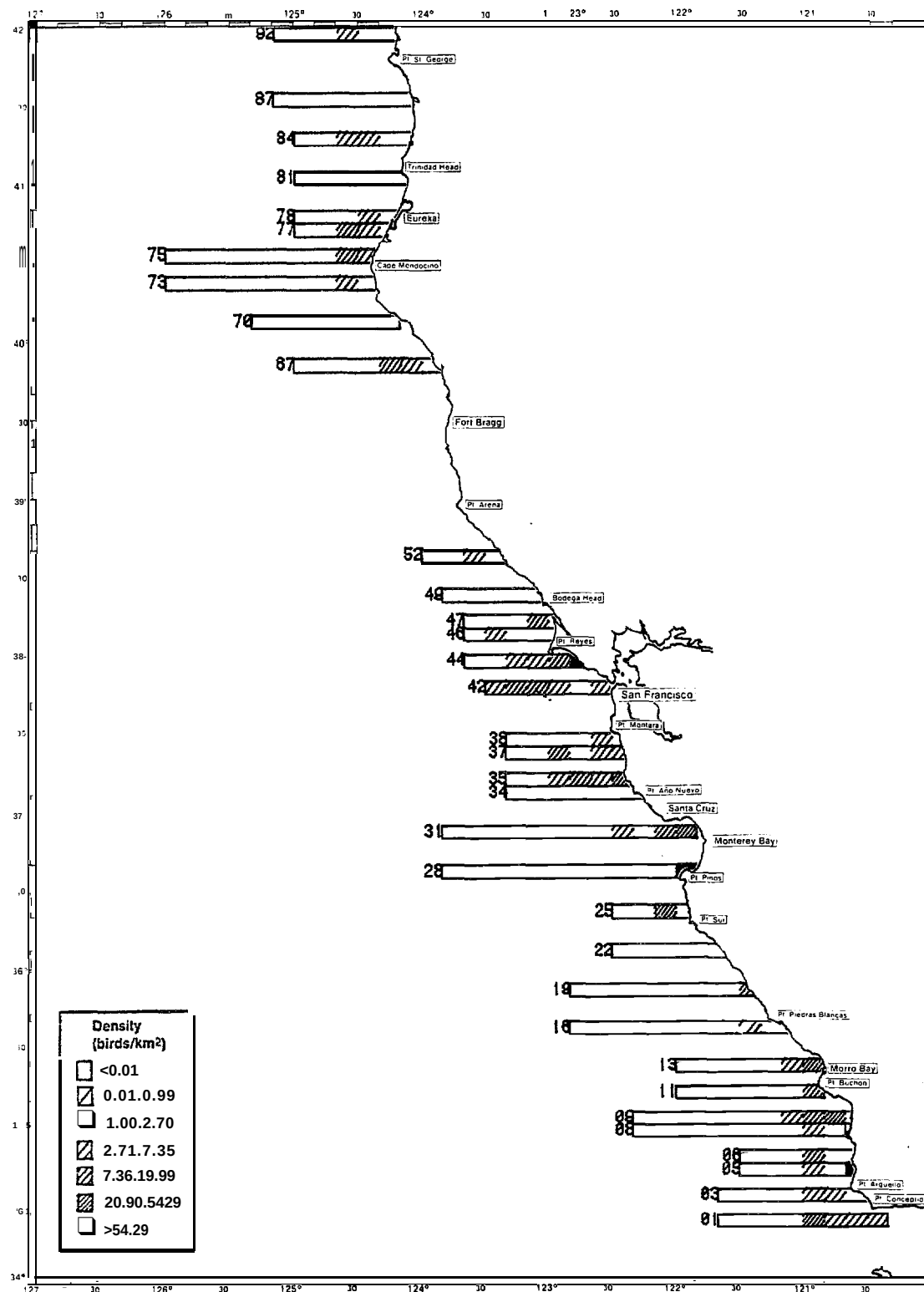


Figure 44. Density of California Gulls in waters of central and northern California, January 1981.

kittiwake population represents perhaps half of the estimated world population of five million (Cramp et al. 1974; Nettleship 1977, **Sowls** et al. 1978). As the young birds fledge in summer, **adult kittiwakes** move offshore to shelf and slope waters; as many as 0.8 to 1.5 million birds remain in the Gulf of Alaska through winter (calculated from figures presented by Gould et al. 1982). In most years, especially warmer ones, juvenile kittiwakes move south into California waters by November or early December; they outnumbered adults in the southern California Bight by about 6:1 during 1977 and 1978 (**Briggs** et al. 1981a). Reoccupation of nesting cliffs occurs by mid-March each year (Gould et al. 1982), yet young kittiwakes may linger off California well into April or **May**.

Kittiwakes are more characteristically found **in** pelagic waters than are most other gulls, and do not rely substantially on human refuse. Instead, they are very adept at obtaining fish, squid and large crustaceans from the open sea, and often constitute the 'nucleus' of mixed species feeding flocks (**Baltz** and Morejohn 1977, Wiens et al. 1978b).

We found kittiwakes in all regions of central and northern California from December through March each year. Their densities varied between months, peaking in January, February, or March, and were approximately comparable each winter except in 1983 (Fig. 45). The curve of monthly mean density is **bimodal** for 1980-81 and 1981-82; lows in January 1981 and February 1982 may, however, be artifacts of stormy observation conditions. When maximally abundant, kittiwakes were present in densities up to 5-15 **birds/km²** over outer shelf, slope and offshore waters the length of the study area (Fig. 46).

Although they have been regarded as being more numerous south of Monterey than to the north (**Ainley** 1976), we found that kittiwakes were distinctly more abundant in the north most of the time: utilizing data from our study of the Southern California Bight (**Briggs** et al.

Black-legged Kittiwake

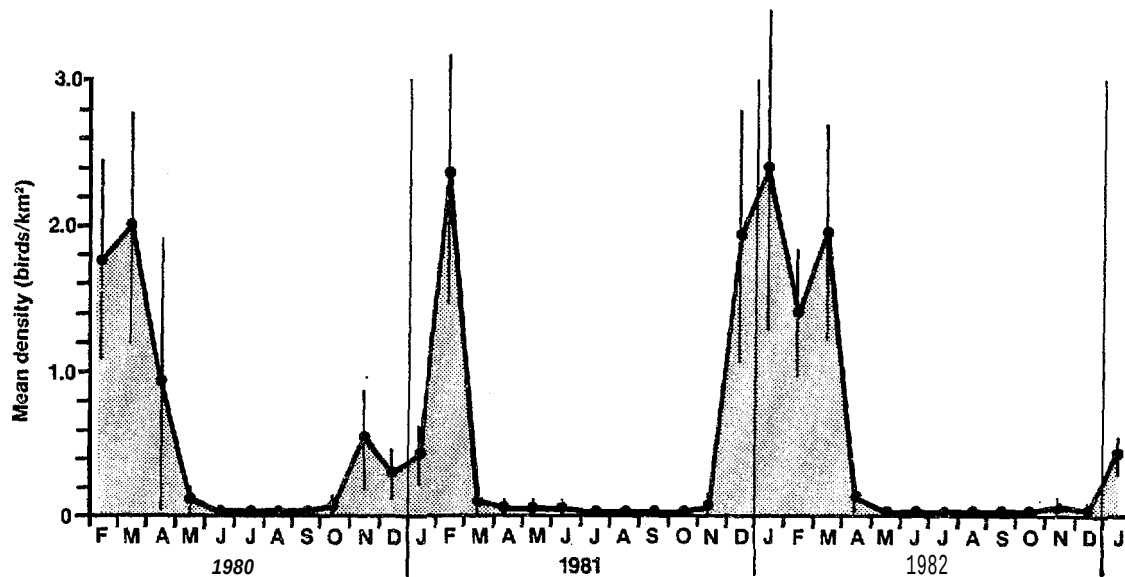


Figure 45. Monthly mean density of Black-legged Kittiwakes in waters of central and northern California, 1980-1983.

1981a) and dividing central and northern California into two areas at a line just north of Bodega, we can examine the monthly pattern of kittiwake density in three latitudinal regions of approximately equal size. In the present study, density in the northern region (Russian River to Oregon) exceeded that in the central (Point Conception to Russian River) by more than 125% in seven of the thirteen fall-winter months during which kittiwakes were at least moderately numerous. In contrast, central region average density exceeded that of the north only in three of thirteen months, and then never by more than 32%. During fall 1982 and winter 1983, kittiwakes generally were absent everywhere south of Point Montara; they were not abundant in the north, but still, by January density north of Cape Mendocino had reached 1.56 birds/km².

The situation in the Southern California Bight during 1975-78 is clouded by the fact that kittiwakes were quite numerous during the cool winter of 1976. Nevertheless, in 1977 and 1978, average kittiwake densities in the Southern California Bight were comparable

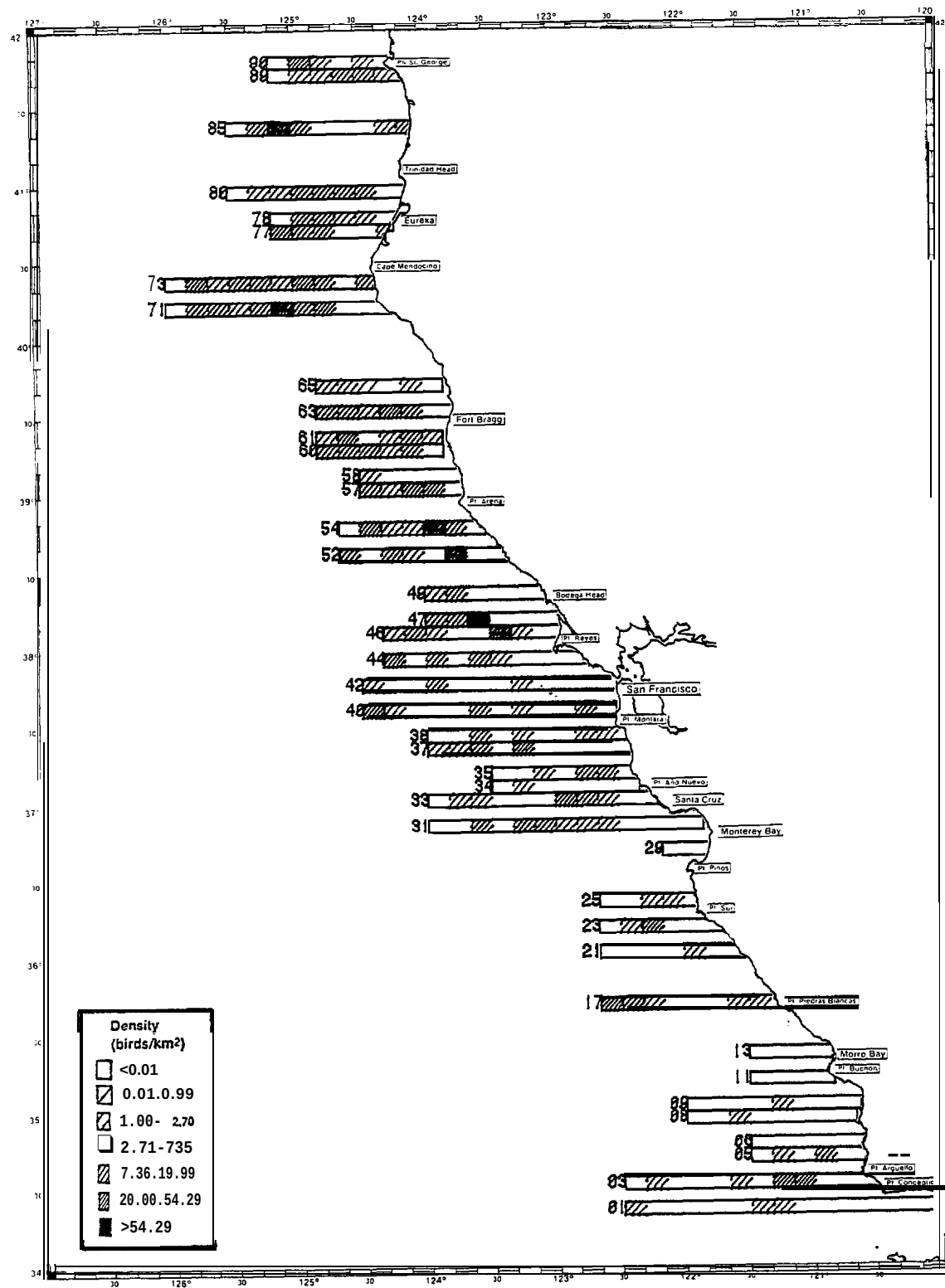


Figure 46. Density of Black-legged Kittiwakes in waters of central and northern California, February 1981.

to those of the central region during 1980-1983, and much below that of northern California.

We think the **status** of this species off California can be reduced to the following scenario: as suggested by Barrington (1975), juveniles account for the great majority of birds off California in most years and are decidedly more abundant north of Bodega than to the south. Densities generally are highest over the slope, although local concentrations near shore and over deep, offshore waters can boost densities there to quite high levels (>20 birds/km²). When adults leave Alaskan waters to a greater extent than usual, as was the case in 1976, they can greatly outnumber juveniles (up to 500:1 in the Southern California Bight; Briggs et al. 1981). At such times overall densities may be larger than 'normal' near the coast, where observers on day-trips from central and southern California ports may see thousands of birds. That is, numbers of birds may spill into nearshore waters from their usual area of concentration over the slope. Because we saw relatively slight interannual variation in mean densities at the winter peak, we surmise that east-west relocations may account for at least some of the variations previously reported. Whether juvenile kittiwakes move farther south in these cooler winters, to concentrate off Baja California, for example, is unclear. Following appearance of large numbers of kittiwakes near the coast, return migration of large populations can result in substantial flights near the coast in April and May. This occurred in the Southern California Bight in 1976 and in central and northern California in 1980. Because our central and northern California study occurred during four consecutive warm winters (Fig. 2), we are unable to estimate the maximum numbers of birds that might be present in a cold year.

Common Tern (*Sterna hirundo*),

Arctic Tern (*Sterna paradisaea*), These two species of terns, indistinguishable by airborne observers, represent the most numerous 'pure migrants' from northern waters that occur in our area. Arctic Terns pass north off California in April and May, arriving in the northwestern Gulf of Alaska no earlier than mid-April (Wiens et al. 1978a, Harrison 1982). This species nests at scattered colonies on all the northern land masses (40° to 82°N). The Arctic Terns nesting on the coast in Alaska, about 25,000 birds, probably represent less than one quarter of the total for the interior (Sowls et al. 1978, Harrison 1982). Common Terns, on the other hand, nest throughout interior North America east of the Rockies, and in most other north temperate areas throughout the world.

Both species are present in larger numbers in late summer as they pass southward along the Pacific Coast: in this season they probably linger much longer to feed than they do in spring. They are very uncommon after October, with only a few scattered records of Arctic Terns in southern California in January and February (Bent 1921, Grinnell and Miller 1944, Stallcup 1976, Briggs et al. 1981a). The winter quarters of the two terns mirror the latitudinal distributions of their nesting ranges: Common Terns winter from about 35°N to 40°S while Arctic Terns move into Antarctic waters. The diet of both species during migration is poorly known, but it probably consists mostly of small schooling fish.

Our data from central and northern California complement those available for other segments of the migration route. Occurring from mainland beaches to the seaward limits of our study, Arctic and Common Terns moved rapidly northward in April and May and southward in August through October (Fig. 47). The autumn density peak exceeded that in spring by more than an order of magnitude; the yearly peaks were fairly comparable. Confirming our earlier statements (Briggs et al. 1981a), the density maxima in autumn occur at the same time in the

Gulf of Alaska (Wiens et al. 1978a) as off California, indicating a very rapid, synchronous migration. Since peak densities of these terns in southern California waters were about half those reported here, we surmise that substantial numbers of Arctic Terns, in particular, pass seaward of the Southern California Bight.

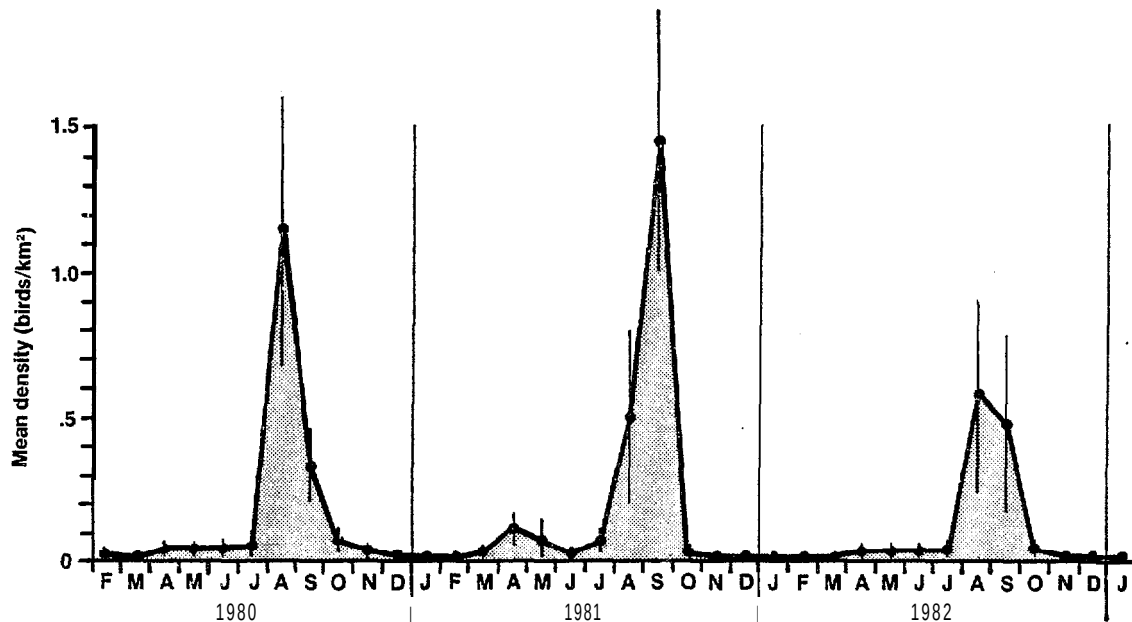


Figure 47. Monthly mean density of Arctic and Common Terns in waters of central and northern California, 1980-1983.

The sighting and specimen data for the Southern California Bight indicate that Common Terns typically occur near the mainland while Arctic's typically migrate offshore (stallCup 1976). We suppose the same to be true in central and northern California (from boats we have seen Common Terns by the hundreds in Monterey Bay in spring and fall). Density in August and September (Fig. 48) was generally low to moderate in waters seaward of the shelf from Trinidad to Point Conception. Overall densities were higher from Point Arena to Point Sur than elsewhere, perhaps reflecting the poor observation conditions occasionally encountered near Cape Mendocino. Our impression was that Arctic Terns frequented relatively clear, warm waters seaward of the coastal upwelling zone. Where warm eddies approached the shore most

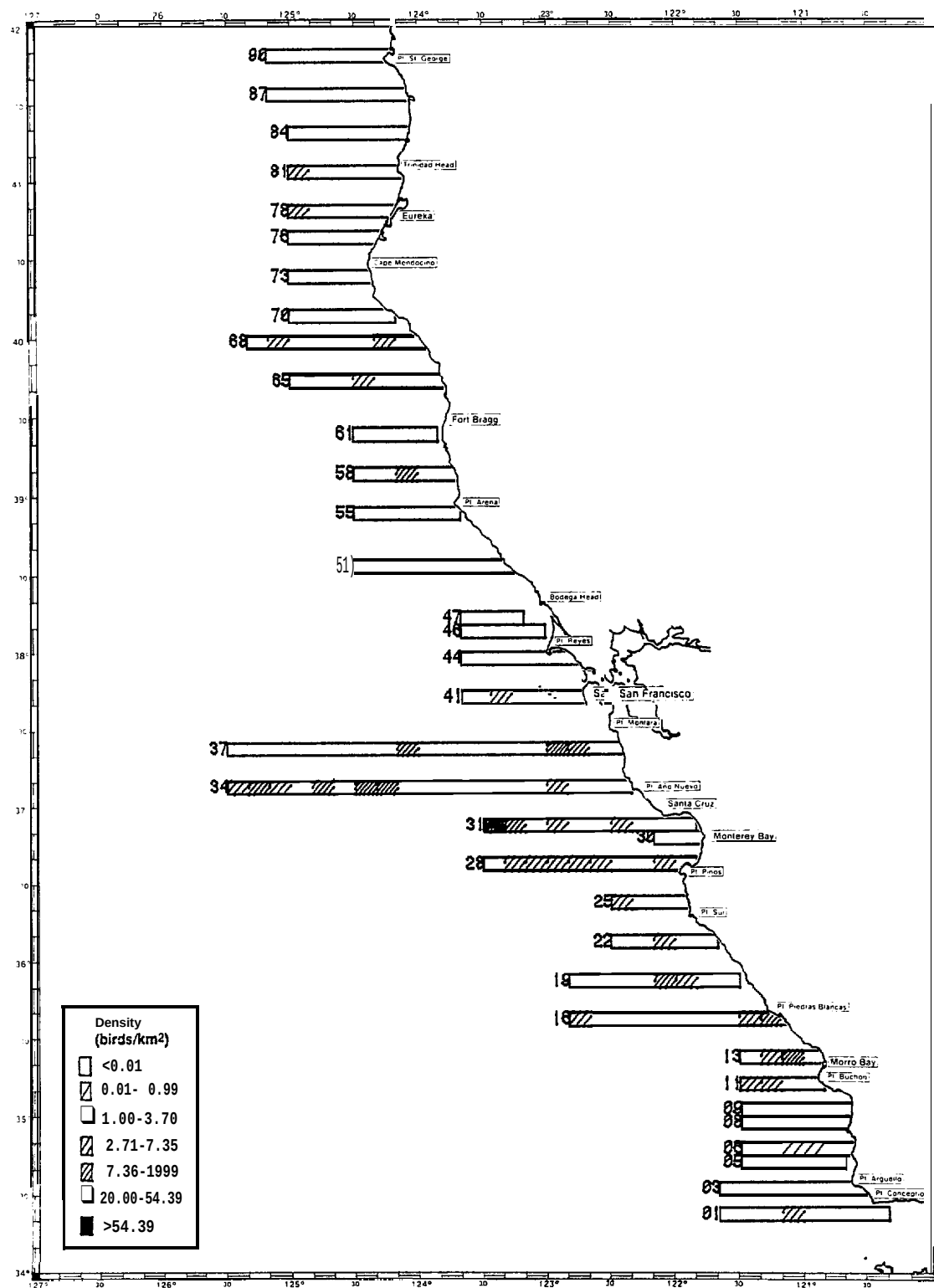


Figure 48. Density of Arctic and Common Terns in waters of central and northern California, August 1982.

Common Tern & Arctic Tern

closely, as off Point Arena, Common/Arctic Terns were fairly numerous within 15 km of shore. In contrast, we seldom saw even modest densities of these birds where late summer upwelling prevailed, such as over the shelf from Point Reyes to Point Año Nuevo.

After October, we recorded only a few scattered sightings of these terns, mostly south of Point Sur. None were seen in December through March each year.

Common Murre (*Uria aalge*). The Common Murre is California's most abundant breeding seabird, constituting an important part of the fauna at sea in all months. Murres are among the most numerous seabirds of the northern hemisphere, totalling perhaps 15 million, of which about 10 million reside in the North Pacific (Tuck 1961). Sowlset al. (1978) estimated the Alaskan population of Common Murres at five million, based on colony counts. Murres are extremely colonial, forming dense nesting aggregations on cliffs, rocks, and islands. A single chick is fledged per nest each year.

Common Murres are pursuit divers (Ashmole 1971), that feed on a variety of small schooling fishes, cephalopods, and macrozooplankton. During the breeding season in Oregon, Scott (1973) reported the most important prey items to be anchovy, herring (*Clupea*), and smelt, whereas from September-April in Monterey Bay, Baltz and Morejohn (1977) found anchovy, juvenile rockfish (*Sebastes*), and market squid (*Loligo*) predominant among eleven prey species. At the Farallones, murres apparently feed mainly on euphausiids and to a lesser extent on cephalopods (Ainley and Sanger 1979).

Storer (1952) and Smail et al. (1972) report that the California subspecies (*u. a. californica*) is sedentary, remaining near the breeding colonies throughout the year, whereas populations of murres from

British Columbian and Alaskan waters (*u. a. lomvia*) move south into northern California, augmenting local murre populations during winter.

In California over 175,000 pairs of Common Murres annually occupy at least nineteen colony sites between Castle Rock (Del Norte County) and Hurricane Rock (Monterey County) (Sowls et al. 1980; this study). A small colony on Prince Island (Santa Barbara County) has been inactive since early this century (Hunt et al. 1981). Sowls et al. (1980) cite evidence for recent increases in California murre numbers and colony sites, especially in Humboldt and Del Norte counties. The Common Murre population at southeast Farallon Island dropped from about 400,000 Murres in 1854 to a low of 6,000-7,000 in the mid-1960's (Ainley and Lewis 1974). Since then, numbers of murres breeding at the island have increased 10-15% per annum (DeSante and Ainley 1980).

We surveyed all murre colonies in California in early May and early July, 1980-82 (Table 14). We consider our July censuses to be the best estimate of the colony populations, as colony attendance in early May is apt to be sporadic (A. Sowls, pers. comm.). Accordingly, our May census figures each year totalled fewer birds than in July. To estimate total colony size (as per Sowls et al. 1980) we multiplied each count by a factor of 1.67 to account for the absence of foraging adults. Our July 1980 colony estimates closely resembled those of Sowls et al. (1980) except at the Farallones, where their data (supplied by Point Reyes Bird Observatory) were from the 1979 nesting season and excluded North Farallon Island (where we counted over 30,000 murres and estimated [$\times 1.67$] over 50,000).

Overall, peak counts at colonies increased by 20% in two years; the extrapolated population in July 1982 totaled nearly 520,000 murres. Between 96% and 99% of all nesting murres in California reside within two regional colony systems, each exploiting a locally-expanded area of continental shelf. The region from Cape Mendocino to Point St. George contains about 55% of the statewide

Table 14. Common Murre colony population estimates 1980-1982. Numbers indicate actual counts x 1.67 to allow for foraging adults (see text).

Colony	North Latitude	Sowls et al. (1980)	1980		1981		1982	
			May	July	May	July	May	July
Castle Rock	41°43.6'	126,000	31,213	131,805	71,000	69,138	66,793	142,368
Sister Rocks	41°39.5'	30			50	42	157	
False Klamath Rocks	41°35.7'	26,500	8,684	37,592	23,380	16,700	25,551	53,108
Redding Rock	41°20.5'	2,100	1,754	1,722	1,336	1,086	1,470	1,169
White Rock	41°05.2'	2,600	5,057	3,307	3,340	5,473	6,313	5,102
Green Rock	41°04.5'	55,000	35,905	28,323	23,380	42,009	33,397	38,550
Flatiron Rock..	41°03.6'	24,000	24,215	17,702	5,845	23,931	31,062	17,964
Blank Rock	41°03.2'	1,000		433	668	543	543	5,344
Pilot Rock	41°03.1'	2,500		1,460	1,503	1,837	2,422	2,410
False Cape Rks.	40°30.6'	8,000	14,112	10,989	15,598	15,197	19,706	14,394
Sugarloaf	40°26.3'					334		
Steamboat Rock	40°24.9'	4,500	6,680	5,130	5,845	7,348		7,882
Cape Vizcaino	39°43.6'	5,800	5,845	4,026	837	(Fog)	4,542	7,288
Bruhel Pt. Rks.	39°36.0'							85

Table 14. (continued)

Colony	North Latitude	Sowls et al. (1980)	1980		1981		1982	
			May	July	May	July	Nay	July
Pt. Resistance	37°59.9'	7,500	2,588	7,313	17,749	6,012	4,801	6 , 8 4 7
Point Reyes	37°59.5'	16,500	27,593	22,416	58,225	27,512	26,563	43,983
Millers Pt. Rks.	37°58.9'			105	30	110	830	
Double Point	37°56.9'	13,000	2,560	14,780	23,145	9,811	14,446	11,857
N. Farallon Is.	37°46.2'		22,448	52,485	35,989	48,597	50,184	51,626
S. Farallon Is.	37°41.9'	60,000	21,137	87,720	39,245	83,458	73,898	102,722
Devil's Slide Rock	37°34.5'	2,300	2,557	2,923	2,368	1,336	3,841	2,555
Martin's Beach	37°22.5'					30		
Castle Rock	36°22.6'	3,500	1,834	1,328	2,001	11,161	1,670	1,845
Hurricane Point Rocks	36°21.7'	2,300	2,383	1,910	3,340	2,505	5,060	1,697
TOTALS		363,130	216,565	433,469	334,874	374,170	373,249	518,796

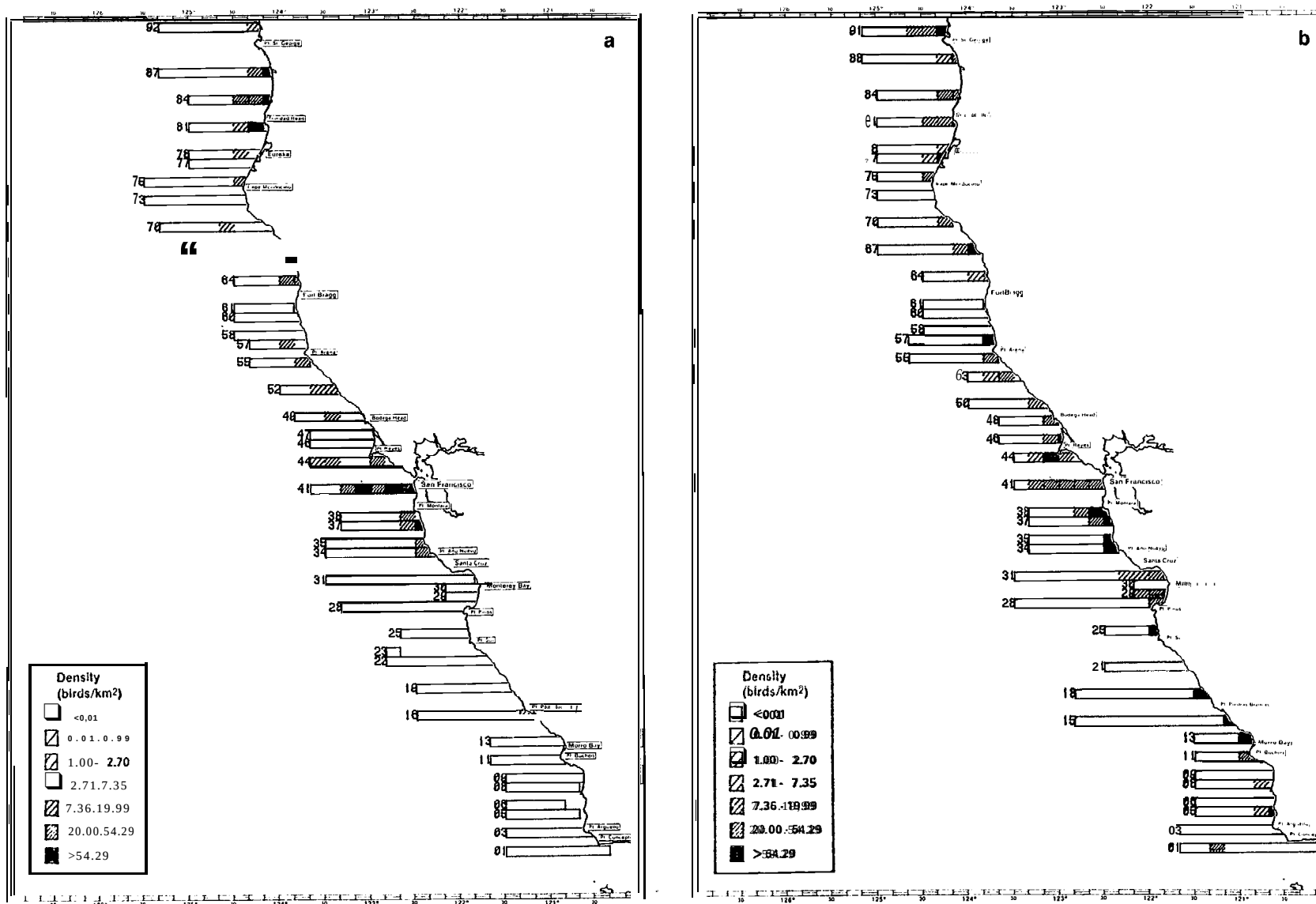
Common Murres

total, chiefly in four colonies or colony complexes (Castle Rock, False ~~Klamath~~ Rock, Trinidad Head, and Cape Mendocino) and contains the **state's single largest** murre colony (140,000+) at Castle Rock. The region from Point Reyes to Point Montara contains about 43% of the total breeding population, mainly at four major sites (North ~~Farallon~~ Island, southeast ~~Farallon~~ Island, Point ~~Reyes~~, and Point Resistance/Double Point), including the second largest colony (102,000+) at South ~~Farallon~~ Island. The remaining 1-3% (3500-8000 birds) occupy small colonies at Cape ~~Vizcaino~~ and Hurricane Point. The population increase we observed was skewed slightly toward the northern region (19%, versus the southern region 17%).

During monthly surveys at sea, densities of Common Murres averaged from 0.9 to 5.2 ~~birds/km²~~; highest densities were recorded during winter, and lowest in spring/summer when northern visitors departed and most local birds occupied colonies. In all seasons **murres** were predominantly creatures of the continental shelf; on only four occasions did we record less than 80% of our total there. We often found high **murre** densities near the shelf break along the inshore edges of **upwelling** plumes, downstream (south) and seaward of major coastal promontories at Cape ~~Blanco~~ (Oregon), Cape ~~Mendocino~~, Point Arena, Point ~~Año Nuevo~~, and Point Sur. These downstream locations also coincide with the location of the major murre colonies. In the Southern California Bight, **Briggs et al.** (1981a) also found wintering **murres** generally restricted to areas of cool, locally **upwelled** waters; Gould et al. (1982) reported highest average densities (5-7 **murres/km²**) in the Gulf of Alaska were over shelf waters during spring and summer, with most spring sightings near colonies.

As expected, during the breeding season (May-July), Common **Murres** at sea were largely restricted to the vicinity of their colonies (**Fig. 49a**). Shelf densities at these times averaged 6 to 12 **birds/km²** overall, and peaked at 20 to 200 **birds/km²** near the major colonies;

Figure 49. Density of Common Murres in waters of central and northern California, a) June 1981, b) July 1981.



moderate densities were often found over the shelf break, especially near the Farallones.

Post-nesting dispersal was evident by late June and obvious by late July each year, as presumed non-breeders and, later, parent-chick pairs occupied extra-colonial shelf waters (Fig. 49b). Late July and August shelf densities typically increased by a factor of 1.5 or 2, to between 12.0 and 18.0 birds/km², as parents, juveniles, and non-breeders dispersed southward. Although highest at-sea densities were still recorded near the colonies at this time, 30-200 birds/km² were found on some transect segments between Point Montara and Point Año Nuevo, in Monterey Bay, off Point Sur and from Morro Bay to Point Arguello. This pattern continued through autumn each year, with highest average fall densities recorded in September.

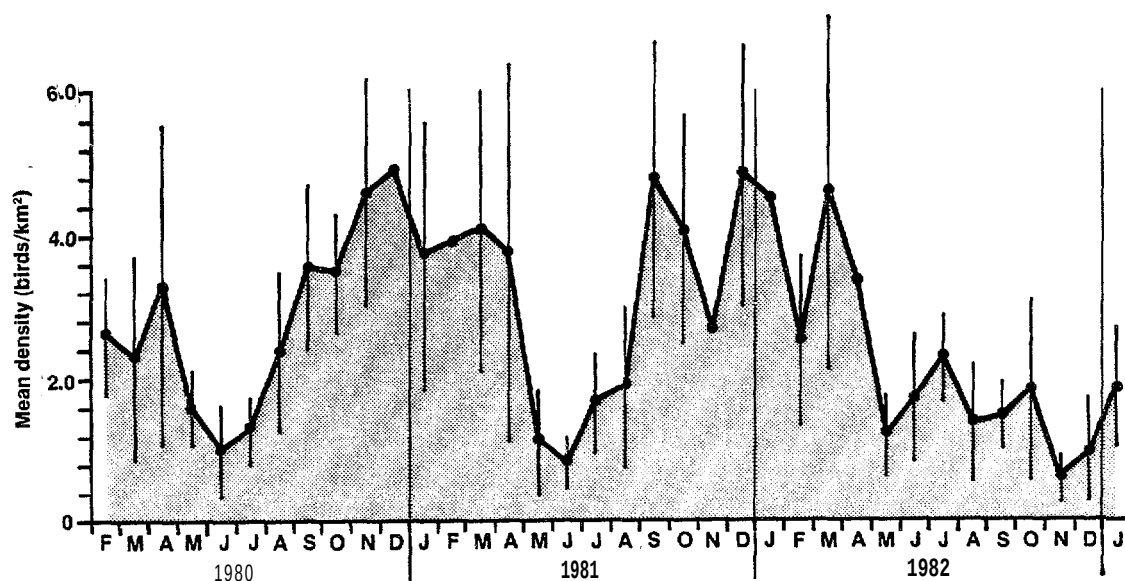


Figure 50. Monthly mean density of Common Murres in waters of central and northern California, 1980-1983.

Immigration of northern murres culminated in maximum annual average densities in December or January each year (Fig. 50). Density increases were noted from all sectors, but were generally greatest

between Point St. George and Cape Mendocino, where densities of 60 to 200 murre/km² were commonplace. Overall shelf densities exceeding 35 murre/km² in November and December 1980 and December 1981, are attributable to this immigration. Other important local wintering grounds (often-with densities exceeding 100 murre/km²) included Cordell Bank, the Gulf of the Farallones, Pillar Point-Point Año Nuevo, Monterey Bay, and occasionally Morro Bay-Point Sal.

From January through April average densities gradually declined as the murre population retreated northward in anticipation of nesting. Sightings south of Point Sur became sparse, and most birds were again recorded adjacent to colonies. Average densities suddenly dropped by one-half to two-thirds in May, as colony occupation became steady.

Cassin's Auklet (*Ptychoramphus aleuticus*). Cassin's Auklet occupies an extensive breeding range in the North Pacific with colonies located from Buldir Island (latitude 57°N) in the Aleutians to Isla San Roque (27° N) off the west coast of Mexico (Udvardy 1963, Van Rossem 1939). Although suffering potentially major depredation by Arctic foxes, the Alaskan population is presently estimated at around 600,000 birds (Sowls et al 1978). Approximately 1.06 million Cassin's Auklets occupy colonies in British Columbia, but only about 100 pairs nest in Washington (Manuwal and Campbell 1979) and 120 pairs in Oregon (Varoujean and Pittman 1980). Of the 131,170 Cassin's Auklets nesting in California, 80% (105,000) occupy Southeast Farallon Island, 17% (23,000) use the northern Channel Islands (20,000 on Prince Island), and the remainder nest at Castle Rock and Green Rock in Del Norte County; they are second to Common Murres in California seabird nesting population (Sowls et al 1980). Ainley and Lewis (1974) documented the history of this species at southeast Farallon Island: Cassin's Auklets, apparently rare in the mid-late 19th century, became the island's most abundant breeding seabird by 1911, apparently due to the

return of a cool-water regime and the associated production of appropriate food items; they experienced decreased fledging success during two subsequent warm-water periods. The exceptionally low reproductive success occurred during the "El Niño" event of 1982-83 (B. Boekelheide pers. comm.).

Cassin's Auklets are primarily burrow-nesters, but also inhabit rock crevices. During the nesting season, parents forage by day, departing and returning to the colony only under cover of darkness (Thoreson 1964, Manuwal 1974). Their colonies are not amenable to aerial censusing techniques, so we present here no new data on colony populations.

Cassin's Auklets feed on a diverse assemblage of macrozooplankton species and larval fishes; Hunt et al. (1981) found that larval *Sebastes*, *Citharichthys*, and *Engraulis*, as well as euphausiids comprised the bulk of the auklet diet near San Miguel Island. From winter specimens collected on Monterey Bay, Baltz and Morejohn (1977) took euphausiid parts, otoliths of medusafish and *Citharichthys*, and an identified crustacean. At southeast Farallon Island, they reportedly feed on euphausiids, squid, amphipods, and "immature, semi-transparent whitebait" (Thoreson 1964, Manuwal 1974). At Triangle Island (British Columbia), Cassin's Auklets fed their young primarily copepods, euphausiids, and larval fish (*Ammodytes* and *Hemilepidotus*); Cassin's Auklets there apparently time their nesting phenology so that hatching and fledging peaks coincide with maximum zooplankton abundance offshore (Vermeer 1981b). Sanger (1953) found auklets in the Gulf of Alaska mostly contained calanoid copepods, but also significant amounts of unidentified fish, the euphausiid *Thysanoessa spinifera*, and unidentified squid.

Cassin's Auklets

Cassin's Auklets aggregate in dense foraging rafts which often cover several km² at preferred feeding locations, especially near colonies (Hunt et al. 1981; our observations).

We frequently observed feeding flocks associated with reddish clouds of plankton, upon which they were presumably feeding. On one such occasion near Cordell Bank, several Humpback Whales (*Megaptera novaeangliae*) shared the same resource, while scores of phalaropes converged upon each "fluke print", as they apparently fed on whatever welled up. Dolphin and McSweeney (1983) reported the incidental ingestion of Cassin's Auklets by humpbacks, where both species had been observed feeding on the same plankton shoal at 27-35 m depth.

We found Cassin's Auklets to be at least moderately abundant at sea in California in all months. They occupied waters of all latitudes and depth zones, and although highest densities were almost always found over the continental shelf or slope, the largest proportion of the population seasonally occurred on waters exceeding 2000 m depth (see Fig. 55).

The lowest annual densities of Cassin's Auklets (0.3 to 1.1 birds/km²) occurred during late spring and summer months when resident birds congregated at the Farallones and Humboldt/Del Norte County colonies, coincident with the absence of winter visitors (Fig. 51). Their distribution at this time became extremely clumped, with the great majority of birds congregating at preferred feeding locations near the colonies (Fig. 52). Densities often exceeded 100 auklets/km² near the Farallones, especially over the continental shelf south and east of Cordell Bank where concentrations of over 200 auklets/km² were common. High density (100-150 birds/km²) feeding flocks of Cassin's Auklets could be expected almost anywhere over the shelf and slope from Point Año Nuevo to Bodega during this season. Lower but significant densities (10-25 auklets/km²) occurred near the smaller northern colonies, and, curiously, over shelf waters off

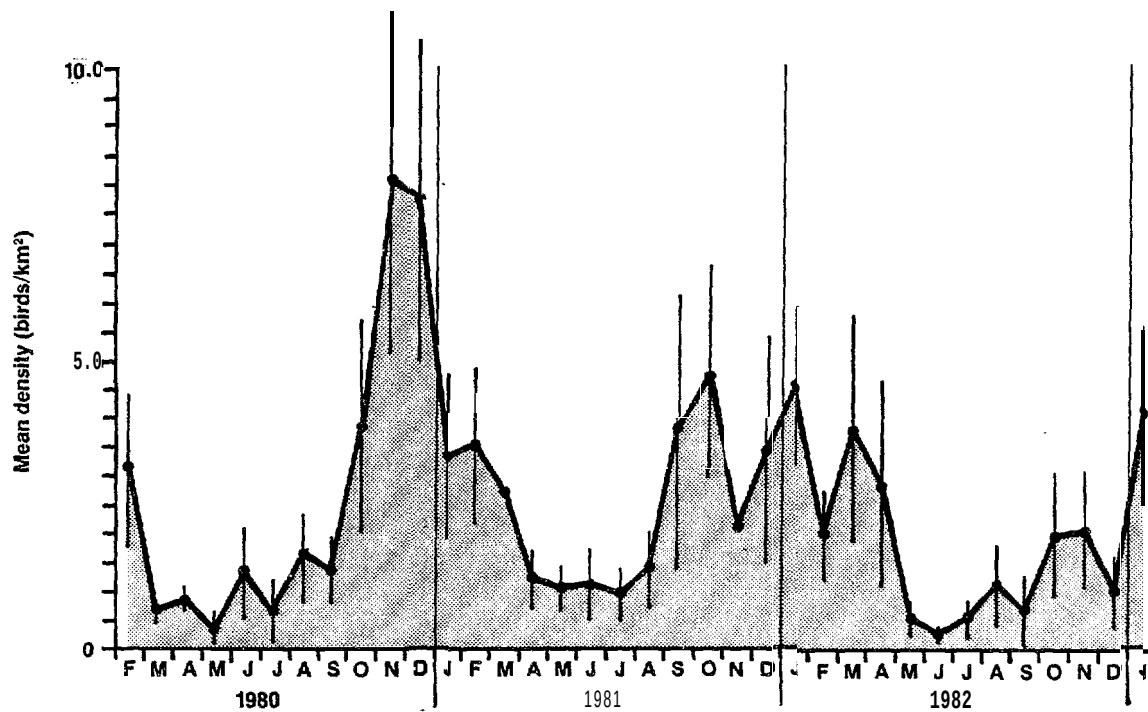


Figure 51. Monthly mean density of Cassin's Auklets and unidentified small auklets in waters of central and northern California, 1980-1983.

Purissima Pt. These southerly birds may have been from the San Miguel Island colonies, non-breeding immature birds, or possibly residents of a small undiscovered colony in the Point Arguello-Point Buchon region.

From August through October each year the local nesting population of Cassin's Auklets dispersed throughout the study area. Largest numbers still remained over the shelf near the colonies, but significant densities were recorded at many other locations (Fig. 53). Average densities for the entire region indicated no major influx of birds into the area until late September or October when overall densities increased dramatically to about 3.5 birds/km². Cassin's Auklets apparently delayed their arrival to the area in autumn 1982, however, since November average densities had reached only about 2 birds/km² and apparently dropped in December. Unusually warm waters

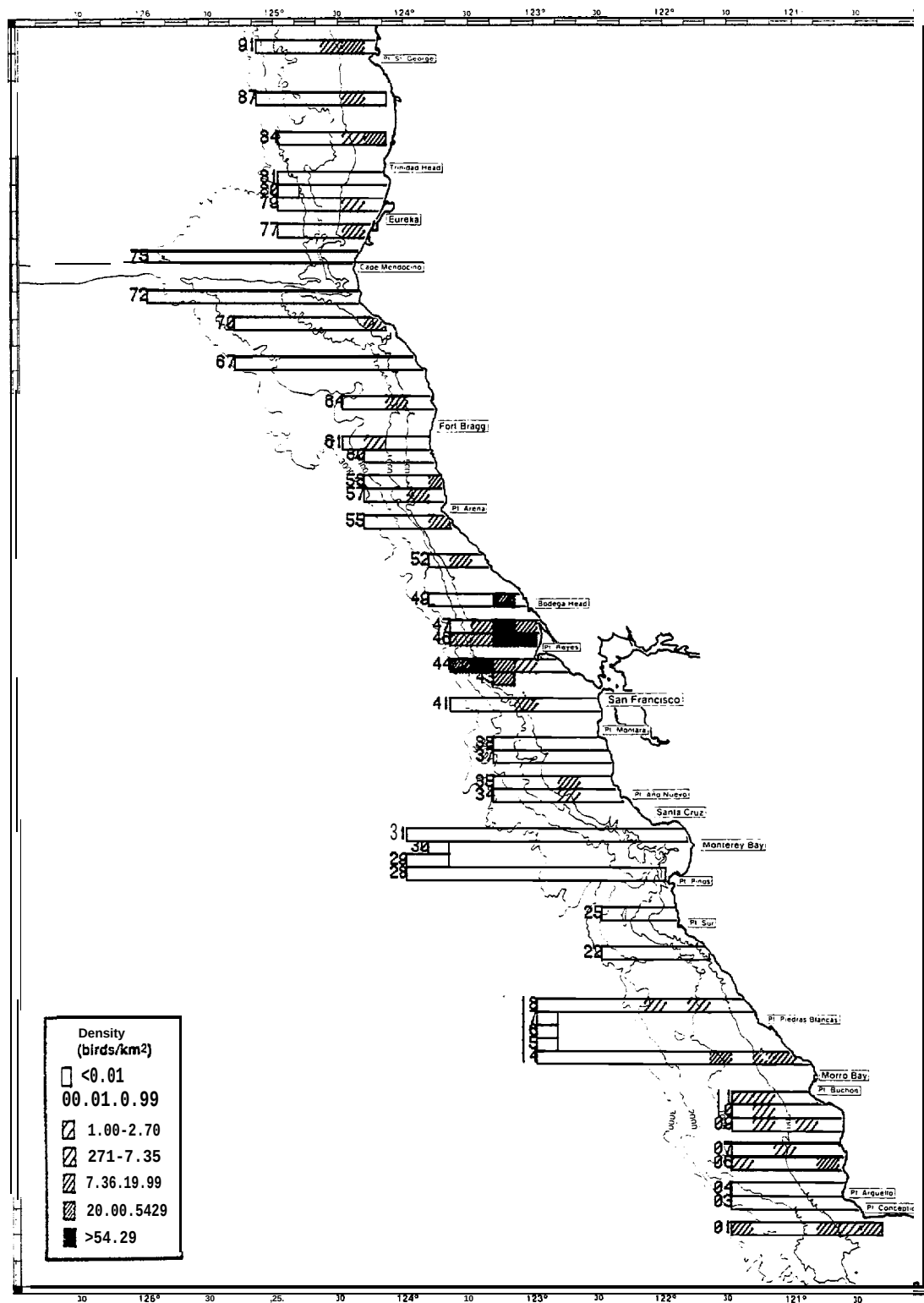


Figure 52. Density of Cassin's and unidentified auklets in waters of central and northern California, June 1980.

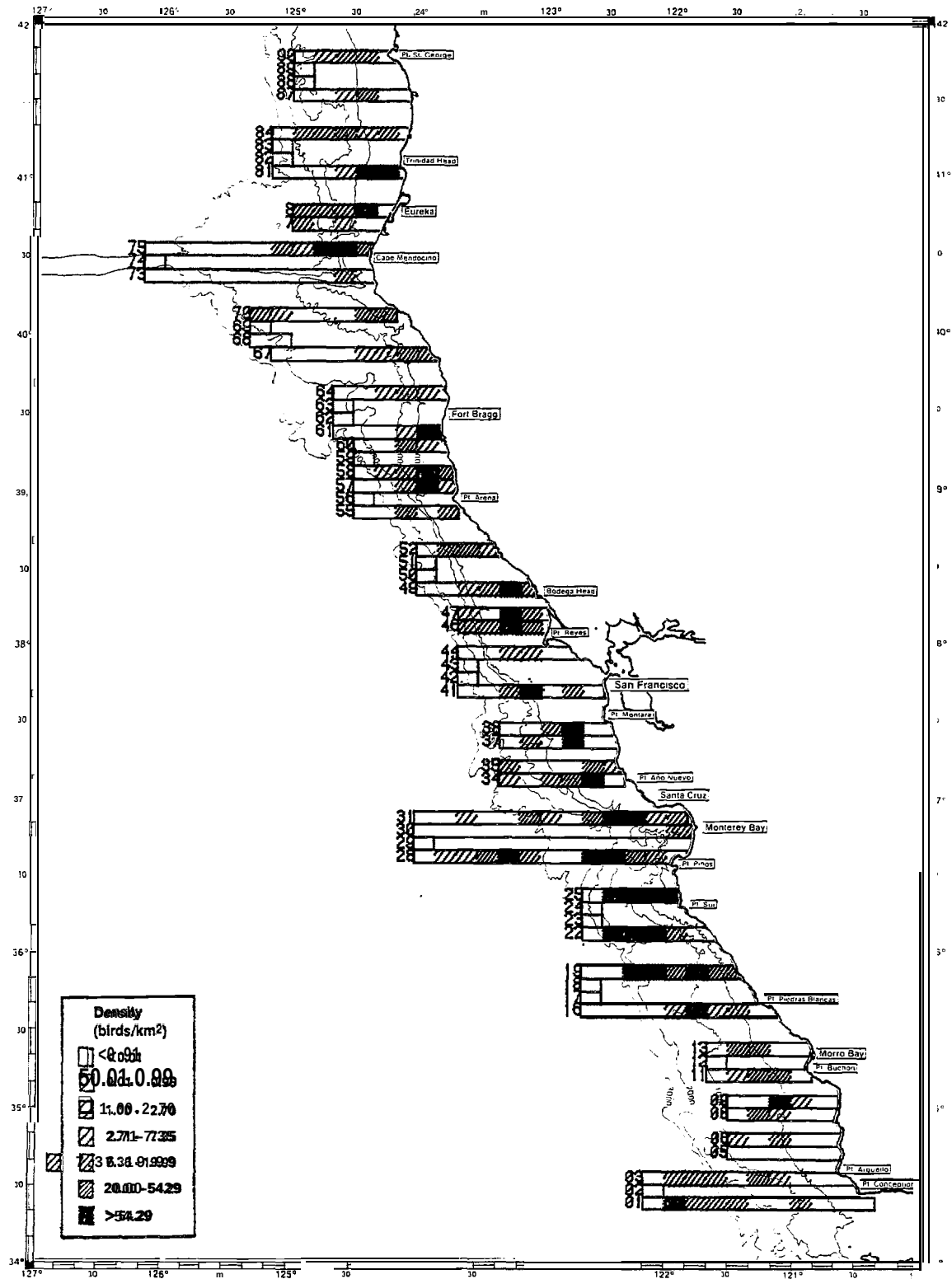


Figure 53. Density of Cassin's and unidentified auklets in waters of central and northern California, November 1980.

Cassin's Auklets

in the Gulf of Alaska ($2-4^{\circ}$ C above the 20-year mean, Auer 1983) may have allowed Cassin's Auklets and other winter immigrants to linger in the north that year. Expected winter densities of Cassin's Auklets did not appear in our study area until January 1983.

We recorded annual maximum numbers of Cassin's Auklets beginning about November and continuing through January or February. During the three year study peak winter densities reached 4.0 to 8.0 auklets/km²; over a million individuals may have occupied the waters off northern and central California at this time. We often encountered extremely high densities of Cassin's Auklets distributed in bands 4-8 km wide, "-" with few individuals on either side. This clumping of the population, although less pronounced in winter, makes risky any extrapolations of total population from average densities. However, it is possible that virtually the entire population of Cassin's Auklets south of Alaska may be found off California in winter. Indeed, winter records of Cassin's Auklets are scarce from waters north of California (Gould et al. 1982, Wahl 1975). Since winter densities of Cassin's Auklets in southern California (0.5 to 1.1 birds/km²) account for only 50,000-100,000 birds (Briggs et al. 1981a) we surmise that the bulk of visiting northern auklets do not reach waters south of Point Conception.

During the winter, Cassin's Auklets ranged widely throughout the study area. Although several locations intermittently harbored moderate to high auklet densities, the dense feeding aggregations (>150 birds/km²) typical of summer were uncommon. Rather, auklets occupied the entire study area in low to moderate densities, with the majority tending to occur between Point Pinos and Cape Mendocino (Fig. 54). Densities of 25-75 auklets/km² could be expected almost anywhere within this region, but almost always prevailed offshore of Point Arena-Fort Bragg. We generally found lower densities to the north and south of this region, but occasional concentrations of up to 50 birds/km² appeared in either area.

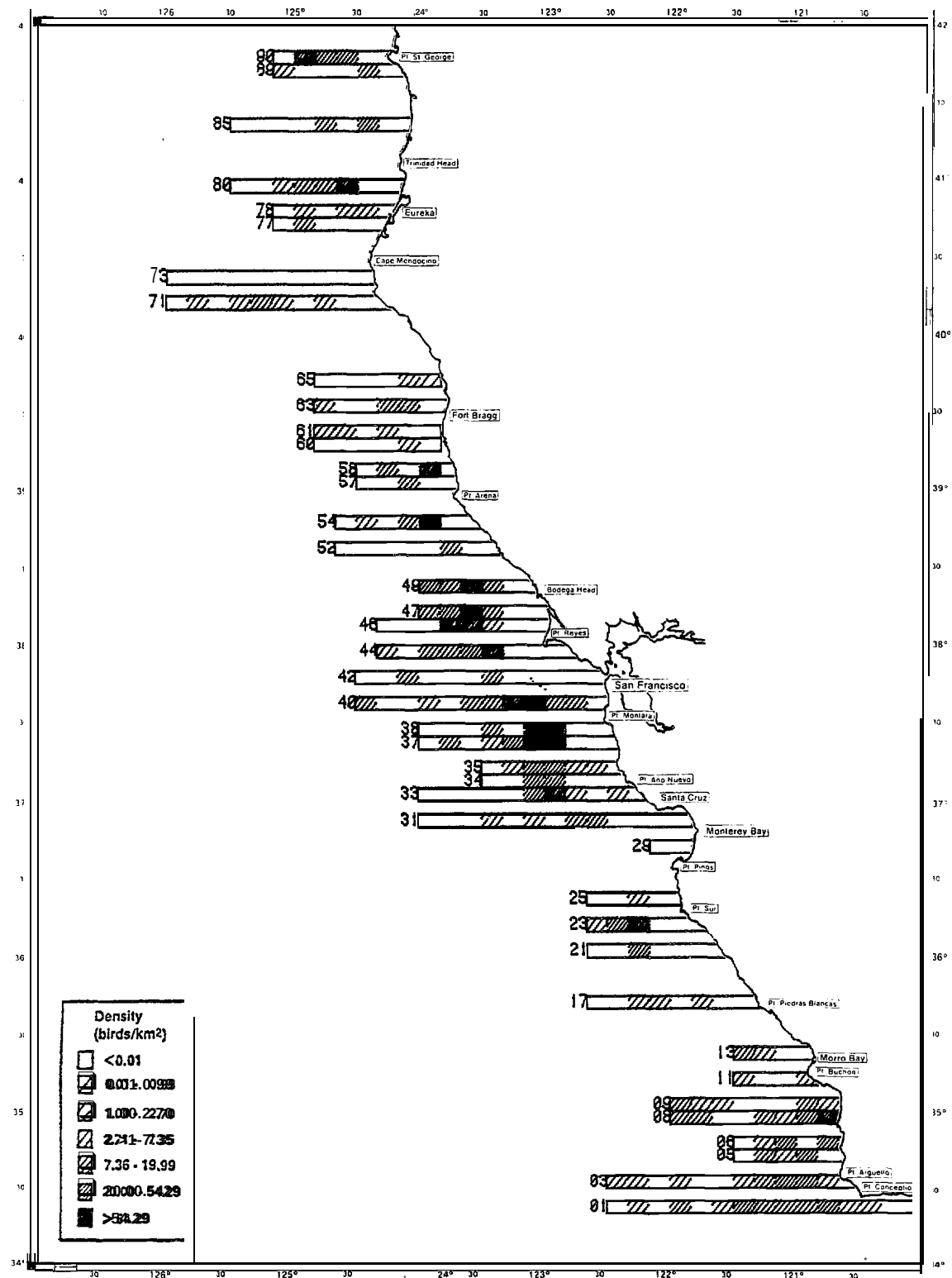


Figure 54. Density of Cassin's and unidentified auklets in waters of central and northern California, February 1981.

Cassin's Auklet

Overall densities dropped during spring, usually quite abruptly, as resident birds congregated near colonies and winter visitors departed northward. The timing of this exodus was variable each year; low average densities typical of the resident nesting population were reached in March 1980, March/April 1981, and April/May 1982.

We observed a cyclic shift in Cassin's Auklet distribution relative to depth zones during each year (Fig. 55). During the height of the nesting season (June-August) most birds were projected to be over the shelf ($\bar{x}$ = 69.1%; range: 59.2%-84.1%), with the remainder over the continental slope; few auklets occupied deep water. In contrast, during the winter months (November-February), about half

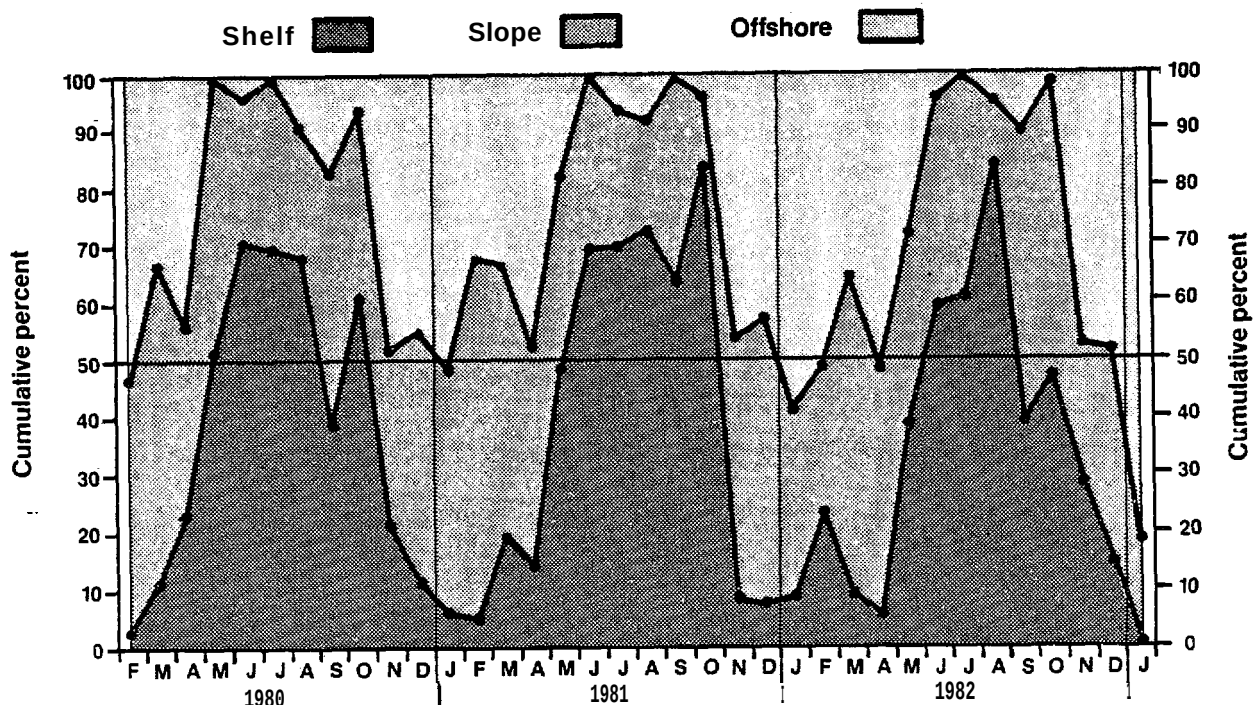


Figure 55. Relative abundance of Cassin's Auklets occupying shelf (0-199m), slope (200-1999m), and offshore (≥ 2000 m) waters of central and northern California, February 1980-January 1983. Besides the obvious seasonal shift between shelf and offshore waters, note the relatively stable numbers which occupy waters of the continental slope (see text).

Cassin's Auklets

($\bar{x}$ = 50.7%; range: 32.9%-81.2%) of the Cassin's Auklet population resided in waters deeper than 2000 m, while only a small percentage ($\bar{x}$ = 11.6; range: 1.0%-28.2%) remained over shelf waters. The portion of the population occupying Slope waters (depth 200-1999 m) remained relatively stable throughout the study:

'slope = 36.2%; s = 12.34; range: 11.3%-61.4%
versus

$\bar{x}_{shelf}$ = 36.5%; s = 27.1; range: 1.0%-84.4%
and

$\bar{x}_{outer}$ = 27.4%; s = 22.7; range: 0.0%-81.2%.

Thus, Cassin's Auklets appear mostly to inhabit the coastal upwelling zone during summer, but become more widespread in winter, when nearshore-offshore gradients in temperature and perhaps biological (feeding) conditions are minimal.

Rhinoceros Auklet (*Cerorhinca monocerata*). Rhinoceros Auklets

are distributed discontinuously around the rim of the North Pacific from northern Japan to central California (Udvardy 1963). The Alaskan population numbers about 200,000 birds, of which 108,000 nest at Forrester Island in southeast Alaska; predation by introduced Arctic foxes possibly eliminated many colonies on Alaskan islands, and may account for the absence of Rhinoceros Auklets in the Aleutians, except at fox-free Buldir Island (Sowls et al. 1978). Manuwal and Campbell (1979) estimated 11,700 nesting pairs from British Columbia, another 11,415 pairs from the outer coast of Washington, and Wahl et al. (1981) reported 17,900 pairs from the Strait of Juan de Fuca. Only 100 pairs reportedly nest in Oregon, mainly at Oregon Caves (Varoujean and Pitman 1980).

The California nesting population of Rhinoceros Auklets numbers only about 180 pairs: 100 pairs at Castle Rock, 6 pairs at Prince Island (both Del Norte County), 50 pairs at Southeast Farallon Island, and another 25 pairs scattered among five suspected locations as far

south as Point Arguello (Sowls et al. 1980), Ainley and Lewis (1974) documented the history of this seabird species at southeast Farallon Island: nesting Rhinoceros Auklets were present on the island in small numbers in the mid-nineteenth century, but disappeared in the early 1860's until they occupied burrows there in 1972, The Farallones population is now thought to be expanding (DeSante and Ainley 1980).

Rhinoceros Auklets are burrow-nesters, excavating tunnels up to 6 m in length (Heath 1915, Willet 1915). Recently discovered colonies in Oregon (Scott 1973, Varoujean and Pittman 1980) and California (Sowls et al. 1980) indicate this species may also occupy rocky mainland nest sites. Their colonies are not amenable to aerial survey techniques so we present here no new colony data.

While attending east Pacific colonies, Rhinoceros Auklets feed mainly on a variety of small fishes, most notably Pacific sand lance, *Ammodytes hexapterus* (Heath 1915, Richardson 1961, Scaly 1973); whereas in the northwest Pacific they may take more euphausiids (Komaki 1967) and invertebrates (Koslova 1957). Sanger (1983) reported Capelin (*Mallotus villosus*) to be the most important prey item of adults taken near Kodiak Island, but found sand lance and Pacific herring (*Clupea harengus*) comprised the bulk of the diet of nestlings at Forrester Island. At the Farallones, Rhinoceros Auklets have been observed bringing "fish" to burrows (DeSante and Ainley 1980). In southern California, wintering Rhinoceros Auklets reportedly eat small crustaceans (Grinnell 1899) and small sardines (Linton (1908). Baltz and Morejohn (1977) found market squid (*Loligo opalescens*) predominant among twelve prey species (nine fishes, three cephalopods) from auklets wintering on Monterey Bay.

Rhinoceros Auklets regularly occur south of Alaska during the winter, but few workers have attempted to describe their winter distribution in any detail. Wahl (1975) stated that off Washington

Rhinoceros Auklet

they were common from spring through fall, but that their winter status was uncertain. Briggs et al. (1981a) reported on their occurrence in the Southern California Bight where average densities reached 0.5-2.0 birds/km² each winter; they preferred cool offshore waters, Ainley (1976) described the seasonal occurrence of Rhinoceros Auklets off California as peaking during December and January, decreasing substantially in February, most birds being gone by March.

Rhinoceros Auklets were recorded in most months of our survey. usually, they preferred waters beyond the continental shelf (>200 in), although significant densities often occurred over shelf waters adjacent to submarine canyons such as in Monterey Bay. Highest numbers were seen bimodally during winter, when northern immigrants visited California; lowest densities occurred during summer (Fig. 56). In contrast to Ainley (1976), we found that maximal study area-wide densities of Rhinoceros Auklets (combined over three years) prevailed from December through March; most birds were gone by April, and substantial numbers returned to California as early as October.

During the nesting season (May-August), the few Rhinoceros Auklets remaining in the study area were found mainly in the vicinity of the Farallones colony; occasionally low numbers were seen near the Point Arguello and Castle Rock (Del Norte County) colonies, and at other scattered locations. Overall densities never exceeded 0.06 birds/km² during this time.

Immigration of Rhinoceros Auklets into California waters was detected each autumn when elevated densities first appeared north of Cape Mendocino. Average summer densities of near zero within the Cape Mendocino-Oregon region initially increased to 0.75-2.35 birds/km² each October (November in 1982), accounting for 40-60% of the estimated visitors. overall densities varied between 0.2 and 0.8 birds/km² at this time. By November or December, northern densities dropped substantially, average study area-wide densities

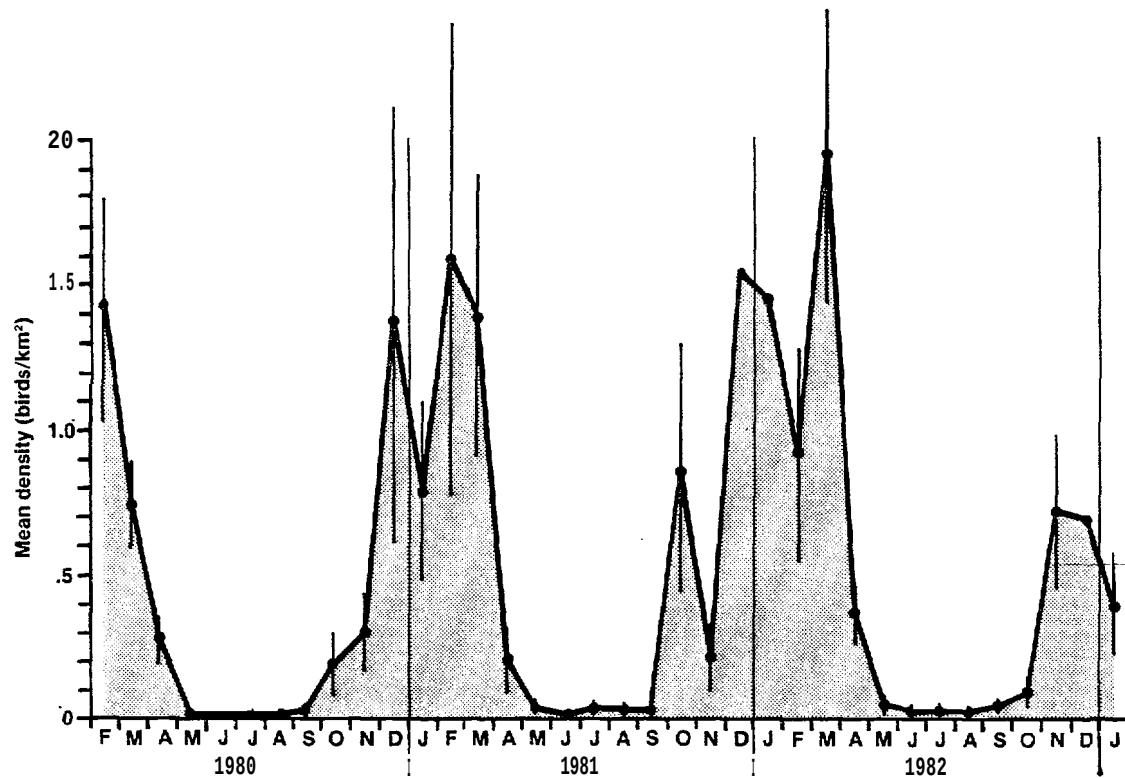


Figure 56. Monthly mean density of Rhinoceros Auklets in waters of central and northern California, 1980-1983.

reached sub-maxima (0.75 to 1.60 birds/km²), and the bulk of the auklet population moved south, locating mainly between Point Sur and Bodega. For the majority of the winter, 50%-95% of the Rhinoceros Auklets we saw in the study area occupied waters between Bodega and Point Conception. We recorded densities of up to 150 Rhinoceros Auklets/km², but concentrations of over 20 birds/km² were rare; Rhinoceros Auklets did not clump into dense feeding clusters as readily as Cassin's Auklets.

During midwinter (January or February) each year, we observed a sudden drop in overall Rhinoceros Auklet densities extrapolating to approximately 130,000 to 150,000 birds. This decrease in the population coincides with the timing of the abrupt annual peak in auklet occurrence (roughly 180,000 to 250,000 birds) in southern California (Briggs et al. 1981a), and may, in fact, reflect the

passage of these birds past Point Conception. These months were also the period of maximal southern occupancy of our study area, when 85%-95% of the auklets appeared to be south of Bodega.

Highest overall densities (1.5-2.0 birds/km²) in central and northern California were reached the month following the midwinter decline each year (February 1981 and March 1982) as, we suspect, birds exited northward from southern California and moved through our study area to their northern colonies (Fig. 57). During this time, the bulk of the east Pacific Rhinoceros Auklet population probably occupied the waters off central and northern California. Each April, densities dropped abruptly toward low summertime levels.

Fig. 58 compares the proportions of wintering Rhinoceros Auklets projected to occupy the shelf {depth <200m), slope (200-2000 m), and offshore (>2000 m) waters of the study area each month. These are birds of the slope and offshore zones: in all months except October 1982 (in which latitudinal distribution indicated pre-immigration), 70%-95% of the Rhinoceros Auklets present occupied waters seaward of the continental shelf. Although this distribution closely approximates that of wintering Cassin's Auklets and there was much overlap between the two species, Rhinoceros Auklets usually were found to inhabit waters seaward of Cassin's Auklets.

3d . Annotated Species List

The following annotated list briefly describes the historical and present occurrence of each seabird species known to occur off central and northern California (Jones et al. 1981). Unless specifically noted in accounts, world or North American population sizes are unknown. Table 3 gives nesting population sizes for some Pacific Coast breeders. All waders, shorebirds except phalaropes, and all waterfowl, except typically marine species are excluded from

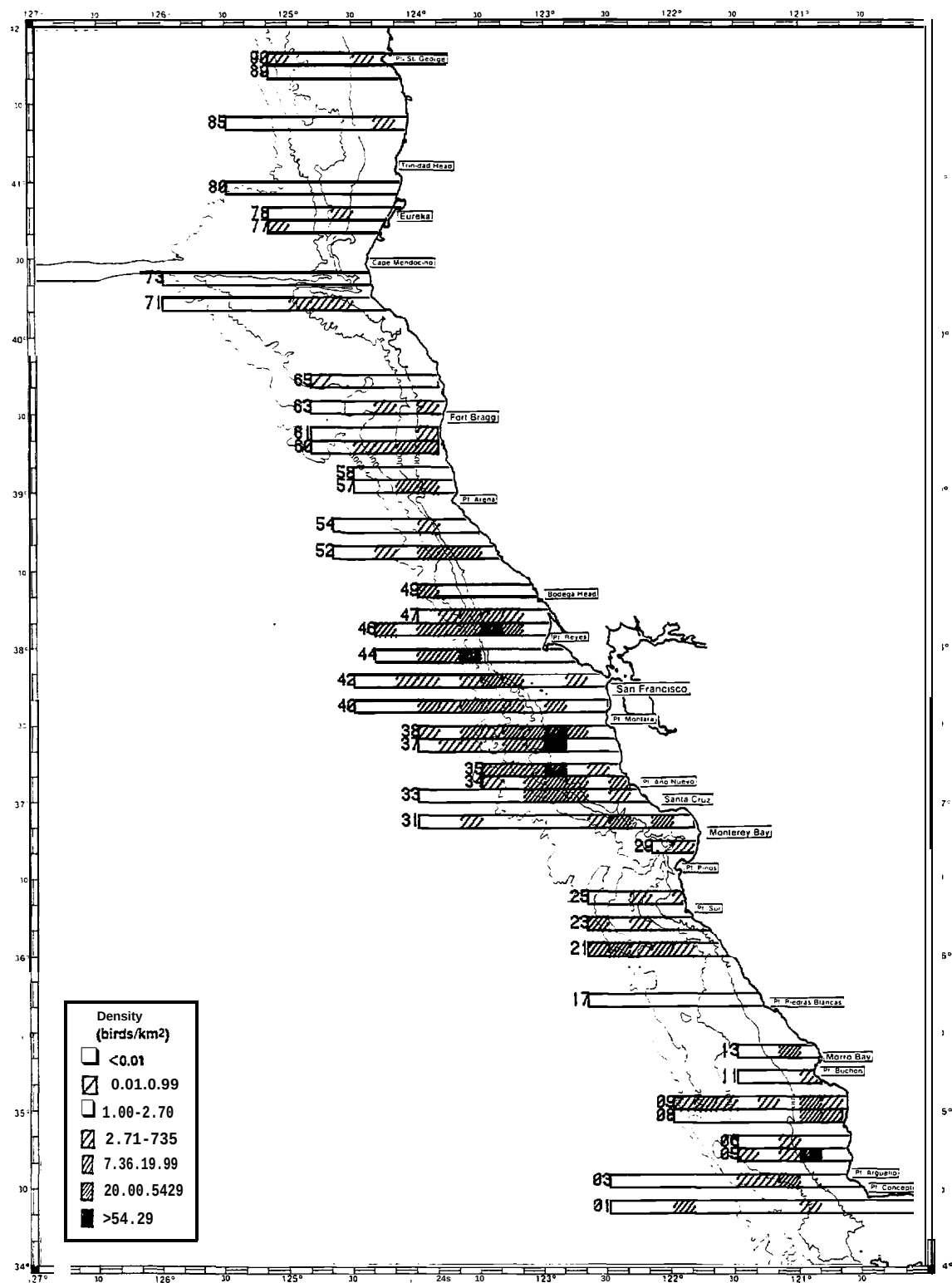


Figure 57. Density of Rhinoceros Auklets and unidentified medium-sized alcids in waters of central and northern California, February 1981.

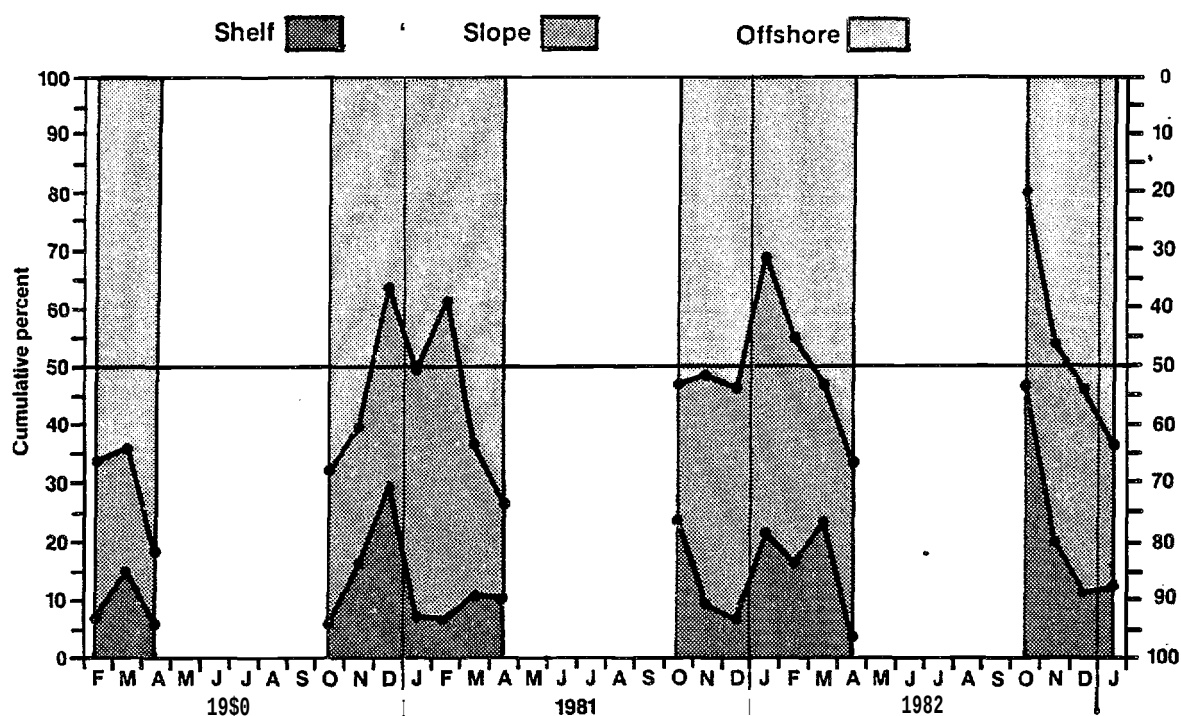


Figure 58. Relative abundance of Rhinoceros Auklets occupying shelf (0-199m), slope (200-1999m), and offshore (≥ 2000 m) waters of central and northern California, February 1980-January 1983..

consideration. In parentheses following many accounts are listed figure numbers corresponding to maps of distribution that appear beginning on page 213 in Section 6, Appendix-Distributional Graphics. In the interest of brevity, literature sources for historical information are not cited individually but are listed here: Ainley (1976), Ainley and Manolis (1979), American Birds (1977-1983), Baltz and Morejohn (1977), Bellrose (1976), Briggs et al. (1981a), Crossin (1974), DeSante and Ainley (1980), Hasegawa (1977), Helm (1980), Holmes (1984), Holmes and Cronshaw (1977), Jones et al. (1981), McCaskie et al. (1979), McHugh (1950), Morejohn (1978), Palmer (1962), Pyle and DeLong (1968), Remsen and Binford (1974), Sanger (1973, 1974a, 1974b), Small (1974), Sowls et al. (1978), Sowls et al. (1980), and Stallcup (1976). R.L. Pitman

supplied us with many unpublished sighting records, and D.W. Anderson provided breeding bird estimates for Baja California.¹

ORDER GAVIIFORMES

Red-throated Loon

(*Gavia stellata*)

This loon is an uncommon to common migrant and winter resident along the coast; a few nonbreeders remain through summer. They prefer waters very near the coast and are the least frequently seen loon >5 km offshore.

Present study. Somewhat larger numbers were recorded during spring migration (March through May) than in fall, **probably** reflecting increased detectability. Population estimates from three April surveys ranged from 3,800 to 16,400 birds; fall numbers are probably similar (though fewer **Red-throateds** were identified **among large** numbers of unidentified loons), while mid-winter numbers were somewhat lower. This species accounted for 16% of all loons identified to species on three **May coastal surveys**. They appeared to migrate earlier in spring and **later** in fall than other loons. This may reflect greater distance to nesting areas or a "more leisurely pace" (Palmer 1962). They were rarely seen seaward of the shelf break.

Key to terms for **seabird** abundance:

Abundant = Seen *in* large numbers in preferred habitat during season(s) of maximum abundance; estimated instantaneous population in central and northern California more than 50,000.

Common = *Seen* in large numbers in preferred habitats during season(s) of maximum abundance; estimated instantaneous population in central and northern California 5,000-50,000.

Uncommon = Not seen on every trip even in preferred habitats; occurring in relatively small numbers; estimated instantaneous population in central and **northern** California typically not more than 5,000.

Rare = Only a few records each year.

Accidental = Not a part of the expected fauna.

* Nests in the study area.

Records exist in the literature, but not seen by us in 1980-1983.

Arctic Loon
(*Gavia arctica*)

See Section 3c.

Nesting on freshwater lakes along the Arctic **Circle** and wintering along the Pacific coast from southeast Alaska to southern Baja California, this is the most **abundant** loon found off California and the most pelagic. Though they are present off California in all months, Arctic Loons are least numerous in **summer**, when only a few hundred non-breeders remain.

Present study. Arctic Loon migration peaked each year in April and November. **We** estimate that 75,000 to 287,000 Arctic Loons occurred at once during each month of peak migration, while midwinter and summer numbers were on the **order** of 1,000 to 5,000. Despite wide occurrence in migration, preferred coastal wintering areas were relatively few. *On* average, 36% of wintering loons were seen from Point **Montara** to **Bodega**; Monterey Bay averaged 17%, and **11%** occurred from Point **Buchon** to Point **Piedras Blancas**.

Common Loon
(*Gavia immer*)

This loon is an uncommon migrant and winter visitor which resides primarily on protected coastal waters, bays, and estuaries. A few individuals usually **oversummer**.

Present study. The largest numbers of Common Loons were recorded during spring migration (April-May), **probably** reflecting increased detectability. Population estimates from three April surveys ranged from 3,800 to 9,200 birds. This species accounted **for** 10% of all loons identified to species on three May coastal surveys. **We rarely** saw Common Loons on open coastal waters during winter.

#Yellow-billed Loon
(*Gavia adamsii*)

This is a very rare visitor along the mainland coast. Most sightings have occurred during October through April from Monterey Bay to Bodega, but records exist for summer months and latitudes south to Baja California.

ORDER PODICIPEDIFORMES

Horned Grebe

(*Podiceps auritus*)

Horned Grebes are uncommon along the coast during migration and winter and are *rare during summer*. They are **least numerous** south of Point Sur. Preferring protected coastal waters, lagoons, etc., Horned Grebes are rarely found seaward of the littoral zone. They are **about** as abundant **coastally** as the Eared Grebe and much less so than the Western. They **exhibit** stronger affinity for salt water than do Eared Grebes.

Present study. These grebes usually were not distinguishable from Eared Grebes during aerial surveys. Low numbers (up to 66 birds) of unidentified small grebes were recorded on most near-coast surveys (except summer); most sightings occurred from Point Sur to Point Arena. The late January 1980 coastal survey counted over 1,800 unidentified grebes (1,147 on Tomales Bay).

#Red-necked Grebe

(*Podiceps grisegena*)

Red-necked Grebes are a rare but regular visitor along the coast. Most sightings occur during winter and migration from Monterey Bay north. They prefer estuaries, harbors, and bays, but can occur along the open coast, even offshore.

Eared Grebe

(*Podiceps nigricollis*)

These grebes are uncommon to common along the coast in most seasons, but are rare in summer. Eared Grebes are more gregarious than Horned Grebes and often are distributed farther south. This species prefers protected bays, estuaries, and harbors, but during winter can be quite numerous at offshore islands including the Farallones.

Present study. See Horned Grebe.

Western Grebe

(*Aechmophorus occidentals*)

See Section 3c.

With major nesting colonies on lakes and ponds from northern California through the Rocky Mountains into Canada, Western Grebes are a prominent component of the seabird fauna wintering off central and northern California. Migration to Salt Water occurs from late September through autumn, and return migration occurs mainly in April and May. The portion of the wintering population occurring off California varies but little each year, though substantial shifts occur along the coasts of Washington and British Columbia.

Western Grebe (continued)

Present study, We found substantial annual variability in grebe populations along the coast, at least some of which was **probably** related to inland movement of birds during stormy weather. **Population** peaks occurred in November, December, or January each year, with a maximum coastal count of **24,580** birds, Western Grebes concentrated near the shoreline, over sandy substrates; protected waters south of promontories were preferred. The waters from Point **Montara** to **Bodega** harbored an average of 45% of all **grebes** in winter (up to 75% on single **May** surveys), while an average of 20% of the **total** was seen from **Trinidad** to **Point St. George**.

ORDER PROCELLARIIFORMES

#Wandering Albatross

(*Diomedea exulans*)

This species is regarded as accidental; the only **North Pacific record** is of a **subadult** female photographed *on shore in Sonoma County* during July 1967.

#Short-tailed Albatross

(*Diomedea albatrus*)

Formerly common *near* the California coast, Short-tailed Albatross now are exceedingly rare. There exist only three California records since 1946, the most recent being a **subadult** seen 80 km off Monterey **Bay** in **April 1980**. The world population now *numbers* perhaps 250+ birds and is increasing very slowly.

Black-footed Albatross

(*Diomedea nigripes*)

The commonest of the albatrosses, the Black-footed is present year-round offshore; peak numbers occur during late spring and summer. Densities are highest in cooler waters. Black-footed **Albatross** often associate with large fishing and transport vessels. The **world** nesting population numbers about 100,000.

Present study. **Numbers** of Black-footed **Albatrosses** began to increase in March and April, peaked from May through **July**, then declined gradually through September. They were scarce during winter (*October* through February). The estimated population peaked at 15,000 to 75,000 birds and **fell** below 1,600 birds during winter. Black-footed Albatross were most abundant from Cape **Mendocino** north during summer and from Point **Reyes** north in other seasons; they were scarce south of Point Sur. Densities were highest *over* continental slope waters, slightly lower over the *outer shelf* and much lower far offshore. (Figs. 59, 60) "

Laysan Albatross

(*Diomedea immutabilis*)

'Exceedingly rare off California prior to 1950, Laysans now are rare but regular offshore in late autumn through spring. The world nesting population numbers about 600,000.

Present study. We recorded thirty-three sightings of single individuals; all but two (August 1982) were in November through April and all but five were north of Monterey Bay. Their distribution was irregular: in winter 1980 they were widespread, while in winter 1980-81 they were present mostly south of Point Arena. They were absent the following year, and present mostly north of Point Arena in 1982-83. Most birds were observed seaward of the shelf break. (Fig. 61)

Northern Fulmar

(*Fulmarus glacialis*)

See section 3c.

Nesting abundantly throughout the Arctic, fulmar populations in Alaska are estimated to total about 12 million, including 38% non-breeders. After nesting they disperse to California waters, where they constitute an important part of the offshore fauna each winter. Numbers here are reported to vary considerably from year to year.

Present study. Fulmars arrived off northern California by October each year and reached peak densities in early winter. A midwinter dip in estimated populations brought numbers down from as high as 291,000 to as low as 33,000. Late winter population increases probably resulted from northward movement of birds wintering south of central California. When birds were abundant in winter (1981), a few lingered through the following summer. At times of maximum numbers, fulmars generally were most abundant from Point Pinos to Bodega and least so south of Point Sur. To some extent the fulmars reputation for extreme interannual variability in abundance results from relocations of populations from one area to another off central and northern California; populations seaward of the continental slope are less variable than those closer to shore.

#Cape Petrel

(*Daption capense*)

This species is regarded as being accidental; there exists one possible record from Monterey Bay September 9, 1962.

***Pterodroma* spp.**

The occurrence of these southern hemisphere petrels in North American waters is poorly known. However, four species have been recorded off California in recent years, as follows:

#Mottled Petrel
(*Pterodroma inexpectata*)

A very rare migrant in coastal waters during late winter and spring, this species occurs closer to the Pacific coast in cool winters. Mottled Petrels are much more common west of the California Current than in the study area.

#Cook's Petrel
(*Pterodroma cookii*)

The first sightings of this species from California coastal waters occurred near Davidson Seamount during fall 1980. They were also recorded several hundred km southwest of Point Conception during spring and summer 1967-1968. Cook's Petrels are probably regular visitors in California Current waters during autumn.

#Stejneger's Petrel
(*Pterodroma longirostris*)

One was recorded November 17, 1979 at Davidson Seamount with several Cook's Petrels.

#Solander's Petrel
(*Pterodroma solandri*)

Twenty birds seen by R. Pitman, 65 to 110 km offshore from Point Reyes to Cape Mendocino on May 21, 1981 represent the only records.

Present study. Plumage similarities and relative rarity rendered these species difficult to detect (among other procellariiforms) and impossible to distinguish for airborne observers. We totalled eleven sightings of unidentified *Pterodroma* petrels--ten in spring (March-June), and one in fall (November). All sightings occurred well offshore, and their locations were scattered.

#Streaked Shearwater
(*Calonectris leucomelas*)

The first and only specimen record for the Western Hemisphere came from Monterey Bay in October 1975. Since then, additional Monterey Bay sightings of this Japanese shearwater occurred in October in 1977, 1978, and 1982.

Pink-footed Shearwater

(*Puffinus creatopus*)

Pink-footed Shearwaters are uncommon to abundant visitors from late spring through early autumn, and are **rare** in winter. They are most numerous south of Monterey Bay. This is the second most numerous shearwater close to shore in central California in summer, but it is outnumbered almost everywhere over the shelf by the Sooty, and **over** the slope in August by the **Buller's**.

Present study. Pink-footed Shearwaters were present during April through September and scarce or absent October through May. During 1980 and 1981 birds arrived in April and May, the population increased rapidly in June and **July** and peaked in September, then declined abruptly **in** October. We estimated the peak population to be about 130,000 birds. The majority of sightings occurred on slope and shelf waters south of Point Arena. In 1982 large numbers of Pink-footed Shearwaters arrived in the central region in May, but by July none remained; a **modest** peak was attained in September (20,000 birds), with most birds seen from Monterey Bay north. Independent shipboard observers reported concentrations of 10-20,000 birds in Monterey Bay at that time. (Figs. 62, 63, 64)

Flesh-footed Shearwater

(*Puffinus carneipes*)

This species is present in very low numbers during autumn and is rare and irregular in other seasons. They appear to prefer warmer southern waters and may be absent in the coolest years.

Present study. This is a difficult species to identify by aerial survey; one possible sighting occurred in October 1980 near **Cordell** Bank. Shipboard observers reported a probable Flesh-footed Shearwaters near Guide **Seamount** in September **1981** and possibly one north of Monterey Bay" **in May** 1981.

#Greater Shearwater

(*Puffinus gravis*)

The only North Pacific record of this species was of a bird seen in Monterey Bay during February 1979.

Buller's Shearwater

(*Puffinus bulleri*)

This species was formerly considered to be an uncommon to (locally) common migrant in late summer and autumn, particularly in waters near the shelf break. Spring and winter records are very rare. **Buller's** appear to be increasing in abundance off central California in recent years.

Present study. We observed **Buller's** Shearwaters from July through November each year, Peak numbers occurred in August and September; population estimates at this time ranged to at least

Buller's Shearwater (continued)

150,000. During peak months, density was highest offshore, seaward of the shelf break. Density often increased nearer shore later in the year (October). Highest numbers were usually found from Point Sur to Point **Reyes**, but during the August 1981 peak, most birds occurred from **Bodega** to Trinidad. (Figs. 65, 66)

Sooty Shearwater
(*Puffinus griseus*)

See section 3c.

Many recent authors regard Sooty Shearwaters to be among the most important of avian predators in the North Pacific during spring and summer. Nesting both off South America and in the southwestern Pacific, Sooty Shearwaters arrive off California in early spring and reach peak populations in May through July. Flocks numbering in the tens or hundreds of thousands have been reported. Return migration occurs after August, with most birds departing by mid-September. **Sooties**, presumably young birds, may be found off California in any month.

Present study. Sooty Shearwaters occurred in mean densities exceeding **1 bird/km²** from April through September each year, reaching a peak of 9.5 to 13.6 **birds/km²** in May, June, or July. Combined populations off all of California are estimated to reach maxima around **3.7** million. Concentrations were noted everywhere over the shelf with a spectacular **flock** of more than 600,000 birds in northern Monterey Bay in June 1981. The coolest (upwelling) and warmest (offshore) waters were little utilized; **11-14°C** waters were preferred. Thermal fronts bordering **upwellings** attracted feeding shearwaters in large numbers.

Short-tailed Shearwater
(*Puffinus tenuirostris*)

This species is an uncommon and sporadic visitor in autumn, winter, and spring. In Monterey Bay this may be the most abundant winter shearwater, but records are rare south of there.

Present study. This species is very difficult to distinguish from the Sooty Shearwater. Any unidentified shearwater sighted during mid-winter may have been of this species.

Manx Shearwater
(*Puffinus puffinus*)

One possible record exists for this Atlantic species from Monterey Bay in October 1979.

Black-vented Shearwaters

(*Puffinus opisthomelas*)

This is an uncommon autumn visitor; it is rarer in other seasons. Unknown numbers of this species nest on islands off Baja California. Black-vented Shearwaters prefer warm, nearshore waters and are most frequently seen south of Santa Cruz; they are very rare north of Point Reyes. Formerly, they were more abundant.

Present study. Small numbers were observed in February and August 1980, July through December 1981, and November 1982. Most birds were sighted on shelf waters south of San Francisco. Three probable Black-vented Shearwaters near Eureka in December 1981 could constitute an unusual northerly record.

/)Townsend's Shearwaters

(*Puffinus auricularis*)

There is one possible record from Monterey Bay in November 1977.

#Wilson's Storm-Petrel

(*Oceanites oceanicus*)

This is a very rare visitor to central and northern California during August through November; the only spring record was in 1978. They are seen more frequently in Monterey Bay than anywhere else in the eastern North Pacific.

*Fork-tailed Storm-Petrel

(*Oceanodroma furcata*)

This species nests at six sites in northern California (the southern nesting range limit), The California nesting population totals 310+ birds, Present throughout the year, they disperse to offshore areas as far south as southern California in midwinter.

Present study. We observed Fork-tailed Storm-Petrels in all months, usually in low numbers, but sometimes in concentrations at latitudes near colonies. During spring and summer most birds were observed beyond the shelf break north of Cape Mendocino. During winter we found them distributed farther south and offshore. (Figs. 67, 68)

*Leach's Storm-Petrel

(*Oceanodroma leucorhoa*)

See section 3c.

One of the most wide-ranging and abundant storm-petrels of the Pacific, Leach's nest from southeast Alaska to central Baja California. They are generally found over cold waters during nesting season and over subtropical or tropical waters in winter. Their migratory habits are poorly known.

Leach's Storm-Petrel (continued)

Present study. Though we **observed** Leach's Storm-Petrels offshore throughout **the** year, they were distinctly most abundant during spring and summer. Reaching mean densities above 1 **bird/km²** in early summer, Leach's concentrated primarily offshore north of Cape **Mendocino** in spring, and everywhere seaward of the shelf later in the year. In fall and winter, populations were **low** and were located primarily seaward of the continental slope, south of San Francisco. About 90% of **the** state's 18,000-bird nesting population attends colonies on rocks north of Trinidad.

*Ashy Storm-Petrel
(*Oceanodroma homochroa*)

The world nesting population of about 5,200 birds is centered on the **Farallones (80±%)**. **Ashys** are found **all year** near their colonies with most birds at sea in autumn. Large rafts are reported from Monterey Bay each autumn.

Present study. Generally, Ashy Storm-Petrels were most abundant at sea from September through January, and they were scarce in other months. **An increase** in density began each fall as **early** as **August** (1981) and as late as October (1982); in **1981**, **few** were seen after November. During autumn most were birds found on slope waters from Monterey Bay to Bodega and south of Point **Buchon**. **Ashys** were more numerous on *offshore* waters by **December**, suggesting that most birds may winter well offshore. On only one occasion (27 July 1981), did we see a large flock; 1,000 birds were seen in central Monterey Bay. (Fig. 69)

#Wedge-rumped (Galapagos) Storm-Petrel
(*Oceanodroma tethys*)

Apparently only three records **exist** for central and northern California: January 1969 and September 1977, from **the Monterey-Carmel** Bay area; and December 1, 1979 at Davidson **Seamount**.

Black Storm-Petrel
(*Oceanodroma melania*)

The Black Storm Petrel is found off southern California (where it is a rare breeder) in all months. Nesting populations in the Gulf of California number above 100,000 individuals. They are present in central California only in late summer through autumn and are rare north of Monterey Bay. Thousands "raft" in Monterey Bay with other storm-petrels during autumn.

Present study. Low numbers were observed each year from May through **November**. Few sightings occurred north of Monterey Bay " and none north of **Bodega**. We found these birds primarily on continental **shelf** waters.

Least Storm-Petrel
(*Oceanodroma microsoma*)

Rare autumn visitors to central California, they are recorded north to Humboldt County and are seen only in years of warm sea temperatures. Nesting populations in the Gulf of California number above 100,000 individuals.

Present study. We observed several "very small dark storm-petrels", possibly **Leasts**, south of Monterey Bay in January 1983; at that time sea surface temperatures were 1-2°C higher than the 20-year mean,

ORDER PELECANIFORMES

#White-tailed Tropicbird
(*Phaethon lepturus*)

This species is accidental off California. There is one possible record from Monterey Bay in March 1970 and one near-coast record from southern California in spring 1964.

Red-billed Tropicbird
(*Phaethon aethereus*)

This is a rare visitor from Mexican waters during summer and fall, About one thousand pairs nest in the Gulf of California. It may be more common far offshore than coastal records indicate. Only 5 records exist north of Morro Bay (though a 1941 specimen record exists for Washington); 34 recent records from 75-200 km south and southwest of Point Conception spanned the months June through January.

Present study. See Red-tailed Tropicbird.

#Red-tailed Tropicbird
(*Phaethon rubricauda*)

This is an extremely rare visitor, though it may be regular far offshore. This species was first recorded at the Farallon Islands in July 1979; two more were observed 180-240 km off central California in autumn 1979.

Present study. We recorded two probable sightings of this species in July 1981; one 90 km west of Point Arguello, and another 75 km west-northwest of Point Arena. The latter would represent the northernmost record for the species. Additional sightings of unidentified tropicbirds were: one off Point Pines in July 1980; one 100 km west of Monterey in June 1982.

#Blue-footed Booby
(*Sula nebouxii*)

This is a rare visitor from Mexican waters during very warm years, Gulf of California nesting populations number about 100,000 individuals, California records (primarily immatures) span the months August through October, except one off Point St. George in January 1981.

#Brown Booby
(*Sula leucogaster*)

This is an extremely rare visitor in summer from Mexican waters. Gulf of California nesting populations number about 100,000 individuals. One recent record exists from Davenport in July 1975.

#Red-footed Booby
(*Sula sula*)

The only state records of this species were of two different individuals on South Farallon Island in August and October 1975.

American White Pelican
(*Pelecanus erythrorhynchos*)

White Pelicans are uncommon but regular along the open coast during autumn and winter, when large numbers occupy nearby protected bays (e.g., up to 2,000 on San Francisco Bay). They are rare north of Sonoma County.

Present study. We found up to 169 birds during six autumn and winter coastal surveys; virtually all were in or near Drake's, Tomales, and Bodega bays.

Brown Pelican
(*Pelecanus occidentals*)

see section 3c.

Brown Pelicans formerly nested in central California at Point Lobos, successfully raising young there as late as 1959, but not thereafter. Occurring in the study area now primarily as summer-fall visitors from colonies in Mexico, pelicans remain a prominent component of the fauna of the shoreline and neritic waters. Maximum numbers occur from July through October and few birds are present in winter or early spring.

Present study. Pelicans occurred in all months along the south-central coast, with population lows (less than 500 total birds) in January. Numbers increased steadily, and progressively northward roost occupation occurred after midspring. More than 25,000 pelicans occupied coastal roosts in September 1981. Maximum numbers occurred at Seal Beach Rocks, Bird Island (Point Lobos), Elkhorn Slough, Año Nuevo Island, South Farallon Island, Bird Island (Marin County), and Bird Rock

Brown Pelican (continued)

(**Bodega** Bay); over 1,000 birds were counted at each site during at least one summer or fall survey. Use of coastal roosts was unpredictable, but the Monterey-Bodega and Point Conception-Point **Buchon** regions were **clearly** the most heavily used.

Birds foraged offshore to 88 km (3,000+ m depth), primarily off Point Sur to **Bodega**. The great majority of foraging pelicans were seen within 20 km of shore.

*Double-crested Cormorant

(*Phalacrocorax auritus*)

Uncommon as a nesting species the length of California, 60% of the (1,885± bird) coastal population of Double-crested Cormorants nests north of Cape Mendocino. Significant declines in this population since 1900 have been followed by slight recoveries in the last decade. Foraging is done near shore. They frequent fresh and brackish water much more than the two other cormorants listed here and many nest inland. During fall, the coastal population is augmented by inland nesters, though most-withdraw from exposed coast and inhabit protected areas during winter; some birds may also withdraw southward.

Present study. Often this species was difficult to distinguish from other cormorants. Up to 196 were identified on coastal surveys with the largest numbers found in autumn from Monterey Bay to Bodega, including **Tomales** Bay.

*Brandt's Cormorant

(*Phalacrocorax penicillatus*)

See section 3c.

Brandt's Cormorants are, to a large extent, endemic to California Current waters. Their 59,000-bird nesting population is third largest among central and northern California species; the **Farallon** Islands harbor the world's **largest** colonies. Formerly thought to be sedentary throughout their range, it now appears that after August, Brandt's Cormorants disperse both northward and southward from colonies in northern California. This is the most abundant cormorant **offshore**, but usually is found over waters less than 100 m deep.

Present study. Large numbers of **Brandt's** Cormorants occurred along the coast in **all** seasons, reaching annual maxima of 46,000 to 56,000 in early July. (A few thousand of these may have been Pelagic or Double-crested, but specific identification was often impossible.) The largest colonies include the **Farallon** Islands, Bird Island (Point **Lobos**), Point **Reyes**, Cape **Vizcaino**, and Castle Rock. Total numbers declined to winter lows of 6,000 to 15,000, with movement **away** from northern California. Sightings occurred offshore near all colonies and roosts with about 85% in waters no more than 10 **km** offshore.

*Pelagic Cormorant
(*Phalacrocorax pelagicus*)

With a total nesting population of almost 16,000, Pelagic Cormorants rank as California's sixth most numerous breeding species. Unlike Brandt's Cormorant, the Pelagic nests in low density on precipitous cliffs, occupying many hundreds of sites. This species is perhaps the least pelagic of the cormorants and appears to undertake no major post-nesting population movements.

Present study. It was very difficult to discriminate among the species of cormorants anytime except in nesting season, when the white flank patches of the Pelagic rendered them unmistakable. We identified no more than 460 Pelagics during individual coastal counts, and relatively few over open water, but many thousands of cormorants could not be positively identified each survey. Offshore sightings generally occurred within 5 km of shore, in water less than 30 m in depth.

#Magnificent Frigatebird
(*Fregata magnificens*)

A rare but regular visitor from Mexican waters in summer and fall, the Magnificent Frigatebird is most numerous in warm years. Nesting populations in the lower Gulf of California number perhaps 100,000 individuals. Records exist for June through October at sites as far north as Humboldt Bay; the only winter record is of one bird at Point Lobos, January 12, 1953.

ORDER ANSERIFORMES

Brant
(*Branta bernicla*)

Brant are uncommon migrants and winter residents the length of the state; a few summer along the coast. Formerly, as many as 40,000 wintered in central California, but the population is now reduced due to hunting pressure and destruction of eelgrass beds, their favored feeding habitat. Brant migrate along the open coast, even well offshore, but usually winter on protected bays. Large concentrations are found in Humboldt Bay during spring.

Present study. We recorded five sightings of up to 12 birds up to 90 km offshore during migrations (March through May and November). The highest coastal count was 120 birds in May 1982 with most birds in Humboldt, Drake's, and Tomales bays. Few Brant were seen in winter.

#King Eider

(*Somateria spectabilis*)

A rare visitor to central and northern California waters from the far north, this species has been recorded throughout the year. It is seen most frequently in the colder months, often in harbors. The North American population numbers above 1 million.

#Harlequin Duck

(*Histrionicus histrionicus*)

Harlequin Ducks are very uncommon migrants and winter residents along the open coast, Individuals are seen through summer, though most birds depart marine waters by May. up to 1,000,000 birds nest in Alaska.

Oldsquaw

(*Clangula hyemalis*)

A rare winker visitor along open coasts and deeper bays south at least to Morro Bay, the Oldsquaw is somewhat more numerous in far northern California. The North American population has been estimated at 3-4 million.

Present study. One was observed by shipboard observers inside the harbor at Half Moon Bay in February 1981.

Black Scoter

(*Melanitta nigra*)

This is a rare to uncommon migrant and winter resident, Though they are quite scarce south of central California, Black Scoters may be locally numerous north of Point Reyes in some years. Occasionally, individuals overwinter as far south as San Diego. The North American population is thought to be about 0.5 million birds.

Present study. These are not easily distinguished from the other, more abundant scoters during aerial surveys. Black Scoters were not recorded, but were undoubtedly present in low numbers.

Surf Scoter

(*Melanitta perspicillata*)

See section 3c.

The most abundant of marine waterfowl in coastal waters and migration, Surf and White-winged Scoters together maintain North American nesting populations of over one million birds. All Surf Scoters in the world nest in Alaska and Canada. Scoters migrate over neritic waters and feed in shallow waters near the shoreline.

Present study. It was seldom possible to identify more than 20% of scoters seen during coastal surveys. However, Surf Scoters probably accounted for more than two-thirds of the total,

Surf **scoter** (continued)

especially south of Monterey. Peak numbers occurred from October through March and **only** a few thousand birds **over-**summered. Several tens of thousands appeared each fall north of Cape **Mendocino**, then spread southward **along** the coast by late November. **Scoters** concentrated over soft substrate (sand or mud), often in the lee of promontories. Major concentrations occurred **near Morro Bay**, Monterey Bay, **Tomales Bay**, and north of the Eel River. Birds wintering in **Tomales Bay** **probably** fed on herring eggs.

White-winged **Scoter**

(*Melanitta fusca*)

See section 3c and Surf **Scoter** above.

Red-breasted Merganser

(*Mergus serrator*)

The Red-breasted Merganser is an uncommon migrant and winter resident **all along** the coast of California. A few non-breeders are present through the summer. About 75% of the estimated **winter** population (1,000 birds) is found in central and northern California. The North American population is thought to number about one-quarter million birds.

Present study. These ducks were difficult to detect in their favored littoral zone habitats. Up to twelve were identified on **coastal surveys** (none in summer); most were seen from **Morro Bay** to Point Arena.

ORDER CHARADRIIFORMESRed **Phalarope**

(*Phalaropus fulicarius*)

See section 3c.

Red **Phalaropes** and Red-necked **Phalaropes** nest *in* large but unknown numbers throughout Arctic North America and migrate through and winter off California. Much circumstantial evidence suggests that Red-necked **Phalaropes** migrate earlier and **closer** to shore than do Reds. These two species usually are impossible to distinguish during aerial surveys.

Present study. We found **phalaropes** to be among the most numerous of all seabirds off central and northern California from July through May, even eclipsing the shearwaters in abundance during spring. Reaching estimated total numbers above 2.5 million in October, they were a dominant part of the fauna everywhere except near the shoreline {and even there, at some localities}. During autumn **Phalaropes** concentrated for feeding within sharp thermal fronts bordering **upwellings**. Migration was much more **rapid, probably** with less *lingering* ~~to~~ feed, during spring than in fall.

Red-necked Phalarope

(*Phalaropus lobatus*)

See section 3c and Red Phalarope above,

Pomarine Jaeger

(*Stercorarius pomarinus*)

This is a common fall migrant and uncommon winter resident offshore, but few are seen during summer. This is the most numerous jaeger in migration, especially seaward of the shelf break.

Present study. Pomarines were observed throughout the year at all latitudes in all water depth strata. They were most abundant during southbound migration (September-October) when the estimated population at peak (of Pomarine and unidentified jaegers) ranged from 32,000 to 66,000 birds. Moderate numbers (estimated 7,000-18,000) were present from November through April, but few were seen from May through July. Although Pomarine Jaegers generally occupied most latitudes of the study area uniformly, their distribution relative to depth was seasonally variable. During fall migration (August-September) most birds were seen on slope and offshore waters, until October when highest densities shifted to the shelf. They were distributed fairly evenly during November through January, but from February through July densities were generally highest well offshore, and lowest on the shelf. (Figs. 70, 71, 72, 73)

Parasitic Jaeger

(*Stercorarius parasiticus*)

This is an uncommon migrant and winter visitor. It is much less numerous overall, but more often seen near the coast than is the Pomarine Jaeger.

Present study. Parasitic Jaegers were not always distinguishable from other jaegers during aerial surveys. Eighteen sightings spanned the months March-April and August through December; the maximum number (6) was sighted in November 1982. This species was usually observed on shelf and slope waters. (Fig. 74)

Long-tailed Jaeger

(*Stercorarius longicaudus*)

A very uncommon to rare migrant and winter visitor, the Long-tailed Jaeger is most often seen during autumn, usually well offshore. Spring records suggest a possible inland migration, perhaps at high altitude.

Long-tailed Jaeger (continued)

Present study. We logged eight records of this species: five during autumn (September-October), two in January, and one in May; most were seaward of the shelf break. This species was not always distinguishable from other jaegers during aerial surveys. Some of the many unidentified jaegers were undoubtedly Long-tailed. (Fig. 75)

South Polar Skua
(*Catharacta maccormicki*)

A rare migrant in offshore waters throughout the state; the South Polar Skua appears to be most numerous from August through November. However, recent sightings in Monterey Bay (March through June) and southern California (late April through June) indicate that small numbers arrive from the southern hemisphere in spring as well.

Present study. We made eleven sightings of 12 Skuas spanning the months August-October; most were beyond the shelf break and south of Point Arena. The maximum monthly total was 5 seen between Point Año Nuevo and Point Reyes in September 1980. One bird seen west of Cape Mendocino in May 1980 was the only spring record, (Fig. 76)

#Laughing Gull
(*Larus atricilla*)

This is a very rare coastal migrant. Records of Laughing Gulls span the months of March-September, There is one (August 1977) record from the Farallon Islands.

#Franklin's Gull
(*Larus pipixcan*)

This species occurs very rarely along the coast in all seasons; sightings are slightly more frequent during migration than at other times.

#Little Gull
(*Larus minutus*)

Little Gulls are extremely rare vagrants in California, probably coming from the U.S. Gulf Coast via Mexico. Only five coastal records exist for central and northern California--two from the Monterey Bay area, two from the Humboldt Bay area, and one near Crescent City; these sightings were from various seasons.

#Common Black-headed Gull
(*Larus ridibundus*)

An extremely rare vagrant from the east coast and Europe, the Black-headed Gull is usually found among Bonaparte's Gulls on large bays during winter.

Bonaparte's Gull

(*Larus philadelphia*)

During migration Bonaparte's Gulls are abundant near the coast and common over the shelf and offshore. Numbers are much lower in winter, with most birds found at major bays and estuaries south of Bodega. Low numbers of birds oversummer in some years,

Present study. Large numbers of Bonaparte's Gulls were seen only during migration. Southbound birds arrived by September or October, and the population peaked sharply in November and declined in December. Few Bonaparte's were seen in January or February, Northbound migration commenced in March, peaked sharply in April and was over by the end of May. They were virtually absent during June through August.

Our estimates of the peak population ranged from about 130,000 to 530,000 birds (April 1981). Average densities were highest over shelf waters and lowest offshore on all April and November surveys. During 1981, 90-95% of the population was found on the shelf in both spring and fall. In contrast, during 1982 the population was fairly **evenly** distributed over different depth strata, with under 40% on the shelf in both spring and fall. (Figs, 77, 78, 79)

*Heermann's Gull

(*Larus heermanni*)

This is a common summer and autumn visitor from Mexico which stays very close to the coast. A few hundred thousand birds nest on islands in the Gulf of California. A few birds overwinter in central California. Most birds arrive after 1 May and depart by January. Unsuccessful nesting attempts, one at Alcatraz Island (San Francisco Bay) and two at Shell Beach Rocks, San Luis **obispo** County, were documented in 1980.

Present study. We found **Heerman's** Gulls each year from May or June through February; the highest numbers occurred from July through November. We never observed them more than 1 km offshore. Counts from three July coastal surveys ranged from 3,399 (1980) to 13,350 (1981) birds. In 1980, 85% were seen south of Point **Reyes**; in 1981, **over** 50% were south of Santa **Cruz**, but 31% were north of Trinidad; in 1982, over 60% were found Santa Cruz to Point Arena and only 20% south of there. These patterns were similar to those seen for *Brown Pelicans* (*q.v.*), indicating that environmental conditions south of the study area were probably influencing distribution of these species. Counts from three autumn coastal surveys ranged from 6,998 (October 1982) to 12,787 (September 1981) birds. In this season numbers were higher south of Point Reyes, with peak counts from Monterey Bay. Though numbers were generally found on the north coast, the coast between Trinidad and Oregon border

Heerman's Gull(continued)

accounted for 7-13% of the birds each year. Few birds were seen on May coastal *surveys*, except during 1981, when 152 were found between Point Reyes and Point Arena. January coastal counts ranged from 31 to 71 birds, with a distribution similar to that of the previous season (Fig. 80).

Mew Gull

(*Larus canus*)

An uncommon to common migrant and winter resident along the coast and in bays and estuaries, the Mew Gull is rarely seen seaward of the continental shelf. Mew Gulls are scarce during summer.

Present study. Small numbers of Mew Gulls were observed irregularly from November-February, primarily near the coast. **Often**, they were associated with windrows marking water mass boundaries. Possibly, Mew **Gulls were** present in other months, but were difficult to distinguish during aerial surveys.

Ring-billed Gull

(*Larus delawarensis*)

This is an uncommon to common migrant and winter resident along the coast; a few nonbreeders **oversummer**. Ring-billed Gulls prefer protected **bayshores** to the open coast; rarely are they seen more than a few km offshore.

Present study. These gulls are very difficult to distinguish during aerial surveys. They were undoubtedly present among the many unidentified gulls we recorded. Ring-billed **Gulls probably** don't account for a large percentage of the open coast **larid** population.

California Gull

(*Larus californicus*)

See section 3c.

Nesting primarily on bodies of fresh water east of the Sierra Nevada, California Gulls are nevertheless present in at least modest numbers along the Pacific Coast in all seasons. A small colony has become established in South **San** Francisco Bay in the last few years, the only such colony near the coast, This is an abundant **member** of the shoreline and neritic fauna from late summer through **midspring**.

Present study. California Gulls frequently went undetected **among** thousands of unidentified **gulls**. They were, however, observed regularly along the coast, where they numbered many thousands, and offshore to **at** least the central continental slope. Populations offshore peaked in November and March at an

California Gull (continued)

estimated 200,000-300,000. There was a suggestion of concentration of these birds off Eureka in early autumn and off Point Arena to Monterey during November and December. Populations remaining through summer were in the low thousands.

Herring Gull

(*Larus argentatus*)

This species is a common to abundant winter resident *along* the coast, most often seen at garbage dumps, fish docks, and islands with **pinniped** rookeries. Herring Gulls are seen in large numbers offshore throughout late autumn and winter. A few birds oversummer but most arrive after September and depart by April.

Present study. Each year moderate *numbers* of birds arrived by October or November. During 1980-81, and 1981-82, the Herring Gull population peaks occurred during December through February; but in 1982-83, the population declined after reaching **above-**average numbers in November and by January few remained; extremely warm SST's that winter presumably influenced distribution. Each year, most birds departed the area by April, and few were seen during May through September. Densities of Herring **Gulls** were generally highest over the continental shelf, but a substantial portion of the population visited slope and offshore waters December through March. The latitudinal distribution was variable, but far fewer birds were seen south of Point Sur than to the north. Because gulls are difficult to identify during aerial surveys, it is not easy to estimate population size with precision. We believe that during winter, in excess of 100,000 Herring Gulls were present, and that population peaks may have reached 300,000 or more individuals. (Figs. 81, 82)

#Thayer's Gull

(*Larus thayeri*)

As it was only recently **re-recognized** as a distinct species, the status and **seasonality** of **Thayer's** Gulls are poorly known. Apparently, moderate numbers winter along the California coast. This species exhibits greater preference for shoreline habitats than does the similar Herring Gull.

Present study, Same as the Ring-billed Gull,

#Lesser Black-backed Gull

(*Larus fuscus*)

An adult bird photographed near Monterey on January 14, 1978 was the first Pacific Coast record of this species.

*Western Gull
(*Larus occidentals*)

See section **3c**.

Ranking as the state's fourth most numerous nesting species, the Western Gull breeding population tops 50,000 birds, with more than 40 colonies of greater than 50 birds. Western Gulls are ubiquitous along the shoreline and in neritic waters, but appear not to venture inland or much beyond the continental slope. The world population of this California Current endemic is centered on the Farallon Islands.

Present study. Western Gulls were numerous every month in every region except waters seaward of the slope. Densities at sea were highest in autumn and early winter (0.5 to 1.0 birds/km²) and lowest in the nesting season (0.3 to 0.6 birds/km²); densities were lower by one third in autumn 1982, during onset of the El Niño event. Foraging at sea generally reflected locations and sizes of breeding colonies. At all times, combined shoreline and at-sea numbers were greatest from Monterey to Bodega, north of Cape Mendocino and south of Point Piedras Blancas.

Glaucous-winged Gull
(*Larus glaucescens*)

This is an uncommon to common winter resident along the coast and well out to sea. They are rare but regular in summer. About one-half million birds are thought to nest in Alaska. Many Glaucous-winged Gulls winter at pinniped rookeries; immatures are thought to outnumber adults offshore.

Present study. Glaucous-winged Gulls were present during all seasons. The fall influx began in September or October, and moderate numbers were observed November through March. The peak population (December 1980, February 1982) was estimated to be 35,000 to 50,000 birds. Only low numbers remained by May and these birds were scarce during summer. The pattern for the 1982-83 winter was similar to that for other gulls—an unusually high November peak was followed by a sharp decline in December and January. Densities of Glaucous-winged Gulls were generally highest on shelf waters, but moderate numbers of birds visited slope and offshore waters during winter months. Fewer birds were seen south of Point Sur than at other latitudes; later in the season (after January) numbers at sea were also lower north of Cape Mendocino. (Figs. 83, 84)

#Glaucous Gull
(*Larus hyperboreus*)

Glaucous Gulls **are** rare winter residents along the open coast and at garbage dumps throughout the state. Most birds are present October through May, and immatures are seen more frequently than adults. The Alaskan nesting population numbers around 20,000.

Black-legged Kittiwake
(*Rissa tridactyla*)

See section 3c.

Black-legged Kittiwakes nest in abundance throughout Arctic and subarctic North America. The Bering Sea nesting population accounts for **about** half of the world population of 5 million. After the nesting season Kittiwakes move to oceanic waters and disperse southward off North America, reaching as far south as northern Mexico. Earlier **accounts of their** occurrence off California implied great year to year variation in wintering numbers. Most kittiwakes return northward by early spring, though following winters of high **abundance** near the coast, some will linger through midsummer.

Present study, Peaking in density in midwinter at about 2.5 birds/km², kittiwakes were predominant members of the fauna over and seaward of the continental slope. Numbers over the shelf were variable, but kittiwakes clearly were more numerous north of the Russian River than to the south. During the 1982-83 warm water period, kittiwakes were numerous only in cooler waters well offshore, north of Eureka. Some interannual variability reported previously probably relates to **onshore-**offshore or north-south redistribution of similarly sized wintering populations.

Sabine's Gull
(*Xema sabini*)

The **Sabine's** Gull is an uncommon to common migrant offshore in spring and autumn; it is always very uncommon near shore. Migration in spring is more rapid and perhaps more geographically concentrated than in autumn. Midsummer sightings are not unusual, but very few winter records exist for California.

Present study. We observed **Sabine's** Gulls from April through September 1980, and from May through October in 1981 and 1982. Densities were higher during the spring peak (April or May) than during the autumn peak (September or October). The estimated population at the spring peak was 25,000-50,000 birds. Midsummer numbers were lower (under 5,000 birds), except during 1981 when up to 15,000 birds were present through August.

Sabine's Gull (continued)

Except during peak migration, when Sabine's Gulls were distributed widely, densities were generally highest over the continental slope and lowest over the shelf. (Figs. 85, 86)

*Caspian Tern

(*Sterna caspia*)

This species is an uncommon to common nesting resident in estuaries and larger bays. They are present all year along the coast, but numbers are highest from April through October. Caspian Terns are very uncommon more than a few km from shore. About 1,470 birds nest at California coastal colonies.

Present study. Low numbers of Caspian Terns were observed coastally during May through October, but the birds were scarce in other months. Highest counts from coastal surveys occurred each year in July (up to 251 birds). They were observed at all latitudes, but were most heavily concentrated from Monterey Bay to Bodega, and Cape Mendocino to Trinidad, corresponding to locations of breeding colonies. Fewer birds were seen at northern latitudes during autumn.

#Royal Tern

{ *Sterna maxima* }

Although Royal Terns are uncommon and regular in southern California all year, they are very uncommon north of Morro Bay (to about Point Reyes) in autumn, and absent there at other times. Perhaps 20,000 birds nest on islands in the Gulf of California.

Present study. See Elegant Tern.

Elegant Tern

(*Sterna elegans*)

Elegant Terns are uncommon autumn visitors to the central coast from Mexico. They arrive on the central coast by July, their numbers peak August-October, and most birds depart by December. There exists only one winter record for the region. The Gulf of California nesting population numbers about 160,000.

Present study. These terns are virtually indistinguishable from Royal Terns during aerial surveys; however, all birds seen north of Point Sur were assumed to be of this species. Monthly transect surveys recorded small numbers near shore during approximately July through November, but coastal surveys also reported a few individuals in January (1980 and 1982) and May (1982). The peak count (245 birds) was from the only September coastal survey (1981); numbers on October surveys were much lower. During September 1981, most birds were concentrated from Point Buchon to Monterey Bay, with none north of Point Reyes. The only more northerly records were considered "possible" sightings: one bird each just north of Point Arena in October 1980, and just north of Trinidad Head in August 1980.

Common Tern
(*Sterna hirundo*)

See section 3c.

This species is regular but uncommon along the California coast during migration. The majority pass by shoreward of the continental shelf break. Sightings are more numerous during the fall, and a few birds may winter off southern California.

Present study. This species is not distinguishable from the Arctic Tern by airborne observers. We saw low to moderate numbers of unidentified terns migrating north in April-May and south in August-October. Peaks were an order of magnitude higher each year during fall. Sightings of unidentified terns ranged from near the coast to the outer limits of our surveys, but ship surveys indicated that most birds seen near the coast were Common Terns.

Arctic Tern
(*Sterna paradisaea*)

See section 3c.

This species is uncommon on California coastal waters during migration. During normal years the majority pass far offshore (well beyond the shoreward edge of the California Current). Sightings are more frequent during autumn, though few are seen after October.

Present study. This species was not distinguishable from the Common Tern by airborne observers. We saw low to moderate numbers migrating north in April-May and south in August-October. Peaks were an order of magnitude higher each year during fall. Sightings of unidentified terns ranged from nearshore to the outer limits of our surveys, with the likelihood of a bird being an Arctic Tern (rather than a Common Tern) increasing with distance from shore.

*Forster's Tern
(*Sterna forsteri*)

This is a common species at central and northern California estuaries and larger bays; they are less common along the open coast, and uncommon offshore. A few hundred nest at California coastal sites. Forster's Terns are very uncommon in winter (rare north of Bodega), when most birds withdraw south.

Present study. Forster's Terns were sometimes difficult to distinguish from other medium-sized terns, but they appeared to be the only numerous species along the coast outside of migration. Low to moderate numbers were recorded in all seasons near the coast and in coastal bays. Annual peaks (Forster's plus unidentified terns) from coastal surveys occurred in July 1980 (143), September 1981 (487), and May 1982 (226), but their

3d. Annotated Species List

Forster's Tern (continued)

latitudinal distribution was widest during summer (July). The majority was found from Point Sur to Point Arena in all seasons; few were seen farther north. A flock of 6 possible Forster's Terns at the Smith River in January 1982 would represent the northernmost winter record for California.

#*Least Tern

(*Sterna antillarum*)

Endangered Species: Nesting populations of this species are very much reduced in California due to destruction or disturbance of beach nesting habitat; only about 2,000 birds now nest at coastal sites. Birds from the small nesting populations in San Francisco Bay (75-90± pairs) visit the central California coast after mid-July; southward migration takes the population out of the region by September.

#Black Tern

(*Chlidonias niger*)

This species is very rare along the California coast during migration (April-October). Most Black Tern sightings are from protected bays and harbors.

#Black Skimmer

(*Rynchops niger*)

This is a very rare summer visitor to central California. Most records are from bays and estuaries north as far as Bodega.

*Common Murre

(*Uris aalge*)

See section 3c.

The common Murre is California's most abundant nesting seabird, occupying about 20 colony sites from Hurricane Point (Monterey County) to Castle Rock (Del Norte County). The major California colonies are located from Trinidad Head to Castle Rock (Humboldt and Del Norte Counties) and at the Farallon Islands. Common Murres are usually encountered over shelf waters, where they are abundant; fewer are observed offshore. Numbers are highest during winter, when immigrants from northern colonies enter California waters. The world population has been estimated at 15 million birds, of which, about 10 million reside in the North Pacific. The Alaskan population numbers about 5 million birds.

Present study. We found murre common to abundant at sea in all seasons. During the nesting season (May-July), murre sightings were largely restricted to shelf areas adjacent to colonies where densities of 20-200 murre/km² were often recorded. These are creatures of the continental shelf: in only 4 of 36 surveys were fewer than 80% of the murre recorded there, mainly occupying cool upwelled waters downstream (south) of major coastal promontories. During post-nesting dispersal (June-

Common Murre (continued)

August) murre permeated the extra-colonial areas of the continental shelf within the study area. Maximum annual densities (4.8-5.2 birds/km²) occurred each winter. Highest local winter densities (60-200 birds/km²) were commonly recorded between Cape Mendocino and Point St. George. Other regions of winter murre concentrations (where densities often exceeded 100 birds/km²) included Cordell Bank, the Gulf of the Farallones, Pillar Point-Año Nuevo, Monterey Bay, and occasionally Morro Bay-Point Sal.

#Thick-billed Murre

(*Uris lomvia*)

An extremely rare winter visitor, one or two individuals of this Alaskan species are found on Monterey Bay in most years. Records span the months August-February, with one April record. One bird at the Eel River in January 1977 was the first California record away from Monterey Bay. Perhaps 5,000,000 Thick-billed Murres nest in Alaska.

*Pigeon Guillemot

(*Cepphus columba*)

A common nesting resident at hundreds of sites all along the coast, the state nesting total is about 14,700 birds. The nesting season is April-August. A few birds persist through autumn and winter, but most birds are absent from October through February. The winter range is virtually unknown, though banding evidence suggests northward movement out of the state. The population probably is stable. usually Guillemots are found near land, but they may be seen anywhere over the continental shelf. The Alaskan nesting population numbers around 200,000 birds.

Present study. Low to moderate numbers were observed along the coast during February-September. Three birds seen coastally in January 1980, and a single bird recorded 125 km west of Point Pinos, were the only winter records. Coastal surveys recorded from 34 to 428 birds in May, and 180 to 320 in July. The heaviest concentrations (25-40% on average) were found from Santa Cruz to Point Reyes, while the lowest numbers were seen from Point Arena to Cape Mendocino. Distribution of guillemots was quite uniform elsewhere.

*Marbled Murrelet

(*Brachyramphus marmoratus*)

This is an uncommon nesting resident of central and northern California, where it apparently nests in coastal conifers and forages to about 2 km offshore. They are found throughout the year north of Monterey but only rarely south of there. The state's nesting population is about 2,000 birds.

Marbled Murrelet (continued)

Present study. Low numbers were recorded near the coast throughout the year, Counts from coastal surveys were highest in fall and winter (maximum of 77 in October 1980). Marbled Murrelets were most widely distributed in autumn, though few birds were seen south of Monterey Bay. Most birds were recorded north of Point Arena in all other seasons. (Fig. 87)

Xantus' Murrelet

(*Synthliboramphus hypoleucus*)

This is an uncommon summer and autumn visitor from southern California and Mexico; numbers peak in August through October. They are more numerous south of Monterey Bay than north of there. Some individuals are present in winter and spring, especially in warm years. The southern California nesting population, which numbers a few thousand birds, may be the world's largest.

Present study. It was extremely difficult to distinguish between murrelet species during aerial surveys. Most unidentified murrelets offshore (seaward of the shelf break), were probably Xantus' or Craveri's. Low numbers were recorded offshore in February through April (possibly Ancient Murrelets), and May through October. Peak numbers occurred in August through October 1980, when densities reached 0.79 birds/km² offshore between Point Piedras Blancas and Point Año Nuevo. Few murrelets were seen offshore north of Bodega and none were noted north of Cape Mendocino. (Fig. 88)

#Craveri's Murrelet

(*Synthliboramphus craveri*)

This is an extremely rare summer and autumn visitor to central coastal waters, present offshore only in the warmest of years. This species cannot be distinguished from the Xantus' by aerial observers. Perhaps 10,000 pairs nest in the Gulf of California.

Present study. See Xantus' Murrelet.

Ancient Murrelet

(*Synthliboramphus antiquus*)

A rare to uncommon winter visitor off California, numbers of Ancient Murrelets appear to vary widely between years. They usually arrive in autumn and depart in January through April (depending on winter oceanographic conditions), but records exist for all seasons. This species usually is most numerous from Monterey Bay northward. The Alaskan nesting population numbers around 400,000.

3d. Annotated Species List

Ancient Murrelet (continued)

Present study. Low to moderate numbers of Ancient and unidentified murrelets were recorded during February through April 1980. Most birds were beyond the shelf break from Point Arena south. We have only one other definite record—in April 1982, 3 birds were **seen** west of Humboldt Bay. Any winter records of unidentified murrelets could have been this species.

*Cassin's Auklet (*Ptychoramphus aleuticus*)

See section 3c.

This abundant alcid occupies an extensive breeding range in the North Pacific. The Alaskan population numbers about 600,000, and there are about 1.06 million nesting in British Columbia. Of the 131,170 Cassin's Auklets nesting in California, 80% (105,000) occupy Southeast Farallon Island, 17% (23,000) use the northern Channel Islands, and the remainder nest at Castle Rock and Green Rock in Del Norte and Humboldt Counties. Cassin's Auklet commonly occurs offshore during winter (year-round near the Farallones).

Present study. We found Cassin's Auklets at least moderately abundant at sea in central and northern California in all months. Lowest overall annual densities (0.3 to 1.1 birds/km²) occurred during late spring and summer months, when resident birds congregated at the Farallones and Humboldt/Del Norte County colonies. High density feeding flocks (100-150 birds/km²) could be expected almost anywhere over shelf and slope waters from Point Año Nuevo to Bodega during this season, especially over the continental shelf south and east of Cordell Bank, where concentrations of over 200 auklets/km² were often found. From August-October, Cassin's Auklets dispersed throughout the study area, and by late September or October overall densities increased to about 3.5 birds/km² as northern immigrants arrived. Peak numbers (overall 4.0 to 8.0 birds/km²) were recorded during winter each year, when (in contrast to the summer distribution) the bulk of the population occupied waters seaward of the continental shelf. Overall densities dropped sharply each spring, as winter visitors departed northward.

#Parakeet Auklet (*Cyclorhynchus psittacula*)

The Parakeet Auklet is an exceedingly rare winter visitor from Alaskan waters, though seen and collected not infrequently in California waters early in this century. A March 1974 specimen from Monterey Bay appears to be the only California record of this species in over 30 years. Perhaps 800,000 Parakeet Auklets nest in Alaska.

#Least Auklet

(*Aethia pusilla*)

A Least Auklet in weakened condition was found on a San Mateo County Beach in June 1981, representing the only state record, The Alaskan nesting population totals around 6 million birds.

#Crested Auklet

(*Aethia cristatella*)

A live individual of this species (subsequently found dead) seen near Bolinas in mid-July 1979, is the only California record. Crested Auklets usually occur no farther south than the Shumagin Islands, Alaska, some 4,200 km from Bolinas. The Alaskan population numbers about 2 million birds.

*Rhinceros Auklet

(*Cerorhinca monocerata*)

See Section 3c.

Rhinceros Auklets are seasonally abundant in California waters when large numbers of wintering birds enter the region from the north. This species is distributed discontinuously around the rim of the North Pacific. In Alaska, where predation by introduced Arctic foxes probably eliminated many former colonies, the population numbers about 200,000 birds. The California nesting population totals only about 180 pairs, including 100 pairs at Castle Rock (Del Norte County) and 50 pairs at Southeast Farallon Island.

Present study. Rhinceros Auklets were present during most months of our surveys. Immigration and emigration of winter visitors occurred each October-November and April, respectively. Highest numbers were recorded bimodally during winter, when average densities reached 1.5-2.0 birds/km², and the bulk of the population occupied waters between Bodega and Point Conception, In all but one month of our surveys, the majority of Rhinceros Auklets in central and northern California were found seaward of the continental shelf.

*Tufted puffin

(*Fratercula cirrhata*)

This is an uncommon nesting resident at several island and mainland sites in California, where nesting numbers now total only about 250 birds. The state's population has declined significantly and its nesting range contracted northward since 1900. Tufted Puffins are uncommon offshore throughout central and northern California waters during winter with peak numbers near the shelf break in January and February, The Alaskan population totals about 4,000,000 birds.

Tufted **Puffin** {continued}

Present study. The puffin species were not always separable during winter aerial *surveys*. Moderate numbers of puffins were observed from February through May (of 32 puffins seen in April 1980, 20 were identified as Tufted). Up to two were seen on surveys in all other months except October. Tufted Puffins were most numerous in March and April when the **majority** occurred beyond the shelfbreak from Point Sur north. In other months most sightings **were** on shelf and slope waters from Point **Sur** to Bodega. (Fig. 89)

Horned Puffin

(*Fratercula corniculata*)

Formerly, the Horned Puffin **was** seen only in winter, but since 1953 it has become an uncommon spring migrant offshore and (occasionally) to within a few km **of** the coast. This species has recently expanded its nesting range southward into British Columbia and possibly (in 1979) into Oregon. The Alaskan population numbers about 1,500,000 birds.

Present study. Low numbers (up to 7, February 1980) of Horned Puffins were observed in February through May; most of these were well offshore. Single birds were sighted over the continental slope north of Cape Mendocino in August 1980 and **November 1982**, but none were identified in other months. Also see: Tufted Puffin. (Fig. 90)

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6. APPENDIX - DISTRIBUTIONAL GRAPHICS

This section presents maps of density distribution and coastal censuses (aggregated by 10' of latitude) for species not treated in detail in Section 3c., Predominant Species, Following is a directory of the species and time periods included.

<u>Species</u>	<u>Month</u>	<u>Figure Number</u>	<u>Page</u>
Black-footed Albatross	May 1980	59	215
Black-footed Albatross	July 1981	60	216
Laysan Albatross	1980-1983	61	217
Pink-footed Shearwater	June 1981	62	218
Pink-footed Shearwater	July 1981	63	219
Pink-footed Shearwater	September 1981	64	220
Buller's Shearwater	August 1981	65	221
Buller's Shearwater	August 1982	66	222
Fork-tailed Storm-Petrel	July 1981	67	223
Fork-tailed Storm-Petrel	January 1982	68	224
Ashy storm-Petrel	September 1981	69	225
Pomarine and unidentified jaegers	September 1980	70	226
Pomarine and unidentified jaegers	October 1980	71	227
Pomarine and unidentified jaegers	February 1981	72	228
Pomarine and unidentified jaegers	April 1981	73	229
Parasitic Jaeger	1980-84	74	230

6. APPENDIX - DISTRIBUTIONAL GRAPHICS

<u>Species</u>	<u>Month</u>	<u>Figure Number</u>	<u>Page</u>
Long-tailed Jaeger	1980-83	75	231
South Polar Skua	1980-83	76	232
Bonaparte's Gull	April 1981	77	233
Bonaparte's Gull	April 1982	78	234
Bonaparte's Gull	November 1982	79	235
Heerman's Gull	September 1981	80	236
Herring Gull	February 1981	81	237
Herring Gull	November 1982	82	238
Glaucous-winged Gull	December 1980	83	239
Glaucous-winged Gull	February 1982	84	240
Sabine's Gull	Feb-July 1980-83	85	241
Sabine's Gull	May 1981	86	242
Marbled Murrelet	1980-83	87	243
Unidentified murrelets	June-Nov 1980-83	88	244
Tufted and unidentified puffins	1980-83	89	245
<i>Horned Puffin</i>	1980-83	90	246

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