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Report on the Seabird and Marine Mammal Censuses Conducted For the Long-Term Management Strategy (LTMS)

August 1990 through November 1991

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

In support of the Ocean Studies Plan (EPA 1991) of the Long-Term Management Strategy (LTMS), we censused seabirds and marine mammals from vessels engaged in oceanographic research during five cruises between August 1990 and October/November 1991. The Ocean Studies Plan describes the scientific work that "will support the preparation of a thorough and technically defensible Environmental Impact Statement (EIS) which evaluates the designation of an ocean dredged-material disposal site." Our study was performed as part of the Ocean Studies plan. This Plan describes the full range of research to be done in physical oceanography, benthic infauna and sediments, epifauna and fisheries, as well as additional marine bird and mammal studies. Four study sites were predetermined by US EPA staff as potential locations for the disposal of dredged material from the San Francisco Bay. Our study area was the shelf, slope, and offshore waters in the vicinity of the Gulf of the Farallones, bounded to the north and south by the 37° and 38° parallels, and to the east and west by the coastline and the meridian at about 123°41'W. The goals of the study were:

(1) to generally report on the abundance and distribution of seabirds and marine mammals in the study area, and

(2) to determine if there were any differences among the four EPA-designated study sites in usage by seabirds and marine mammals.

We participated in five cruises that lasted from 5-12 days (in August 1990; February, May, August, and October/November 1991). We censused a total of 391 stations that covered 472 km^2. The number of stations sampled during the five cruises was 110, 52, 59, 107, and 63, respectively.

Of the 103 migratory and breeding species of seabirds on the California state list, we observed 47 species (including phalaropes, but not including seven other shorebird species). Overall seabird density for all cruises was 28.2 birds km^{-2}. We measured a low of 9.0 birds km^{-2} during the August 1990 (when we censused mostly slope and offshore waters) and a high of 56.5 birds km^{-2} during the cruise in May 1990.

As expected, the seasonal abundance and distribution of seabirds and mammals changed as animals migrated in and out of the study area and engaged in breeding activities at the Farallon Islands. During August, several locally breeding seabird species (Western Gull, Cassin's Auklet, and Common Murre), as well as some regular visitors (Sooty Shearwater, Pink-footed Shearwater, Black-footed Albatross, Red Phalarope, and Red-necked Phalarope) were the most abundant and frequently observed species. In February and October/November, the avifauna was dominated by wintering

populations of the Northern Fulmar; Western, California and Herring Gulls; Black-legged Kittiwake; and Rhinoceros and Cassin's Auklet. During the cruise in May, the Sooty Shearwater was the most abundant and most frequently observed species. Also abundant was the Western Gull, Common Murre, and the two species of phalaropes.

Preferences by certain seabirds for oceanic conditions described by depth, temperature, salinity, and distance from land were indicated by a canonical correspondence analysis. The Common Murre, Red-necked Phalarope, Brandt's Cormorant, and Western Gull appeared to have an affinity for water of relatively high salinity and low temperature close to land. We also found Cassin's Auklets preferred conditions that were farther from land where the water was warmer and less saline, opposite to the first group.

The Sooty Shearwater, Brown Pelican, Brandt's Cormorant, both phalaropes, Western Gull, Common Murre and Rhinoceros Auklet were found often and in relatively high densities over the shelf. Also, we censused over twice the expected number of birds within the study site on the shelf. This finding further emphasizes the importance of this shelf habitat to a large number of seabird species. In one of the EPA study areas and adjacent waters on the slope (from the shelf break to 1800 m), we found several species (Black-footed Albatross, Pink-footed and Sooty Shearwaters, Ashy Storm-Petrel, both phalaropes, Western Gull, and Cassin's Auklet) in moderate to high densities. In a study site south of Pioneer Canyon, we observed only one quarter of the number of individual birds (and fewer groups) than expected. Over a site west of the Farallon Islands, there were one half to two thirds of the expected number of individuals and groups of seabirds.

The number of cetaceans (9 species total) and pinnipeds (5 species total) seen in the study area was generally much higher in late summer and the fall as compared to the winter and spring. Blue and humpback whales were seen in relatively high numbers in August, as were Dall's porpoise, California sea lions and northern fur seals. The winter cruise was depauperate (Dall's porpoise, California sea lion, and northern fur seal accounted for 95% of sightings), unlike the fall cruise during which 9 species of marine mammals were sighted (including an uncommon group of short-finned pilot whales). The Dall's porpoise, northern fur seal, and California sea lion, were again the most abundant species during the May cruise.

There was no difference between the observed and expected number of individual marine mammals observed within the shelf study site. By contrast, there were about 50% more individual marine mammals seen in the study site north of Pioneer Canyon than expected. The study site south of Pioneer Canyon and the site west of the Farallon Islands had fewer than expected individuals, though the number of groups seen in latter area was the same as expected.

Two leatherback turtles were sighted during the study period.

Overall, the study site on the continental shelf and the one site north of Pioneer Canyon on the slope were the areas of highest abundance and greatest frequency of usage by marine birds and mammals during this study period.

INTRODUCTION

A team of seabird and marine mammal observers, organized by EPA's Oceans and Estuaries Section, Region IX, conducted surveys on 5 different cruises for the LTMS between August, 1990 and November, 1991 (Table 1 and Appendix 1). The R/V Farnella and R/V Point Sur conducted geophysical and oceanographic research in waters west and south of the Farallon Islands off of San Francisco, California (see Figure 1). The study area was defined approximately as the waters between the latitudes 37° and 38° N from the shoreline to the longitude of 123°40'W.

During the study period, from one to four members of the team of five biologists accompanied the hydrographic research teams (but usually two or more; see Appendix 1) to census marine birds and mammals encountered as the vessels conducted side-scan sonar, coring, photographic, and other hydrographic operations. These cruises were designed to accommodate the requirements of the hydrographic studies. For this reason, the study areas were not surveyed equally and the seabird and mammal censuses were performed when the conditions of our predetermined protocols (see Methods) were met.

The goal of the study was to assist EPA Region IX, working under the auspices of the Long-Term Management Strategy, with the selection of one of four proposed sites (see map for cruise during February 1991 in Figure 1 for locations) to be used for the disposal of dredged material from the San Francisco Bay-Delta.

Consistent with EPA's site designation criterion at 40 CFR § 228.6(a)(2), a specific objective of our study was to determine, as best as possible, which of the four proposed disposal sites would have the least overall effect on the seabirds and marine mammals that breed and feed in or migrate through the Gulf of the Farallones. Additionally, the Endangered Species Act (16 USC § 1531 et seq.) requires special consideration of the listed and candidate species that reside in or migrate through the area. For this reason we discuss endangered and specially protected species in separate sections of this report.

General information on the occurrence, abundance and distribution of seabird and marine mammal species is well summarized in several existing publications (Ainley and Boekelheide 1990, Ainley and Allen 1992, EPA 1991, Briggs et al. 1987) and will not be discussed here.

METHODS

Survey Protocol

We performed continuous observations from about sunrise to sunset according to prearranged standard protocols. Observations were taken from the ship's bridge from the side that afforded the best observation conditions (taking wind direction and glare from the sun into account). We rotated from the observer position to data recorder every 15-minutes to minimize fatigue.

With exception of a small percentage of on-effort transects from the cruise in August 1990, there was an observer and recorder present during all the transects. As the ship travelled at a relatively constant course and speed, we censused a strip 300-m wide from directly in front of the vessel to 90° abeam. Animals counted were detected with the unaided eye; however, verification of number and identification of individuals was permitted using binoculars as needed. Uninterrupted 15-minute periods were the basic sampling unit. Whenever possible, we censused for 3 consecutive periods, then skipped one as a rest break.

All other observations were coded as "general observations" (see Gould and Forsell 1989) and were not used in the density estimates. However, both transect data and general observations were used to compile species lists and seasonal occurrence (Tables 2 and 3). Tables 2 and 3 also list the scientific and common names for the seabirds, marine mammals, and turtles referred to throughout this report.

We used US Fish & Wildlife Service data forms, as found in Gould and Forsell 1989, for both general observations and for data collected while on effort. We recorded data on ship's position, course, speed, wind speed (knots), cloud cover, elapsed time, observation conditions [per Gould and Forsell (1989)], transect width (300 m, weather permitting; see below), water depth (m), distance to land (nm; February 1991 and August 1991, cruises 2 & 4, only), sea surface temperature (SST, °C), sea surface salinity (SSS, ppt), barometric pressure (mb), sea state, swell height [per Gould and Forsell (1989)].

We periodically calibrated transect width using a range finder (Heinemann 1981). Information on species identification, number of individuals, group size, and behavior was also recorded. The speed of the ship varied between 0-12 knots according to the type of oceanographic work being performed. We considered a sighting to be a "general observation" (per Gould and Forsell, 1990) if the ship was traveling at less than 4 knots, or if it significantly changed speed or course during the observation period. All other determinations were noted on the data sheets in accordance with the guidance and recommendations in our protocols or in Gould and Forsell (1989). Observations were made from a height-of-eye of 10 m (R/V Farnella) or 8 m (R/V Point

Sur) from the port or starboard bridge wings, whichever afforded the best visibility as described above.

In August 1990 (cruise 1) aboard the R/V Farnella, four observers worked in two teams from 5-10 August. Two biologists censused seabirds, while the other two censused marine mammals. A single observer was on board for the remainder of that cruise. Three observers participated in February 1991 (cruise 2), while two team members participated in the other three cruises (Table 1 and Appendix 1).

Data Analyses

The data from the field sheets were entered into dBase IV on a standard IBM-compatible computer at EPA, Region IX. Data analyses were performed: (1) by computations made using the standard functions in dBase IV, (2) by a scientist at Point Reyes Bird Observatory (PRBO) under contract with EPA [see Methods in Ainley and Allen (1992) for details], and (3) by an EPA scientist at the EPA Environmental Research Laboratory in Corvallis, Oregon.

For statistical purposes, the data from 15-minute census periods were combined into one "station" if the periods were continuous in time and if the course of the vessel was constant. Figure 1 shows station locations for each cruise. The overall density estimates (without confidence measures) and general summary statistics were computed in dBase IV by EPA staff. The canonical correspondence analysis (CCA) on data collected during August 1991 (cruise 4, the only cruise for which we had adequate sample sizes to perform CCA), the maps of densities for the most common species, the descriptive statistics, box plots of environmental variables, and other maps were produced by Sarah G. Allen of Point Reyes Bird Observatory (PRBO) and Dr. Christine A. Ribic of EPA's Environmental Research Laboratory in Corvallis, Oregon. For more information on the CCA and other methods used to analyze our data, see the Methods in Ainley and Allen (1992).

Sample sizes, except where noted otherwise, are represented by the number of stations (e.g., see Table 12, Descriptive Statistics for Environmental Variables). Ship following birds, such as albatrosses, gulls, and fulmars, were weighted by a factor of 0.3 to more equally represent their actual densities at sea (Ainley and Allen 1992).

In the Results and Discussion sections, the terms "shelf," "slope," and "offshore" are used as defined in Briggs et al. (1987) to correspond approximately to respective depths of 0-199, 200-1999, and >1999 m.

RESULTS

A. General Sighting and Weather Information

Weather, Observation, and Hydrographic Conditions

In general, the weather was moderate throughout the duration of the five cruises. However, we recorded estimated wind speeds from 25-45 knots for over 24 h during the cruises in February, May, and October 1991 (cruises 2, 3, and 5). During these periods, strip widths were reduced to 200 m (at approximately Beaufort 5) and 100 m (at approximately Beaufort 7) as required by the predetermined protocols.

However, because of violations of certain statistical assumptions in strip-transect analyses (C. Ribic, pers. comm.), the data collected during the times when strip width was reduced were not used in the statistical analyses. Detailed weather and hydrographic information is available from the US Geological Survey for August 1990 (cruise 1) and the Naval Postgraduate School for remaining cruises.

Transect Observations

We censused a total of 391 stations (15-minutes each) during the entire study covering 471.9 km^2 (or 1.2 km^2 per station). The breakdown by cruise is as follows: 110 in August 1990 (cruise 1), 52 in February 1991 (cruise 2), 59 in May 1991 (cruise 3), 107 in August 1991 (cruise 4), and 63 in October 1991 (cruise 5). The difference in effort is due to the variations in weather, cruise length, daylength, and the ship's activity during the cruises. The number of stations that were sampled in the EPA-designated study sites (Figure 1) is summarized in Table 5.

General Observations

During the time the vessel was stationary or moving slowly, we recorded birds and mammals observed in a 360° arc around the ship. We made approximately 110 h of these general observations during all 5 cruises, and the list of species seen is in Tables 2 and 3. These general observations were not made systematically; therefore, they were used only to tabulate the species list and their seasonal occurrence (Tables 2 and 3).

B. Biological Findings

Overall Observations

We observed a total of 52 species of birds (not including several landbird species; Table 2), 9 species of cetaceans, 5 species of pinnipeds, and 1 species of sea turtles (Table 3) during the 39 days at sea that covered the 4 seasons.

Seabird Species

1. Distribution and Density

The overall measure of seabird density is summarized in Table 4. The highest concentration of seabirds occurred in May 1991 (cruise 3) with 56.5 birds/km^2 estimated in 59 stations, and the lowest in August 1990 (cruise 1, 9.0 birds/km^2, 110 stations). Except during the August 1991 cruise, statistical difficulties associated with sample size prohibited the calculation of confidence intervals for bird and mammal densities.

Density maps (Figure 3) were created for the five most abundant species per cruise; therefore, not all species are mapped for all cruises. The following summaries by species are derived mostly from the maps (Figure 2), and to a lesser degree from the descriptive statistics (Appendix 2):

Black-footed Albatross Diomedea nigripes August 1990 (Cruise 1)

This species was widely distributed at low densities throughout the slope, and occurred in study sites 3, 4, and 5. The only map for this bird was for August 1990 (cruise 1), during which all of the stations occurred in slope and offshore waters. Though not plotted, they did occur infrequently farther inshore (pers. observ., Ainley and Allen 1992).

Northern Fulmar Fulmaris glacialis No maps

As mentioned under the section on Black-legged Kittiwake, this common spring, fall, and winter visitor to central California was seen in low densities in all areas. Tables 7, 9, and 11 (and Appendix 2) show that this species was also on the list of frequently observed species (though in all cases less than 10% of the total) and was found in depths that averaged between 970 and 1700 m.

Pink-footed Shearwater Puffinus creatopus August 1990 (Cruise 1)

Pink-footeds, common visitors to the Gulf of the Farallones, were found in low numbers throughout the slope waters and occurred in and near study site 3 in moderate densities.

In August 1990 (cruise 1) they comprised 14% of the total observations and ranked highest in numbers of individuals seen (Table 7), and in August 1991 (cruise 4) they were the fifth most frequently seen species (Table 10).

Sooty Shearwater <u>P. griseus</u> All Cruises except February 1991 (Cruises 1, 3, 4, & 5)

This very abundant seabird (2.7 to 4.7 million offshore California, Briggs et al. 1987) was also widespread throughout the study area in low to moderate densities and in all study sites. In May 1991, Sooty Shearwaters were in the vicinity of Pioneer Canyon in very high densities, and in high densities northwest of the Farallon Islands and north of study site 5. By contrast, they were absent in February 1991 (as expected since this correlates with their breeding season in the austral summer).

Ashy Storm-Petrel <u>Oceanodroma homochroa</u> August 1990 (Cruise 1)

This species was found in low densities over slope waters south of the Farallones, consistent with the findings of Briggs et al. 1987, Ainley and Boekelheide 1990, and Ainley and Allen 1992. In August 1990, they were ranked fifth in the list of the most frequently observed and abundant species (Table 7).

Brown Pelican <u>Pelecanus occidentalis</u> August 1990 & 1991, October 1991 (Cruises 1, 4, & 5)

This species was not sighted frequently enough to enable calculating and plotting densities on a grid map. However, because of its endangered status, the sightings of Brown Pelicans were plotted on a contour map. Though more abundant on the shelf and upper slope, this species was seen in very deep water (2000 m) to the south and west of the Farallon Islands.

Red-necked Phalarope <u>Phalaropus lobatus</u> May, August, & October 1991 (Cruises 3, 4, & 5)

As expected from the findings of Dohl et al. (1983) and Briggs et al. (1987), this migratory species (over California waters) was found in sometimes dense patches along the shelf and shelf break (May), as well as over waters seaward of the shelf (October-November). As noted in the field, these birds were often seen surface feeding in current shear and drift lines as well as in large migrating flocks.

Red Phalarope <u>P. fulicarius</u> May and October 1991 (Cruises 3 & 5)

This species showed similar distribution and densities to the closely related Red-necked Phalarope, but were found mostly over the slope or at the shelf break.

California Gull   Larus californicus October 1991 (Cruise 5)

This gull typically migrates to the ocean in the post-breeding period from September-February where it is a dominant member of the marine avifauna (Dohl et al. 1983), and we were not surprised to have found them throughout the study area in low to moderate numbers. They did occur in somewhat higher densities near study site 2.

Western Gull L. occidentalis All Cruises

This is the only species seen frequently enough that there are density maps for all five cruises. Generally we found Western Gulls throughout the study area in low to moderate densities, but in high numbers near the Southeast Farallon Island (SEFI) where there is currently a breeding population of about 25,000 birds. They were generally scarce in deep water; however, over the upper and middle slope there were moderate concentrations in all five cruises south and southeast of SEFI, in or near study sites 2 and 3.

Black-legged Kittiwake Rissa tridactyla February 1991 (Cruise 2)

Like the Northern Fulmar (which was observed too infrequently to generate a density map), this winter visitor was distributed in low densities throughout the study area and in each of the study sites.

Common Murre Uria aalge February, May, August, & October 1991 (Cruises 2 through 5)

Found almost exclusively over the shelf, Common Murres were concentrated around the Farallones and other breeding sites near the coast. They were measured in highest densities north of the Farallon Islands.

Cassin's Auklet   Ptychoramphus aleuticus February & August 1991 (Cruises 2 & 4)
and
Rhinoceros Auklet Cerorhinca monocerata February 1991 (Cruise 2)

Both auklets were widespread in the Gulf of the Farallones, but were observed in moderate to high (Rhinoceros) and very high (Cassin's) concentrations between study sites 2 and 3 and south of SEFI. They were also seen to the west and northwest of the Islands during the winter and fall.

The range of median depths over which commonly observed seabirds were seen in the Gulf of the Farallones is graphically presented in Figure 6 (descriptive statistics are in Appendix 2). The abundant breeders, Brandt's Cormorant and Common Murre, were found almost exclusively in shelf water, up to 100 m in depth. The other common and abundant species that also breed on SEFI [Cassin's Auklet, Rhinoceros Auklet (mostly a visitor in the Gulf of the Farallones), and Western Gull] and several of the visitors (Sooty and Pink-footed Shearwaters, California Gull, and the phalaropes) were found in shelf and upper slope waters from a few hundred to 1000 m.

Clearly, Leach's Storm-Petrel and Murphy's Petrel preferred the deepest waters, and the Black-footed Albatross and Northern Fulmar were primarily seen in the 800-2000 m range (though the fulmar was also seen farther inshore). Ashy Storm-Petrels were observed over the mid-slope. With exception of the albatross, fulmar, and Leach's Storm-Petrel, the other species mostly preferred depths landward of the 1000-m isobath.

In an attempt to determine if there were any tendencies for seabirds to use certain study sites more than others, the expected number of sightings (groups) and individual animals was calculated proportional to the number of stations in each study area (Table 5). It should be pointed out that this analysis was performed on combined data (because of sample size limitations) for all cruises and we recognize the potential bias this represents.

However, we think the combined results were reflective of the general patterns of usage among the study sites. In study site 2, the only site located on the continental shelf, we saw roughly two times the number of individual birds as expected, and the number of birds seen in study site 3 was also higher than expected. In site 4, we observed only one quarter of the number of individual birds (and fewer groups) than we might have seen in that number of stations, and in study site 5 there were one third to one half of the expected number of individuals and groups.

2. Seabird Diversity

Of the 103 migratory and breeding species of seabirds on the California state list (Briggs et al. 1987), we observed 47 species (including phalaropes, but not including seven other shorebird species). This compares to 74 species counted by Briggs et al. (1987) in their statewide survey that spanned 8 years. In February, when most species present were gulls or alcids, species diversity was notably lower than in the other seasons (Tables 2, 7-11). Gulls and alcids were also numerically dominant in February and October (Tables 8 and 11). During the breeding season (Table 9), the Sooty Shearwater was most abundant, followed by the Western Gull, migrating phalaropes, and the Common Murre. By contrast, other breeders (such as Cassin's and Rhinoceros Auklets) were frequently observed, but not in large numbers.

Tables 12 and 13 list the most numerous and frequently seen species in study sites 2 and 3, respectively. Unfortunately, the cruise tracks did not cross study sites 4 and 5 often enough to warrant creating a such a table for those areas. We found the typical assemblage of seabirds in study site 2 (Briggs et al. 1987), characterized by common breeding and wintering visitors such as the Western Gull, Common Murre, Sooty Shearwater, and Rhinoceros Auklet that are known to prefer shelf waters at certain times of the year (Ainley and Boekelheide 1990, Briggs et al. 1987, Dohl et al. 1983). Study site 3 is a mid-slope site in which we observed species of tubenoses (Black-footed Albatross, Sooty Shearwater, Ashy Storm-Petrel, and Northern Fulmar) as well as gulls, auklets, and phalaropes.

The results of the canonical correspondence analysis (CCA) for August 1991 (cruise 4) graphically represent the relationship of the species in this seabird community to the environmental variables that were measured. To perform this analysis, the data set was divided into two sets, referred to as set A and B [see the Methods section and Ainley and Allen (1992) for more details on CCA]. For both sets A and B, temperature and salinity were important variables along axis 1 and depth and distance from land were important along axis 2 (Table 14). The species with greater than 10% variance explained by axes 1 and 2 for both sets of data are five important local breeders and two of the most abundant migratory species (Table 14), which means that most of the ecologically important species found in the area are under consideration in this analysis. In set A, 60% of the variance is explained by axis 1 and another 17% is explained by axis 2. In set B, those number are 48% and 26%, respectively (Table 15). The cumulative percentage of variance of the species-environment relation for each of the axes tested of 21 and 27% for set A (and 17 and 25% for set B) indicate a strong correlation that was statistically significant ($p<.01$, Monte Carlo Permutation Test of Significance).

The results of the descriptive statistics (Appendix 2) and box plots (Appendix 3) are pulled together in the CCA biplot in a way that permits visual groupings of species that are found in definable sets of environmental conditions. It is probably worth mentioning that the casual inspection of the box plots of sea temperature for most species will show that they were found in warmer water during August 1990, August 1991, and October 1991 (cruises 1, 4, and 5 and cooler water in May 1991 (cruise 3). One might be tempted to interpret these result in terms of species' seasonal preference for a certain temperature range; however, it might simply represent the range of ambient conditions during those seasons.

The CCA integrates these factors and demonstrates that the distribution of some species of birds appears to have been driven by the same suite of environmental variables. For example, the Western Gull, Common Murre, Red-necked Phalarope, and Brandt's Cormorant were found in an area of the biplot that represented conditions of higher salinity and colder water (perhaps indicating upwelling) than an area characterized by warm water and low salinity where Cassin's Auklets were found. In both sets A and B, Rhinoceros Auklets appear to have preferred deep waters far from land and of high salinity. Sooty Shearwaters (and to a lesser degree the other tubenoses) were found to prefer deeper waters of cooler temperature.

Mammal Species

The following species accounts are from the on-effort station data and do not include the general observations.

Blue Whale <u>Balaenoptera musculus</u> August 1990 & 1991 (Cruises 1 & 4)

Blue whales have been regularly sighted in the Gulf of the Farallones since 1983 (Calambokidis et al. 1989a, Webber et al. 1989). They are most frequently observed starting in August and continuing through November (Dohl et al. 1984, Calambokidis et al. 1989a, Webber et al. 1989). All blue whales observed during these cruises occurred in August, in waters west of the 100 m isobath. Site 3 was the only one in which blue whales were seen.

Minke Whale <u>Balaenoptera acutorostrata</u> August 1990 & October 1991 (Cruises 1 & 5)

There were two sightings of minke whale during this study, both sightings occurring on the shelf east of the 100-m isobath.

Humpback Whale <u>Megaptera novaeangliae</u> August 1990 & 1991 (Cruises 1 & 4)

Humpback whales were the most frequently sighted baleen whale during this study. This species was most abundant in the waters between sites 2 and 3, along the edge of the continental shelf and over the continental slope in a median depth of 385 m.

Pacific White-sided Dolphin <u>Lagenorhynchus obliquidens</u> All Cruises (except February 1991)

The Pacific white-sided dolphin was the second most frequently sighted cetacean during this study. All the sightings were recorded in August and October in waters over the continental slope ranging in depth from 290-3200 m. They were most abundant in the area in and around site 3. They were also observed in site 5. The Northern right whale dolphin is often observed in mixed schools with the Pacific white-sided dolphin (Leatherwood and Walker 1979). During this study we encountered two mixed schools, one in August 1990 and the second in October 1991.

Northern Right Whale Dolphin <u>Lissodelphis borealis</u> August 1990 & 1991, October 1991 (Cruises 1, 4 & 5)

Our four sightings of this cetacean occurred over the continental slope near study sites 3 and 4 and in association with <u>Lagenorynchus</u>. This finding agrees with those reported by Dohl et al. (1983) and Ainley and Allen (1992).

Short-finned Pilot Whale <u>Globicephala macrorhynchus</u> October 1991 (Cruise 5)

During this study there was a single sighting of pilot whales just west of study site 4. The pod of 25 animals included several calves and was travelling at a uniform speed to the south.

Risso's Dolphin <u>Grampus griseus</u> October 1991 (Cruise 5)

There was a single sighting of Risso's dolphin in the southeast corner of site 4 during this study. They were travelling south in the same direction as the short-finned pilot whales, but were about 10 miles landward of the pilot whales at the eastern boundary of site 3.

Harbor Porpoise <u>Phocoena phocoena</u> October 1991 (Cruise 5)

During the entire study, we sighted only 2 animals in 116 m of water at the southern end of the study area in November 1991.

Dall's Porpoise <u>Phocoenoides dalli</u> All Cruises

This species was the most frequently observed cetacean. They were sighted in the deeper waters of the continental shelf and slope. A majority of the sightings occurred in the summer. They were most abundant in the eastern portion of site 3, although they were also observed in sites 2 and 5.

Northern Sea Lion <u>Eumetopias jubatus</u> August 1990 & 1991

(Cruises 1 & 4)

There were two sightings of northern sea lions during this study, one in study site 3 and the second in study site 5, both during the month of August.

California Sea Lion <u>Zalophus californianus</u> All Cruises

During this study, the California sea lion was observed in all seasons and in all study sites, and it was the most abundant pinniped seen overall. This pinniped was most abundant in August in the vicinity of and within site 3, along the continental slope, but was also observed in and near study site 5 west of SEFI. The largest group observed in our study, 210 individuals, was on the shelf break at the northwest corner of study site 2 in August 1991. In general, they were found about 25 nm from land in water depths that ranged from 35-2962 m (median = 385 m).

Northern Fur Seal <u>Callorhinus ursinus</u> All Cruises

This species was the second most frequently observed pinniped during this study. They were observed on all the cruises in the deeper waters of the continental slope. They were observed in site 3, however, almost half of the sightings of this species occurred in waters west of the study sites.

Northern Elephant Seal <u>Mirounga angustirostris</u> August 1990, May 1991 (Cruises 1 & 3)

Elephant seals are common in northern California throughout the year. They feed in deeper waters of the continental slope to depths of 1500 m (Ainley and Allen 1992). There were five sightings of Northern elephant seals over the continental slope during this study, three of which were west of Pioneer Seamount.

The number of cetaceans and pinnipeds seen in the study area was generally much higher in late summer and the fall as compared to the winter and spring (Tables 17 through 21). As was done for the bird species observed in the four study sites, we calculated the number of observed and expected individuals and groups of marine mammals for all cruises combined (Table 6).

There was no difference between the observed and expected number of individuals in study site 2; however, there were about 50% more individual marine mammals seen in site 3 than expected. Study sites 4 and 5 had fewer than expected individuals, though the number of groups seen in study site 5 was the same as expected. The number of observed groups of animals was higher in study site 3 than expected, which was consistent with the results for individuals.

Sea Turtles

Leatherback turtle <u>Dermochelys coriacea</u> August 1990 & 1991 (Cruises 1 & 4)

Soon after some of the crew left the R/V Farnella on a liaison vessel on 10 August 1990, we sighted a leatherback turtle at 37°39.5'N and 122°49.2'W. Another animal was sighted during a regular cruise on 17 August 1991 at 37°18.1'N and 123°07.2'W.

DISCUSSION

1. Seabirds

When attempting to interpret the results of seabird census work, it is important to recognize that there is much observer bias, which exists for several reasons. Ryan and Cooper (1989) found low observer precision (51% for all birds combined) that was due to two main sources: (1) failure to correctly categorize birds (as in or out of the transect strip, ship follower or not), and (2) failure to detect birds.

The degree to which a bird is conspicuous at sea is a function of its size, color, and behavior, as well as of the weather and sea conditions at the time of the sighting (Tasker et al. 1984, Ryan and Cooper 1989). Observer ability and fatigue is another cause of variation in censusing results (Tasker et al. 1984). Other elements of study design and methods affect results and interpretation. For example, absolute abundances are difficult to calculate because of scale-dependent variability (Haney 1985).

For the reasons explained above (especially when coupled with the statistical difficulties associated with sample size and measuring confidence intervals) comparisons on the level of orders of magnitude are probably most appropriate. Rigorous statistical comparisons among studies are either not possible or inappropriate under these circumstances. It is with these caveats that the results of our efforts were presented and discussed in this report.

The overall density estimate for all cruises (28 birds km^{-2}, Table 4) is very similar to the estimate of seabird densities (> 30 birds km^{-2}) in areas of special importance (which includes the Gulf of the Farallones) in Dohl et al. 1983. However, our average is less than the average aggregate bird density (50 birds km^{-2}) in five areas of highest concentration (one of which is Pt. Reyes to Monterey) reported by Briggs et al. (1987). The lowest density of seabirds we estimated (9.0 birds km^{-2}) occurred during August 1990 (cruise 1), which was mostly a survey of lower slope and offshore waters.

This is approximately equal to the 7.8 ± 0.9 birds km^{-2} for offshore waters in Briggs et al. (1987). The highest density we measured (56.5 birds km^{-2}) occurred in May 1991 (cruise 4), not surprisingly in the middle of the breeding season on the Farallones and adjacent colonies on land. The densities estimated in fall and winter were intermediate to the high and low estimates. Briggs et al. (1987) measured densities of 111.3 ± 19.8, 27.5 ± 2.8, and 7.8 ± 0.9 birds km^{-2} over the shelf, slope, and offshore areas, respectively.

In general, our cruise tracks ran perpendicular to the isobath lines on the shelf (i.e., the tracks ran northeast-southwest), which means that the density estimates were (except for August 1990) averages of shelf, slope, and offshore densities. As such, our densities fall within the range of monthly mean averages for all seabirds in waters off central and northern California in Dohl et al. (1983, pp82-86). Briggs et al. (1987) report that in certain areas along the coastline, including the area from Point Reyes to Monterey, aggregate bird density exceeded 50 birds km^{-2}, as we found in May 1992.

Several seabird species were found often and in relatively high densities over the shelf [Sooty Shearwater, Brown Pelican, Brandt's Cormorant, both phalaropes, Western Gull, Common Murre and the Rhinoceros Auklet (February 1991)]. Also, we censused over twice the expected number of birds in this area, which further emphasizes the importance of this shelf habitat to a large number of seabird species.

Dumping of dredged material at study site 2 could have excessive negative impacts on the birds (and presumably their prey) that use this area. Similarly, study area 3, and the waters between sites 2 and 3, attracted several species (Black-footed Albatross, Pink-footed and Sooty Shearwaters, Ashy Storm-Petrel, both phalaropes, Western Gull, and Cassin's Auklet) in moderate to high densities. Typically, high concentrations of Cassin's Auklets and Sooty Shearwater are found in these slope waters from 80 m to 1000 m (Briggs and Chu 1986, Briggs et al. 1987, and Ainley and Boekelheide 1990).

The CCA results might be useful in estimating which seabird species having affinities for certain waters defined by depth, distance to nearest land, salinity and temperature (Figure 3) might be most affected by the ocean disposal of dredged spoils in a certain location. For example, it appears that the Common Murre, Red-necked Phalarope, Brandt's Cormorant, and Western Gull all had an affinity for waters of higher salinity and lower temperature water close to land (Figure 3), conditions suggestive of study site 2.

However, much caution should be exercised in coming to these conclusions. In their discussion of seabird habitat and habitat choice, Briggs et al. (1987) suggest that "the importance of temperature probably overshadows that of salinity to California seabirds." Furthermore, they find Cassin's Auklets associate with Common Murres, Western Gulls and Sooty Shearwaters; whereas, we found Cassin's opposite of the murres and gulls in warmer, less saline waters farther from land.

The distribution of seabirds during the study (Figure 3), as well as the supporting descriptive statistics in Appendix 2 and the results of the site comparisons in Tables 5 and 6, suggest that disposal activities in the deep-water sites farther from land, namely sites 4 and 5, might have an impact on fewer species and individuals than the same activities in the shallower study sites 2 and 3. Ainley and Allen (1992) report highest species densities and abundance in study site 5 (and site 2, though our results are consistent with their findings regarding this study site).

Possibly, there were seasonal or annual shifts in area usage by seabirds and marine mammals that could account for this discrepancy. Factors such as the El Niño-Southern Oscillation or ENSO, large-scale population shifts, human activities, and food and nest-site availability (Briggs et al. 1987, Calambokidis et al. 1989, and Ainley and Boekelheide 1990) are known to induce changes in animal numbers and behavior. Because these results are not mutually exclusive, it might be most prudent to consider the combined results that indicate that study sites 2, 3, and 5 are important to the marine fauna of the Gulf of the Farallones.

We should also mention that the Ashy Storm-Petrel, whose numbers in the Gulf of the Farallones represent 85% of the world's population, forage regularly to the west and northwest of the Farallones (Ainley and Boekelheide 1990, Ainley and Allen 1992). Special consideration should be given to impacts to this species, particularly if study site 5 is selected as the permanent disposal site.

2. Mammals

Interpreting the results of marine mammal census work has inherent difficulties [see excellent review by Hiby and Mammond (1989)]. First, a marine mammal must be at the surface to be sighted. The intermittent surfacing behavior and movement of marine mammals, as well as the movement of a survey vessel will serve to reduce the probability of a marine mammal surfacing within the sighting region of the vessel (Stern 1992). Second, once at the surface, a marine mammal must be sighted by an observer. The probability of a whale being sighted is a function of observer behavior, and has been addressed in several studies (Doi 1974; Doi et al. 1982; Doi et al. 1983; Hiby 1985; Hiby and Thompson 1985; Thompson and Hiby 1985; Ward et al. 1986; Schweder 1990). Last, sightings are biased toward the daylight hours; thus, the results of this study and similar studies may not be representative of the nighttime distribution of nocturnal feeders.

Of the 37 species of marine mammals known to occur in California, 32 species have been sighted or have stranded in the Gulf of the Farallones or adjacent northern California waters. Of the six species of pinnipeds recorded in this region, three have local breeding colonies here (Huber 1985). Five species of small cetaceans breed in this area: harbor porpoise, Dall's porpoise, Risso's dolphin, Pacific white-sided dolphin and northern right whale dolphin.

During the summer and autumn months, six species of large baleen whales (blue, humpback, minke, fin, sei, and gray whales) have been seen feeding in the waters of the Farallon Basin (Webber et al. 1989). Sperm whales have also been sighted in slope and offshore waters (Dohl et al. 1983; S. Bailey, P. Jones, pers. observ., described in the Results section), although none was seen during this study.

Thus, the waters of the Gulf of the Farallones and the nearby offshore waters represent an important feeding and breeding area for many species of marine mammals. Spatial and temporal distribution patterns of marine mammals have been documented off the west coast in general (Leatherwood et al. 1982, Dohl et al. 1983) and in the study area specifically (Dohl et al. 1983, Calambokidis et al. 1990, Webber and Cooper 1983, Webber et al. 1989, Ainley and Allen 1992). Our results support these previous findings (Tables 3, 16-20).

Many more species of cetaceans and pinnipeds were seen in the study site during the late summer and fall cruises than in winter and early spring, which can be partially explained by the increased food availability during the earlier period (see Ainley and Boekelheide (1990) for a review of seasonal patterns in the physical and biological conditions of the marine environment). The other obvious cause for this difference is due to movement in and out of the area in relation to the different breeding cycles of the cetaceans and pinnipeds.

The number of individual mammals seen in study site 3 was 50% greater than expected, which is similar to the results of the same analysis for seabirds. We saw no marine mammals in study site 4, and only one third of the expected number of individuals in study site 5. These results are consistent with the seabird usage of these areas from our study, and are slightly different from the findings of Ainley and Allen 1992, who found that study site 5 is also important to marine animals during the May-June period.

Calambokidis et al. (1989a) reported that blue whales were "significantly associated with concentrations of marine birds, primarily Cassin's Auklets and phalaropes." During this cruise, blue and humpback whales were observed in the area of greatest abundance of Cassin's Auklets (Figures 2, 4, and 5). Cassin's Auklets breeding on the Farallon Islands feed primarily on two euphausiids, <u>Thysanoessa spinifera</u> and <u>Euphausia pacifica</u> (Manual 1974, Ainley and Boekelheide 1990). Fecal samples from blue whales feeding near the Farallon Islands contained primarily <u>Thysanoessa spinifera</u> (C. Ewald, personal communication). This trophic linkage probably explains why Cassin's Auklets and blue whales were seen together.

Although the minke whale comprises a very small portion of the baleen whale population of northern and central California (Dohl et al. 1983), they are observed year round in the Gulf of the Farallones (Ainley and Allen 1992) and in the Monterey Bay area (Stern 1991). Mark and recapture analysis of photographs of individual whales suggests that no exchange of individuals occurs between the Gulf of the Farallones, the Monterey Bay area, the San Juan Islands, Washington, and Johnston Strait, British Columbia (Dorsey et al. 1990, Stern 1991). Resightings of individuals within and between years suggests the possibility that some whales may be year-round residents within these area (Stern 1991). Studies to address this question are planned for the near future (J. Stern, pers. comm.).

Minke whales were seen twice during this study while on effort, shoreward of the 100-m isobath. This finding is consistent with the spatial distribution patterns of minke whales in the Monterey Bay area (Stern 1991) and in other areas of the northern hemisphere (Horwood 1989), suggesting that minke whales are essentially shelf dwellers.

Minke whales off central California have been observed to feed on a variety of prey including krill (Thysanoessa spp.) and Euphausia spp.) and rockfish (Sebastes spp.) in the spring and anchovy (Engraulis mordax) in summer and fall (Stern 1991, Stern and Long, in prep.). Stern (1991) also reports it is possible that minke whales wintering locally feed on herring (Clupea harengeus). Minke whales along the west coast of North America are distributed in small and possibly isolated populations that, unlike the other balaenopterids, may not make extensive migrations out of the area. Therefore, they would rely on the presence of suitable prey on a year-round basis (Stern 1991).

After the gray whale, the humpback whale was the second most abundant baleen whale along northern and central California (Dohl et al. 1983). They are most abundant in the Gulf of the Farallones from August through October (Calambokidis et al. 1989b, Webber et al. 1989). They have been observed feeding on subsurface schools of bait fish, euphausiids and pelagic red crabs (Pleuroncodes planipes) in the Farallon basin (Dohl et al. 1983). They were the most frequently seen baleen whale in this study, and could be disturbed by dredging disposal activities in study sites 2 and 3.

Kieckhefer (1991) has reported responses in feeding behavior by humpback whales relative to prey abundance and red-tide phenomena. If this species does respond to naturally occurring phenomena in this manner, it is likely that their response (and that of other visual-feeding marine predators) to a plume of dredged material would be at least similar.

Stern (1991; and other work in prep.) has done some modelling on searching for prey, probability of prey detection, and foraging rates in feeding whales. From these models, it is clear that a decreased sweep width as the result of increased turbidity from a dumping event would reduce the probability of a whale (or any visual aquatic predator) detecting prey. While this seems intuitively logical and simple, the implications are perhaps more complicated and important.

A large mobile predator, such as whale, could simply leave the area to search for displaced prey or a new patch of prey. This assumes that individuals can find other areas and that the prey that were expect to be in the impacted area are similarly redistributed. It is not only resource abundance, but also availability, that dictates patterns of resource use (Weins 1984). The effect of reducing the availability of some proportion of a finite and patchily distributed resource, or requiring more effort to locate a unit of biomass of prey by forcing a predator to search longer within a patch or leave a patch to find another, will affect functional response.

Functional response is the relationship between the amount of prey consumed per predator and the density of the prey (Stephens and Krebs 1986, Pulliam 1989). A change in the amount of time spent foraging also affects the amount of time available for other activities, so that fitness in one set of environmental conditions might be different in other sets of environmental conditions (Tilman 1989). The question then arises as to what cumulative effects these changes in predation patterns would have on population dynamics, food web dynamics, and community structure [e.g., Hastings and Powell 1991)].

The Pacific white-sided dolphin is the most abundant species of cetacean in northern and central California (Dohl et al. 1983). In the Gulf of the Farallones, it was the second most abundant and third most frequently sighted species of small cetaceans between 1983-1987 (Webber et al. 1989). They are most abundant in September and October (Dohl et al. 1983, Webber et al. 1989). This species feeds on small schooling fish and squid in the epipelagic and mesopelagic region (Ainley and Allen 1992). Jones (1981) reported that squid, smelts, and midshipmen are the major prey items of this species in northern California. Like many of the other marine mammals (and seabirds) these dolphins were sighted in the vicinity of study site 3 in water ranging in depth from 290-3200 m (Figures 4 and 5).

According to Dohl et al. (1983), the northern right whale dolphin was the second most abundant cetacean from northern and central

California. They sighted this species in our study area in all three years of their survey. From 1983 to 1987, this species was the fifth most abundant species observed in the vicinity of the Gulf of the Farallones (Webber et al. 1989). Northern right whale dolphins feed primarily on squid and mesopelagic fish (Leatherwood and Walker 1979) feeding in waters over 250 m in depth (Dohl et al. 1983). Like the Pacific white-sided dolphin with which this species often associates, they were seen in four mixed groups from the shelf break to deep water west of study site 4.

The short-finned pilot whale is a rare visitor to the Gulf of the Farallones. There is one stranding (Schonewald and Szczepaniak 1979) and one sighting (Webber et al. 1989) of pilot whales previously recorded from this area. Because of its uncommon status, this cetacean is unlikely to be affected by the activities associated with dredged material disposal in the study area.

Risso's dolphin is regularly sighted in the Gulf of the Farallones. Dohl et al. (1983) reported sighting Risso's dolphin in the vicinity of the Gulf of the Farallones during all three years of their study. They were the fourth most frequently sighted odontocete in the Gulf of the Farallones between 1983-1987 (Webber et al. 1989). Risso's dolphin in this area appears to feed primarily on squid (Orr 1966). Our single sighting of this species belies its higher sighting frequency in the study area; however, it seems unlikely that Grampus, like many of the other smaller, highly mobile cetaceans, would be adversely affected by dredging activities in the Gulf.

The harbor porpoise is the most commonly sighted marine mammal in the Gulf of the Farallones (Webber et al. 1989). It is found here year round, but is most abundant in the summer and autumn (Calambokidis et al. 1990, Szczepaniak 1990). The population of harbor porpoise in the Gulf of the Farallones has been estimated as between 1268-2109 animals (Szczepaniak 1990, Calambokidis et al. 1990).

The majority (89%) of harbor porpoise sightings occur in water under 38 m (20 fathoms) and they are not usually seen in waters deeper than 90 m (50 fathoms, Szczepaniak 1990, Ainley and Allen 1992), although during the cruise in October 1991 we sighted one animal in 116 m (64 fathoms). The most common prey item of harbor porpoise in the Gulf of the Farallones is juvenile rockfish Sebastes spp. (Jones 1981). Based on the results of previous studies (Calambokidis et al. 1990 and Ainley and Allen 1992), the only study site in which we expected to find harbor porpoise was study site 2. Though impacts due to dredging activities in study site 2 might heavily impact many other bird species, the effects on the harbor porpoise would probably not be detrimental because of its affinity for shallower waters (assuming that there were no indirect impacts to the food web).

The Dall's porpoise is the most frequently sighted small cetacean in the study area (Ainley and Allen 1992). They are found year-round although they are most abundant in the autumn (Dohl et al. 1983). According to Jones (1981), the preferred food items of Dall's porpoise from the Gulf of the Farallones is Pacific hake (Merluccius productus) and Pacific tomcod (Microgadus proximus). He did not find squid in the stomach of any specimen examined. Morejohn (1979), however, reported that squid (Loligo opalescens) is eaten year round by Dall's porpoise in the Monterey area.

The northern sea lion is one of the three species of pinnipeds known to breed in this area. In this area of California, their diet consists primarily of rockfish, Pacific hake and flatfish (Jones 1981). Because this pinniped was seen only twice during this study, the impacts on this species from dredging activities anywhere in the Gulf of the Farallones is likely to be minimal.

The California sea lion was the most frequently sighted pinniped in the Gulf of the Farallones between 1983-1987 (Webber et al. 1989). Ainley and Allen (1992) report that it was the second most frequently sighted pinniped during their survey of the study area. California sea lions feed primarily on squid and small schooling fish (Jones 1981). Pacific hake and northern anchovy make up 87% of the prey items of this species in northern California (Jones 1981). During this study, California sea lions were observed in all seasons and were most abundant in August in the vicinity of and within site 3.

This is in contrast to the findings of Webber et al. (1989) and Ainley and Allen (1992), who reported that this species was most abundant over the shelf. This suggests possible seasonal shifts in resource usage (since the above authors did not census during all seasons) or a peculiar event associated with this study period [which is thought to coincide with the early part of a weak to moderate El Niño-Southern Oscillation event (S. Ramp, pers. comm.)].

Ainley and Allen (1992) reported that the northern fur seal was the most common species of pinniped observed in the study area. Unlike the California sea lion, the northern fur seal is more commonly observed in the deeper waters of the continental slope (Ainley and Allen 1992). Our results support the above findings and those of Dohl et al. (1983) who report areas of high pinniped density (>0.61 animals km^{-2}) north and south of SEFI during the fall and winter and moderate densities (0.151-0.60 animals km^{-2}) in the summer south of SEFI to Santa Cruz, Calif. During this study, the only study site in which this pinniped was seen was site 3.

3. Threatened and Endangered Species

Seabirds

The only endangered bird species seen during the study was the Brown Pelican, which was observed during the cruises in August 1990 and 1991, and October 1991. They were seen in groups of 2-10 animals over water depths that ranged from 44-3422 m (median range was 80-1503, n=18; Figure 2 and Appendix 2). We did not observe the American Osprey (Pandion haliaetus) or Peregrine Falcon (Falco peregrinus) during this study.

Marine Mammals

Two of the three baleen whales seen during this study (blue and humpback) were listed June 2, 1970 as endangered under the Endangered Species Act (50 CFR 17.11 & 17.12, January 1, 1989).

The minke whale, seen twice over shelf waters, is not listed at this time. Outside of the areas in the western North Pacific, minke whales were given Initial Management Stock status by the International Whaling Commission, since no reliable stock size existed (Horwood 1959). The results of Dorsey et al. (1990) suggest that North Pacific minke whales are a distinct species rather than part of a single cosmopolitan species (Amos and Dover, 1991; Hoezel and Dover 1991; Wada and Numachi, 1991, Wada et al. 1991; vanPijlen et al. 1991).

The gray whale is also endangered, but was not seen during the study. Grays were most likely to have been observed in February 1991 (cruise 2), but most of the stations (46 out of 52, Figure 1) were over deep shelf and slope waters where gray whales are rarely seen (Rice and Wolman 1971, Poole 1984). They could be disturbed by disposal activities in study sites 2 and 3. For a review of the effects of human activities on whales, see Malme et al. (1983). They found that gray whales responded to the sounds of undersea oil exploration activities up to 3 km away.

Both blue and humpback whales were seen over waters of the shelf break and slope, primarily to the west and south of SEFI (Figure 5). Nine of the 15 sightings of these species were either inside study site 3 or between site 3 and the western boundary of study site 2. Including animals seen while off effort, we saw in August 1991 (cruise 4) a total of 10 groups of humpbacks (23 individuals) and 9 groups of blues (17 individuals) mostly in the areas south and southwest of SEFI. The humpbacks were observed feeding in 91-1650 m of water, and the blue whales were in depths from 87-1335 m. Dredging activity in that general area could affect adults and calves of these species, which are known to use the Gulf of the Farallones as summer feeding grounds (Calambokidis et al. 1989a 1989b, Ainley and Allen 1992).

Sperm whales are listed as endangered (50 CFR 17.11 & 17.12, January 1, 1989), but were not seen during this study. However, there have been several recent sightings of sperm whales in or near the study area. An adult male was observed on July 29, 1989 from a vessel on a natural history excursion in relatively shallow water of about 550 m at 37°31.6'N and 123°03.1'W (P. Jones, pers. observ.). Two different large pods were seen on May 4, 1991 from another vessel on a similar trip in more than 3000 m (one pod of 18 whales at 37°10.7'N and 123°42.9'W, the other of 17 whales at 37°05.7'N and 123°32.9'W; S. Bailey, pers. comm.). These sightings support the findings of Dohl et al. (1983) who report this species as a regular visitor to the area and the sixth most abundant cetacean in the offshore waters along the California coast.

Northern sea lions, recently listed as a threatened species, were only seen at two stations during this study; once on the western boundary of study site 5 and the other at the eastern tip of study site 3. We agree with Ainley and Allen (1992) that "any further degradation of habitat by pollution would be of concern for this species," especially if the term "pollution" includes impacts to the food web from the disposal of dredged material.

Sea Turtles

As mentioned above, we sighted a leatherback turtle in 54 m of water at 37°39.5'N and 122°49.2'W. That animal was photographed eating the moon jelly, *Aurelia aurita*. Another animal was sighted in 168 m of water during a regular cruise on 17 August 1991 at 37°18.1'N and 123°07.2'W.

The leatherback turtle is the most frequently observed sea turtle in central and northern California (Dohl et al. 1983). They reported that leatherback turtles were most common in the summer and autumn months. Most of their sightings were in waters near the 1800 m isobath. Our sightings were in much shallower water. There have been numerous sightings and strandings of this species in the Gulf of the Farallones since 1983 (Webber and Szczepaniak, in prep.).

Although most of the sightings and strandings were in the summer and autumn, there are records of leatherback turtles in this area in the winter (Webber and Szczepaniak, in prep.). Some recent work by Eckert (1992) has revealed that this turtle feeds primarily on organisms in the deep scattering layer (DSL), and follows the DSL as it makes its known diurnal vertical movements.

However, until more information is available on the trophic relationships of the marine fauna of the Gulf of the Farallones and on the effects of ocean disposal of dredged material on the organisms that make up the food web, it will be difficult to precisely determine the potential negative effects of these human activities on sea turtles (and other marine organisms).

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Table 1. Cruise dates and vessels

Cruise Number	Vessel	Date and Year
1	R/V Farnella	5-16 August 1990
2	R/V Point Sur	13-18 February 1991
3	R/V Point Sur	15-22 May 1991
4	R/V Point Sur	12-19 August 1991
5	R/V Point Sur	30 October-3 November 1991

Table 2. Species of birds observed during the 5 cruises (for data collected while on effort and during general observations.

COMMON NAME	SCIENTIFIC NAME	CODE	Cruise 1 AUG 90	Cruise 2 FEB 91	Cruise 3 MAY 91	Cruise 4 AUG 91	Cruise 5 NOV 91
Pacific Loon	*Gavia pacifica*	PALO			X		
Common Loon	*G. immer*	COLO			X		X
Black-footed Albatross	*Diomedea nigripes*	BFAL	X	X	X	X	X
Laysan Albatross	*D. immutabilis*	LAAL		X	X	X	
Northern Fulmar	*Fulmaris glacialis*	NOFU	X	X	X	X	X
Murphy's Petrel	*Pterodroma ultima*	MUPE			X		
Pink-footed Shearwater	*Puffinus creatopus*	PFSH	X		X	X	X
Buller's Shearwater	*P. bulleri*	BUSH	X			X	X
Sooty Shearwater	*P. griseus*	SOSH	X	X	X	X	X
Short-tailed Shearwater	*P. tenuirostris*	STSH		X			
Black-vented Shearwater	*P. opistomelas*	BVSH	X				
Forked-tailed Storm-petrel	*Oceanodroma furcata*	FTSP			X	X	
Leach's Storm-Petrel	*O. leucorhoa*	LESP	X		X	X	
Ashy Storm-Petrel	*O. homochroa*	ASSP	X		X	X	X
Black Storm-Petrel	*O. melania*	BLSP	X				
Brown Pelican	*Pelecanus occidentalis*	BRPE	X			X	X
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO				X	
Brandt's Cormorant	*P. penicillatus*	BRCO			X	X	X
Pelagic Cormorant	*P. pelagicus*	PECO			X	X	X
Semipalmated Plover	*Charidrius semipalmatus*	SEPL	X				
Whimbrel	*Numenius phaeopus*	WHIM			X		
Surfbird	*Aphriza virgata*	SURF	X				
Western Sandpiper	*Calidris mauri*	WESA	X				
Least Sandpiper	*C. minutilla*	LESA				X	
Baird's Sandpiper	*C. bairdii*	BASA	X				
Pectoral Sandpiper	*C. melanotus*	PESA	X				
Red-necked Phalarope	*Phalaropus lobatus*	RNPH	X		X	X	X
Red Phalarope	*P. fulicarius*	REPH	X		X	X	X
Pomarine Jaeger	*Stercorarius pomarinus*	POJA	X	X	X	X	X
Parasitic Jaeger	*S. parasiticus*	PAJA	X		X	X	
Long-tailed Jaeger	*S. longicaudus*	LTJA	X			X	
South Polar Skua	*Catharacta mccormickii*	SPSK	X		X	X	X
Bonaparte's Gull	*Larus philadelphia*	BOGU					X
Mew Gull	*L. canus*	MEGU					X
Heerman's Gull	*L. heermani*	HNGU	X			X	X

Table 2, continued

COMMON NAME	SCIENTIFIC NAME	CODE	Cruise 1 AUG 90	2 FEB 91	3 MAY 91	4 AUG 91	5 NOV 91
Ring-billed Gull	*L. delawarensis*	RBGU					X
California Gull	*L. californicus*	CAGU	X	X	X	X	X
Herring Gull	*L. argentatus*	HEGU	X	X			X
Thayer's Gull	*L. thayeri*	THGU		X			
Western Gull	*L. occidentalis*	WEGU	X	X	X	X	X
Glaucous-winged Gull	*L. glaucescens*	GWGU		X			X
Sabine's Gull	*Xema sabini*	SAGU	X		X	X	X
Black-legged Kittiwake	*Rissa tridactyla*	BLKI		X			
Caspian Tern	*Sterna caspia*	CATE				X	
Common Tern	*Sterna hirundo*	COTE			X		
Arctic Tern	*Sterna paradisaea*	ARTE	X		X	X	X
Common Murre	*Uria aalge*	COMU	X	X	X	X	X
Pigeon Guillemot	*Cepphus columba*	PIGU		X	X	X	
Xantus' Murrelet	*Synthliboramphus hypoleucus*	XAMU				X	X
Craveri's Murrelet	*S. craveri*	CRMU	X				
Cassin's Auklet	*Ptychoramphus aleuticus*	CAAU	X	X	X	X	X
Rhinoceros Auklet	*Cerorhinca monocerata*	RHAU	X	X	X	X	X
Tufted Puffin	*Fratercula cirrhata*	TUPU		X	X	X	X
Horned Puffin	*F. corniculata*	HOPU			X		

Table 3. Species of marine mammals and turtles observed, including species code (for data collected while on effort and during general observations).

			Cruise				
			1	2	3	4	5
COMMON NAME	SCIENTIFIC NAME	CODE	AUG 90	FEB 91	MAY 91	AUG 91	NOV 91
CETACEANS							
Blue whale	Balaenoptera musculus	BLWH	X			X	
Minke whale	B. acutorostrata	MIWH				X	X
Humpback whale	Megaptera novaeangliae	HUWH	X	X		X	
Harbor porpoise	Phocoena phocoena	HAPO					X
Dall's porpoise	Phocoenoides dalli	DAPO	X	X	X	X	X
Risso's dolphin	Grampus griseus	RIDO					X
Northern right whale dolphin	Lissodelphis borealis	NRWD	X			X	X
Pacific white-sided dolphin	Lagenorhynchus obliquidens	PWSD	X		X	X	X
Short-finned pilot whales	Globicephala macrorhynchus	SFPW					X
PINNIPEDS							
Northern sea lion	Eumetopius jubatus	STSL	X			X	
Northern fur seal	Callorhinus ursinus	NFSE	X	X	X	X	X
California sea lion	Zalophus californianus	CASL	X	X	X	X	X
Harbor seal	Phoca vitulina richardsi	HASE	X				
Northern elephant seal	Mirounga angustirostris	NESE	X	X	X	X	
TURTLES							
Leatherback	Dermochelys coriacea	LETU	X			X	

Table 4. Seabird density (birds km^{-2}) for the five cruises for the entire study area from station data only (not including general observations).

CRUISE NO. No.	DENSITY (birds km^{-2})		No. of STATIONS
1 Aug 1990	9.0		110
2 Feb 1991	24.7		52
3 May 1991	56.5		59
4 Aug 1991	34.2		107
5 Oct/Nov 1991	21.2		63
Grand Mean	28.2	Total	391

Note: Total number of birds counted was 13,323 and the total area covered was 471.9 km^2).

Table 5. Percentage of seabird species (and numbers) observed and expected in each of the study sites for all cruises combined (on-effort data only).

Study Site	Number Stations n	(%)	No. Groups n	(%)	No.[a] Spp. n	No. Indiv. n	Exp.[b] Indiv. n	Exp.[b] Groups n
2	5	(6.1)	29	(9.9)	12	122	56	18
3	46	(56.1)	190	(65.0)	37	669	518	164
4	10	(12.2)	21	(7.2)	11	30	113	35
5	21	(25.6)	52	(17.9)	14	103	237	75
TOTAL	82	(100.0)	292	(100.0)	74	924	924	292

[a] number of species is total for that area, but are not unique among areas.

[b] number of individuals or observations expected in each area proportional to the level of effort as measured by the number of stations censused in each area (i.e., the total number of groups or individuals multiplied by the percentage of stations censused in that particular study site).

Table 6. Percentage of mammal species (and numbers) observed and expected in each of the study sites for all cruises combined (on-effort data only).

Study Site	Number Stations n	(%)	No. Groups n	(%)	No.[a] Spp. n	No. Indiv. n	Exp.[b] Indiv. n	Exp.[b] Groups n
2	5	(6.1)	3	(8.1)	2	6	8	2
3	46	(56.1)	29	(78.4)	7	111	72	21
4	10	(12.2)	0	(0.0)	0	0	15	5
5	21	(25.6)	5	(13.5)	4	11	33	9
TOTAL	82	(100.0)	37	(100.0)	7	128	128	37

[a] number of species is total for that area, but are not unique among areas.

[b] number of individuals or groups expected in each area proportional to the level of effort as measured by the number of stations censused in each area (i.e., the total number of groups or individuals multiplied by the percentage of stations censused in that particular study site).

Table 7. Most abundant and most frequently observed species of seabirds for cruise 1 (only species ranking ≥ 5% listed).

CRUISE 1 AUGUST 1990

Most frequently observed ↓ | Most abundant ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
Black-footed Albatross	61	18	Pink-footed Shearwater	231	27
Pink-footed Shearwater	47	14	Sooty Shearwater	130	15
Sooty Shearwater	45	13	Black-footed Albatross	107	13
Western Gull	36	11	Western Gull	81	10
Ashy Storm-Petrel	23	7	Ashy Storm-Petrel	48	6
California Gull	22	6	Red Phalarope	41	5
Northern Fulmar	18	5	All others		<5%
All others		<5%			

Table 8. Most abundant and most frequently observed species of seabirds for cruise 2 (only species ranking ≥ 5% listed).

CRUISE 2 FEBRUARY 1991

Most frequently observed ↓ | Most abundant ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
Rhinoceros Auklet	32	14	Common Murre	719	40
Herring Gull	30	13	Rhinoceros Auklet	362	20
Black-legged Kittiwake	28	12	Cassin's Auklet	342	19
Northern Fulmar	25	11	Western Gull	99	6
Cassin's Auklet	22	9	All others		<5%
Western Gull	18	8			
Common Murre	14	6			
Glaucous-winged Gull	12	5			
Black-footed Albatross	11	5			
All others		<5%			

Table 9. Most abundant and most frequently observed species of seabirds for cruise 3 (only species ranking ≥ 5% listed).

CRUISE 3 MAY 1991

Most frequently observed ↓ | Most abundant ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
Sooty Shearwater	50	18	Sooty Shearwater	1023	26
Western Gull	49	18	Red Phalarope	876	23
Black-footed Albatross	33	12	Western Gull	542	14
Rhinoceros Auklet	17	6	Red-necked Phalarope	492	13
Red Phalarope	16	6	Common Murre	450	12
Red-necked Phalarope	15	5	All others		<5%
Northern Fulmar	15	5			
Murphy's Petrel	14	5			
Common Murre	13	5			
Cassin's Auklet	13	5			
All others		<5%			

Table 10. Most abundant and most frequently observed species of seabirds for cruise 4 (only species ranking ≥ 5% listed).

CRUISE 4 AUGUST 1991

Most frequently observed ↓ | Most abundant ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
Western Gull	76	20	Cassin's Auklet	3042	62
Sooty Shearwater	57	15	Western Gull	478	10
Common Murre	32	9	Red-necked Phalarope	429	9
Cassin's Auklet	27	7	Sooty Shearwater	313	6
Pink-footed Shearwater	23	6	Common Murre	256	5
Rhinoceros Auklet	21	6	All others		<5%
Brandt's Cormorant	21	6			
Black-footed Albatross	19	5			
Red-necked Phalarope	18	5			
All others		<5%			

Table 11. Most abundant and most frequently observed species of seabirds for cruise 5 (only species ranking ≥ 5% listed).

CRUISE 5 OCTOBER/NOVEMBER 1991

<u>Most frequently observed</u> ↓ <u>Most abundant</u> ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
California Gull	51	15	Red-necked Phalarope	520	26
Western Gull	46	14	Western Gull	287	14
Cassin's Auklet	28	8	Unidentified Phalarope	213	10
Rhinoceros Auklet	27	8	California Gull	213	10
Northern Fulmar	21	6	Red Phalarope	206	10
Unidentified Gull	19	6	Rhinoceros Auklet	120	6
Unidentified Phalarope	16	5	All others		<5%
Red-necked Phalarope	16	5			
Sooty Shearwater	16	5			
All others		<5%			

Table 12. Most abundant and most frequently observed species of seabirds for study site 2 (only species ranking ≥ 5% listed).

STUDY SITE 2

Most frequently observed ↓ | Most abundant ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
Western Gull	5	17	Rhinoceros Auklet	57	47
Sooty Shearwater	4	14	Western Gull	31	25
Rhinoceros Auklet	3	10	Common Murre	7	6
Black-legged Kittiwake	2	7	All others		<5%
Cassin's Auklet	2	7			
California Gull	2	7			
Herring Gull	2	7			
Northern Fulmar	2	7			
All others		<5%			

Table 13. Most abundant and most frequently observed species of seabirds for study site 3 (only species ranking ≥ 5% listed).

STUDY SITE 3

<u>Most frequently observed</u> ↓ <u>Most abundant</u> ↓

SPECIES NAME	No. of STN	%	SPECIES NAME	No. of IND	%
Black-footed Albatross	23	12	Red-necked Phalarope	166	25
California Gull	18	10	Red Phalarope	77	12
Sooty Shearwater	17	9	Pink-footed Shearwater	51	8
Western Gull	15	8	Western Gull	43	6
Northern Fulmar	13	7	Black-footed Albatross	36	5
Ashy Storm-Petrel	12	6	All others		<5%
Cassin's Auklet	12	6			
Red Phalarope	11	6			
Pink-footed Shearwater	10	5			
All others		<5%			

Table 14. Canonical Correspondence Analysis. (1) Species were selected from the cumulative fit of species scores, and (2) environmental variables were selected from the intra- and inter-set correlations. The results of both data sets A and B are combined.

CRUISE 4

(1) Important species with > 10% variance explained by axes 1 and 2 for both sets.

SPECIES	CODE
Brandt's Cormorant	BRCO
Cassin's Auklet	CAAU
Rhinoceros Auklet	RHAU
Common Murre	COMU
Western Gull	WEGU
Red-necked Phalarope	RNPH
Sooty Shearwater	SOSH

(2) Environmental variables important for both sets.

AXIS 1	AXIS 2
TEMPERATURE	DEPTH
SALINITY	LAND

Table 15. Results of the canonical correspondence analysis (CCA) for both sets of data (sets A and B), indicating the degree to which variance was explained by species data and species-environment relationship. Only axes 1 and 2 are necessary to explain the relationship of the species with the environmental variables.
Data were collected during cruise 4, August 1991.

Set A

	AXIS 1	AXIS 2
Eigenvalues	.600	.177
Species-Environment correlations	.862	.704
Cumulative percentage variance		
of species data	20.6	26.6
of species-envn relation	59.7	77.3

Monte Carlo Permutation Test of Significance

	AXIS 1	OVERALL
F ratio	10.61	4.30
p value	.01	.01

SET B

	AXIS 1	AXIS 2
Eigenvalues	.581	.305
Species-Environment correlations	.818	.758
Cumulative percentage variance		
of species data	16.7	25.5
of species-envn relation	48.5	74.0

Monte Carlo Permutation Test of Significance

	AXIS 1	OVERALL
F ratio	9.25	4.85
p value	.01	.01

Table 16. Number of groups and individuals (with percentage of total) for the marine mammals seen during cruise 1 while on effort.

CRUISE 1 AUGUST 1990

SPECIES NAME	No. of GROUPS	%	No. of INDIV-IDUALS	%
Blue whale	1	2	1	1
Humpback whale	4	8	10	5
Northern right whale dolphin	1	2	12	6
Dall's porpoise	11	21	70	35
Pacific white-sided dolphin	7	13	74	37
Unidentified cetacean	1	2	1	1
Northern sea lion	1	2	1	1
Northern fur seal	3	6	3	2
California sea lion	17	33	10	20
Northern elephant seal	4	8	5	3
Unidentified pinniped	2	4	2	1
TOTAL	50	100	199	100

n of stations = 110

Table 17. Number of groups and individuals (with percentage of total) for the marine mammals seen during cruise 2 while on effort.

CRUISE 2 FEBRUARY 1991

SPECIES NAME	No. of GROUPS	%	No. of INDIV-IDUALS	%
Dall's porpoise	3	14	7	14
Unidentified cetacean	1	5	2	4
Northern fur seal	11	52	34	66
California sea lion	6	29	8	16
TOTAL	22	100	51	100

n of stations = 52

Table 18. Number of groups and individuals (with percentage of total) for the marine mammals seen during cruise 3 while on effort.

CRUISE 3 MAY 1991

SPECIES NAME	No. of GROUPS	%	No. of INDIV-IDUALS	%
Dall's porpoise	4	22	37	67
Pacific white-sided dolphin	1	6	2	4
Unidentified small cetacean	1	6	1	2
Unidentified large cetacean	1	6	2	4
Northern fur seal	7	38	9	16
California sea lion	3	16	3	5
Northern elephant seal	1	6	1	2
TOTAL	18	100	55	100

n of stations = 59

Table 19. Number of groups and individuals (with percentage of total) for the marine mammals seen during cruise 4 while on effort.

CRUISE 4 AUGUST 91

SPECIES NAME	No. of GROUPS	%	No. of INDIV-IDUALS	%
Blue whale	7	15	15	4
Minke whale	1	2	1	<1
Humpback whale	8	17	19	6
Dall's porpoise	4	9	16	5
Northern right whale dolphin	1	2	8	2
Pacific white-sided dolphin	1	2	10	3
Northern sea lion	1	2	1	<1
Northern fur seal	4	9	4	1
California sea lion	20	42	266	78
TOTAL	47	100	340	100

n of stations = 107

Table 20. Number of groups and individuals (with percentage of total) for the marine mammals seen during cruise 5 while on effort.

CRUISE 5 OCTOBER/NOVEMBER 1991

SPECIES NAME	No. of GROUPS	%	No. of INDIV-IDUALS	%
Minke whale	1	3	1	<1
Harbor porpoise	1	3	2	<1
Dall's porpoise	5	16	82	8
Risso's dolphin	1	3	4	<1
Unidentified large cetacean	1	3	1	<1
Northern right whale dolphin	2	6	20	2
Pacific white-sided dolphin	3	9	792	82
Short-finned pilot whale	1	3	25	3
Northern fur seal	2	6	4	<1
California sea lion	14	44	36	4
Unidentified pinniped	1	3	2	<1
TOTAL	32	100	969	100

n of stations = 63

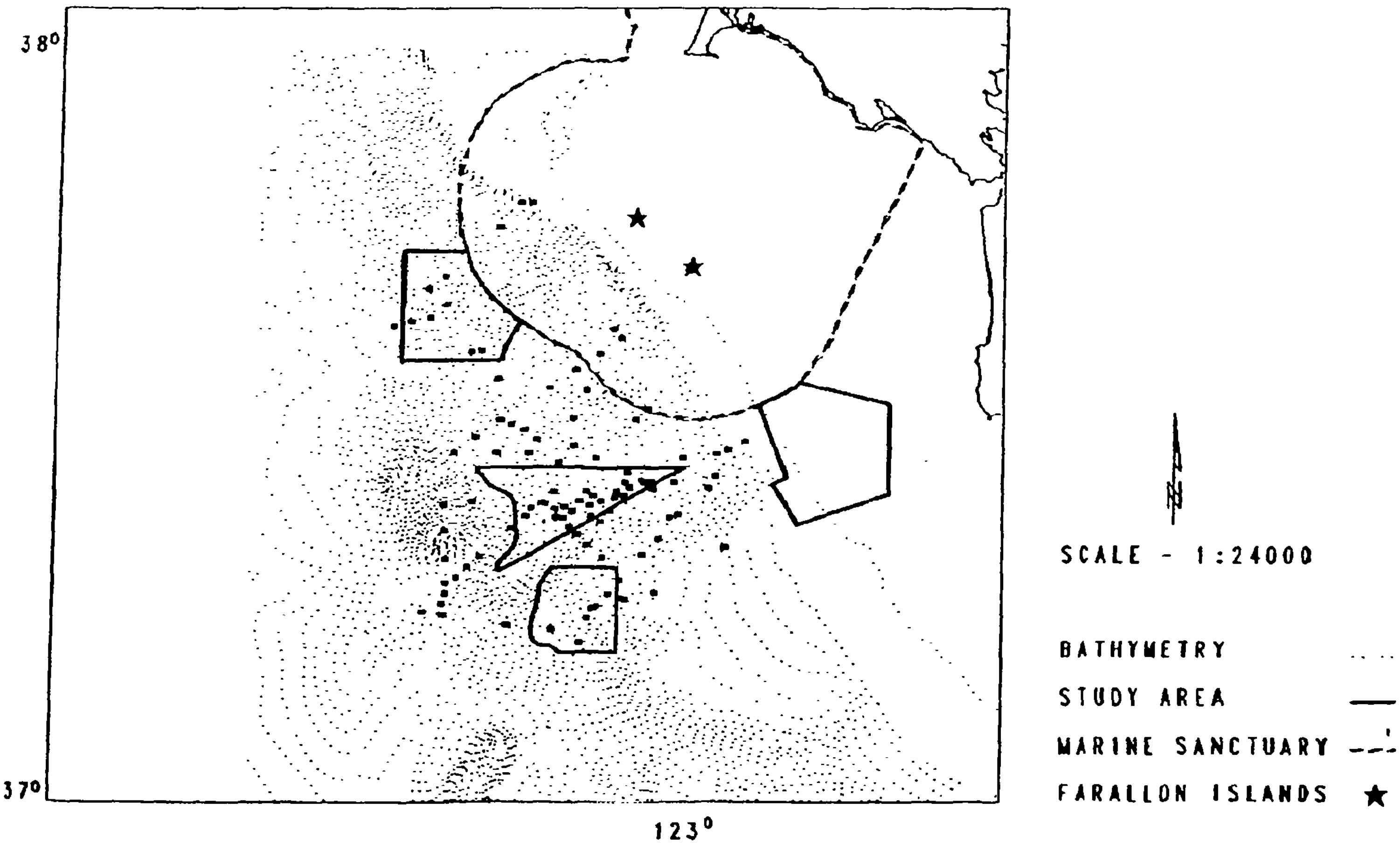
Figure 1. Maps of station locations for each cruise.

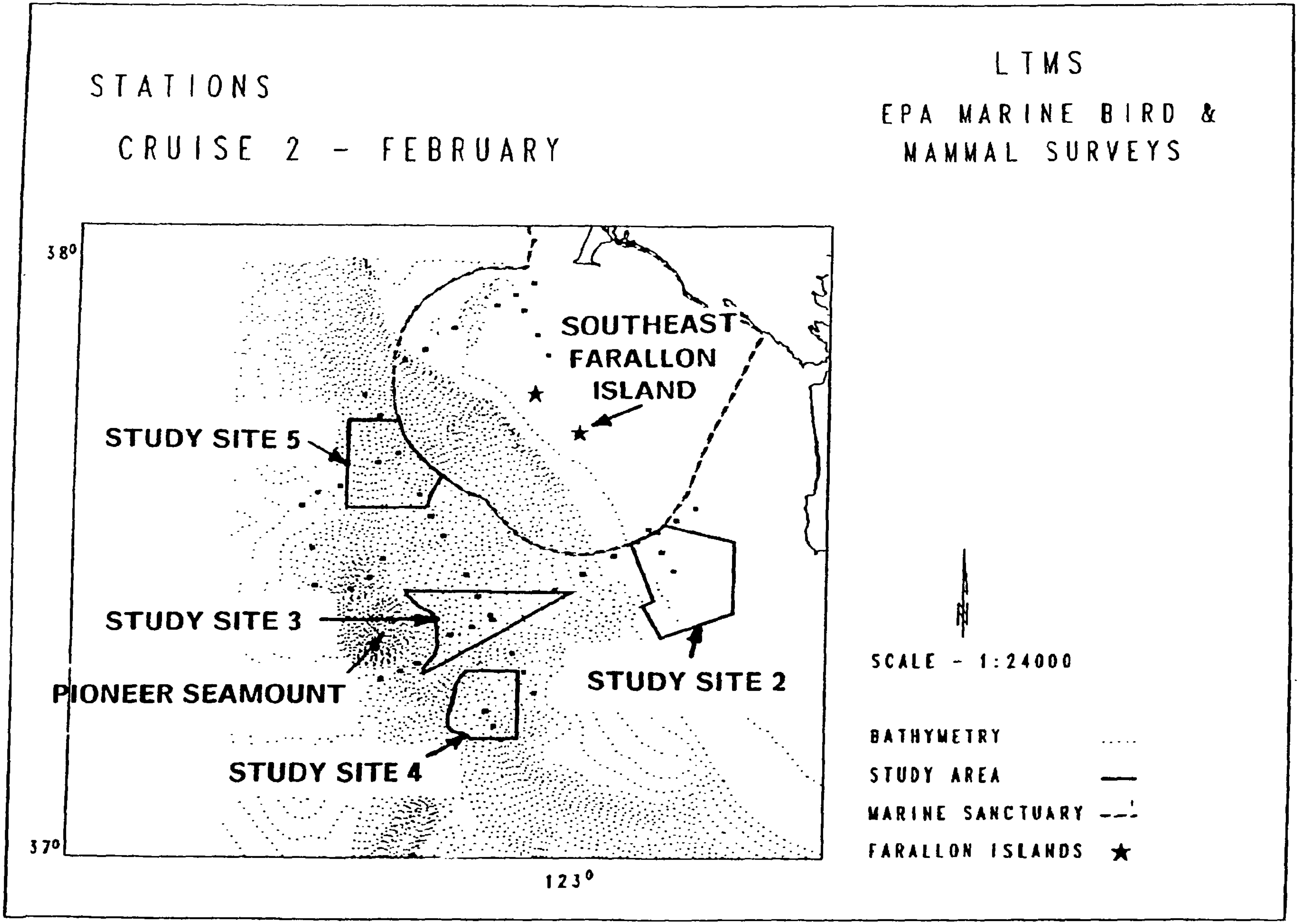
STATIONS

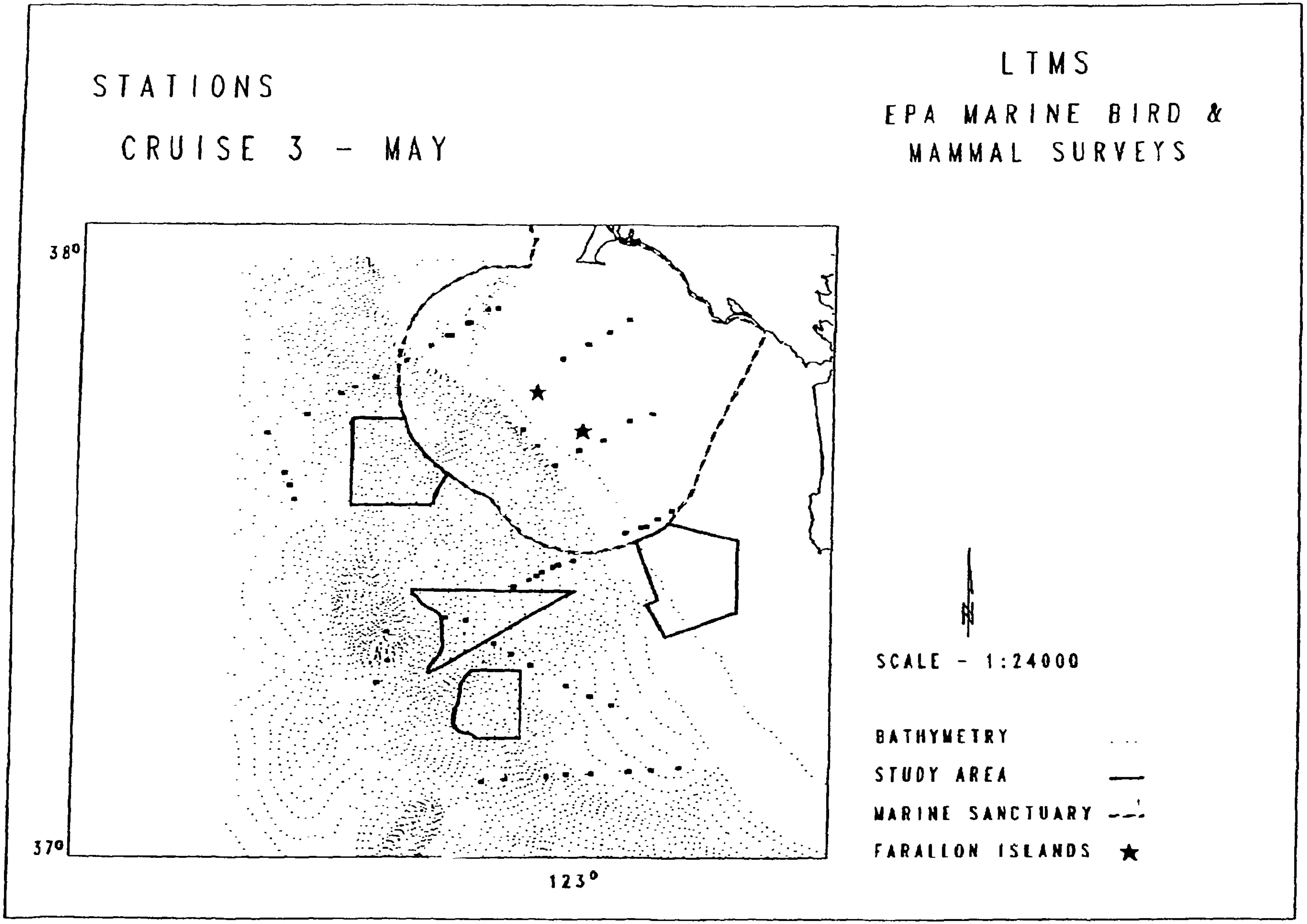
CRUISE 1 - AUGUST

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS




STATIONS
CRUISE 2 - FEBRUARY
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
38°
37°
123°
SOUTHEAST
FARALLON
ISLAND
STUDY SITE 5
STUDY SITE 3
PIONEER SEAMOUNT
STUDY SITE 4
STUDY SITE 2
N
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
FARALLON ISLANDS

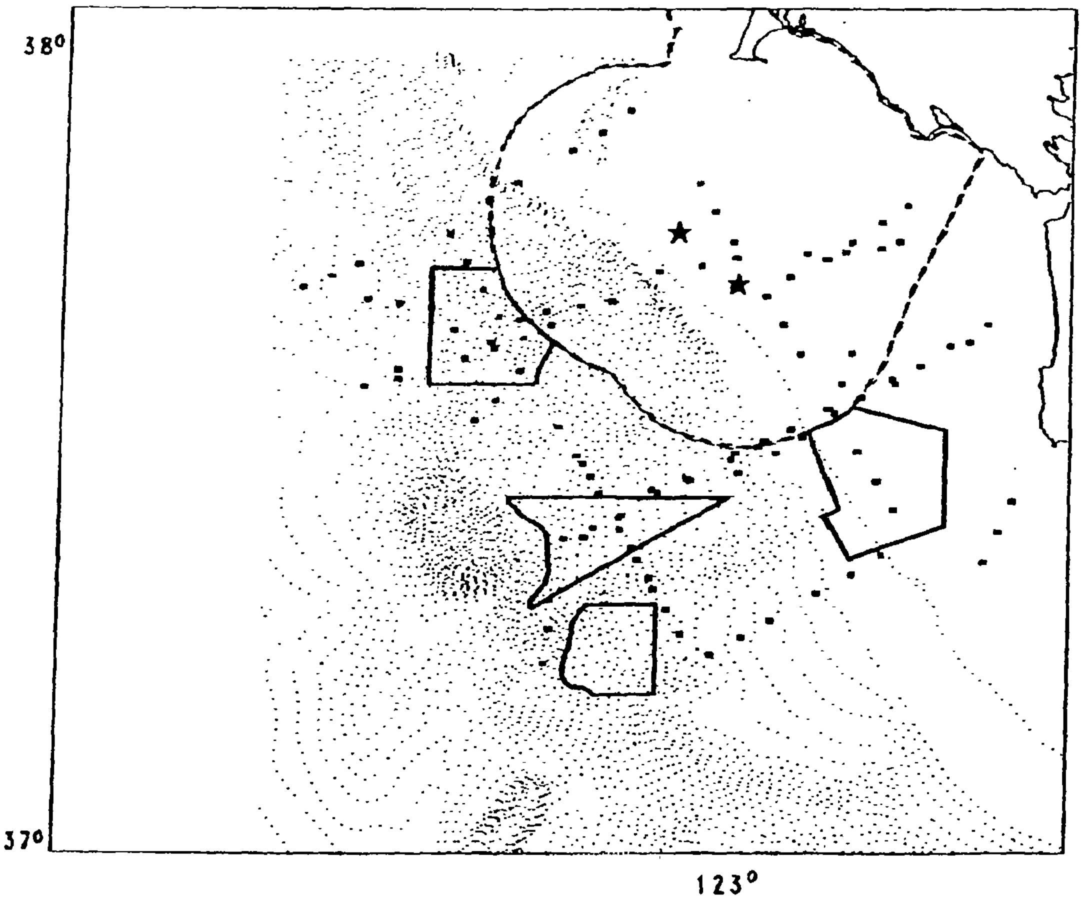

STATIONS
CRUISE 3 - MAY
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
38⁰
37⁰
123⁰
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
FARALLON ISLANDS

STATIONS

CRUISE 4 - AUGUST

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS



SCALE - 1:24000

BATHYMETRY

STUDY AREA

MARINE SANCTUARY

FARALLON ISLANDS ★

STATIONS

CRUISE 5 - OCTOBER

LTMS

EPA MARINE BIRD &
MAMMAL SURVEYS

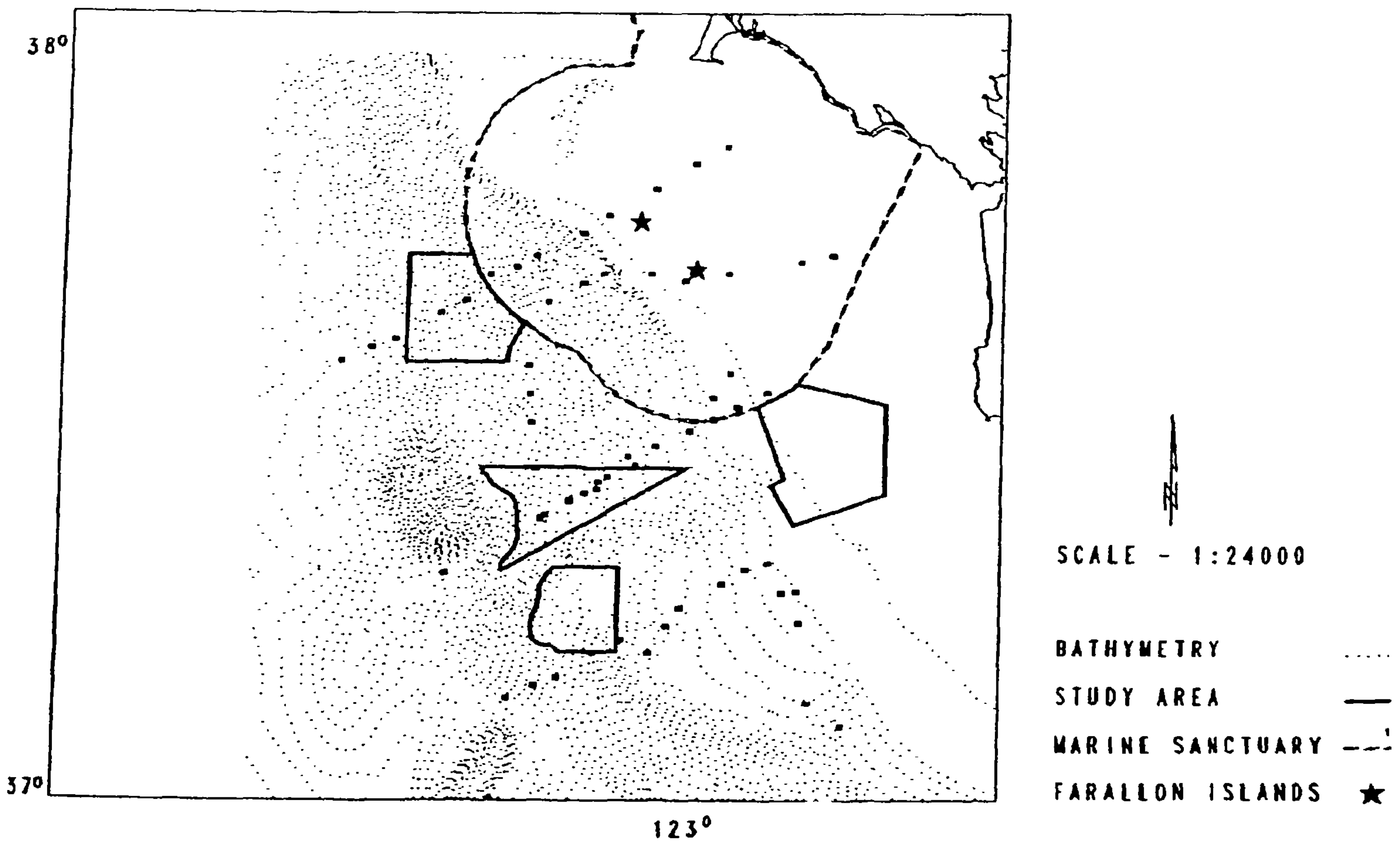
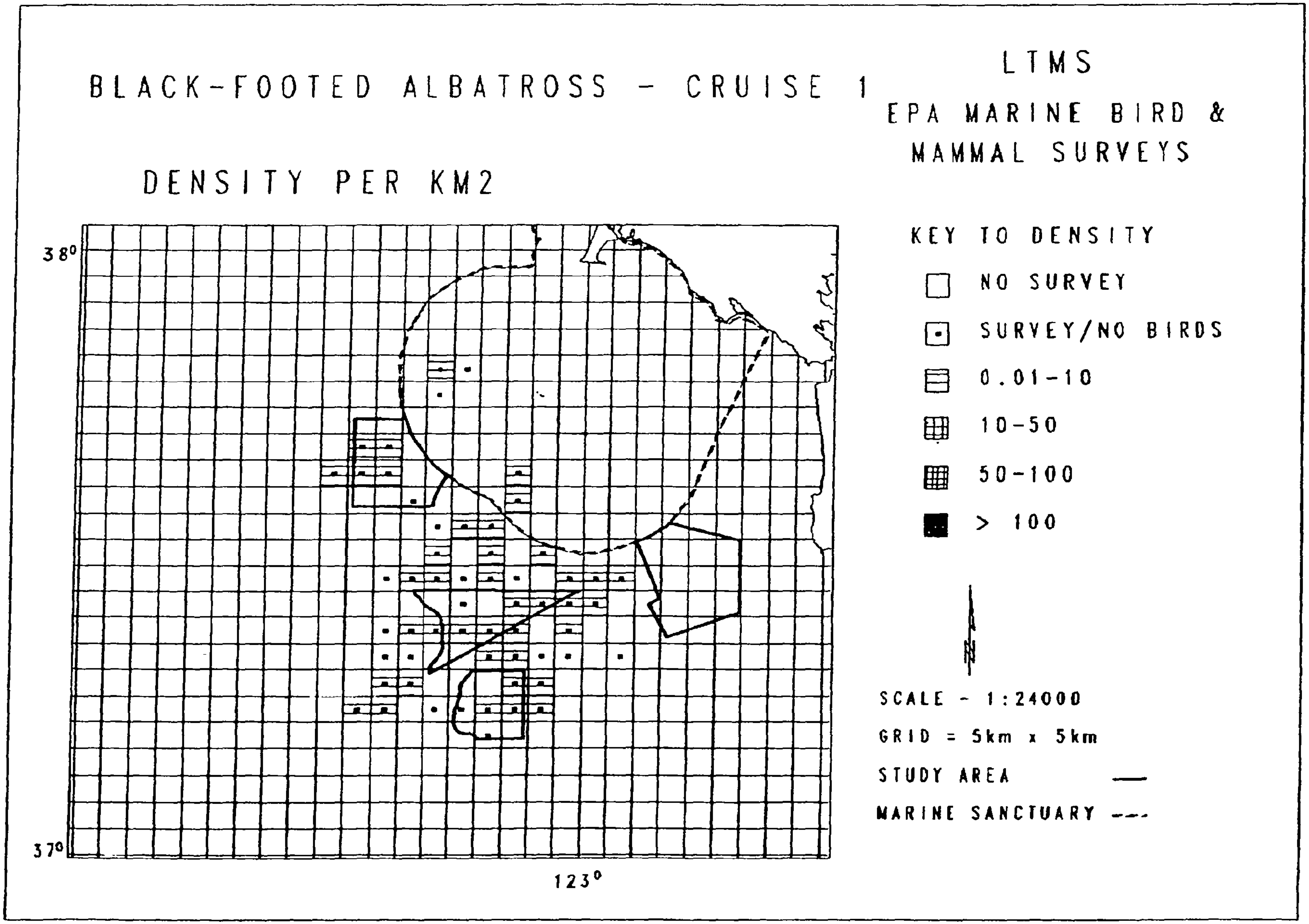
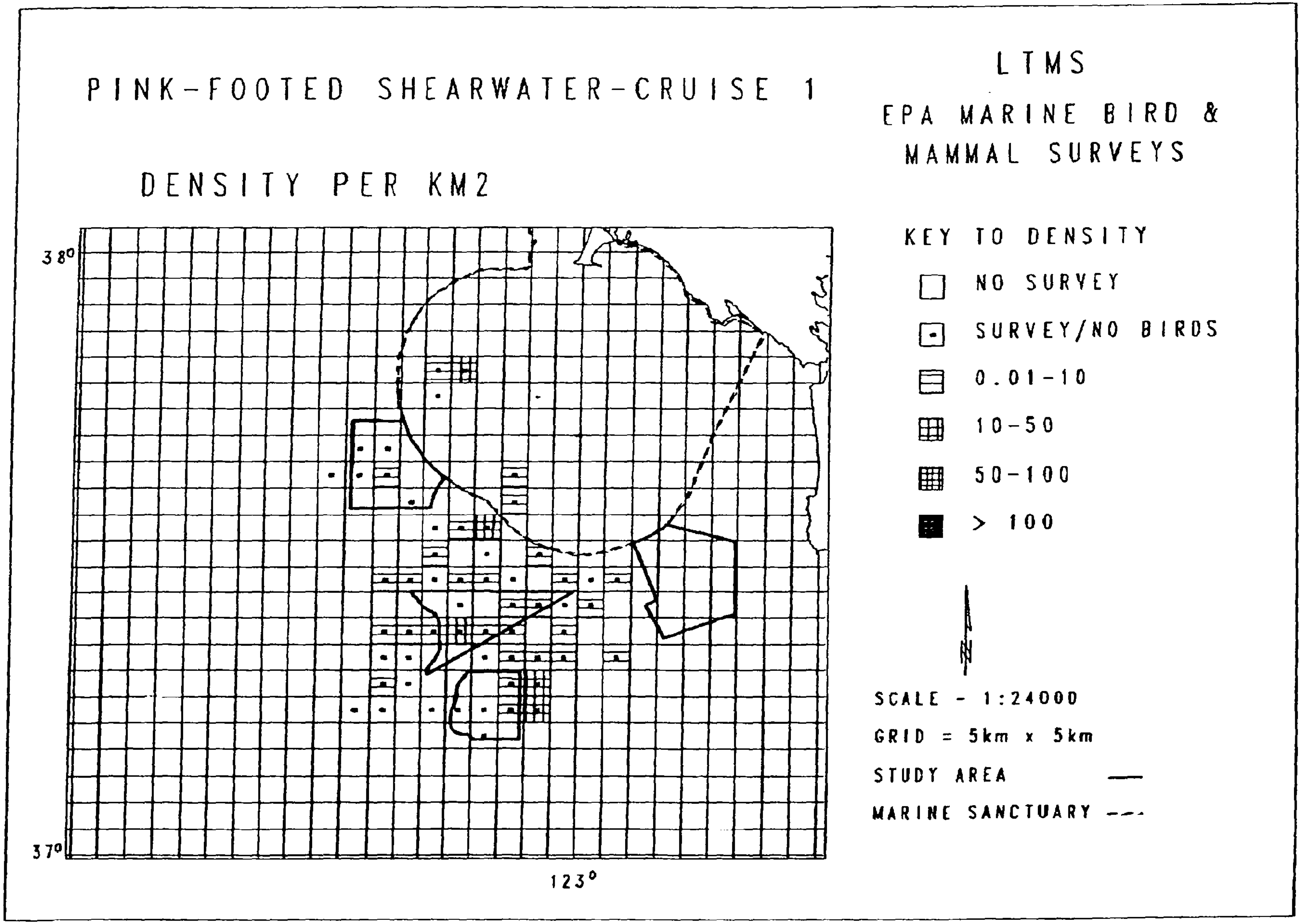
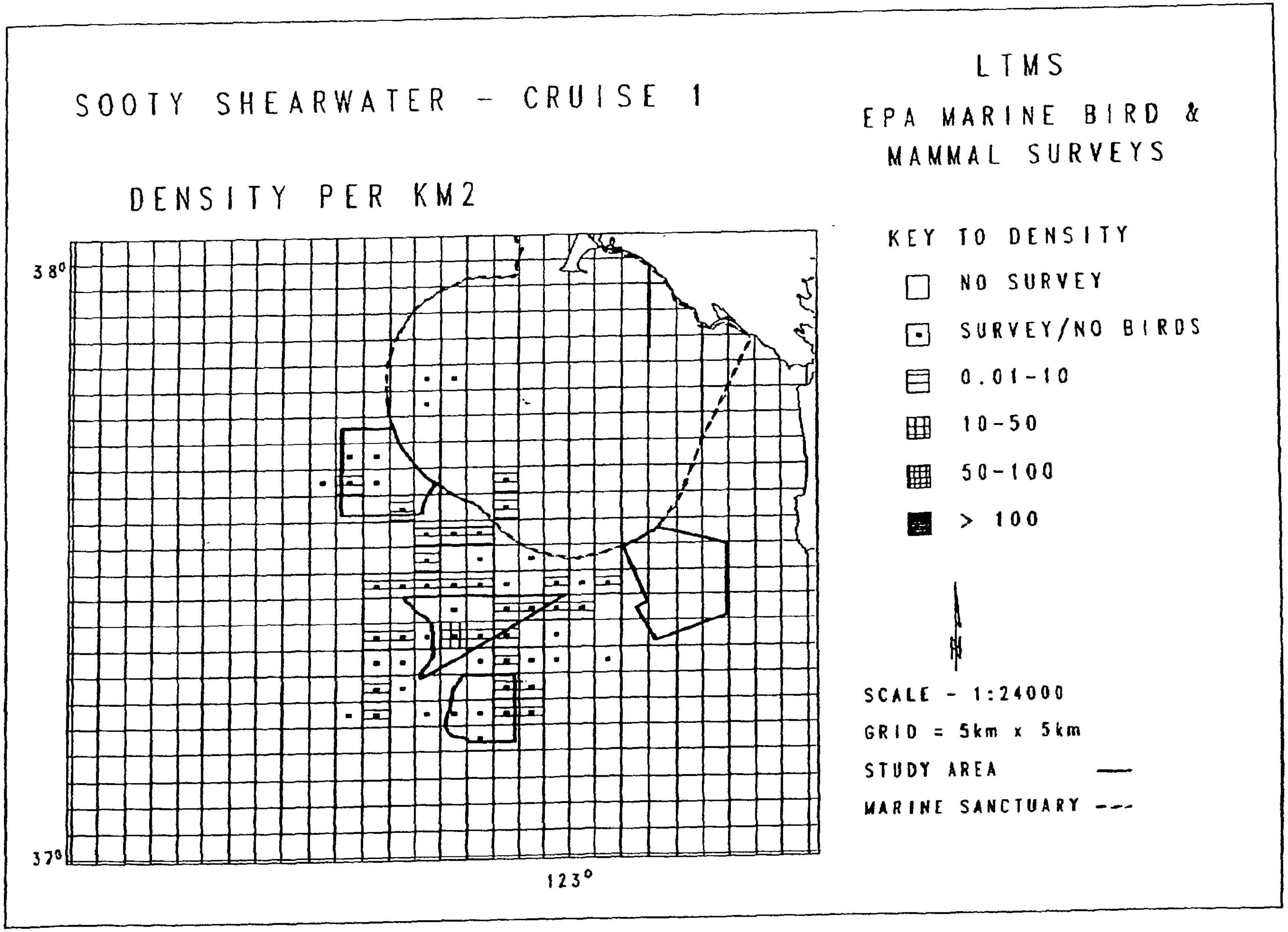


Figure 2. Maps of density estimates of seabird species. Information is from station data and does not include general observations.

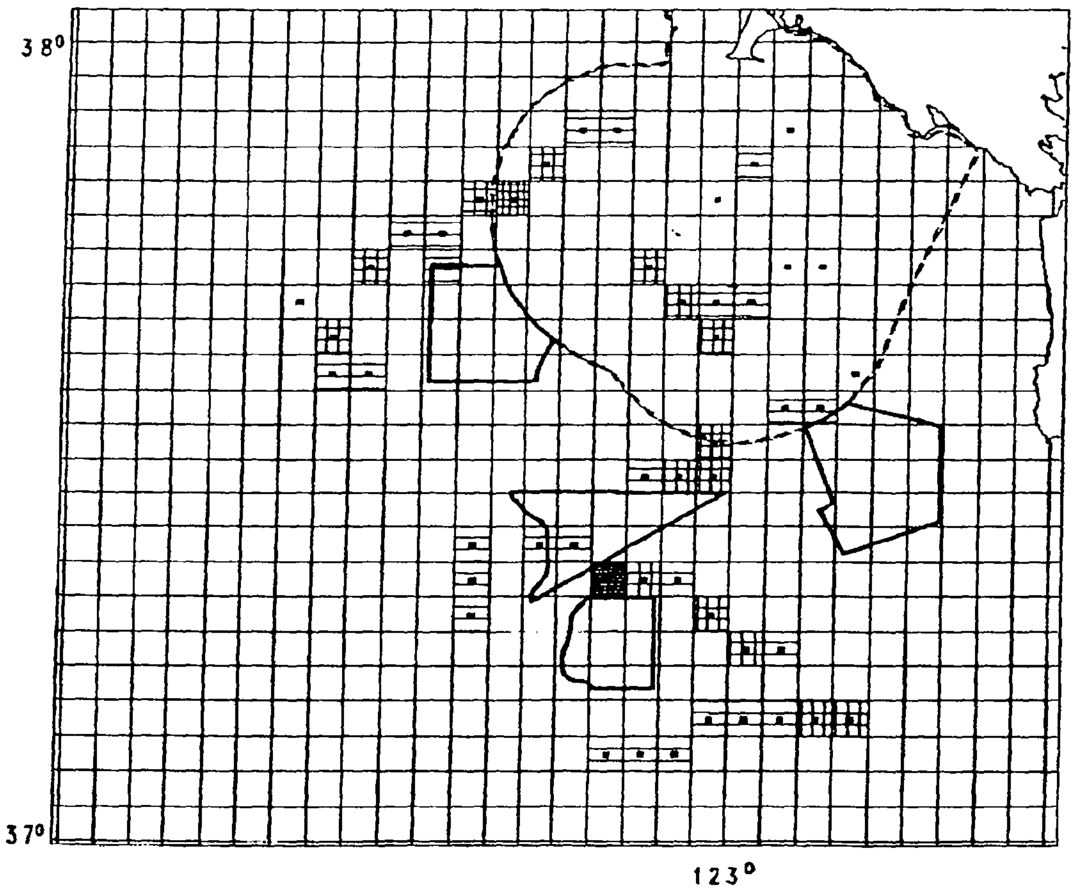

BLACK-FOOTED ALBATROSS - CRUISE 1
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°


PINK-FOOTED SHEARWATER-CRUISE 1
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°


SOOTY SHEARWATER - CRUISE 1
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

SOOTY SHEARWATER - CRUISE 3

DENSITY PER KM2



LTMS

EPA MARINE BIRD & MAMMAL SURVEYS

KEY TO DENSITY

NO SURVEY

SURVEY/NO BIRDS

0.01-10

10-50

50-100

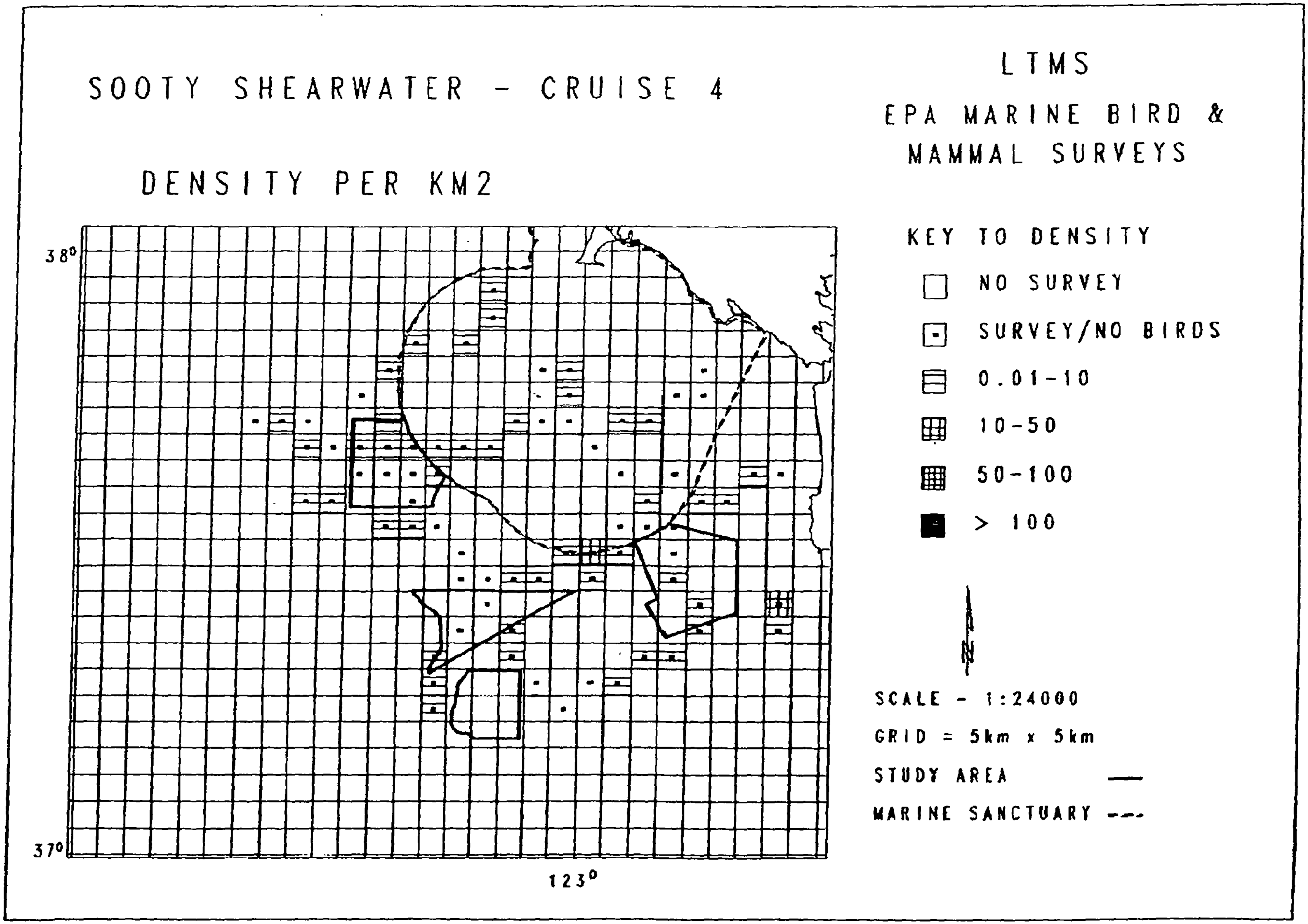
> 100

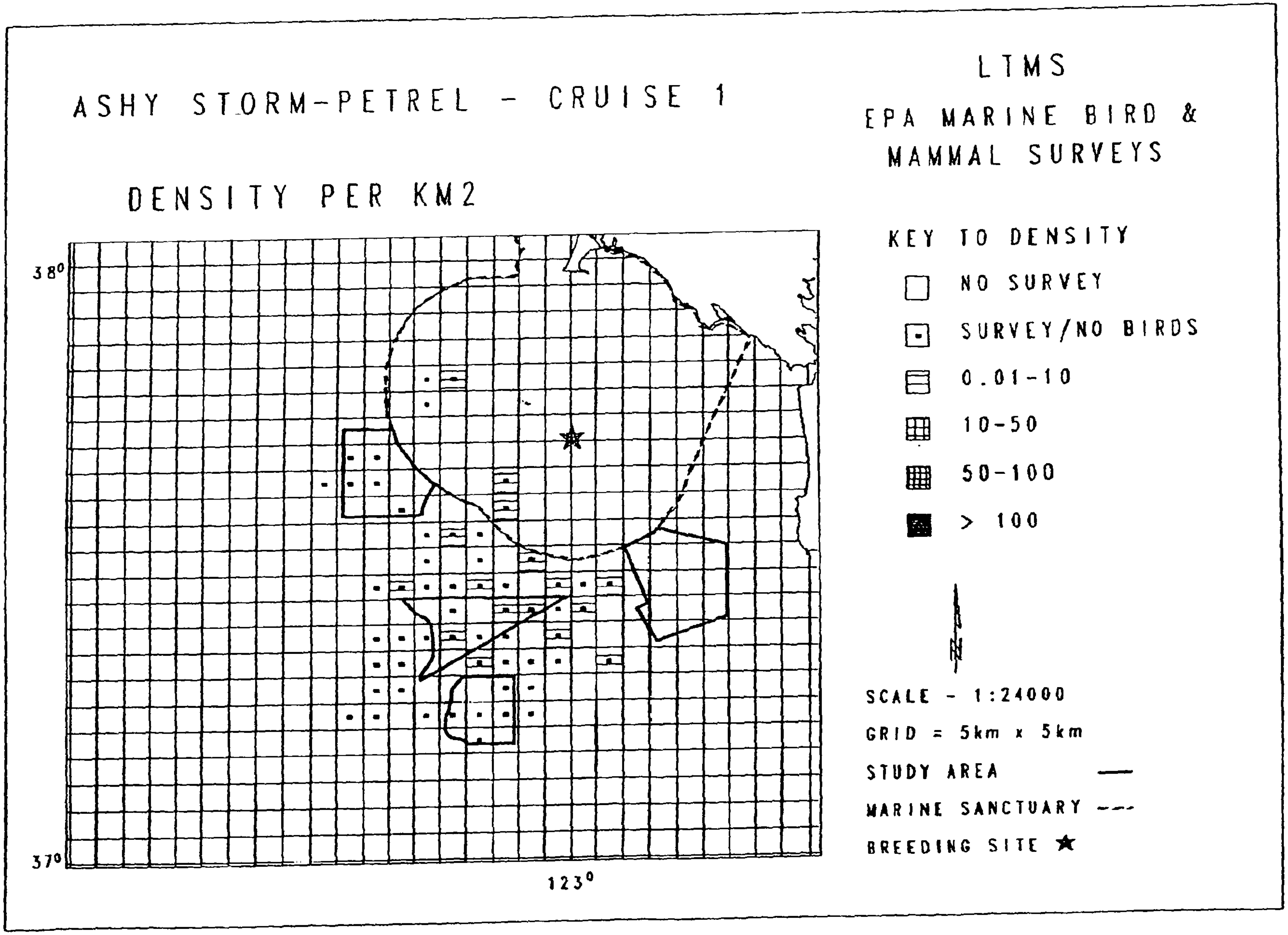
SCALE - 1:24000

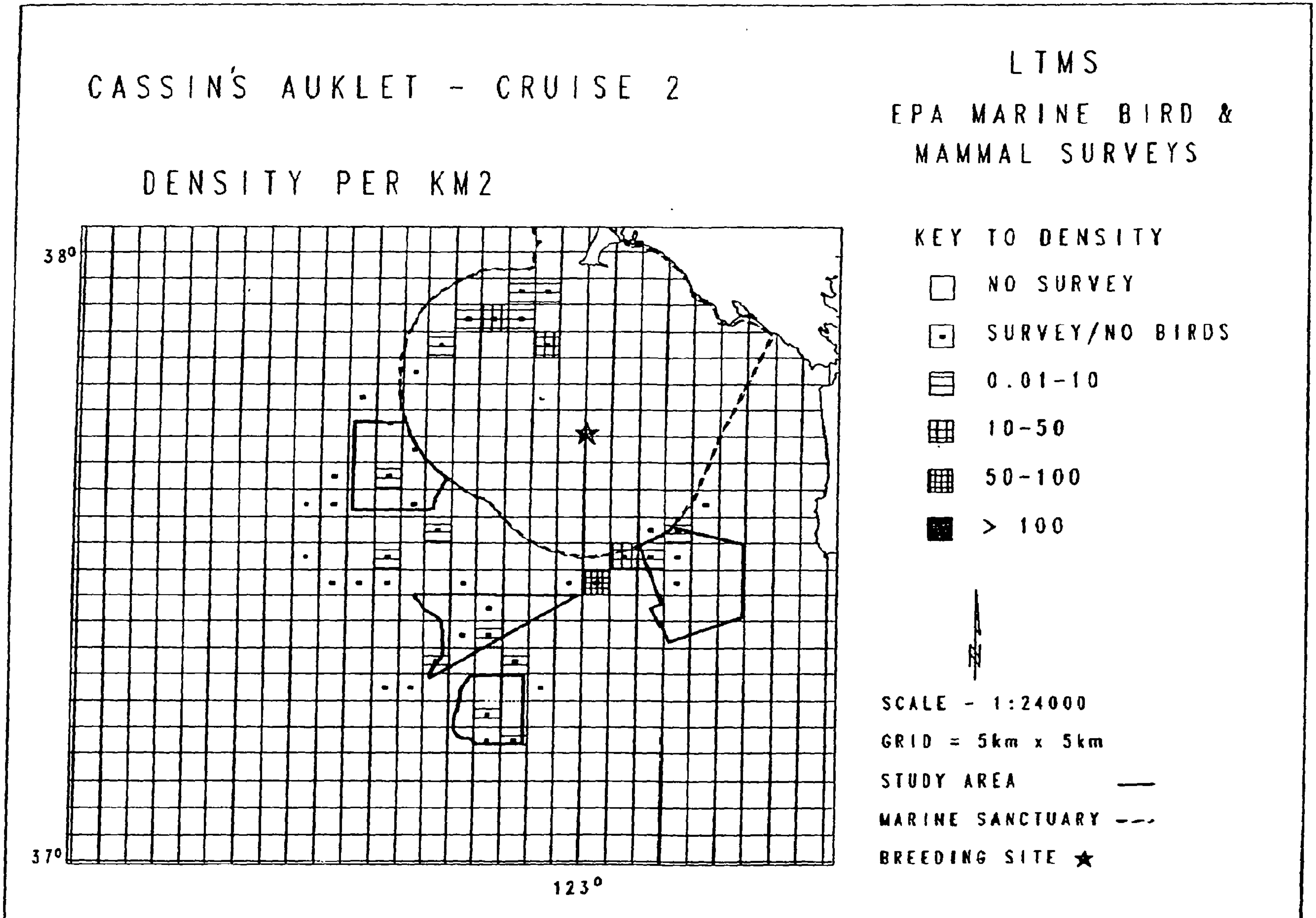
GRID = 5km x 5km

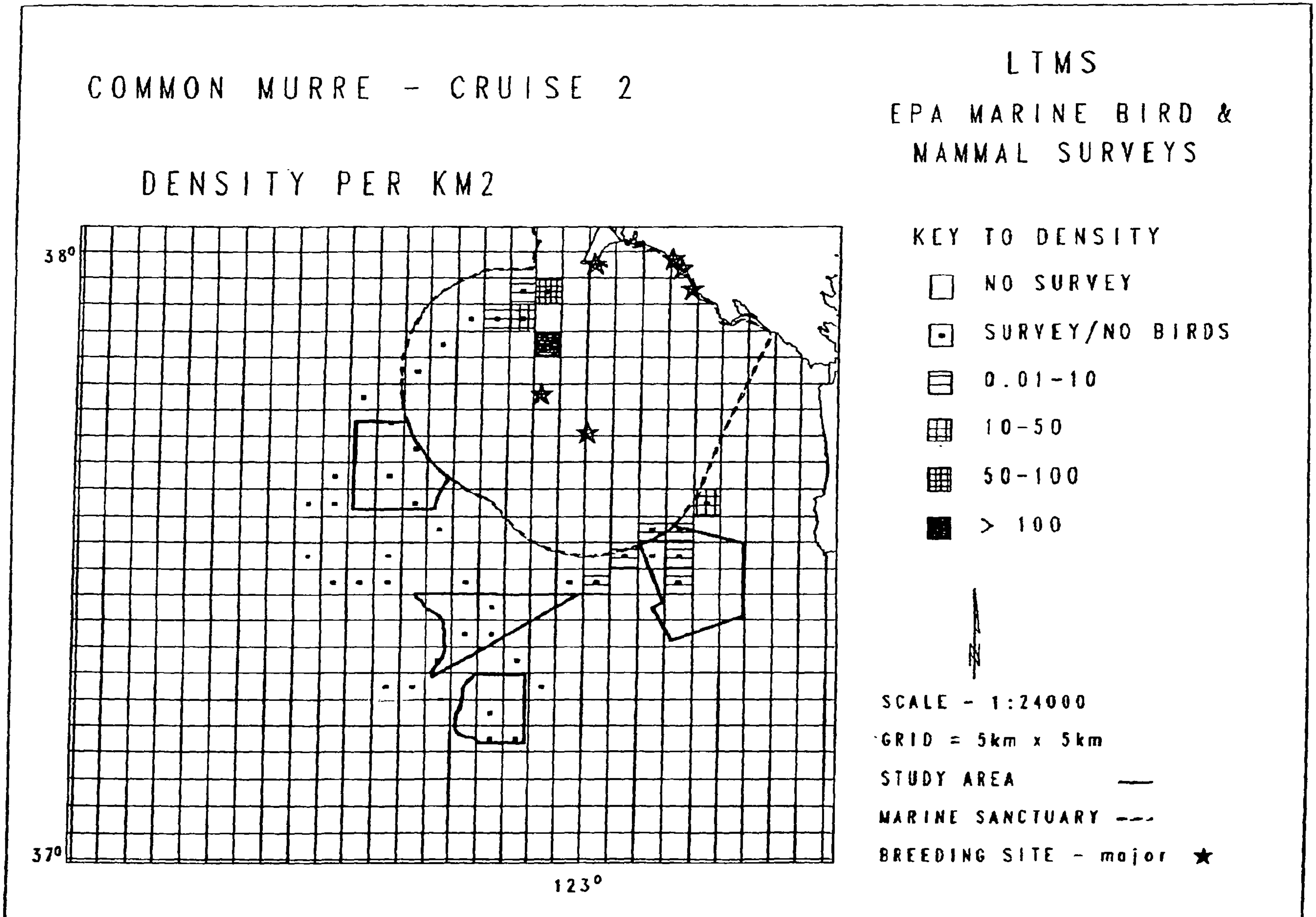
STUDY AREA

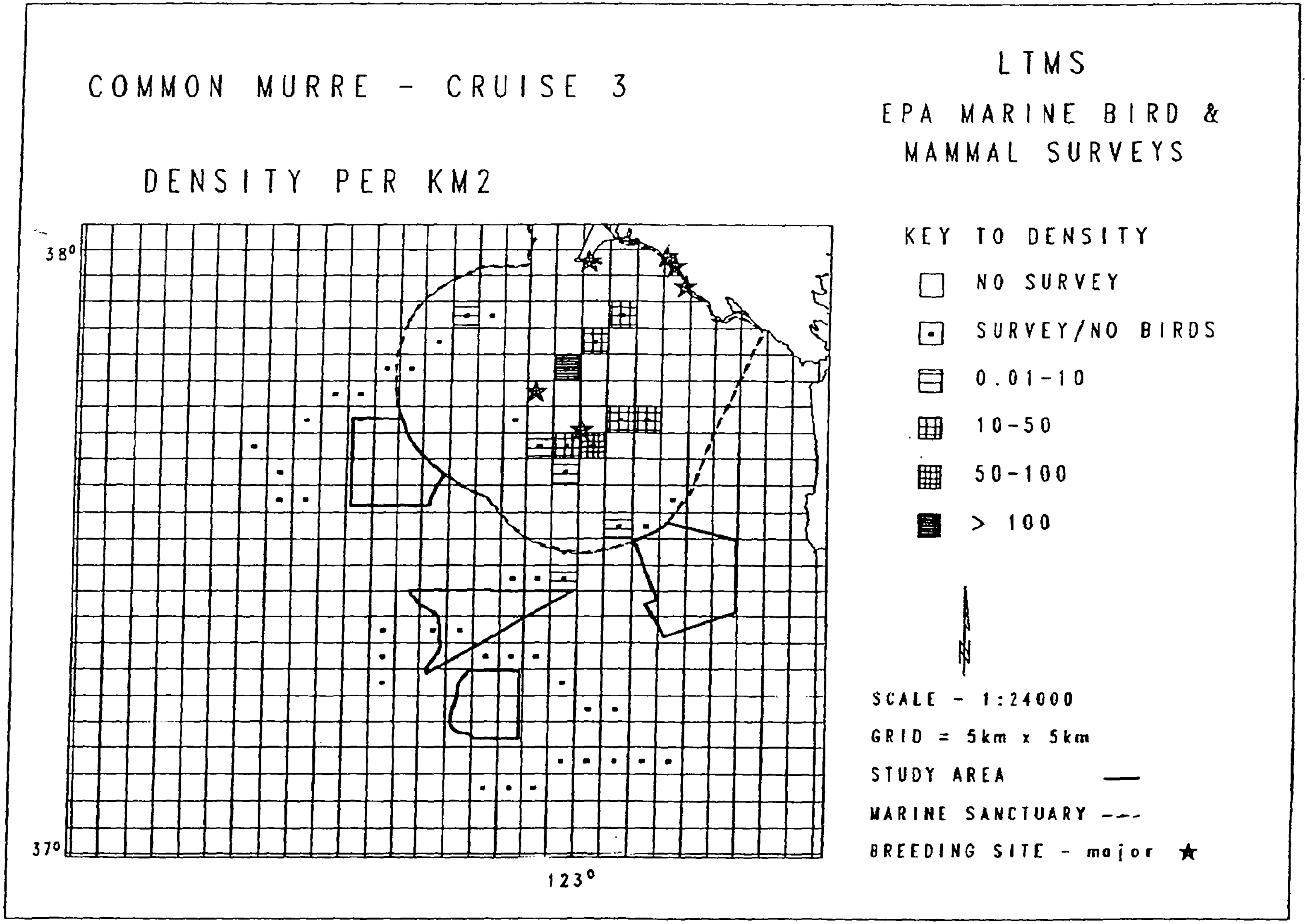
MARINE SANCTUARY

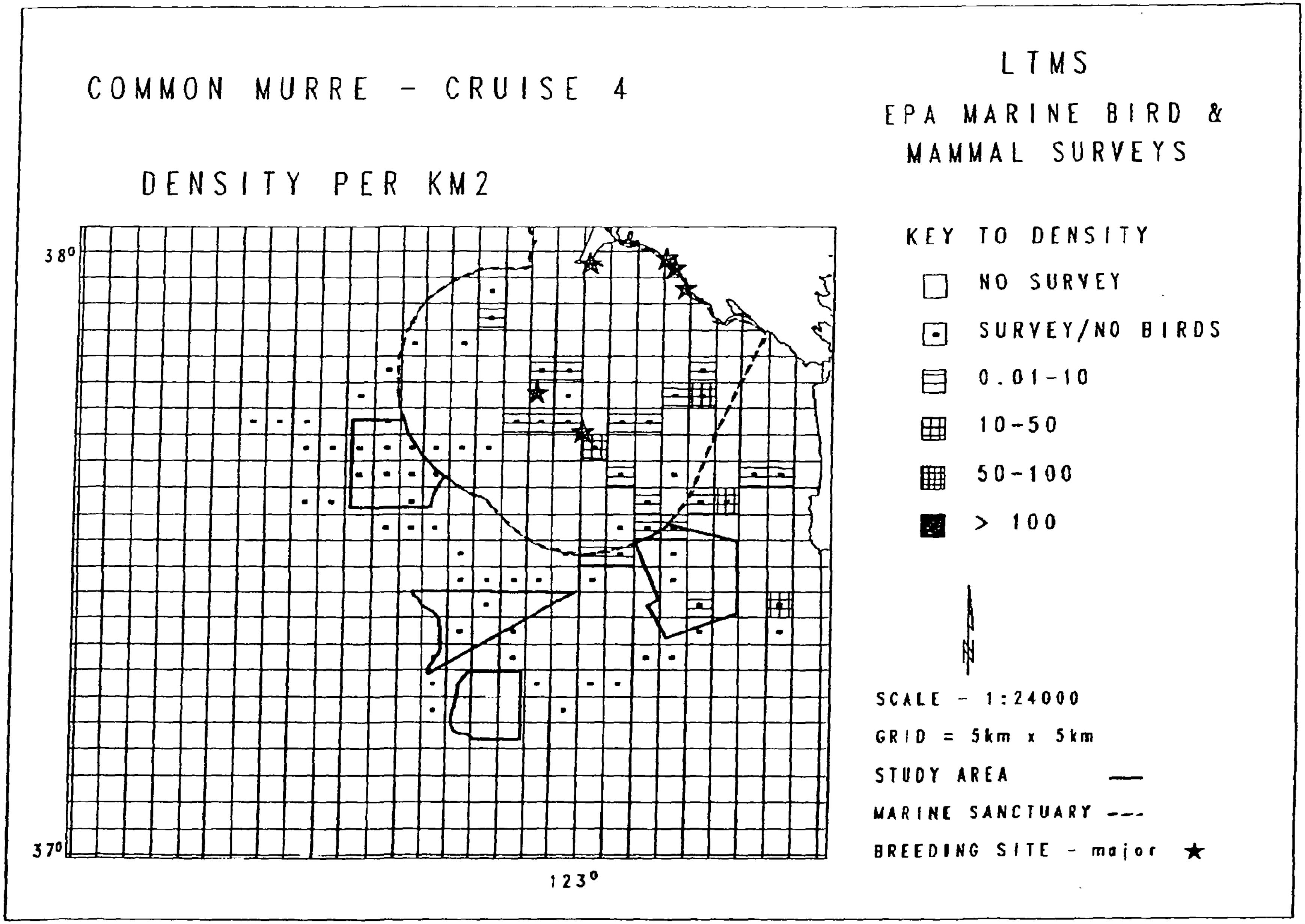

SOOTY SHEARWATER - CRUISE 4
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
N
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

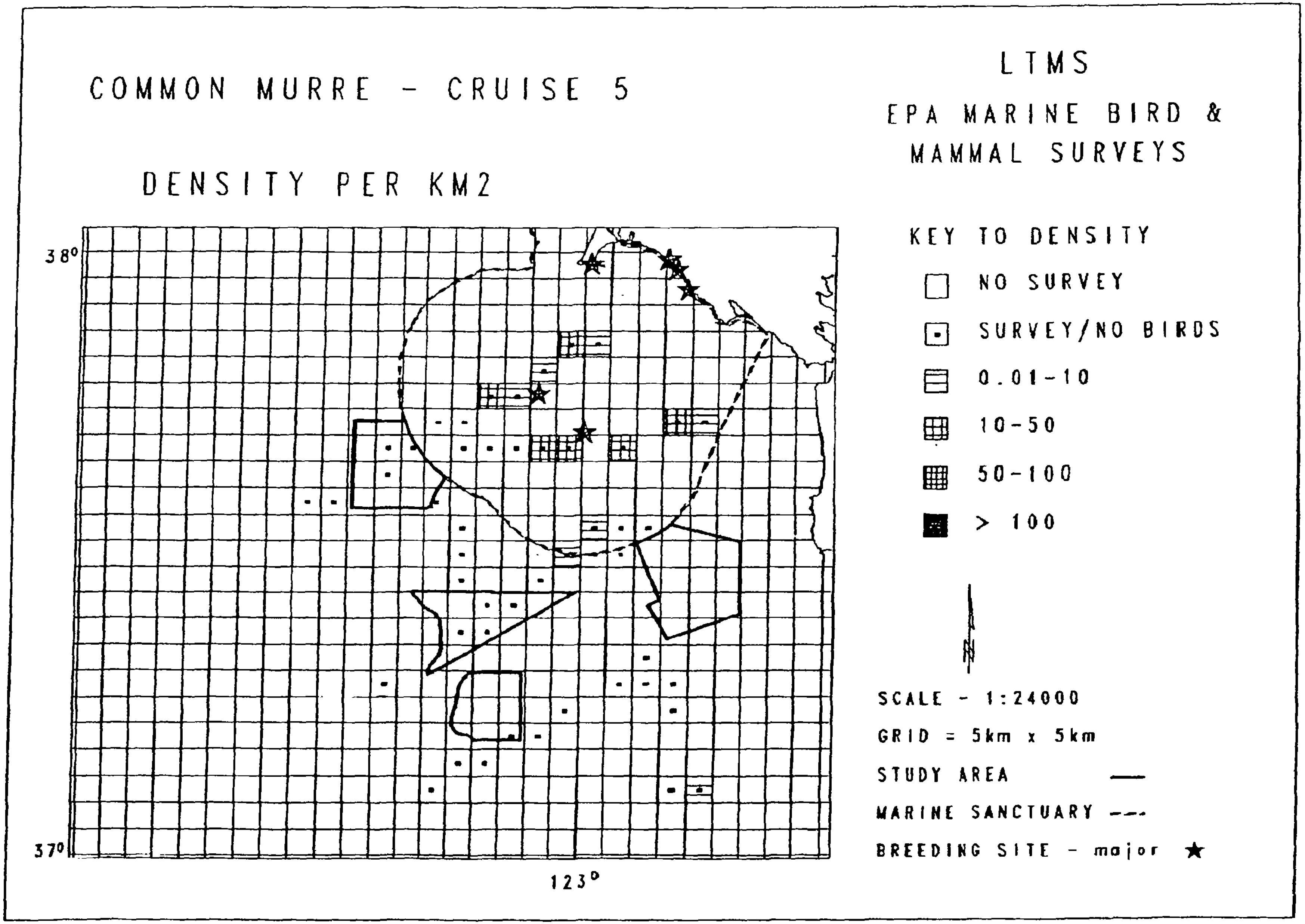

ASHY STORM-PETREL - CRUISE 1
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE
38°
37°
123°

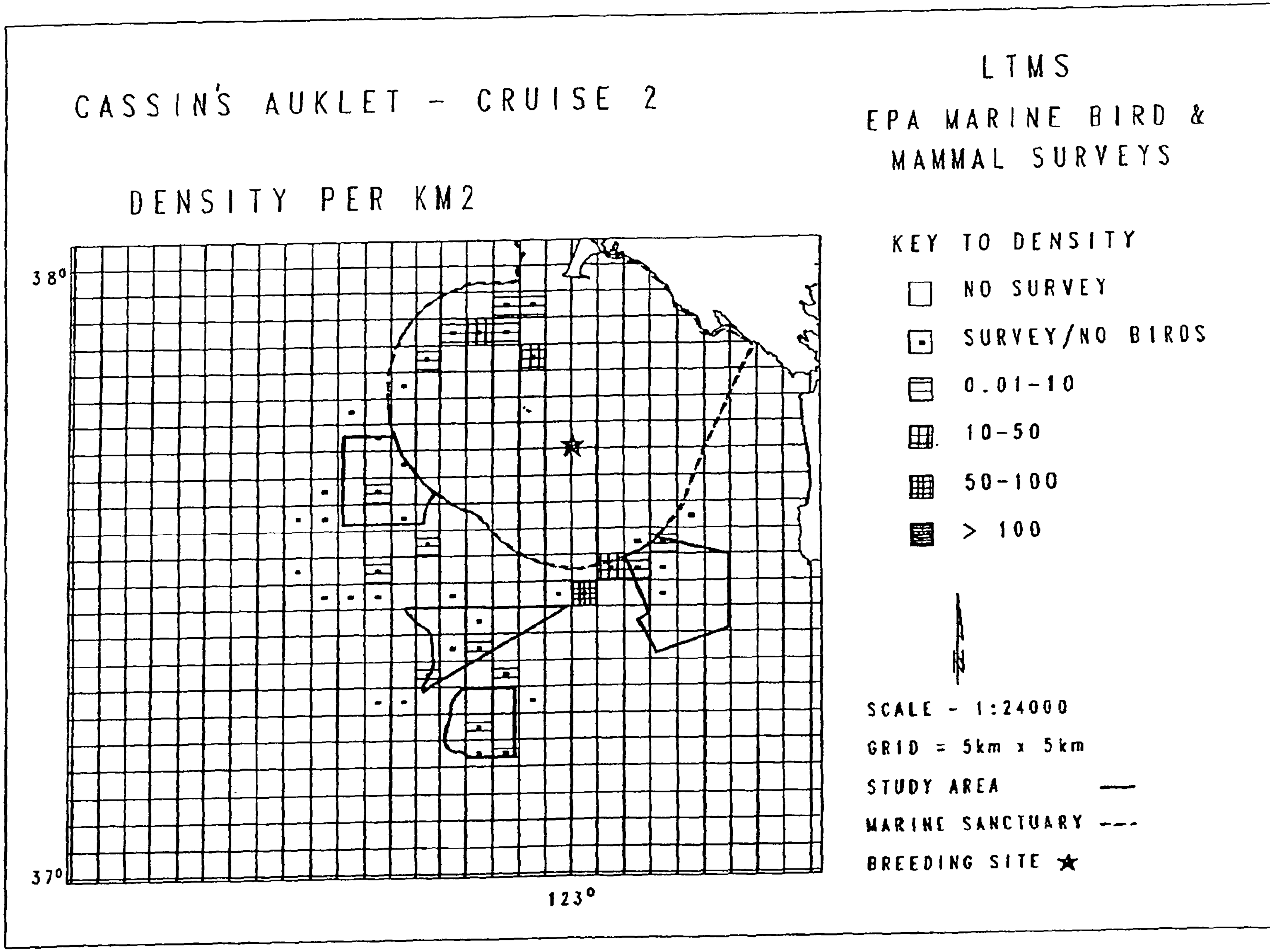

CASSIN'S AUKLET - CRUISE 2
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
38°
37°
123°
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE


COMMON MURRE - CRUISE 2
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
N
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major
38°
37°
123°

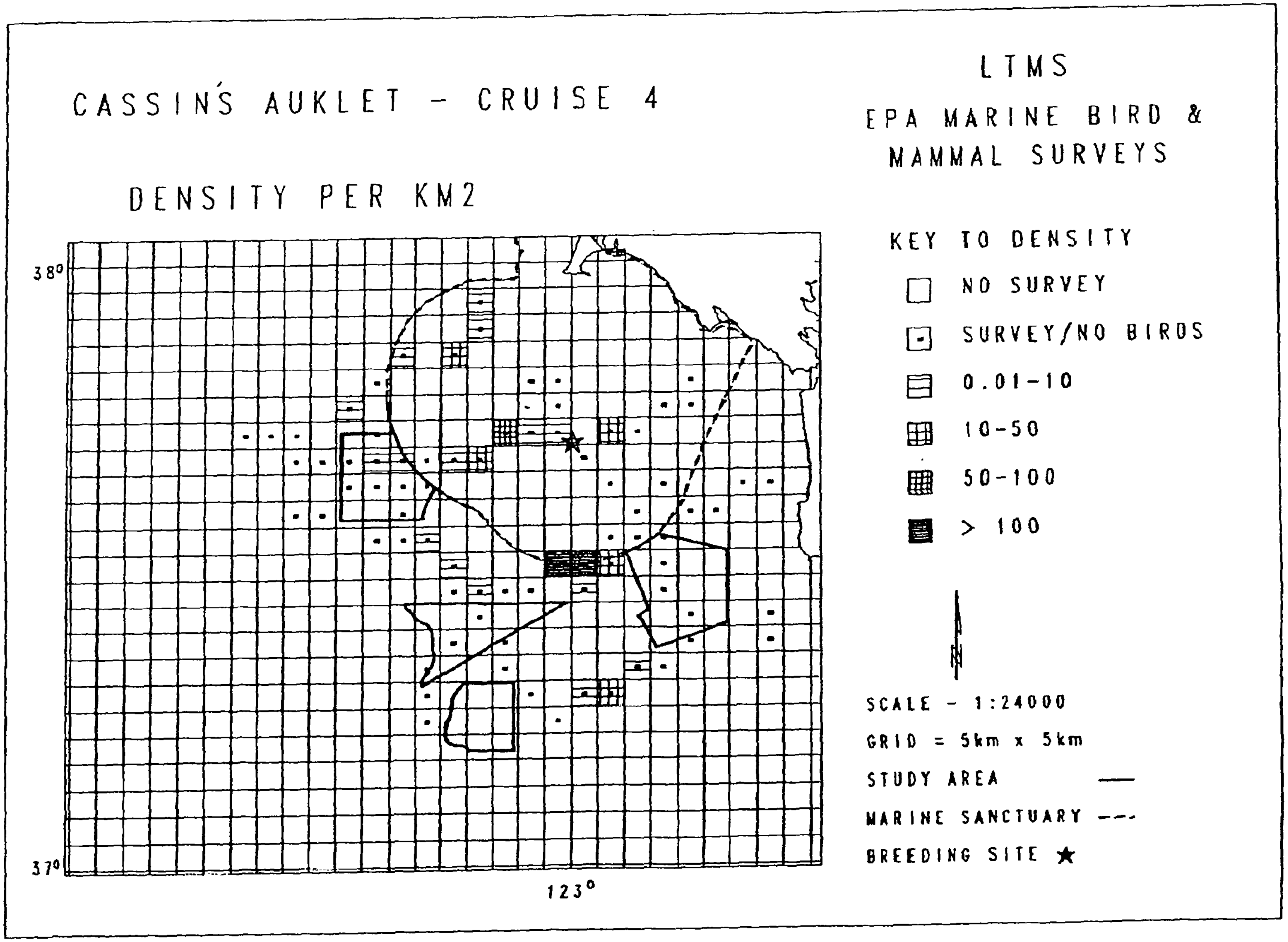

COMMON MURRE - CRUISE 3
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
38°
37°
123°
N
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major

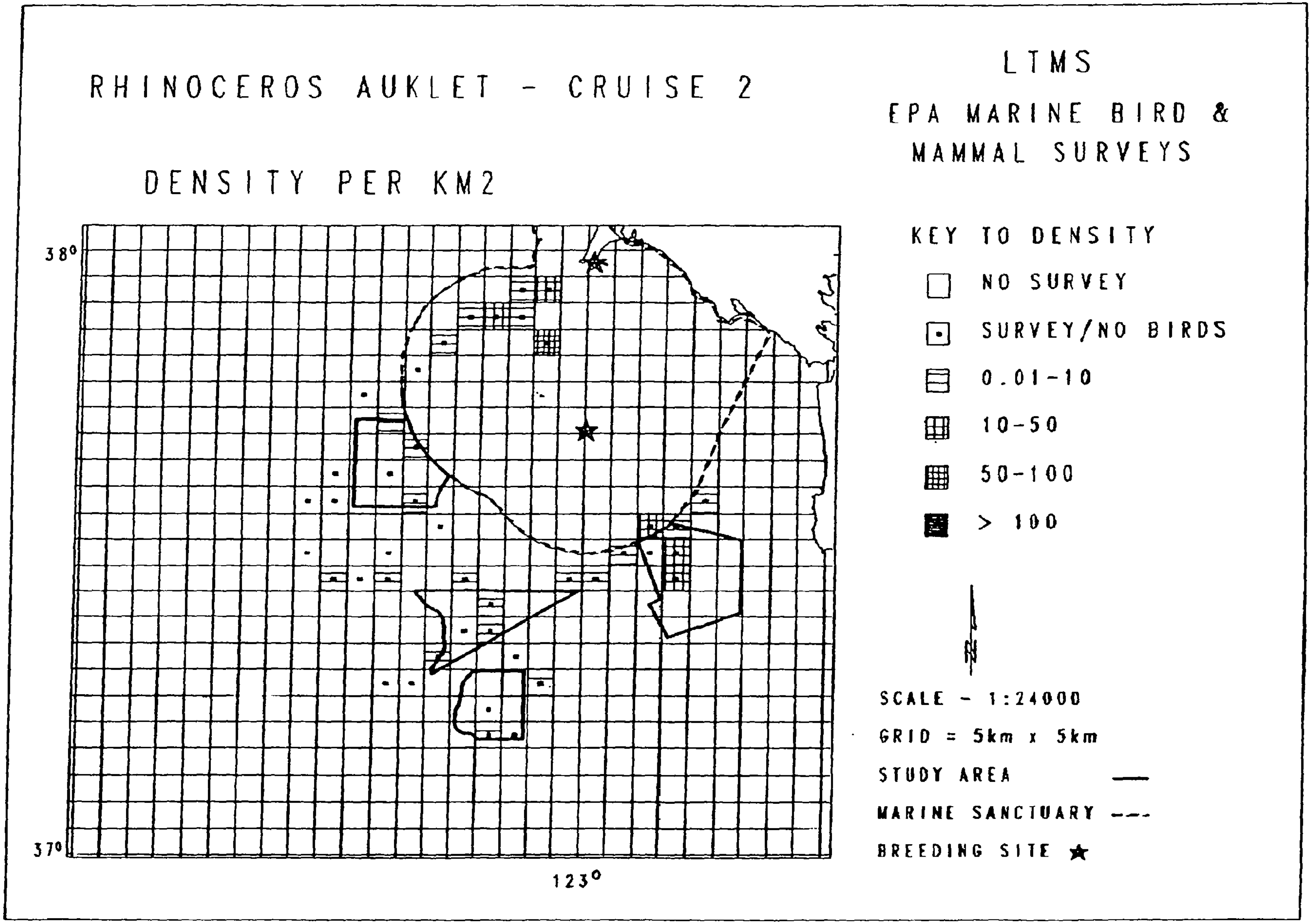

COMMON MURRE - CRUISE 4
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major
38°
37°
123°

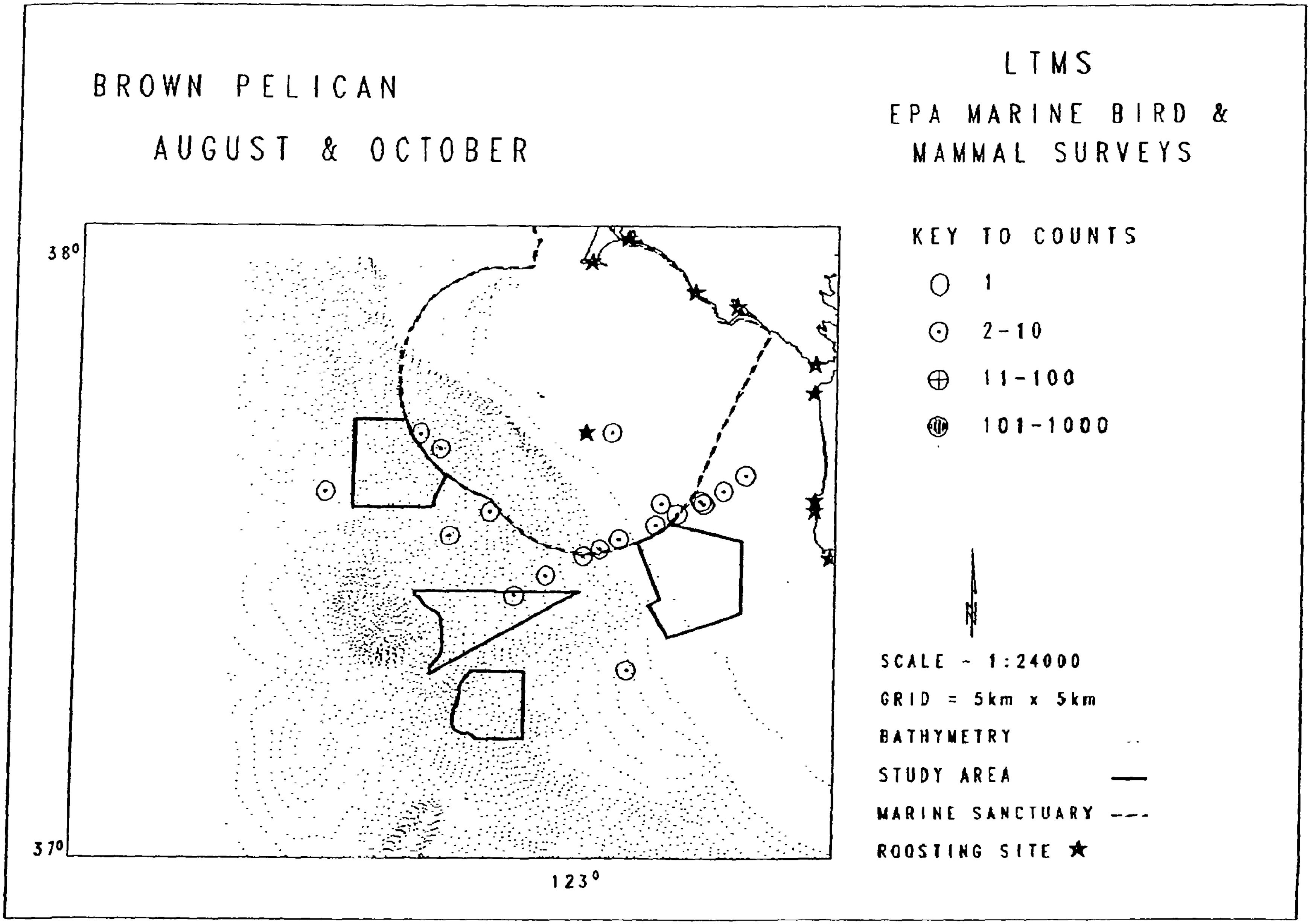

COMMON MURRE - CRUISE 5
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major
38°
37°
123°



CASSIN'S AUKLET - CRUISE 2
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE
38°
37°
123°

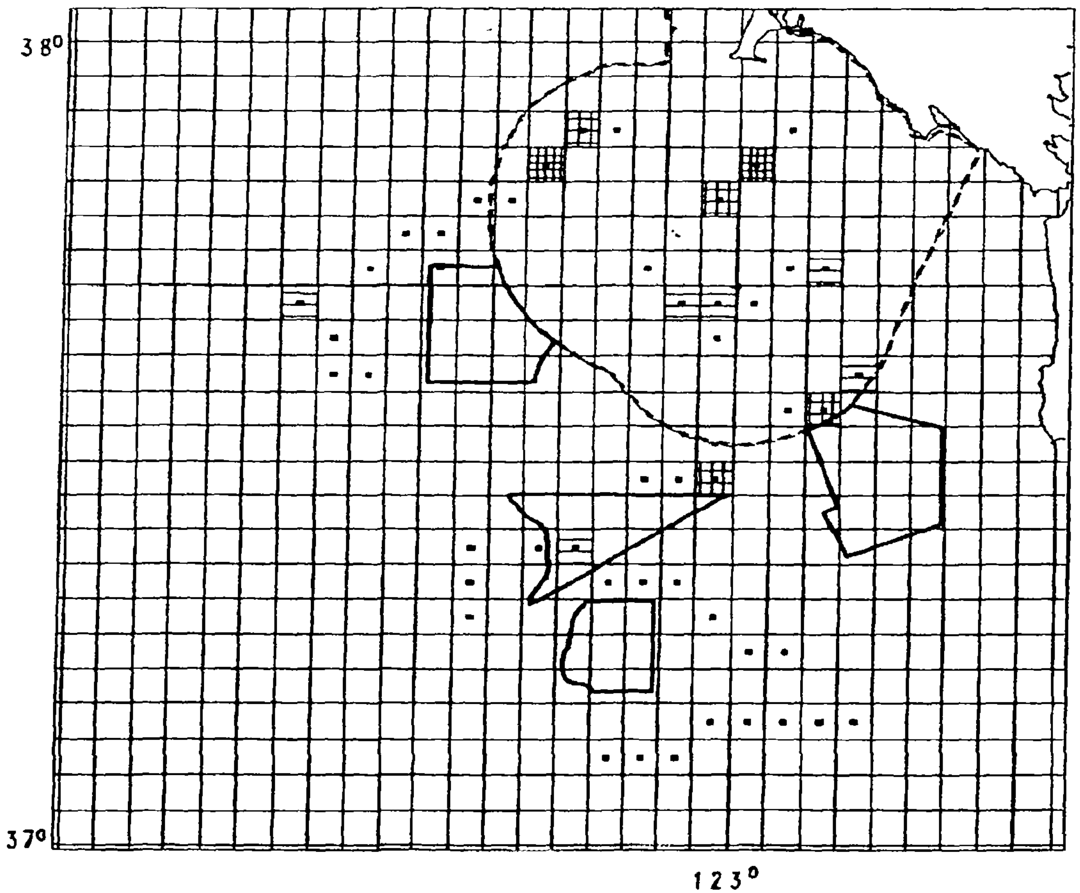

CASSIN'S AUKLET - CRUISE 4
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE
38°
37°
123°


RHINOCEROS AUKLET - CRUISE 2
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE
38°
37°
123°


BROWN PELICAN
AUGUST & OCTOBER
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
1
2-10
11-100
101-1000
38°
37°
123°
SCALE - 1:24000
GRID = 5km x 5km
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
ROOSTING SITE

RED-NECKED PHALAROPE - CRUISE 3

DENSITY PER KM2



LTMS

EPA MARINE BIRD & MAMMAL SURVEYS

KEY TO DENSITY

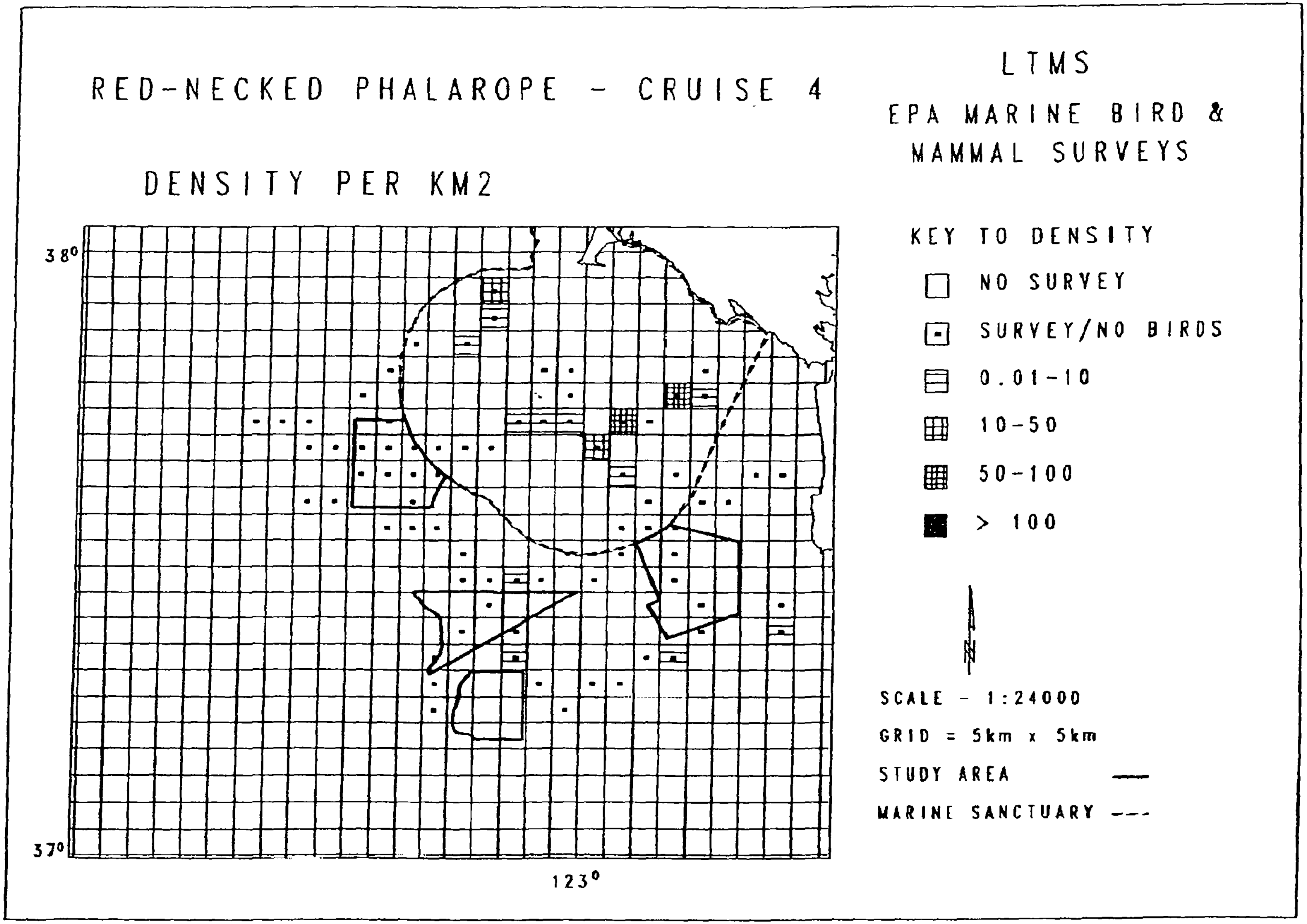
- NO SURVEY
- SURVEY/NO BIRDS
- 0.01-10
- 10-50
- 50-100
- > 100

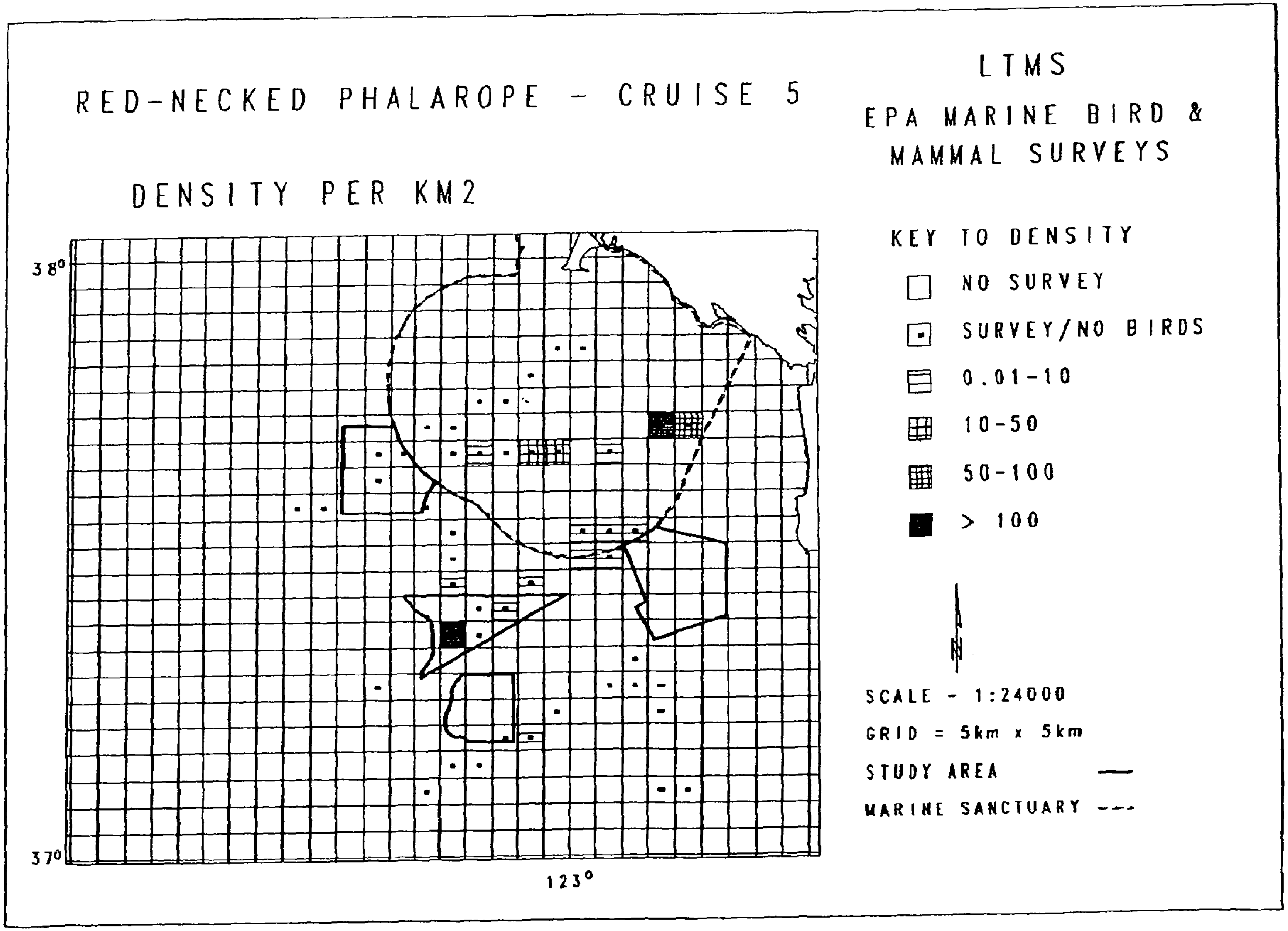
SCALE - 1:24000

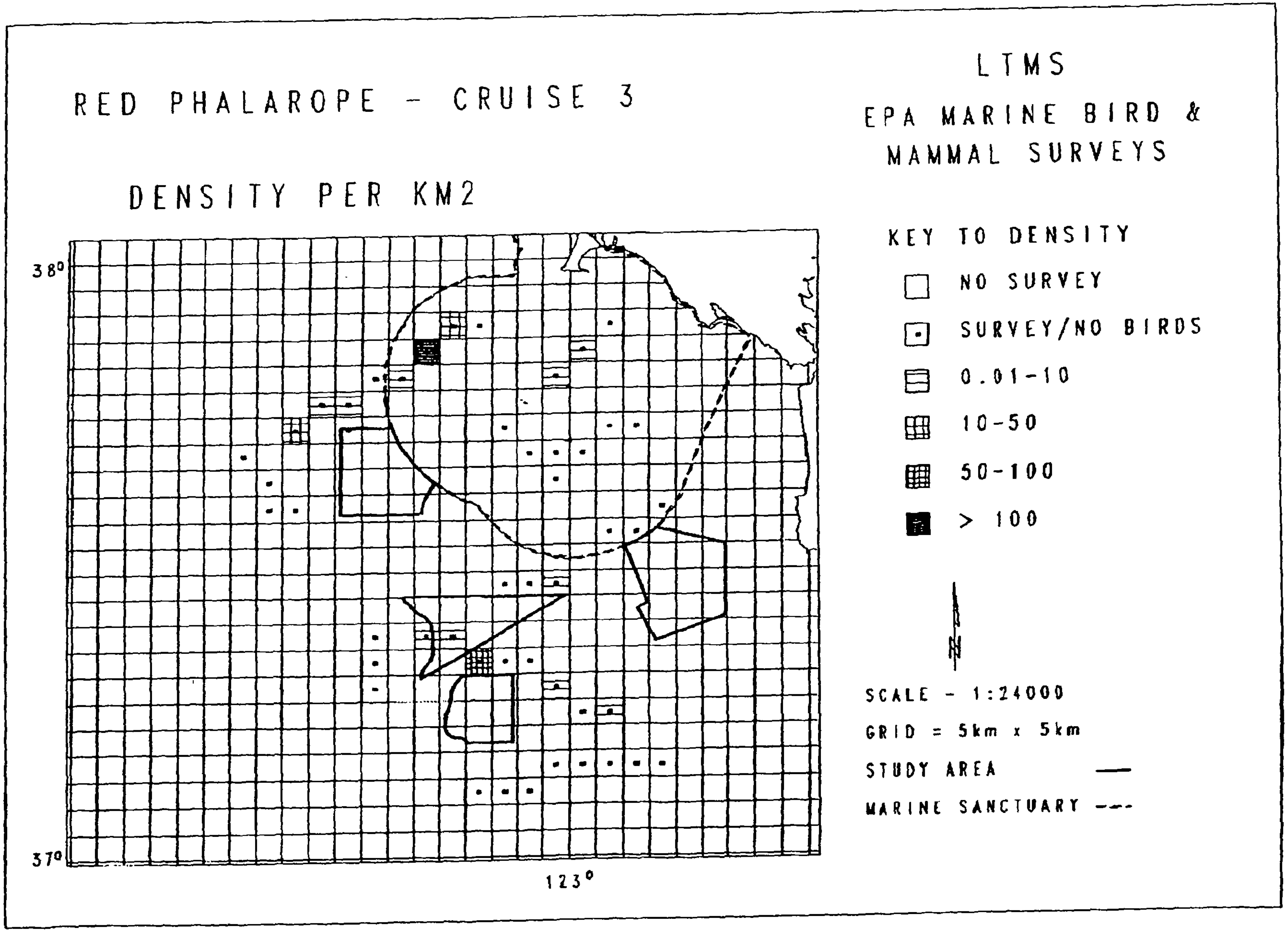
GRID = 5km x 5km

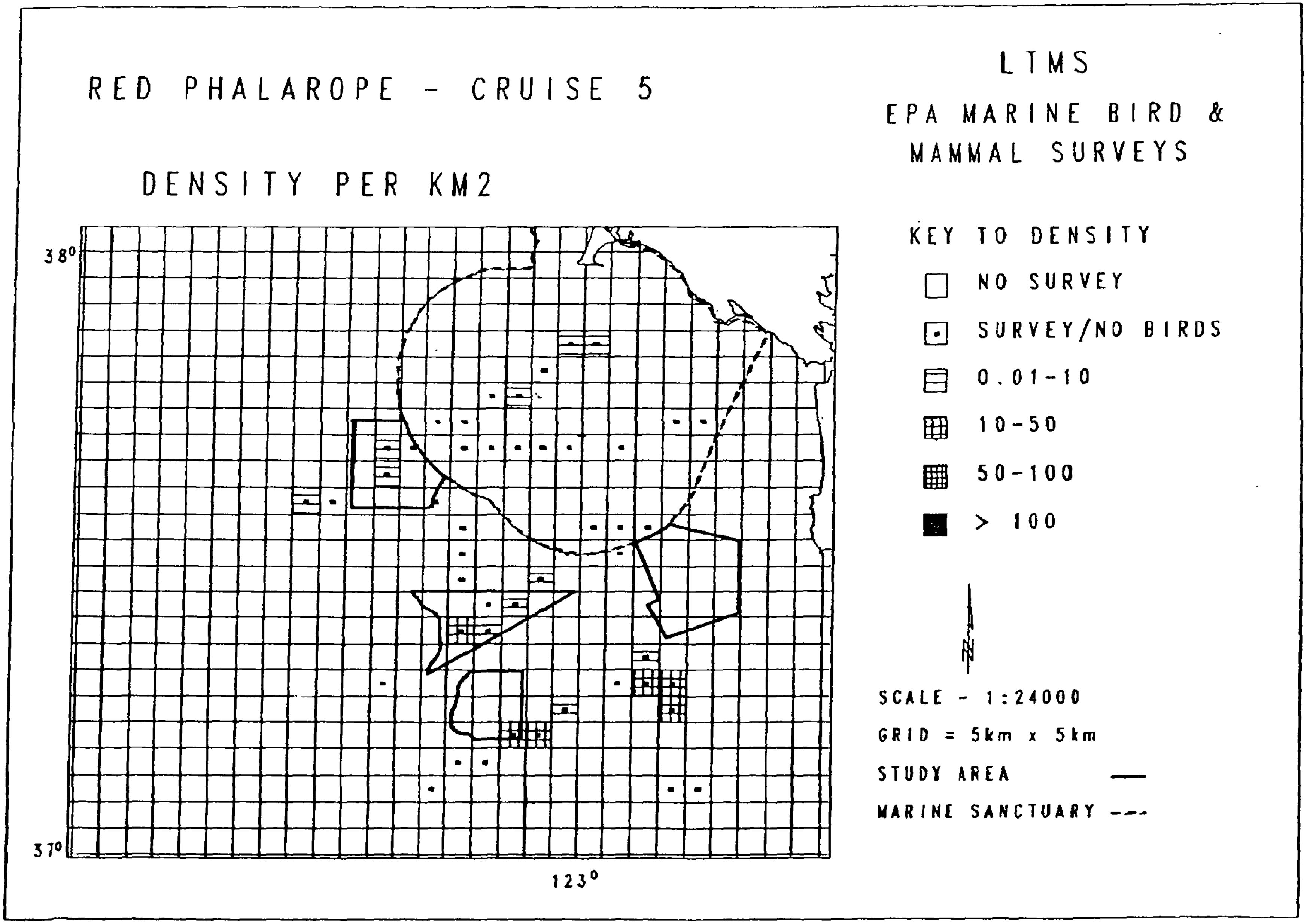
STUDY AREA ——

MARINE SANCTUARY ---


RED-NECKED PHALAROPE - CRUISE 4
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°


RED-NECKED PHALAROPE - CRUISE 5
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
N
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°


RED PHALAROPE - CRUISE 3
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

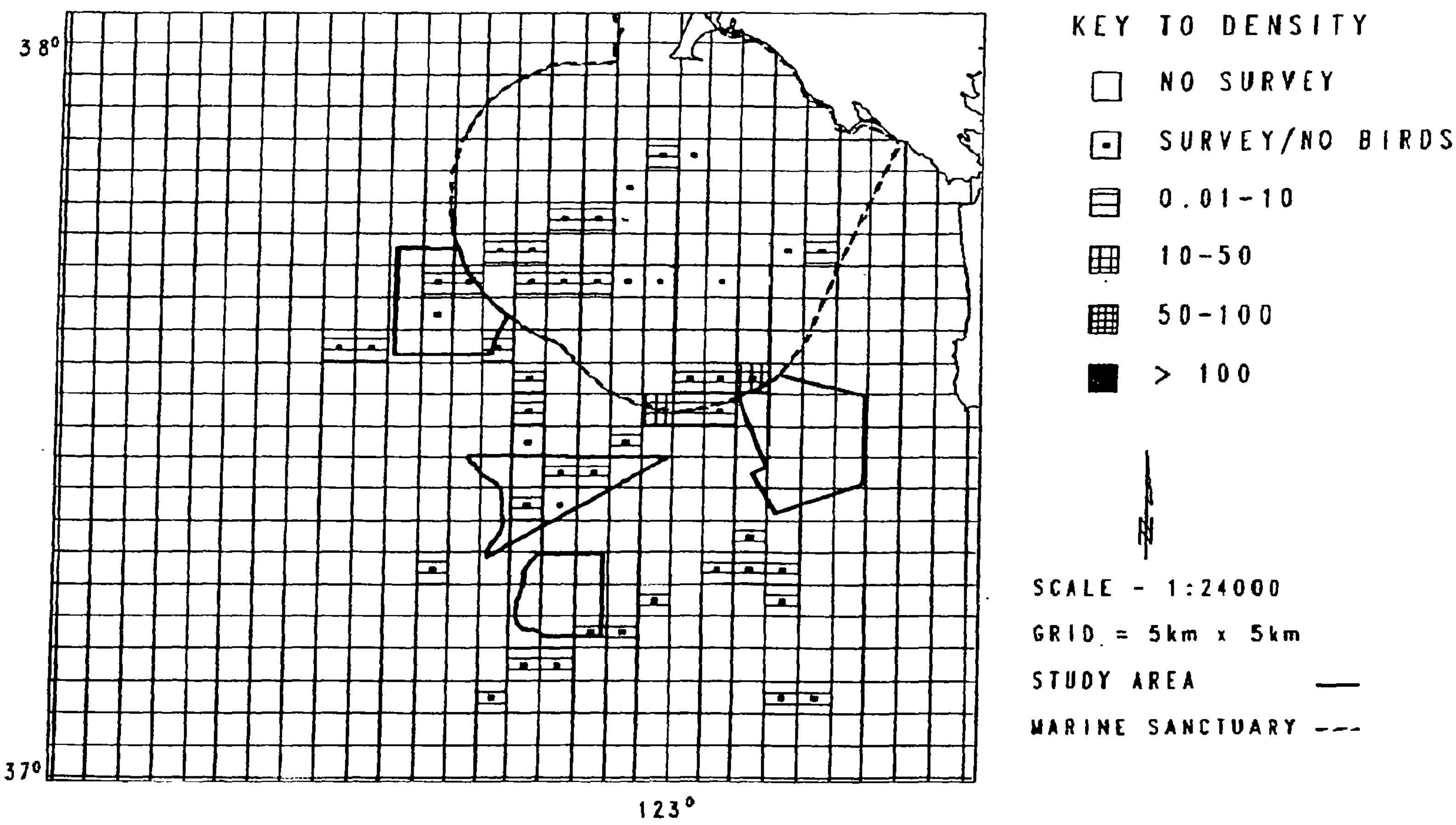

RED PHALAROPE - CRUISE 5
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
N
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

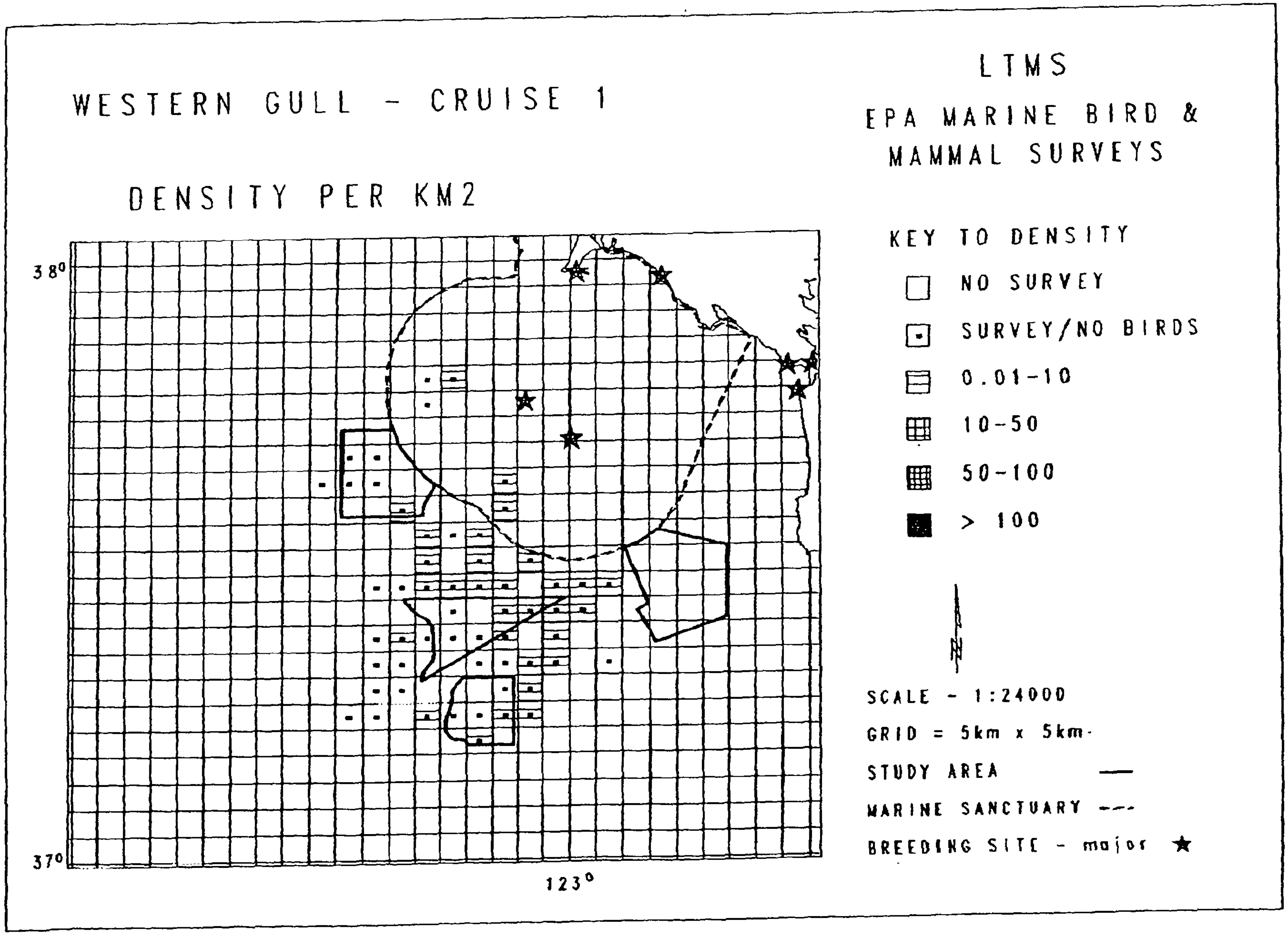
CALIFORNIA GULL - CRUISE 5

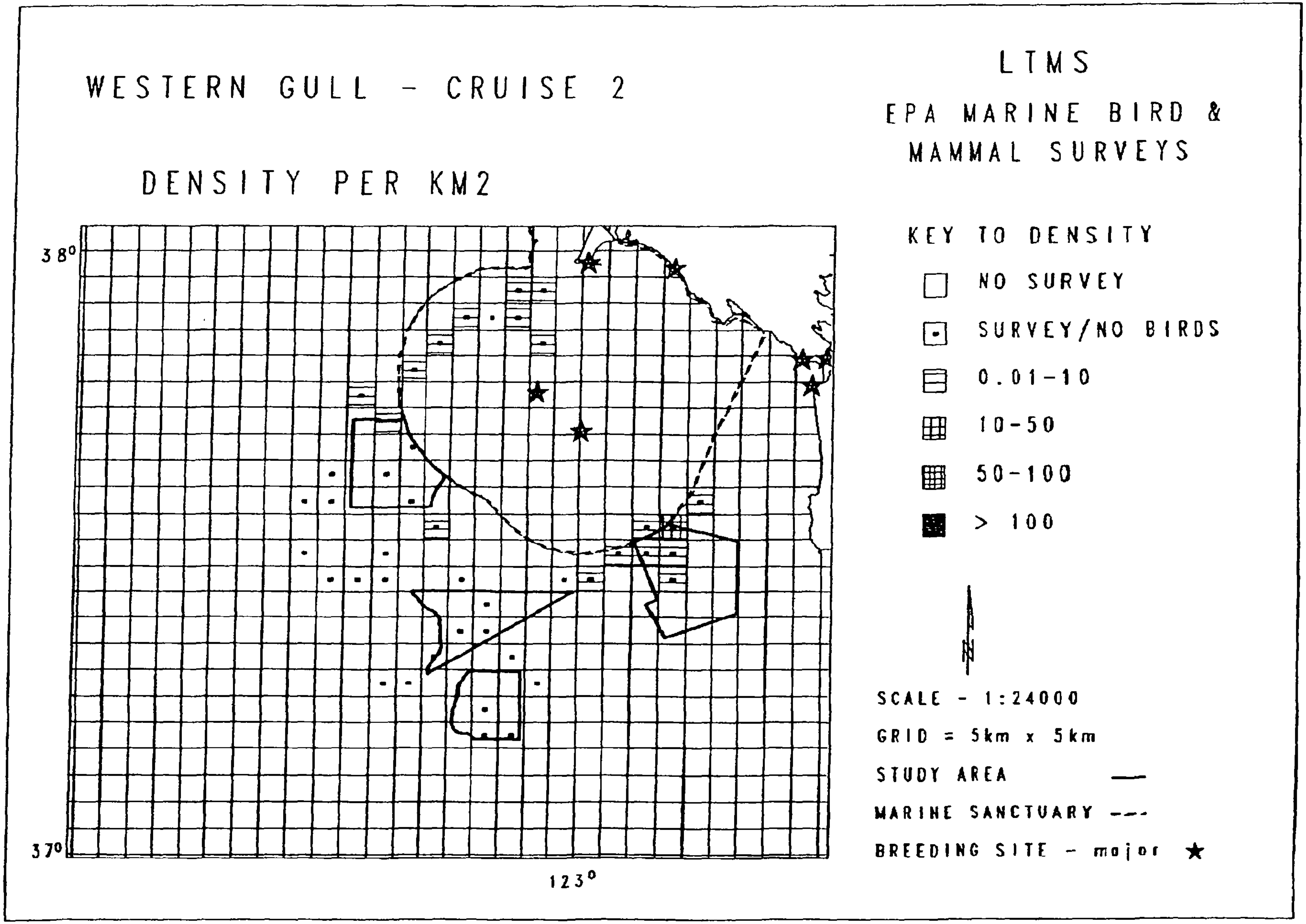
LTMS

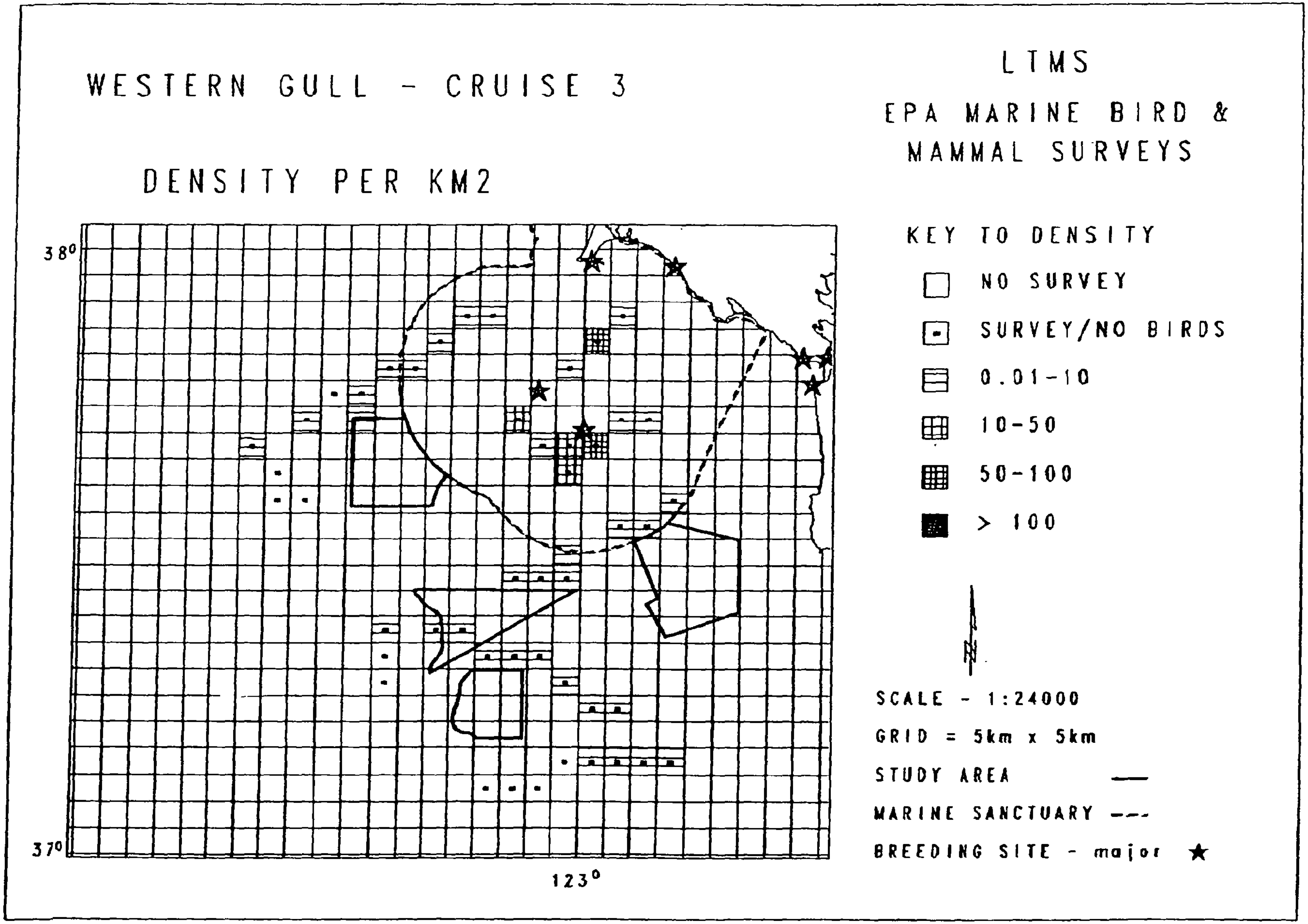
EPA MARINE BIRD & MAMMAL SURVEYS

DENSITY PER KM2




WESTERN GULL - CRUISE 1
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major
38°
37°
123°


WESTERN GULL - CRUISE 2
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major
38°
37°
123°

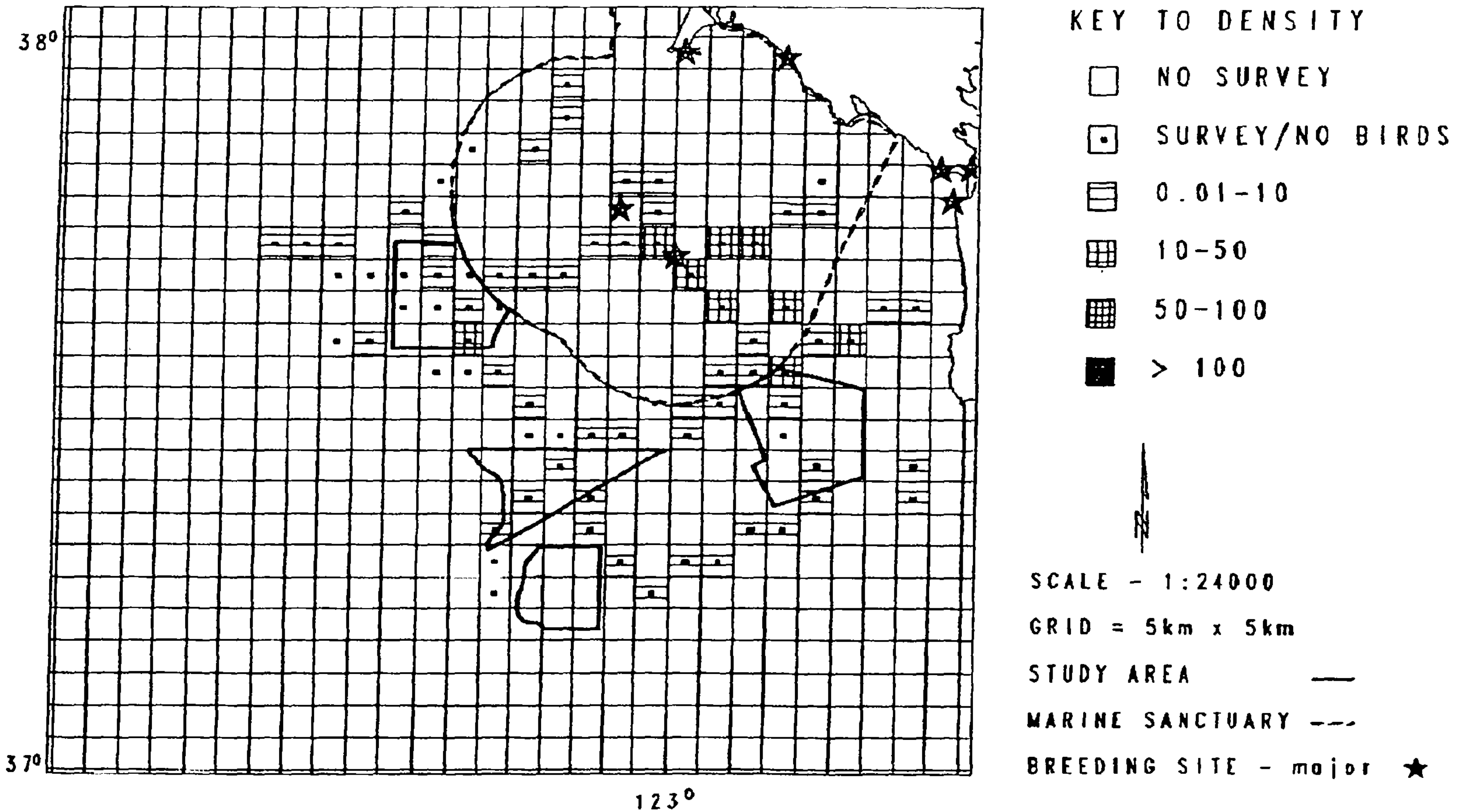

WESTERN GULL - CRUISE 3
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
38°
37°
123°
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major

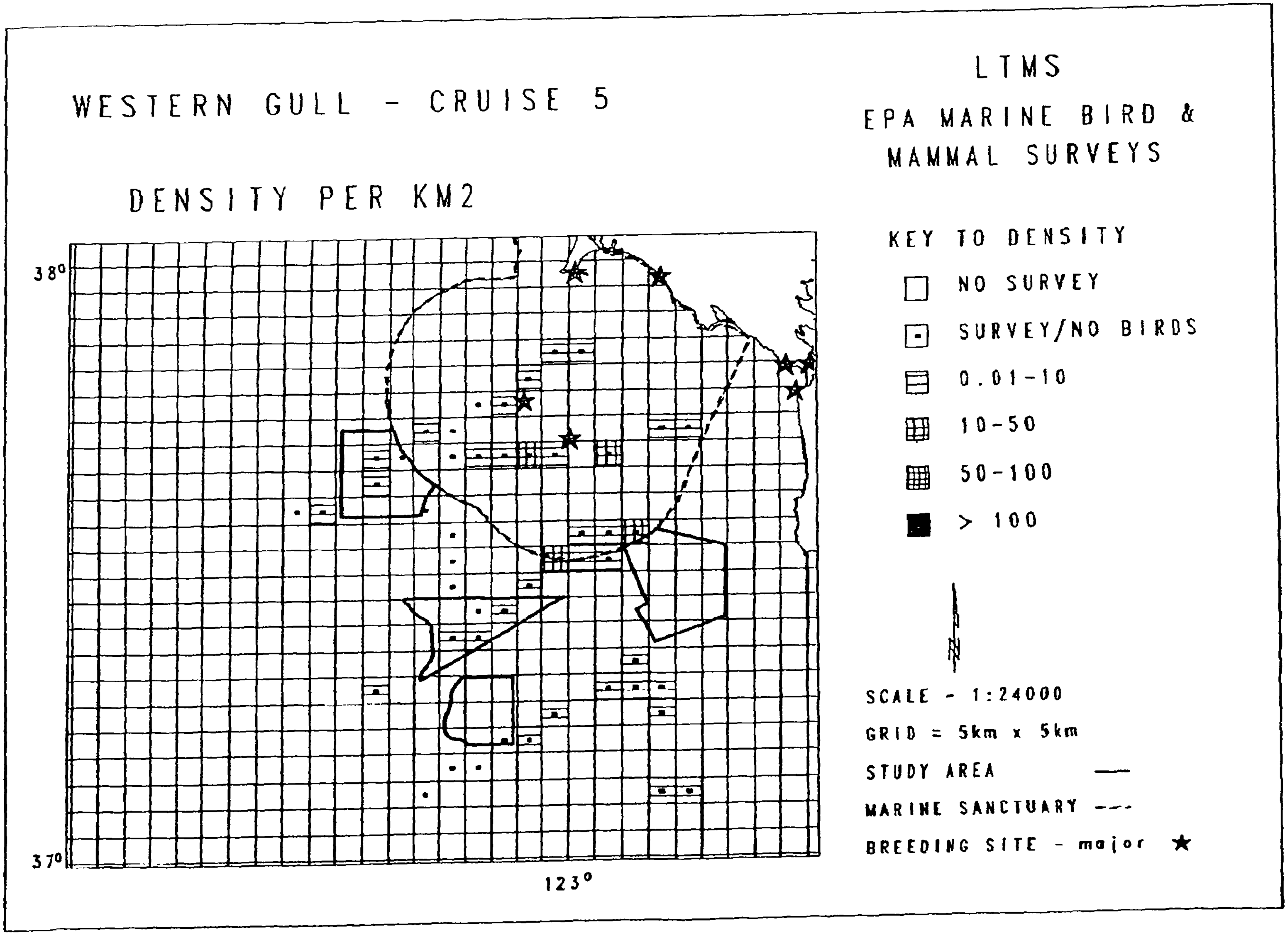
WESTERN GULL - CRUISE 4

DENSITY PER KM2

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS




WESTERN GULL - CRUISE 5
DENSITY PER KM2
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
BREEDING SITE - major
38°
37°
123°

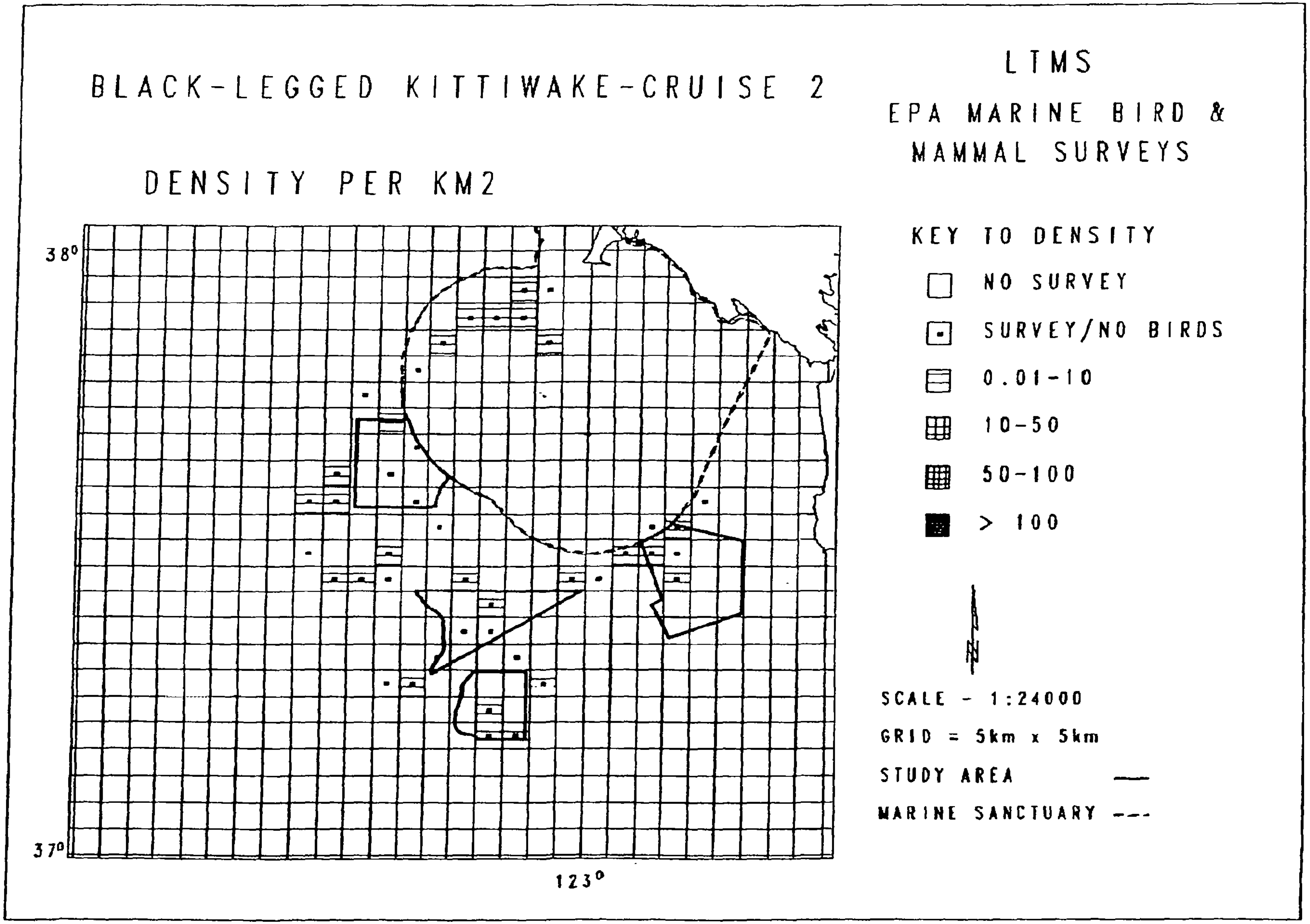
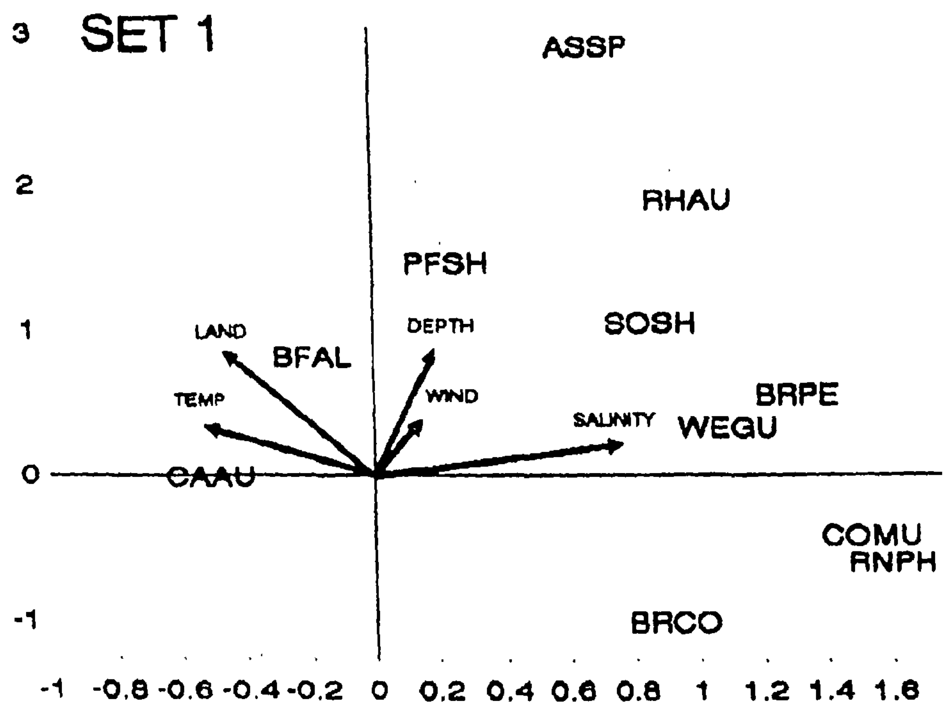

BLACK-LEGGED KITTIWAKE-CRUISE 2
DENSITY PER KM2
LTMS
EPA MARINE BIRD & MAMMAL SURVEYS
KEY TO DENSITY
NO SURVEY
SURVEY/NO BIRDS
0.01-10
10-50
50-100
> 100
SCALE - 1:24000
GRID = 5km x 5km
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

Figure 3. Canonical Correspondence Analysis biplots based on the species scores and environmental variables. The magnitude of the arrow of the environmental variable illustrates the importance of the variable. Abbreviations for species are given in Table 14. Temperature, salinity, wind speed, distance from land, and depth increase away from the origin of the arrow (the grand mean of each environmental variable). The scale is in standard deviation units. The location of the species within the plot explain its relation to other species and to the environmental variables, and whether the first (horizontal) or second (vertical) axis better explains its distribution. For example, the first environmental axis is composed mainly of sea surface temperature and salinity. The distribution of Western Gull (WEGU), found in more saline and cooler water, and Cassin's Auklet (CAAU), found in warmer, less saline water, are both best described by the first axis.

CCA BIPLOTS FOR EPA CRUISE 4



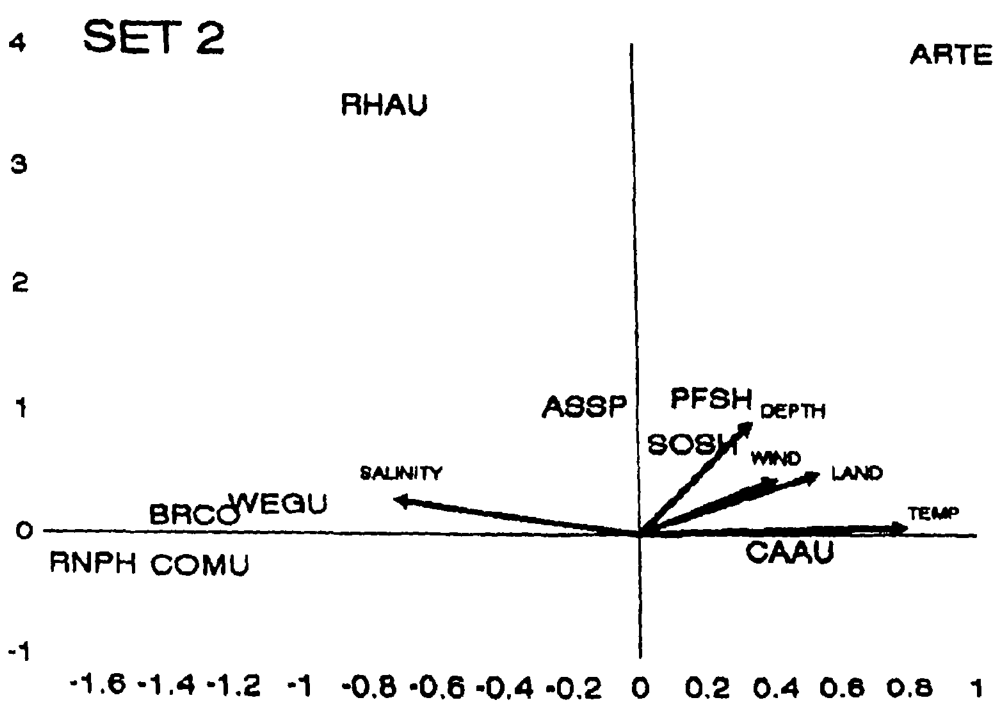
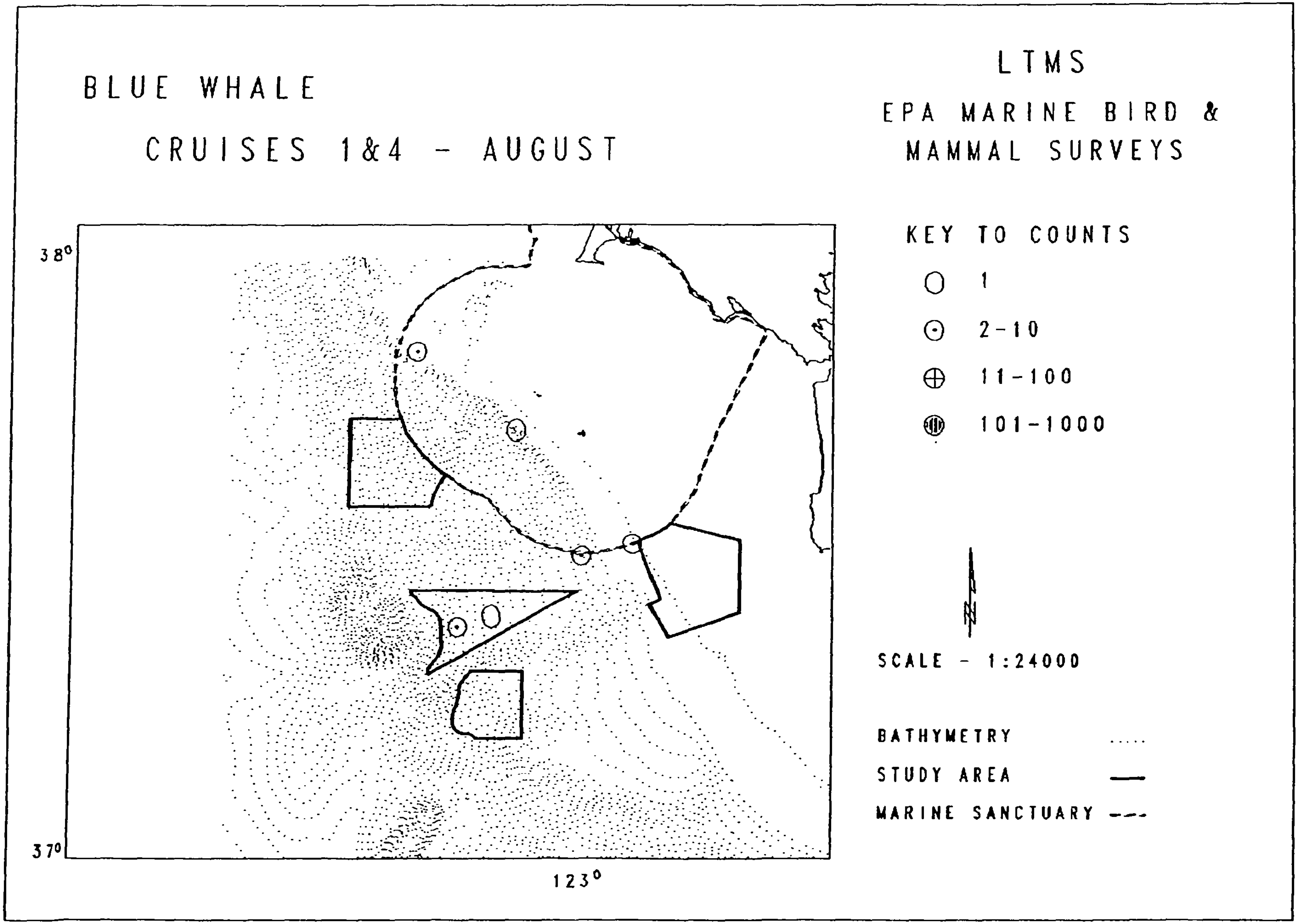
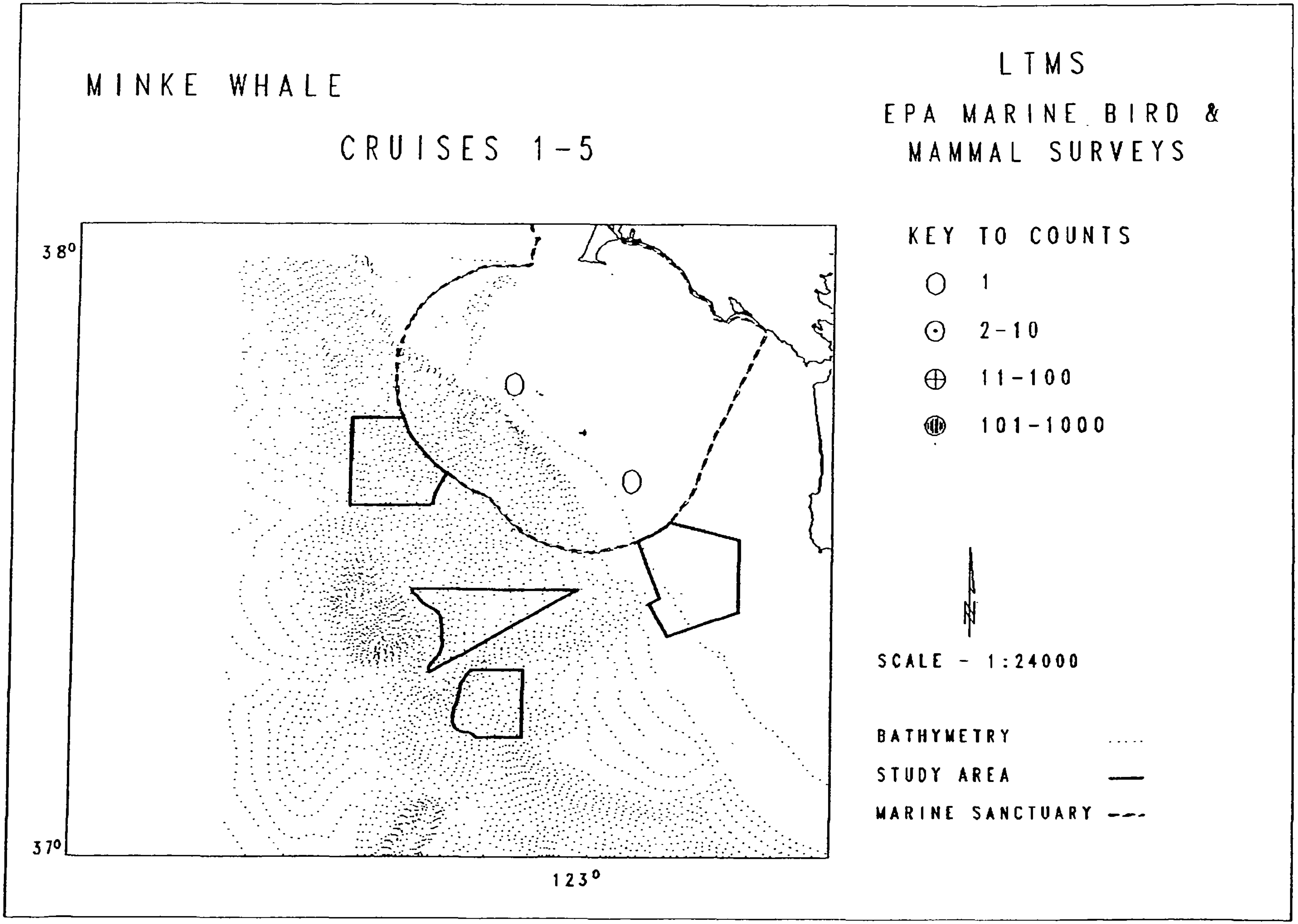


Figure 4. Maps of marine mammals sightings by species. Information is from station data and does not include general observations.


BLUE WHALE
CRUISES 1&4 - AUGUST
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
1
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

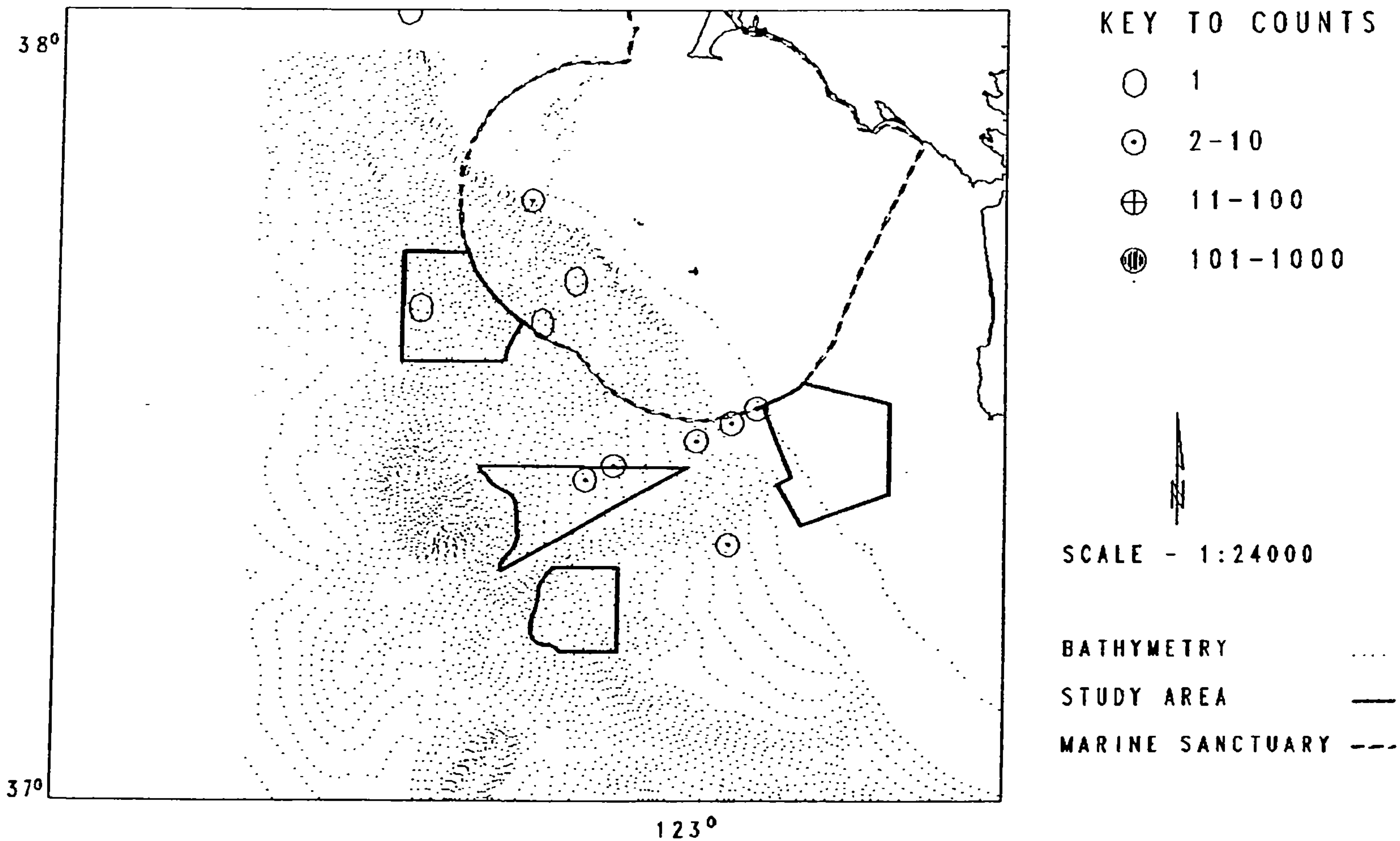

MINKE WHALE
CRUISES 1-5
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
38°
37°
123°
KEY TO COUNTS
1
2-10
11-100
101-1000
N
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY

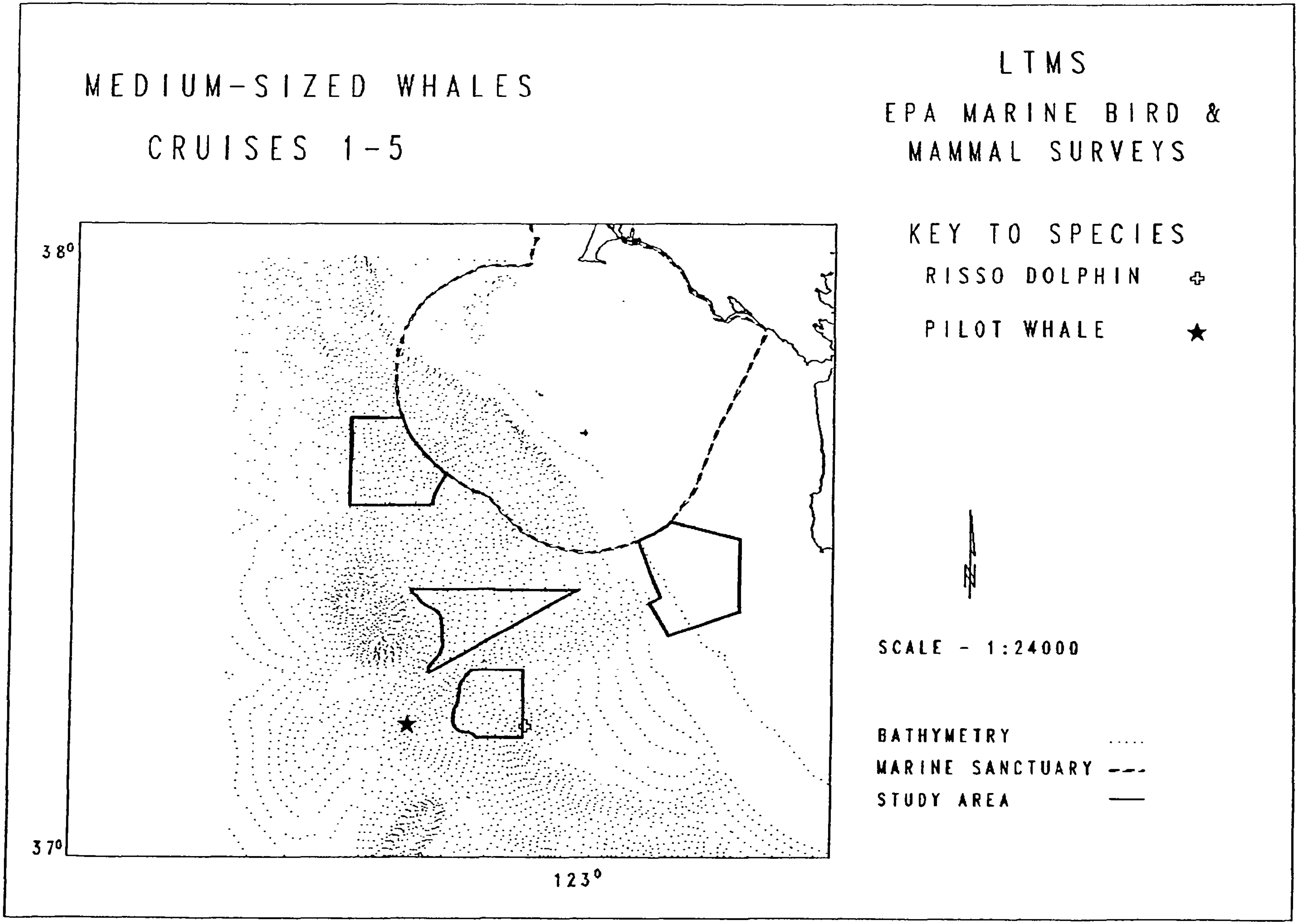
HUMPBACK WHALE

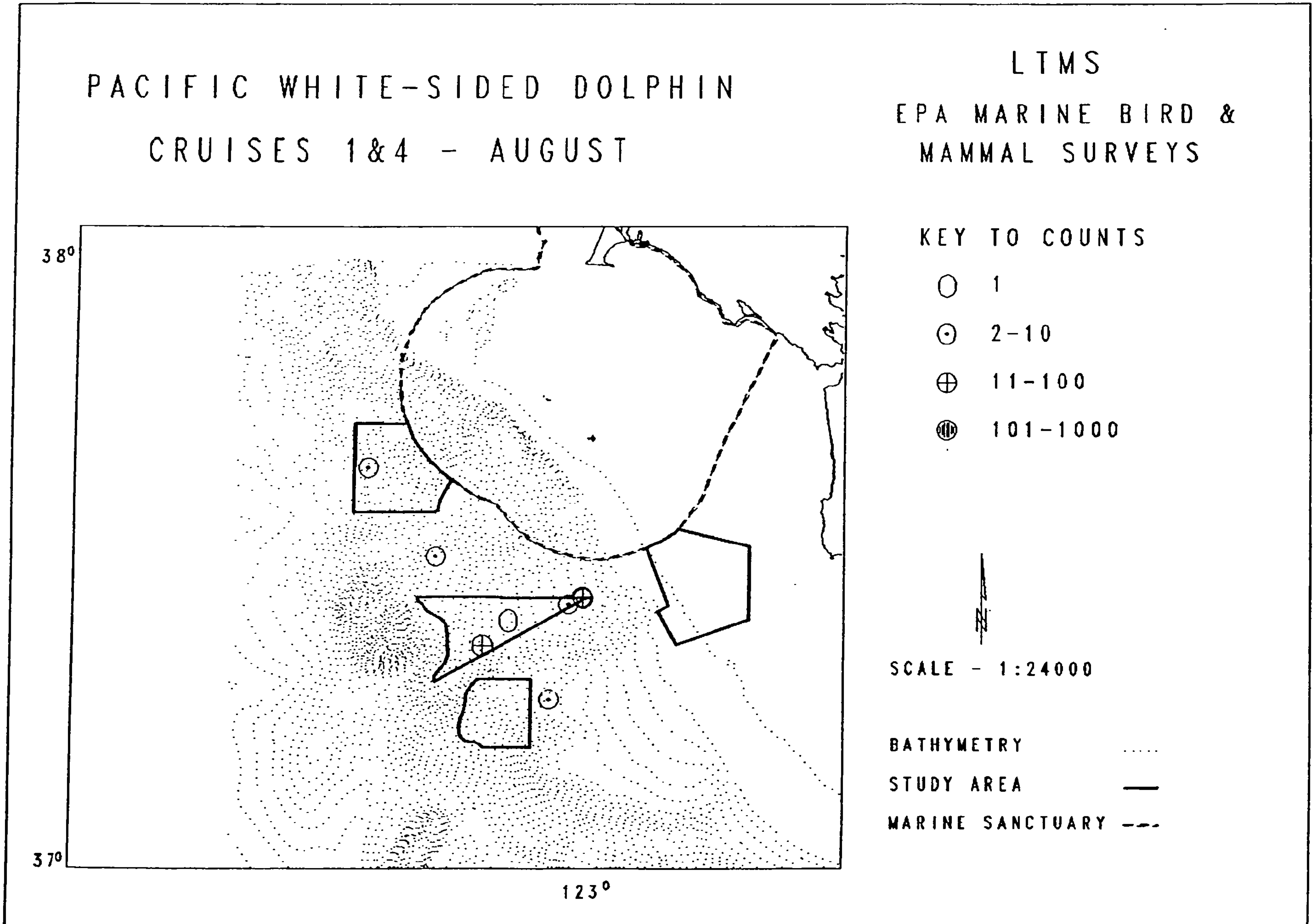
CRUISES 1&4 - AUGUST

LTMS

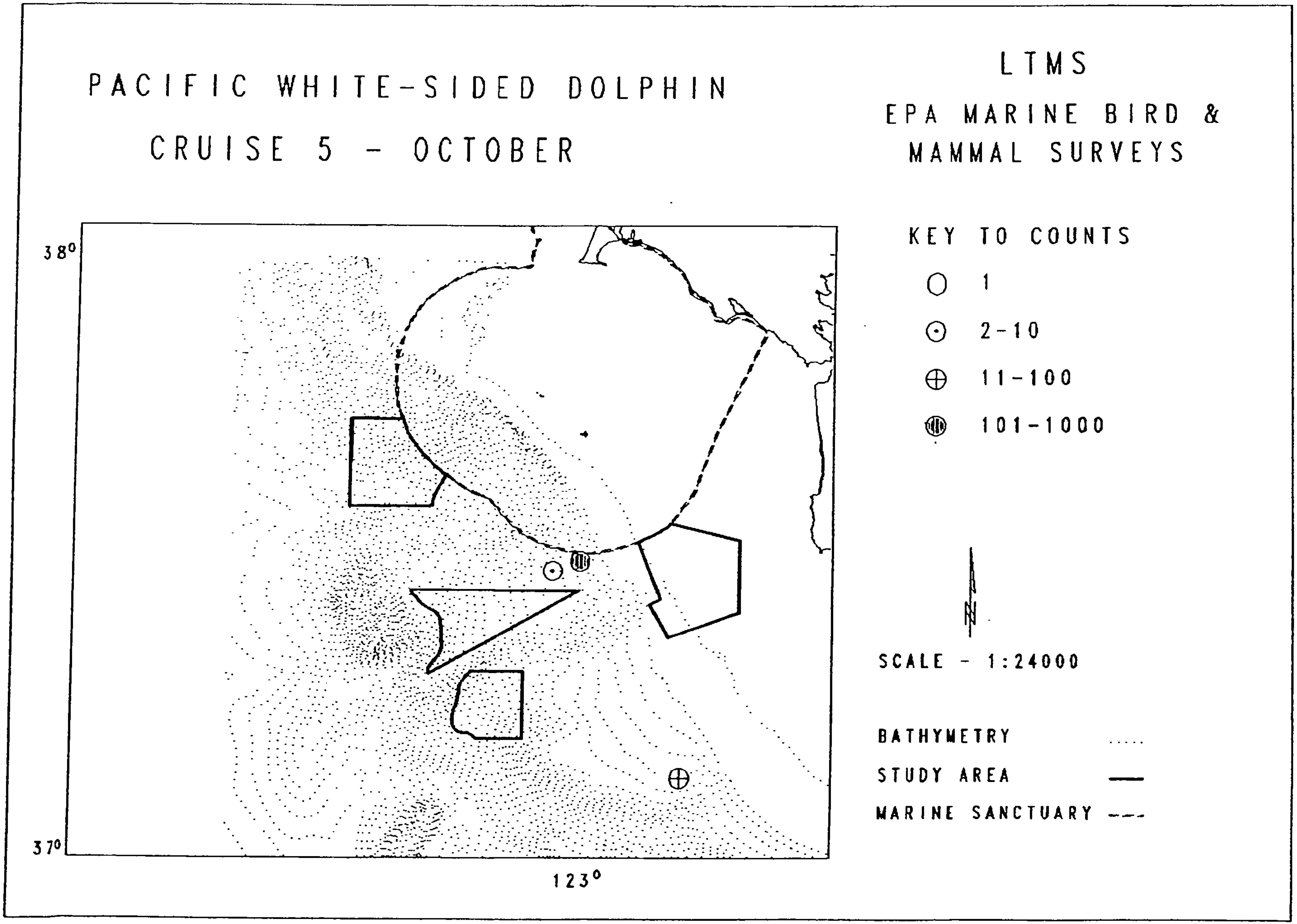
EPA MARINE BIRD & MAMMAL SURVEYS




MEDIUM-SIZED WHALES
CRUISES 1-5
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO SPECIES
RISSO DOLPHIN
PILOT WHALE
38°
37°
123°
SCALE - 1:24000
BATHYMETRY
MARINE SANCTUARY
STUDY AREA



PACIFIC WHITE-SIDED DOLPHIN
CRUISES 1&4 - AUGUST
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
1
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°


PACIFIC WHITE-SIDED DOLPHIN
CRUISE 5 - OCTOBER
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
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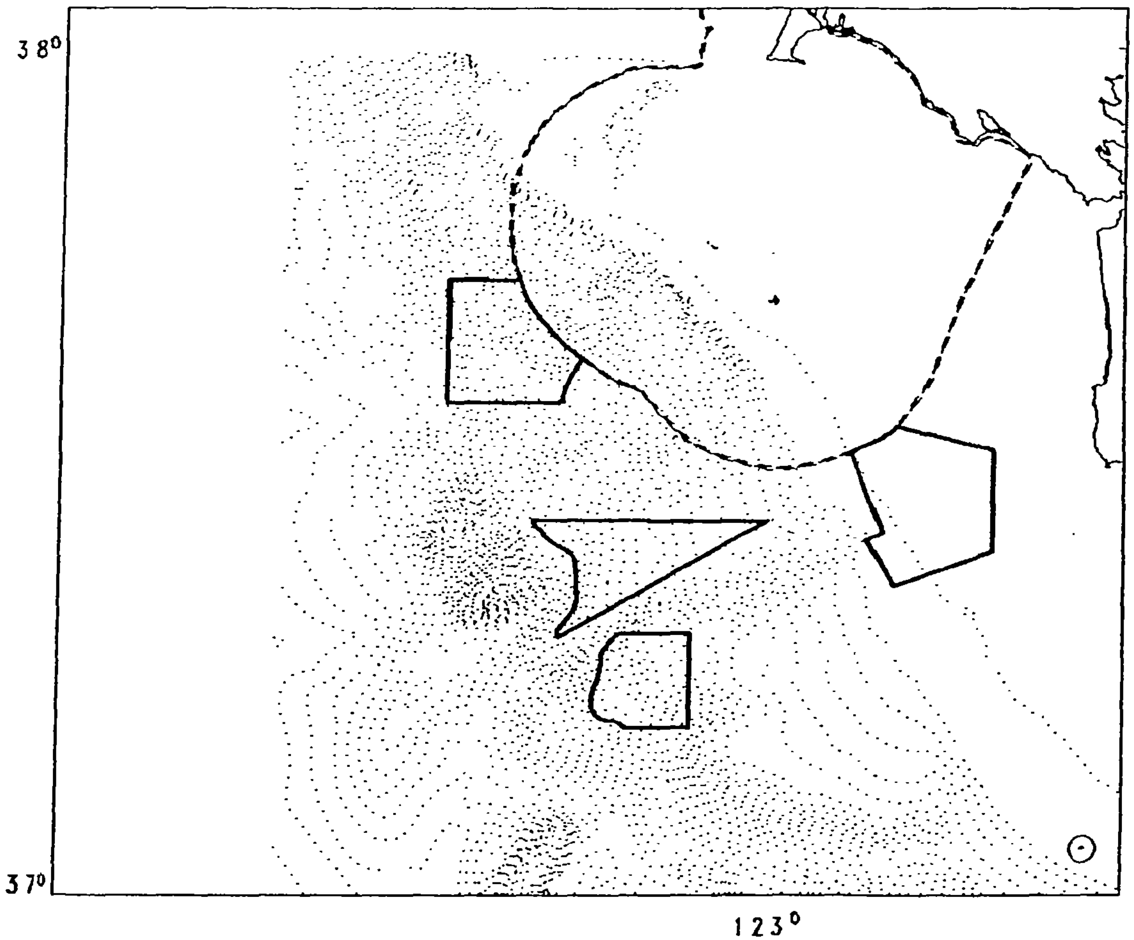
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

HARBOR PORPOISE
CRUISE 5 - OCTOBER

LTMS
EPA MARINE BIRD & MAMMAL SURVEYS



KEY TO COUNTS

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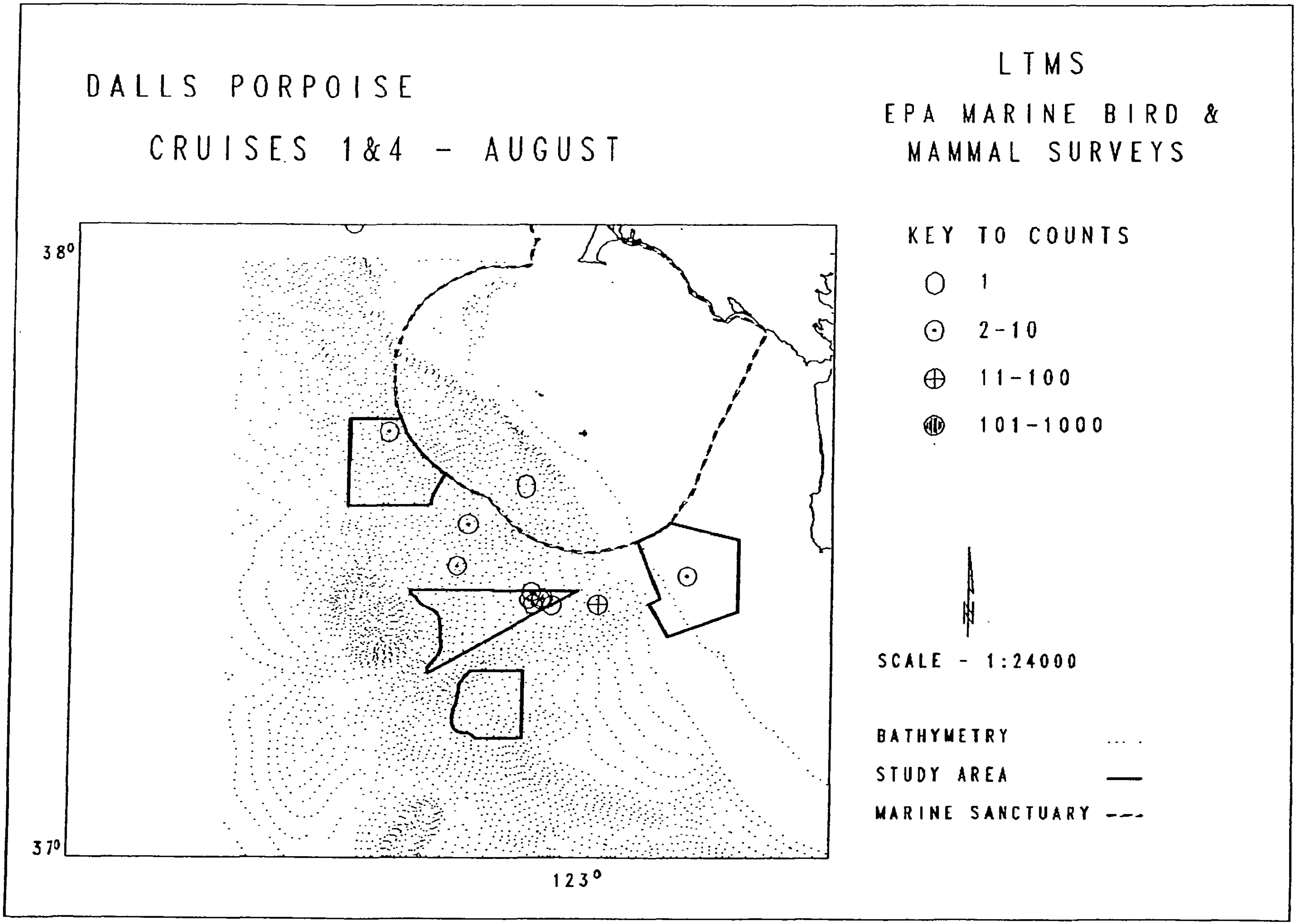
- 2-10
- 11-100
- 101-1000

SCALE - 1:24000

BATHYMETRY ....
STUDY AREA ——
MARINE SANCTUARY ---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CRUISES 1&4 - AUGUST
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
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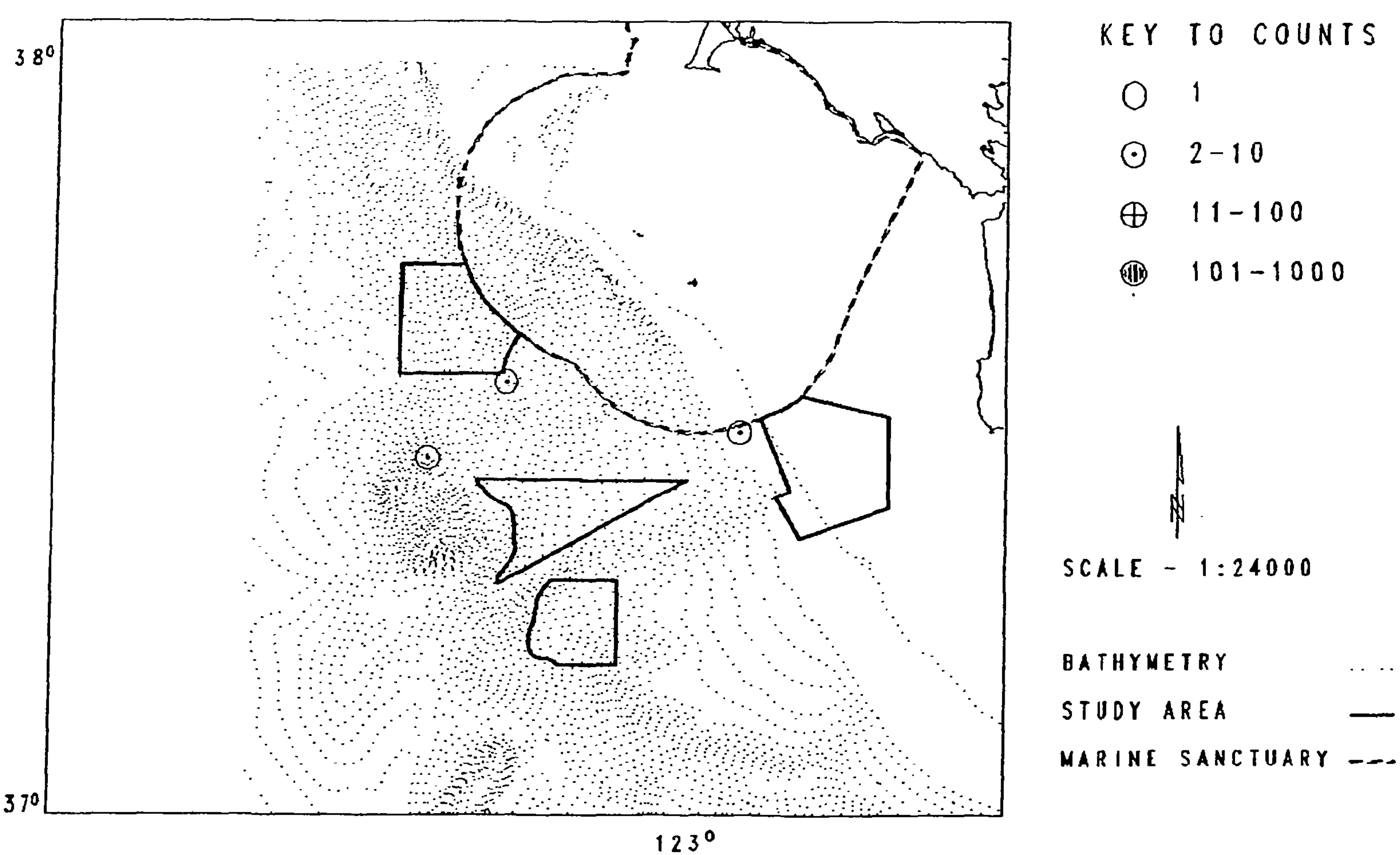
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

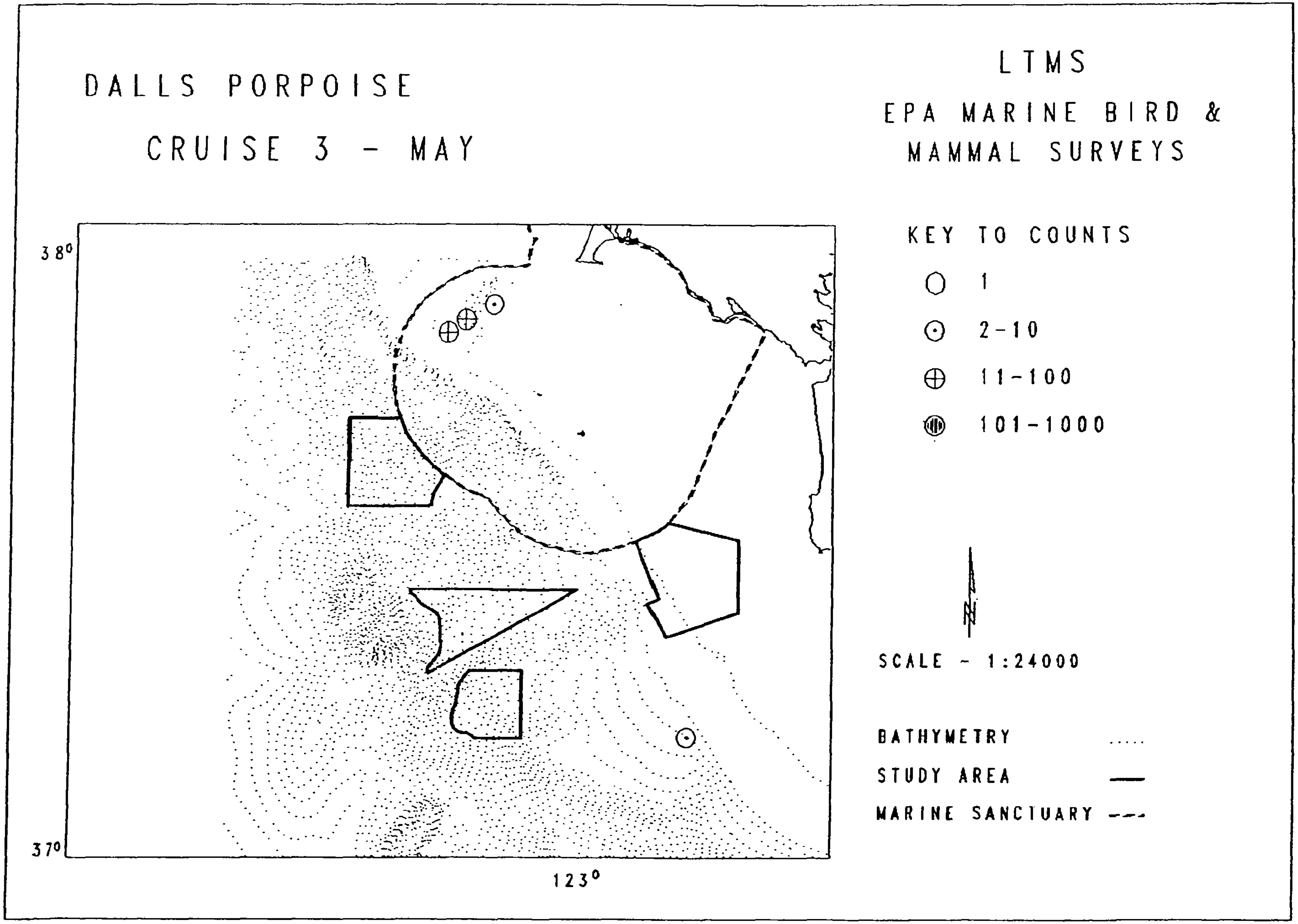
DALLS PORPOISE

CRUISE 2 - FEBRUARY

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS



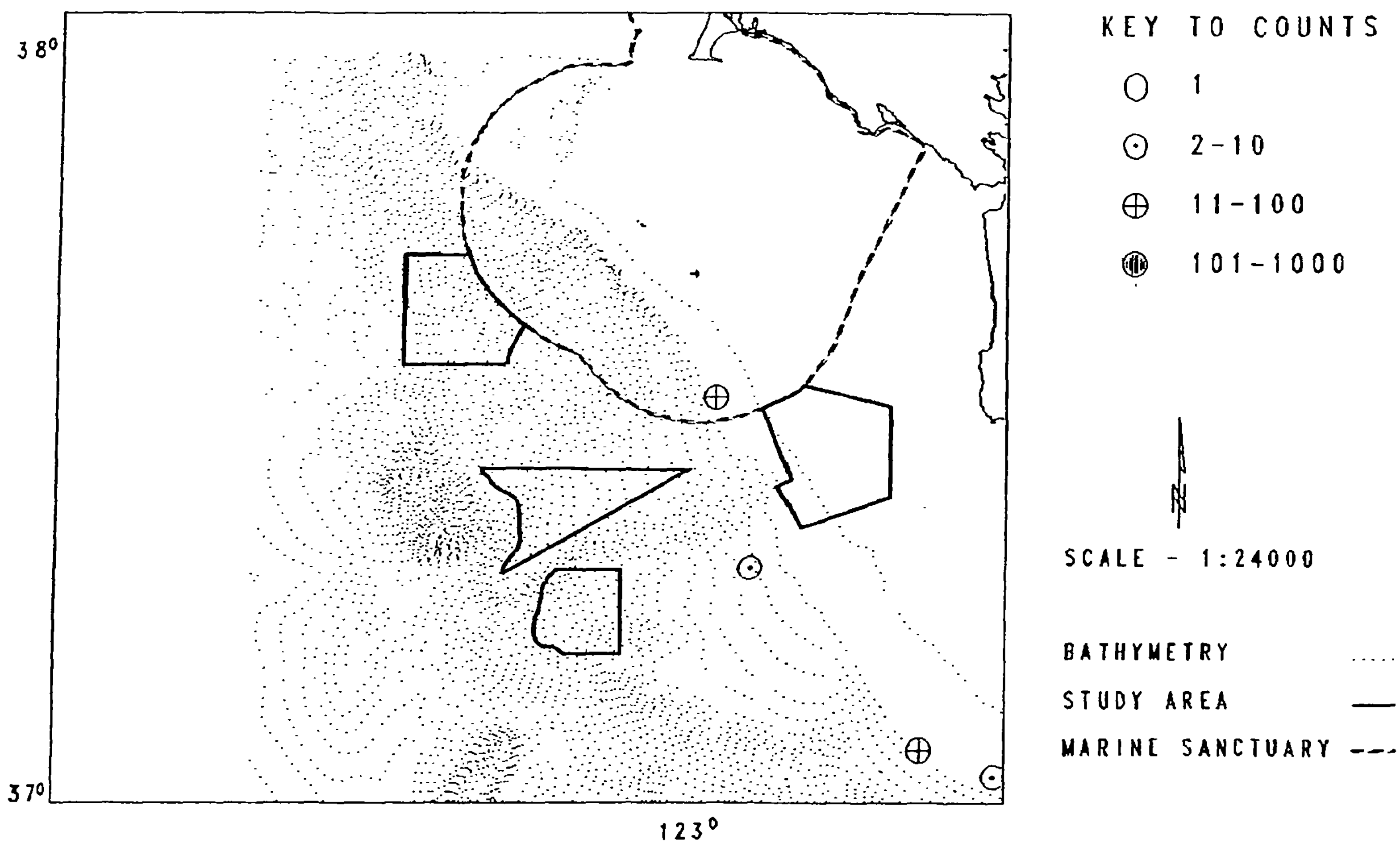

DALLS PORPOISE
CRUISE 3 - MAY
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
1
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

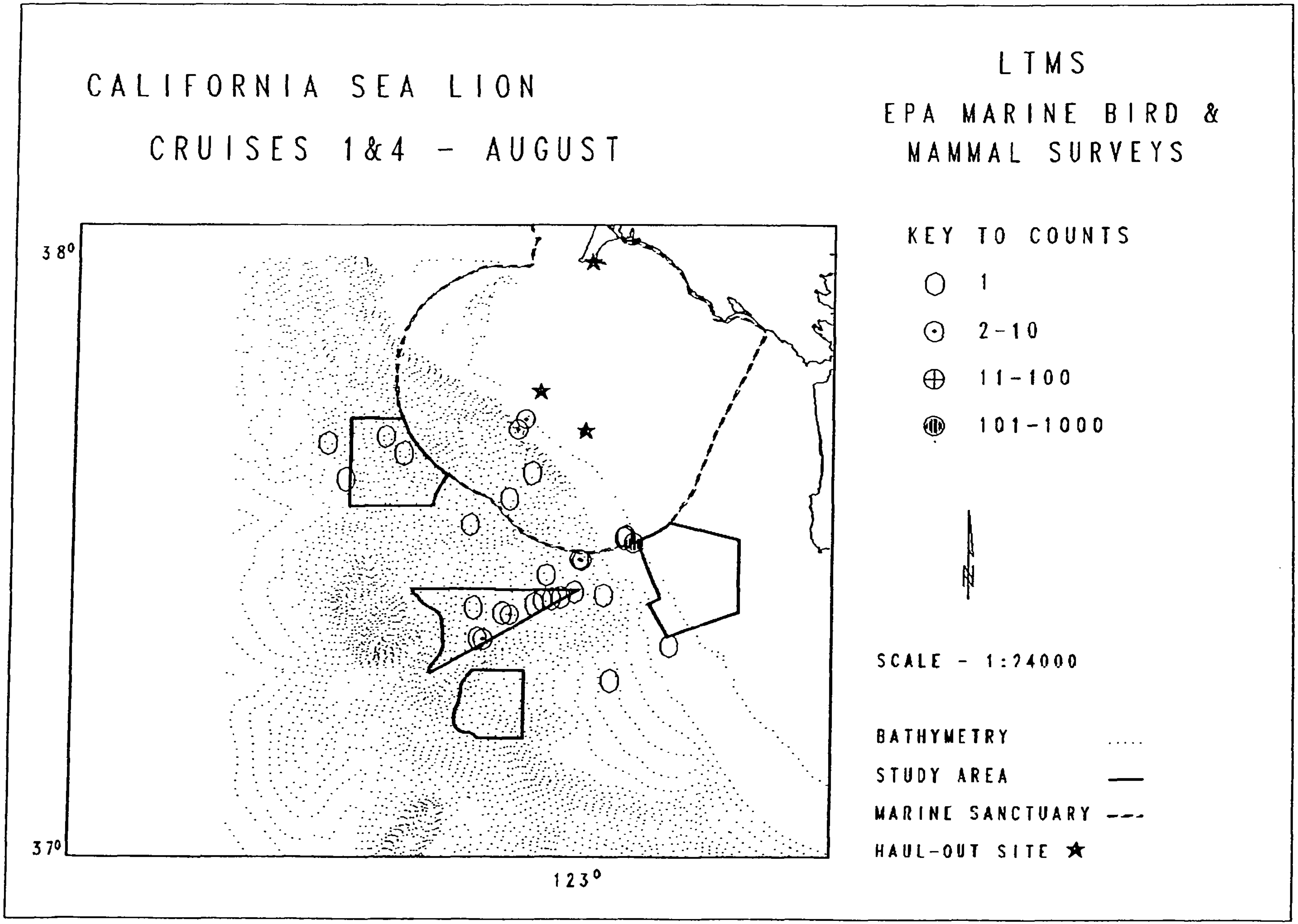
DALLS PORPOISE

CRUISE 5 - OCTOBER

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS




CALIFORNIA SEA LION
CRUISES 1&4 - AUGUST
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO COUNTS
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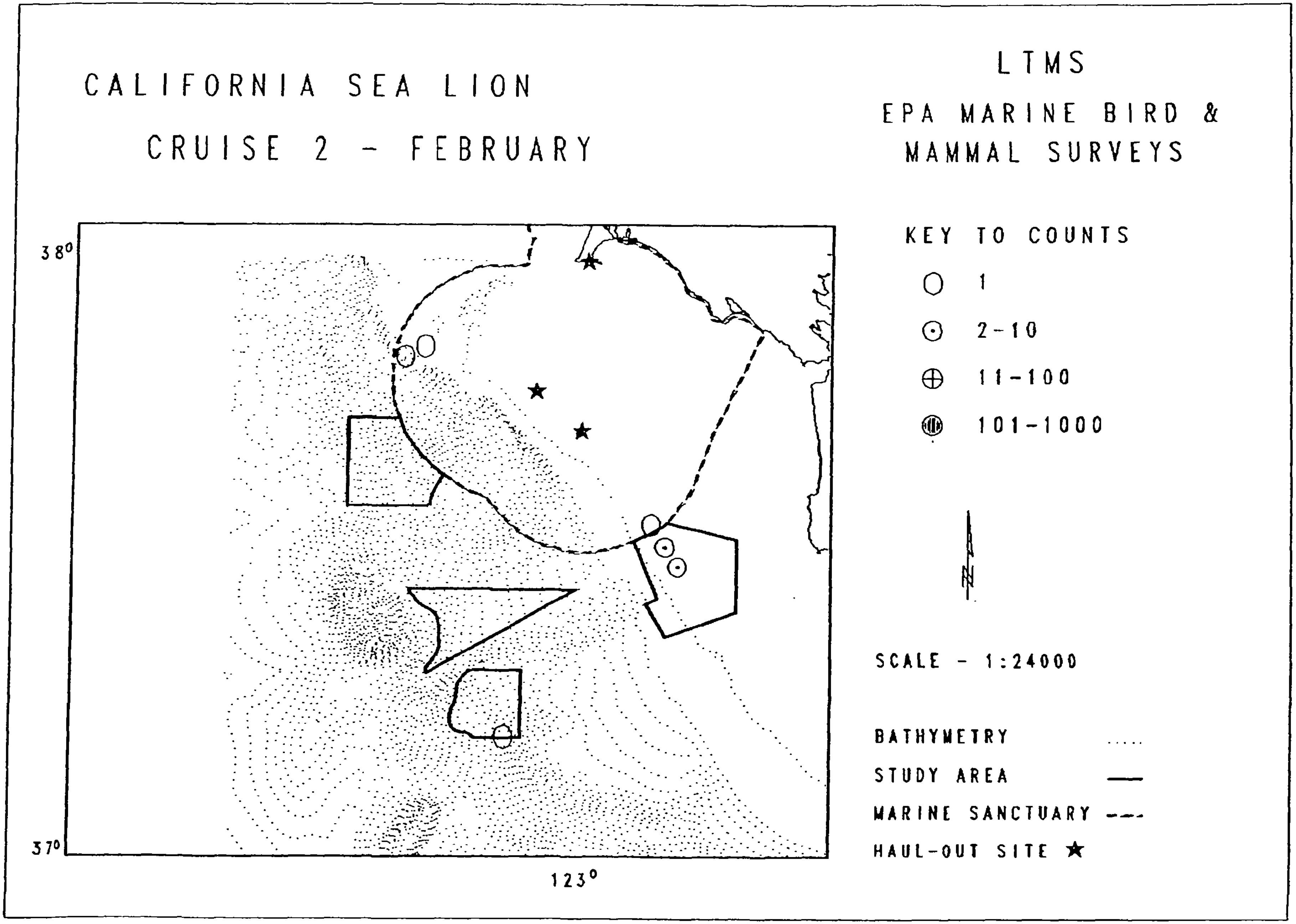
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
HAUL-OUT SITE
38°
37°
123°

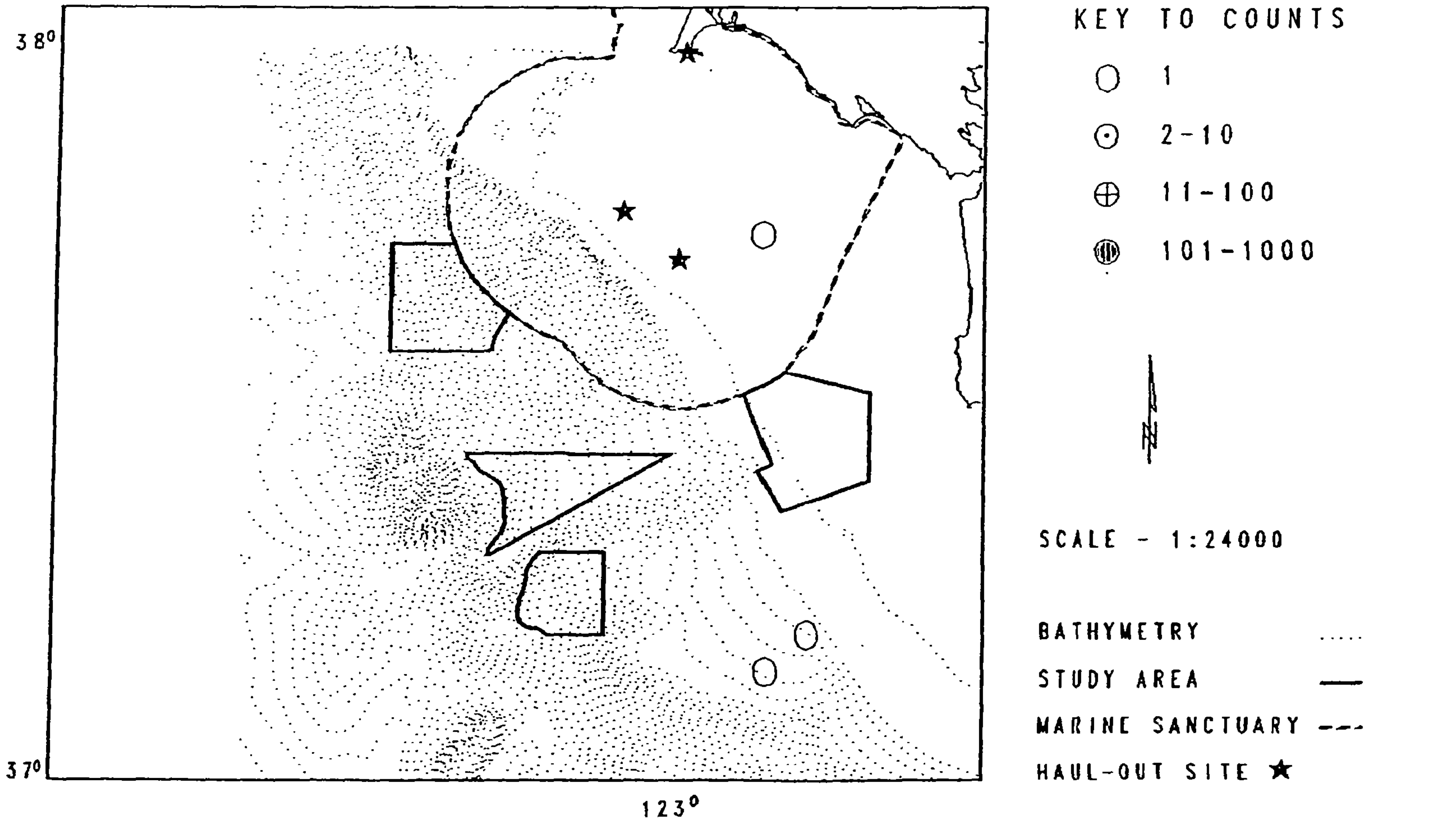

CALIFORNIA SEA LION
CRUISE 2 - FEBRUARY
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
38°
37°
123°
KEY TO COUNTS
1
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
HAUL-OUT SITE

CALIFORNIA SEA LION

CRUISE 3 - MAY

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS

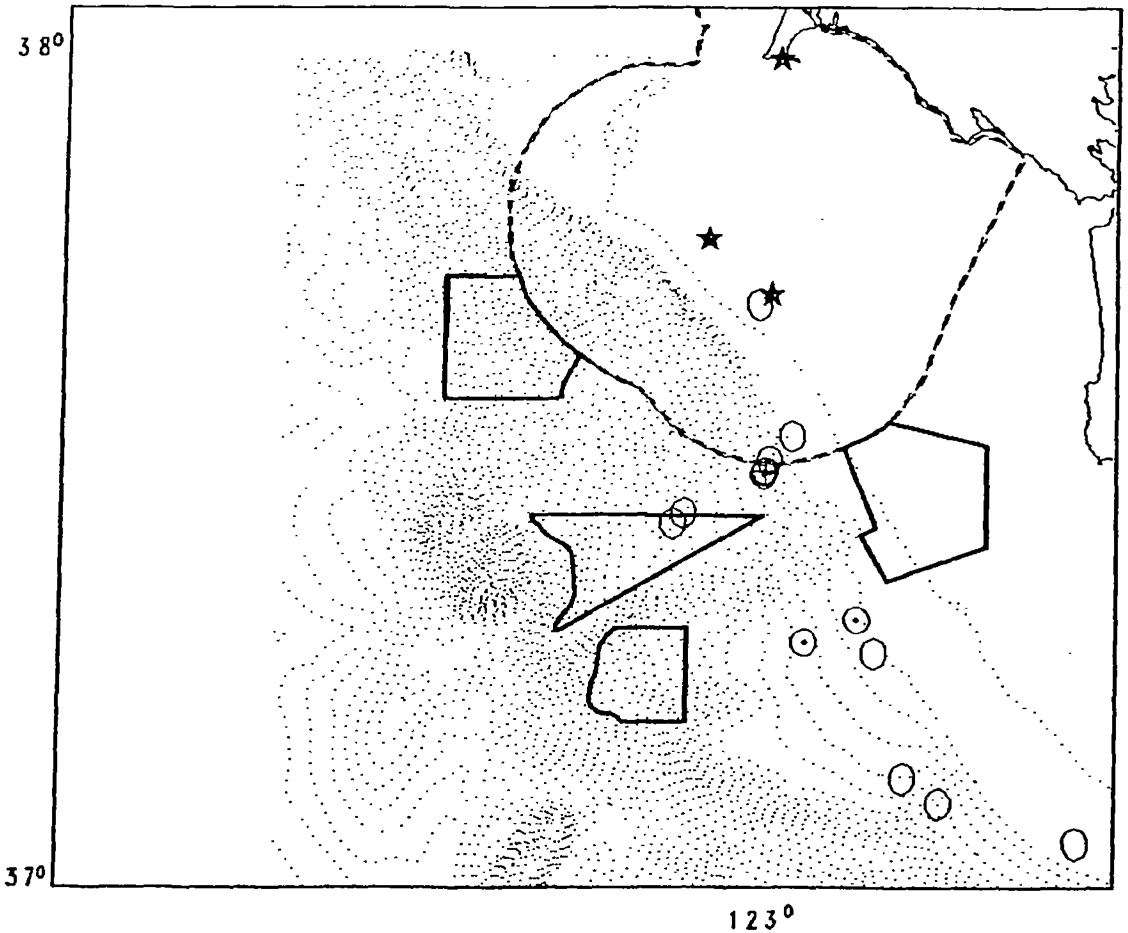


CALIFORNIA SEA LION

CRUISE 5 - OCTOBER

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS



KEY TO COUNTS

- ○ 1
- ⊙ 2-10
- ⊕ 11-100
- ◍ 101-1000

SCALE - 1:24000

BATHYMETRY . . .

STUDY AREA ——

MARINE SANCTUARY ---

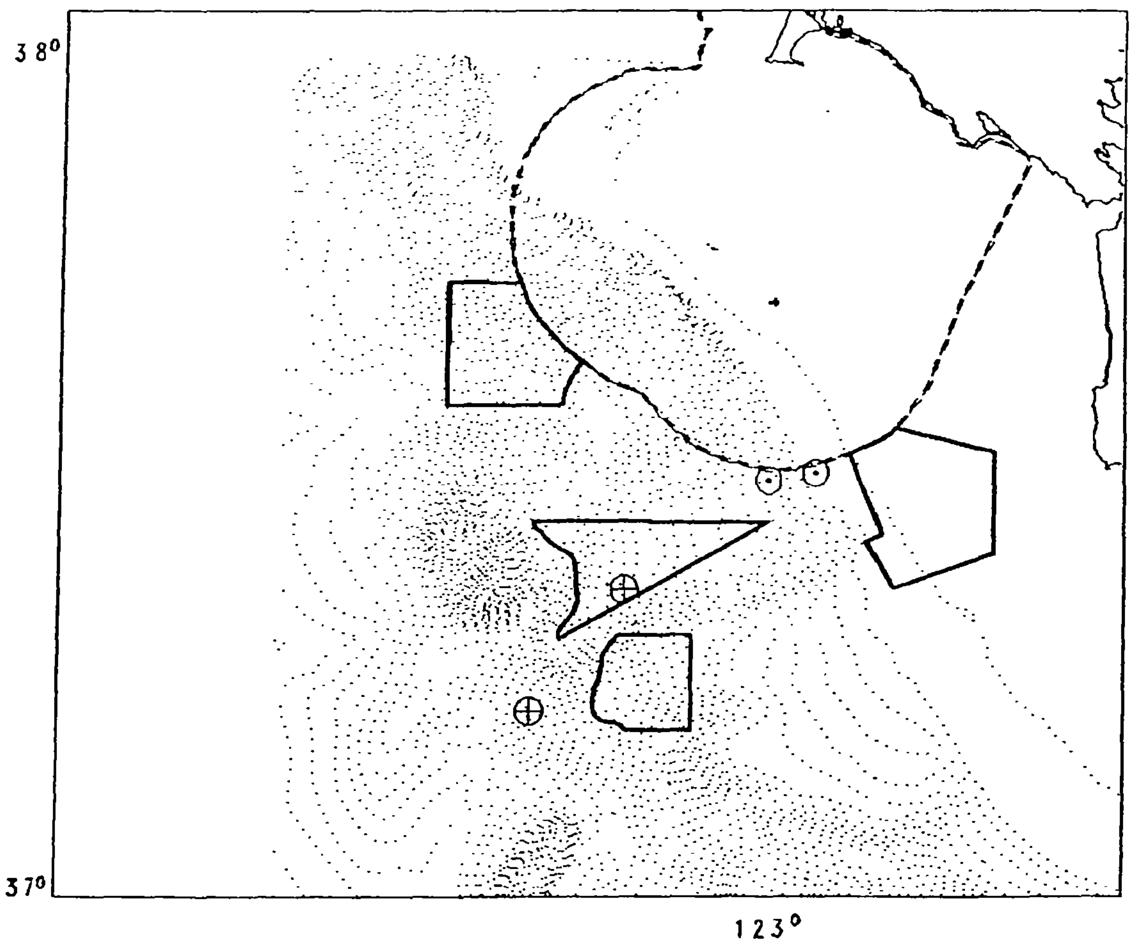
HAUL-OUT SITE ★

NORTHERN RIGHT-WHALE DOLPHIN

CRUISES 1-5

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS



KEY TO COUNTS

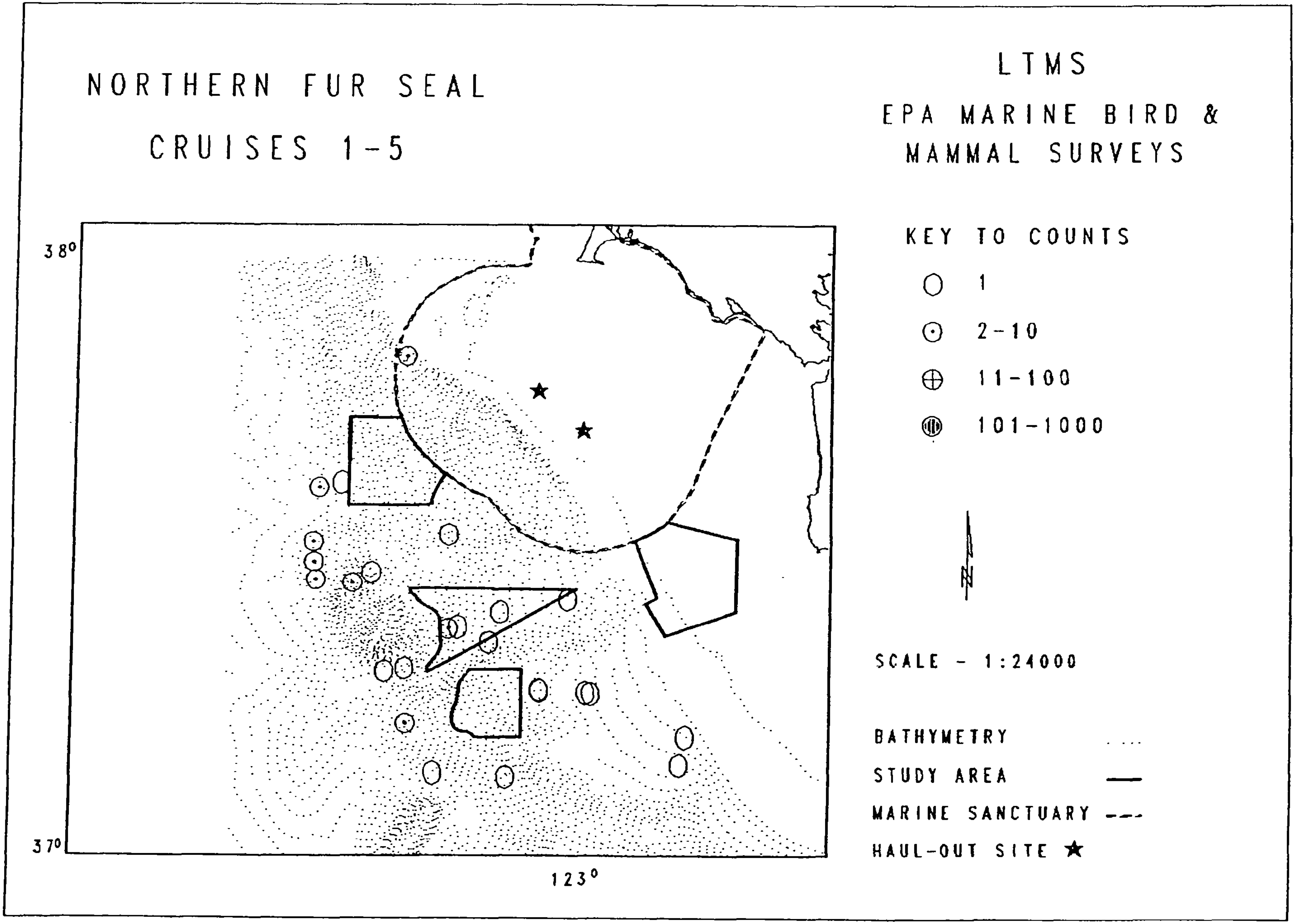
- 1
- 2-10
- 11-100
- 101-1000

SCALE - 1:24000

BATHYMETRY

STUDY AREA

MARINE SANCTUARY

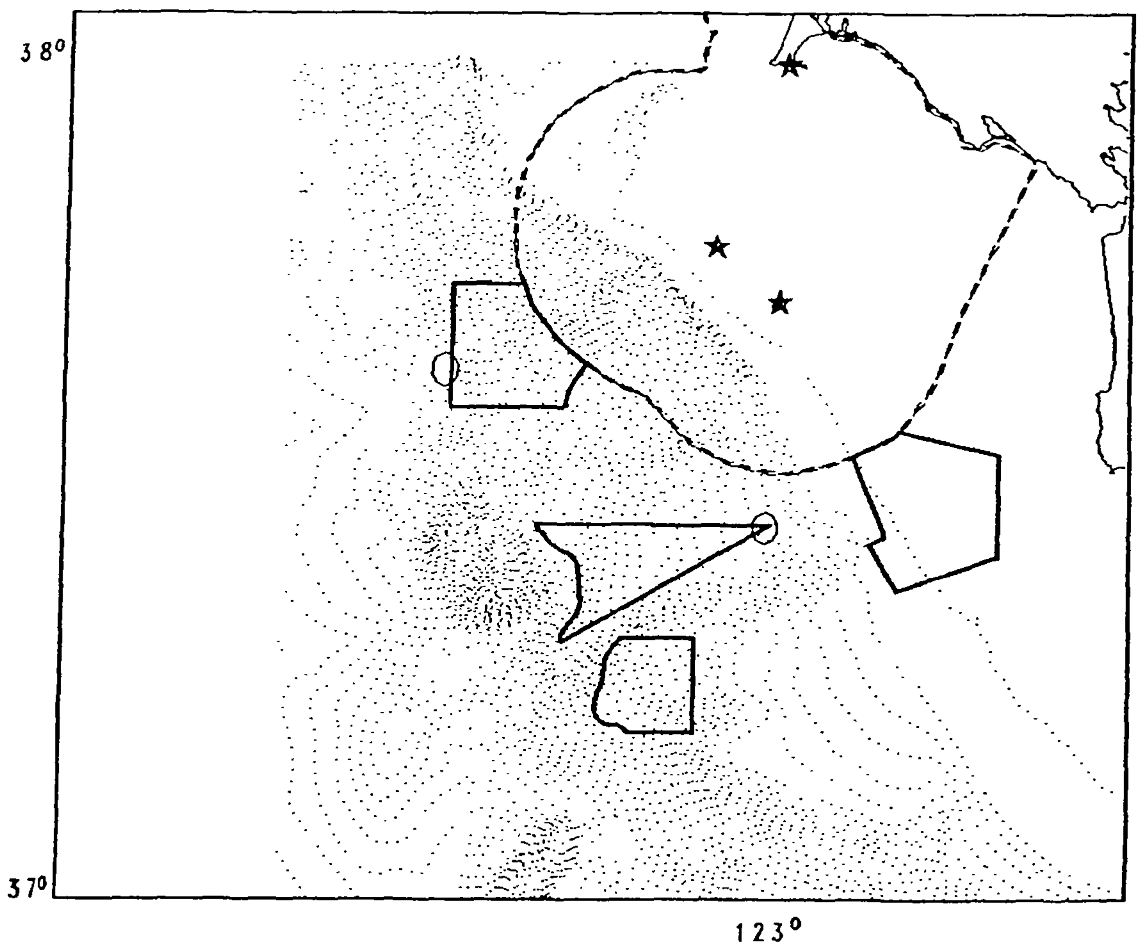

NORTHERN FUR SEAL
CRUISES 1-5
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
38°
37°
123°
KEY TO COUNTS
1
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
HAUL-OUT SITE

NORTHERN SEA LION

CRUISES 1&4 - AUGUST

LTMS

EPA MARINE BIRD & MAMMAL SURVEYS



KEY TO COUNTS

- ○ 1
- ⊙ 2-10
- ⊕ 11-100
- ◍ 101-1000

SCALE - 1:24000

BATHYMETRY ·····

STUDY AREA ——

MARINE SANCTUARY ---

BREEDING SITE ★

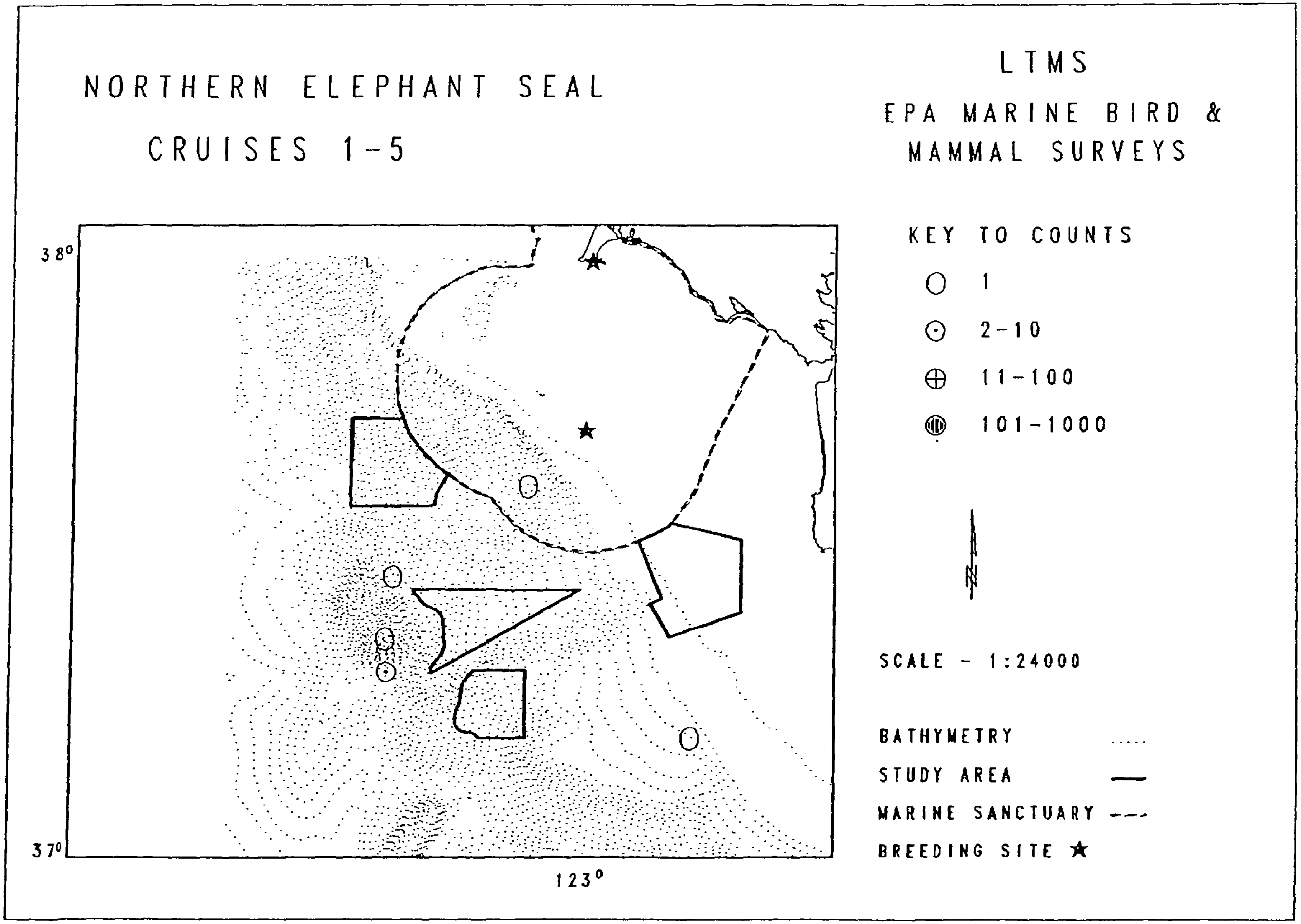
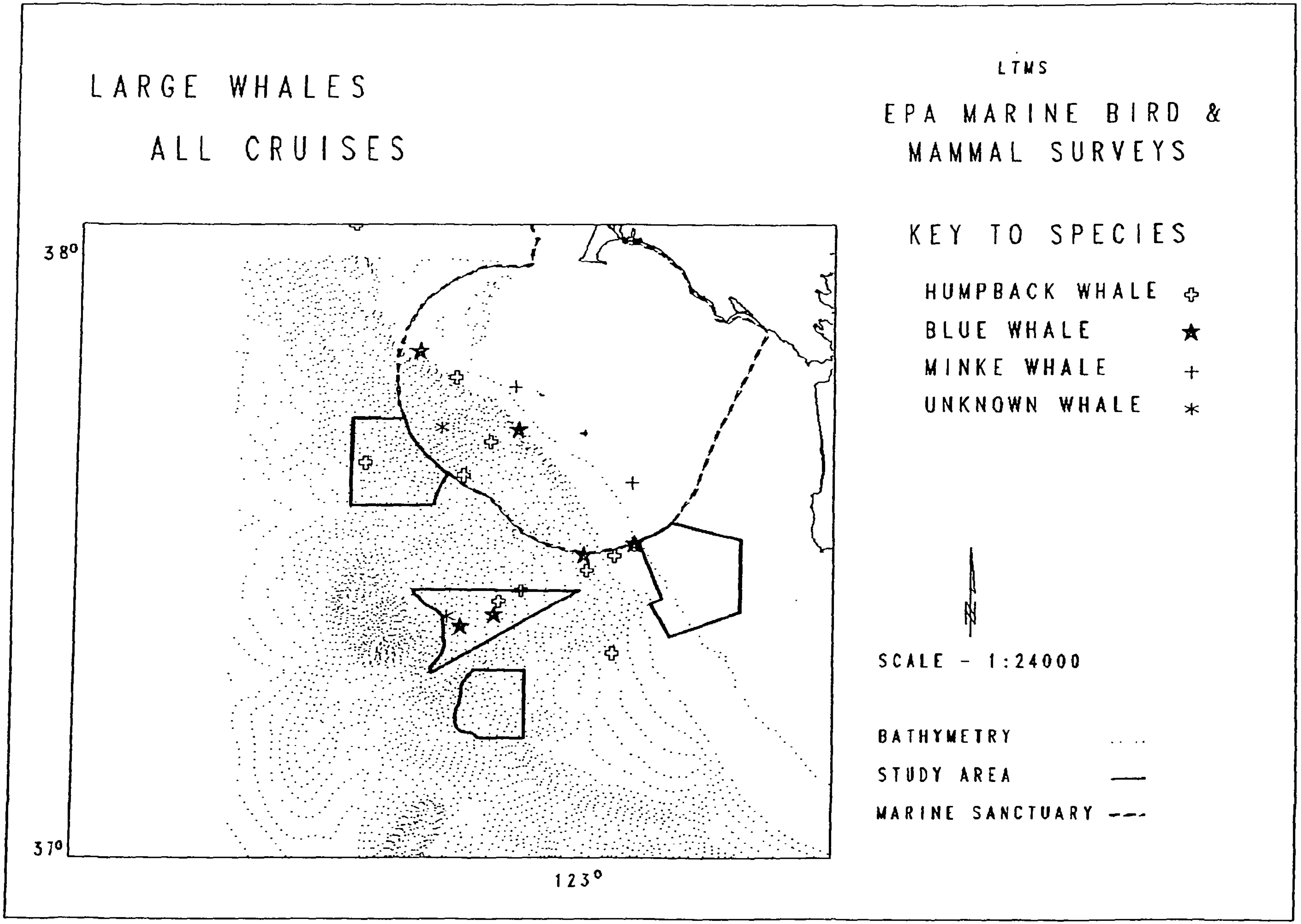
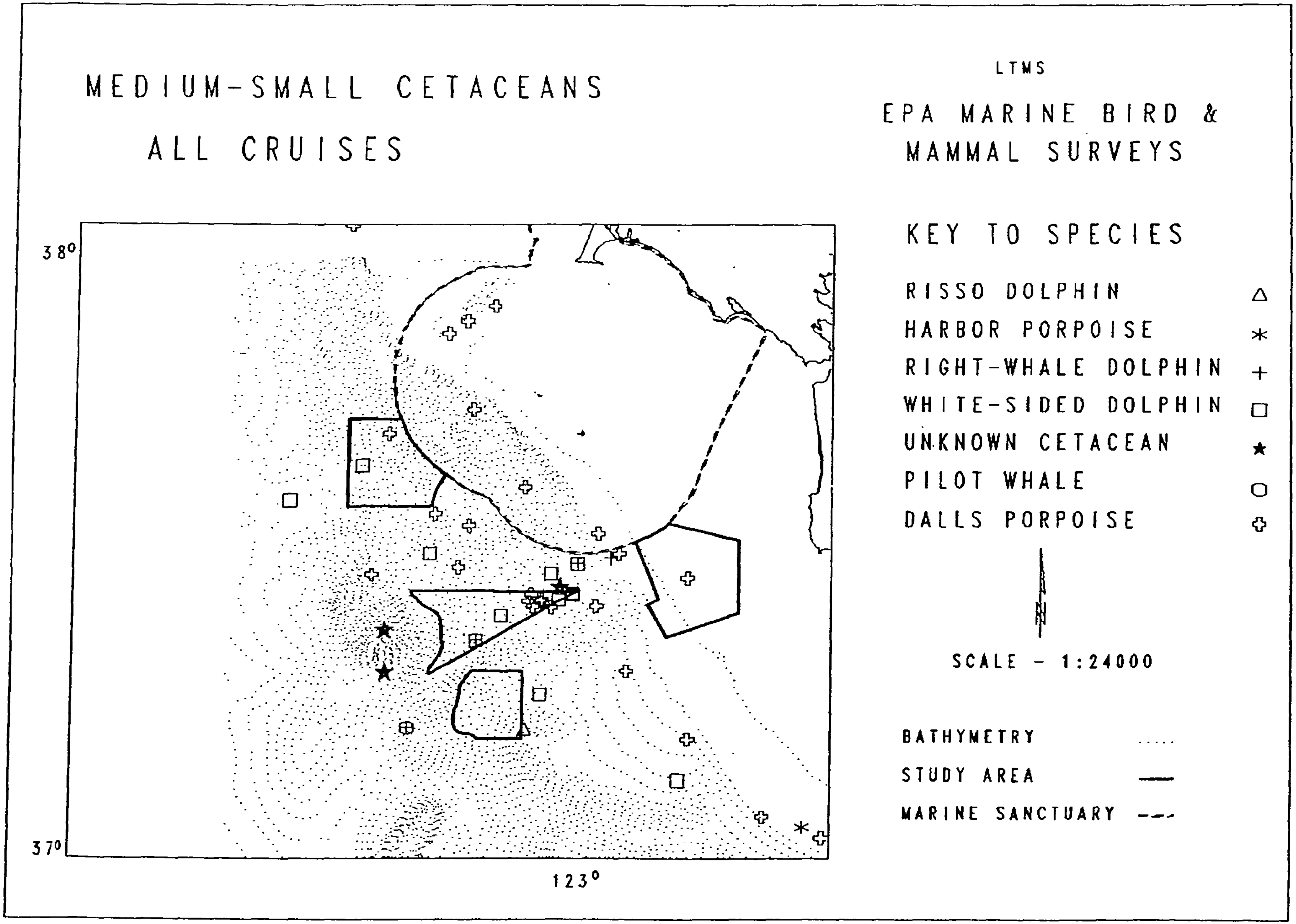

NORTHERN ELEPHANT SEAL
CRUISES 1-5
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
38°
37°
123°
KEY TO COUNTS
1
2-10
11-100
101-1000
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
BREEDING SITE

Figure 5. Maps of marine mammals sightings for all cruises combined by categories: 1) large whales, 2) medium-to-small cetaceans, and 3 pinnipeds. Information is from station data and does not include general observations.


LARGE WHALES
ALL CRUISES
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO SPECIES
HUMPBACK WHALE
BLUE WHALE
MINKE WHALE
UNKNOWN WHALE
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°
N


MEDIUM-SMALL CETACEANS
ALL CRUISES
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO SPECIES
RISSO DOLPHIN
HARBOR PORPOISE
RIGHT-WHALE DOLPHIN
WHITE-SIDED DOLPHIN
UNKNOWN CETACEAN
PILOT WHALE
DALLS PORPOISE
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

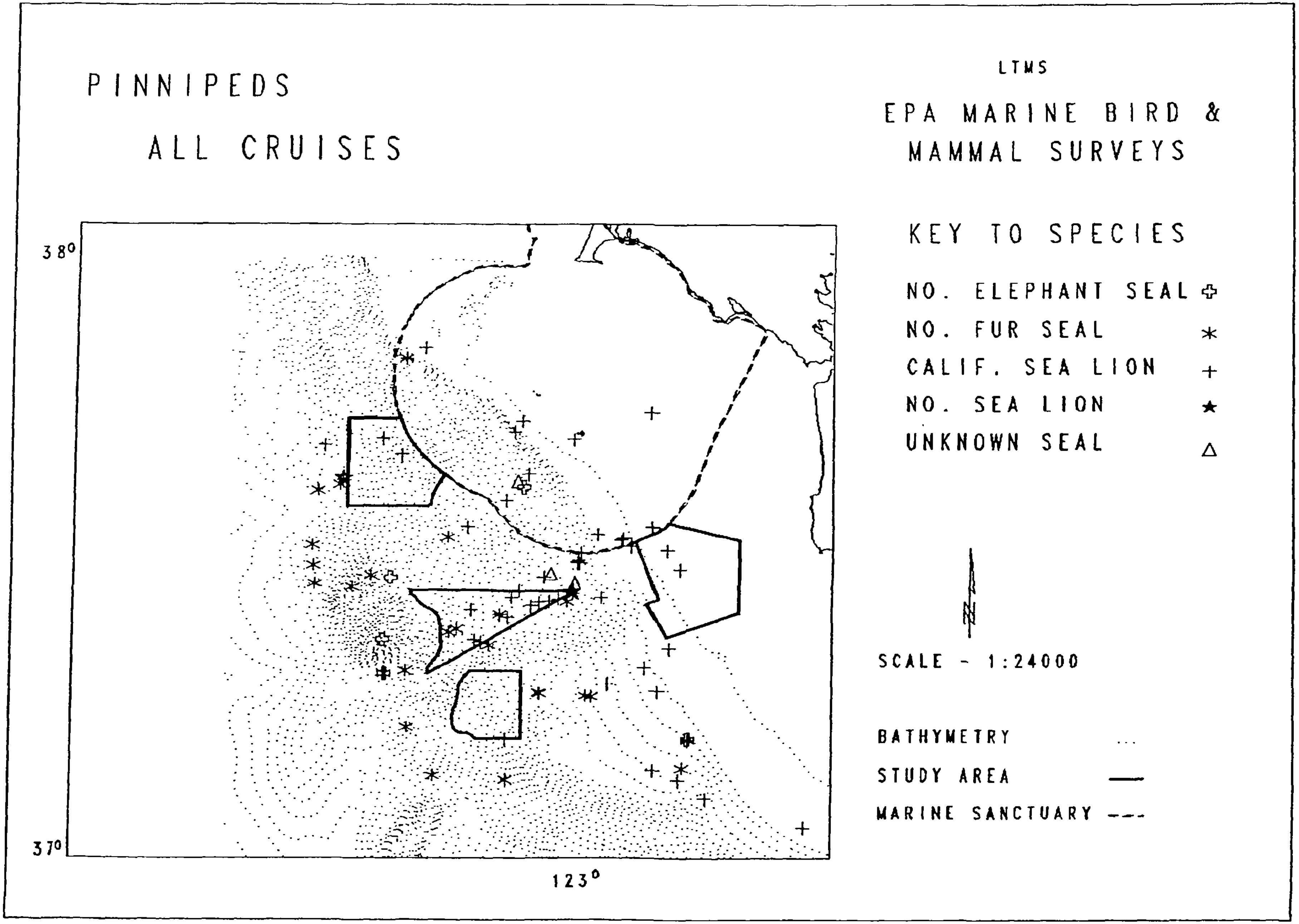
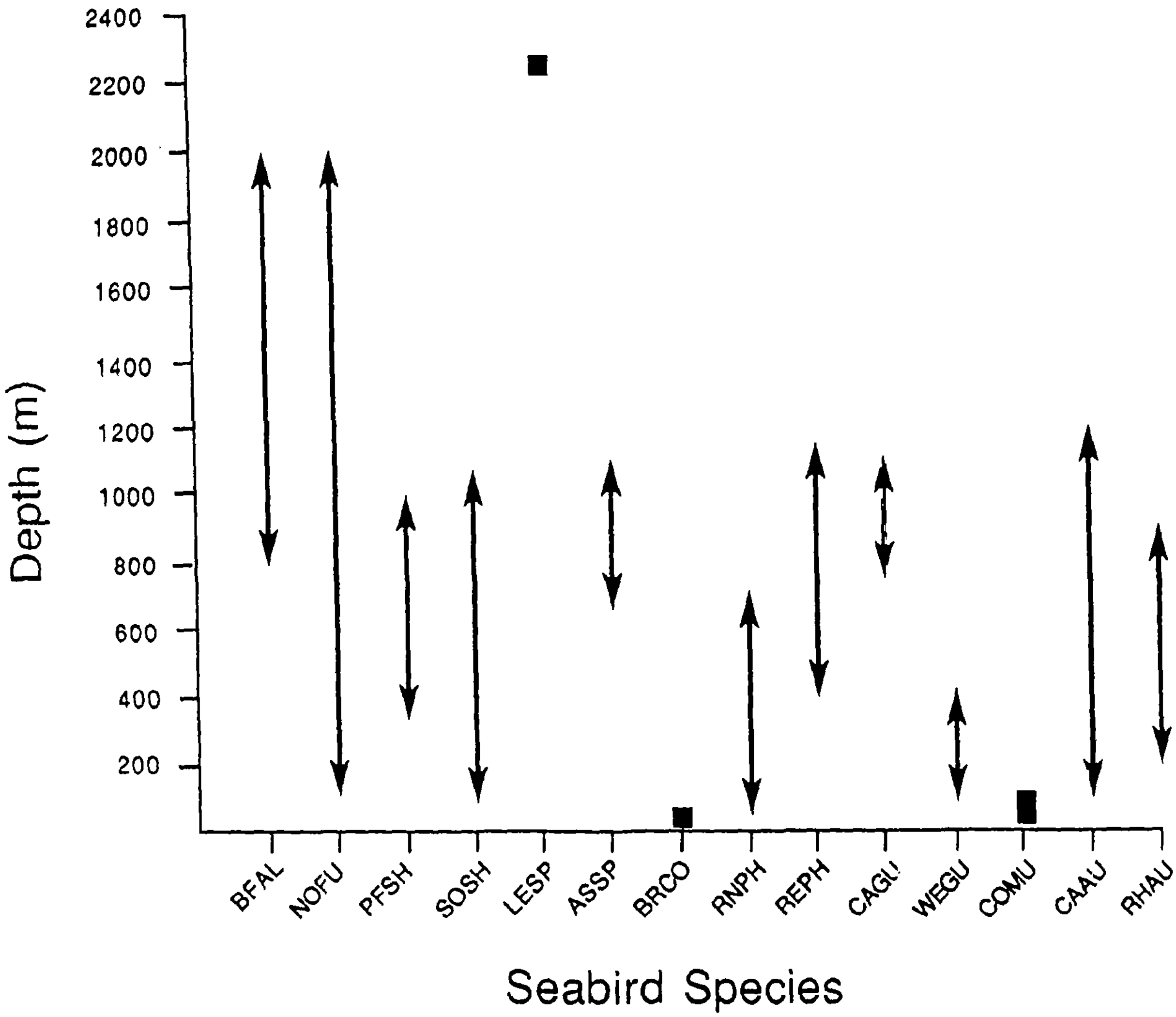

PINNIPEDS
ALL CRUISES
LTMS
EPA MARINE BIRD &
MAMMAL SURVEYS
KEY TO SPECIES
NO. ELEPHANT SEAL
NO. FUR SEAL
CALIF. SEA LION
NO. SEA LION
UNKNOWN SEAL
SCALE - 1:24000
BATHYMETRY
STUDY AREA
MARINE SANCTUARY
38°
37°
123°

Figure 6. Range of median depth of ocean for commonly observed seabird species for all cruises combined.



BFAL Black-footed Albatross n=128
NOFU Northern Fulmar n=83
PFSH Pink-footed Shearwater n=80
SOSH Sooty Shearwater n=171
LSSP Leach's Storm-Petrel n=4
ASSP Ashy Storm-Petrel n=42
BRCO Brandt's Cormorant n=25
RNPH Red-necked Phalarope n=55
REPH Red Phalarope n=52
CAGU California Gull n=101
WEGU Western Gull n=226
COMU Common Murre n=72
CAAU Cassin's Auklet n=74
RHAU Rhinoceros Auklet n=106

APPENDIX 1

Cruise participants

Cruise Number	Name	Affiliation
1	Dr. Stephen Bailey	California Academy of Sciences
	Paul Jones	EPA
	Don Roberson*	Monterey Peninsula Audubon Society
	Isidore Szczepaniak	California Academy of Sciences
	Jon Stern	California Academy of Sciences

*only member on board from noon on 10 August to end of cruise.

2	Dr. Stephen Bailey	California Academy of Sciences
	Michael Newcomer	Independent researcher
	Don Roberson	Monterey Peninsula Audubon Society
3	Dr. Stephen Bailey	California Academy of Sciences
	Paul Jones	EPA
4	Dr. Stephen Bailey	California Academy of Sciences
	Paul Jones	EPA
5	Paul Jones	EPA
	Marc Webber	California Academy of Sciences

APPENDIX 2

Descriptive Statistics for seabird and marine mammal species.
See Methods in Ainley and Allen (1992) for details.

CRUISE NUMBER 1

THE FOLLOWING RESULTS ARE FOR ASHY STORM-PETREL

	DEPTH(m)	TEMP(C)
N OF CASES	23	4
MINIMUM	160.000	15.400
MAXIMUM	2000.000	16.900
RANGE	1840.000	1.500
MEAN	851.217	15.975
VARIANCE	195446.451	0.522
STANDARD DEV	442.093	0.723
C.V.	0.519	0.045
MEDIAN	781.000	15.800

THE FOLLOWING RESULTS ARE FOR BLACK-FOOTED ALBATROSS

	DEPTH(m)	TEMP(C)
N OF CASES	61	18
MINIMUM	135.000	15.000
MAXIMUM	3065.000	16.900
RANGE	2930.000	1.900
MEAN	1286.000	15.794
VARIANCE	535461.500	0.398
STANDARD DEV	731.752	0.631
C.V.	0.569	0.040
MEDIAN	1070.000	15.600

THE FOLLOWING RESULTS ARE FOR BLACK STORM-PETREL

	DEPTH(m)	TEMP(C)
N OF CASES	14	5
MINIMUM	174.000	15.200
MAXIMUM	2700.000	16.900
RANGE	2526.000	1.700
MEAN	1130.214	16.100
VARIANCE	564283.104	0.610
STANDARD DEV	751.188	0.781
C.V.	0.665	0.049
MEDIAN	925.000	16.200

THE FOLLOWING RESULTS ARE FOR CASSIN'S AUKLET

	DEPTH(m)	TEMP(C)
N OF CASES	12	5
MINIMUM	540.000	15.300
MAXIMUM	1990.000	16.200
RANGE	1450.000	0.900
MEAN	1218.667	15.580
VARIANCE	154802.242	0.132
STANDARD DEV	393.449	0.363

C.V.	0.323	0.023
MEDIAN	1185.000	15.400

THE FOLLOWING RESULTS ARE FOR CALIFORNIA GULL

	DEPTH(m)	TEMP(C)
N OF CASES	22	7
MINIMUM	385.000	14.80
MAXIMUM	2650.000	16.80
RANGE	2265.000	2.00
MEAN	1117.818	16.04
VARIANCE	311990.442	0.56
STANDARD DEV	558.561	0.75
C.V.	0.500	0.04
MEDIAN	1075.000	16.20

THE FOLLOWING RESULTS ARE FOR NORTHERN FULMAR

	DEPTH(m)	TEMP(C)
N OF CASES	18	6
MINIMUM	279.000	15.200
MAXIMUM	2691.000	16.200
RANGE	2412.000	1.000
MEAN	1045.056	15.683
VARIANCE	267506.056	0.186
STANDARD DEV	517.210	0.431
C.V.	0.495	0.027
MEDIAN	1030.000	15.600

THE FOLLOWING RESULTS ARE FOR PINK-FOOTED SHEARWATER

	DEPTH(m)	TEMP(C)
N OF CASES	47	19
MINIMUM	135.000	15.000
MAXIMUM	2780.000	17.500
RANGE	2645.000	2.500
MEAN	1173.404	15.932
VARIANCE	393207.768	0.532
STANDARD DEV	627.063	0.730
C.V.	0.534	0.046
MEDIAN	1000.000	15.700

THE FOLLOWING RESULTS ARE FOR POMARINE JAEGER

	DEPTH(m)	TEMP(C)
N OF CASES	9	5
MINIMUM	690.000	15.000
MAXIMUM	2700.000	16.800
RANGE	2010.000	1.800

MEAN	1249.444	15.760
VARIANCE	331602.778	0.548
STANDARD DEV	575.850	0.740
C.V.	0.461	0.047
MEDIAN	1200.000	15.600

THE FOLLOWING RESULTS ARE FOR RED PHALAROPE

	DEPTH(m)	TEMP(C)
N OF CASES	10	6
MINIMUM	690.000	15.400
MAXIMUM	1920.000	16.900
RANGE	1230.000	1.500
MEAN	1198.300	16.083
VARIANCE	200398.456	0.238
STANDARD DEV	447.659	0.488
C.V.	0.374	0.030
MEDIAN	1145.000	16.050

THE FOLLOWING RESULTS ARE FOR RHINOCEROS AUKLET

	DEPTH(m)	TEMP(C)
N OF CASES	7	3
MINIMUM	500.000	15.200
MAXIMUM	1070.000	15.400
RANGE	570.000	0.200
MEAN	785.286	15.267
VARIANCE	53948.905	0.013
STANDARD DEV	232.269	0.115
C.V.	0.296	0.008
MEDIAN	872.000	15.200

THE FOLLOWING RESULTS ARE FOR RED-NECKED PHALAROPE

	DEPTH(m)	TEMP(C)
N OF CASES	6	NO DATA
MINIMUM	545.000	
MAXIMUM	1089.000	
RANGE	544.000	
MEAN	757.333	
VARIANCE	39694.667	
STANDARD DEV	199.235	
C.V.	0.263	
MEDIAN	715.000	

THE FOLLOWING RESULTS ARE FOR SOOTY SHEARWATER

	DEPTH(m)	TEMP(C)
N OF CASES	45	17
MINIMUM	160.000	15.000

MAXIMUM	2966.000	17.500
RANGE	2806.000	2.500
MEAN	1281.067	15.912
VARIANCE	466323.336	0.540
STANDARD DEV	682.879	0.735
C.V.	0.533	0.046
MEDIAN	1060.000	15.600

THE FOLLOWING RESULTS ARE FOR WESTERN GULL

	DEPTH(m)	TEMP(C)
N OF CASES	36	13
MINIMUM	135.000	15.000
MAXIMUM	2140.000	17.500
RANGE	2005.000	2.500
MEAN	1003.472	15.877
VARIANCE	277835.856	0.549
STANDARD DEV	527.101	0.741
C.V.	0.525	0.047
MEDIAN	920.000	15.600

CRUISE NUMBER 2

THE FOLLOWING RESULTS ARE FOR BLACK-FOOTED ALBATROSS

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	11	11	11	11
MINIMUM	90.000	11.600	12.780	33.100
MAXIMUM	3500.000	12.500	94.450	33.200
RANGE	3410.000	0.900	81.670	0.100
MEAN	1826.364	12.327	57.445	33.118
STANDARD DEV	1283.606	0.272	25.030	0.040
C.V.	0.703	0.022	0.436	0.001
MEDIAN	2000.000	12.400	62.040	33.100

THE FOLLOWING RESULTS ARE FOR BLACK-LEGGED KITTIWAKE

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	28	28	30	30
MINIMUM	75.000	11.200	12.780	32.900
MAXIMUM	3500.000	13.300	94.450	33.200
RANGE	3425.000	2.100	81.670	0.300
MEAN	1159.143	12.243	48.572	33.127
STANDARD DEV	1173.081	0.485	28.163	0.083
C.V.	1.012	0.040	0.580	0.002
MEDIAN	775.000	12.400	48.150	33.100

THE FOLLOWING RESULTS ARE FOR CASSIN'S AUKLET

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	22	22	24	24
MINIMUM	85.000	11.200	8.700	32.900
MAXIMUM	2600.000	13.300	77.780	33.200
RANGE	2515.000	2.100	69.080	0.300
MEAN	759.591	12.141	39.340	33.129
STANDARD DEV	855.261	0.555	24.535	0.091
C.V.	1.126	0.046	0.624	0.003
MEDIAN	125.000	12.300	31.110	33.150

THE FOLLOWING RESULTS ARE FOR CALIFORNIA GULL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	23	23	23	23
MINIMUM	75.000	11.200	12.780	32.900
MAXIMUM	3500.000	13.300	94.450	33.200
RANGE	3425.000	2.100	81.670	0.300
MEAN	1326.783	12.335	55.077	33.130
STANDARD DEV	1195.059	0.439	28.393	0.093
C.V.	0.901	0.036	0.516	0.003
MEDIAN	1100.000	12.500	64.820	33.200

THE FOLLOWING RESULTS ARE FOR COMMON MURRE

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	14	14	16	16
MINIMUM	60.000	11.200	8.700	32.900
MAXIMUM	300.000	13.300	42.230	33.200
RANGE	240.000	2.100	33.530	0.300
MEAN	109.714	11.900	21.356	33.106
STANDARD DEV	57.261	0.568	9.168	0.100
C.V.	0.522	0.048	0.429	0.003
MEDIAN	100.000	11.800	17.315	33.100

THE FOLLOWING RESULTS ARE FOR GLAUCOUS-WINGED GULL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	12	12	14	14
MINIMUM	85.000	11.200	14.820	33.000
MAXIMUM	2800.000	12.600	64.820	33.200
RANGE	2715.000	1.400	50.000	0.200
MEAN	1110.417	12.008	36.154	33.150
STANDARD DEV	1077.013	0.489	19.454	0.065
C.V.	0.970	0.041	0.538	0.002
MEDIAN	960.000	12.000	29.630	33.200

THE FOLLOWING RESULTS ARE FOR HERRING GULL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	30	30	32	32
MINIMUM	90.000	11.200	8.700	32.900
MAXIMUM	3500.000	12.600	94.450	33.200
RANGE	3410.000	1.400	85.750	0.300
MEAN	1213.000	12.190	47.133	33.134
STANDARD DEV	1116.201	0.446	25.157	0.079
C.V.	0.920	0.037	0.534	0.002
MEDIAN	1050.000	12.350	47.225	33.100

THE FOLLOWING RESULTS ARE FOR NORTHERN FULMAR

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	25	25	25	25
MINIMUM	60.000	11.600	12.780	32.900
MAXIMUM	3500.000	12.600	94.450	33.200
RANGE	3440.000	1.000	81.670	0.300
MEAN	1722.800	12.356	60.397	33.132
STANDARD DEV	1114.490	0.280	23.589	0.069
C.V.	0.647	0.023	0.391	0.002
MEDIAN	2000.000	12.500	64.820	33.100

THE FOLLOWING RESULTS ARE FOR POMARINE JAEGER

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	3	3	3	3
MINIMUM	130.000	12.300	35.930	33.100
MAXIMUM	1600.000	12.600	74.080	33.200
RANGE	1470.000	0.300	38.150	0.100
MEAN	776.667	12.433	52.720	33.133
STANDARD DEV	750.755	0.153	19.481	0.058
C.V.	0.967	0.012	0.370	0.002
MEDIAN	600.000	12.400	48.150	33.100

THE FOLLOWING RESULTS ARE FOR RHINOCEROS AUKLET

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	32	32	34	34
MINIMUM	60.000	11.200	8.700	32.900
MAXIMUM	3000.000	13.300	92.600	33.200
RANGE	2940.000	2.100	83.900	0.300
MEAN	799.875	12.169	41.266	33.124
STANDARD DEV	893.932	0.495	23.859	0.089
C.V.	1.118	0.041	0.578	0.003
MEDIAN	215.000	12.300	33.705	33.100

THE FOLLOWING RESULTS ARE FOR SOOTY SHEARWATER

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	3	3	3	3
MINIMUM	100.000	11.600	25.930	33.100
MAXIMUM	100.000	11.800	27.780	33.100
RANGE	0.000	0.200	1.850	0.000
MEAN	100.000	11.733	26.547	33.100
STANDARD DEV	0.000	0.115	1.068	0.000
C.V.	0.000	0.010	0.040	0.000
MEDIAN	100.000	11.800	25.930	33.100

THE FOLLOWING RESULTS ARE FOR WESTERN GULL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	19	19	19	19
MINIMUM	60.000	11.200	8.700	32.900
MAXIMUM	2000.000	13.300	64.820	33.200
RANGE	1940.000	2.100	56.120	0.300
MEAN	444.000	12.032	29.271	33.084
STANDARD DEV	695.851	0.502	14.197	0.096
C.V.	1.567	0.042	0.485	0.003
MEDIAN	100.000	12.100	27.780	33.100

CRUISE 3

THE FOLLOWING RESULTS ARE FOR ASHY STORM-PETREL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	6	6	6
MINIMUM	108.000	9.300	33.200
MAXIMUM	2430.000	10.900	33.800
RANGE	2322.000	1.600	0.600
MEAN	1096.333	10.200	33.450
STANDARD DEV	839.438	0.716	0.243
C.V.	0.766	0.070	0.007
MEDIAN	1090.000	10.400	33.350

THE FOLLOWING RESULTS ARE FOR BLACK-FOOTED ALBATROSS

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	33	33	32
MINIMUM	86.000	9.200	32.900
MAXIMUM	3300.000	12.100	33.800
RANGE	3214.000	2.190	0.900
MEAN	1308.424	10.181	33.397
STANDARD DEV	1114.481	0.084	0.271
C.V.	0.852	9.700	0.008
MEDIAN	800.000	9.700	33.400

THE FOLLOWING RESULTS ARE FOR BRANDT'S CORMORANT

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	4	4	4
MINIMUM	55.000	9.700	33.100
MAXIMUM	60.000	9.800	33.800
RANGE	5.000	0.100	0.700
MEAN	56.250	9.750	33.600
STANDARD DEV	2.500	0.058	0.337
C.V.	0.044	0.006	0.010
MEDIAN	55.000	9.750	33.750

THE FOLLOWING RESULTS ARE FOR CASSIN'S AUKLET

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	13	13	13
MINIMUM	55.000	9.200	33.100
MAXIMUM	1400.000	10.700	33.900
RANGE	1345.000	1.500	0.800
MEAN	398.923	9.746	33.585
STANDARD DEV	453.784	0.407	0.248
C.V.	1.138	0.042	0.007
MEDIAN	145.000	9.700	33.700

THE FOLLOWING RESULTS ARE FOR COMMON MURRE

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	13	13	13
MINIMUM	55.000	9.200	33.100
MAXIMUM	560.000	9.800	33.900
RANGE	505.000	0.600	0.800
MEAN	119.385	9.585	33.708
STANDARD DEV	135.217	0.212	0.214
C.V.	1.133	0.022	0.006
MEDIAN	79.000	9.700	33.800

THE FOLLOWING RESULTS ARE FOR MURPHY'S PETREL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	14	13	13
MINIMUM	620.000	9.500	32.900
MAXIMUM	3300.000	12.200	33.500
RANGE	2680.000	2.700	0.600
MEAN	2084.500	10.854	33.162
STANDARD DEV	1048.937	0.952	0.206
C.V.	0.503	0.088	0.006
MEDIAN	2200.000	10.900	33.100

THE FOLLOWING RESULTS ARE FOR NORTHERN FULMAR

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	15	15	15
MINIMUM	98.000	9.200	33.100
MAXIMUM	2743.000	12.200	33.800
RANGE	2645.000	3.000	0.700
MEAN	1126.733	9.907	33.533
STANDARD DEV	965.686	0.815	0.241
C.V.	0.857	0.082	0.007
MEDIAN	640.000	9.600	33.500

THE FOLLOWING RESULTS ARE FOR PINK-FOOTED SHEARWATER

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	4	4	4
MINIMUM	145.000	9.500	33.400
MAXIMUM	1280.000	9.700	33.700
RANGE	1135.000	0.200	0.300
MEAN	679.250	9.575	33.525
STANDARD DEV	470.222	0.096	0.126
C.V.	0.692	0.010	0.004
MEDIAN	646.000	9.550	33.500

THE FOLLOWING RESULTS ARE FOR PIGEON GUILLEMOT

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	3	3	3
MINIMUM	74.000	9.200	33.800
MAXIMUM	80.000	9.800	33.900
RANGE	6.000	0.600	0.100
MEAN	77.667	9.433	33.833
STANDARD DEV	3.215	0.321	0.058
C.V.	0.041	0.034	0.002
MEDIAN	79.000	9.300	33.800

THE FOLLOWING RESULTS ARE FOR RED PHALAROPE

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	16	16	16
MINIMUM	74.000	9.200	33.200
MAXIMUM	3100.000	10.900	33.900
RANGE	3026.000	1.700	0.700
MEAN	919.625	9.725	33.588
STANDARD DEV	961.836	0.552	0.236
C.V.	1.046	0.057	0.007
MEDIAN	605.500	9.500	33.700

THE FOLLOWING RESULTS ARE FOR RHINOCEROS AUKLET

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	17	17	17
MINIMUM	55.000	9.200	32.900
MAXIMUM	3300.000	11.200	33.900
RANGE	3245.000	2.000	1.000
MEAN	877.588	9.829	33.518
STANDARD DEV	1159.871	0.498	0.277
C.V.	1.322	0.051	0.008
MEDIAN	420.000	9.800	33.500

THE FOLLOWING RESULTS ARE FOR RED-NECKED PHALAROPE

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	15	15	15
MINIMUM	55.000	9.200	32.900
MAXIMUM	3200.000	11.200	33.900
RANGE	3145.000	2.000	1.000
MEAN	409.667	9.713	33.653
STANDARD DEV	835.977	0.467	0.253
C.V.	2.041	0.048	0.008
MEDIAN	103.000	9.700	33.800

THE FOLLOWING RESULTS ARE FOR SABINE'S GULL

	DEPTH(m)	TEMP(C)	SALINITY

N OF CASES	9	9	9
MINIMUM	108.000	9.400	33.000
MAXIMUM	2800.000	10.800	33.800
RANGE	2692.000	1.400	0.800
MEAN	1014.778	10.033	33.478
STANDARD DEV	1048.996	0.608	0.282
C.V.	1.034	0.061	0.008
MEDIAN	780.000	9.700	33.500

THE FOLLOWING RESULTS ARE FOR SOOTY SHEARWATER

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	50	48	48
MINIMUM	55.000	9.200	32.900
MAXIMUM	3300.000	12.200	33.800
RANGE	3245.000	3.000	0.900
MEAN	1037.440	10.198	33.435
STANDARD DEV	1016.143	0.889	0.277
C.V.	0.979	0.087	0.008
MEDIAN	670.000	9.800	33.450

THE FOLLOWING RESULTS ARE FOR WESTERN GULL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	49	48	48
MINIMUM	55.000	9.200	32.900
MAXIMUM	3200.000	12.200	33.900
RANGE	3145.000	3.000	1.000
MEAN	646.082	9.967	33.531
STANDARD DEV	792.605	0.727	0.260
C.V.	1.227	0.073	0.008
MEDIAN	420.000	9.700	33.500

CRUISE NUMBER 4

THE FOLLOWING RESULTS ARE FOR ARCTIC TERN

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	9	9	9	9
MINIMUM	106.000	15.100	24.080	33.180
MAXIMUM	3500.000	15.700	55.560	33.420
RANGE	3394.000	0.600	31.480	0.240
MEAN	1649.333	15.344	37.698	33.312
STANDARD DEV	1153.863	0.224	11.860	0.087
C.V.	0.700	0.015	0.315	0.003
MEDIAN	1557.000	15.300	34.630	33.280

THE FOLLOWING RESULTS ARE FOR ASHY STORM-PETREL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	13	13	13	13
MINIMUM	130.000	14.500	24.080	33.260
MAXIMUM	2026.000	15.400	55.370	33.450
RANGE	1896.000	0.900	31.290	0.190
MEAN	802.154	15.077	37.809	33.352
STANDARD DEV	522.257	0.298	9.790	0.061
C.V.	0.651	0.020	0.259	0.002
MEDIAN	662.000	15.100	35.560	33.340

THE FOLLOWING RESULTS ARE FOR BLACK-FOOTED ALBATROSS

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	19	19	19	19
MINIMUM	97.000	14.200	15.370	33.050
MAXIMUM	3500.000	15.700	61.860	33.450
RANGE	3403.000	1.500	46.490	0.400
MEAN	1335.053	15.200	35.811	33.322
STANDARD DEV	1146.951	0.389	12.163	0.088
C.V.	0.859	0.026	0.340	0.003
MEDIAN	990.000	15.300	35.560	33.310

THE FOLLOWING RESULTS ARE FOR BRANDT'S CORMORANT

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	21	21	21	21
MINIMUM	37.000	13.900	4.630	33.240
MAXIMUM	3500.000	16.300	45.370	33.410
RANGE	3463.000	2.400	40.740	0.170
MEAN	339.381	15.019	15.601	33.331
STANDARD DEV	895.167	0.619	10.993	0.051
C.V.	2.638	0.041	0.705	0.002
MEDIAN	61.000	14.900	14.080	33.330

THE FOLLOWING RESULTS ARE FOR BROWN PELICAN

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	11	11	11	11
MINIMUM	44.000	14.800	10.000	33.280
MAXIMUM	2000.000	15.800	32.220	33.410
RANGE	1956.000	1.000	22.220	0.130
MEAN	495.364	15.282	22.139	33.345
STANDARD DEV	766.453	0.306	6.274	0.051
C.V.	1.547	0.020	0.283	0.002
MEDIAN	80.000	15.400	22.220	33.320

THE FOLLOWING RESULTS ARE FOR CASSIN'S AUKLET

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	27	27	27	27
MINIMUM	55.000	14.100	0.000	33.250
MAXIMUM	2410.000	15.500	52.600	33.450
RANGE	2355.000	1.400	52.600	0.200
MEAN	671.926	15.067	24.975	33.315
STANDARD DEV	745.374	0.445	12.739	0.052
C.V.	1.109	0.030	0.510	0.002
MEDIAN	347.000	15.300	25.370	33.290

THE FOLLOWING RESULTS ARE FOR CALIFORNIA GULL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	5	5	5	5
MINIMUM	41.000	14.900	12.590	33.290
MAXIMUM	2150.000	15.300	37.040	33.430
RANGE	2109.000	0.400	24.450	0.140
MEAN	928.400	15.060	26.410	33.352
STANDARD DEV	892.968	0.152	12.009	0.068
C.V.	0.962	0.010	0.455	0.002
MEDIAN	1072.000	15.000	33.710	33.320

THE FOLLOWING RESULTS ARE FOR COMMON MURRE

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	32	32	32	32
MINIMUM	29.000	13.900	0.000	33.240
MAXIMUM	146.000	16.300	25.370	33.450
RANGE	117.000	2.400	25.370	0.210
MEAN	70.375	14.956	13.896	33.330
STANDARD DEV	29.158	0.541	6.814	0.054
C.V.	0.414	0.036	0.490	0.002
MEDIAN	61.500	14.950	13.335	33.325

THE FOLLOWING RESULTS ARE FOR LEACH'S STORM-PETREL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	4	4	4	4
MINIMUM	2000.000	15.000	40.000	33.170
MAXIMUM	3010.000	15.600	64.450	33.310
RANGE	1010.000	0.600	24.450	0.140
MEAN	2374.000	15.375	50.930	33.270
STANDARD DEV	477.987	0.263	11.193	0.067
C.V.	0.201	0.017	0.220	0.002
MEDIAN	2243.000	15.450	49.635	33.300

THE FOLLOWING RESULTS ARE FOR NORTHERN FULMAR

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	4	4	4	4
MINIMUM	80.000	14.900	20.000	33.280
MAXIMUM	1050.000	15.400	25.370	33.290
RANGE	970.000	0.500	5.370	0.010
MEAN	342.500	15.275	22.778	33.283
STANDARD DEV	472.182	0.250	2.997	0.005
C.V.	1.379	0.016	0.132	0.000
MEDIAN	120.000	15.400	22.870	33.280

THE FOLLOWING RESULTS ARE FOR PINK-FOOTED SHEARWATER

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	23	23	23	23
MINIMUM	48.000	13.900	0.000	33.230
MAXIMUM	2864.000	15.800	64.450	33.440
RANGE	2816.000	1.900	64.450	0.210
MEAN	700.565	15.113	29.181	33.315
STANDARD DEV	882.727	0.520	14.560	0.051
C.V.	1.260	0.034	0.499	0.002
MEDIAN	347.000	15.300	24.630	33.300

THE FOLLOWING RESULTS ARE FOR RED PHALAROPE

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	7	7	7	7
MINIMUM	55.000	14.100	8.890	33.290
MAXIMUM	2612.000	15.400	52.600	33.450
RANGE	2557.000	1.300	43.710	0.160
MEAN	863.714	14.929	30.584	33.363
STANDARD DEV	1079.455	0.464	16.236	0.066
C.V.	1.250	0.031	0.531	0.002
MEDIAN	400.000	14.900	29.630	33.330

THE FOLLOWING RESULTS ARE FOR RHINOCEROS AUKLET

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY

N OF CASES.	21	21	21	21
MINIMUM	55.000	14.100	4.630	33.250
MAXIMUM	2864.000	15.700	45.000	33.460
RANGE	2809.000	1.600	40.370	0.210
MEAN	965.905	15.181	25.240	33.330
STANDARD DEV	1009.142	0.446	11.257	0.061
C.V.	1.045	0.029	0.446	0.002
MEDIAN	211.000	15.300	25.370	33.320

THE FOLLOWING RESULTS ARE FOR RED-NECKED PHALAROPE

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	18	18	18	18
MINIMUM	45.000	13.900	0.000	33.250
MAXIMUM	1089.000	16.300	45.000	33.460
RANGE	1044.000	2.400	45.000	0.210
MEAN	170.556	14.906	16.009	33.334
STANDARD DEV	286.299	0.605	11.892	0.058
C.V.	1.679	0.041	0.743	0.002
MEDIAN	70.000	14.850	13.795	33.330

THE FOLLOWING RESULTS ARE FOR SOOTY SHEARWATER

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	57	57	57	57
MINIMUM	44.000	14.100	0.000	33.120
MAXIMUM	3500.000	15.800	64.450	33.460
RANGE	3456.000	1.700	64.450	0.340
MEAN	975.228	15.170	30.356	33.327
STANDARD DEV	1112.529	0.430	15.798	0.073
C.V.	1.141	0.028	0.520	0.002
MEDIAN	375.000	15.300	27.040	33.310

THE FOLLOWING RESULTS ARE FOR WESTERN GULL

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	76	76	76	76
MINIMUM	29.000	13.900	0.000	33.050
MAXIMUM	3500.000	16.300	61.860	33.500
RANGE	3471.000	2.400	61.860	0.450
MEAN	641.066	15.093	25.972	33.331
STANDARD DEV	879.349	0.448	15.046	0.072
C.V.	1.372	0.030	0.579	0.002
MEDIAN	106.500	15.100	23.710	33.320

THE FOLLOWING RESULTS ARE FOR XANTUS' MURRELET

	DEPTH(m)	TEMP(C)	LAND(km)	SALINITY
N OF CASES	6	6	6	6
MINIMUM	347.000	15.000	22.780	33.230

MAXIMUM	3400.000	15.700	55.560	33.500
RANGE	3053.000	0.700	32.780	0.270
MEAN	1640.833	15.483	41.423	33.317
STANDARD DEV	1213.167	0.264	14.177	0.096
C.V.	0.739	0.017	0.342	0.003
MEDIAN	1338.000	15.550	46.855	33.300

CRUISE NUMBER 5

THE FOLLOWING RESULTS ARE FOR BLACK-FOOTED ALBATROSS

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	4	4	4
MINIMUM	626.000	12.600	33.200
MAXIMUM	3330.000	13.300	33.400
RANGE	2704.000	0.700	0.200
MEAN	1740.500	12.975	33.300
STANDARD DEV	1148.775	0.330	0.082
C.V.	0.660	0.025	0.002
MEDIAN	1503.000	13.000	33.300

THE FOLLOWING RESULTS ARE FOR BONAPARTE'S GULL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	6	6	6
MINIMUM	94.000	12.400	33.300
MAXIMUM	2650.000	13.500	33.400
RANGE	2556.000	1.100	0.100
MEAN	1344.833	12.900	33.317
STANDARD DEV	975.015	0.400	0.041
C.V.	0.725	0.031	0.001
MEDIAN	1252.000	12.850	33.300

THE FOLLOWING RESULTS ARE FOR BROWN PELICAN

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	7	7	7
MINIMUM	53.000	12.000	33.200
MAXIMUM	3475.000	13.200	33.400
RANGE	3422.000	1.200	0.200
MEAN	965.857	12.686	33.329
STANDARD DEV	1269.215	0.426	0.076
C.V.	1.314	0.034	0.002
MEDIAN	314.000	12.600	33.300

THE FOLLOWING RESULTS ARE FOR CASSIN'S AUKLET

	DEPTH(m)	TEMP(C)	SALINITY

N OF CASES	28	28	28
MINIMUM	35.000	12.000	33.200
MAXIMUM	3330.000	13.600	33.400
RANGE	3295.000	1.600	0.200
MEAN	829.214	12.839	33.314
STANDARD DEV	869.847	0.438	0.065
C.V.	1.049	0.034	0.002
MEDIAN	595.500	12.800	33.300

THE FOLLOWING RESULTS ARE FOR CALIFORNIA GULL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	51	51	51
MINIMUM	45.000	12.000	33.200
MAXIMUM	3475.000	13.800	33.400
RANGE	3430.000	1.800	0.200
MEAN	1050.882	13.018	33.310
STANDARD DEV	936.044	0.403	0.057
C.V.	0.891	0.031	0.002
MEDIAN	772.000	13.000	33.300

THE FOLLOWING RESULTS ARE FOR COMMON MURRE

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	13	13	13
MINIMUM	35.000	11.300	33.200
MAXIMUM	426.000	13.100	33.400
RANGE	391.000	1.800	0.200
MEAN	140.154	12.377	33.323
STANDARD DEV	135.479	0.478	0.073
C.V.	0.967	0.039	0.002
MEDIAN	78.000	12.300	33.300

THE FOLLOWING RESULTS ARE FOR GLAUCOUS-WINGED GULL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	9	9	9
MINIMUM	78.000	12.300	33.200
MAXIMUM	2012.000	13.700	33.400
RANGE	1934.000	1.400	0.200
MEAN	558.444	12.967	33.333
STANDARD DEV	627.623	0.409	0.071
C.V.	1.124	0.032	0.002
MEDIAN	290.000	13.000	33.300

THE FOLLOWING RESULTS ARE FOR HERRING GULL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	5	5	5
MINIMUM	180.000	12.800	33.300
MAXIMUM	596.000	13.300	33.400
RANGE	416.000	0.500	0.100
MEAN	338.800	13.080	33.320
STANDARD DEV	166.184	0.179	0.045
C.V.	0.491	0.014	0.001
MEDIAN	290.000	13.100	33.300

THE FOLLOWING RESULTS ARE FOR NORTHERN FULMAR

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	21	21	21
MINIMUM	180.000	12.600	33.200
MAXIMUM	3330.000	13.900	33.400
RANGE	3150.000	1.300	0.200
MEAN	1012.476	13.067	33.314
STANDARD DEV	868.913	0.314	0.057
C.V.	0.858	0.024	0.002
MEDIAN	765.000	13.000	33.300

THE FOLLOWING RESULTS ARE FOR PINK-FOOTED SHEARWATER

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	6	6	6
MINIMUM	170.000	12.600	33.200
MAXIMUM	1097.000	13.300	33.300
RANGE	927.000	0.700	0.100
MEAN	490.500	12.983	33.283
STANDARD DEV	357.469	0.248	0.041
C.V.	0.729	0.019	0.001
MEDIAN	412.000	13.050	33.300

THE FOLLOWING RESULTS ARE FOR RED PHALAROPE

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	19	19	19
MINIMUM	66.000	12.100	33.200
MAXIMUM	3330.000	13.800	33.400
RANGE	3264.000	1.700	0.200
MEAN	1052.211	13.037	33.300
STANDARD DEV	940.325	0.467	0.058
C.V.	0.894	0.036	0.002
MEDIAN	772.000	13.100	33.300

THE FOLLOWING RESULTS ARE FOR RHINOCEROS AUKLET

	DEPTH(m)	TEMP(C)	SALINITY

N OF CASES	27	27	27
MINIMUM	35.000	11.300	33.200
MAXIMUM	3330.000	13.800	33.400
RANGE	3295.000	2.500	0.200
MEAN	614.111	12.726	33.322
STANDARD DEV	808.066	0.519	0.058
C.V.	1.316	0.041	0.002
MEDIAN	234.000	12.800	33.300

THE FOLLOWING RESULTS ARE FOR RED-NECKED PHALAROPE

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	16	16	16
MINIMUM	35.000	11.300	33.300
MAXIMUM	1426.000	13.900	33.400
RANGE	1391.000	2.600	0.100
MEAN	455.750	12.719	33.344
STANDARD DEV	512.207	0.662	0.051
C.V.	1.124	0.052	0.002
MEDIAN	144.500	12.800	33.300

THE FOLLOWING RESULTS ARE FOR SOOTY SHEARWATER

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	16	16	16
MINIMUM	35.000	11.300	33.200
MAXIMUM	3330.000	13.500	33.400
RANGE	3295.000	2.200	0.200
MEAN	677.375	12.638	33.319
STANDARD DEV	992.085	0.533	0.075
C.V.	1.465	0.042	0.002
MEDIAN	218.000	12.750	33.300

THE FOLLOWING RESULTS ARE FOR WESTERN GULL

	DEPTH(m)	TEMP(C)	SALINITY
N OF CASES	46	46	46
MINIMUM	35.000	11.300	33.200
MAXIMUM	2962.000	13.800	33.400
RANGE	2927.000	2.500	0.200
MEAN	681.304	12.839	33.324
STANDARD DEV	764.163	0.503	0.057
C.V.	1.122	0.039	0.002
MEDIAN	339.500	12.800	33.300

DESCRIPTIVE STATISTICS FOR MARINE MAMMALS - ALL CRUISES COMBINED

THE FOLLOWING RESULTS ARE FOR BLUE WHALE

	DEPTH (M)	LAND (KM)	SALINITY	SEA TEMP (C)
N OF CASES	6	5	5	6
MINIMUM	88.000	22.780	33.260	14.920
MAXIMUM	1072.000	37.040	33.320	15.590
RANGE	984.000	14.260	0.060	0.670
MEAN	479.833	26.338	33.294	15.267
STANDARD DEV	463.512	6.006	0.023	0.225
C.V.	0.966	0.228	0.001	0.015
MEDIAN	279.000	24.080	33.290	15.290

THE FOLLOWING RESULTS ARE FOR CALIFORNIA SEA LION

	DEPTH (M)	LAND (KM)	SALINITY	SEA TEMP (C)
N OF CASES	45	21	21	39
MINIMUM	35.000	6.300	33.100	9.700
MAXIMUM	2962.000	72.230	33.440	16.900
RANGE	2927.000	65.930	0.340	7.200
MEAN	666.467	31.325	33.246	13.706
STANDARD DEV	744.767	13.653	0.104	1.634
C.V.	1.117	0.436	0.003	0.119
MEDIAN	385.000	28.710	33.280	13.200

THE FOLLOWING RESULTS ARE FOR DALL'S PORPOISE

	DEPTH (M)	LAND (KM)	SALINITY	SEA TEMP (C)
N OF CASES	24	5	5	17
MINIMUM	74.000	24.630	33.100	9.200
MAXIMUM	2218.000	82.040	33.400	17.500
RANGE	2144.000	57.410	0.300	8.300
MEAN	783.958	47.410	33.242	12.590
STANDARD DEV	719.919	24.845	0.115	2.740
C.V.	0.918	0.524	0.003	0.218
MEDIAN	715.000	35.930	33.200	12.500

THE FOLLOWING RESULTS ARE FOR HUMPBACK WHALE

	DEPTH (M)	LAND (KM)	SALINITY	SEA TEMP (C)
N OF CASES	12	8	8	11
MINIMUM	101.000	20.000	33.100	12.500
MAXIMUM	3500.000	94.450	33.300	17.500
RANGE	3399.000	74.450	0.200	5.000
MEAN	969.833	42.966	33.243	15.057
STANDARD DEV	1153.613	31.469	0.088	1.405
C.V.	1.189	0.732	0.003	0.093
MEDIAN	385.000	26.390	33.290	15.420

THE FOLLOWING RESULTS ARE FOR NORTHERN ELEPHANT SEAL

	DEPTH (M)
N OF CASES	4
MINIMUM	910.000
MAXIMUM	2090.000
RANGE	1180.000
MEAN	1430.500
STANDARD DEV	493.749
C.V.	0.345
MEDIAN	1361.000

THE FOLLOWING RESULTS ARE FOR NORTHERN FUR SEAL

	DEPTH (M)	LAND (KM)	SALINITY	SEA TEMP (C
N OF CASES	26	17	17	25
MINIMUM	466.000	32.220	33.100	10.200
MAXIMUM	3400.000	92.600	33.460	15.640
RANGE	2934.000	60.380	0.360	5.440
MEAN	1954.115	74.254	33.194	12.726
STANDARD DEV	1033.017	20.136	0.114	1.349
C.V.	0.529	0.271	0.003	0.106
MEDIAN	2000.000	82.040	33.200	12.500

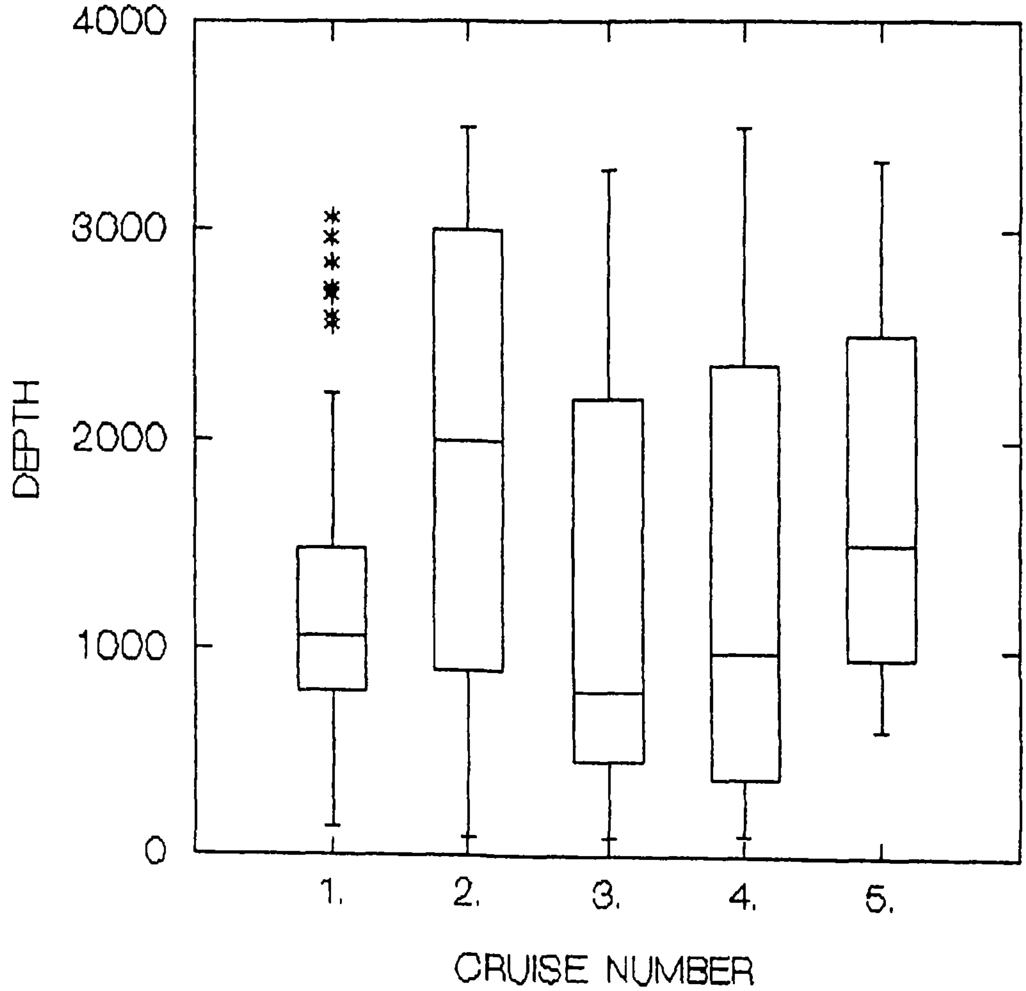
THE FOLLOWING RESULTS ARE FOR PACIFIC WHITE-SIDED DOLPHIN

	DEPTH (M)	LAND (KM)
N OF CASES	8	7
MINIMUM	290.000	9.200
MAXIMUM	3200.000	15.640
RANGE	2910.000	6.440
MEAN	1427.625	12.829
STANDARD DEV	993.915	2.286
C.V.	0.696	0.178
MEDIAN	1312.500	13.000

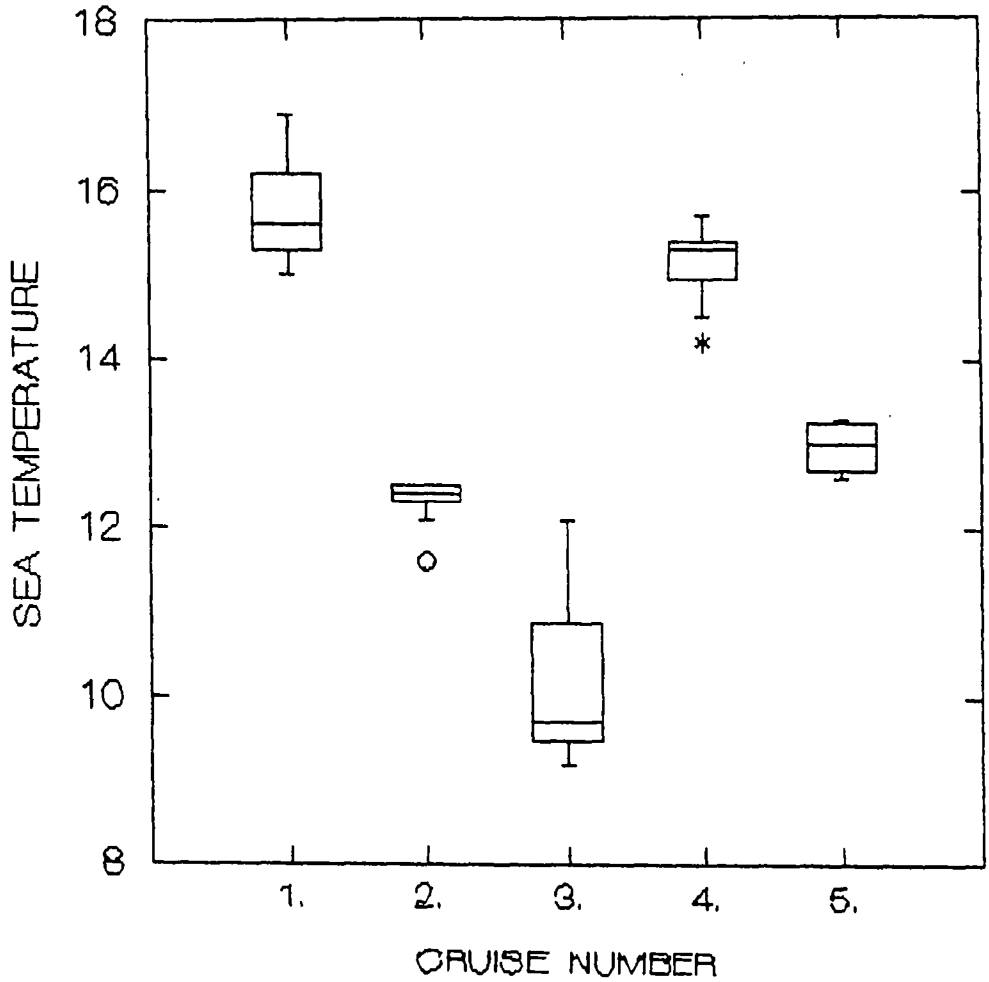
APPENDIX 3

Box plots for seabird and marine mammal species. The middle line in the box represents the **median**. The upper and lower lines on the rectangle are called the **upper** and **lower quartiles**, so that the entire box shows the **interquartile range** (central 50% of the values). The solid lines extend above and below the box from the upper and lower quartiles to the **adjacent values**. The **upper adjacent value** is defined as the largest observation that is less than or equal to the upper quartile plus 1.5 x the interquartile range. The lower adjacent value is defined as the smallest observation that is greater than or equal to the lower quartile minus 1.5 x the interquartile range (Chambers et al. 1983). These are representative of the tails of the distribution. An asterisk indicates a value outside of the adjacent values. In addition to showing the median and range of values, the box plot gives a visual indication of the symmetry (or asymmetry) of the data. See Methods in Ainley and Allen (1992) for additional details.

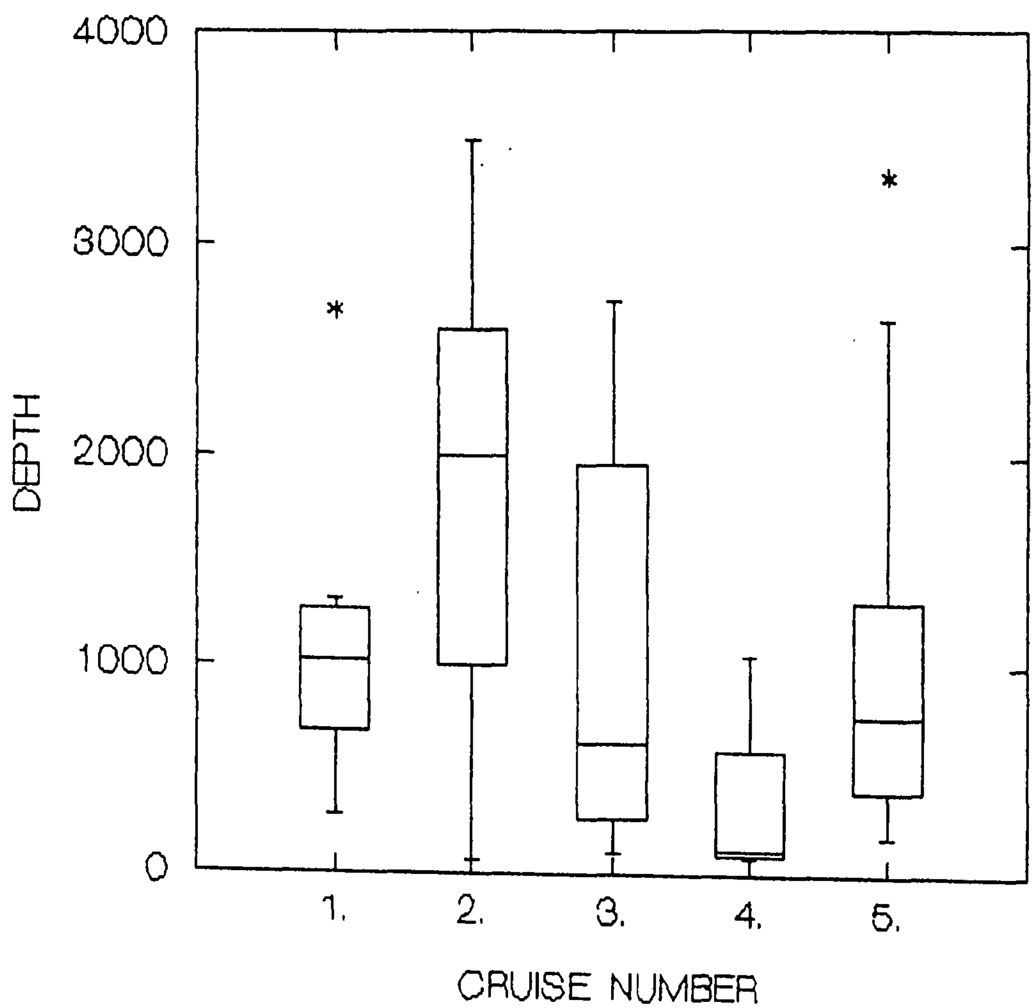
BLACK-FOOTED ALBATROSS

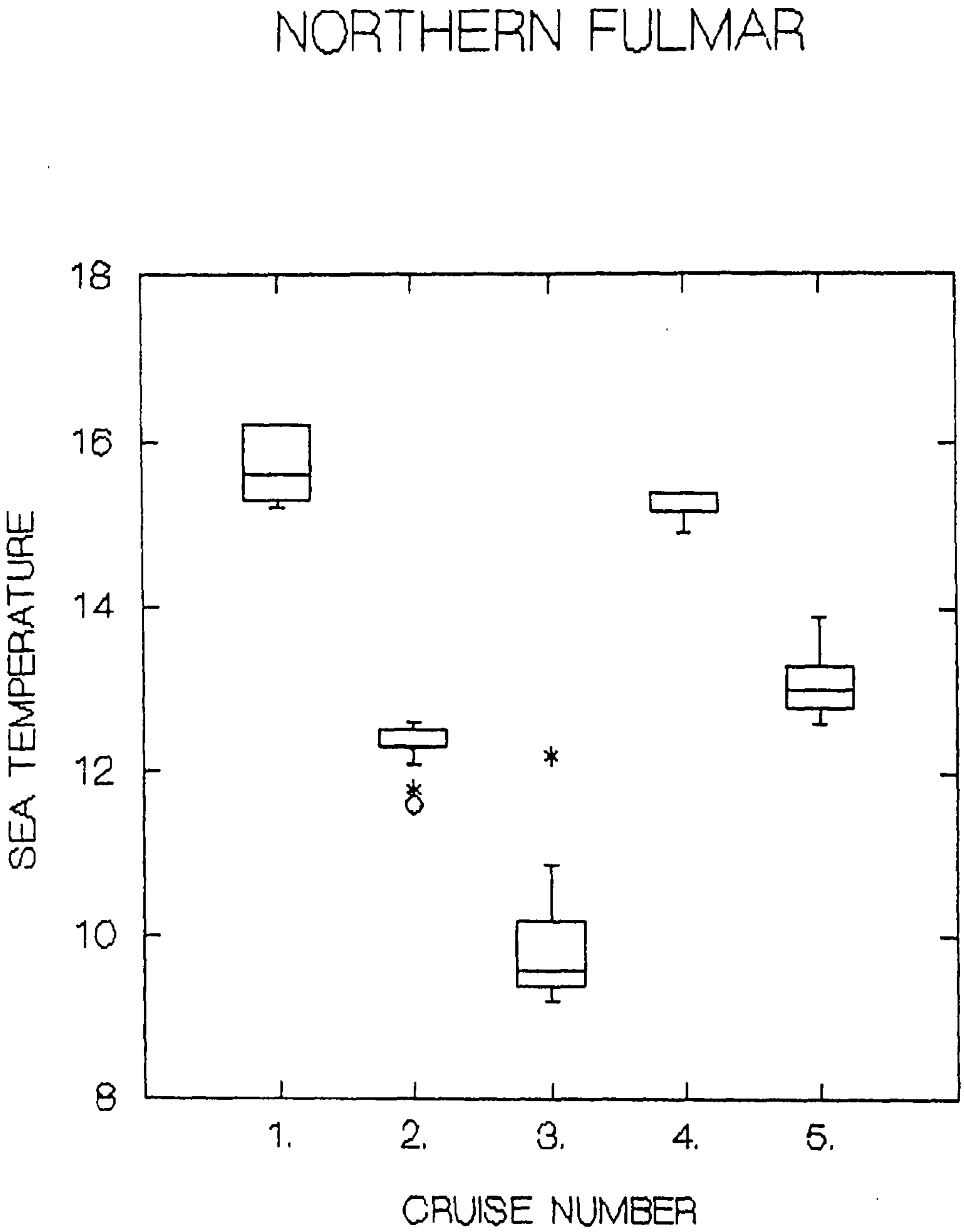


BLACK-FOOTED ALBATROSS

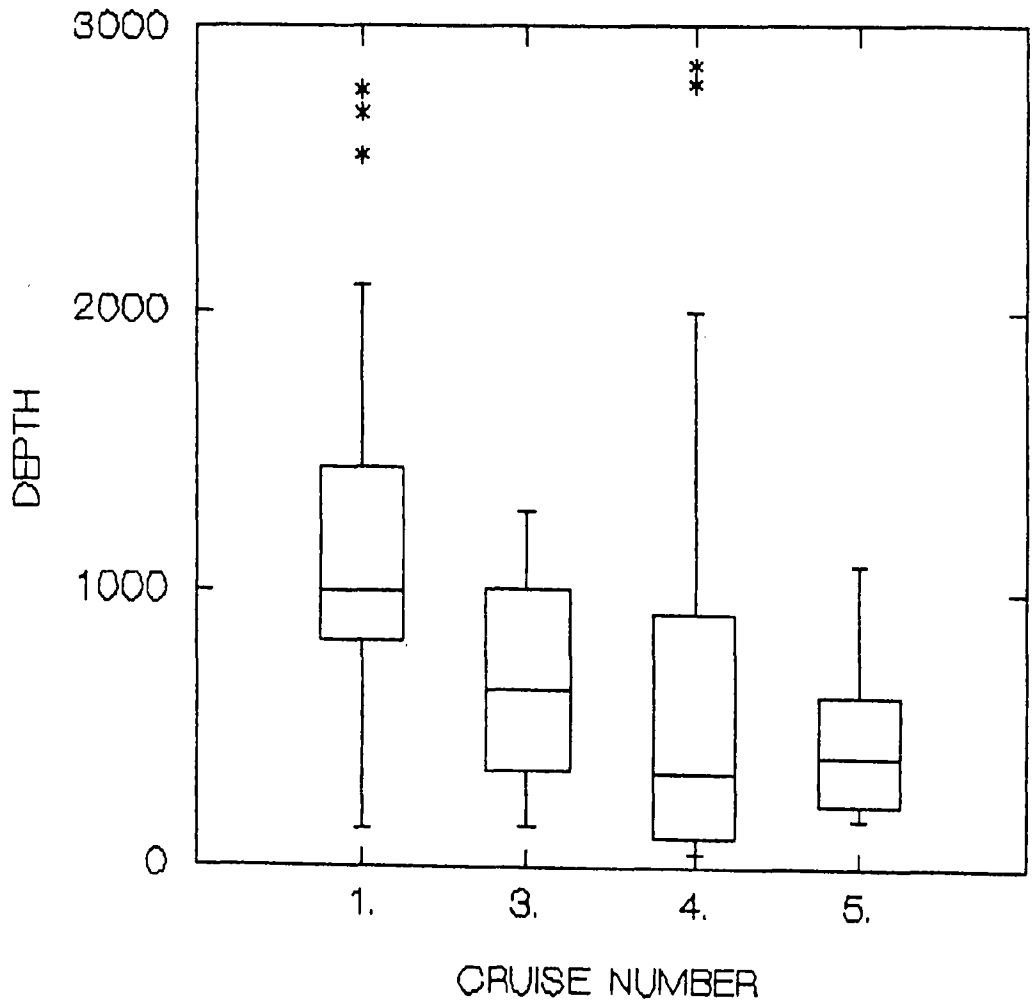


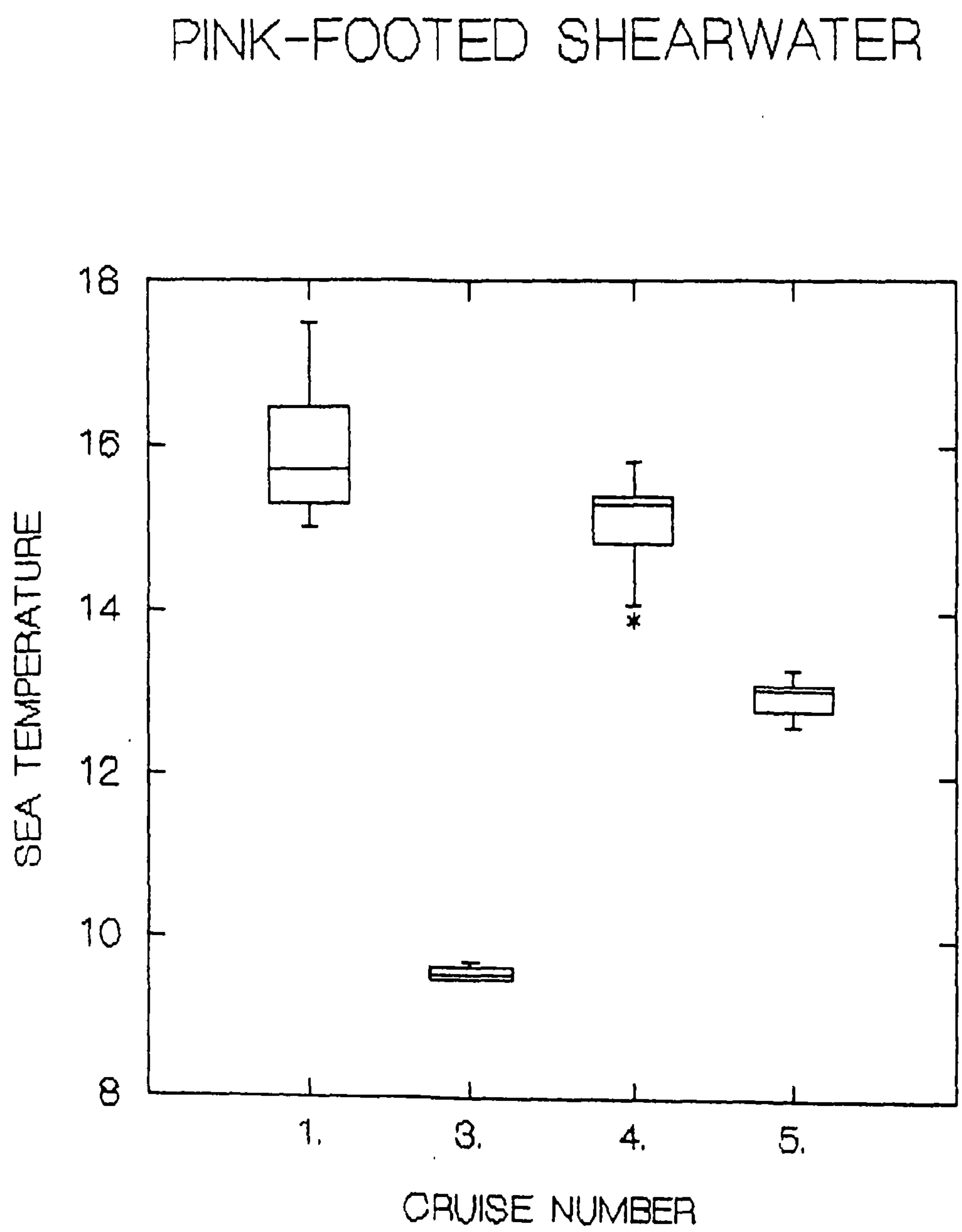
NORTHERN FULMAR



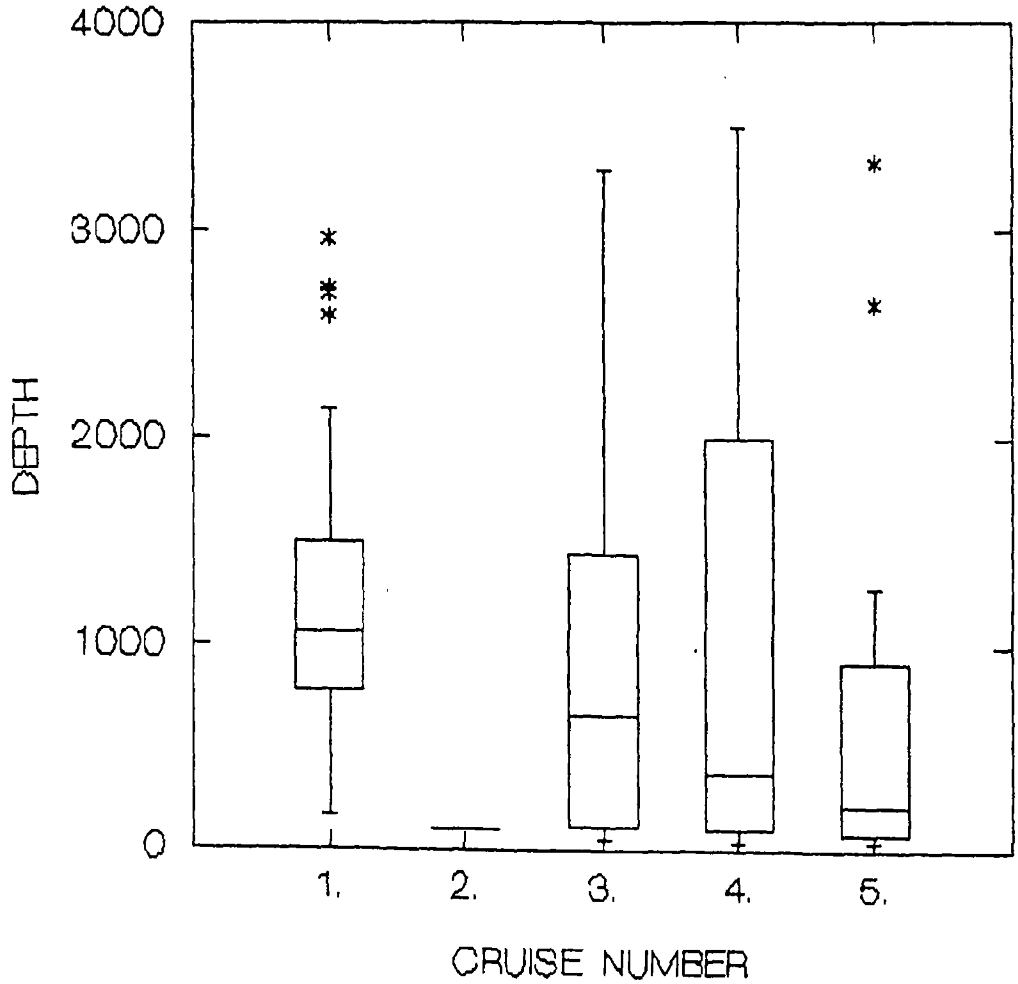

NORTHERN FULMAR
SEA TEMPERATURE
18
16
14
12
10
8
1.
2.
3.
4.
5.
CRUISE NUMBER

PINK-FOOTED SHEARWATER

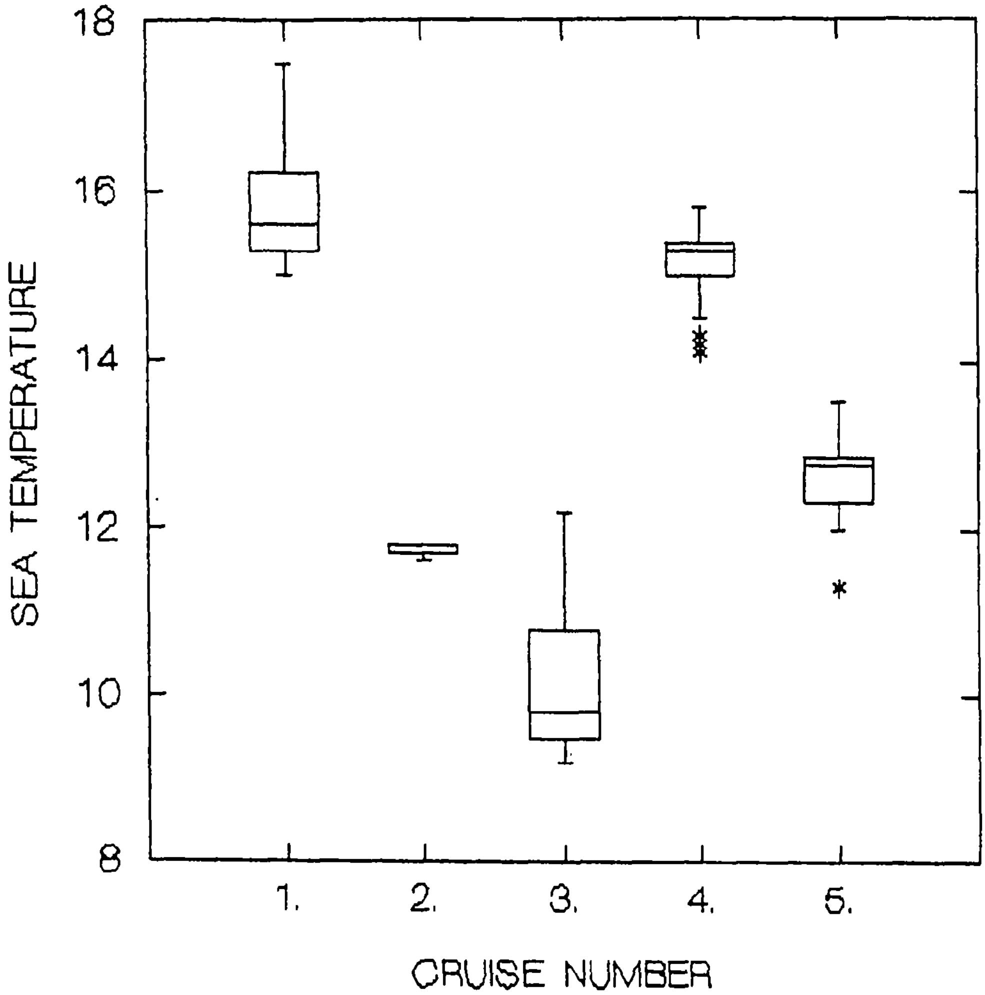


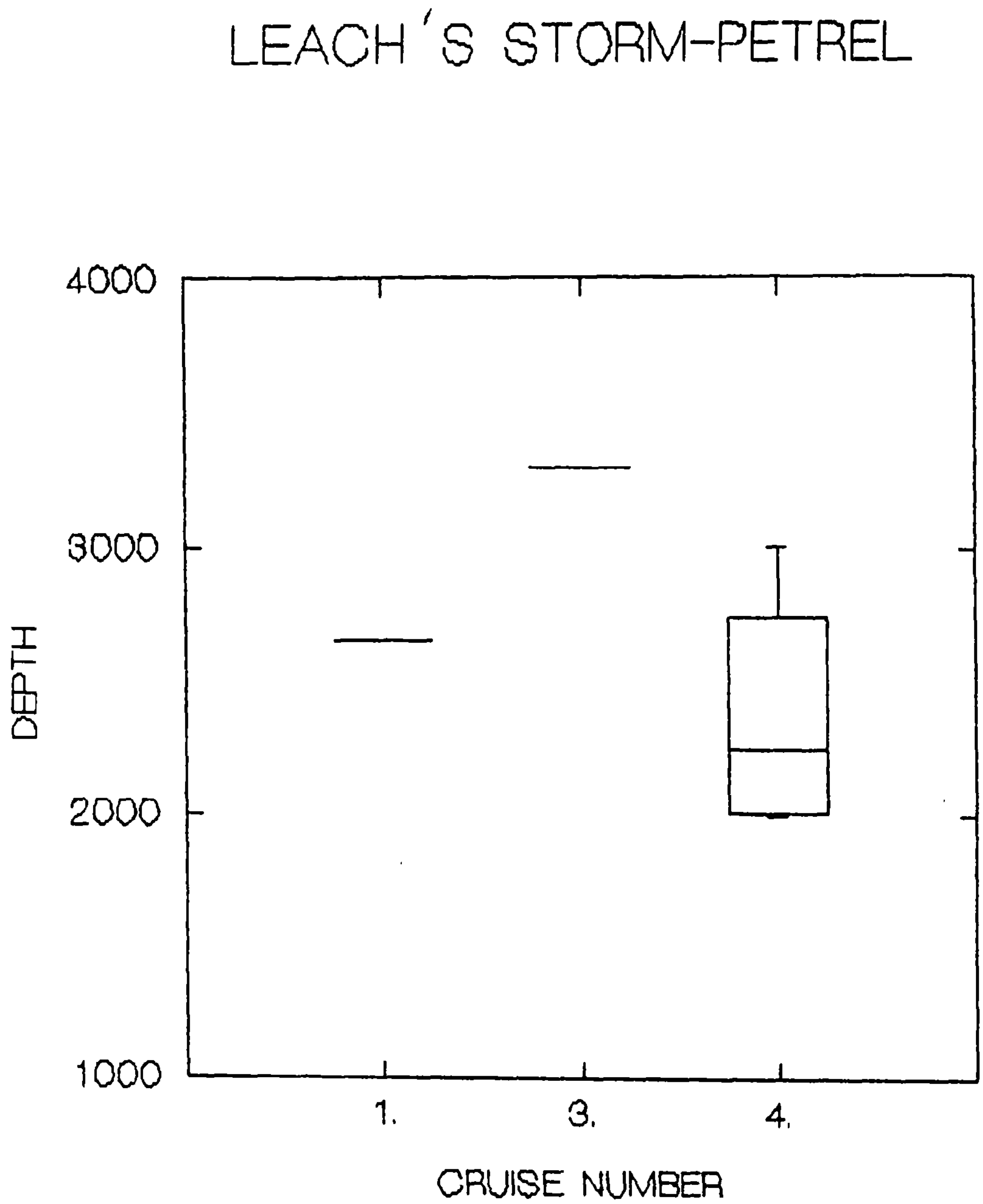

PINK-FOOTED SHEARWATER
SEA TEMPERATURE
18
16
14
12
10
8
1.
3.
4.
5.
CRUISE NUMBER

SOOTY SHEARWATER



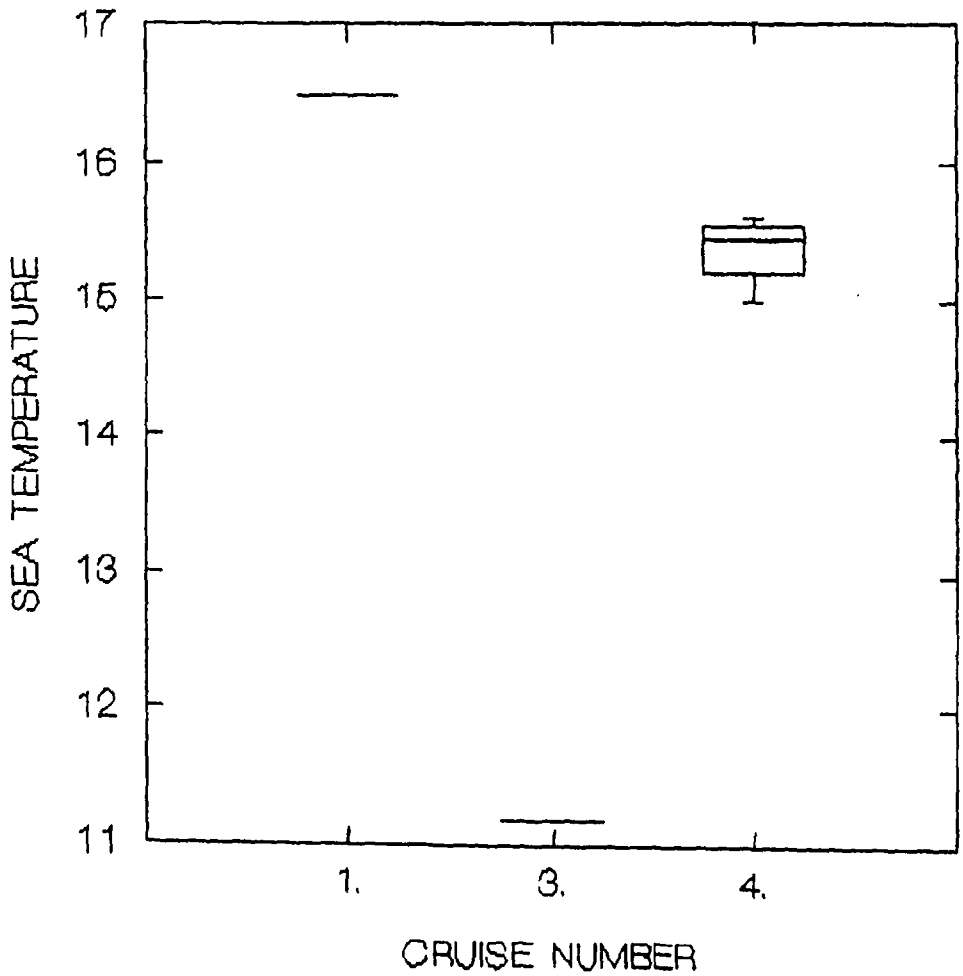
SOOTY SHEARWATER

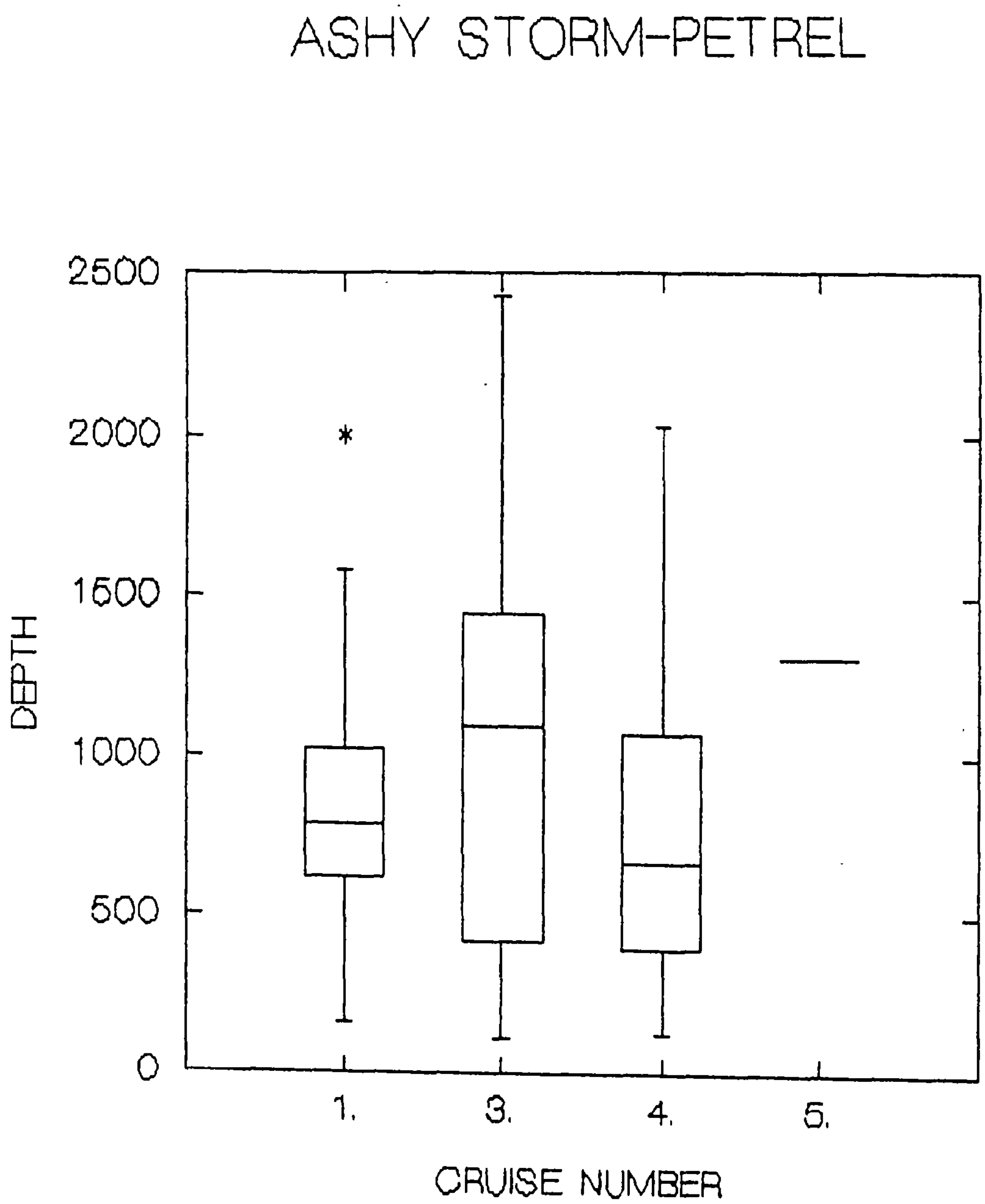




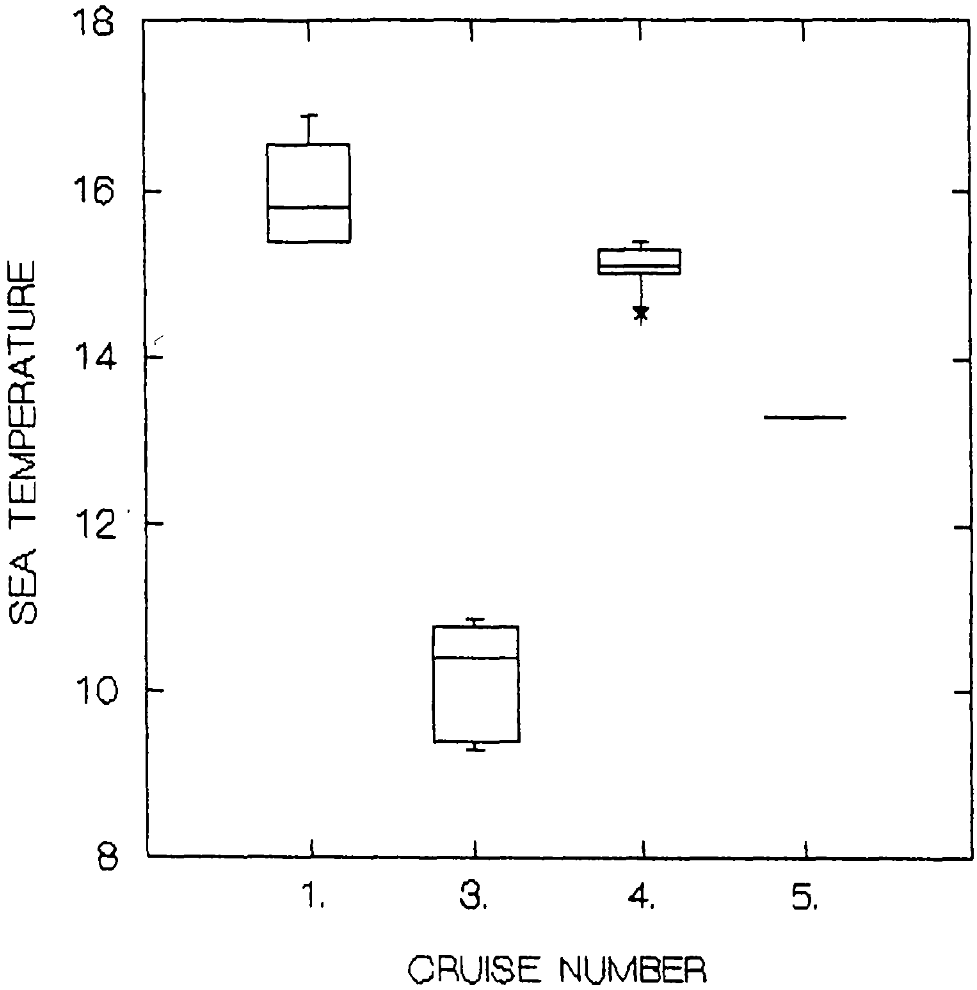
LEACH'S STORM-PETREL
4000
3000
2000
1000
DEPTH
1.
3.
4.
CRUISE NUMBER

LEACH'S STORM-PETREL

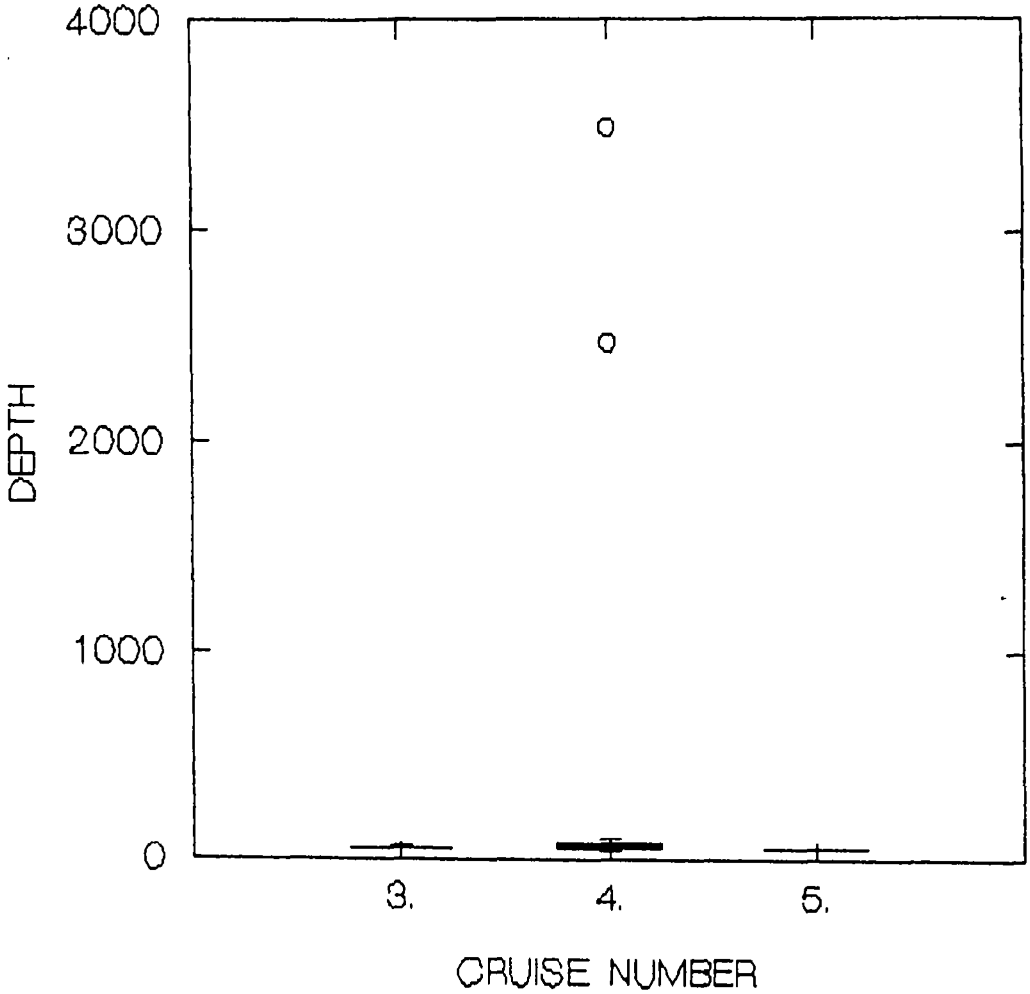



ASHY STORM-PETREL
DEPTH
2500
2000
1500
1000
500
0
1.
3.
4.
5.
CRUISE NUMBER

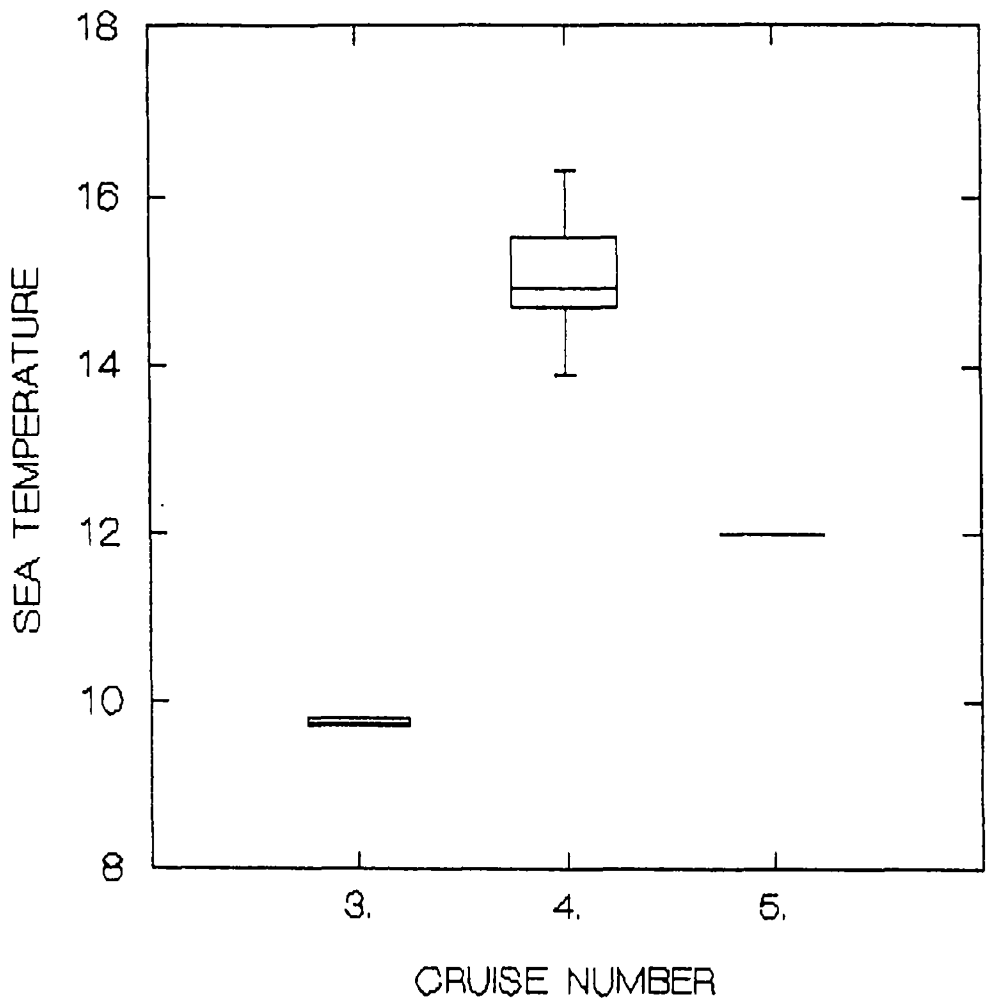
ASHY STORM-PETREL



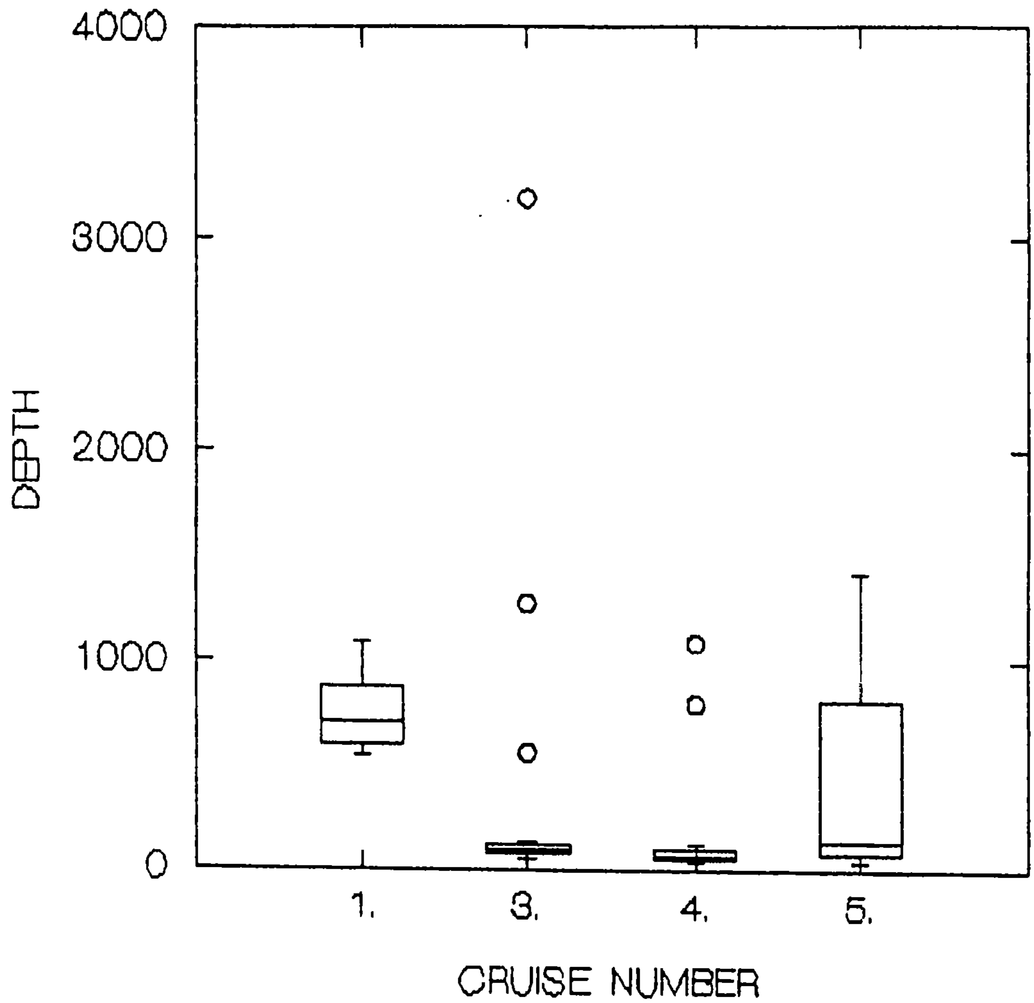
BRANDTS CORMORANT

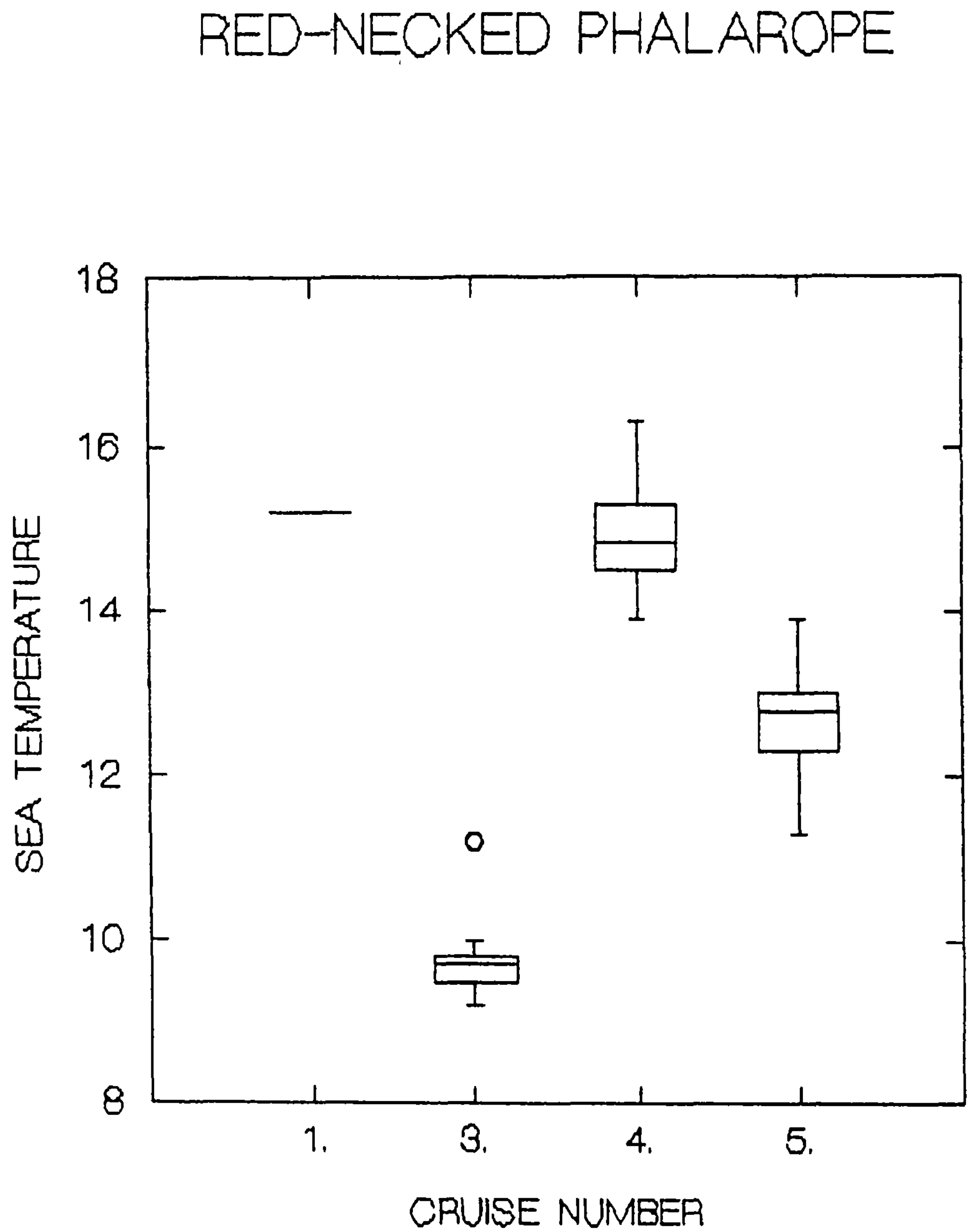


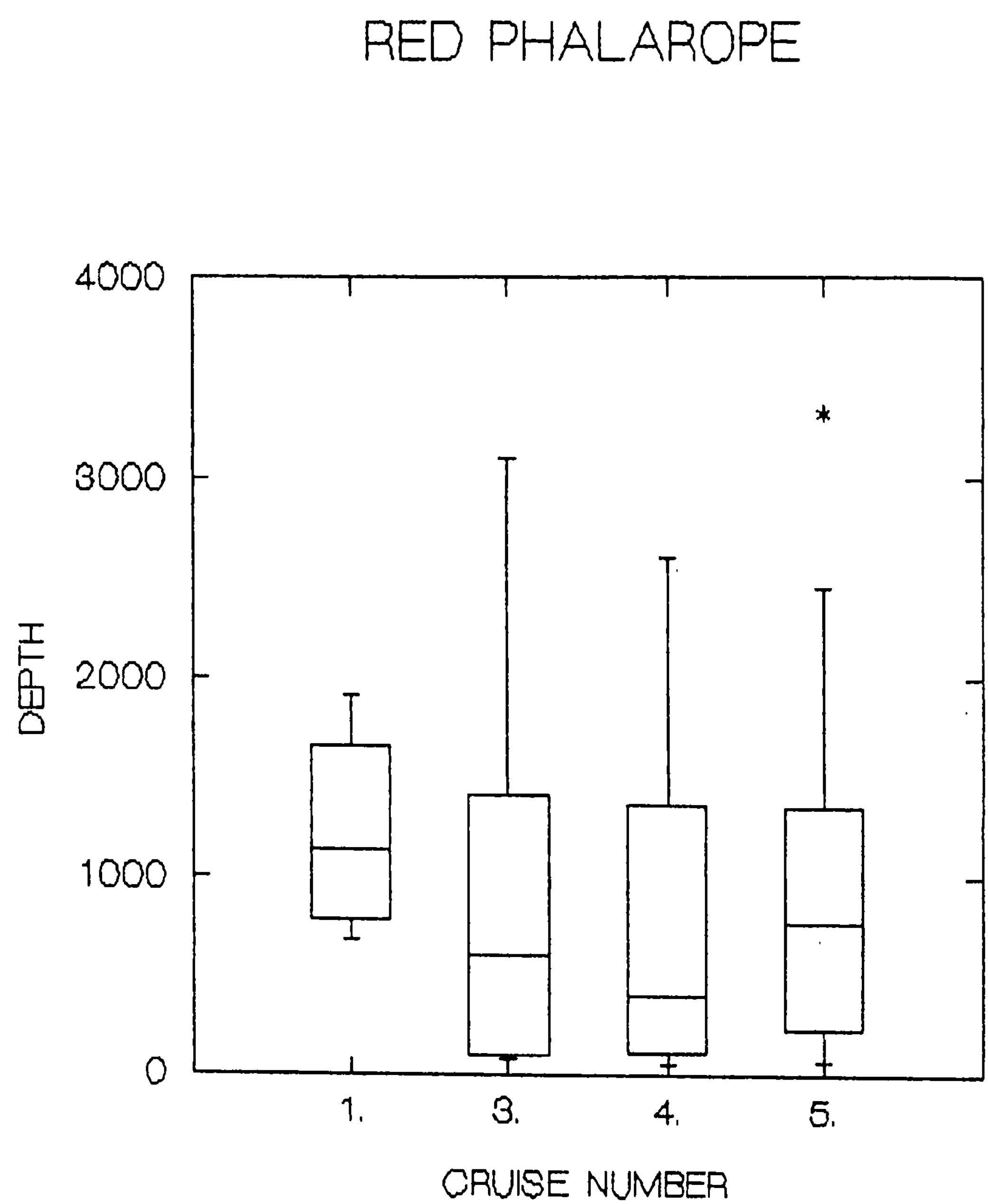
BRANDTS CORMORANT



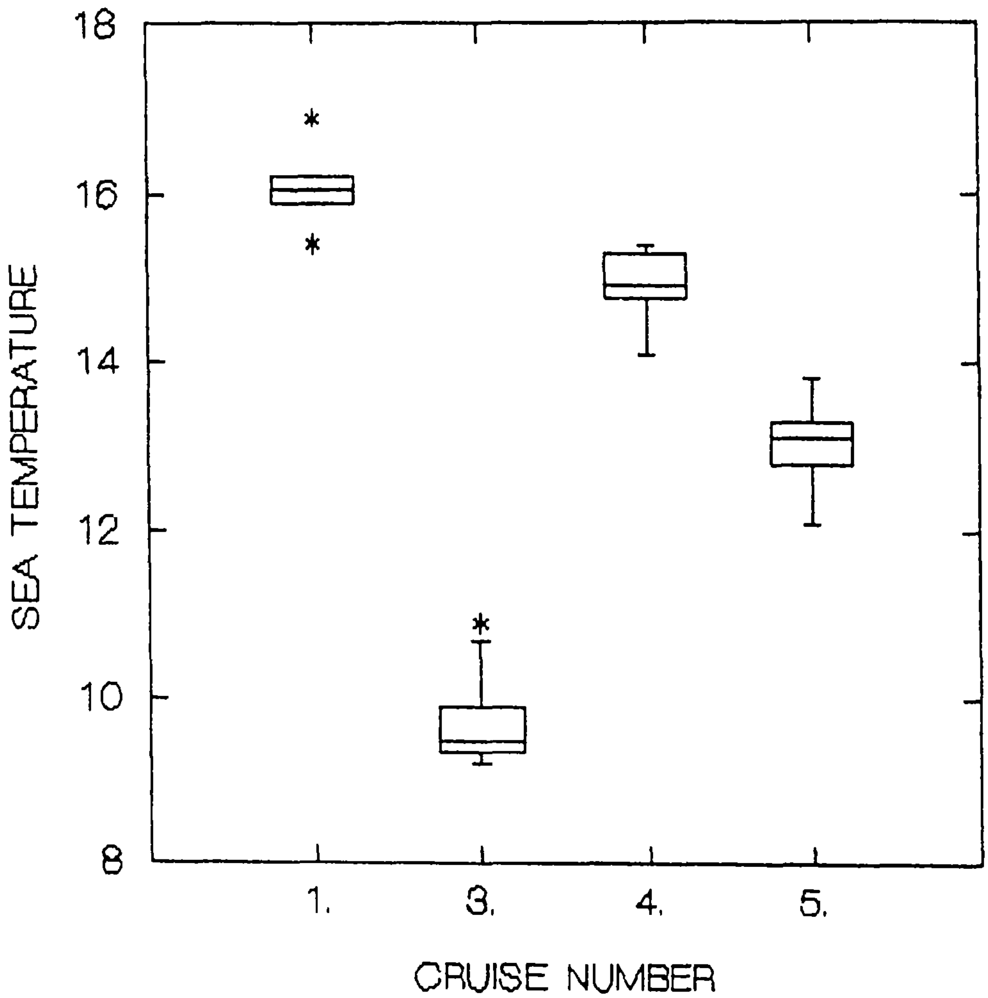
RED-NECKED PHALAROPE



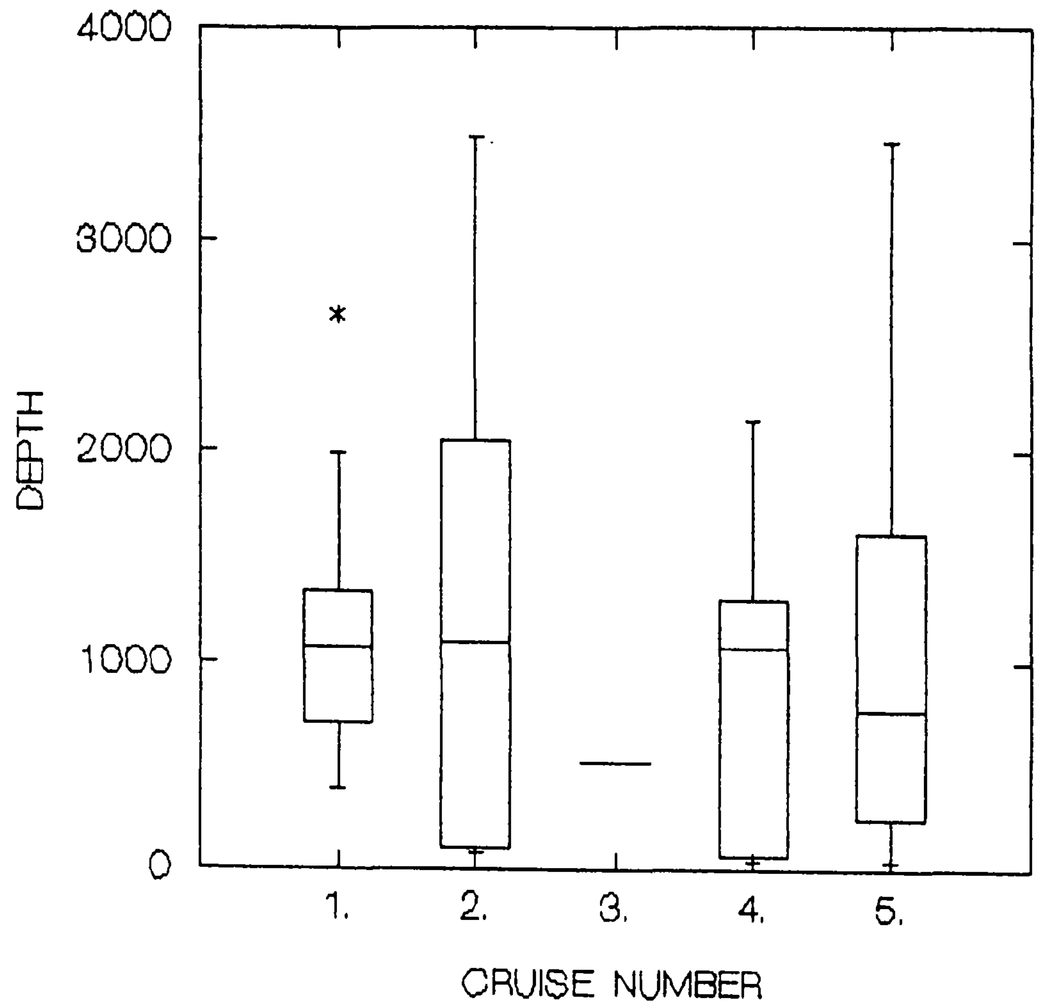

RED-NECKED PHALAROPE
18
16
14
12
10
8
SEA TEMPERATURE
1.
3.
4.
5.
CRUISE NUMBER


RED PHALAROPE
DEPTH
4000
3000
2000
1000
0
1.
3.
4.
5.
CRUISE NUMBER

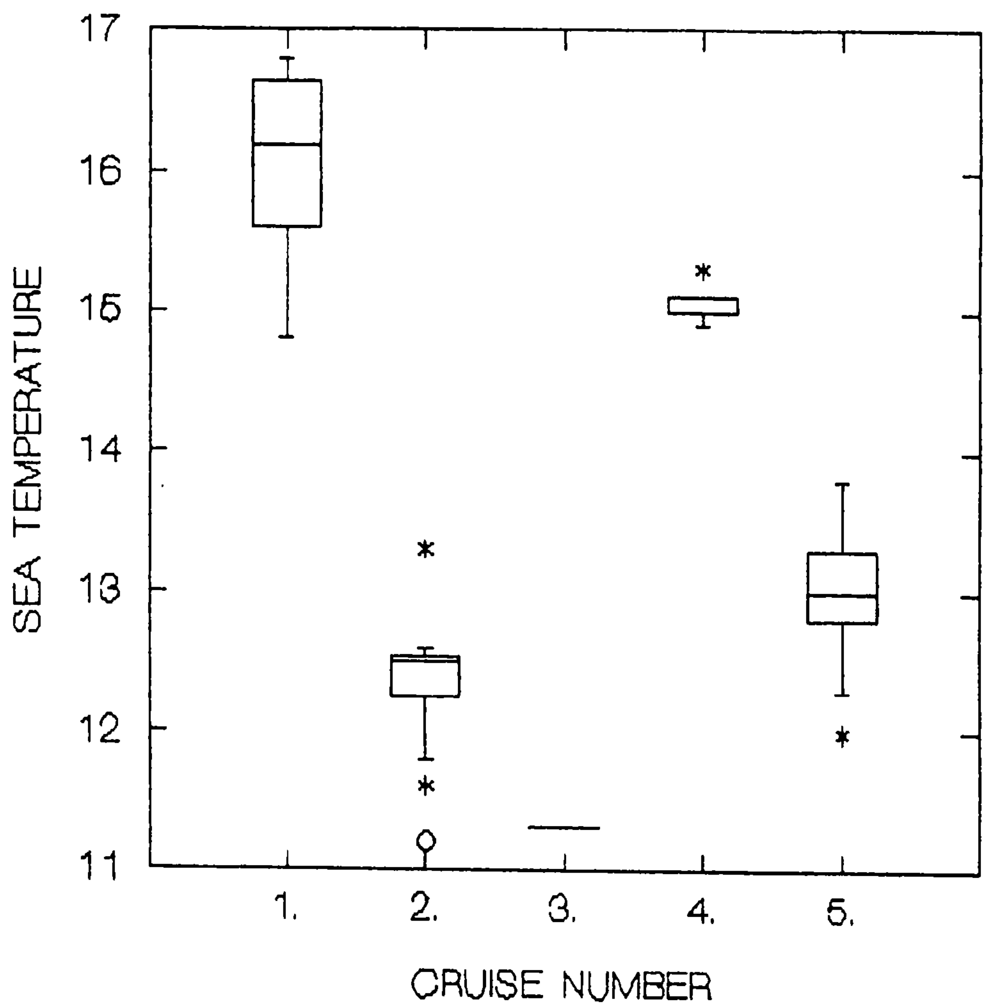
RED PHALAROPE



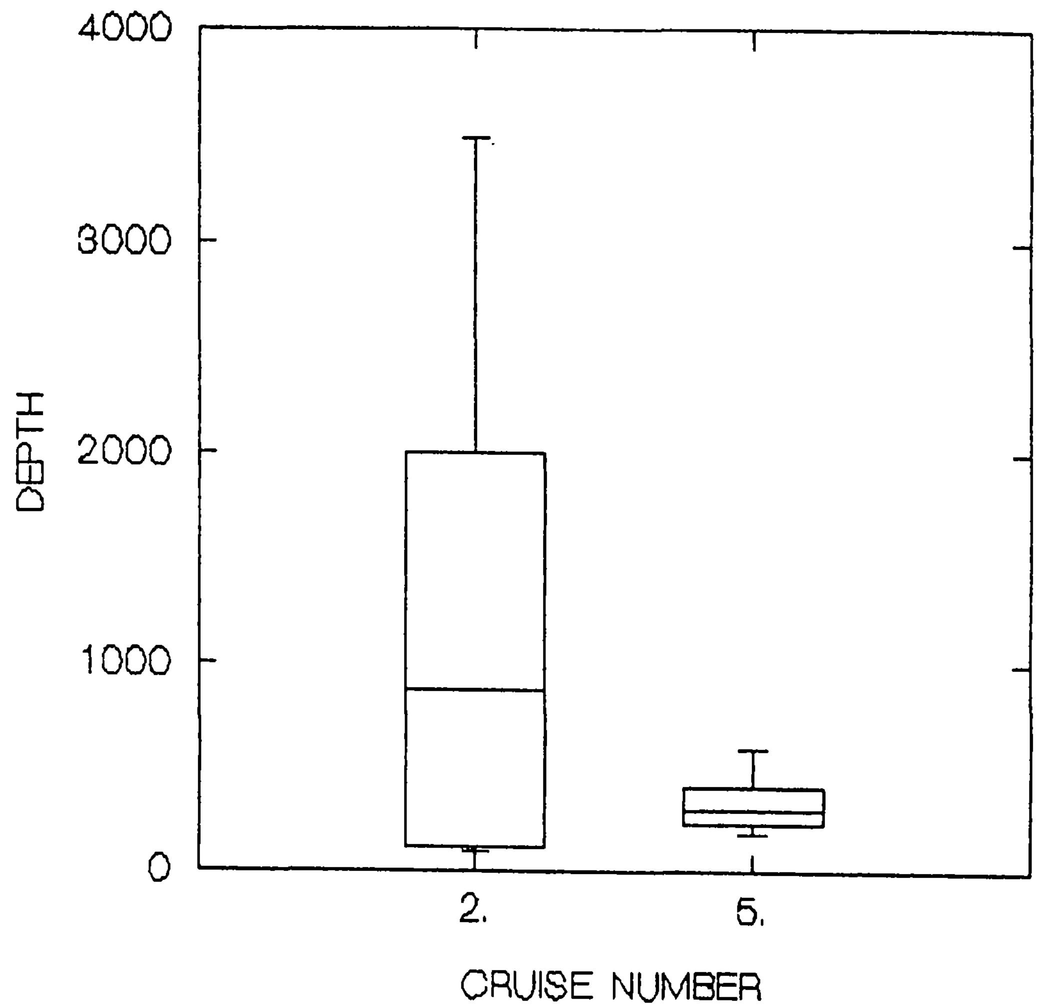
CALIFORNIA GULL.

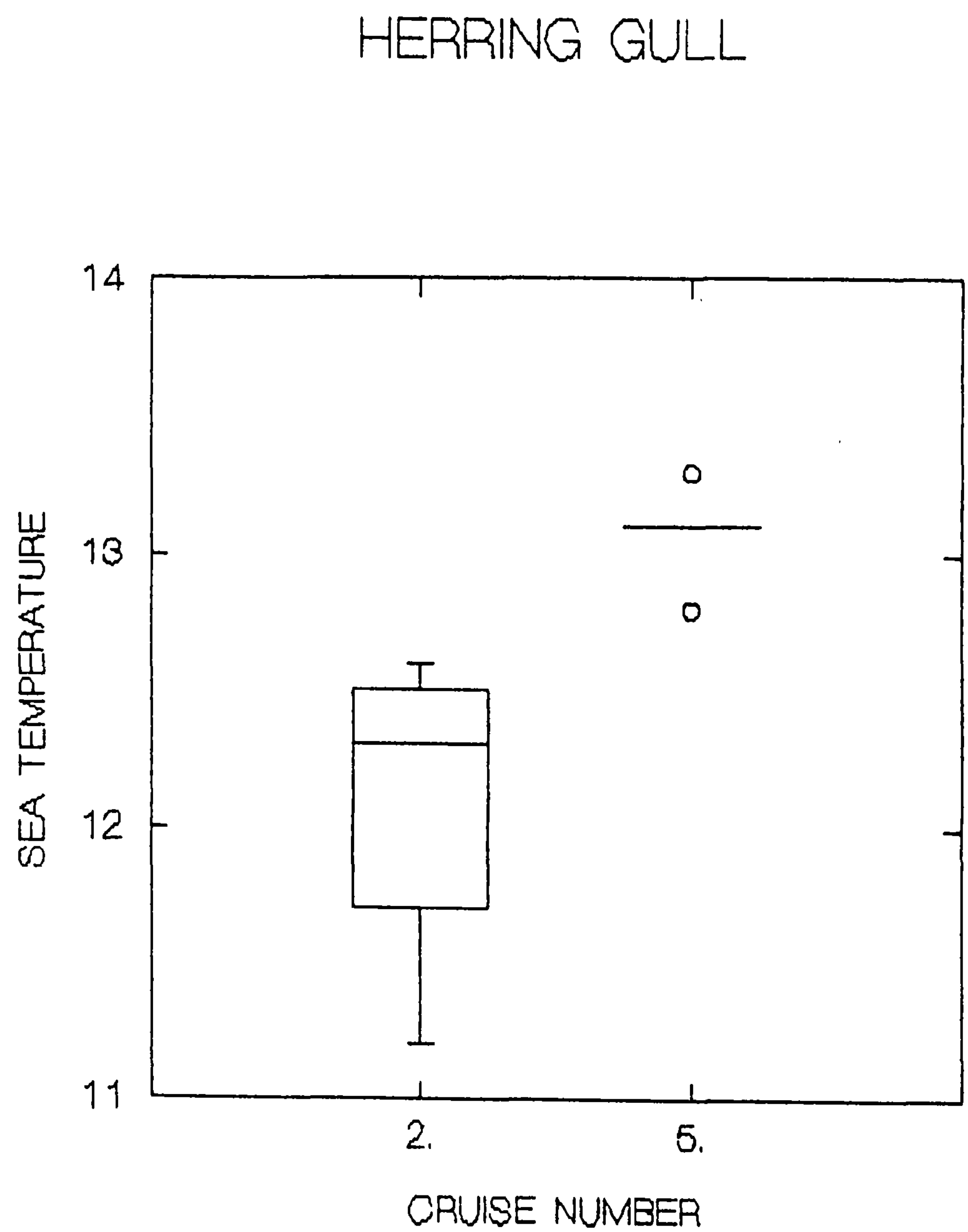


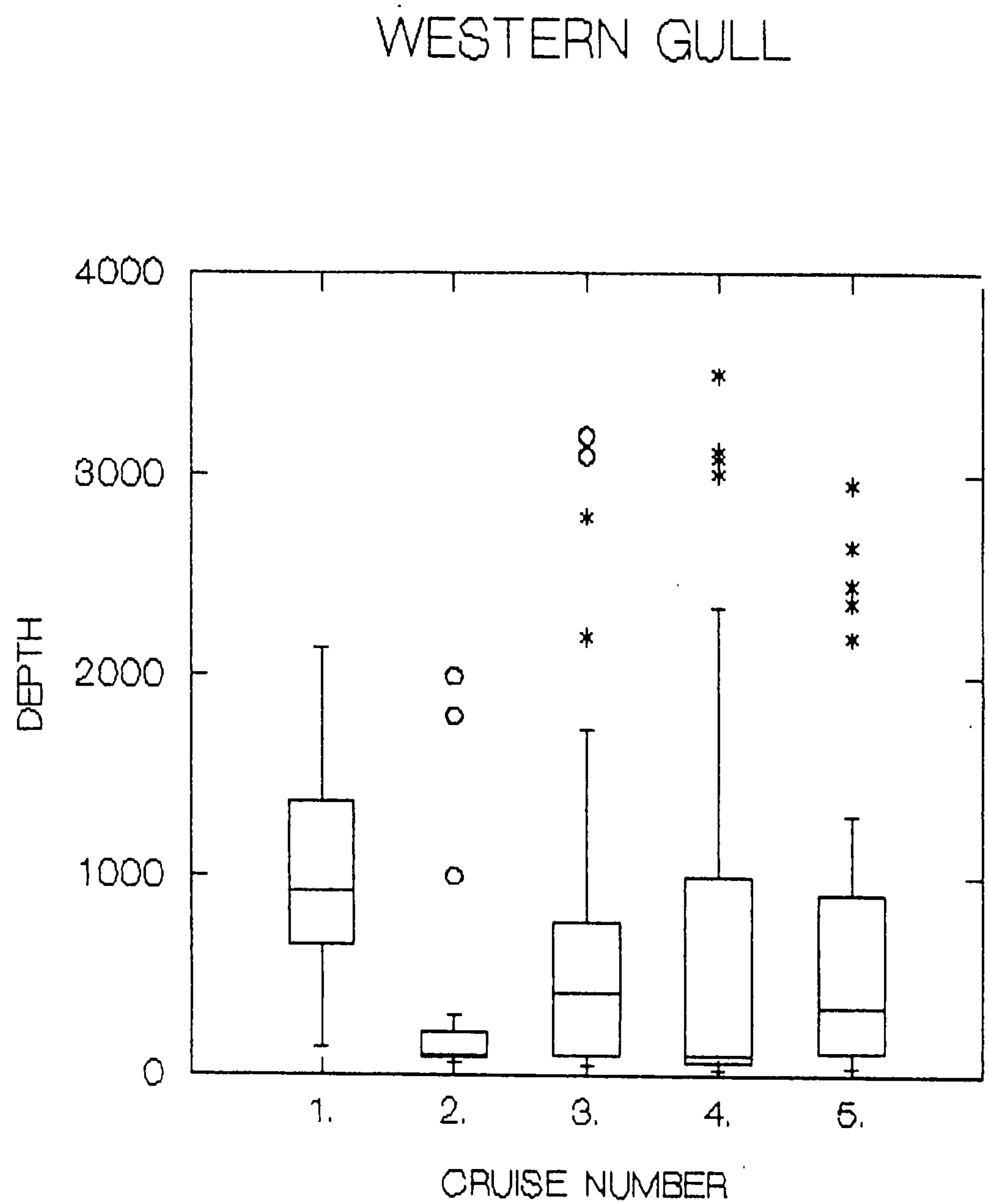
CALIFORNIA GULL



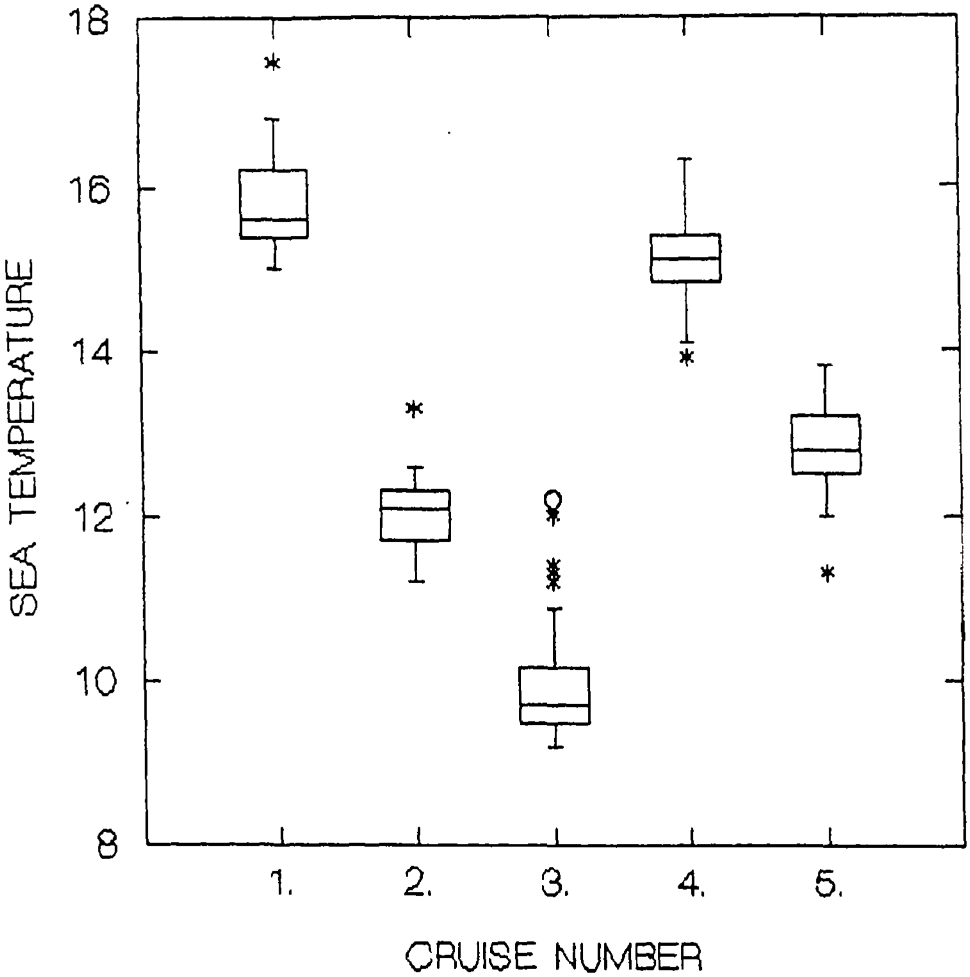
HERRING GULL



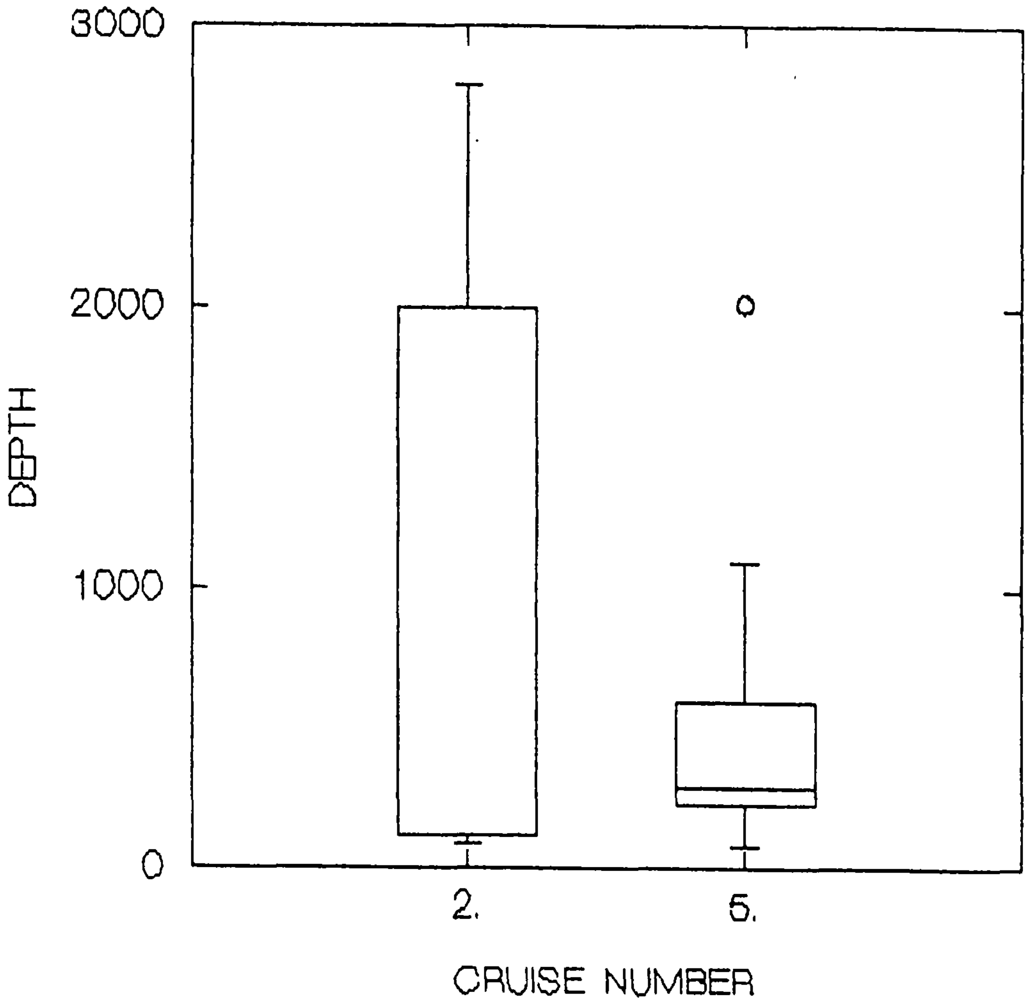

HERRING GULL
SEA TEMPERATURE
14
13
12
11
2.
5.
CRUISE NUMBER


WESTERN GULL
4000
3000
2000
1000
0
DEPTH
1.
2.
3.
4.
5.
CRUISE NUMBER

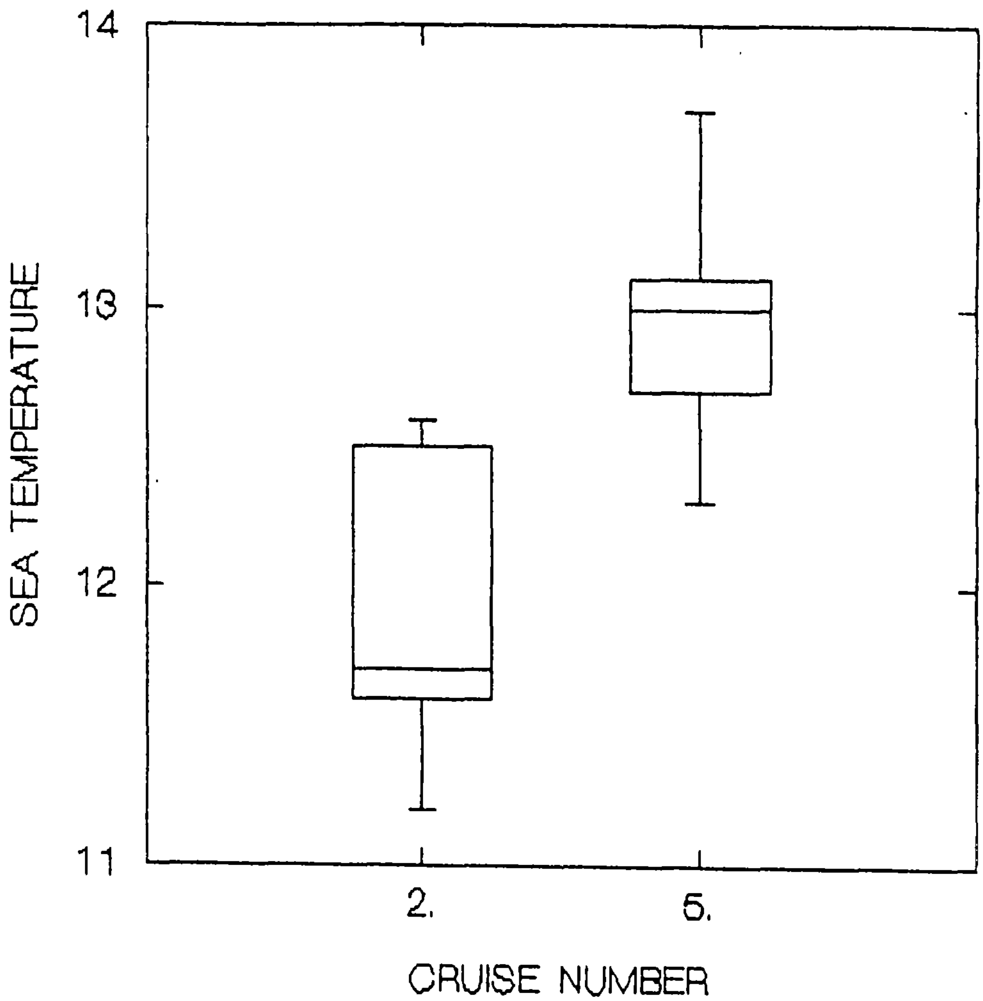
WESTERN GULL



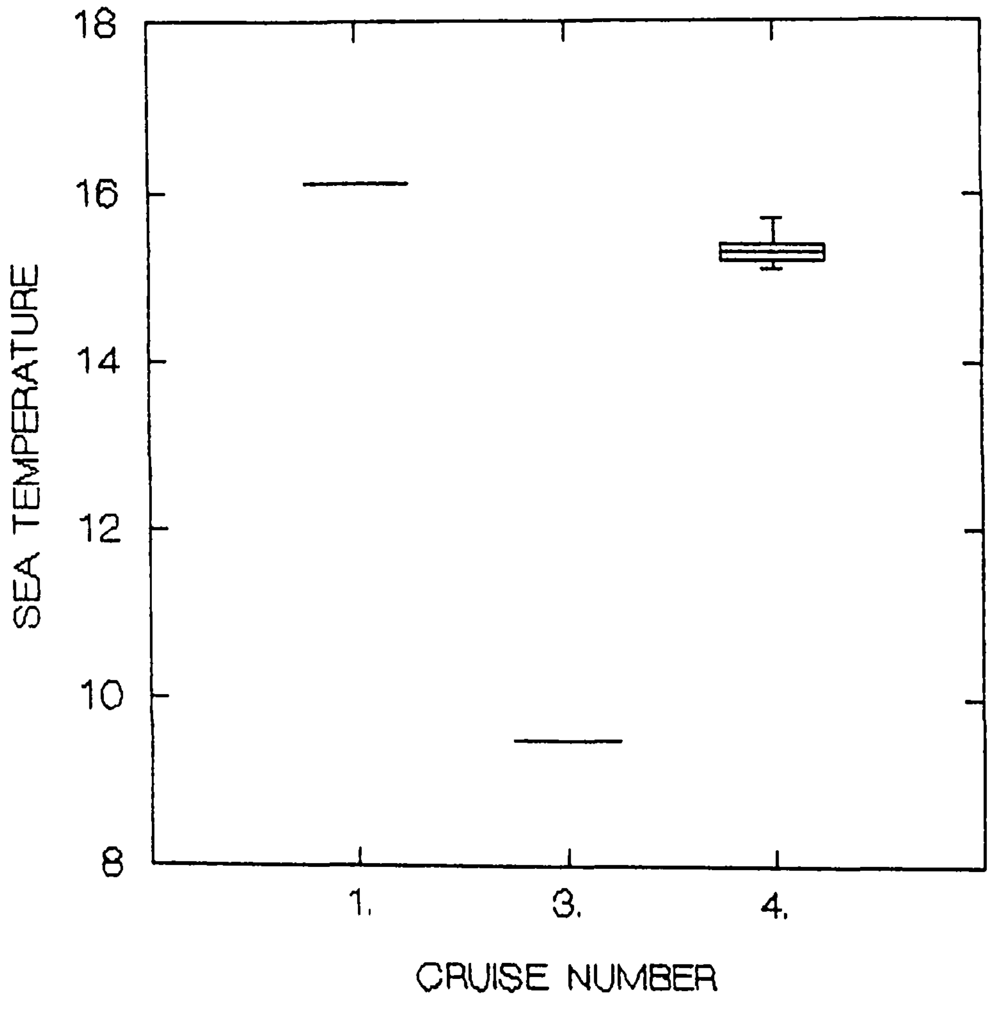
GLAUCOUS-WINGED GULL



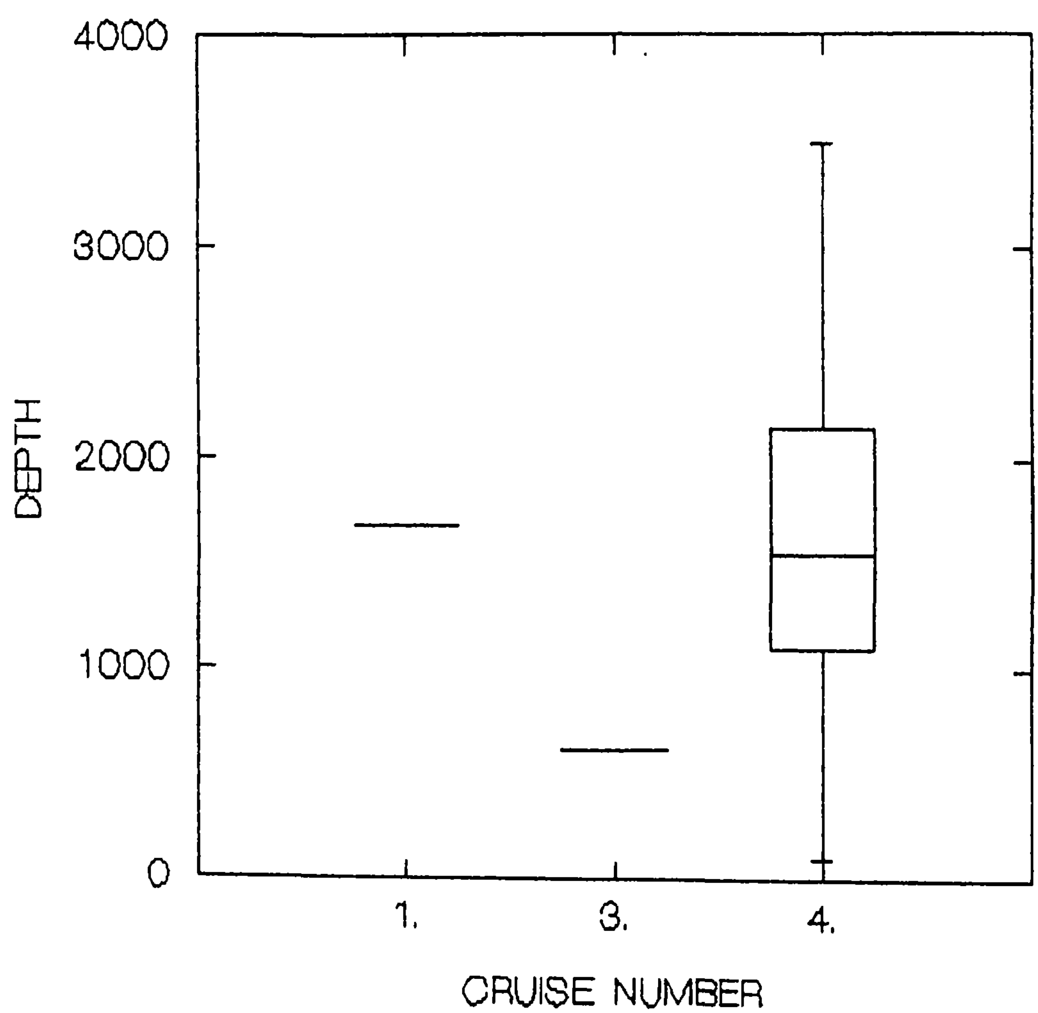
GLAUCOUS-WINGED GULL

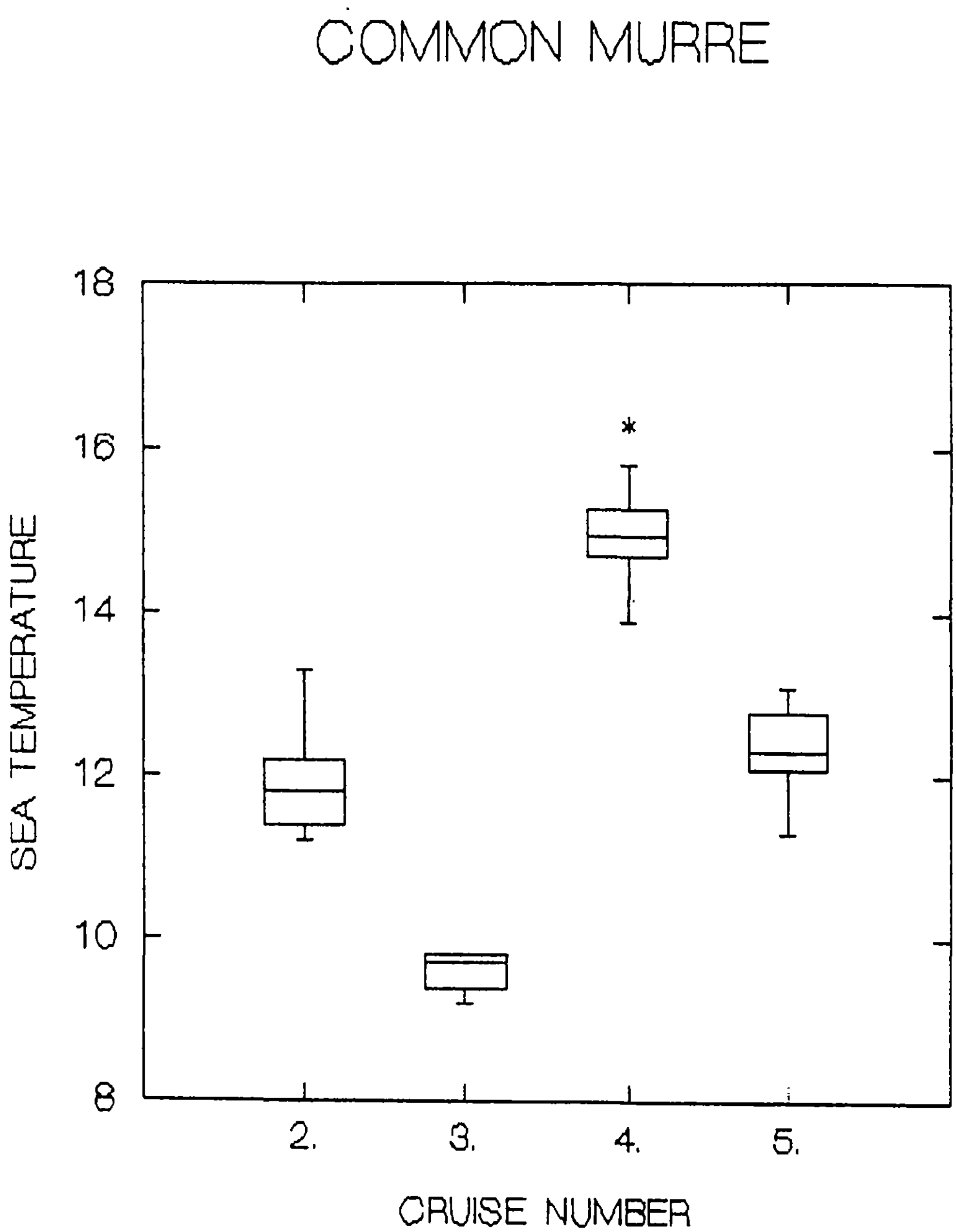


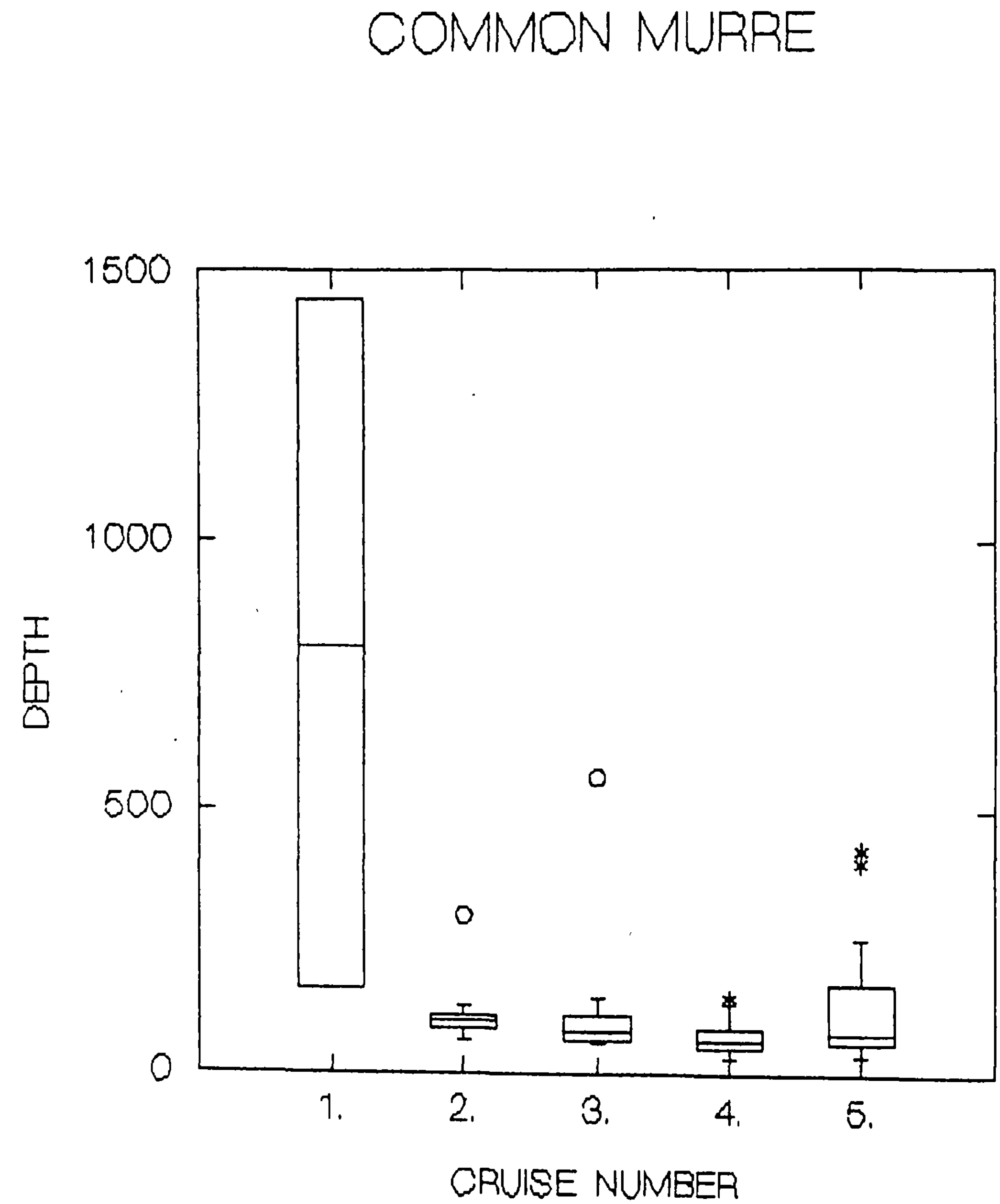
ARCTIC TERN



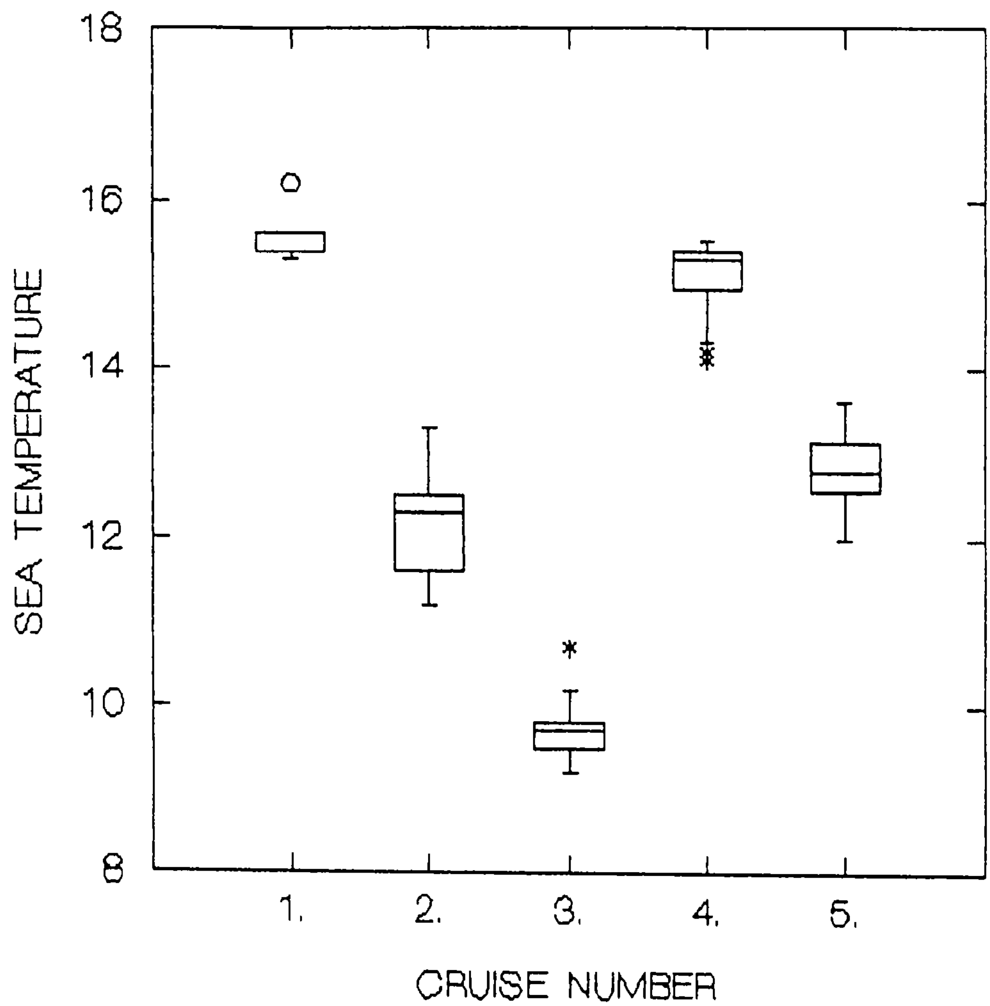
ARCTIC TERN



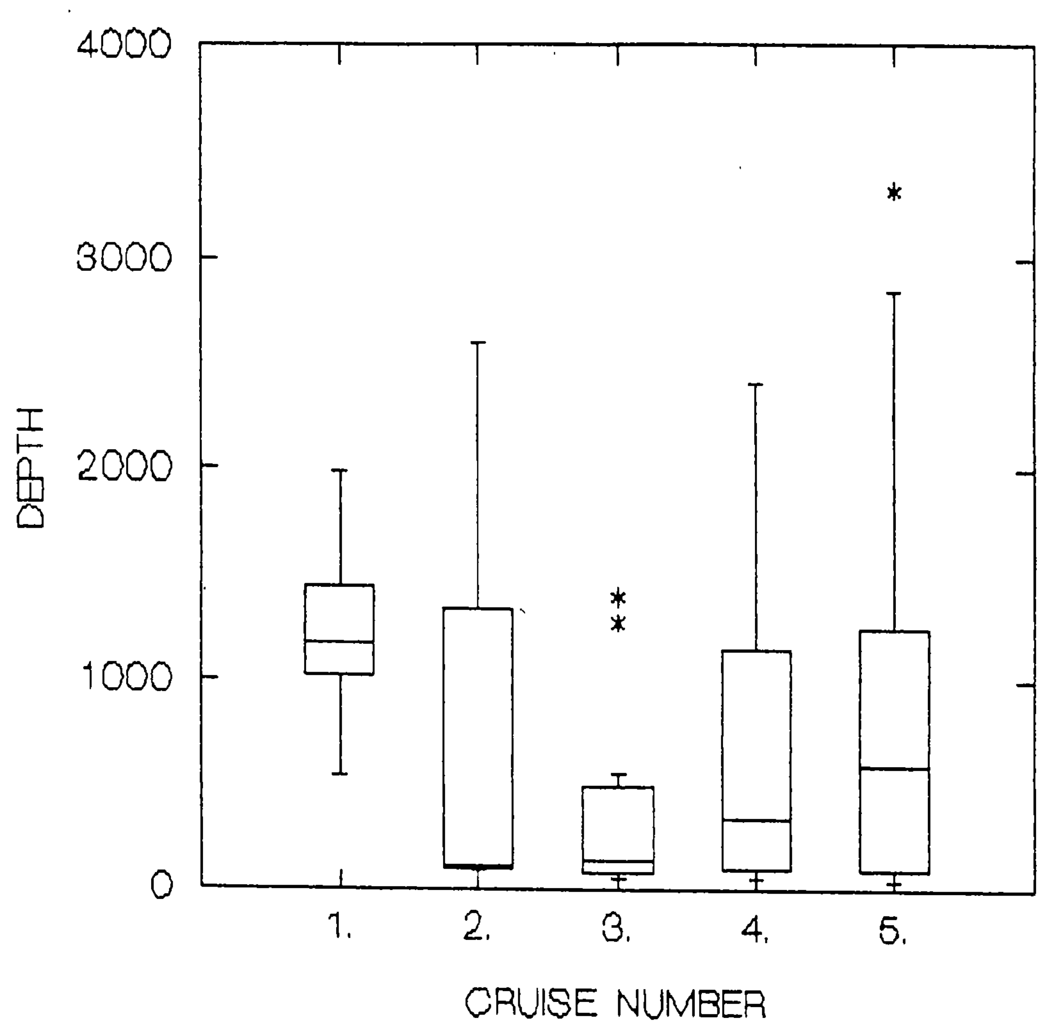

COMMON MURRE
SEA TEMPERATURE
CRUISE NUMBER
18
16
14
12
10
8
2.
3.
4.
5.
*

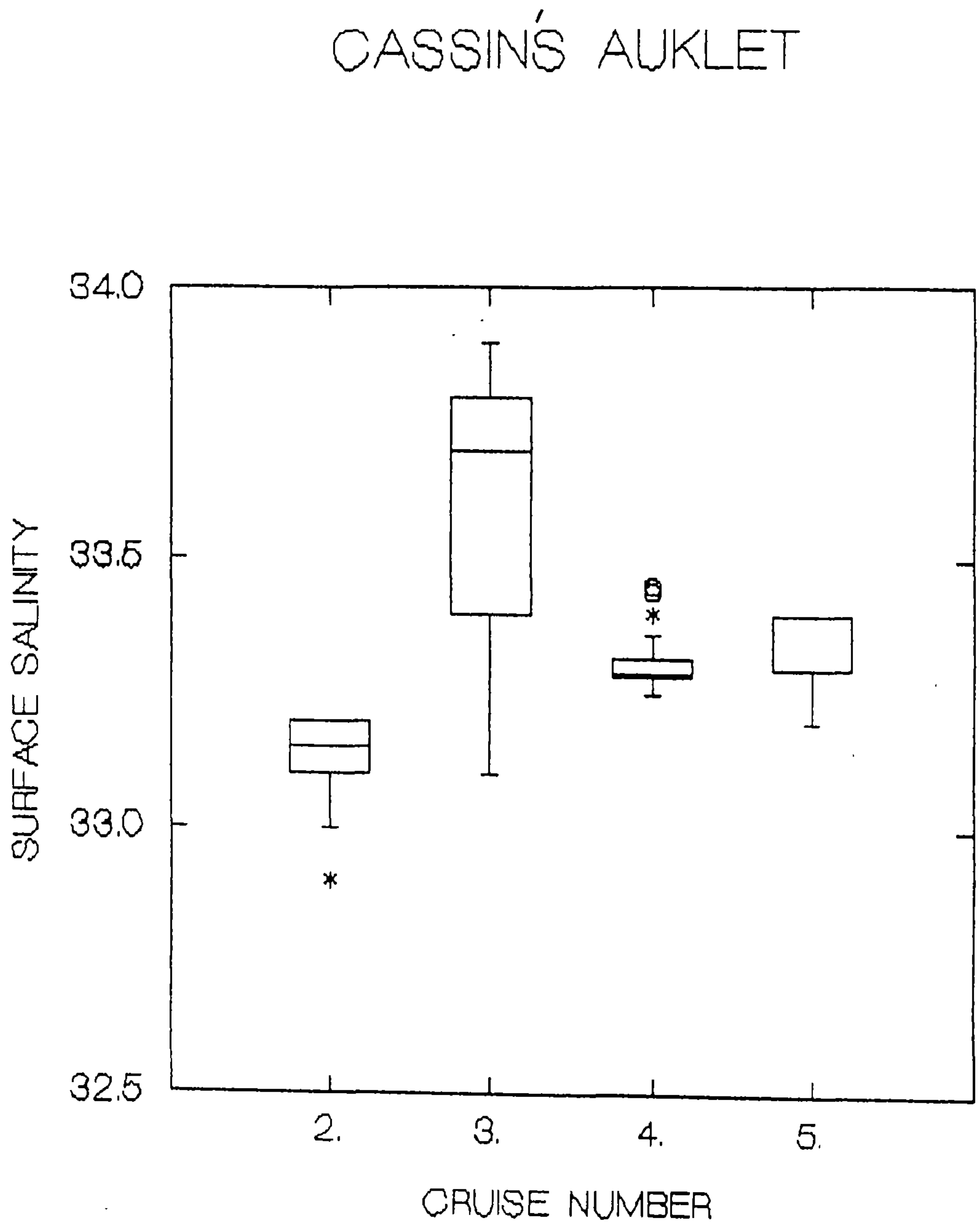

COMMON MURRE
1500
1000
500
0
DEPTH
1.
2.
3.
4.
5.
CRUISE NUMBER

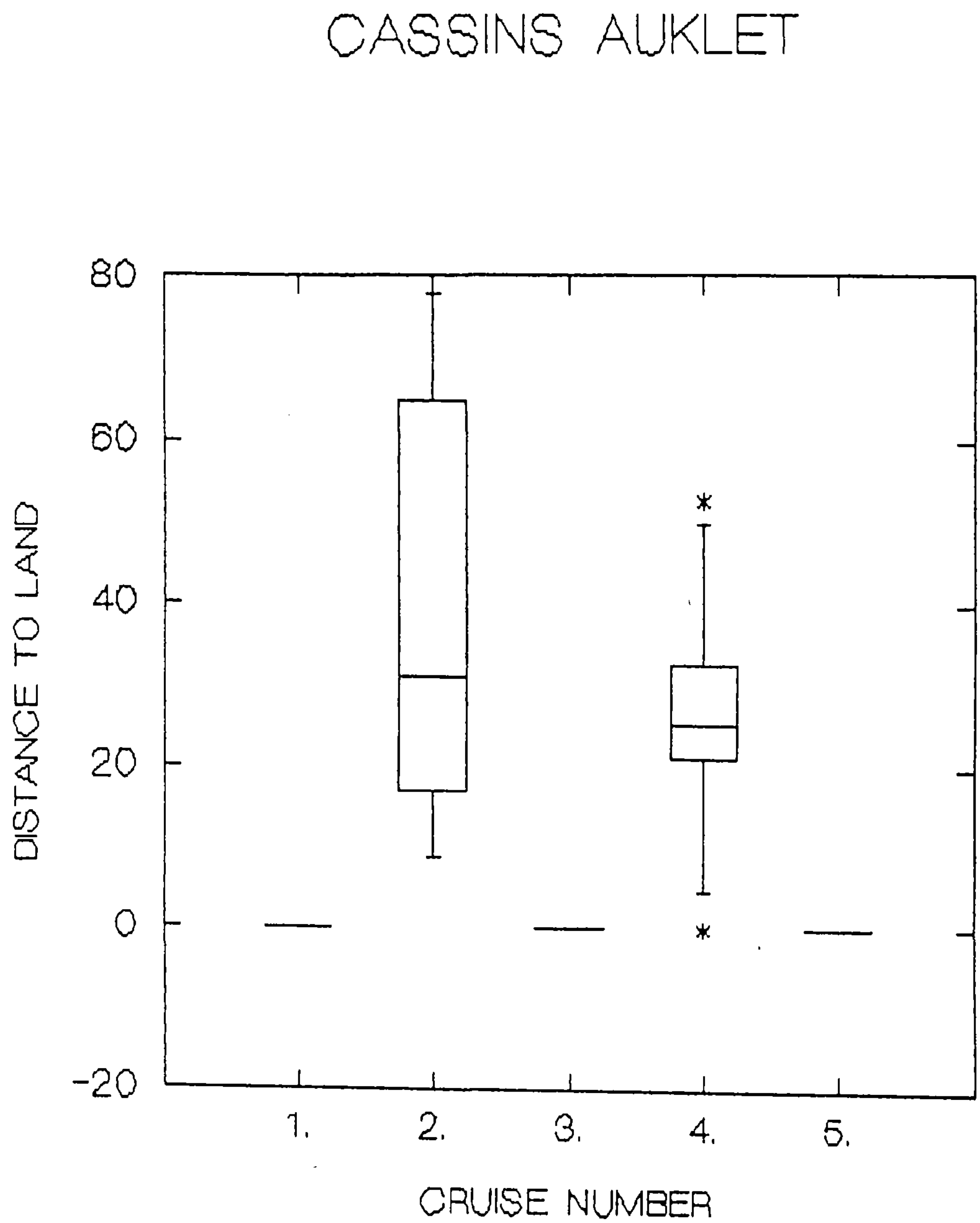
CASSIN'S AUKLET



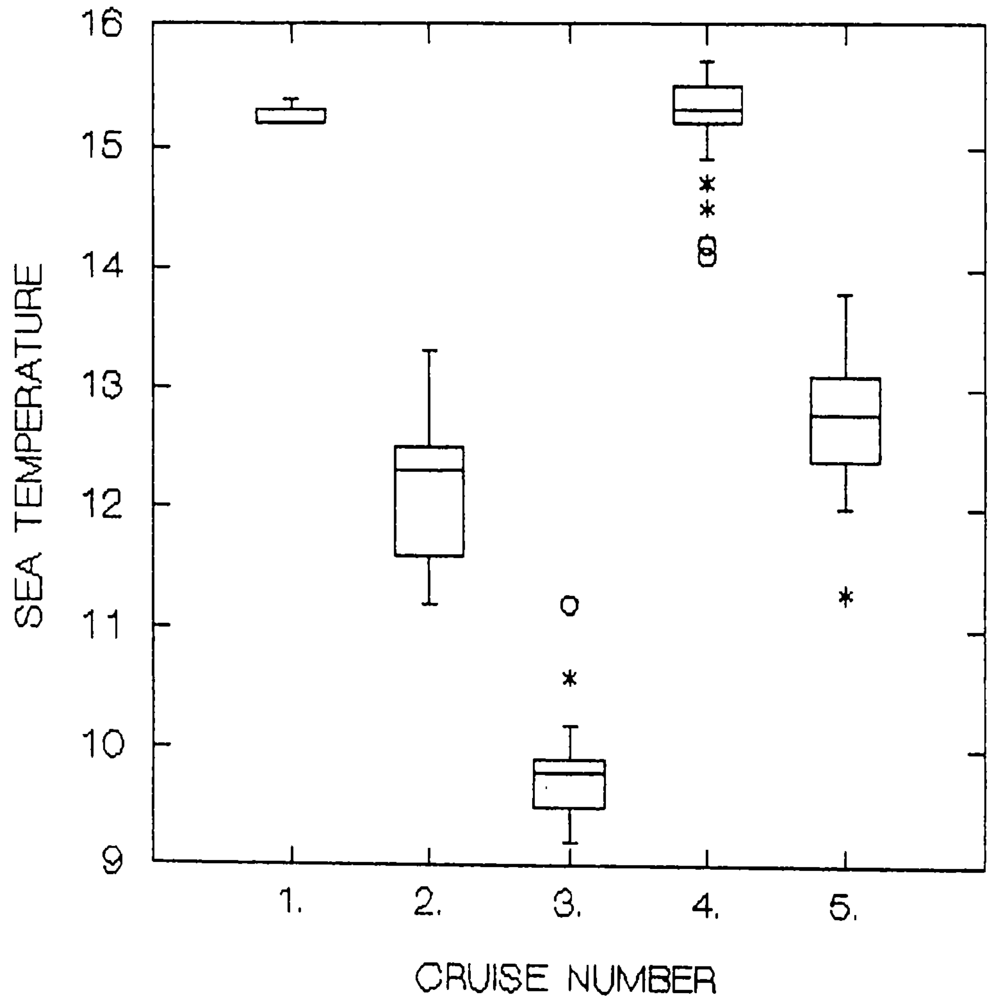
CASSIN'S AUKLET



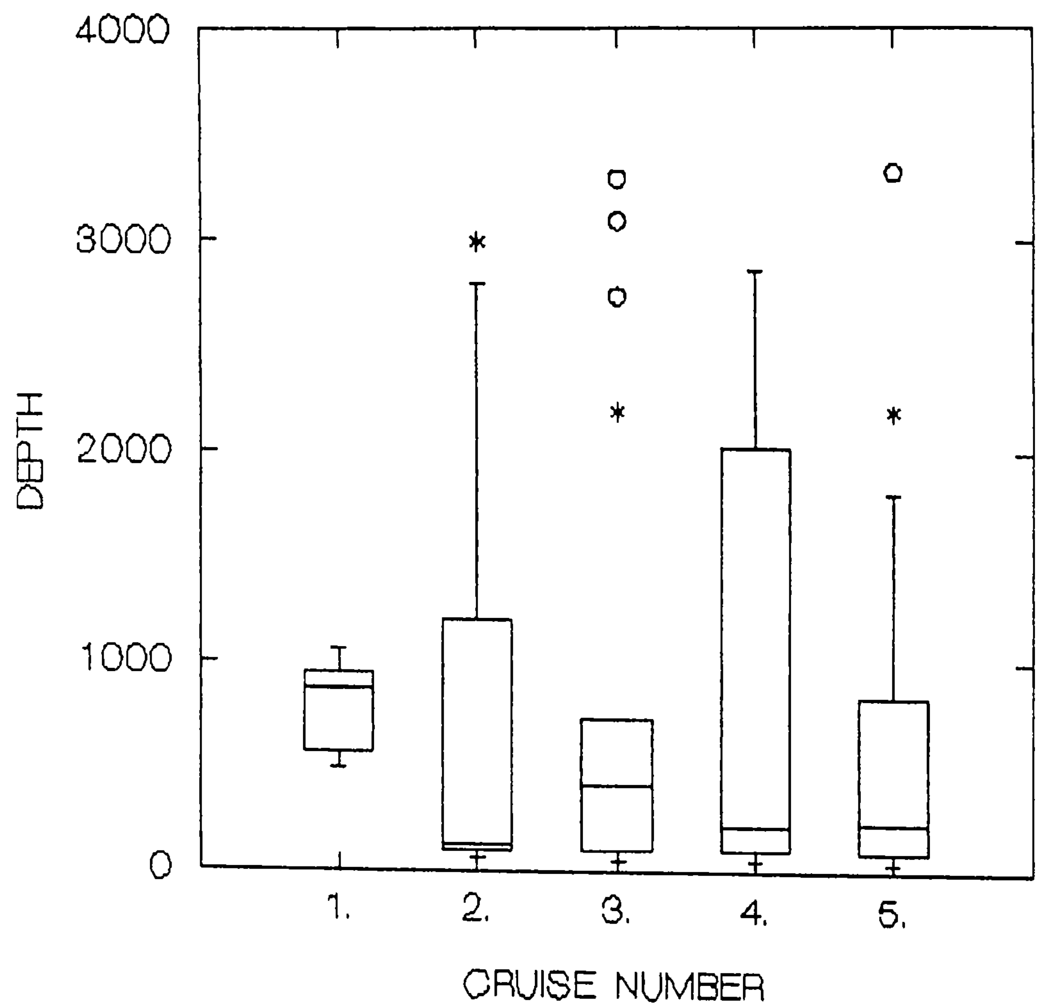

CASSIN'S AUKLET
SURFACE SALINITY
34.0
33.5
33.0
32.5
2.
3.
4.
5.
CRUISE NUMBER


CASSINS AUKLET
80
60
40
20
0
-20
DISTANCE TO LAND
1.
2.
3.
4.
5.
CRUISE NUMBER

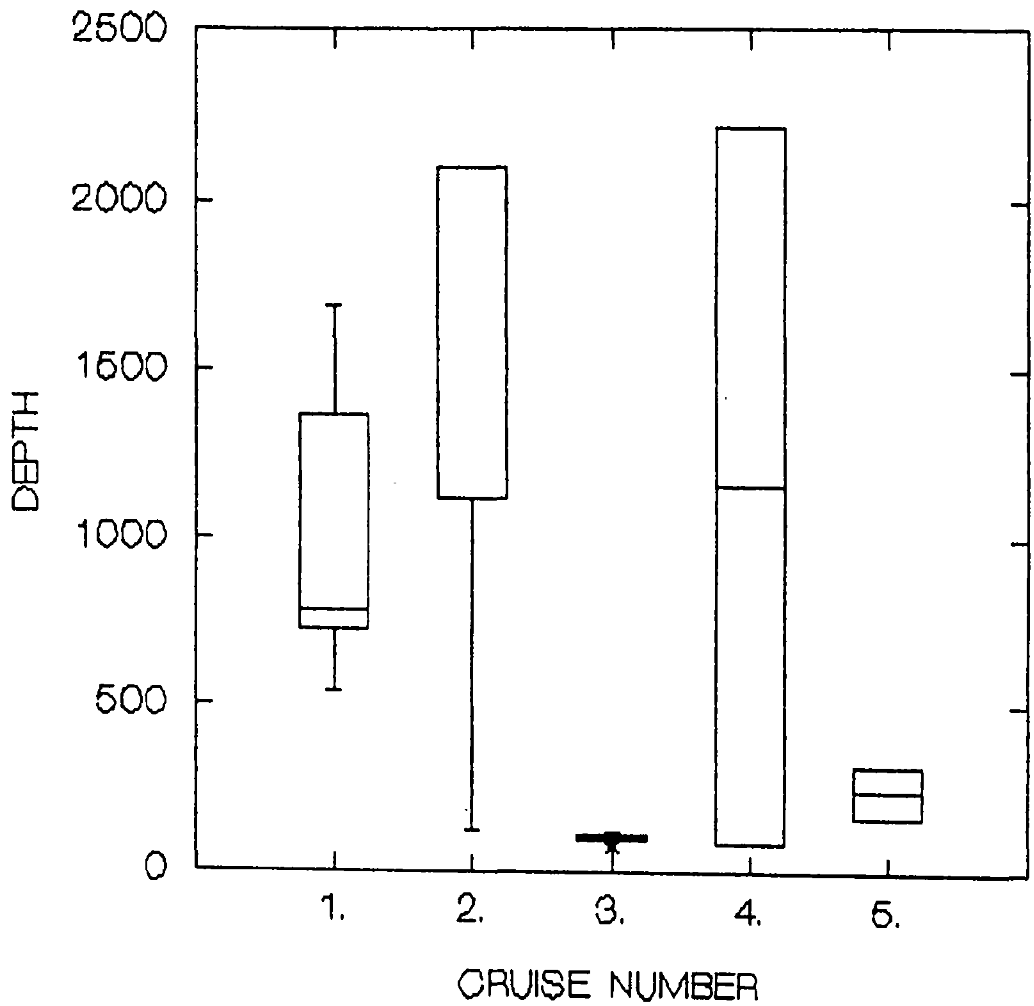
RHINOCEROS AUKLET

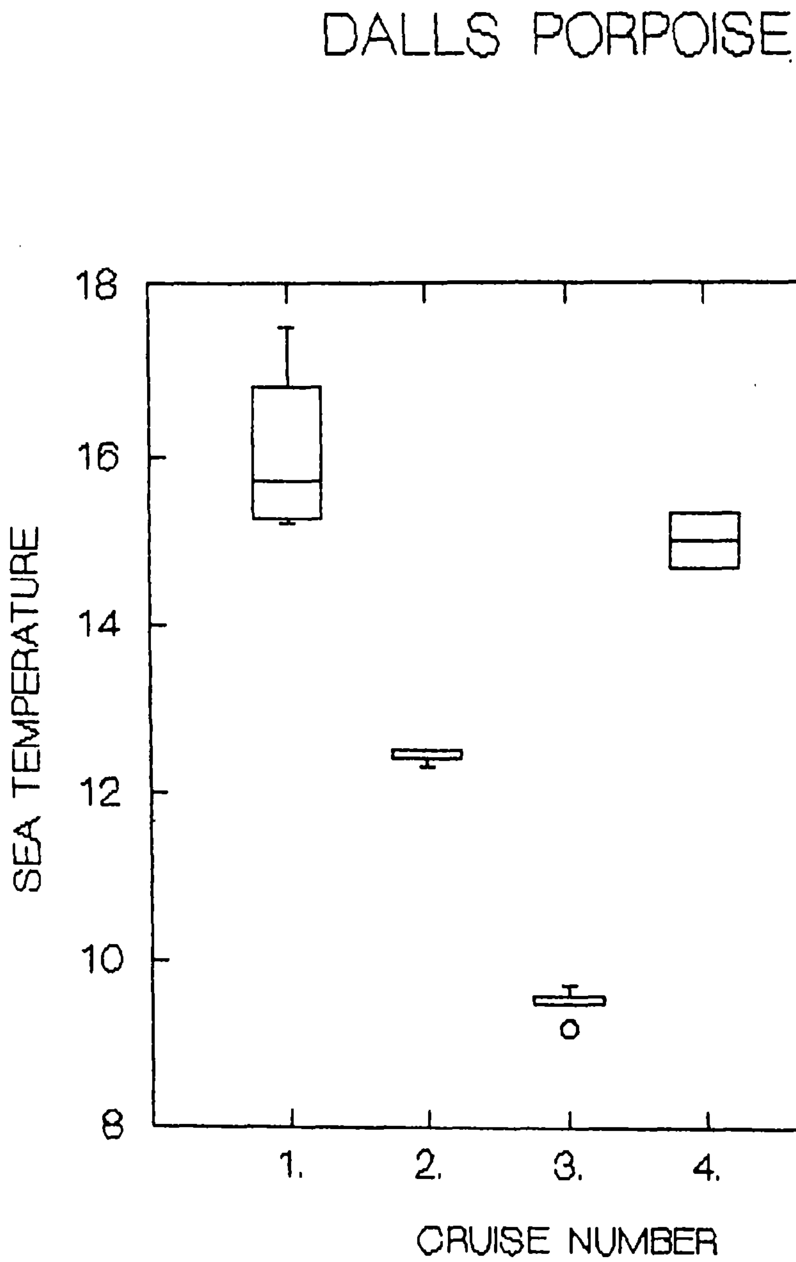


RHINOCEROS AUKLET

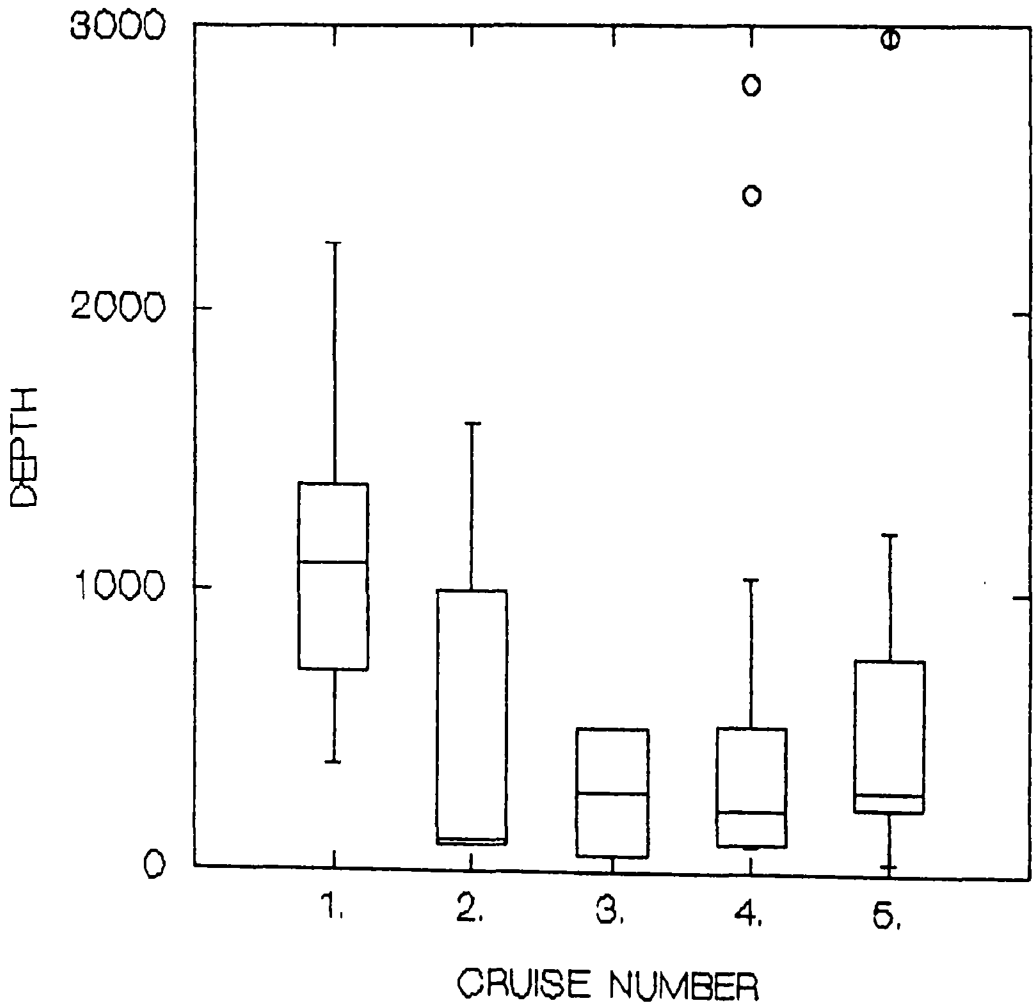


DALLS PORPOISE




DALLS PORPOISE
18
16
14
12
10
8
SEA TEMPERATURE
1.
2.
3.
4.
5.
CRUISE NUMBER

CALIFORNIA SEA LION



CALIFORNIA SEA LION