Waterbird Survey
North and Central San Diego Bay, 1993

Prepared for

U.S. Department of the Navy
Naval Air Station North Island

May 20, 1994

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Prepared by

U.S. Department of the Navy
SOUTHWEST Division
Naval Facilities Engineering Command

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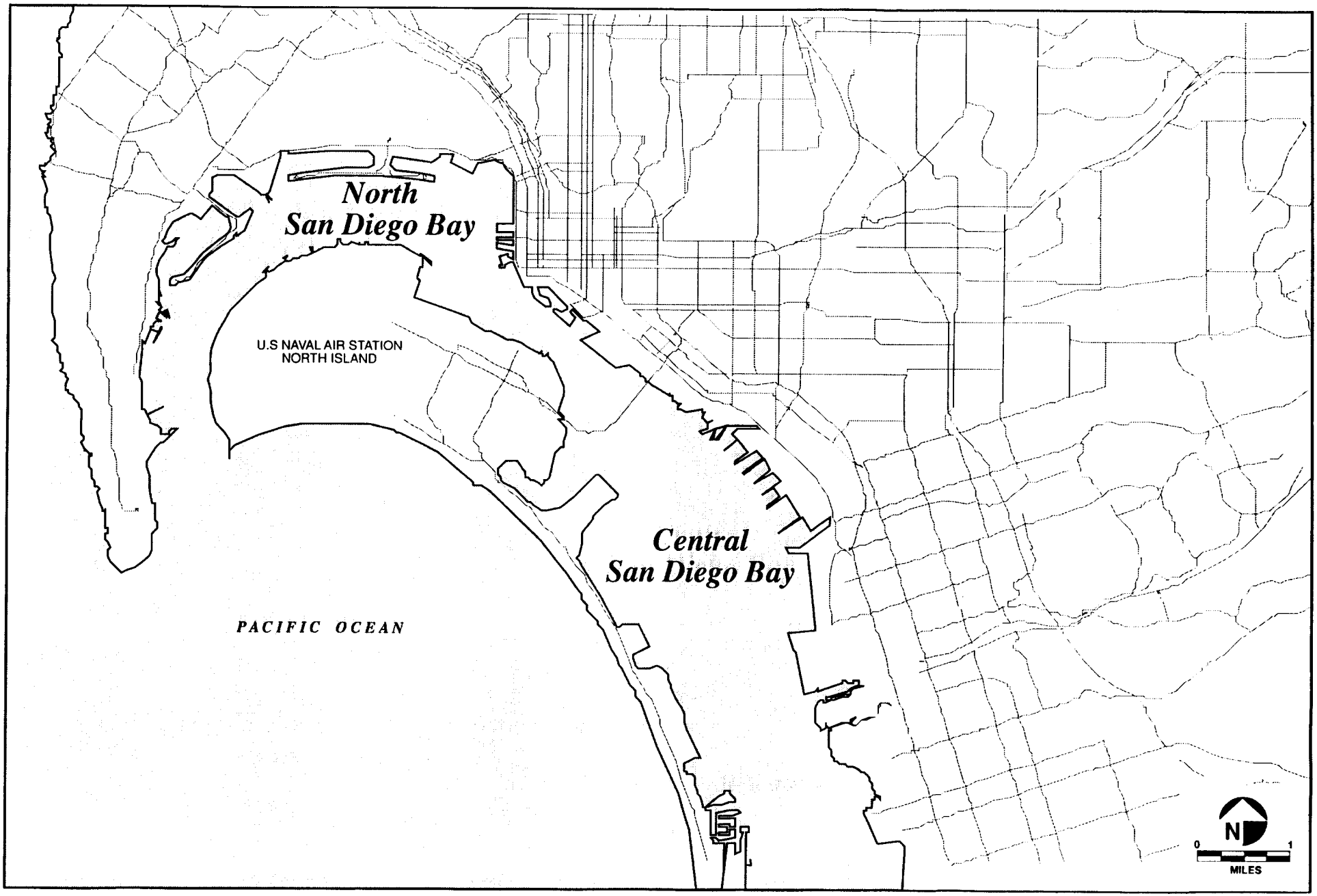
1.0 INTRODUCTION

The Navy initiated a study program to document weekly waterbird use patterns on North San Diego Bay and to conduct monthly waterbird surveys of Central San Diego Bay (Figure 1). The study was designed to provide a comprehensive survey of the sensitive migratory waterbird species potentially occurring in North San Diego Bay. This information provides a database to assist the Navy in assessing the potential impacts of future projects that may involve dredging, shipping channel maintenance, and boat traffic in the Bay. The study was orginally scheduled as a one-year study (1993), and it has been extended to 1994 so that a comparable database will be available for the Central San Diego Bay area.

Coastal bays are dynamic ecological surfaces and volumes with which waterbirds interact for their reproductive and survival needs. The majority of species and numbers of birds that use the southern California coast are wintering birds that breed far to the north. They are not spatially bound to a large degree by point sources of food or by territoriality, but are influenced in their temporal and spatial use of resources (e.g., small schooling fish), the need for shelter from weather and predation, and potentially by human-caused disturbance



FIGURE

1

San Diego Bay and Vicinity
1993 Waterbird Study Areas

factors on the water surface. Furthermore, the distributional patterns of use and the composition of the waterbird assemblage is influenced by daily and seasonal time factors. Waterbird distribution on San Diego Bay may be highly heterogeneous in both time and space, and a study design with temporal and spatial scale was therefore implemented.

1.1 BIOGEOGRAPHY OF THE PROJECT AREA

The generally warm climate and cool coastal waters of southern California provide a benign and productive environment for coastal waterbirds, particularly during winter. San Diego's location on the southern Pacific coast of North America is transitional between warmer subtropics and cooler temperate regions to the north. San Diego Bay is a highly modified estuarine ecosystem. The majority of historically occurring marshlands and other shallow tidal habitats on its fringes have been eliminated from the northern half of the Bay as a result of dredging to provide relatively deep water to accommodate human activities. The Bay is still a significant interface between terrestrial habitats, freshwater inflow, and tidal inflow from the ocean, especially in the southern half of the Bay. Protected from the outer ocean by Silver Strand and Coronado, the Bay provides physical shelter from wind and waves.

The physical conditions and climatic transition are reflected in the avifauna that uses the Bay waters throughout the year. In terms of bird diversity, the Bay receives its highest use in the fall and winter months by bird species that breed in the far north but seek mild climatic conditions during the non-breeding season. Many of these wintering species occur in relatively high local concentrations for brief time periods. Waterbird species composition is biased toward species that have their primary distribution to the north as demonstrated by the many wintering species (e.g., shorebirds and waterfowl) that breed as far north as coastal Alaska (Briggs et al. 1987). Relative population concentrations for many species tend to increase north of San Diego on the Pacific coast; this appears to correspond to the general temperature gradient (Briggs et al. 1987, Root 1988). A smaller component of the Bay avifauna is composed primarily of subtropical species (e.g., elegant tern) that breed in localized concentrations near the Bay shoreline, especially in the southern half of the Bay, and use the protected water for obtaining food for their young. Several of these subtropical species (e.g., brown pelican) also migrate to the Bay from breeding colonies in Baja California during the winter (Case and Cody 1983).

1.2 PREVIOUS SURVEYS OF SAN DIEGO BAY

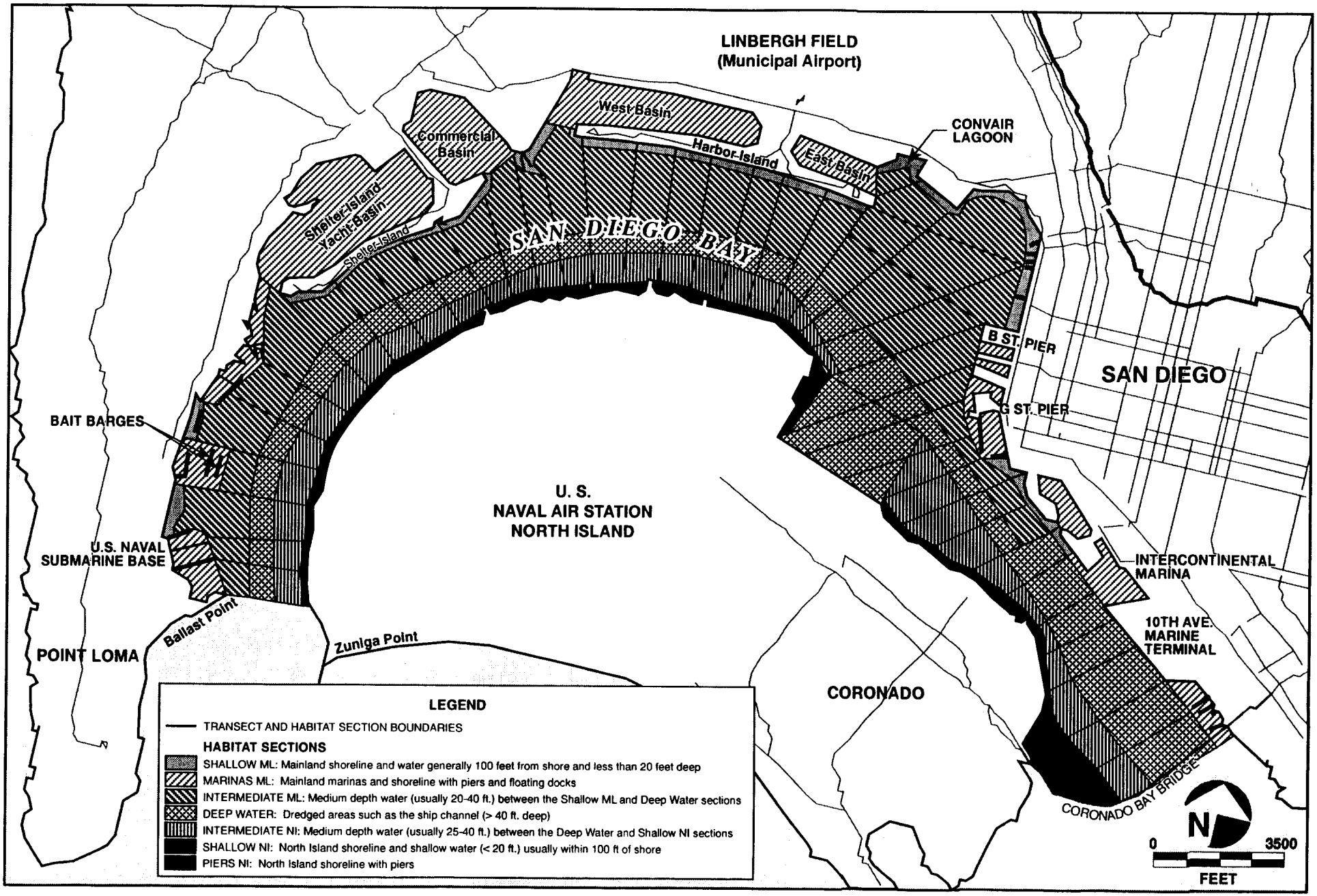
Systematic censusing of waterbird populations in San Diego Bay has usually been limited in scope either spatially or temporally. The most comprehensive effort prior to this study was that of Macdonald et al. (1990a and 1990b) for the South San Diego Bay Enhancement Plan. Macdonald et al. (1990a) conducted onshore shorebird surveys, supplemented by limited census work from a boat. Surveys were conducted in 6 separate months over a 13-month period (June 1988 to June 1989). Censusing efforts prior to Macdonald et al. (1990a) was limited to focused studies for proposed development projects (e.g., Copper 1986). Unitt (1984) summarized general use information for mostly anecdotal observations made prior to 1982. The U.S. Fish and Wildlife Service (USFWS) has initiated concurrent waterbird surveys of South and Central San Diego Bay to complement this study. By the end of 1994, a database for the entire San Diego Bay will have been gathered to provide a comprehensive picture of waterbird distribution and relative abundance in the Bay. This database will be useful in the assessment of future proposed projects in the Bay and allow for bay-wide coordination of project impacts, mitigation, enhancement, and long-range planning as they may relate to waterbird species.

2.0 METHODS

2.1 SURVEY AREAS

This study surveyed for waterbird species in the northern two-thirds of San Diego Bay, which was divided into two study areas. The focus of the 1993 effort was the northern study area. The North San Diego Bay study area extended from the Bay entrance at Ballast Point to the Coronado Bridge (Figure 2a). This study area encompasses over 3,900 acres of water surface and associated shoreline habitats used by waterbird species. The Central Bay survey extended from the Coronado Bridge to the north side of the Sweetwater Channel (Figure 2b).

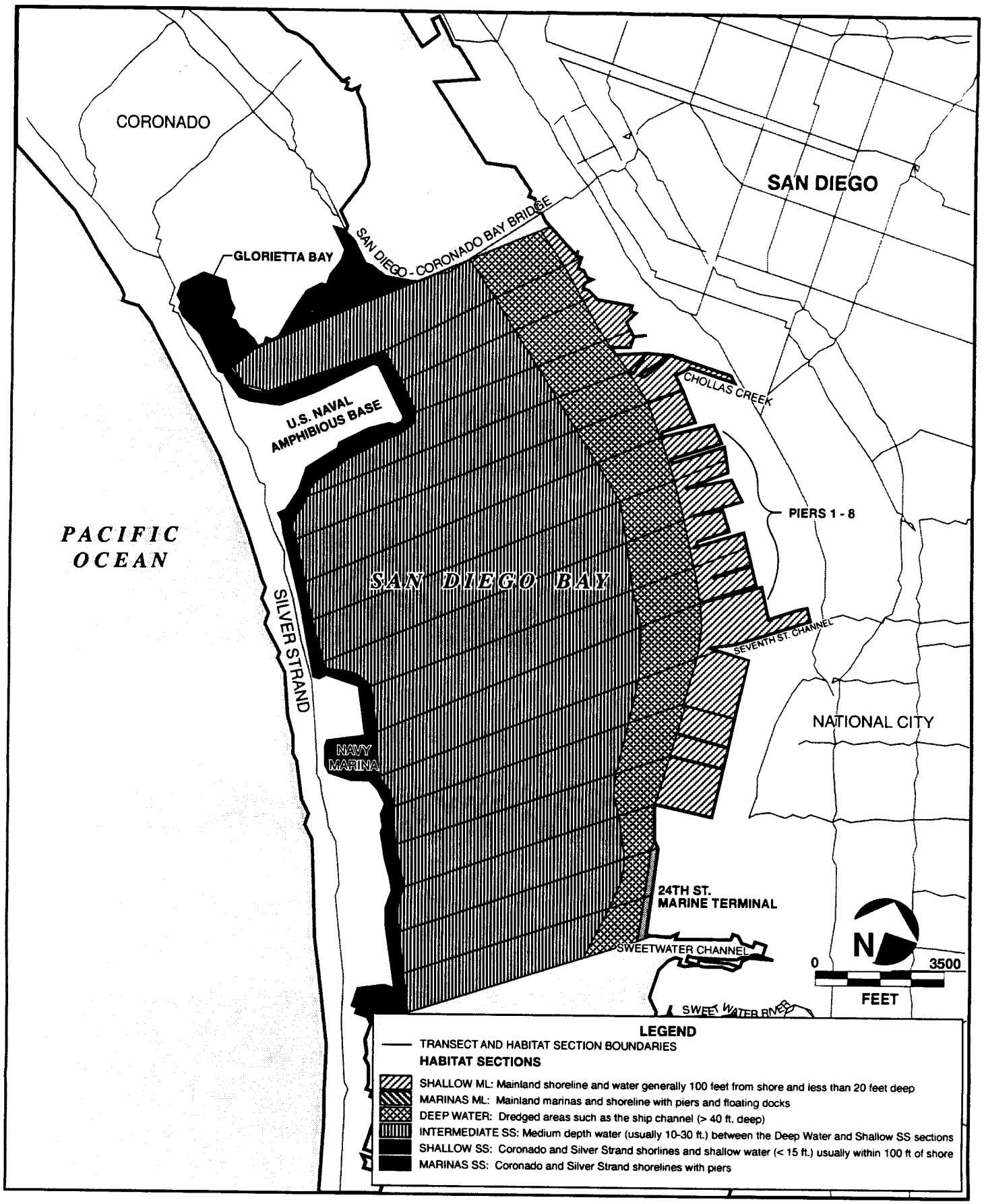
The study areas were divided into 1000-foot wide transects, which were sectioned into cells defined by habitat types related to water depth. The Shallow Mainland (ML) section included the mainland shoreline and water surface within 100 feet of shore. Water depth in the Shallow ML is typically less than 20 feet deep and often less than 10 feet deep. The Intermediate ML section encompassed the area between the Shallow ML and Deep Water sections. Water depths in the Intermediate ML section varied between 15 and 50 feet deep,



FIGURE

2a

North San Diego Bay Survey Area and Habitat Types



FIGURE

Central San Diego Bay Survey Area and Habitat Types

2b

but were typically between 20 and 40 feet deep. The Deep Water Section included the dredged ship channel and other areas whose depths are maintained at greater than 40 feet deep. The Intermediate North Island (NI) section was the area between the Deep Water and Shallow NI sections on the North Island side of the ship channel. Water depth in this section was primarily between 25 and 40 feet deep. The Shallow NI section included the North Island shoreline and the water surface within 100 feet of shore. Water depth in the Shallow NI section ranged up to 20 feet, but was typically less than 10 feet. In addition to these five habitat sections, piers, harbors, docks, and boat basins were designated as Marinas ML or Piers NI.

2.2 SURVEY PROTOCOL

Waterbird surveys of the northern two-thirds of San Diego Bay were conducted between January 1, 1993 and December 31, 1993. Four waterbird surveys were conducted in North San Diego Bay study area each month. The Central San Diego Bay study area was surveyed once each month, usually during the second or third week of each month. The Central San Diego Bay survey was conducted the day following the North San Diego Bay survey of that week to allow for merging data gathered in the same week from both study areas.

Surveys were conducted by three biologists from a 23-foot boat. The boat driver was responsible for following predetermined transect routes, relaying transect and section identification information, and recording weather conditions. The observer searched for and identified birds and documented their behaviors. The recorder compiled waterbird locations and behaviors dictated by the observer and any boat traffic and associated bird avoidance behavior onto standard field data forms (see Appendix D). The observer and recorder typically switched duties every ten transects to minimize observer fatigue.

Routes for the North and Central Bay surveys were conducted from shore-to-shore (Figures 2a and 2b). The driver followed a straight line using pre-established landmarks and compass readings to maintain the course and stay on the north or west side of the 1,000-foot wide transect. At approximately 150 feet from the end of the transect, the driver turned and traveled parallel to the shore to the beginning of the next transect. A speed of 5 to 15 miles per hour was maintained through sections that had few birds, and the boat was stopped when necessary to identify or count large flocks of birds in the section. There were 39 and 19 transects in North Bay and Central Bay study areas, respectively.

The same route was followed in a north to south direction for each survey. The starting point for each survey was varied so that transects were surveyed at varying times of the day each month. Surveys typically began within one hour after sunrise, except when fog limited visibility. On days with dense fog, surveys were begun when it was possible to see over 1000 feet.

Each observation included the following information: transect, section, species, time of observation, number of individuals, and behavior. Behaviors were categorized as foraging, and resting on water, structure or shore. All waterbird species were identified to species level, except most gulls and shorebirds. Gull and shorebird species were recorded and analyzed as a group, except for western snowy plover, Bonaparte's gull, and Heermann's gull for which data were recorded at the species level. A species list was maintained for each survey and included identification of all shorebirds and gulls if feasible. Non-foraging birds flying overhead were not counted unless they were rare species, such as osprey or peregrine falcon. Data on the age classes of brown pelican (adult, subadult, and juvenile) and peregrine falcon (adult and subadult) were also recorded. Age classes were defined using the Humphrey and Parkes (1959) method.

Information on boat traffic was recorded at the beginning of each transect and included the type and number of boats within each section of the transect. Anecdotal observations of bird avoidance of boats was also recorded, including species, type of avoidance behavior (fly, swim, dive), distance from the boat when the avoidance behavior was initiated, and type and speed of boat causing the avoidance. Distance and speed data were grouped into broad categories due to the difficulty in obtaining accurate estimates for these two variables. Information on boat traffic and avoidance behavior was a secondary objective of the study and was collected when feasible. These data were not always collected due to time restrictions (e.g., completing the survey before sunset).

Weather data were recorded at the start of the survey, every fifth transect thereafter, and in all basins and harbors. Weather variables included air and water temperature, wind speed and direction, wave characteristics (Beaufort scale), percent cloud cover, and general visibility.

2.3 DATA ANALYSIS

All observation data were entered into computer spreadsheets and later imported into a relational database and statistical programs for data reduction and summaries. The survey data were analyzed in three ways: by grouping all observations of waterbirds into an "all waterbirds" category; analyzing selected sensitive target species individually; and by grouping waterbird species into guilds based on foraging behavior.

Target species were selected based on their federal sensitivity status or due to concerns expressed by the USFWS in regard to their status in San Diego Bay. Target species included California brown pelican (*Pelecanus occidentalis californicus*), brant (*Branta bernicla*), lesser scaup (*Aythya affinis*), greater scaup (*Aythya marilla*), surf scoter (*Melanitta perspicillata*), American peregrine falcon (*Falco peregrinus anatum*), western snowy plover (*Charadrius alexandrinus nivosus*), elegant tern (*Sterna elegans*), and California least tern (*Sterna antillarum browni*).

The listing of species assigned to each foraging guild is provided in Appendix A. Foraging guilds were categorized as follows:

- The wader/shallow water guild include birds that use the intertidal zone and forage for invertebrates, fish, and other small vertebrates. The wader guild includes mostly egrets and herons.

- The prober guild is characterized by birds (primarily shorebirds) that probe with their bills in the substrate for invertebrates on exposed sandy beaches and tidal mudflats.

- Bottom feeders dive underwater and forage on the bottom substrate for invertebrates and submerged vegetation. The bottom feeding guild includes brant, surf scoter, and scaup species.

- The water column diving guild is composed of loons and grebes that dive under the surface of the water to various depths and forage primarily on fish.

- The plunge diver guild search for fish while flying and dive to just below the surface to capture their prey. Members of the plunge diving guild include brown pelican and tern species.

- The predator guild is represented by peregrine falcon and northern harrier *(Circus cyaneus)* which often prey upon waterbirds.

- The generalist guild include gull species, mallard (*Anas platyrhynchos*), and American coots (*Fulica americana*), and use a wide variety of food sources and employ various foraging techniques on both shore and water.

Each of the 58 shore-to-shore transects was divided into sections corresponding to different habitat types (Figures 2a and 2b):

- The Shallow ML section included the mainland shoreline and water within 100 feet of shore. Water depth in the Shallow ML was less than 20 feet deep and usually less than 10 feet.

- The Intermediate ML section encompassed water between the Shallow ML and Deep Water sections. Water depths in the Intermediate ML section varied between 15 to 50 feet deep, but were typically less than 40 feet.

- The Deep Water Section included the ship channel and other periodically dredged areas of 40 feet or deeper.

- The Intermediate NI section was between the Deep Water and Shallow NI sections on the North Island side of the channel. Water depth in this section was primarily between 25 and 40 feet.

- The Shallow NI section included the North Island shoreline and generally, water within 100 feet of shore. Water depth in the Shallow NI section ranged up to 20 feet, but was typically less than 10 feet.

- Marinas ML section included piers, harbors, docks, and boat basins on the mainland side.

- Piers NI section included piers and docks on the North Island side.

The Marinas ML section included a large number of pier and dock areas along shorelines as well as the major boat basins. If a section was especially large, it was divided into two or more parts. Marinas were not divided into smaller units because surveys in these areas were conducted in a circular manner. Division of these marinas into smaller units could result in confusion over whether some birds had been previously counted. Shoreline areas included tidal mudflats, dirt embankments, sandy beaches, and rip-rap along the water's edge which were visible from the boat. The shoreline is defined as between the water and the top of embankments (seawalls, banks, and rip-rap), the closest man-made structures (e.g., roads, homes, buildings), or landscaped areas (e.g., yards, parks), as appropriate.

Analyses of habitat use versus habitat availability in North Bay were performed for all waterbird species combined, individual target species, and foraging guilds. Data for all waterbird species were analyzed using the following categories: all behaviors combined, foraging, and resting. Resting was the combination of resting on water, structure, and shore. Proportions of birds within each habitat type were calculated and compared to the relative availability of each habitat based on acreage in North Bay. The Piers NI habitat category was a very small proportion of North Bay and was merged with the Marinas ML category. Positive or negative preferences for each habitat type were determined using the Neu test (Neu et al. 1974, Hanley and Solow 1992). An alpha value of $p < 0.05$ was assumed to be statistically significant.

A relative use index was developed for this data set. Cumulative counts were compiled for each North Bay cell and density calculated by dividing the cumulative number of waterbirds observed in each cell by the area of that cell. Cells were ranked relative to the cell with the highest density. Each cell density was divided by this highest density to assign a relative index value for that behavior category. Some of the highest density cells were considered unusual outliers and therefore were not appropriate to use as a base of the index. In these cases, a cell with lower density was chosen as base of the index. Cell index values for target species and foraging guilds were based on the total density of birds (all behaviors combined). The cell with the highest density in which foraging was the predominant activity (> 50 percent of observations) was chosen as the indexing cell. This indexing ensured important foraging areas were included in the very high value category and were not undervalued due to cells with very high densities of roosting birds. The following

Density Index Value	Relative Waterbird Use
greater than 0.75	Very High
0.51 to 0.75	High
0.26 to 0.50	Medium
less than 0.25	Low
Zero	No Use

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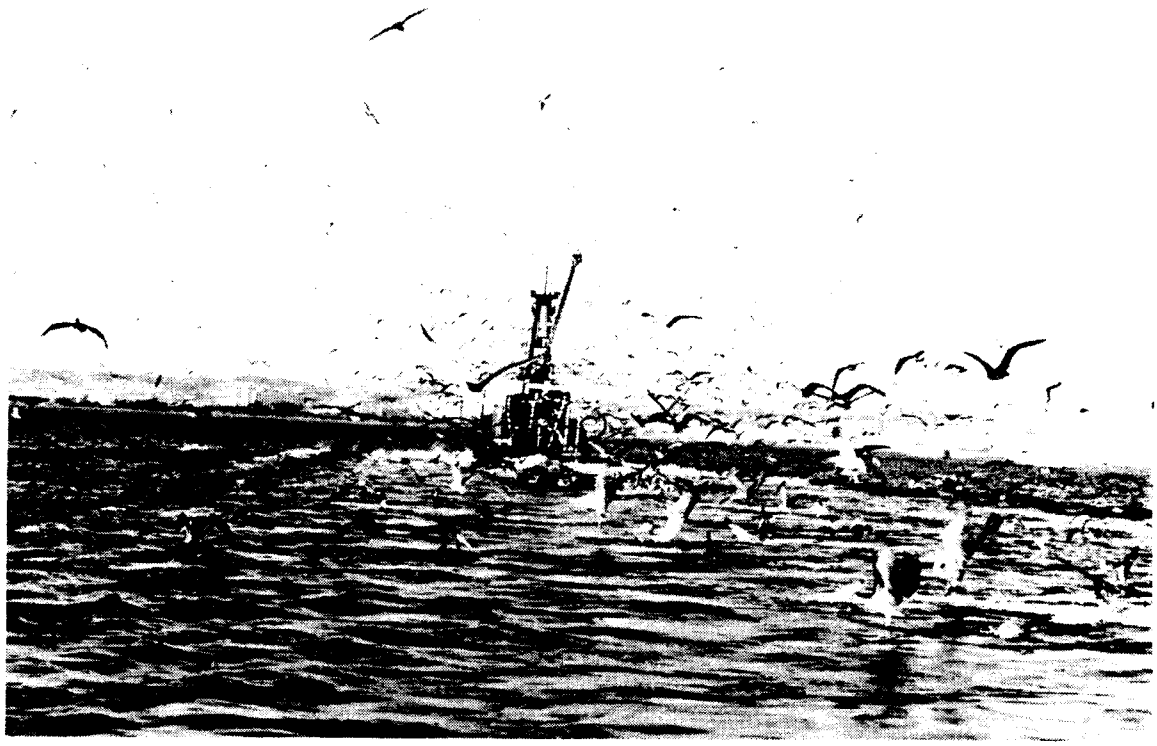


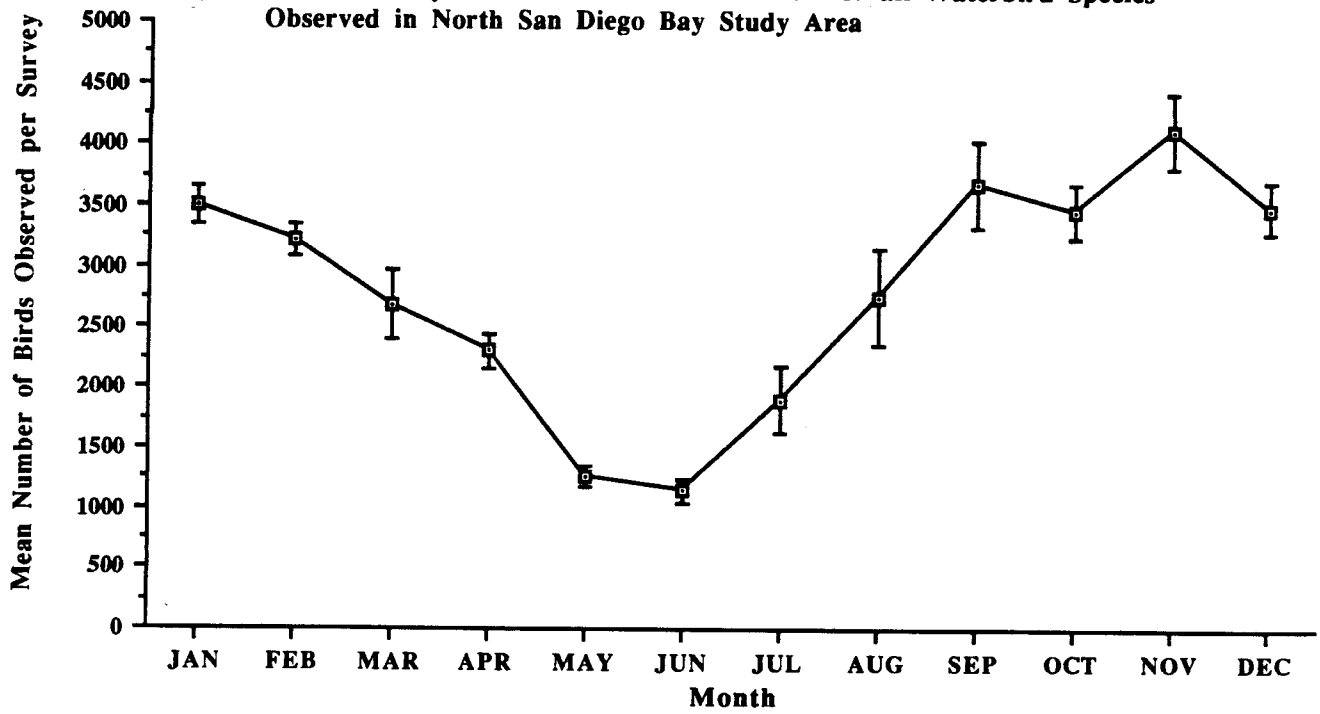
3.0 RESULTS

3.1 SPECIES RICHNESS AND SURVEY COUNTS

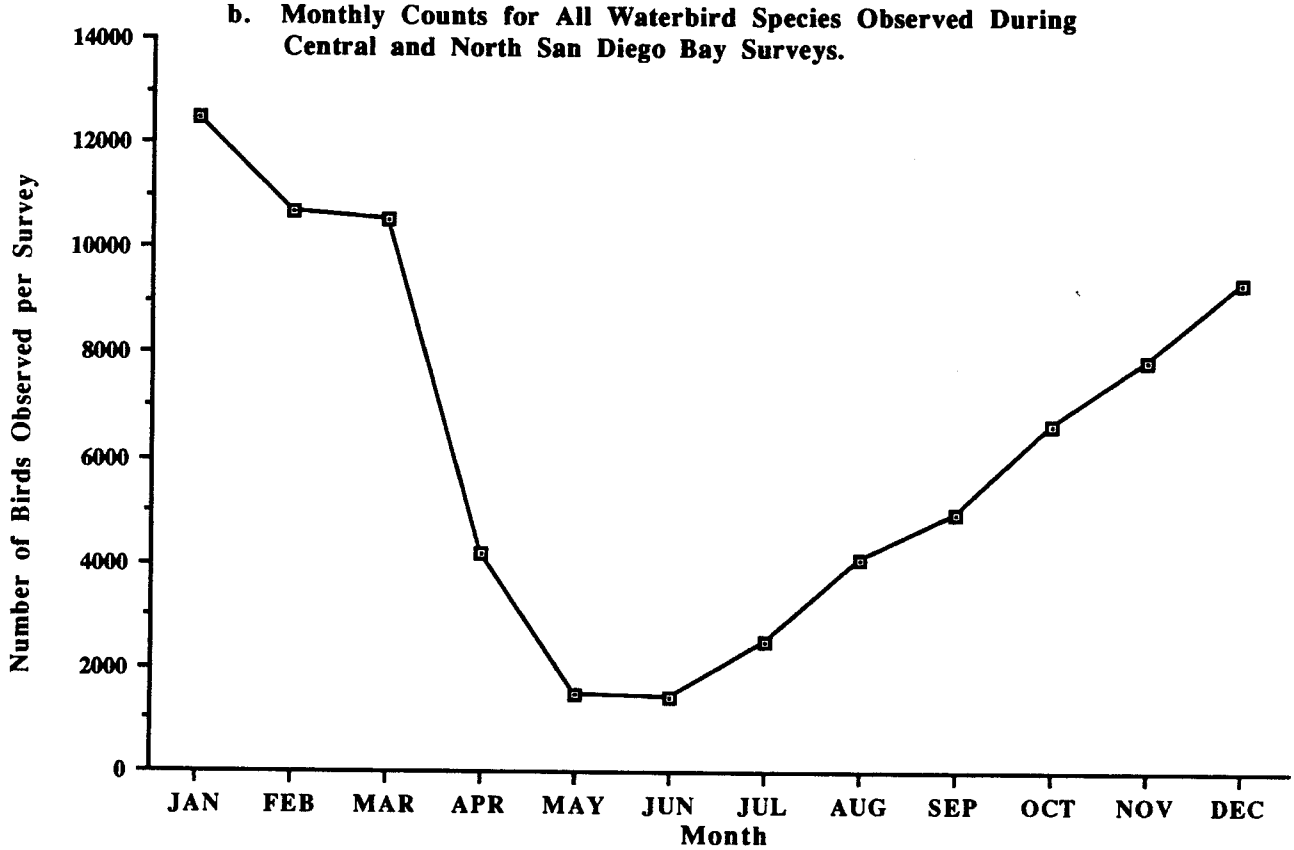
A total of 70 waterbird species was observed during 48 surveys of North San Diego Bay in 1993. The 12 surveys of Central San Diego Bay documented 62 waterbird species. Species richness (i.e., number of waterbird species) peaked at 55 species in North Bay and 40 species in Central Bay during January. Species richness was lowest in June with 21 waterbird species detected for both North and Central Bay study areas. Species accounts provided in Appendix B characterize each waterbird species in regard to their sensitivity status, regional distribution, residency status, relative abundance, foraging guild, preferred habitats, and high use areas in North San Diego Bay.

Highest mean monthly waterbird counts for North Bay occurred from September through January, with a peak in November (4,124 individuals/survey; Figure 3a). The lowest waterbird counts were in May and June (<1,300 individuals/survey). Total counts for individual North Bay surveys ranged from 999 birds (second week of June) to 4,999 birds (second week of November).

a. Mean Monthly Counts and Standard Error for all Waterbird Species Observed in North San Diego Bay Study Area



b. Monthly Counts for All Waterbird Species Observed During Central and North San Diego Bay Surveys.



Note: Different scales between graphs.

FIGURE 3

1993 San Diego Bay Survey Counts for All Waterbird Species

For the 12 corresponding North and Central Bay surveys combined, the highest waterbird counts were from January (12,461 birds) through March (10,511 individuals; Figure 3b). The lowest combined totals were in May and June (approximately 1,450 individuals) Waterbird numbers were more variable in Central Bay than North Bay, with a high of 8,647 birds in January and a low of 303 birds in May. Waterbird abundance peaked later in Central Bay than in North Bay, with highest numbers observed from January through March. May and June was the same period for low numbers of waterbirds for both North Bay and Central Bay. Monthly counts of target species and foraging guilds are presented in Figures 4, 5, and 6. Heermann's gull, Brandt's cormorant and brown pelican were the most abundant species in North Bay, each cumulatively exceeding 10,000 individuals (Table 1). Surf scoter was the dominant species occuring in Central Bay.

Target Species

California Brown Pelican

California brown pelican reached the highest population levels in San Diego Bay in September and October (Figure 4). Pelican age class structure in San Diego Bay varied dramatically throughout the year (Figure 7). Adult pelicans had a brief but sizable population increase in July, followed by a sharp decline in August, then reached a similar peak in October and November. The adult population during the early breeding season was low, typically less than 100 individuals. Subadults appeared in substantial numbers in July and peaked when the adult population was declining in August and September. By the second peak of adults in October, the subadult population had declined and it stayed at low levels for the remainder of the year. Juveniles (young of the year) began arriving in the Bay in July, reaching a peak in September and then declining. For the combined North and Central Bay surveys, brown pelicans showed more fluctuations in total numbers and age class composition than with the monthly North Bay means (Figures 7a and 7b).

California Least Tern

California least terns were first observed in North Bay during the third survey of April and were last seen on the third survey in August. Least tern was the 14th most abundant species observed in North Bay (excluding gull and shorebird species; Table 1) with the population peaking in June (Figure 4a). No nesting was observed in North Bay, although

Table 1

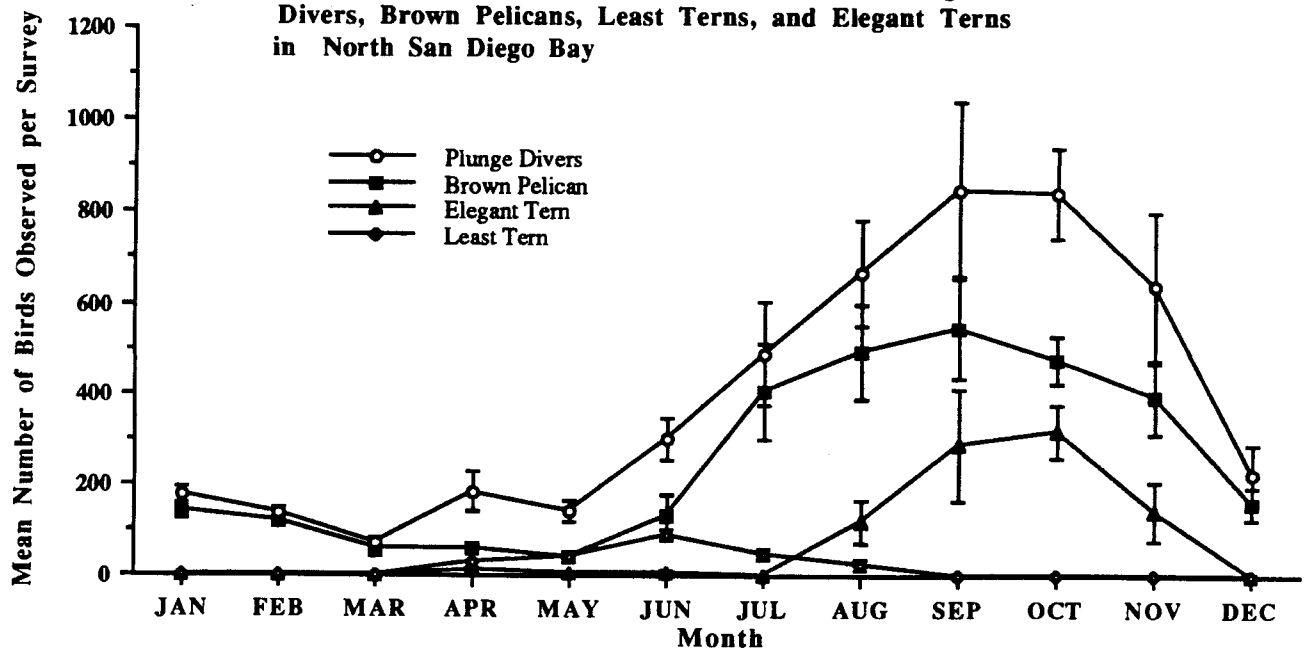
CUMULATIVE COUNTS FOR 25 MOST ABUNDANT WATERBIRD SPECIES OBSERVED IN NORTH AND CENTRAL SAN DIEGO BAY IN 1993

	North San Diego Bay		Central San Diego Bay	
Rank	Species	Total Count	Species	Total Count
1	Heermann's Gull	15,402	Surf Scoter	19,651
2	Brandt's Cormorant	12,672	Scaup Species*	2,300
3	California Brown Pelican	12,020	California Brown Pelican	1,108
4	Surf Scoter	5,185	Bufflehead	1,042
5	Bufflehead	5,104	Heermann's Gull	778
6	Western Grebe	3,636	Eared Grebe	713
7	Elegant Tern	3,550	Mallard	600
8	Scaup Species*	2,993	California Least Tern	568
9	Double-crested Cormorant	2,461	Forster's Tern	536
10	Mallard	2,440	Elegant Tern	438
11	Great Blue Heron	2,214	Brandt's Cormorant	351
12	Forster's Tern	1,994	Double-crested Cormorant	265
13	Snowy Egret	1,811	Western Grebe	182
14	California Least Tern	920	Great Blue Heron	150
15	Eared Grebe	795	Brant	77
16	Great Egret	740	American Coot	73
17	Red-breasted Merganser	395	Snowy Egret	61
18	Bonaparte's Gull	353	Royal Tern	51
19	Black-crowned Night Heron	328	Red-breasted Merganser	50
20	Common Loon	312	Common Loon	47
21	Caspian Tern	175	Great Egret	35
22	Clark's Grebe	145	Caspian Tern	23
23	American Coot	134	Bonaparte's Gull	19
24	Red-throated Loon	127	Black Skimmer	16
25	Pied-billed Grebe	126	Pied-billed Grebe	16
	Total Birds Observed	**132,426**		**76,138**

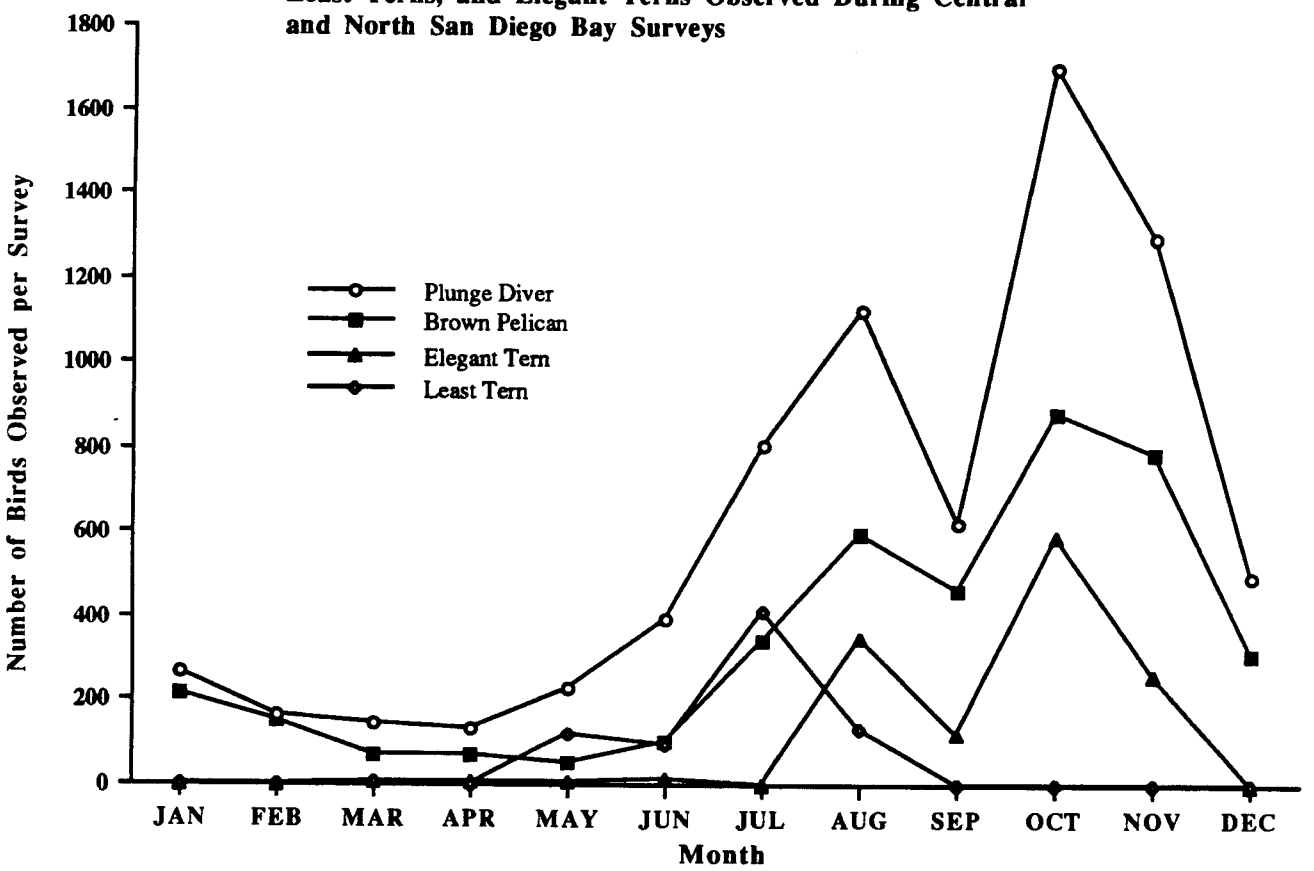
* Lesser and greater scaup were lumped into a single group because of the difficulty and time required to differentiate to species level.

Note: This table excludes counts for gull and shorebird species not identified to species level. Survey effort differed: North Bay was surveyed four times each month and Central Bay was surveyed once each month.

a. **Mean Monthly Counts and Standard Error for Plunge Divers, Brown Pelicans, Least Terns, and Elegant Terns in North San Diego Bay**



b. **Monthly Counts for Plunge Divers, Brown Pelicans, Least Terns, and Elegant Terns Observed During Central and North San Diego Bay Surveys**

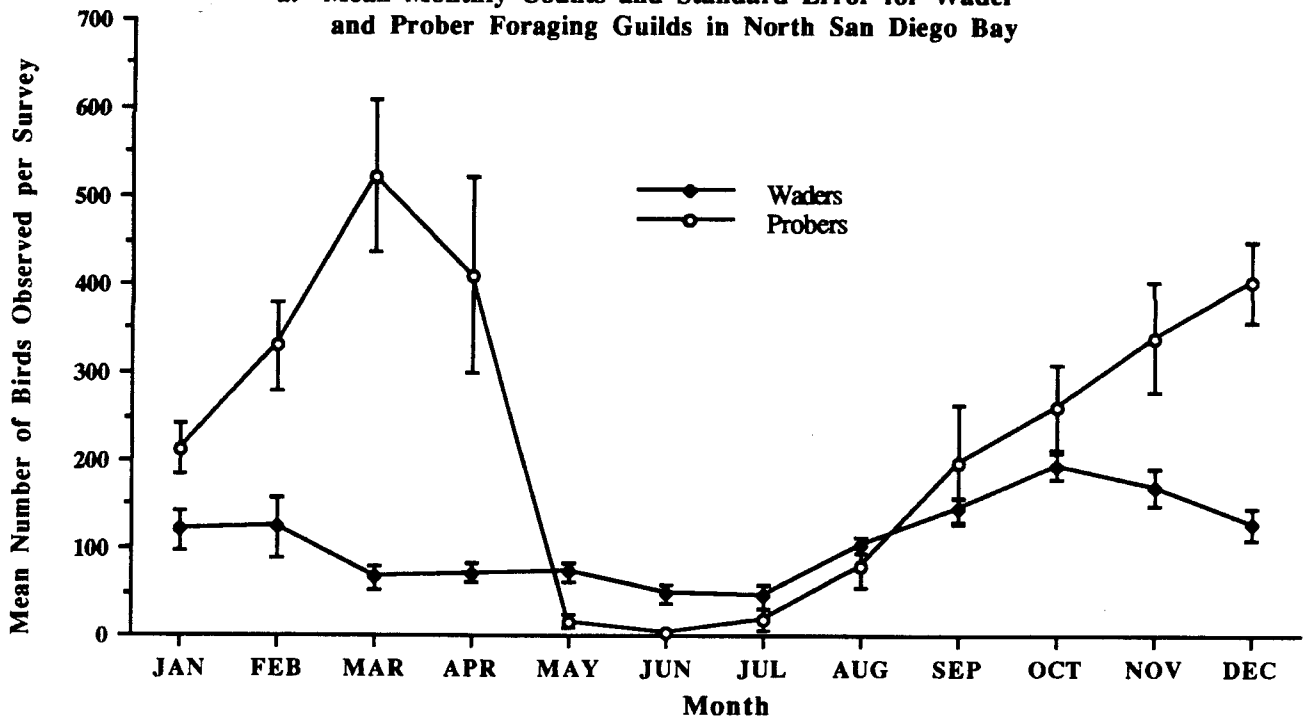


Note: Different scales between graphs.

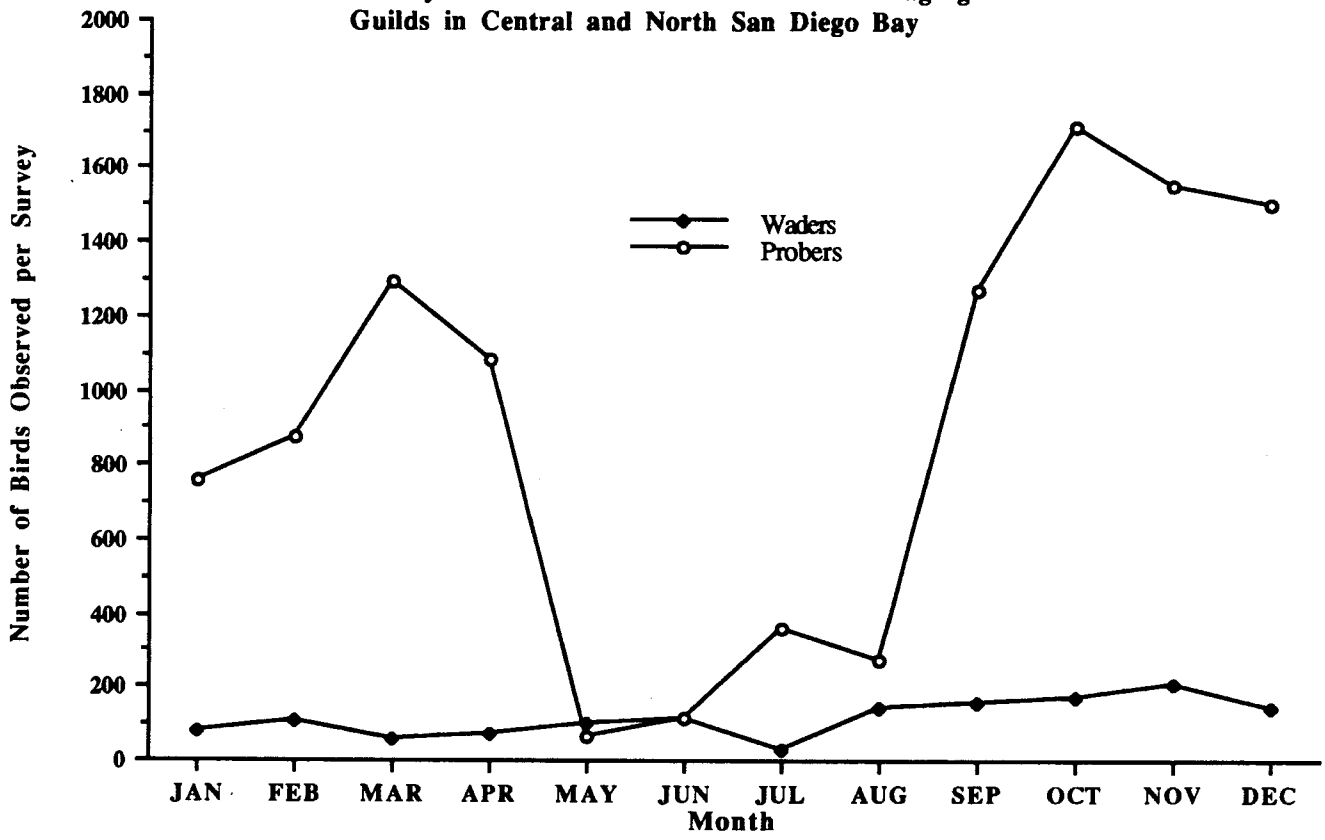
1993 San Diego Bay Monthly Survey Counts for the Plunge Diving Foraging Guild and Associated Species; California Brown Pelican, California Least Tern, and Elegant Tern

FIGURE **4**

a. Mean Monthly Counts and Standard Error for Wader and Prober Foraging Guilds in North San Diego Bay



b. Monthly Counts for Wader and Prober Foraging Guilds in Central and North San Diego Bay

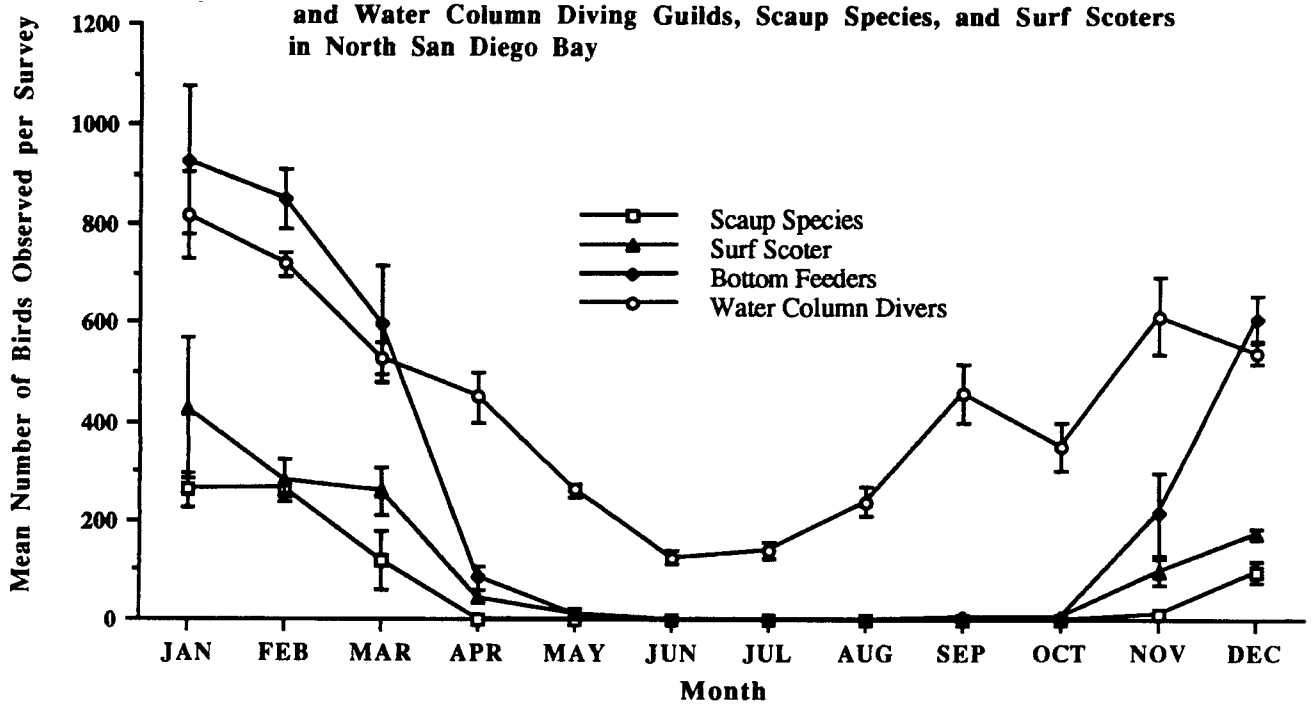


Note: Different scales between graphs.

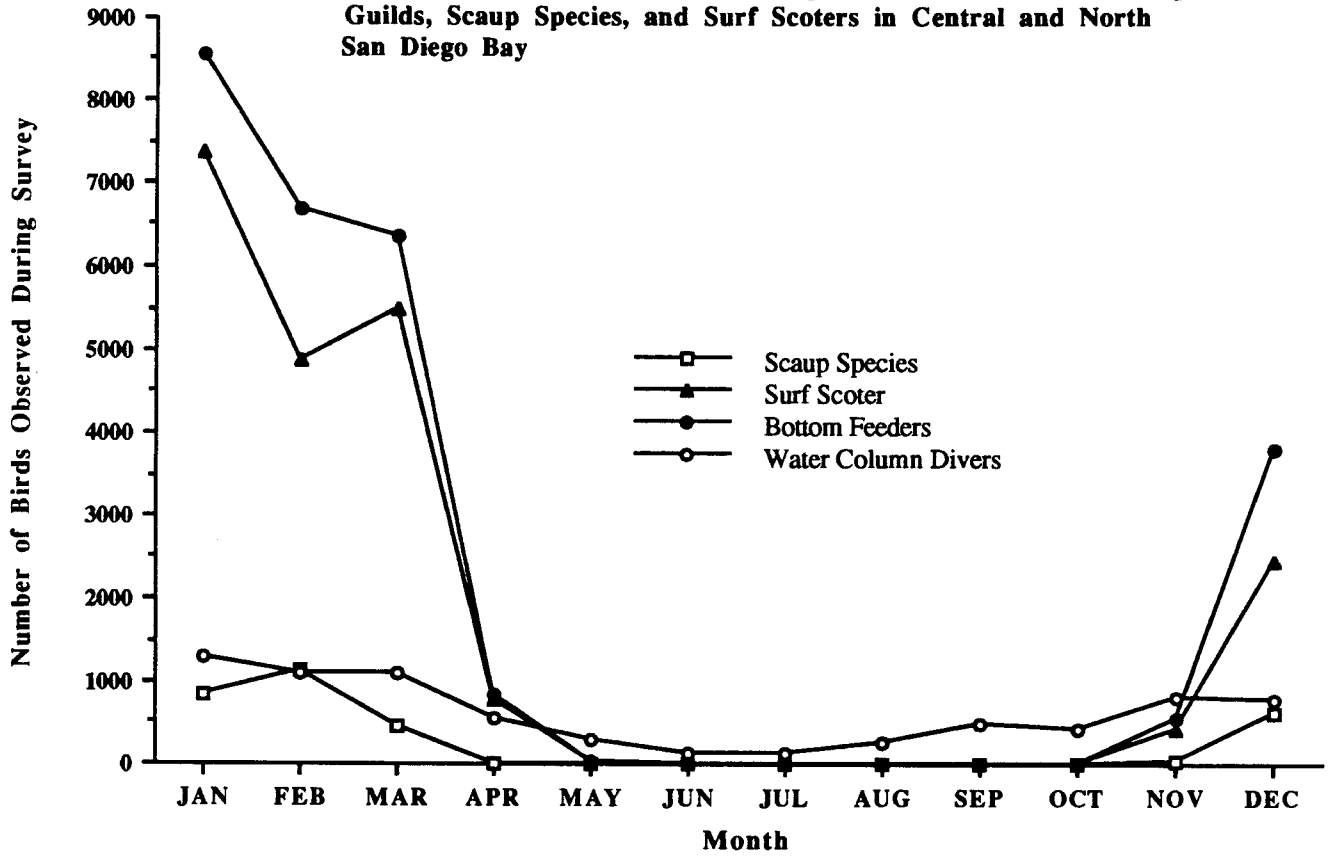
FIGURE 5

1993 San Diego Bay Monthly Counts for the Wader/Shallow Water and Prober Foraging Guilds

a. **Mean Monthly Counts and Standard Error for Bottom Feeding and Water Column Diving Guilds, Scaup Species, and Surf Scoters in North San Diego Bay**



b. **Monthly Counts for Bottom Feeding and Water Column Diving Guilds, Scaup Species, and Surf Scoters in Central and North San Diego Bay**

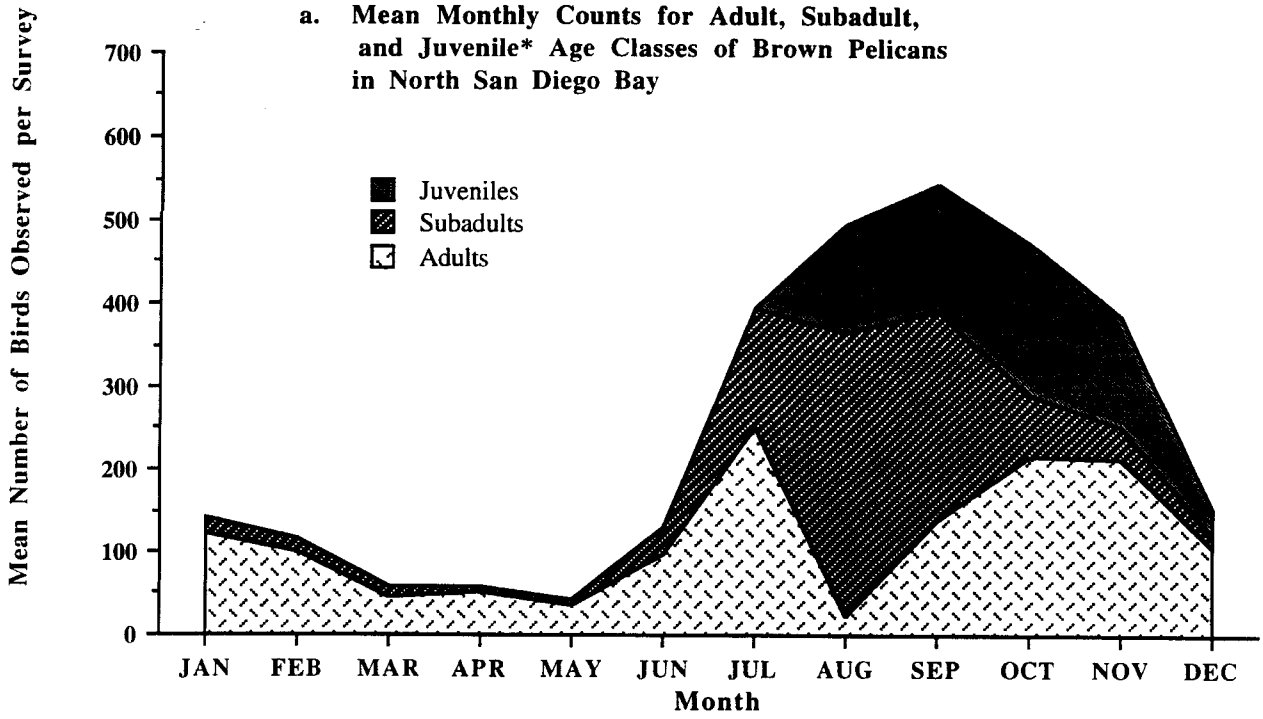


Note: Different scales between graphs.

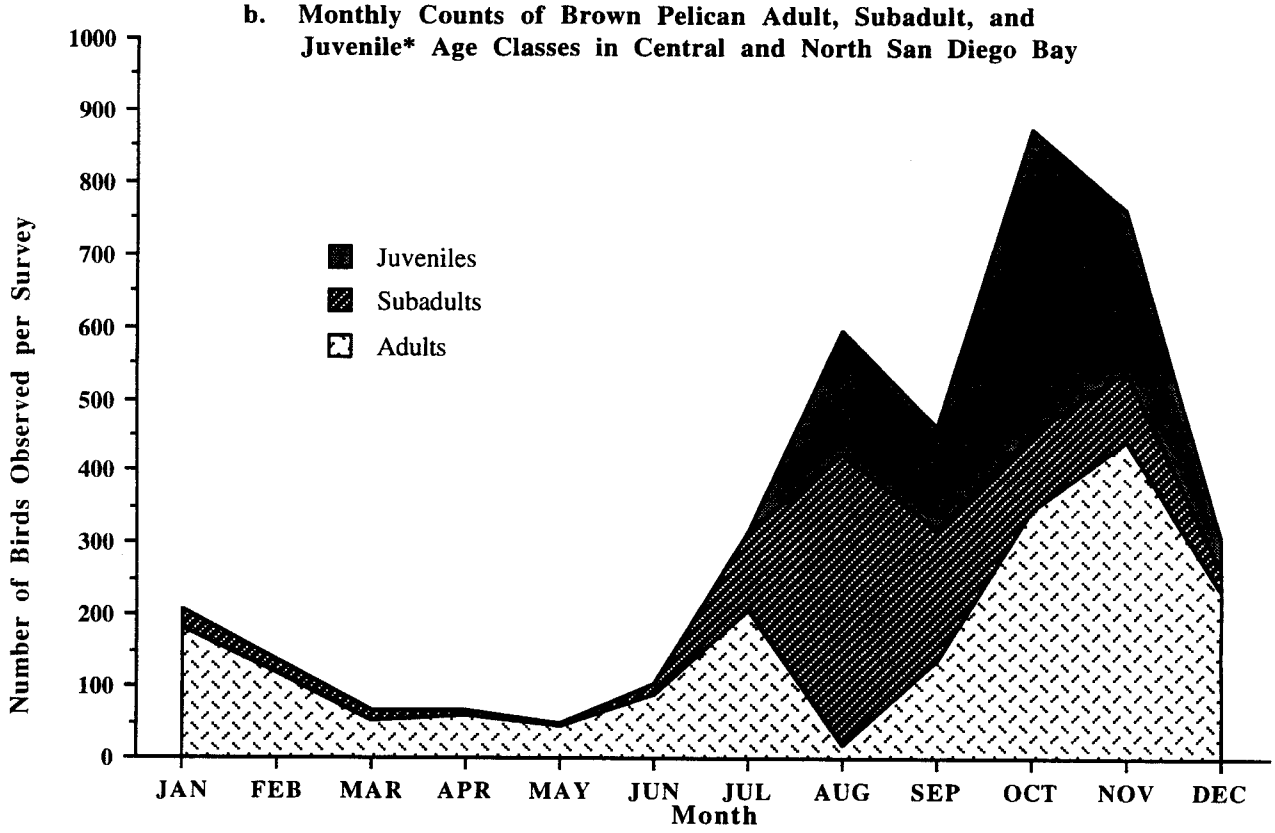
FIGURE 6

1993 San Diego Bay Monthly Counts for the Bottom Feeding and Water Column Foraging Guilds, Scaup Species, and Surf Scoter

a. **Mean Monthly Counts for Adult, Subadult, and Juvenile* Age Classes of Brown Pelicans in North San Diego Bay**



b. **Monthly Counts of Brown Pelican Adult, Subadult, and Juvenile* Age Classes in Central and North San Diego Bay**



* Juvenile age class defined as young of the year based on plumage characteristics.
Note: Different scales between graphs.

1993 California Brown Pelican Age Class Distribution in San Diego Bay

FIGURE **7**

courtship behavior and parental care of recently fledged young was observed on several occasions. Least terns were observed in Central Bay surveys in May through August surveys and were the 8th most abundant species (Table 1). The least tern nesting colony on the Silver Strand (Delta Beach) was active in 1993. The peak count for least terns for the combined North and Central Bay surveys was in July (Figure 4b).

American Peregrine Falcon

American peregrine falcon was observed on 4 of 48 North Bay surveys. Single sightings of adult falcons were made in June and December, and a pair was observed in November. A bird of unknown age was glimpsed briefly in October. Peregrine falcons were observed on 5 of the 12 monthly Central Bay surveys. Single sightings of adult falcons were made in February and December 1993, and a pair was observed near the Coronado Bridge in October. An immature falcon was observed in January and a bird of unknown age was seen in April. Peregrines have used the Coronado Bridge for nesting since 1989 (Pavelka 1990), and a breeding pair was documented near the southern boundary of the Central Bay survey area in 1993 (T. Burr pers. comm.).

Elegant Tern

Elegant tern was the 7th most abundant species observed in North San Diego Bay (Table 1). This species reached peak abundance in September and October (Figure 4a), with a high of 644 individuals on a single survey in September. Elegant terns were not observed in North Bay during the last three surveys in December or from January through the middle of March, except for a single individual during the first week of February. Although the elegant tern was more abundant than the least tern in North Bay, the opposite was true in Central Bay, where relatively fewer elegant terns were observed (Table 1). Combined survey results from North and Central Bay, suggest two peaks of abundance; one peak in August and another larger peak in October (Figure 4b).

Western Snowy Plover

Only two western snowy plovers were observed in North Bay, both in January 1993. It is likely that some snowy plovers were missed due to the difficulty in identifying small shorebirds at a distance from a boat. However, because most individual shorebirds were identified to the species level most of the time, the number of snowy plovers overlooked is

probably small. There were no snowy plovers seen in the Central Bay during the 12 surveys. Surveying the shoreline in Central Bay was more difficult because the water depth is too shallow to manuver the boat close to shore areas likely to support snowy plovers. Snowy plovers were likely present at beaches along the Silver Strand and the southern edge of the Naval Amphibious Base.

Brant

There were no brant observed in North Bay in 1993. A total of 77 brant were observed during Central Bay surveys from February to April.

Scaup Species

A significant effort was required to distinguish scaup species and these ducks were often lumped as scaup species. Lesser and greater scaup combined were the 8th most abundant species in North Bay (Table 1). Of the 2,050 scaup identified in North Bay to species level, 81.4 percent were lesser scaup. Highest scaup counts were in January and February (Figure 6a). In Central Bay, lesser and greater scaup combined were the 2nd most abundant species (Table 1). Lesser scaup accounted for 92.9 percent of the 368 sightings differentiated to species. Lesser and greater scaup counts for corresponding North and Central Bay surveys combined were highest in February (Figure 6b). Scaups were absent from North and Central Bays between April and mid-November.

Surf Scoter

Surf scoter was the fourth most abundant species observed in North San Diego Bay (Table 1). Scoters peaked in abundance in January and were not present from May to October, except for a few transient individuals (Figure 6a). Surf scoters were the most abundant species in Central Bay. Surf scoters ranged from 4,638 to 6,583 individuals per survey in Central Bay between January and March. For the combined monthly North and Central Bay surveys, surf scoters were also the most abundant species. The highest single count of 7,340 individuals of the combined North and Central Bay surveys occured in January (Figure 6b).

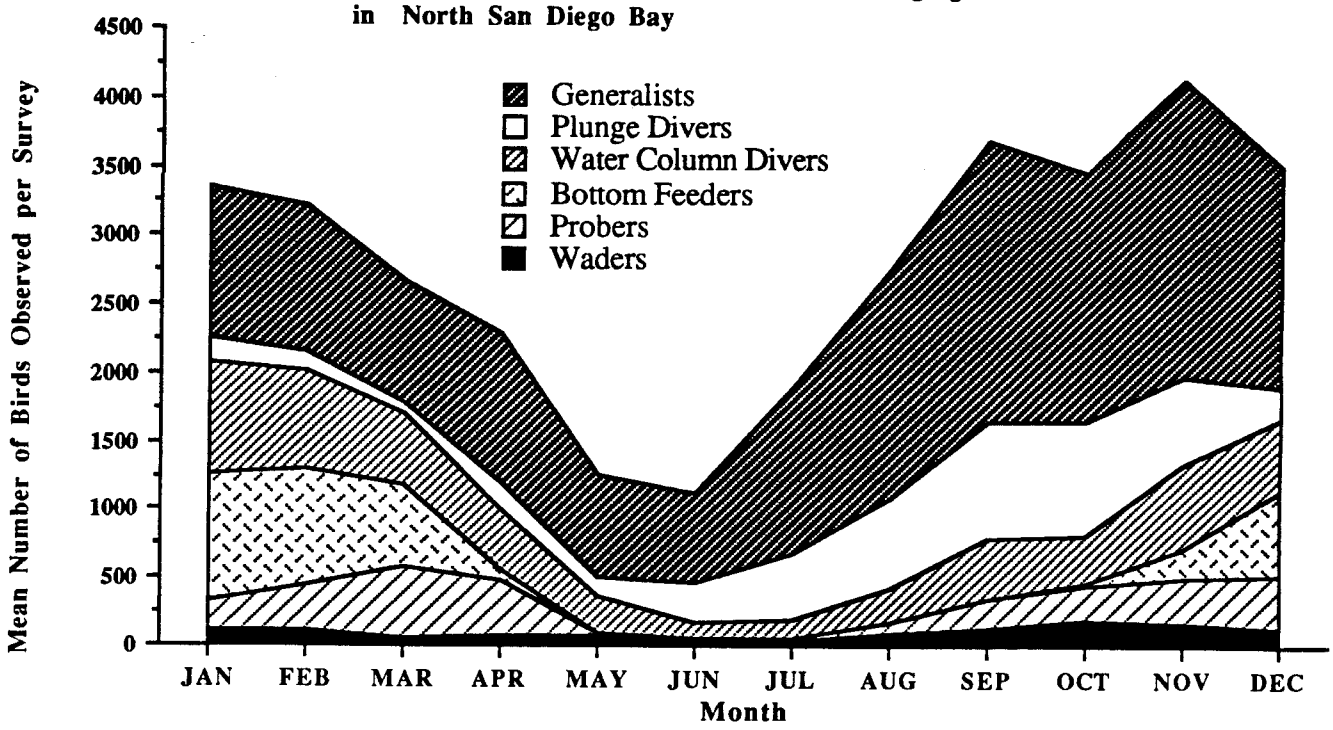
Foraging Guilds

Mean monthly counts of the various foraging guilds fluctuated widely throughout the year in North San Diego Bay (Figures 4a, 5a, 6a, 8a). There was a general trend for high guild counts from late summer through winter with lowest counts in the spring. Plunge divers were most abundant from July through November, with lowest numbers in March (Figure 4a). Highest average counts for waders occurred August to February, with a peak in October (Figure 5a). Prober populations were highest in March, with a secondary peak in November and December, and were mostly absent from May to July (Figure 5a). Bottom feeders and water column divers had a general trend of high counts between December and March, being mostly absent from May to October (Figure 6a).

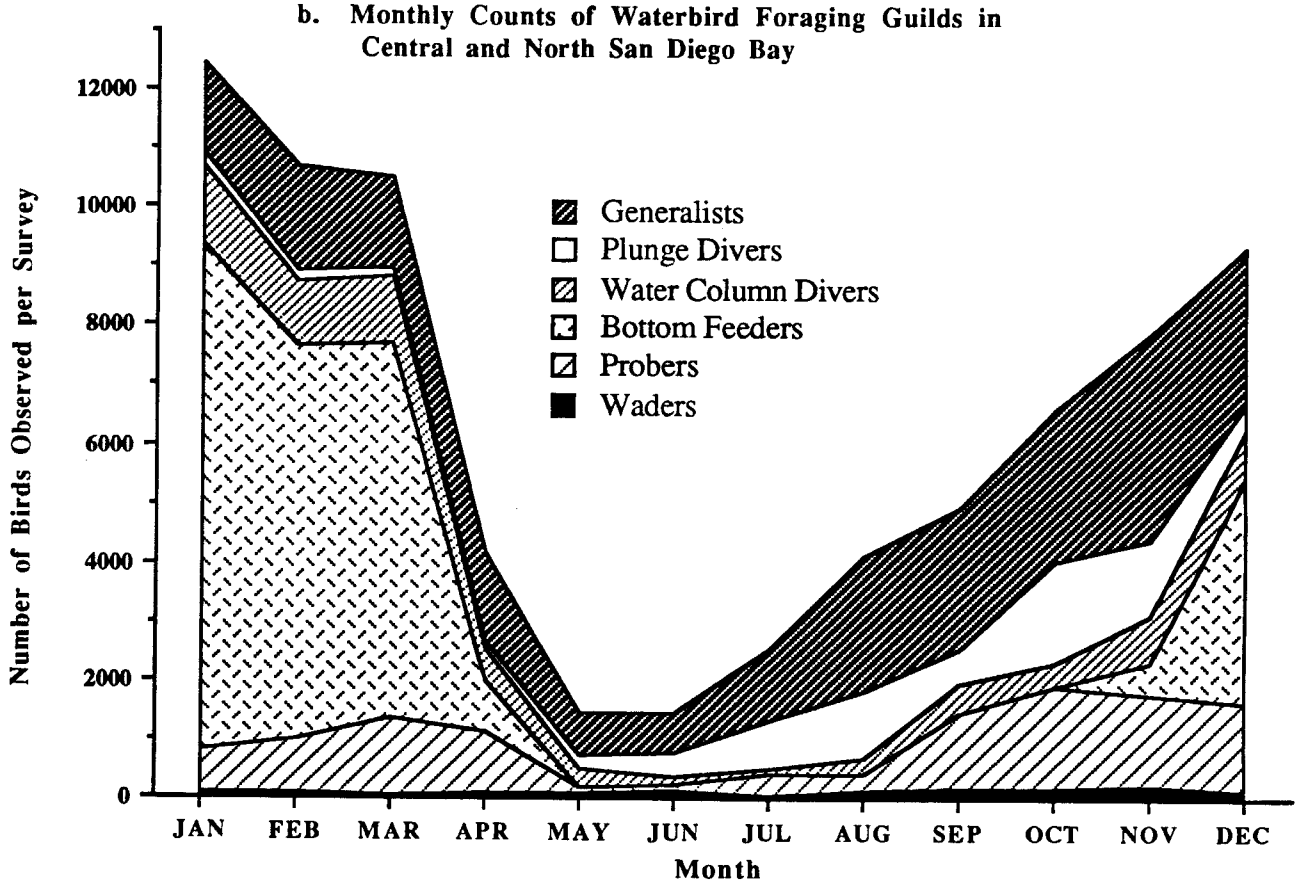
The generalist guild (gulls, mallard) was the most abundant guild in North Bay with 47.6-percent of the 132,426 waterbird sightings. This guild was followed in order of decreasing abundance by water column divers (15.8%), plunge divers (14.2%), bottom feeders (10.0%), probers (7.5%), waders (4.8%). Only four predator guild sightings (peregrine falcons) were made during the 12-month North Bay study.

A substantially different pattern of foraging guild abundance over time is apparent when survey data from the 12 Central Bay and the 12 corresponding North Bay surveys are combined (compare Figures 8a and 8b). The various foraging guilds apparently use the two study areas differently due to differences in habitat type. Central Bay has substantially greater area of shallow water which attracts larger numbers of bottom feeders (primarily scaup and scoter). Bottom feeders become the dominant guild with 35.2 percent of the 76,138 waterbird sightings in the combined North and Central Bay data set. Generalists were second in abundance (29.3%), being proportionately less dominant relative to North Bay. Other guilds that decreased in relative abundance in the combined surveys were plunge divers (9.7%), water column divers (9.7%), and waders (1.8%). Probers increased to 14.3 percent in relative abundance compared with the North Bay surveys. The predator guild in Central Bay remained a very small proportion of the total birds observed, similar to the North Bay survey results.

a. Mean Monthly Counts for Waterbird Foraging Guilds in North San Diego Bay



b. Monthly Counts of Waterbird Foraging Guilds in Central and North San Diego Bay



Note: Different scales between graphs.

FIGURE 8

1993 San Diego Bay Monthly Waterbird Foraging Guild Counts

3.2 HABITAT AND SPATIAL USE OF NORTH SAN DIEGO BAY

All Waterbird Species Combined

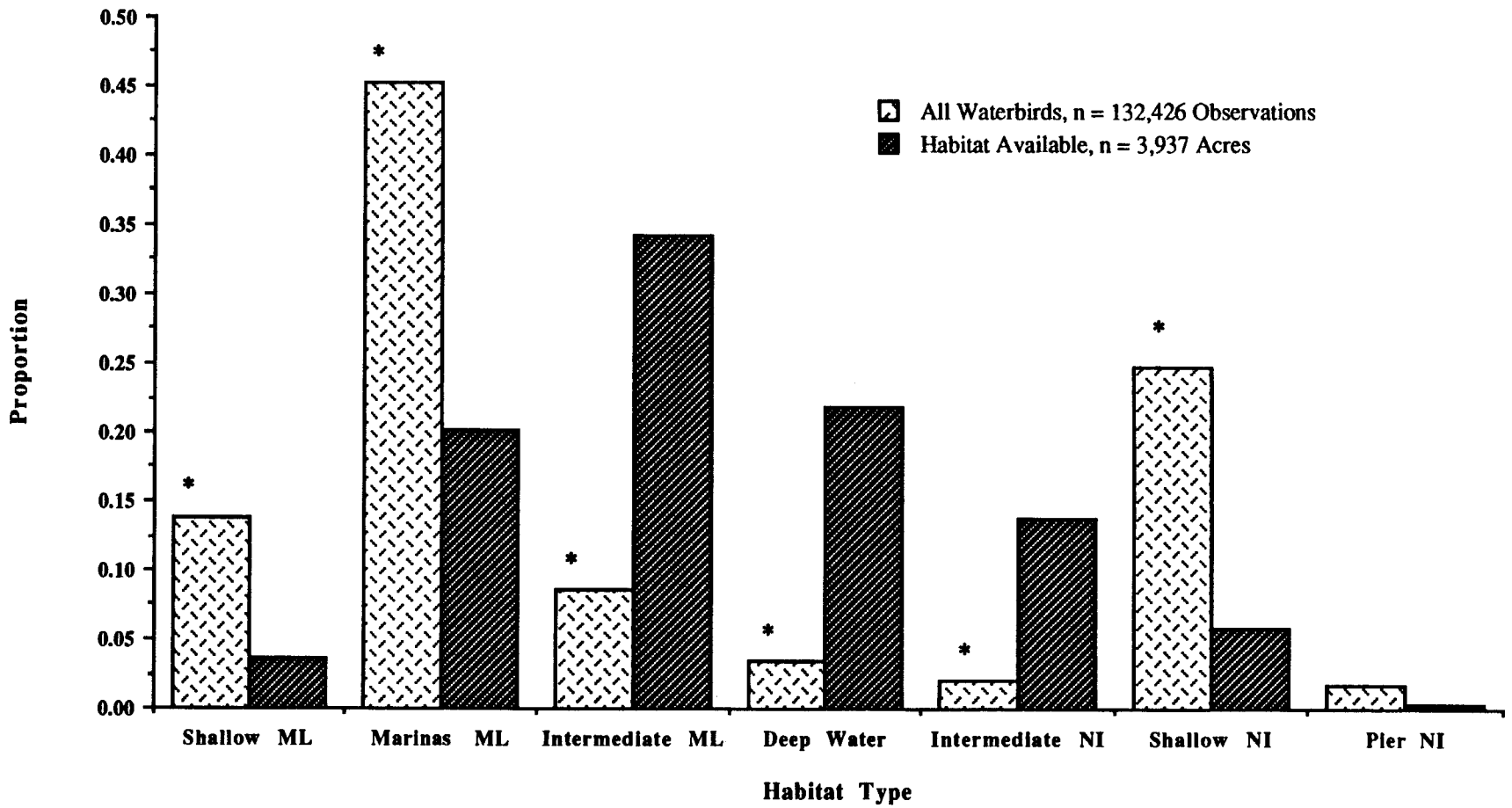
For all waterbird sightings combined, a significant positive preference for relatively shallow water habitat (Marina ML/Pier NI, Shallow ML, and Shallow NI) was shown (Figure 9). Significant negative preferences for relatively deeper water habitats (e.g., Intermediate ML, Deep Water, and Intermediate NI sections) are indicated from these data. This trend was also exhibited for observations of only foraging or resting waterbirds (Figures 10a and 10b).

The indexing and ranking protocol developed for this study was based on cumulative waterbird densities for each cell and was calculated to show waterbird spatial preferences (see Methods, Section 2.0). Behavior categories (all behaviors, foraging, resting on water, on shore, and on structure) were indexed and ranked separately.

For all waterbird sightings, the cell with 7th highest bird density (505 birds/acre) was used as the basis for the cell index and ranking of relative use areas (Figure 11). The highest density cell (1060 birds/acre) was 2.1 times greater than the indexing cell. Areas of highest relative use by all waterbirds included piers, bait barges, and adjacent shoreline north of the Submarine Base; restricted access piers between Commercial Harbor and Harbor Island West Basin and along North Island; and the beach and floating docks at the northeast corner of the North Island adjacent to aircraft carrier berths.

Important foraging areas for all waterbird species were: shoreline areas along the bayside of the breakwater of Shelter Island, the pier and shoreline between the Commercial Basin and Harbor Island West Basin; several sections of North Island and Coronado shoreline; and the bait barge area north of the Submarine Base (Figure 12). The foraging cell index used in ranking cell use was based on the cell with the second highest foraging density (58-birds/acre). The highest foraging density cell (97 birds/acre) was 1.7 times greater than the indexing cell.

Areas with the greatest relative use of North Bay by waterbirds resting on water were Convair Lagoon, Point Loma shoreline, the bait barge area north of the Submarine Base, and a few sections of shoreline along North Island (Figure 13). The cell with the highest



* Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

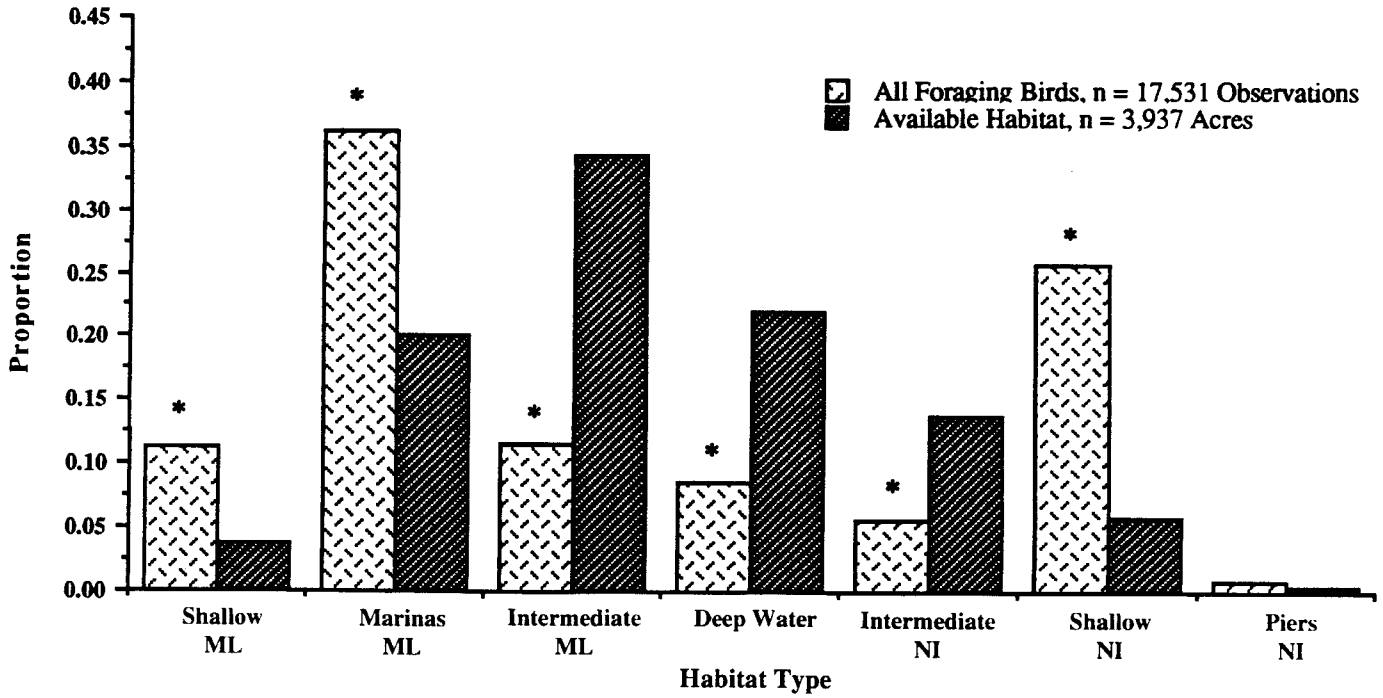
NOTE: Marinas ML and Piers NI were combined for statistical analysis.

* $p < .05$

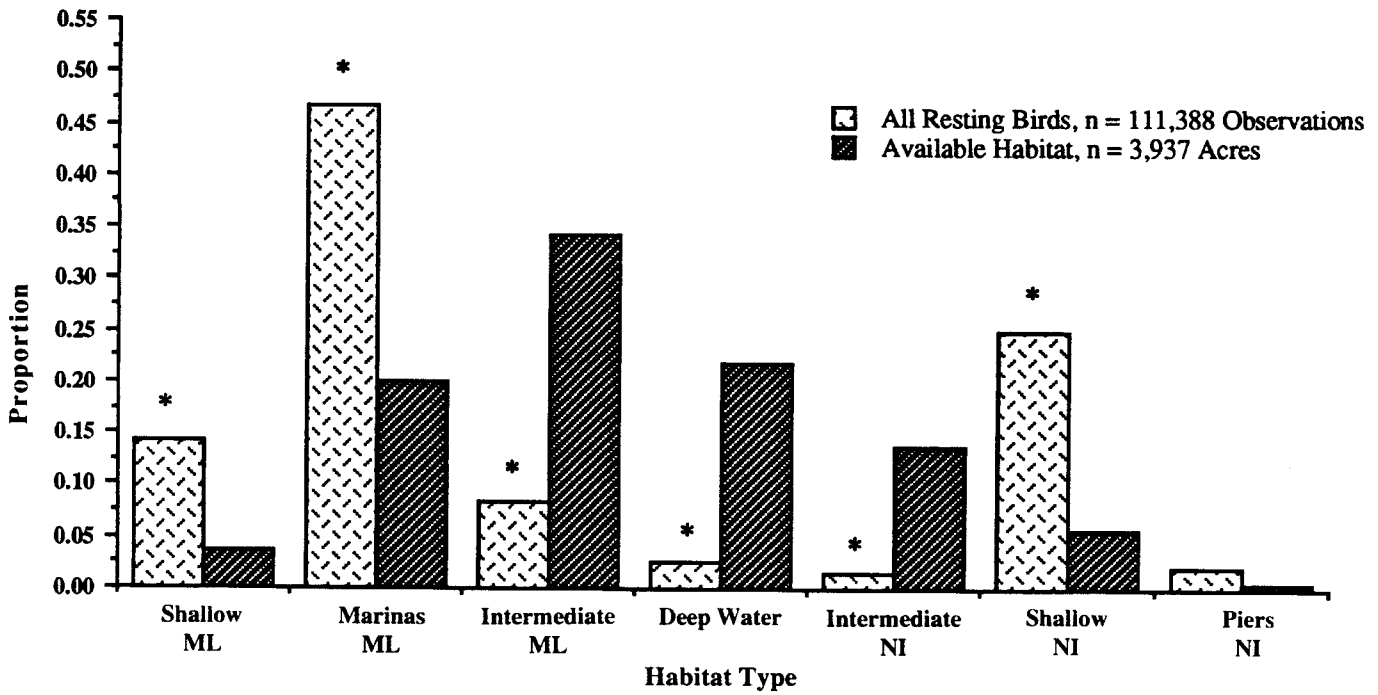
Relative Habitat Utilization by All Waterbird Species in North San Diego Bay During 1993

FIGURE 9

a. Relative Habitat Utilization by All Foraging Waterbirds



b. Relative Habitat Utilization by All Resting Waterbirds



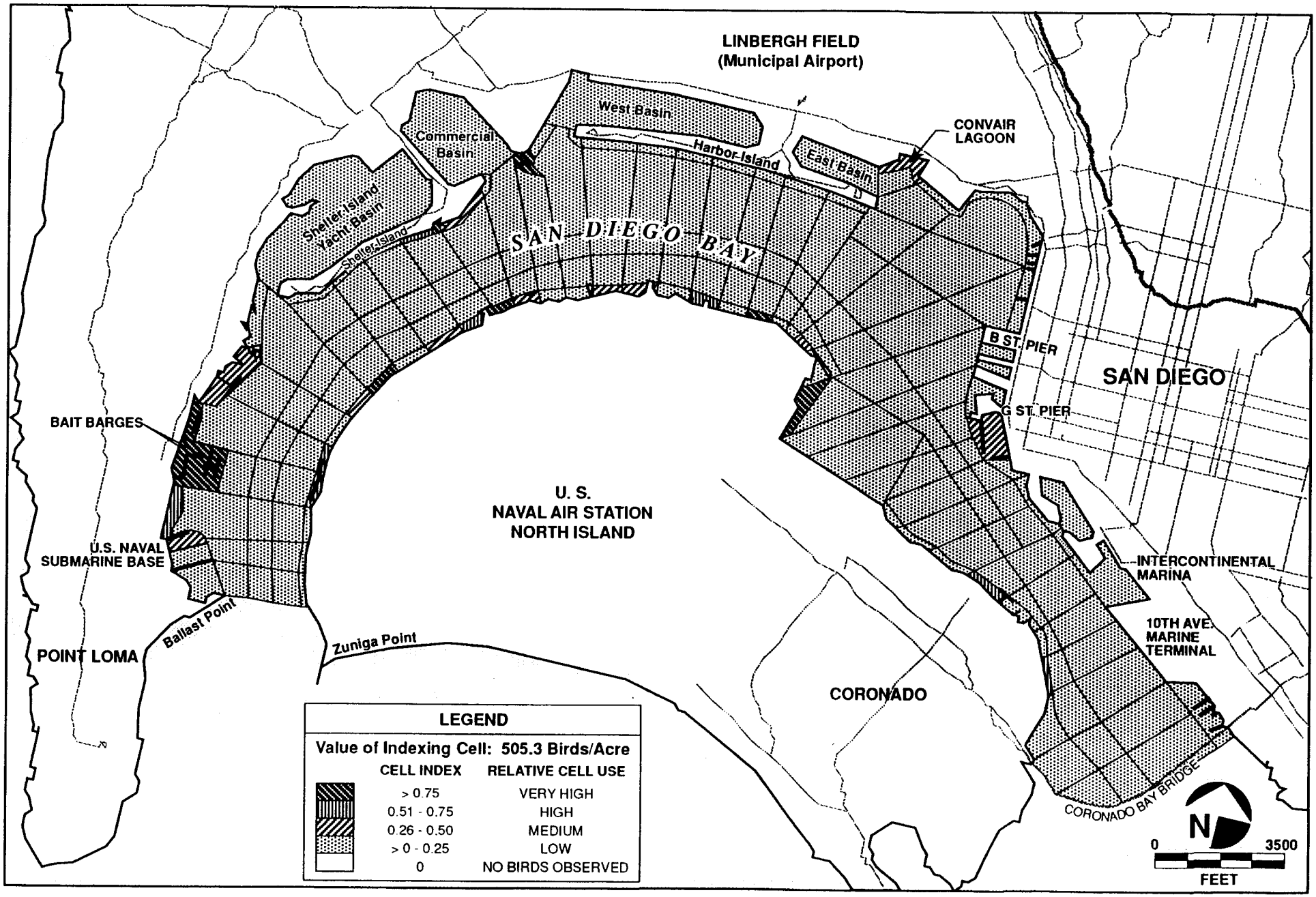
Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

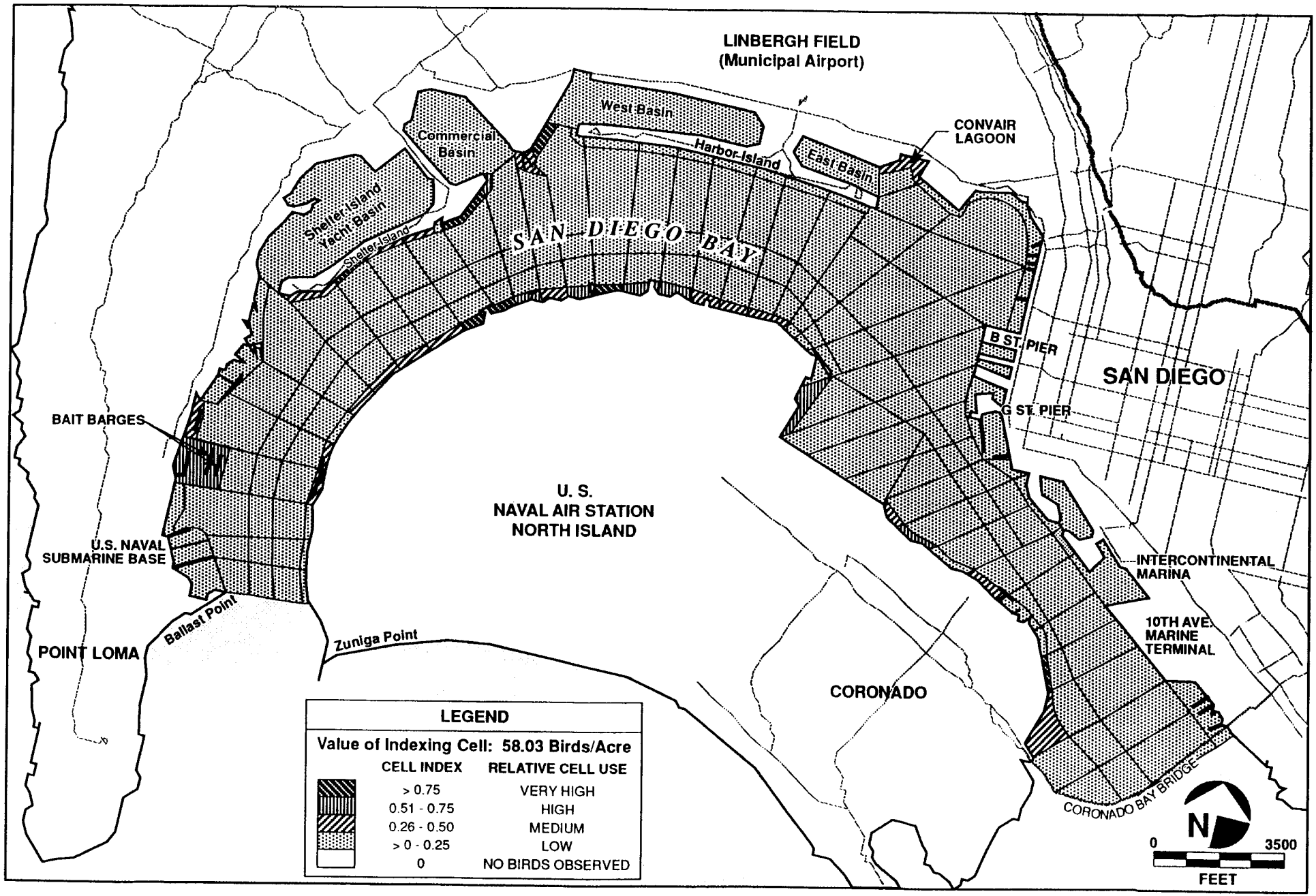
FIGURE 10

Relative Habitat Utilization by All Waterbird Species in North San Diego Bay During 1993



Spatial Use of North San Diego Bay by All Waterbird Species Observed During 1993

FIGURE 11



Spatial Use of North San Diego Bay by All Waterbird Species
Observed Foraging During 1993

FIGURE
12

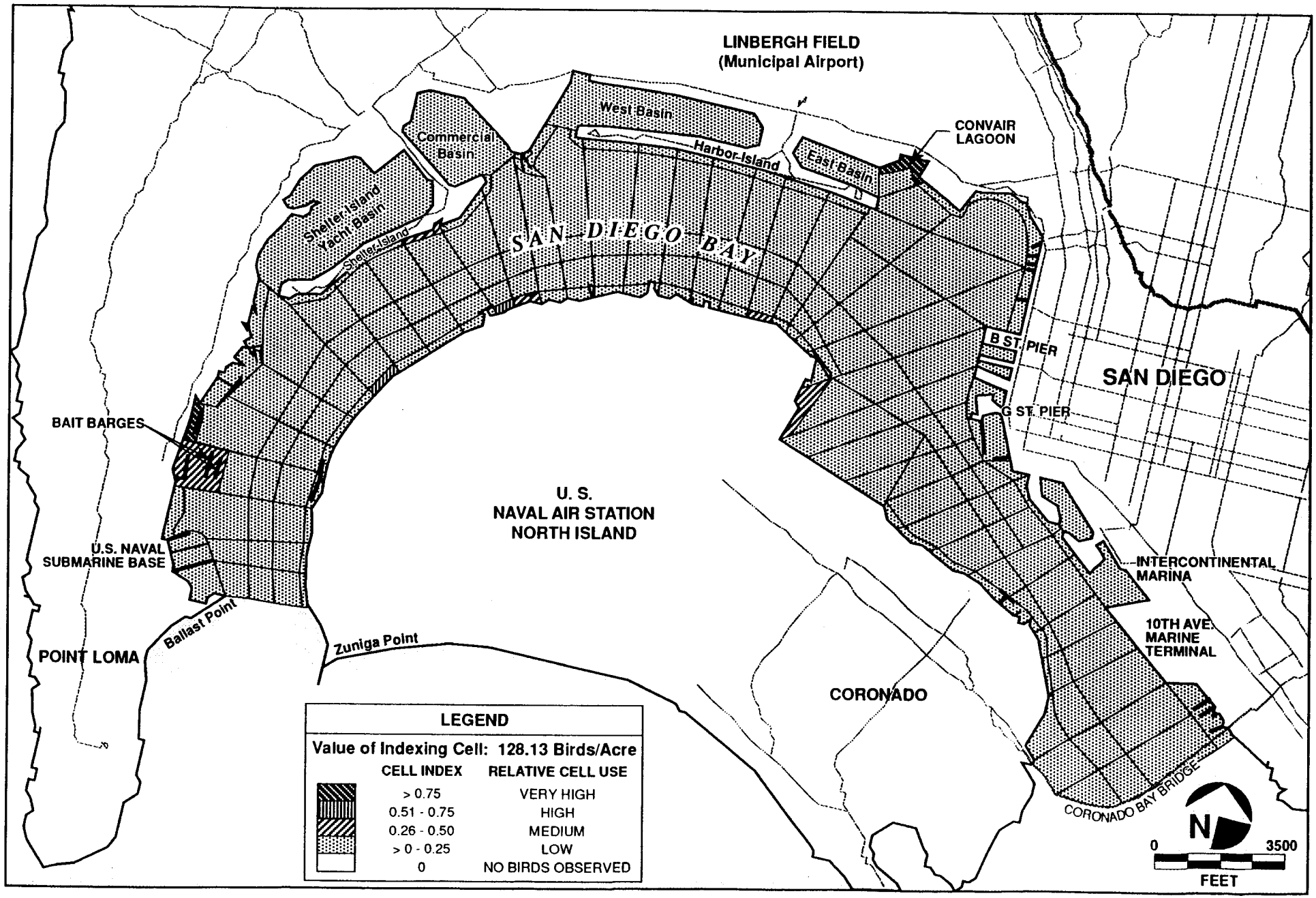


FIGURE 13

Spatial Use of North San Diego Bay by All Waterbird Species Observed Resting on Water During 1993

density of birds resting on water (128 birds/acre) was used for creating the index for birds resting on water.

Shoreline areas preferred by waterbirds were along Point Loma north of the Submarine Base and several areas along North Island and Coronado (Figure 14). The cell with the fourth highest density of birds on shore (399 birds/acre) was used to create this index. The highest density cell (639 birds/acre) was 1.6 times larger than the indexing cell.

The cells with the highest relative value for roosting birds on structures were floating docks, bait barges, and piers north of Submarine Base, the restricted-access Navy pier on North Island across from the bait barges, the restricted-access pier between Commercial Basin and Harbor Island West Basin, and floating docks at the northeast side of North Island, near the aircraft carrier berths (Figure 15). The cell with the third highest density for birds roosting on structures (303 birds/acre) was chosen as the basis for this index. The highest density cell (592 birds/acre) was about 2.0 times greater than the indexing cell.

Target Species

California Brown Pelican

California brown pelicans showed a significant positive preference for foraging in shallow water habitats along both sides of the Bay and in marinas and pier areas along the mainland side of the Bay (Figure 16a). Relatively deeper water habitats were significantly underused. Resting pelicans strongly preferred piers, floating docks, and bait barges (Marina ML/Piers NI habitat types; Figure 16b). There was also a significant secondary preference for structures in shallow water habitats. Relatively deep water habitats were negatively preferred mostly due to a lack of available structures for roosting in these habitat.

Pelicans occurred in highest numbers at roosting locations, particularly in areas where human access was restricted. The most important areas for pelicans were clustered at the west end of the survey area, within and adjacent to the Submarine Base (Figure 17). Piers, floating docks, bait barges, and the associated Point Loma shoreline in this area were used for roosting and foraging. Other relatively high use areas for roosting pelicans included the North Island Navy pier across from the bait barges, floating docks at the northeast corner of the North Island, the pier between the Commercial Basin and Harbor Island West Basin,

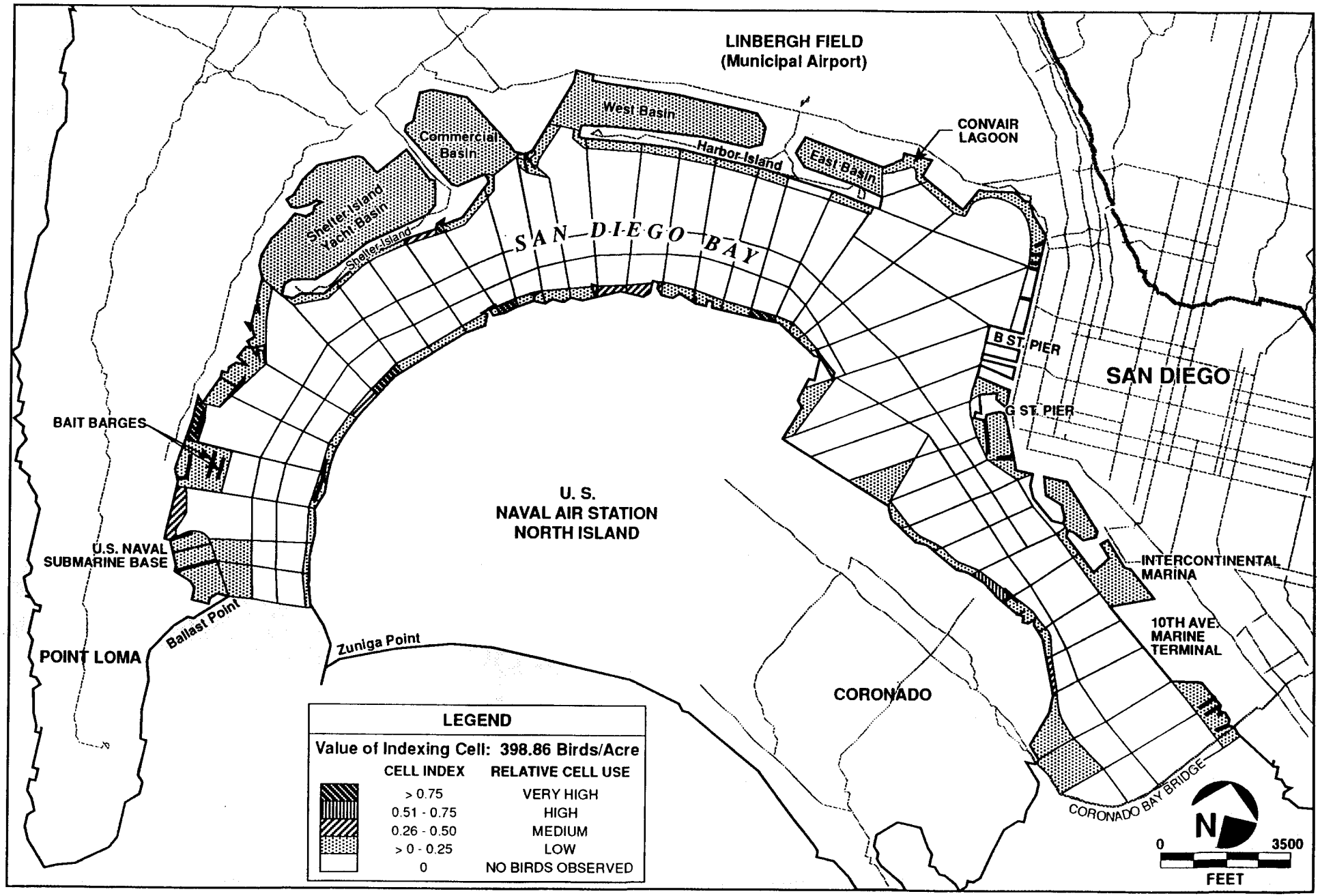
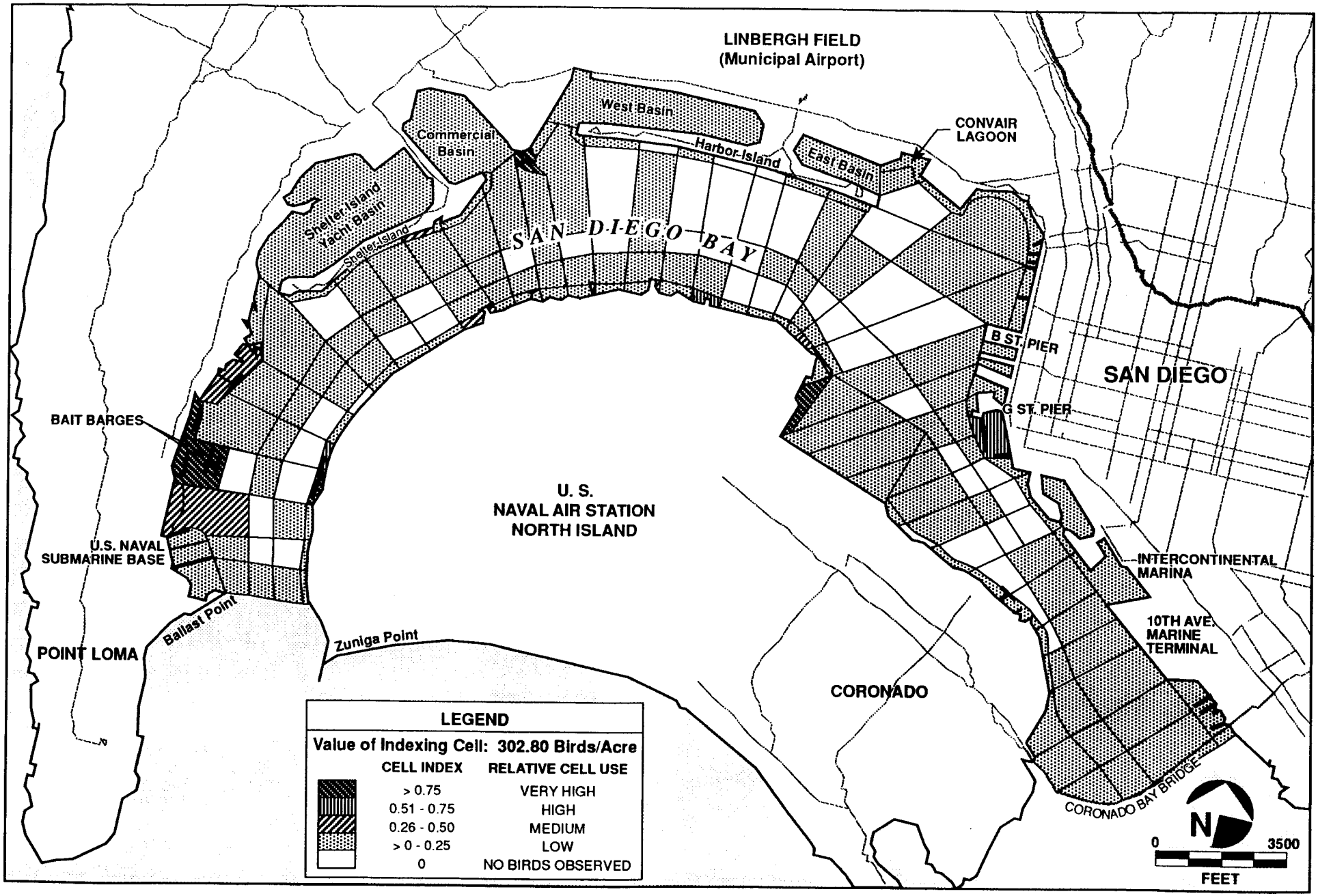


FIGURE 14

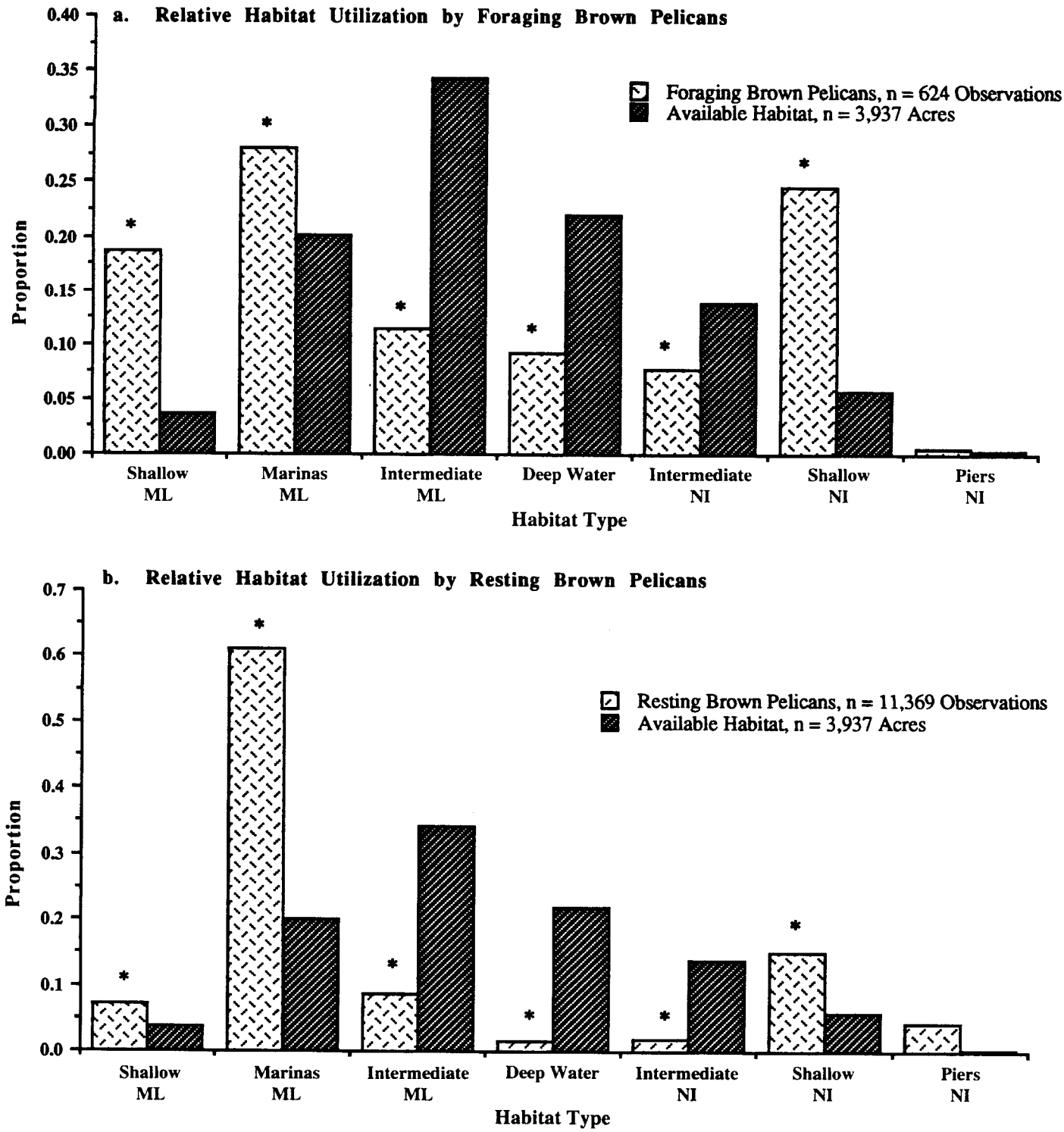
Spatial Use of North San Diego Bay by All Waterbird Species Observed on Shore During 1993



Spatial Use of North San Diego Bay by All Waterbird Species Observed Roosting on Structures During 1993

FIGURE

15



Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

FIGURE 16

Relative Habitat Utilization by California Brown Pelicans in North San Diego Bay During 1993

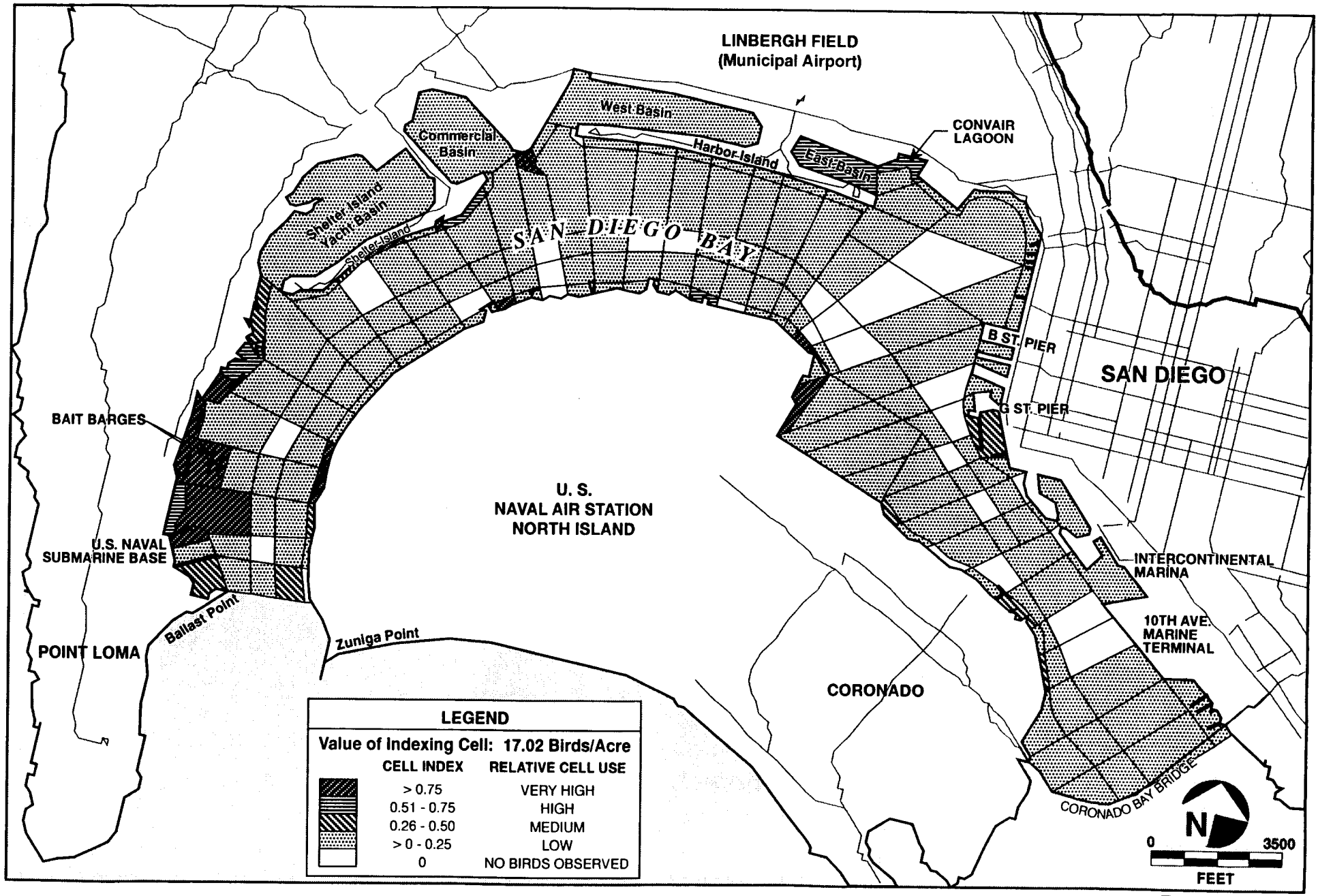


FIGURE 17

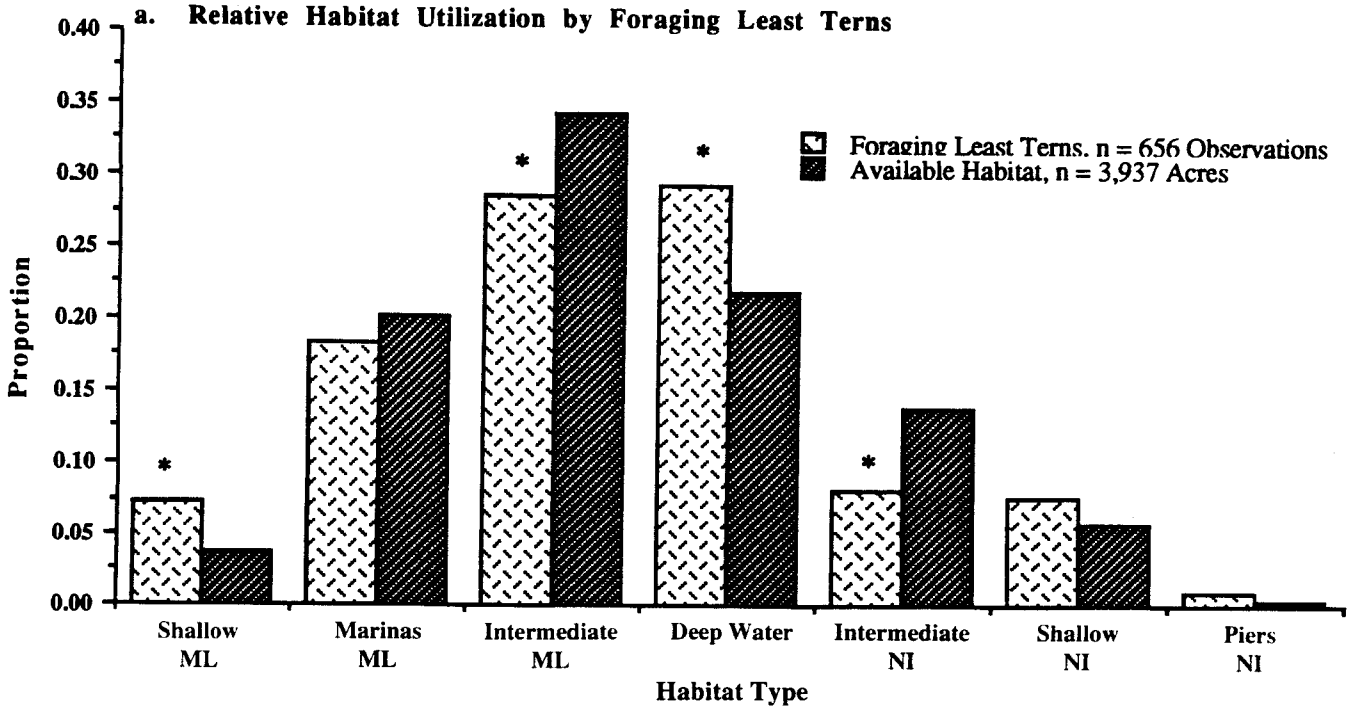
Spatial Use of North San Diego Bay by Brown Pelicans Observed During 1993

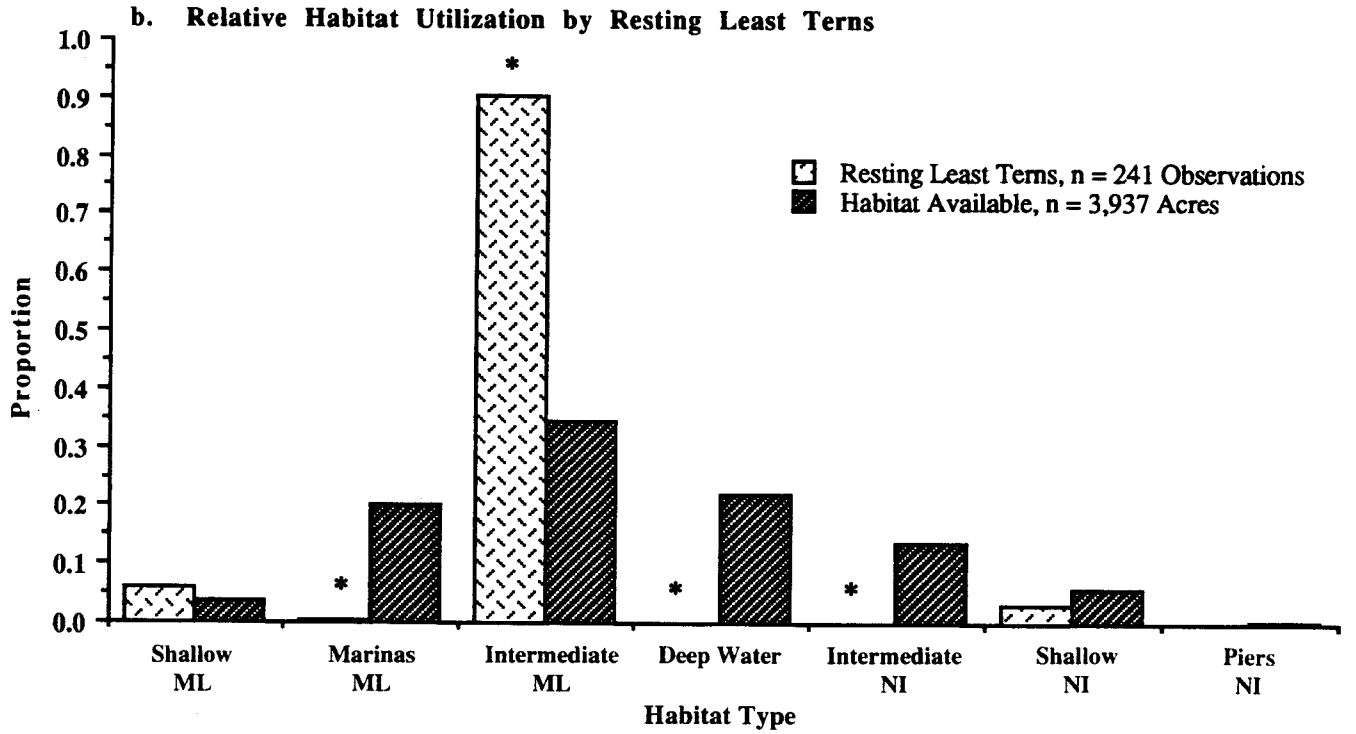
Harbor Island East Basin, and Convair Lagoon. The fishing pier and breakwater of Shelter Island were also used extensively for roosting and foraging. The cell index used to rank cells for brown pelicans was based on the 13th highest total density cell (303 birds/acre). This cell was the cell in which foraging was the dominant activity. The cell with the highest density (17.0 birds/acre) was 9.4 times larger than the indexing cell.

California Least Tern

California least terns showed a significant positive preference for foraging in shallow water habitat along the mainland side of the Bay and in deep water habitat at the center of the Bay (Figure 18a). Least terns exhibited a significant negative preference for waters of intermediate depth. The Marinas ML/Piers NI and Shallow NI habitats were used in roughly the same proportions as were available. Least terns foraging in deep water habitat tended to do so in relatively large mixed-species flocks (usually with Forster's terns), presumably due to the presence of large schools of fish in the ship channel. Resting least terns had a strong positive preference for the intermediate water habitat on the mainland side of the Bay (Figure 18b). There was a significant negative preference by resting least terns for the Marinas ML/Piers NI, Deep Water, and Intermediate NI habitats.

The most intensely used area by California least terns in North San Diego Bay was the open water anchorage area south of the entrance to Commercial Basin (Figure 19). This site accounted for 28 percent of 920 least tern sightings in North Bay. This area is primarily Intermediate ML habitat with a small component of Shallow ML habitat. The high use of the larger cell resulted the strong preference by resting least terns for the Intermediate ML habitat type. Least terns were roosted in large numbers and were observed displaying, courtship feeding, copulating, and feeding recently fledged chicks on the unused boats in this area throughout the breeding season. Foraging was also frequently observed. There were no other locations in North Bay where least terns were observed roosting in large numbers. The remainder of cells where least terns occurred were used primarily by foraging terns. Most of these cells were used at relatively low levels. Exceptions were the deep water channel along the northeast portion of North Island and the entrance to East Basin of Harbor Island. Frequent observations were made of foraging least terns in the Harbor Island West Basin. Due to the large size of this marina, least tern density is comparatively low. The relative value of small areas within this basin for foraging least terns may be underestimated since this marina was treated as a single unit. The cell with the third highest total density (2.3 birds/acre), where foraging was the





Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

Relative Habitat Utilization by California Least Terns in North San Diego Bay During 1993

FIGURE **18**

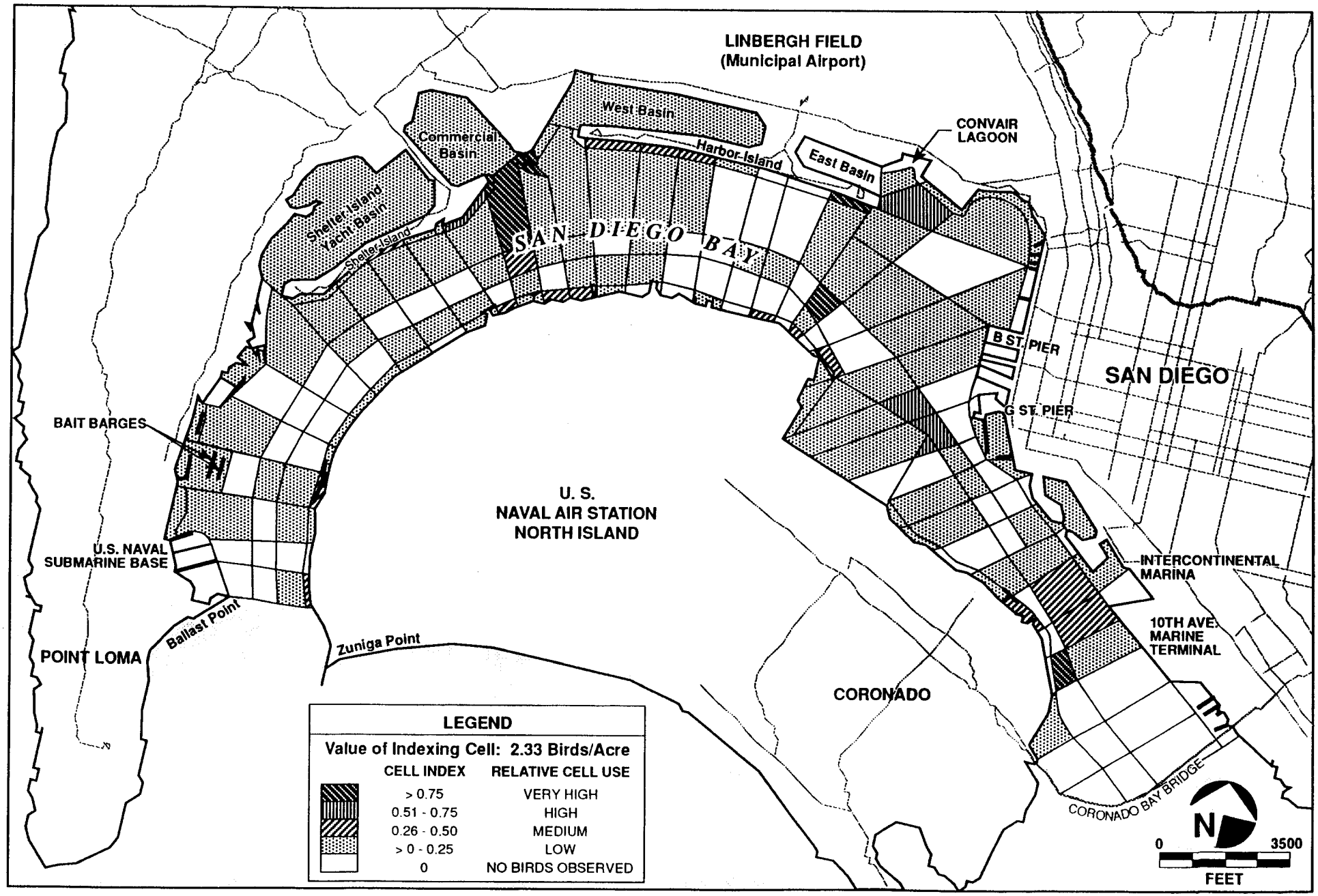


FIGURE 19

Spatial Use of North San Diego Bay by California Least Terns Observed During 1993

predominant activity, was used to create the least tern cell index. The highest density cell (7.0 birds/acre) was 3.0 times greater than the indexing cell.

Elegant Tern

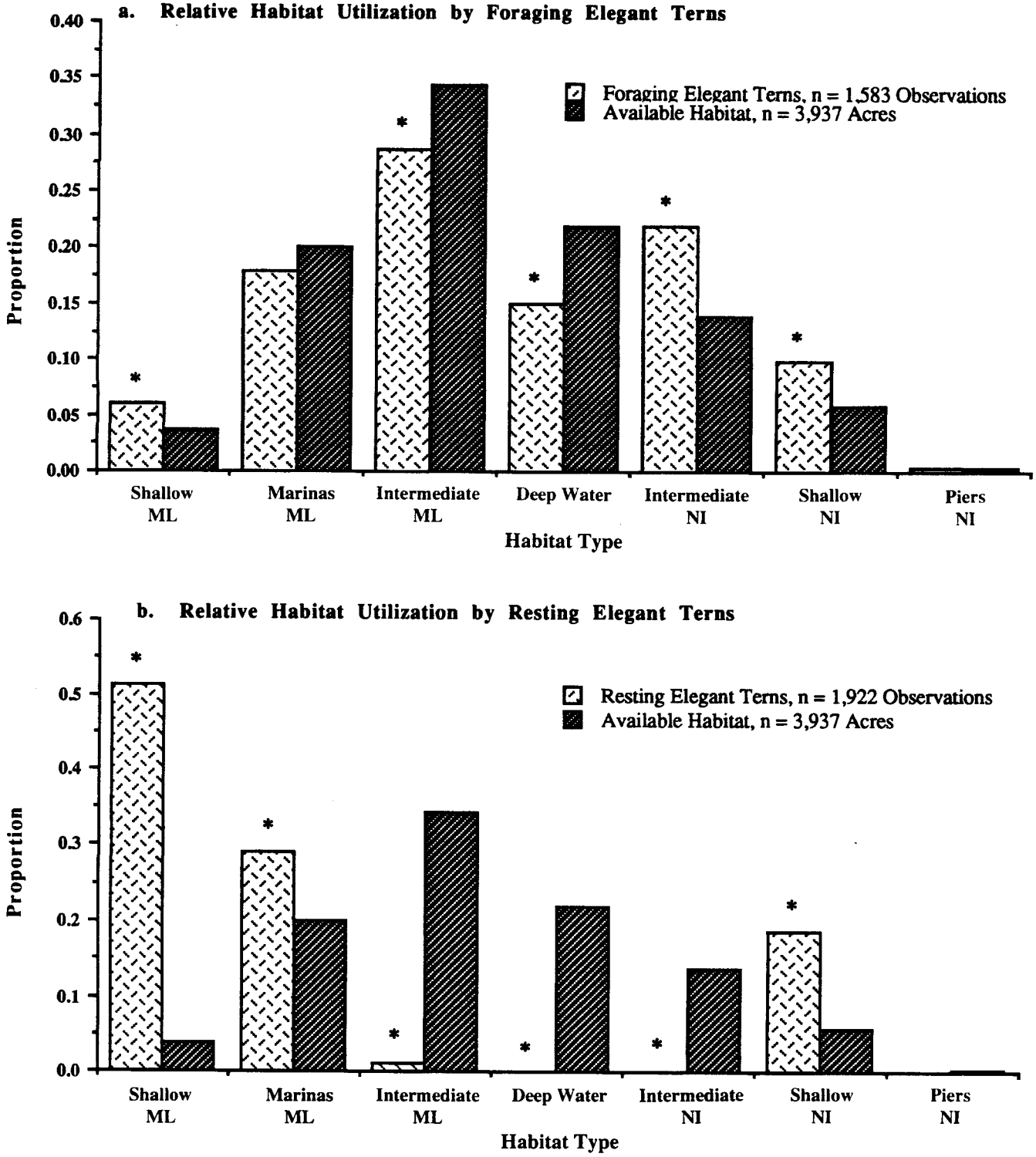
Elegant terns showed a significant positive preference for foraging in shallow water habitats along both sides of North Bay and in intermediate depth water on the North Island side (Figure 20a). Elegant terns showed significant negative preferences for foraging in intermediate depth water on the mainland side and in deep water habitat. Roosting elegant terns showed a strong affinity for resting in shallow water habitats (Shallow ML, Marinas ML/Piers NI, and Shallow NI sections) and significantly underused intermediate and deep water habitats (Figure 20b).

Important roosting locations for elegant terns were restricted access piers. Roosting locations included the pier adjacent and inside the entrance of Commercial Basin, the pier between Commercial Basin and Harbor Island West Basin, and the North Island pier across from Shelter Island (Figure 21). Important foraging areas included the east end of the breakwater of Shelter Island, the bait barge area north of the Submarine Base, and the northern side of Ballast Point. Elegant terns were also seen foraging in relatively large numbers in the Shelter Island Yacht Basin and Harbor Island West Basin. Due to the large size of these marinas, elegant tern densities are relatively low, perhaps underestimating the relative importance of smaller areas used within the basins for foraging since these marinas were treated as large single units. The cell with the 4th highest total density (6.8-birds/acre), where foraging was the predominant activity, was used to create the elegant tern index. The highest density cell (292.1 birds/acre) was nearly 43 times larger than the indexing cell.

Scaup Species

Lesser and greater scaup in North San Diego Bay showed a significant positive preference for foraging and resting in mainland marinas and pier areas and in shallow water habitats on both sides of the Bay (Figures 22a and 22b). Intermediate and deep water habitats were significantly underused.

The highest use areas for scaup were dominated by resting birds using Convair Lagoon, shoreline areas at northeast side of the North Island where the aircraft carriers are berthed,



Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

FIGURE

Relative Habitat Utilization by Elegant Terns in North San Diego Bay During 1993

20

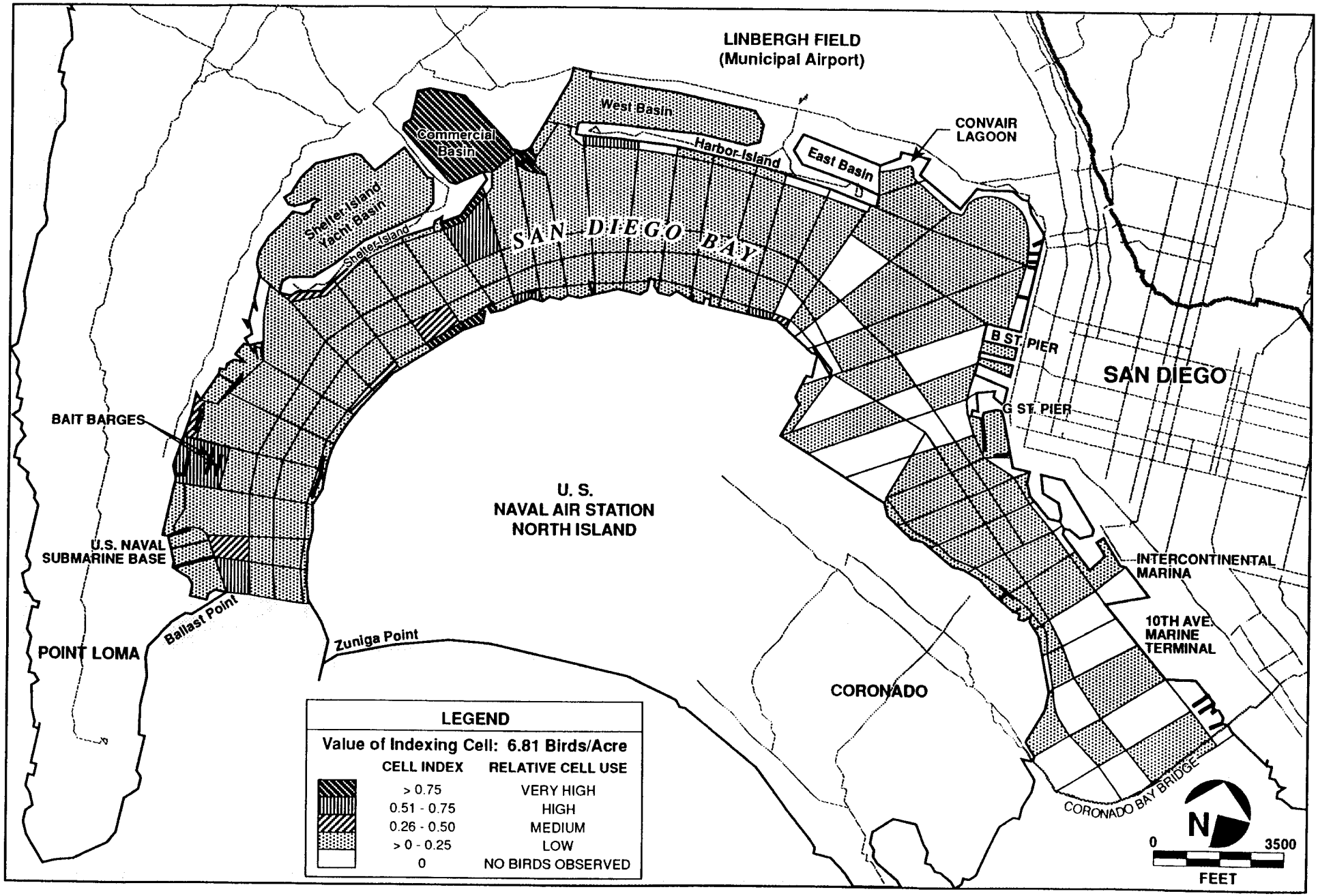
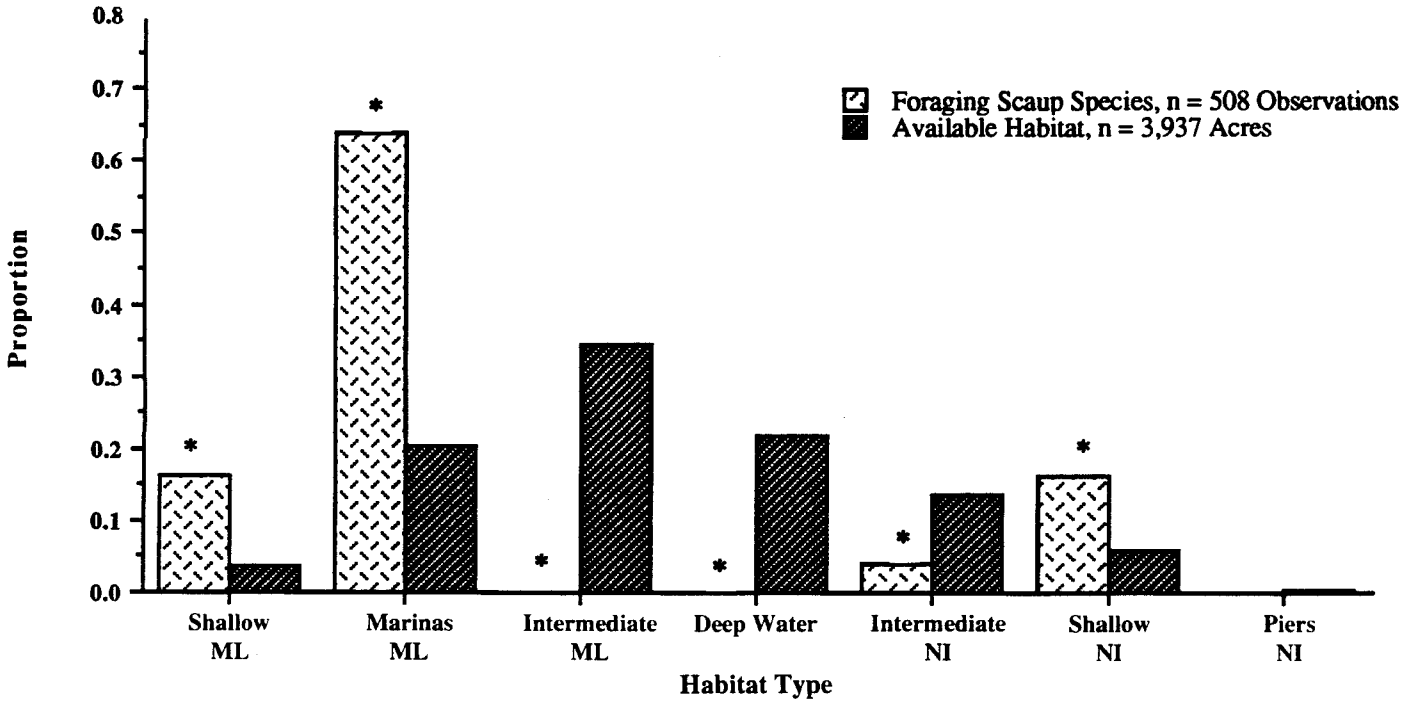


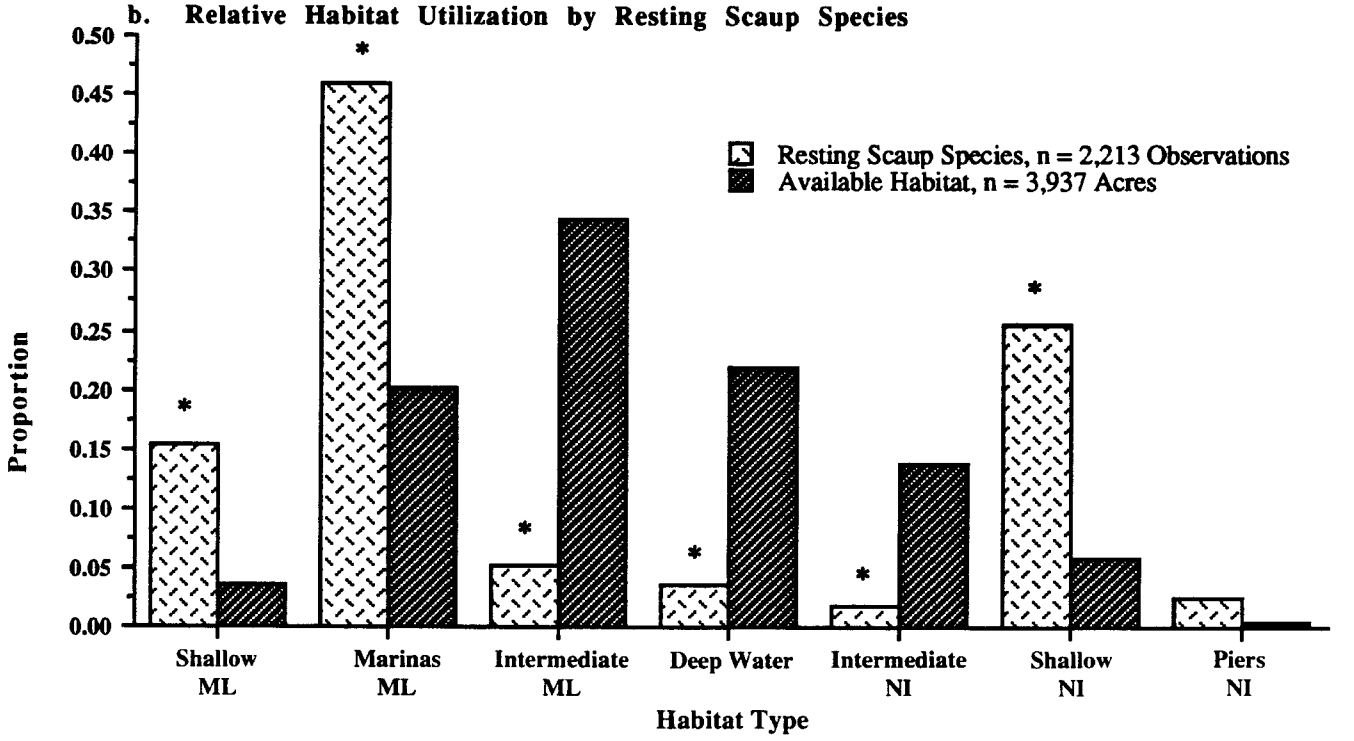
FIGURE 21

Spatial Use of North San Diego Bay by Elegant Terns
Observed During 1993

a. **Relative Habitat Utilization by Foraging Scaup Species**



b. **Relative Habitat Utilization by Resting Scaup Species**



Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

FIGURE

Relative Habitat Utilization by Scaup Species in North San Diego Bay During 1993

22

and the shoreline of Coronado (Figure 23). The highest value cell for foraging activity was also along the Coronado shoreline. Relatively high numbers of scaup were consistently observed in the Shelter Island Yacht Basin and the West Basin of Harbor Island, but the large size of these basins and treating these marinas as single units underestimated the relative importance of smaller areas within these cells. The cell with the 5th highest density (12.3 birds/acre) was used as the basis for the scaup index. The highest density cell (113 birds/acre) was 9.2 times greater than the indexing cell.

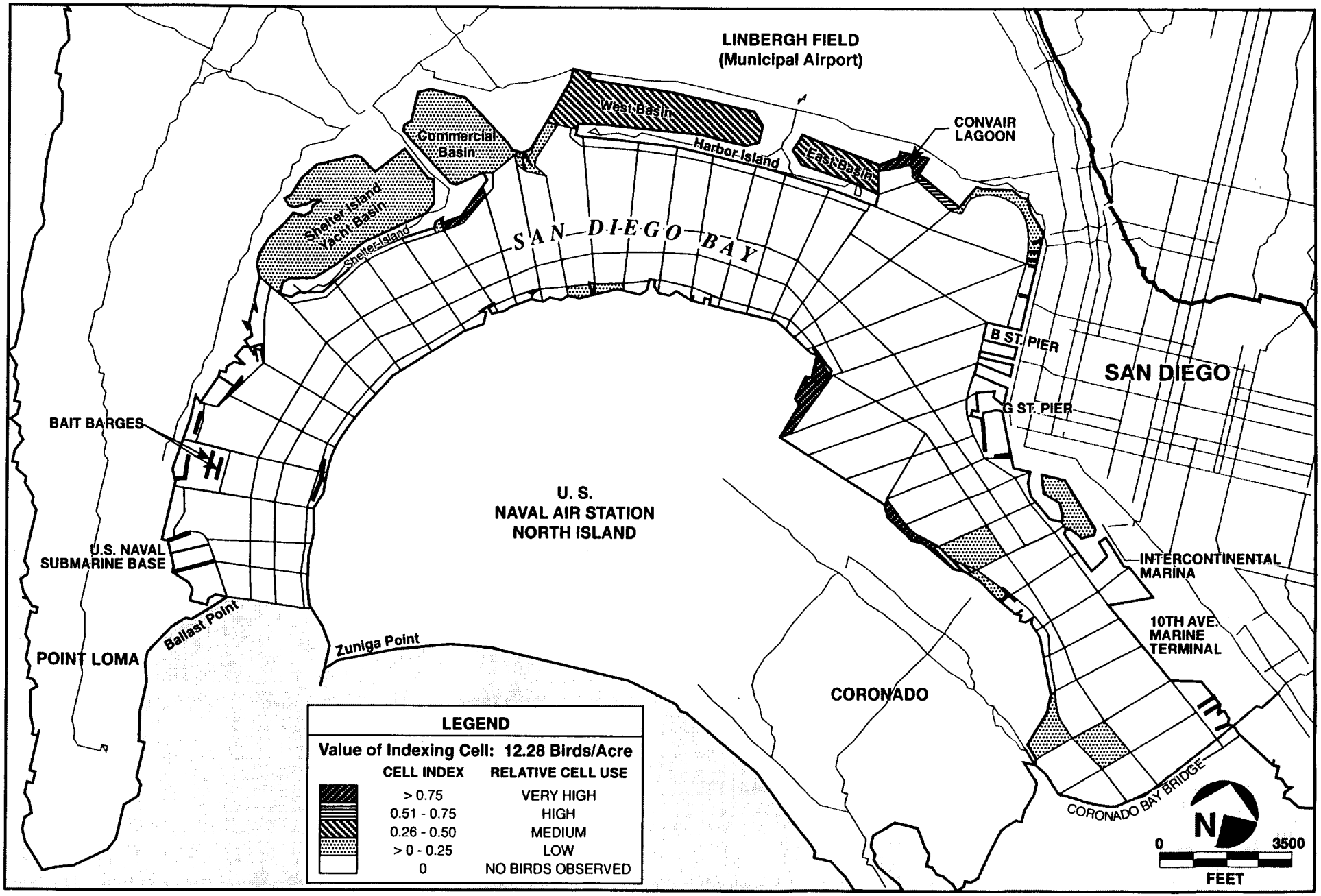
Surf Scoter

Foraging surf scoters preferentially used shallow water habitats along both sides of the Bay, especially the North Island side, and significantly underused the intermediate and deep water habitats (Figure 24a). Resting scoters showed similar habitat utilization, but also preferentially used the Marinas ML habitat type for resting (Figure 24b). Very high use areas for surf scoters were concentrated along the North Island shoreline across from Shelter Island (Figure 25). These locations were used for resting and foraging. Other very high value areas used for resting included the Point Loma shoreline north of the bait barges, Shelter Island breakwater near the fishing pier, and an open water area on the northwest end of the Coronado Bay Bridge. The 3rd highest density cell (30.0 birds/ace) was used as the basis for the surf scoter index. The highest density cell (107.3 birds/acre) was 3.6 times greater than the indexing cell.

Foraging Guilds

Waders

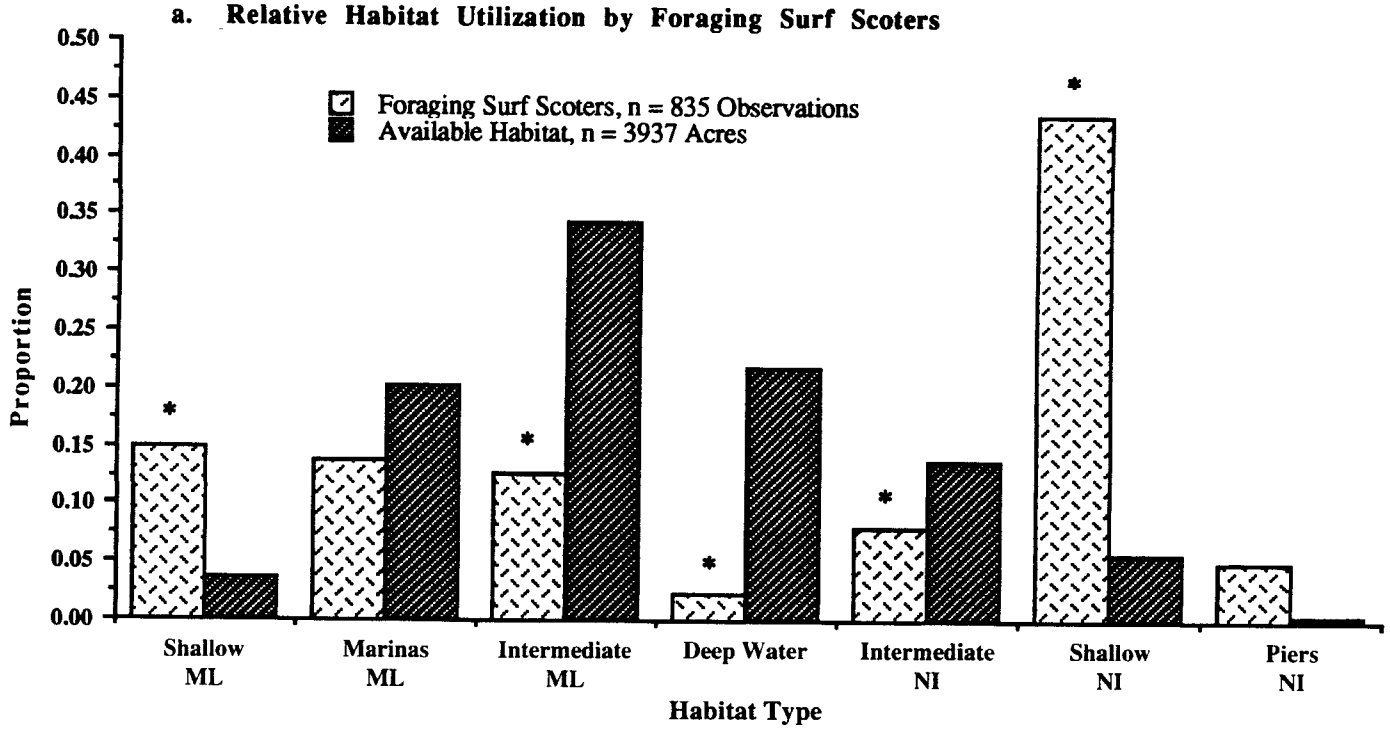
The birds in the wader foraging guild significantly preferred shallow water and marina/pier habitats for foraging as would be expected (Figure 26a). Resting waders showed a significant positive preference for the mainland marinas and pier areas and for shallow water habitats along both sides of the Bay (Figure 26b). As with foraging waders, the intermediate and deep water habitats were significantly underused by resting waders. High use cells for waders resting and foraging onshore include the northern portion of the Submarine Base and adjacent areas to the north, most cells along the North Island and Coronado shoreline, the beach at the west entrance to Harbor Island West Basin, and adjacent to G Street Pier (Figure 27). The cell with the 23rd highest total density (4.2 birds/acre) was chosen to create the wader cell index, since this cell was the highest cell

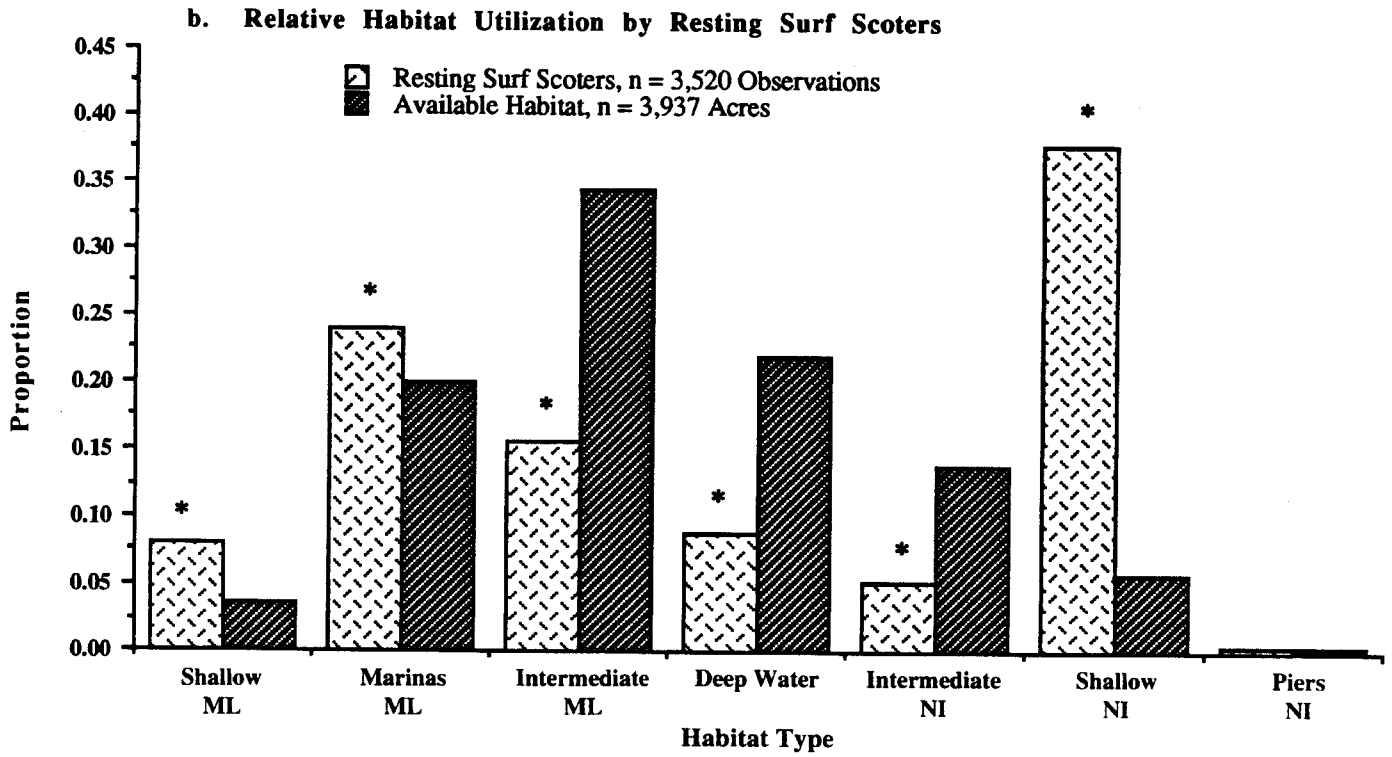


FIGURE

23

Spatial Use of North San Diego Bay by Lesser Scaup and Greater Scaup Observed During 1993





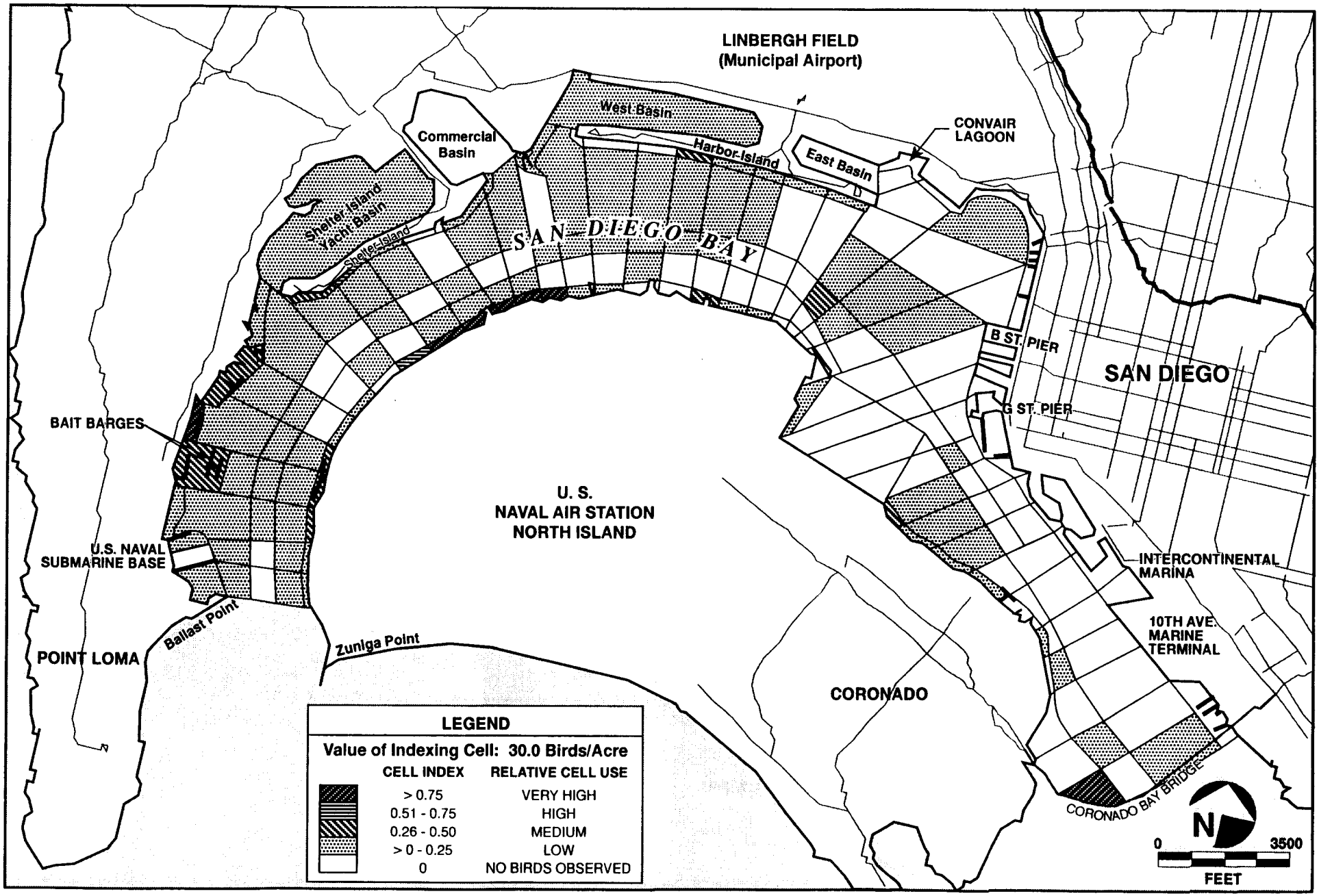
Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

Relative Habitat Utilization by Surf Scoters in North San Diego Bay During 1993

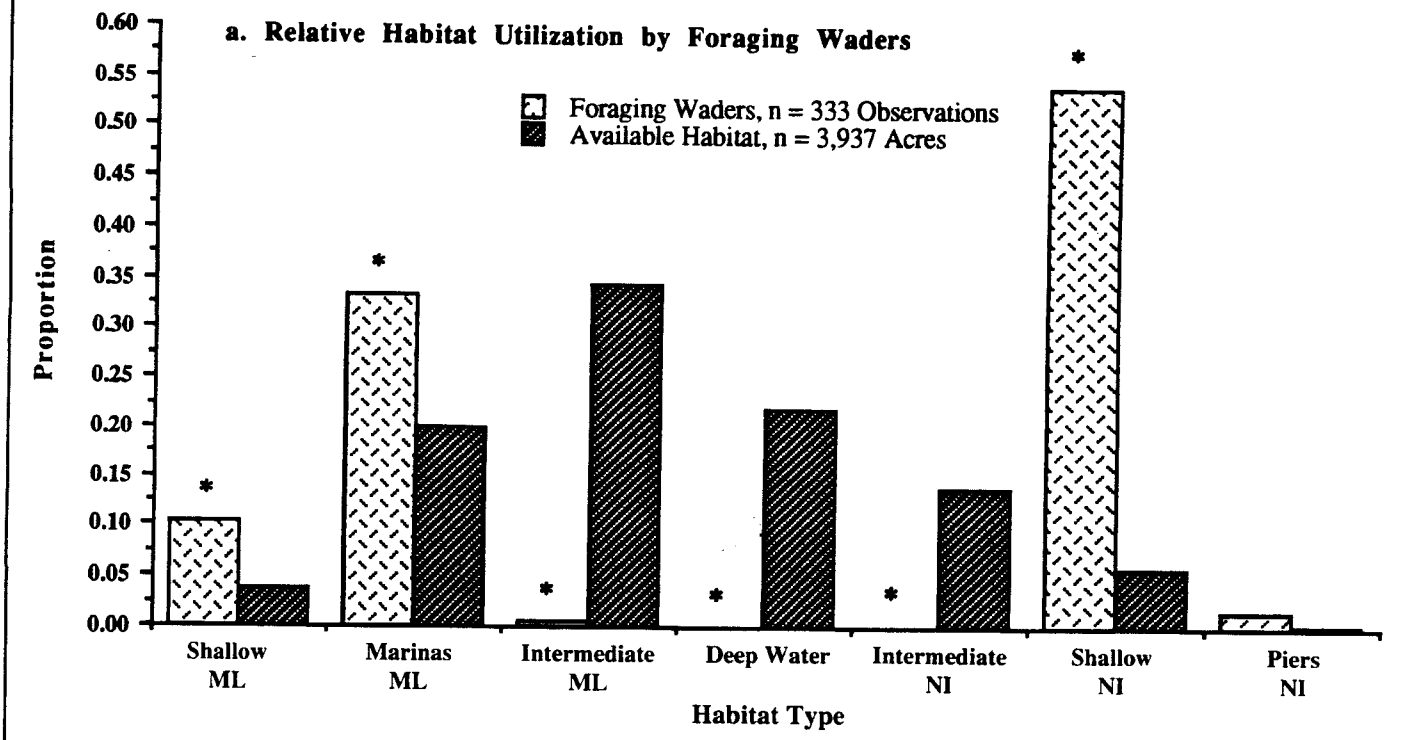
FIGURE **24**

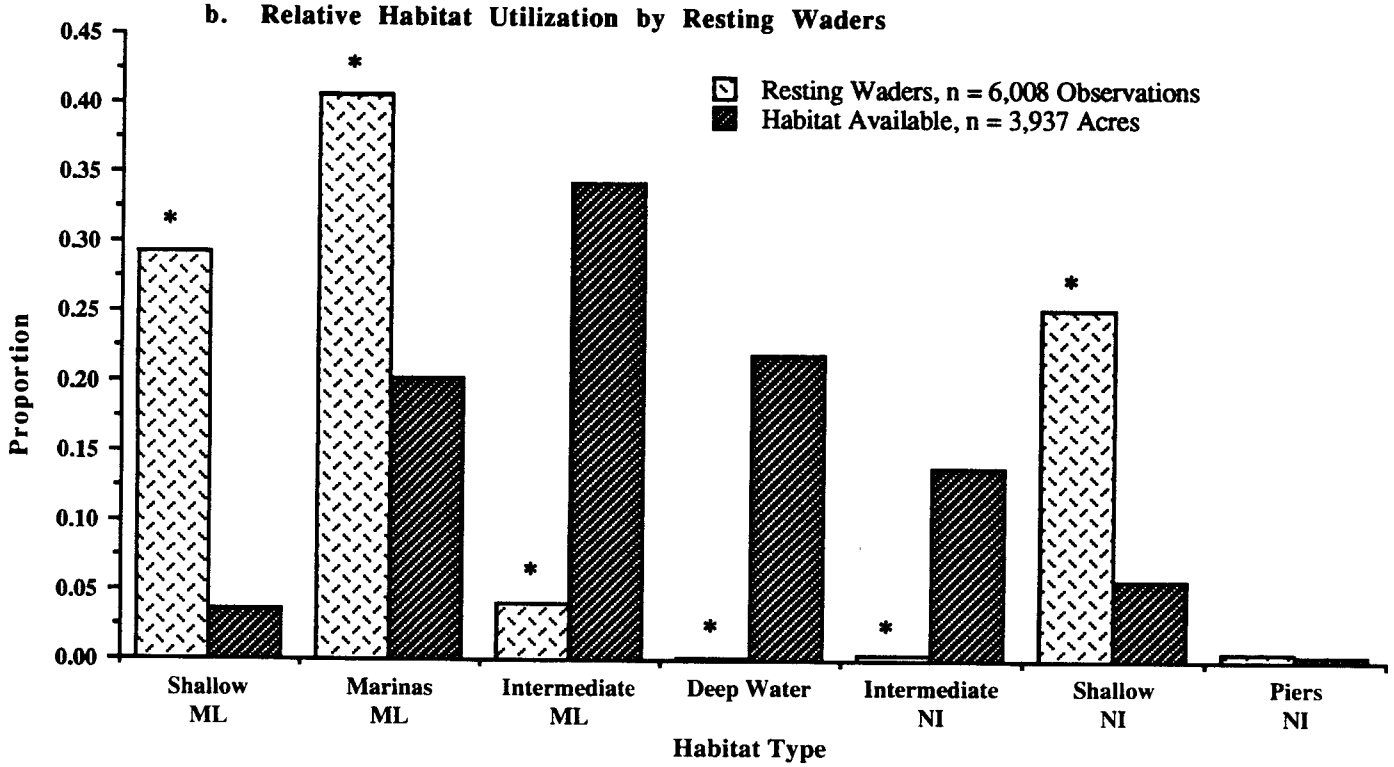


FIGURE

25

Spatial Use of North San Diego Bay by Surf Scoters Observed During 1993





Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

Relative Habitat Utilization by the Wader/Shallow Water Foraging Guild in North San Diego Bay During 1993

FIGURE **26**

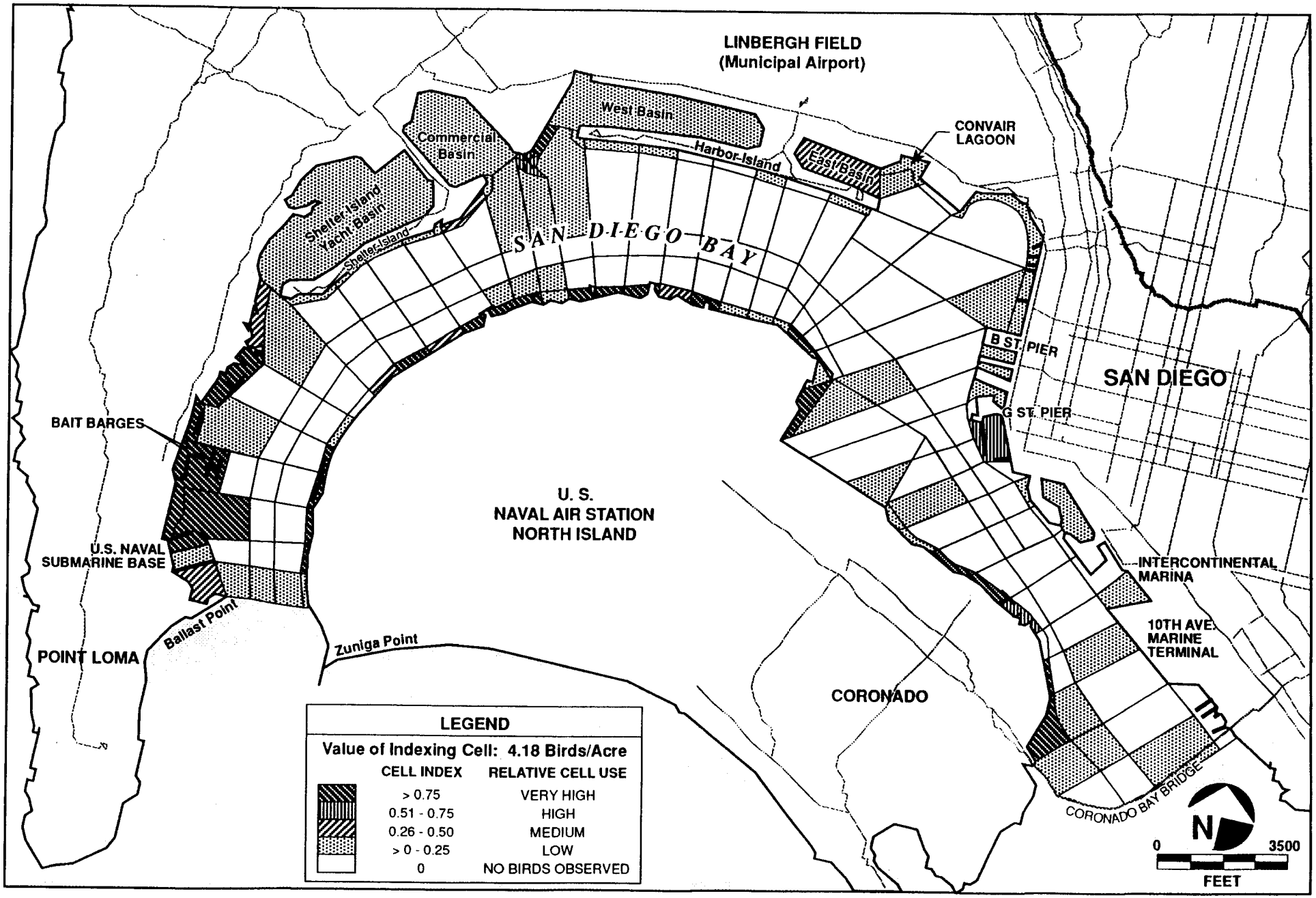


FIGURE 27

Spatial Use of North San Diego Bay by the Wader/Shallow Water Foraging Guild
Observed During 1993

with birds foraging in the water as the dominant activity. The cell with the highest density (210 birds/acre) was 50 times greater than the indexing cell.

Probers

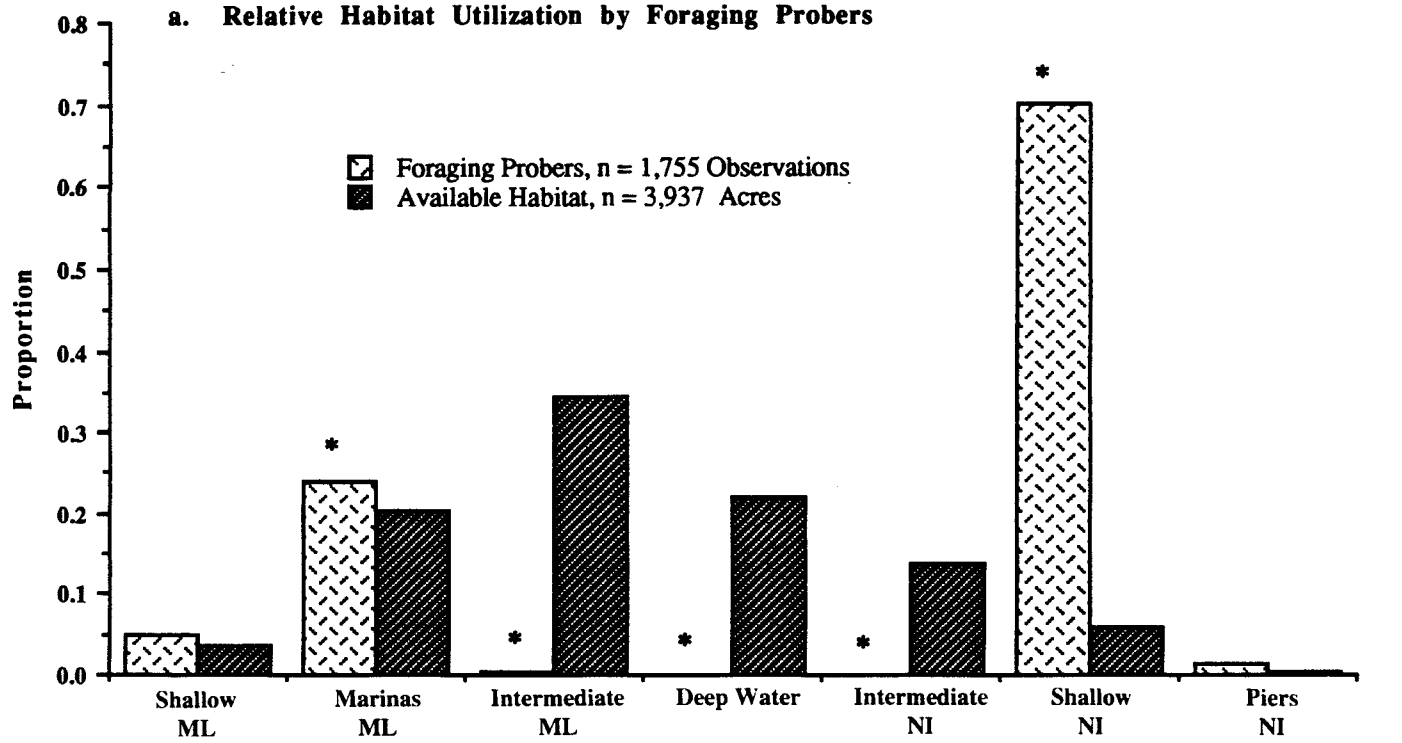
The prober foraging guild exhibited a strong positive preference for foraging in shallow water along the North Island shoreline and a significant secondary preference for the Marinas ML habitat type (Figure 28a). Shallow water along the mainland side of the Bay was used in the same proportion as it was available. Resting probers preferred the same habitat types as foraging probers (Figure 28b). The distribution of high value cells for probers was largely biased toward areas along North Island (Figure 29). Other high value use areas included the East Basin of Harbor Island, Convair Lagoon, and the shoreline on the north side of Ballast Point. The cell with the 22nd highest total density (16 birds/acre) was chosen to create the prober index, since it was the highest cell with birds foraging in the water as the dominant activity. The cell with the highest total density (374 birds/acre) was 23.5 times greater than the indexing cell.

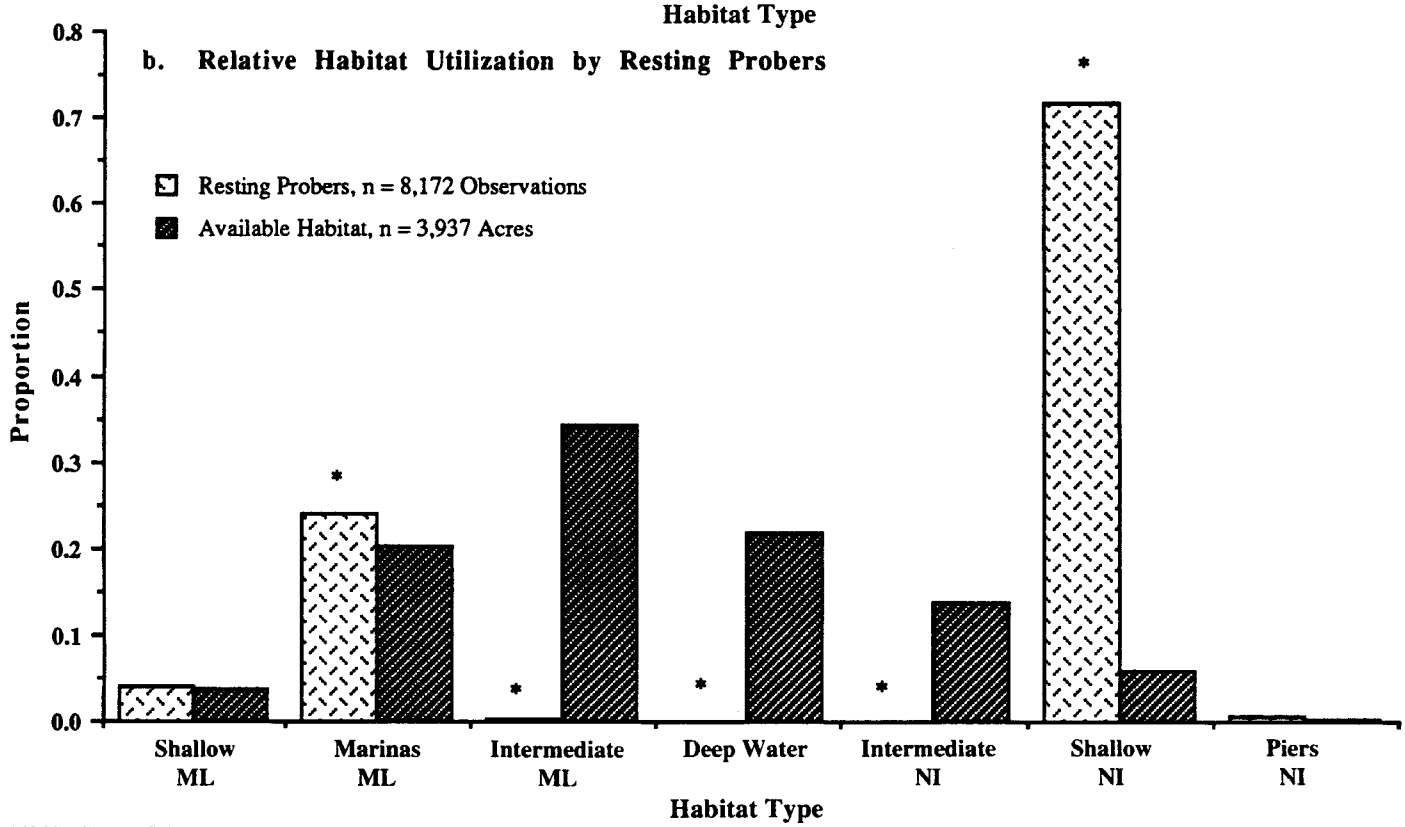
Bottom Feeders

Birds in the bottom feeder foraging guild showed a positive preference for foraging in marinas and pier areas and in shallow water habitats on both sides of the Bay (Figure 30a). Intermediate and deep water habitats were significantly underused. Resting bottom feeders followed the same pattern of habitat use as foraging birds (Figure 30b). High value areas for bottom feeders in North San Diego Bay included the North Island shoreline across from Shelter Island, the beach west of the Harbor Island West Basin entrance, Convair Lagoon, and the Coronado shoreline southeast of the aircraft carrier berthing area (Figure 31). The cell with the 4th highest total density (47 birds/acre) was used to create the bottom feeder index since it was the highest cell with foraging as the dominant activity. The cell with the highest total density (122 birds/acre) was 2.6 times greater than the indexing cell.

Water Column Divers

Water column divers showed a significant affinity for foraging in mainland marina and pier habitat, with a significant secondary preference for shallow water habitats along both sides of the Bay (Figure 32a). There was a significant negative preference for intermediate and deep water habitats. Resting water column divers also significantly preferred mainland





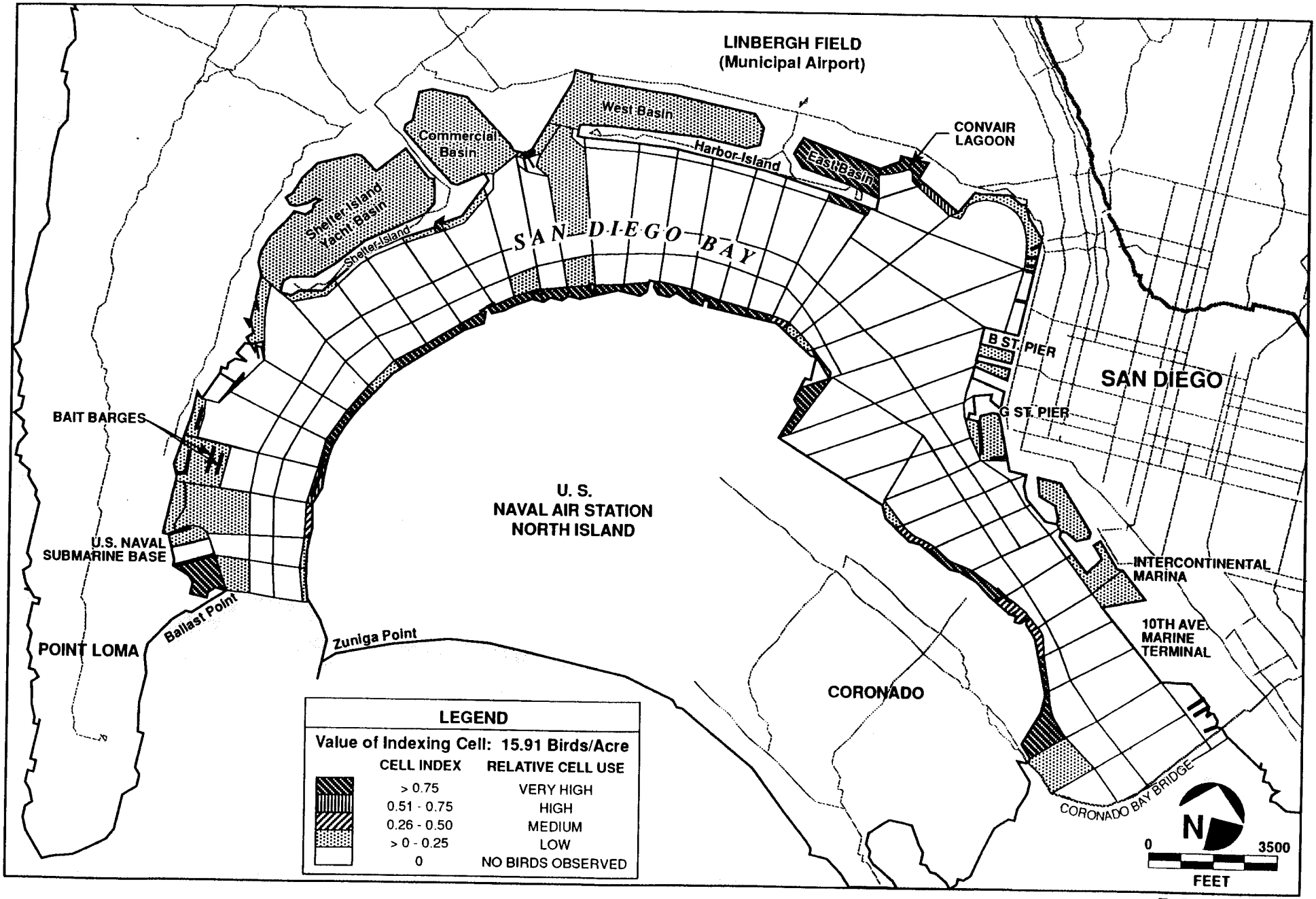
* Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

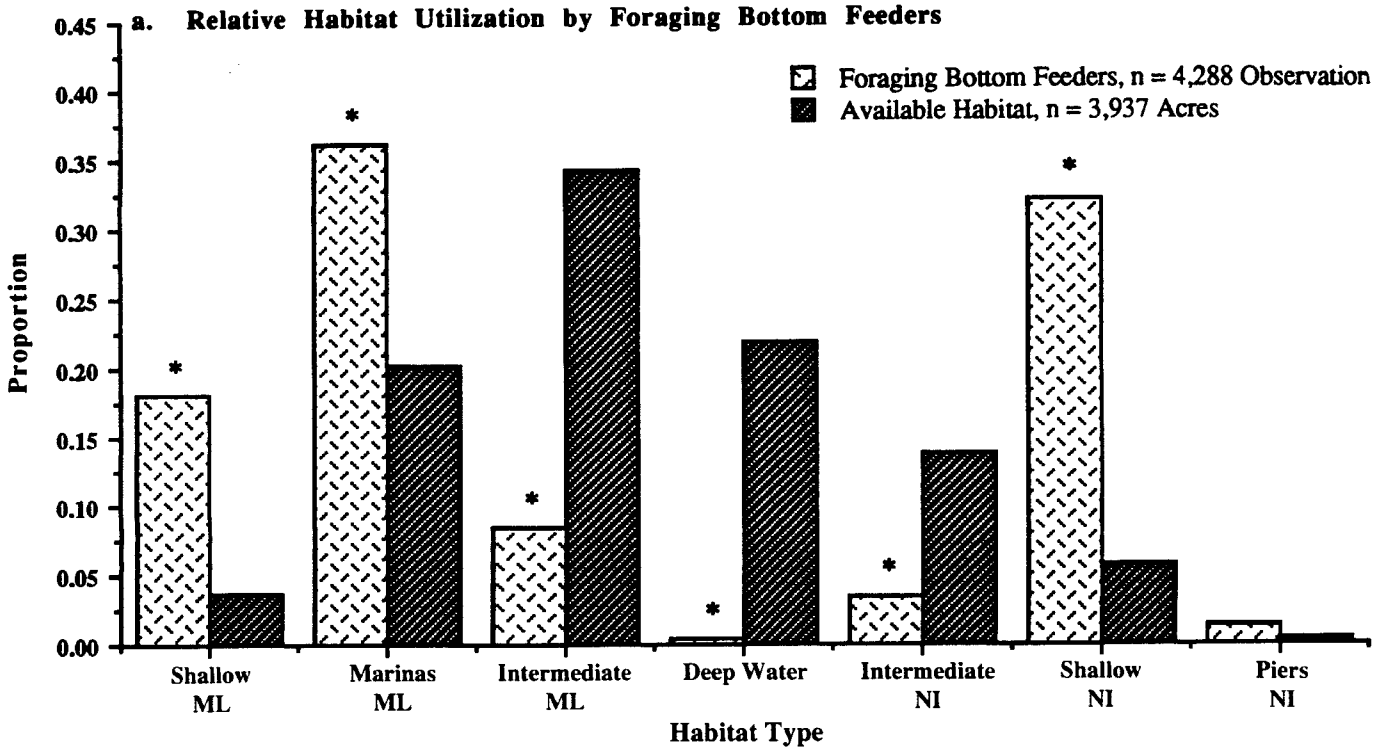
FIGURE 28

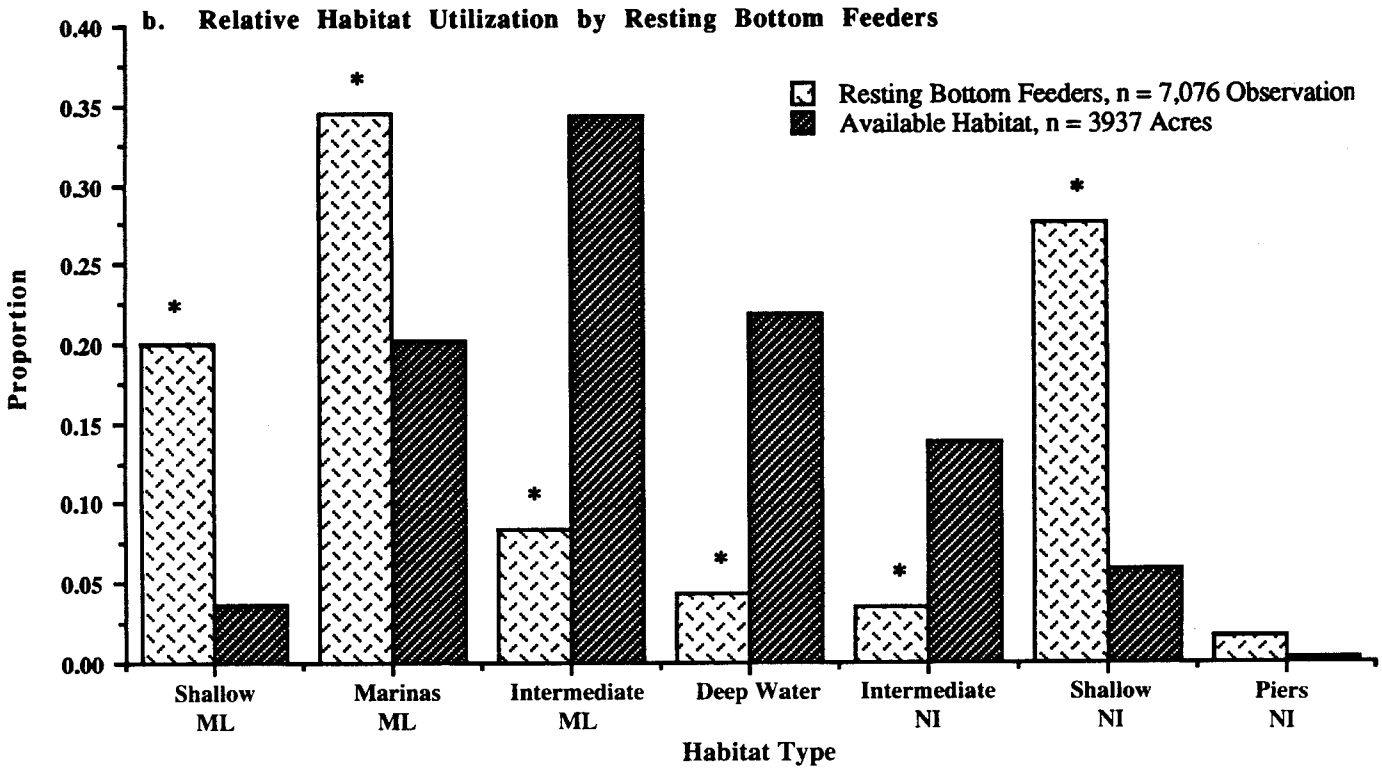
Relative Habitat Utilization by the Prober Foraging Guild in North San Diego Bay During 1993



Spatial Use of North San Diego Bay by the Prober Foraging Guild
Observed During 1993

FIGURE
29





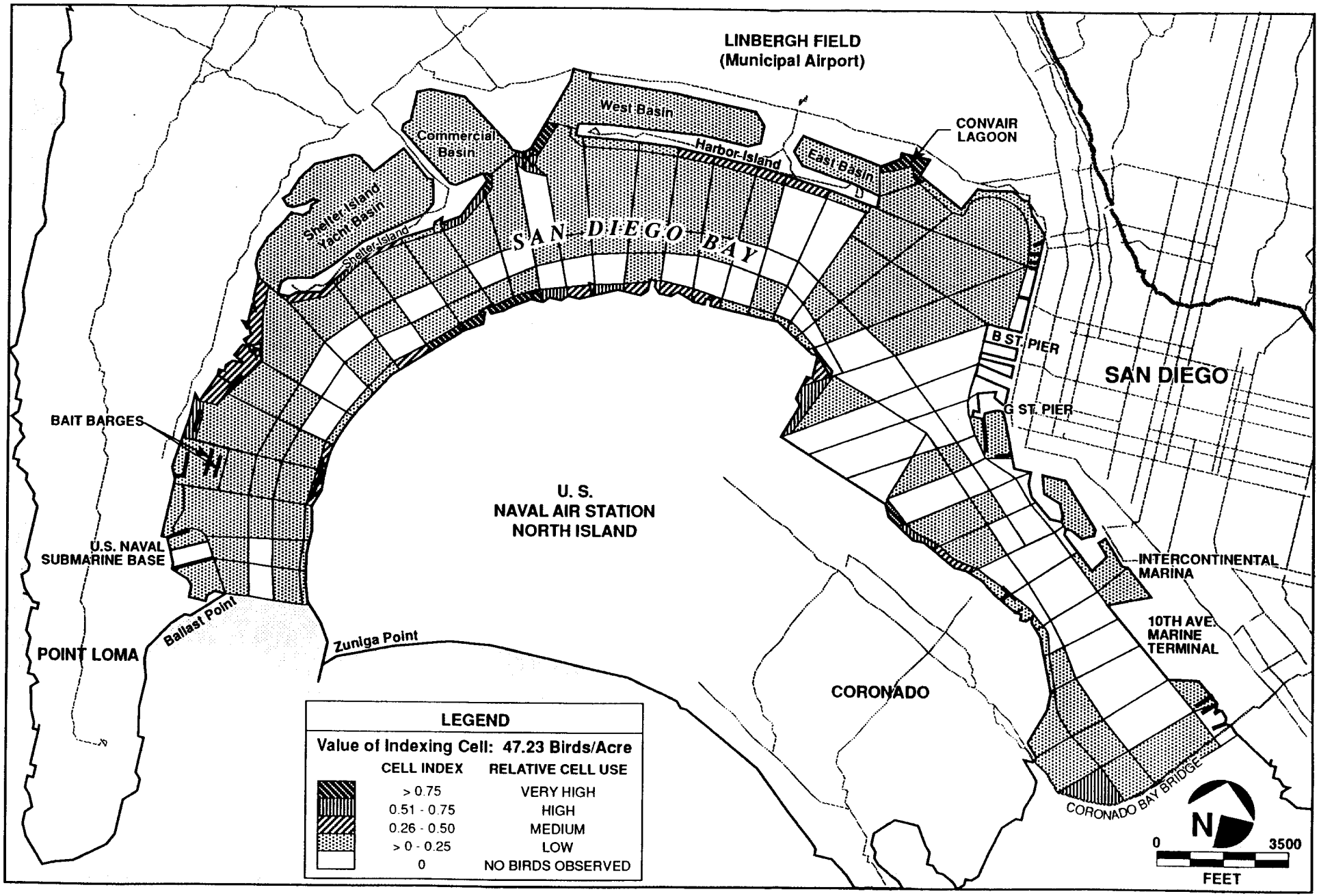
Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

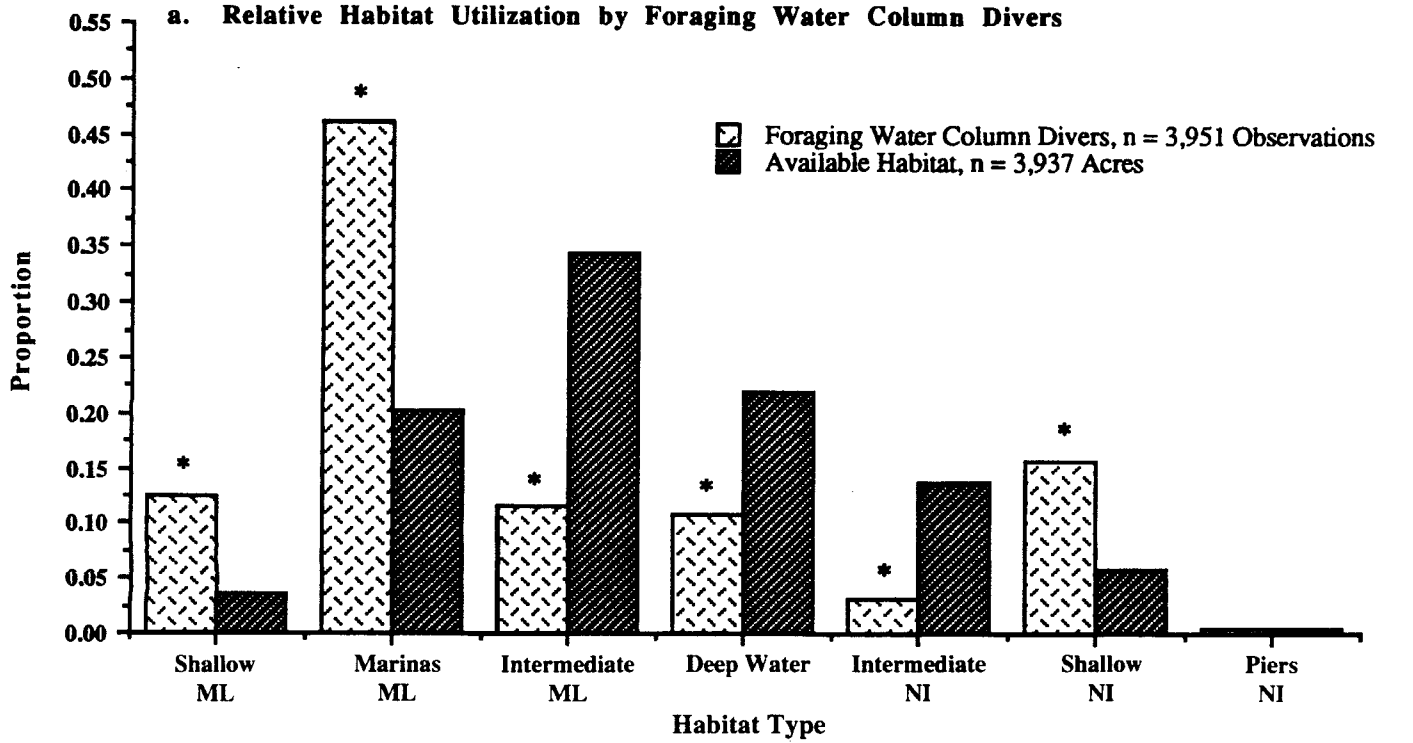
FIGURE 30

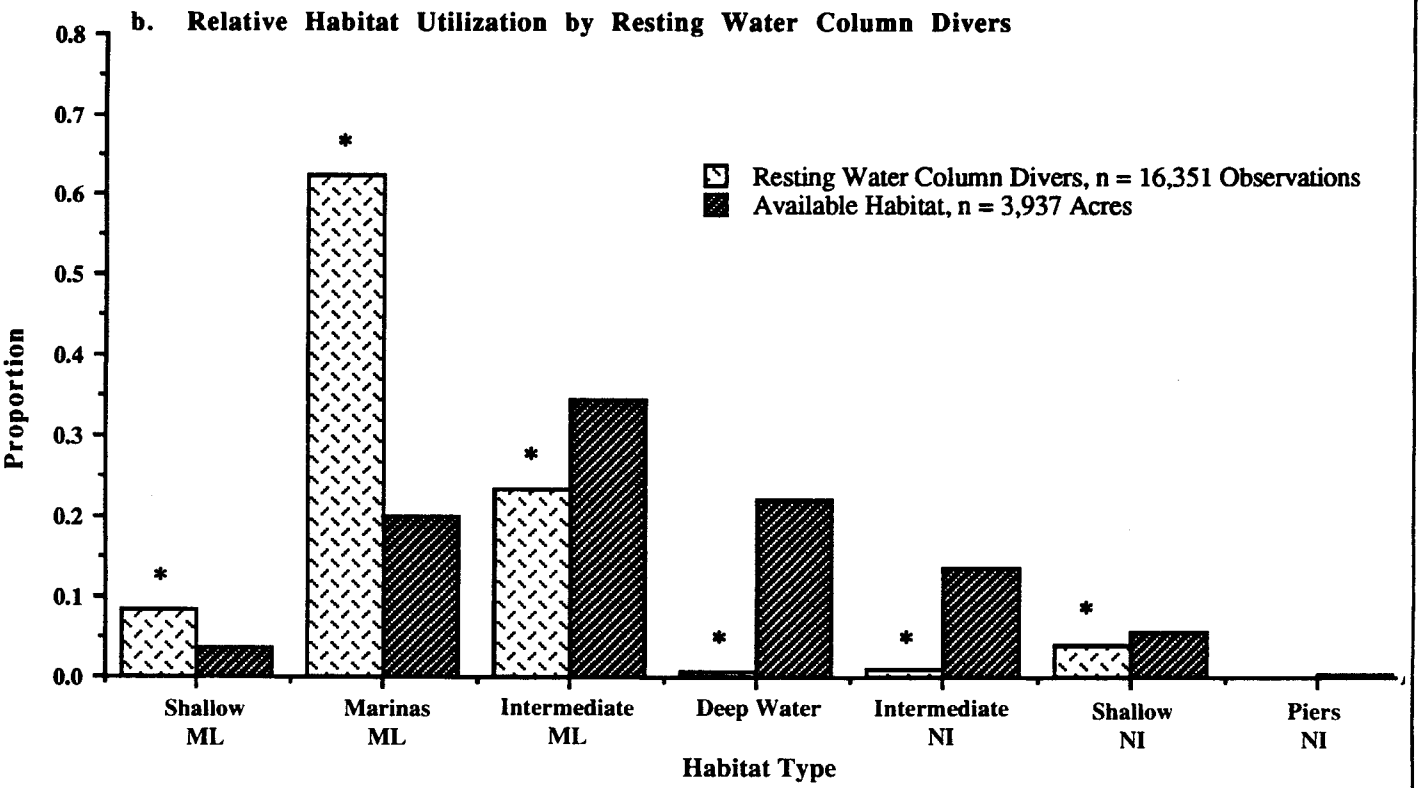
Relative Habitat Utilization by the Bottom Feeding Foraging Guild in North San Diego Bay During 1993



Spatial Use of North San Diego Bay by the Bottom Feeding Foraging Guild
Observed During 1993

FIGURE
31





Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

FIGURE 32

Relative Habitat Utilization by the Water Column Diving Guild in North San Diego Bay During 1993

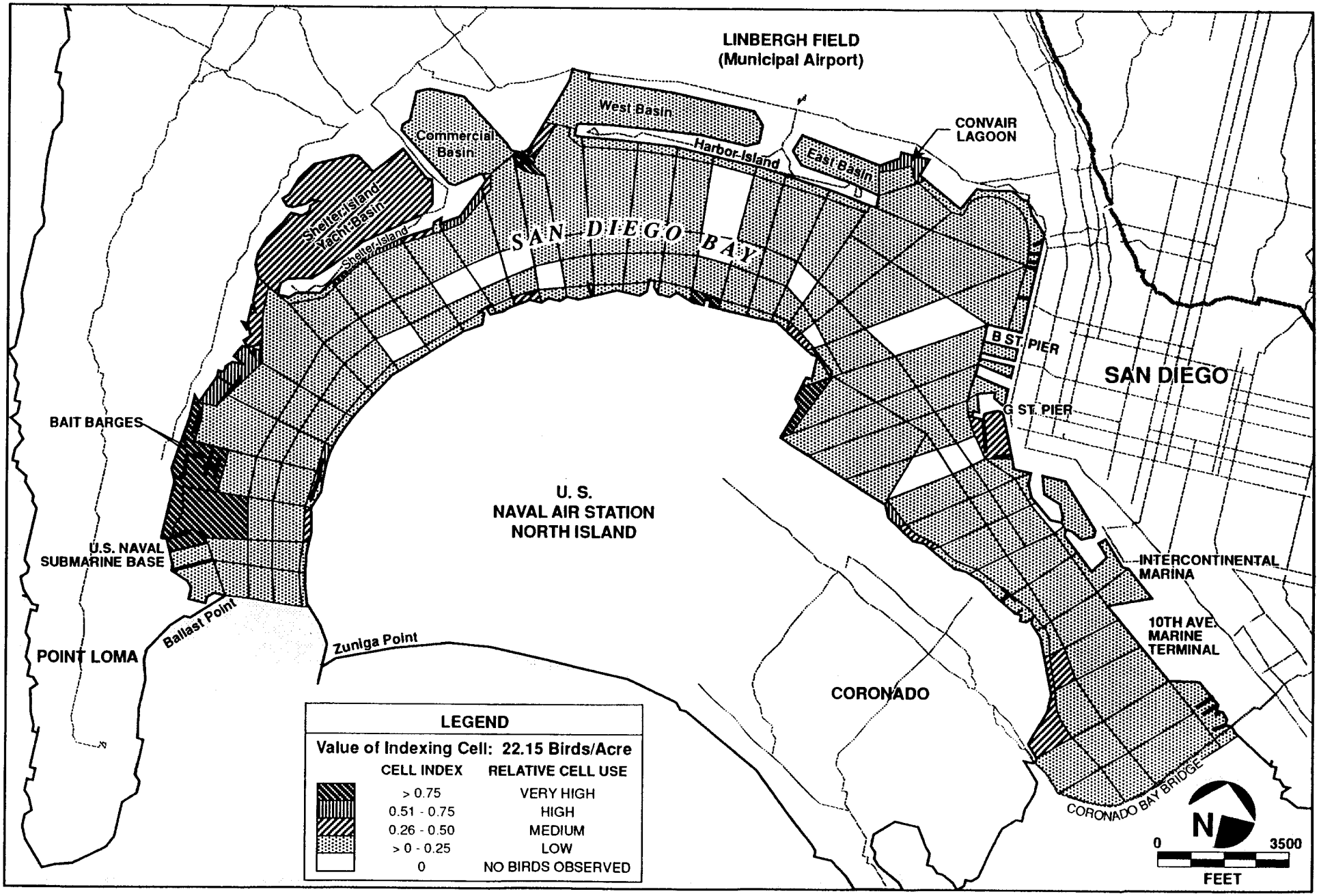
and deep water habitats were also significantly underused. High use areas for water column divers were the northern end of the Submarine Base and and adjacent areas to the north, the breakwater of Shelter Island, selected areas of northeast North Island, the pier between Commercial Basin and Harbor Island West Basin, and Convair Lagoon (Figure 33). The cell with the 10th highest total density (22 birds/acre) was used as the basis for the water column diver index since it was the highest cell with foraging as the dominant activity. The cell with the highest total density (233 birds/acre) was 10.6 times greater than the indexing cell.

Plunge Divers

Plunge divers in North San Diego Bay preferred to forage in shallow water habitats on both sides of the Bay and in mainland marina and pier areas (Figure 34a). Relatively deeper waters were significantly underused. Resting plunge divers showed a strong preference for mainland marina and pier habitat types (Figure 34a). Plunge divers also preferred to rest in shallow water habitats along both sides of the Bay. As with foraging birds, there was a negative preference for intermediate and deep waters. High use areas for plunge divers included the northern end of the Submarine Base and and adjacent areas to the north, several locations along the North Island shoreline, the pier between Commercial Basin and Harbor Island West Basin, and the breakwater of Shelter Island. The cell with the 17th highest total density (22 birds/acre) was used as the basis for the plunge diver index since it was the highest cell with foraging as the dominant activity. The cell with the highest total density (391.8 birds/acre) was 17.6 times greater than the indexing cell.

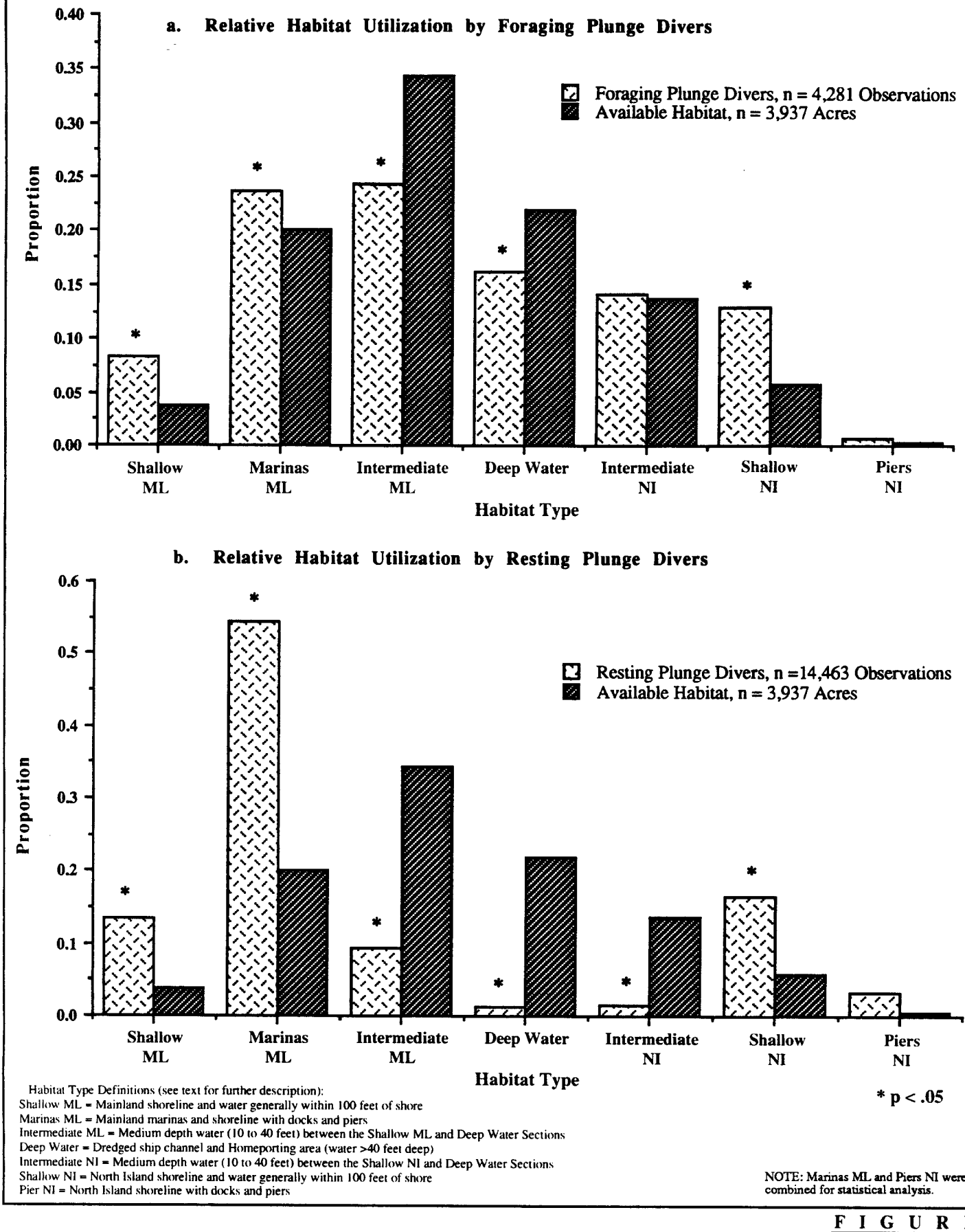
Generalists

The generalist foraging guild showed significant positive preferences for foraging in the mainland marina, pier, and shallow water habitats on both sides of the Bay (Figure 36a). Intermediate and deep water habitats were significantly underused for foraging. Resting generalists showed a similar pattern of preferences, except for a moderately greater use of shallow water habitats along both shorelines of the Bay (Figure 36b). High use areas for resting generalists included the bait barge area north of the Submarine Base and the directly adjacent shoreline to the north and a few shoreline locations North Island (Figure 37). The generalist guild was the only guild for which it was necessary to use different criteria to identify an indexing cell. This was because foraging was not a dominant activity until the 91st highest total density cell. All of the higher total density cells were dominated by



Spatial Use of North San Diego Bay by the Water Column Diving Foraging Guild
Observed During 1993

FIGURE
33

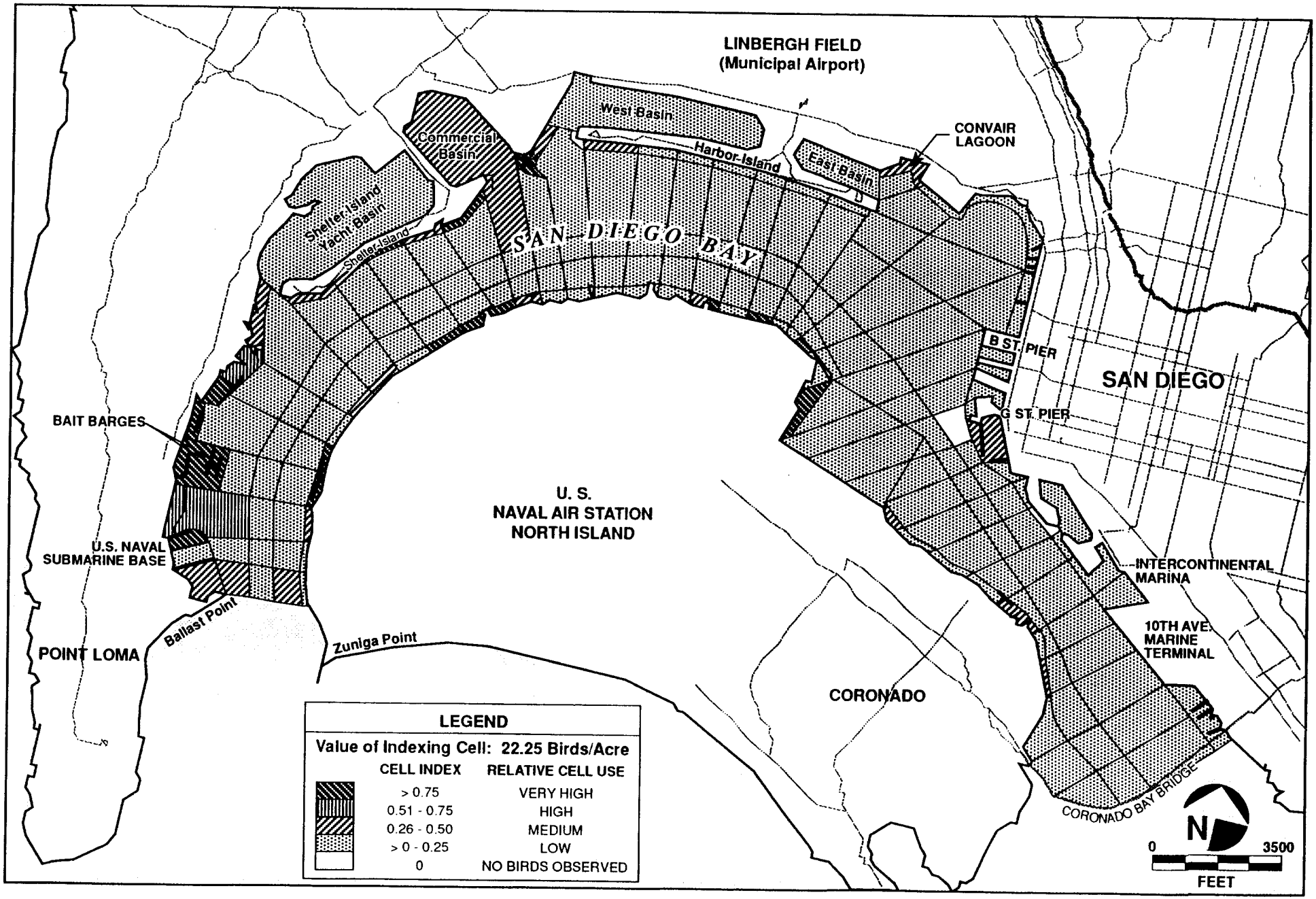


Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

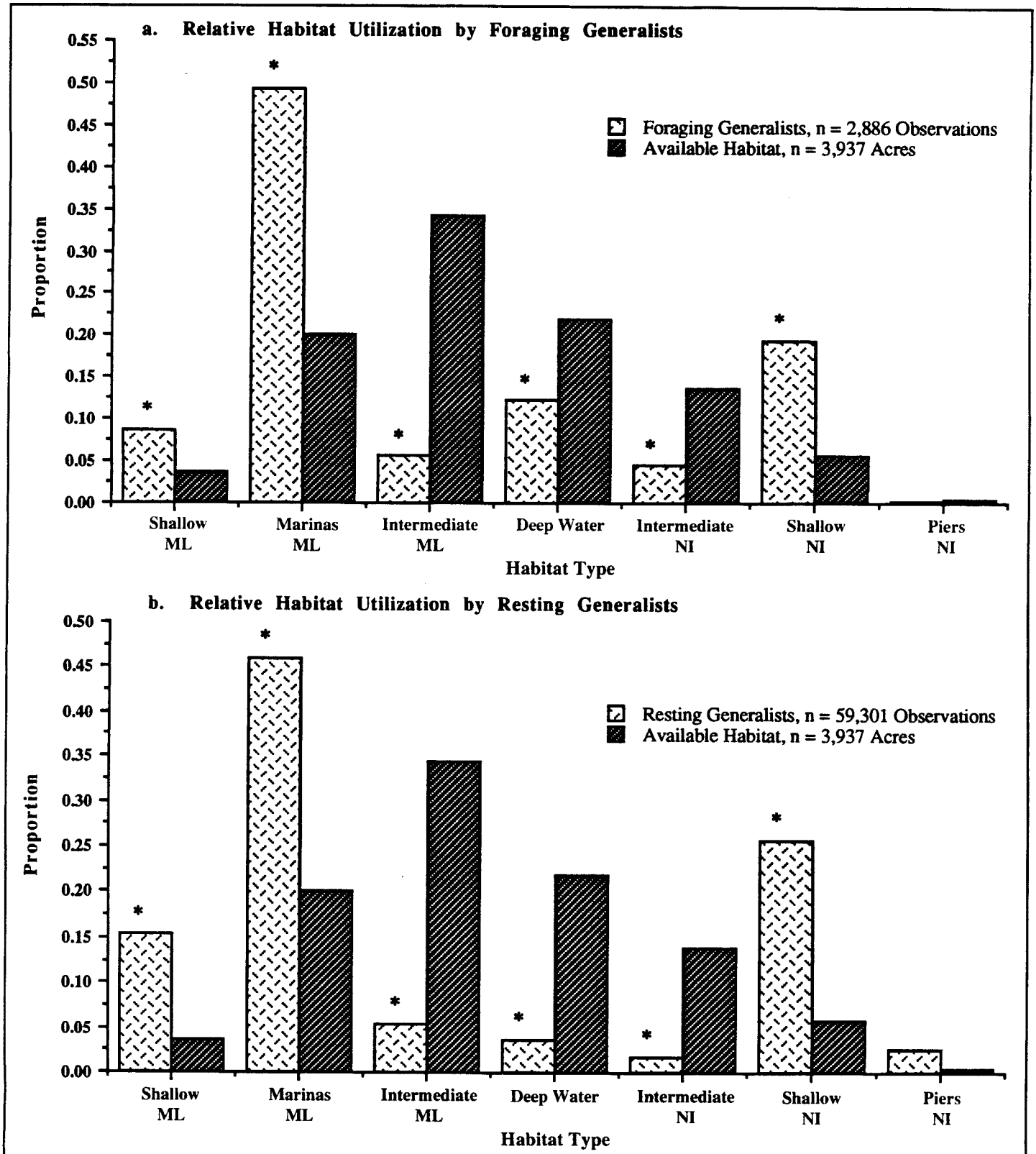
FIGURE 34

Relative Habitat Utilization by the Plunge Diving Foraging Guild in North San Diego Bay During 1993



Spatial Use of North San Diego Bay by the Plunge Diving Foraging Guild
Observed During 1993

FIGURE
35



Habitat Type Definitions (see text for further description):
Shallow ML = Mainland shoreline and water generally within 100 feet of shore
Marinas ML = Mainland marinas and shoreline with docks and piers
Intermediate ML = Medium depth water (10 to 40 feet) between the Shallow ML and Deep Water Sections
Deep Water = Dredged ship channel and Homeporting area (water >40 feet deep)
Intermediate NI = Medium depth water (10 to 40 feet) between the Shallow NI and Deep Water Sections
Shallow NI = North Island shoreline and water generally within 100 feet of shore
Pier NI = North Island shoreline with docks and piers

* $p < .05$

NOTE: Marinas ML and Piers NI were combined for statistical analysis.

FIGURE 36

Relative Habitat Utilization by the Generalist Foraging Guild in North San Diego Bay During 1993

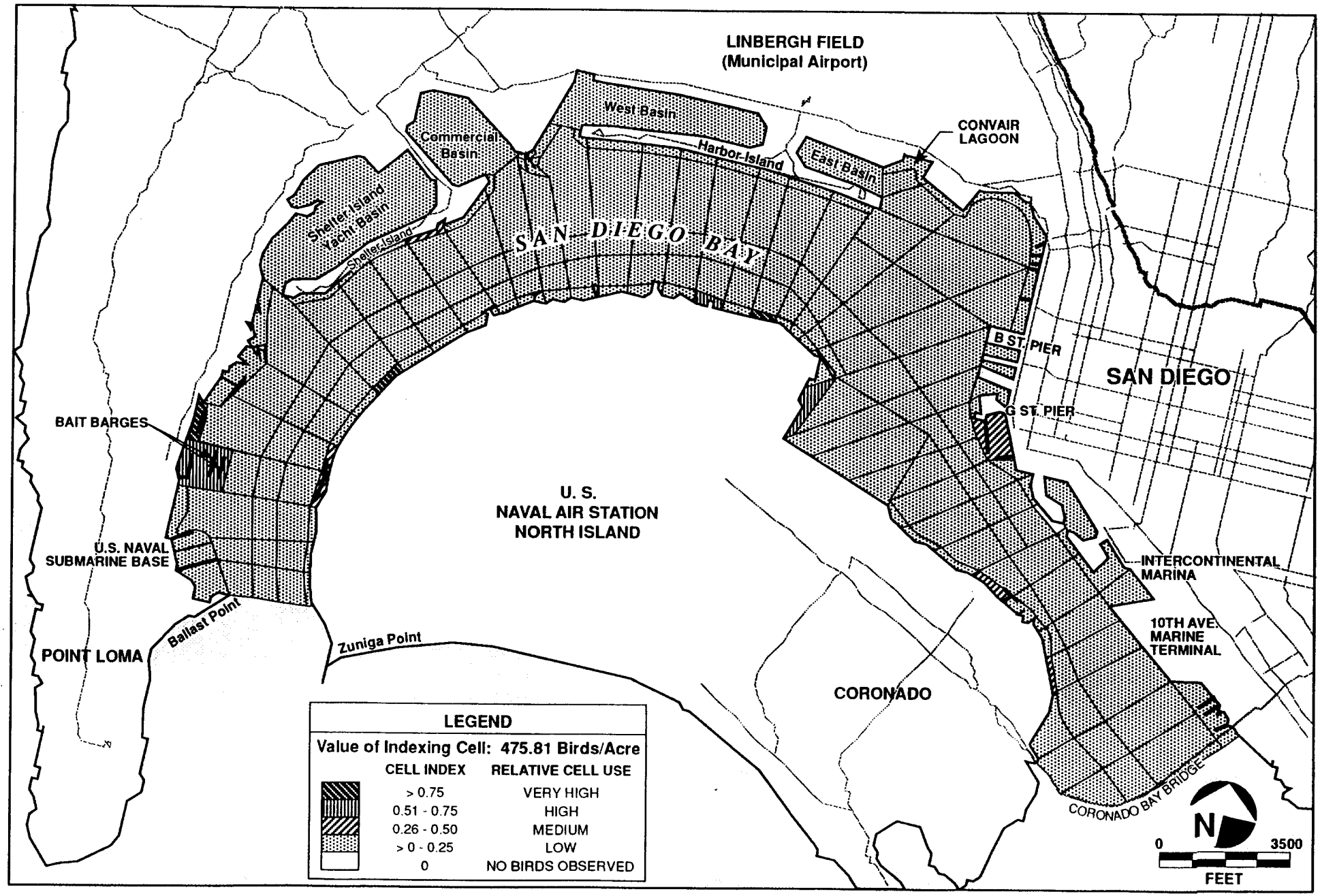


FIGURE 37

Spatial Use of North San Diego Bay by the Generalist Foraging Guild
Observed During 1993

resting birds on water, structure, or shore. As a result, the method for indexing all waterbird cells was used for the generalist guild. The cell with the 4th highest total density (476 birds/acre) was chosen the indexing cell. The highest total density cell (701-birds/acre) was 1.5 times larger than the indexing cell.

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4.0 DISCUSSION

Trends in Waterbird Abundance

The seasonal pattern of waterbird abundance and species composition is consistent with other regional analyses (Briggs et al. 1987). Waterbird species richness and abundances are greatest during winter months and migration periods. Most of the bird species (primarily shorebirds and waterfowl) present at this time leave the Bay to breed elsewhere. The Bay generally supports lower abundance of waterbirds during late spring and summer, and the species composition is dominated by resident species and breeding species that winter south of San Diego (e.g., tern species).

Use of North San Diego Bay by target species was dominated by brown pelican, which is present in the Bay all year with abundances varying from 25 to 828 individuals. Adult pelicans showed two peaks in abundances during early summer and winter. These time periods correspond with post-breeding migration of pelicans that fail in that year's breeding attempt, leaving the breeding colony early, and with the gradual increase of the wintering pelican population.

Least tern and elegant tern were relatively uncommon species, with peak abundances of 109 and 644 individuals, respectively. Least terns are present primarily during the breeding season and elegant terns use the Bay during the breeding season and fall months. Surf scoter and scaup spp. had peak winter abundances of 747 and 330 individuals, respectively, and were virtually absent during the breeding season. Brant were not detected in North Bay.

Habitat Use

Waterbird species in North San Diego Bay showed a significant preference for shoreline and shallow water habitats and for marinas on the mainland side of the Bay. Deep and intermediate depth waters were generally avoided by most waterbird species. The exceptions were mixed-species flocks of terns that foraged in deep water areas when large schools of fish were present. Terns typically foraged in shallow water areas (depth < 20 feet) as individuals or in small groups of less than 5 individuals. Least terns roosted at the anchorage area near Commercial Basin.

The extensive use of marinas and piers by the majority of waterbird species is significant in that these areas are often characterized as being of relatively low biological value to wildlife (e.g., Copper 1986). This study and others (Engineering-Science 1987, ERCE 1989) suggest that developed areas of the Bay often retain significant biological value for selected waterbird species (e.g., brown pelican, scaup, elegant tern). The relative use of a given area may be more closely related to levels of human activity in the vicinity (Anderson and Keith 1990, Batten 1977, Burger 1981, Burger and Gochfeld 1991, Liddle and Scorgie 1980, Owen 1976, 1977). Restricted-access piers and some private marinas generally had higher use by some waterbird species than similar areas with frequent human presence (e.g., commercial marinas and docks). The presence of a localized food resource (i.e., bait barges) greatly influenced the distribution of many waterbird species. The presence or absence of eel grass may also be an important factor that explains the significant preference of many waterbird species for shallow water habitats (ERCE 1989).

Spatial Distribution

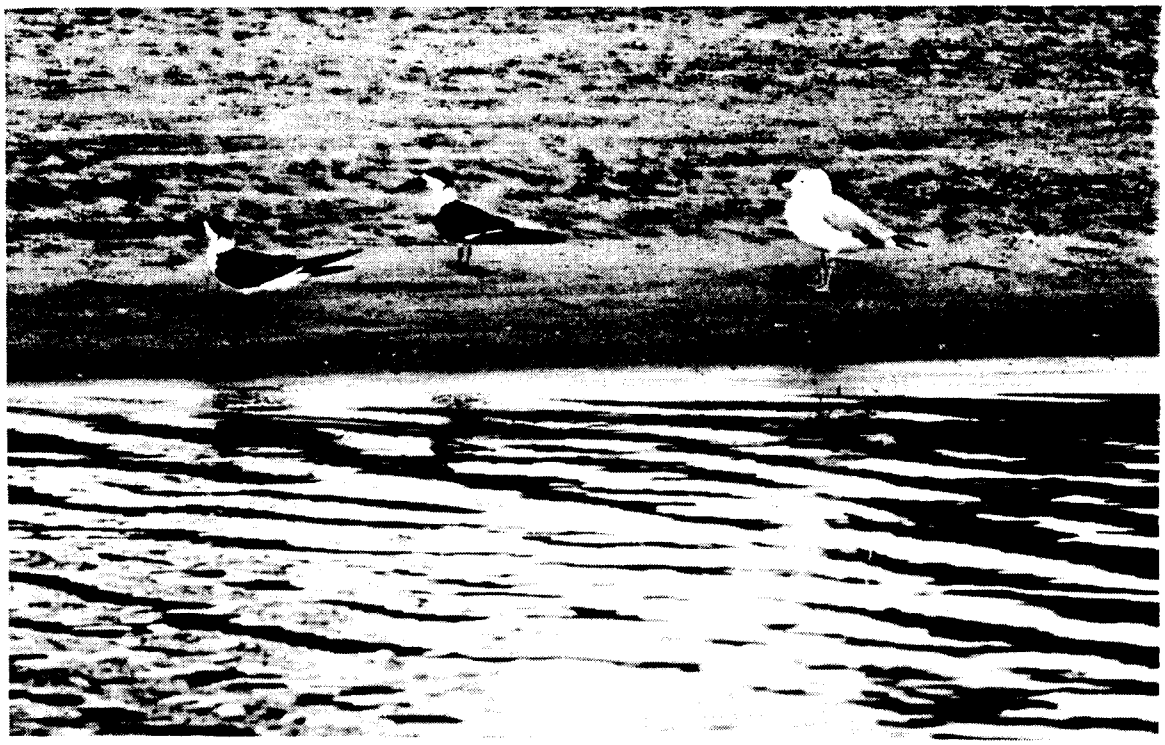
Waterbird distribution within North San Diego Bay showed an uneven spatial distribution, with certain areas being used relatively more than other areas. Key waterbird use areas included the following:

- Areas in the vicinity of bait barges (many species)
- The northern side of Submarine Base (brown pelican, elegant tern, waders, probers, column divers, plunge divers)
- Shoreline areas north of the Submarine Base (brown pelican, surf scoter, wader spp., column divers, plunge divers)
- The breakwater of Shelter Island (brown pelican, least tern, scaup spp., elegant tern, bottom feeders, column divers, plunge divers)
- Selected shoreline areas of North Island (brown pelican, elegant tern, scaup spp., surf scoter, bottom feeders, column divers, plunge divers, waders, proders)
- The entrances of Commercial Basin and Harbor Island West Basin (brown pelican, least tern, elegant tern, waders, bottom feeders, column divers, plunge divers)
- Commercial Basin (elegant tern, plunge divers)
- Convair Lagoon (brown pelican, scaup spp., prober spp., bottom feeders, column divers)
- Shoreline areas of Coronado (scaup spp., column divers, bottom feeders, prober spp., waders)
- Shoreline area north of Ballast Point (prober spp.)

Additional areas considered important include small areas within the large marinas that provide roosting and foraging habitat. The precise delineation of these areas is beyond the scope of this study.

Comparison Between North and Central San Diego Bay

A preliminary comparison between North and Central San Diego Bay is made pending completion of 1994 surveys of Central Bay. Both study areas support the same waterbird species, but in different proportions. Overall species diversity was greater in the North Bay than in Central Bay, with surf scoter being the dominant species in Central Bay. Waterbird abundance in North Bay was distributed among more species: Heermann's gull, Brandt's cormorant, and brown pelican were the most common species. The difference in species composition reflects differences between North and Central bays in the relative availability of roost sites and, to a lesser extent, foraging habitat. North Bay supports relatively greater numbers of waterbirds that are members of the plunge diver, column diver, bottom feeder, wader, and generalist foraging guilds. Central Bay supports mostly surf scoters and more members of the prober guild.



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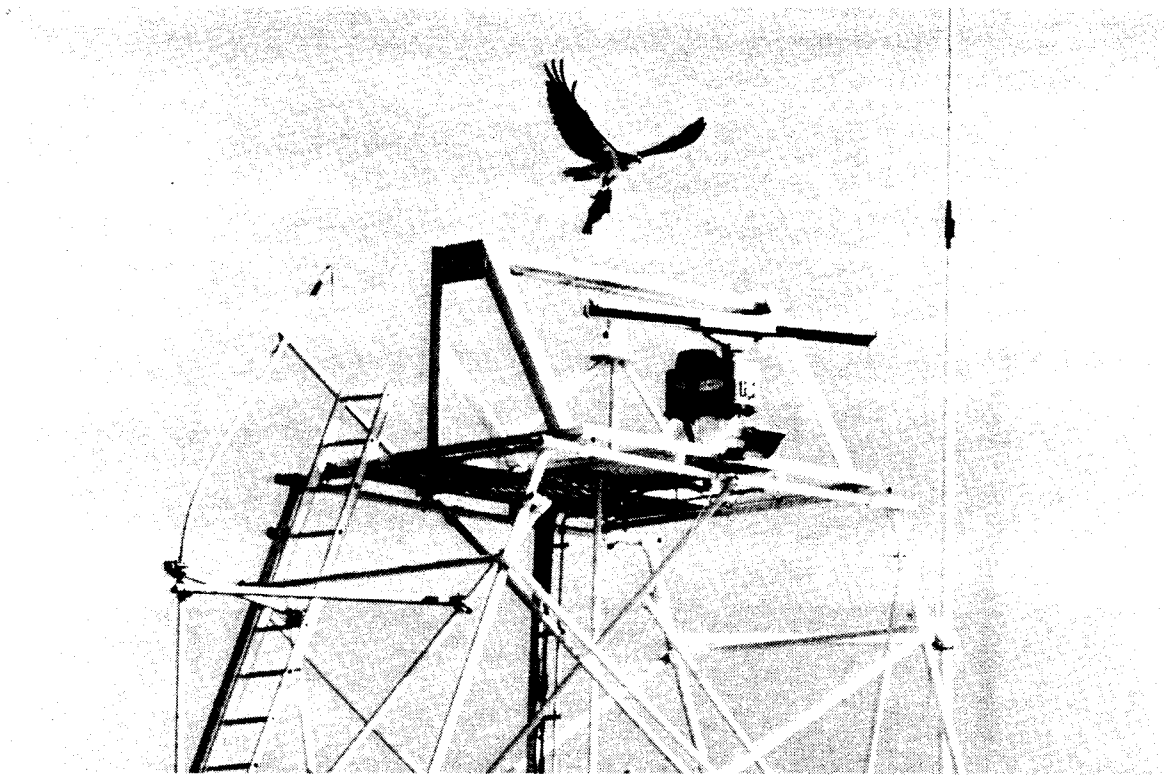

6.0 REPORT PREPARERS

This technical report was prepared by the Biological Resources Branch, Ogden Environmental and Energy Services Co.

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APPENDIX A

WATERBIRD SPECIES OBSERVED AT NORTH AND CENTRAL SAN DIEGO BAY IN 1993

APPENDIX A

WATERBIRD SPECIES OBSERVED AT NORTH AND CENTRAL SAN DIEGO BAY IN 1993

Common Name	Scientific Name	Sensitivity Status †	Residency Status §
Wader/Shallow Water Foraging Guild			
Great Blue Heron	*Ardea herodias*	SSC (rookery)	BR
Great Egret	*Casmerodius albus*	SSC (rookery)	NR
Snowy Egret	*Egretta thula*	SSC (rookery)	BR
Little Blue Heron	*Egretta caerulea*		BR
Green-Backed Heron	*Butorides striatus*		BR
Black-Crowned Night Heron	*Nycticorax nycticorax*	SSC (rookery)	BR
Cinnamon Teal	*Anas cyanoptera*		W
Prober Foraging Guild			
Black-Bellied Plover	*Pluvialis squatarola*		W
Western Snowy Plover	*Charadrius alexandrinus nivosus*	FT, SSC	BR
Semipalmated Plover	*Charadrius semipalmatus*		W
Killdeer	*Charadrius vociferus*		BR
Greater Yellowlegs	*Tringa melanoleuca*		W
Willet	*Catoptrophorus semipalmatus*		W
Wandering Tattler	*Heteroscelus incanus*		W
Spotted Sandpiper	*Actitis macularia*		W
Whimbrel	*Numenius phaeopus*		W
Long-Billed Curlew	*Numenius americanus*	FC3, SSC	W
Marbled Godwit	*Limosa fedoa*		W
Ruddy Turnstone	*Arenaria interpres*		W
Black Turnstone	*Arenaria melanocephala*		W
Surfbird	*Aphriza virgata*		W
Red Knot	*Calidris canutus*		W
Sanderling	*Calidris alba*		W
Western Sandpiper	*Calidris mauri*		W
Least Sandpiper	*Calidris minutilla*		W
Dunlin	*Calidris alpina*		W
Short-Billed Dowitcher	*Limnodromus griseus*		W
Long-Billed Dowitcher	*Limnodromus scolopaceus*		W
Bottom Feeding Diver Guild			
Brant	*Branta bernicla*		W
Greater Scaup	*Aythya marila*		W
Lesser Scaup	*Aythya affinis*		W
Oldsquaw	*Clangula hyemalis*		T
Black Scoter	*Melanitta nigra*		T
Surf Scoter	*Melanitta perspicillata*		W
Bufflehead	*Bucephala albeola*		W

APPENDIX A

WATERBIRD SPECIES OBSERVED AT NORTH AND CENTRAL SAN DIEGO BAY IN 1993

Common Name	Scientific Name	Sensitivity Status †	Residency Status §
Water Column Diving Guild			
Red-throated Loon	*Gavia stellata*		W
Pacific Loon	*Gavia pacifica*		W
Common Loon	*Gavia immer*	SSC	W
Pied-billed Grebe	*Podilymbus podiceps*		W
Horned Grebe	*Podiceps auritus*		W
Eared Grebe	*Podiceps nigricollis*		W
Western Grebe	*Aechmophorus occidentalis*	SSC	NB
Clark's Grebe	*Aechmophorus clarkii*	SSC	W
Double-crested Cormorant	*Phalacrocorax auritus*	SSC (Rookery)	NR
Brandt's Cormorant	*Phalacrocorax penicillatus*		BR
Pelagic Cormorant	*Phalacrocorax pelagicus*		NR
Red-breasted Merganser	*Mergus serrator*		W
Ruddy Duck	*Oxyura jamaicensis*		W
Rhinocerous Auklet	*Cerorhinca monocerata*	SSC (Nesting Colony)	T
Plunge Diving Guild			
California Brown Pelican	*Pelecanus occidentalis californicus*	FE, SE	NR
Osprey	*Pandion haliaetus*	SSC (Nesting)	W
Gull-billed Tern	*Sterna nilotica*	SSC (Nesting Colony)	S
Caspian Tern	*Sterna caspia*	SSC (Nesting Colony)	BR
Royal Tern	*Sterna maxima*		BR
Elegant Tern	*Sterna elegans*	FC2, SSC	S
Forster's Tern	*Sterna forsteri*	SSC (Nesting Colony)	BR
California Least Tern	*Sterna antillarum browni*	FE, SE	S
Black Skimmer	*Rynchops niger*	SSC	BR
Belted Kingfisher	*Ceryle alcyon*		W
Predator Guild			
Northern Harrier	*Circus cyaneus*	SSC	NR
American Peregrine Falcon	*Falco peregrinus anatum*	FE, SE	BR
Generalist Guild			
Fulvous Whistling-Duck	*Dendrocygna bicolor*		T
Black-Bellied Whistling Duck	*Dendrocygna autumnalis*		T
Wood Duck	*Aix sponsa*		BR
Mallard	*Anas platyrhynchos*		BR
American Coot	*Fulica americana*		W
Parasitic Jaeger	*Stercorarius parasiticus*		

APPENDIX A

WATERBIRD SPECIES OBSERVED AT NORTH AND CENTRAL SAN DIEGO BAY IN 1993

Common Name	Scientific Name	Sensitivity Status †	Residency Status §
Bonaparte's Gull	*Larus philadelphia*		W
Heermann's Gull	*Larus heermanni*		NR
Mew Gull	*Larus canus*		W
Ring-billed Gull	*Larus delawarensis*		W
California Gull	*Larus californicus*	SSC (Nesting Colony)	W
Herring Gull	*Larus argentatus*		W
Western Gull	*Larus occidentalis*		BR
Glaucous-Winged Gull	*Larus glaucescens*		W

† species considered sensitive by state and federal resource agencies: FC2 = Federal Candidate Category 2, FC3 = Federal Candidate Category 3, FE= Federally Endangered, FPT= Federal Proposed as Threatened, SE= State Endangered, and SSC= CDFG Species of Special Concern.

§ Residency status codes are based on the predominant status of the species population in the Bay: BR= Year Round Breeding Resident, NR= Year Round Non-Breeding Resident (Breeding Population leaves while some Non-Breeders Remain), S= Summer (Breeding) Visitor , W= Winter (Non-Breeding) Visitor, M = Migrant (species only occurs in bay during migration), T = Transient (stray individual, unusual occurrence for species to be in area)

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APPENDIX B

SAN DIEGO BAY WATERBIRD STUDY SPECIES ACCOUNTS

APPENDIX B
SAN DIEGO BAY WATERBIRD STUDY
SPECIES ACCOUNTS

Common Name: Red-throated Loon
Scientific Name: *Gavia stellata*
Sensitivity Status: none
Regional Distribution: Common winter visitor and transient along the coast remaining rarely in summer. Casual to very rare away from the coast.
Residency Status in San Diego Bay: Uncommon to fairly common winter visitor; casual in summer.
Foraging Guild: Water Column Diver. Eats mostly small fish, but also aquatic invertebrates, and some aquatic plants. Prefers water < 30 feet deep.
Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north
Bayside shoreline of Shelter Island
Portions of shoreline along northeast edge of North Island Naval Air Station
Pier between Commercial Basin and Harbor Island West Basin
Convair Lagoon.

Common Name: Pacific Loon
Scientific Name: *Gavia pacifica*
Status: none
Regional Distribution: Common to abundant transient and fairly common winter visitor along the coast, including offshore waters. Rare along the coast in summer; casual transient and winter visitor away from the coast.
Residency Status in San Diego Bay: Common to abundant migrant and winter visitor, very rare in summer.
Foraging Guild: Water Column Diver. Eats small fish almost exclusively during winter. In other seasons, also includes crustaceans, mollusks, aquatic insects, frogs, and occasionally aquatic vegetation in diet.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: Common Loon

Scientific Name: *Gavia immer*

Sensitivity Status: CDFG Species of Special Concern.

Regional Distribution: Common transient and winter visitor along the length of the coast, remaining rarely through the summer. Uncommon spring and fall migrant inland on deep water lakes, remaining regularly in winter only along the Colorado River. A few summer records away from the coast.

Residency Status in San Diego Bay: Uncommon to fairly common migrant and winter visitor; rare to uncommon in summer.

Foraging Guild: Water Column Diver. Often dives very deep water. Eats mostly fish, but also some aquatic invertebrates (especially crustaceans), frogs, salamanders, and aquatic insects.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: Pied-billed Grebe

Scientific Name: *Podilymbus podiceps*

Status: none

Regional Distribution: Fairly common resident throughout most of the region; most common in winter due to influx of wintering individuals.

Residency Status in San Diego Bay: Fairly common winter visitor on salt water bays and estuaries.

Foraging Guild: Water Column Diver. Prefers foraging in water <20 feet deep. Eats primarily aquatic invertebrates and secondarily fish, but also will eat snails, and frogs.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: Horned Grebe

Scientific Name: *Podiceps auritus*

Status: none

Regional Distribution: Fairly common resident throughout most of the region; most common along coastal nearshore waters in winter.

Residency Status in San Diego Bay: Fairly common to very common winter visitor. San Diego Bay is primary wintering area in San Diego County.

Foraging Guild: Water Column Diver. Usually feeds in water <25 feet deep. Eats mostly fishes and crustaceans during winter .

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north
Bayside shoreline of Shelter Island
Portions of shoreline along northeast edge of North Island Naval Air Station
Pier between Commercial Basin and Harbor Island West Basin
Convair Lagoon.

Common Name: Eared Grebe
Scientific Name: *Podiceps nigricollis*
Status: none
Regional Distribution: Common winter visitor throughout much of the region; primarily a transient away from the coast. Breeds throughout the region, except the Colorado River Valley.
Residency Status in San Diego Bay: Common to abundant migrant and winter visitor; rare in summer. Largest numbers are found in South San Diego Bay at the Saltworks.
Foraging Guild: Water Column Diver. Prefers water <20 feet deep. Eats mostly aquatic insects, but also eats small crustaceans, mollusks, amphibians, and fishes.
Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north
Bayside shoreline of Shelter Island
Portions of shoreline along northeast edge of North Island Naval Air Station
Pier between Commercial Basin and Harbor Island West Basin
Convair Lagoon.

Common Name: Western Grebe
Scientific Name: *Aechmophorus occidentalis*
Status: none
Regional Distribution: Common along the coast in winter. Very local breeding resident in coastal reservoirs, Salton Sea, and Colorado River Valley. Transient and rare winter visitor elsewhere in the interior.
Residency Status in San Diego Bay: Common to abundant migrant and winter visitor.
Foraging Guild: Water Column Diver. Prefers waters <20 feet deep. Eats primarily fish, but also eats aquatic invertebrates and amphibians.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: Clark's Grebe

Scientific Name: *Aechmophorus clarkii*

Status: none

Regional Distribution: Common along the coast in winter. Local breeding resident in coastal reservoirs, Salton Sea, and Colorado River Valley Transient and rare winter visitor elsewhere in the interior.

Residency Status in San Diego Bay: Common to abundant migrant and winter visitor.

Foraging Guild: Water Column Diver. Prefers waters <20 feet deep. Eats primarily fish; also eats aquatic invertebrates and amphibians.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: California Brown Pelican

Scientific Name: *Pelecanus occidentalis californicus*

Status: Federally Endangered, State Endangered.

Regional Distribution: Common throughout the year along the coast, with the largest numbers present in summer. Breeding colonies are located on Channel Islands and the nearby Los Coronados Islands, and in the Gulf of California in Baja California. Regular post-breeding visitor to the Salton Sea. Rare elsewhere away from the coast.

Residency Status in San Diego Bay: Common to very common non-breeding visitor.

Foraging Guild: Plunge Diver. The brown pelican, eats only small schooling fish. Primary forage species in Southern California is northern anchovy.

Preferred Habitat for Species in North San Diego Bay

1° Shallow water along shorelines on both sides of bay (foraging)

2° Marinas and pier areas along Mainland side of bay (roosting)

High Use Areas by Species in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

North Island Navy pier across bay from bait barge area

Pier between Commercial Basin and Harbor Island West Basin

Floating docks northeast of Naval Air Station, near aircraft carrier berths

Common Name: Double-crested Cormorant

Scientific Name: *Phalacrocorax auritus*

Status: CDFG Species of Special Concern at Rookery.

Regional Distribution: Fairly common to common throughout the year along the entire coast, on some of the Channel Islands, and along the Colorado River. Fairly common all year at the Salton Sea. A transient elsewhere in the interior. Breeds locally on the Channel Islands, Salton Sea, and Colorado River Valley.

Residency Status in San Diego Bay: Common to very common non-breeding visitor. A total of 53 nesting pairs documented at the Saltworks in 1993.

Foraging Guild: Water Column Diver. Eats primarily schooling fish; occasionally will eat mollusks, crustaceans, small vertebrates, and sea worms.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north
Bayside shoreline of Shelter Island
Portions of shoreline along northeast edge of North Island Naval Air Station
Pier between Commercial Basin and Harbor Island West Basin
Convair Lagoon.

Common Name: Brandt's Cormorant
Scientific Name: *Phalacrocorax penicillatus*
Status: none
Regional Distribution: Common resident along the coast and around the Channel Islands; primarily a winter visitor in San Diego County.
Residency Status in San Diego Bay: Very common to abundant throughout the year as a non-breeding resident. This species nests sporadically at La Jolla and one pair nested on a Point Loma pier in 1993. Several nesting pairs observed in 1993 in North Bay during this study.
Foraging Guild: Water Column Diver. Eats primarily fishes; also eats crabs and shrimp.
Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north
Bayside shoreline of Shelter Island
Portions of shoreline along northeast edge of North Island Naval Air Station
Pier between Commercial Basin and Harbor Island West Basin
Convair Lagoon.

Common Name: Pelagic Cormorant
Scientific Name: *Phalacrocorax pelagicus*
Status: none
Regional Distribution: Fairly common resident along the coast and around the Channel Islands. Primarily a winter visitor along the coast of San Diego.
Residency Status in San Diego Bay: Fairly common to common winter visitor; casual in summer.

Foraging Guild: Water Column Diver. Deep water diver to nearly 200 feet. Eats primarily fish; occasionally marine invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: Great Blue Heron

Scientific Name: *Ardea herodias*

Status: Species considered sensitive at rookery sites by CDFG.

Regional Distribution: Fairly common resident throughout most of the region, becoming more numerous in warmer areas in winter. Breeds locally.

Residency Status in San Diego Bay: Common throughout the year as a non-breeding visitor, breeds in small numbers at Point Loma and at the northeast corner of the Naval Air Station.

Foraging Guild: Wader/Shallow Water Forager. Eats mostly small fish, but will eat aquatic invertebrates, small mammals, nestling birds, and amphibians.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay

2° Shallow water, shorelines, and marina/pier areas on Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Numerous shoreline areas along North Island and Coronado

Shoreline at west entrance to Harbor Island West Basin (important for foraging)

Common Name: Great Egret

Scientific Name: *Casmerodias albus*

Status: Species considered sensitive at rookery sites by CDFG.

Regional Distribution: Fairly common winter visitor along the coast; common resident and breeder at Salton sea and Colorado River Valley; uncommon transient through the rest of the interior.

Residency Status in San Diego Bay: Fairly common winter visitor; rare to uncommon in summer.

Foraging Guild: Wader/Shallow Water Forager. Eats fish, small vertebrates, and aquatic invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay

2° Shallow water, shorelines, and marina/pier areas on Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Numerous shoreline areas along North Island and Coronado

Shoreline at west entrance to Harbor Island West Basin (important for foraging)

Common Name: Snowy Egret

Scientific Name: *Egretta thula*

Status: Species considered sensitive at rookery sites by CDFG. Breeding documented at Buena Vista Lagoon and Tijuana River Valley.

Regional Distribution: Common winter visitor and uncommon during summer along the coast. . Common resident at Salton Sea and Colorado River Valley. Generally an uncommon transient away from the coast.

Residency Status in San Diego Bay: Common to very common winter visitor, generally uncommon to fairly common in summer.

Foraging Guild: Wader/Shallow Water Forager. Eats aquatic invertebrates, fish, frogs, lizards, and snakes.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay

2° Shallow water, shorelines, and marina/pier areas on Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Numerous shoreline areas along North Island and Coronado

Shoreline at west entrance to Harbor Island West Basin (important for foraging)

Common Name: Little Blue Heron

Scientific Name: *Egretta caerulea*

Status: none

Regional Distribution: Casual visitor along the coast, primarily in fall and winter, and at Salton Sea in summer.

Residency Status in San Diego Bay: Rare non-breeding resident.

Foraging Guild: Wader/Shallow Water Forager. Eats primarily fish, but also amphibians, and aquatic invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay

2° Shallow water, shorelines, and marina/pier areas on Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Numerous shoreline areas along North Island and Coronado

Shoreline at west entrance to Harbor Island West Basin (important for foraging)

Common Name: Green Heron

Scientific Name: *Butorides striatus*

Status: none

Regional Distribution: Uncommon to fairly common resident in the region, but seasonal status varies with locality.

Residency Status in San Diego Bay: Uncommon to fairly common resident.

Foraging Guild: Wader/Shallow Water Forager.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay

2° Shallow water, shorelines, and marina/pier areas on Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Numerous shoreline areas along North Island and Coronado

Shoreline at west entrance to Harbor Island West Basin (important for foraging)

Common Name: Black-crowned Night Heron

Scientific Name: *Nycticorax nycticorax*

Status: Species considered sensitive at rookery sites by CDFG.

Regional Distribution: Fairly common but local resident in the coastal area, Salton Sea, and Colorado River Valley; nests locally. Uncommon transient and rare winter visitor in the dry inland areas and desert.

Residency Status in San Diego Bay: Common to very common fall and winter visitor, uncommon to fairly common in spring and summer, but with substantial numbers nesting at a few localities. Colony sites in San Diego Bay: Point Loma; North Island Naval Air Station; and Coronado.

Foraging Guild: Wader/Shallow Water Forager. An opportunistic forager, this species eats, fish, aquatic invertebrates, eggs, nestling birds, small mammals, amphibians, snakes, and plant material.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay

2° Shallow water, shorelines, and marina/pier areas on Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Numerous shoreline areas along North Island and Coronado

Shoreline at west entrance to Harbor Island West Basin (important for foraging)

Common Name: Brant

Scientific Name: *Branta bernicla*

Status: none

Regional Distribution: Very locally common winter visitor along the coast; common to abundant transient. Erratic spring transient at Salton Sea and locally rare elsewhere in the interior. A few individuals occasionally remain through summer along the coast.

Residency Status in San Diego Bay: Very common but extremely localized winter visitor, and migrant; rare in summer.

Foraging Guild: Bottom Feeding Diver. Prefers shallow water with dense growth of eelgrass. In winter eats primarily eelgrass and sea lettuce, but occasionally marine invertebrates.

Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed in Central Bay

Common Name: Wood Duck

Scientific Name: *Aix sponsa*

Status: none

Regional Distribution: Rare to uncommon transient and rare winter visitor, occurring primarily along the coast.

Residency Status in San Diego Bay: Rare winter visitor. Eats aquatic vegetation seeds and aquatic invertebrates.

Foraging Guild: Generalist

Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed two times in entire Bay

Common Name: Mallard

Scientific Name: *Anas platyrhynchos*

Status: none

Regional Distribution: Fairly common winter visitor throughout; Uncommon to locally common in summer. Nests along coast and on montane lakes. Rare winter visitor to the Channel Islands.

Residency Status in San Diego Bay: Common to very common migrant and winter visitor, generally uncommon to fairly common in summer, with some local breeding.

Foraging Guild: Generalist.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

North Island shoreline at northeast corner of Naval Air Station and across from Shelter Island

Common Name: Cinnamon Teal
Scientific Name: *Anas cyanoptera*
Status: none
Regional Distribution: Common to abundant spring transient, common fall transient, and fairly common breeder and summer resident. Uncommon in winter, with majority concentrated along the coast; very uncommon to rare in winter in the interior, especially away from the Salton Sea.
Residency Status in San Diego Bay: Common to very common fall migrant., but does not winter in San Diego Bay.
Foraging Guild: Wader/Shallow Water Forager. Eats aquatic vegetation and seeds; also eats insects, snails and crustaceans.
Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed 5 times in North Bay

Common Name: Greater Scaup
Scientific Name: *Aythya marila*
Status: none
Regional Distribution: Uncommon winter visitor along the coast. Rare transient and winter visitor in the interior, but concentrations documented at Salton Sea and the Colorado River Valley.
Residency Status in San Diego Bay: Uncommon winter visitor in San Diego Bay.
Foraging Guild: Bottom Feeding Diver. Prefers water <20 feet deep. Primary food in winter are mollusks, but also eats crustacean and aquatic vegetation
Preferred Habitat for Scaup Species in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Scaup Species in North San Diego Bay:

Convair Lagoon
Shoreline northeast of Naval Air Station, near aircraft carrier berths
Coronado shoreline southeast of aircraft carrier berthing area (high foraging value)

Common Name: Lesser Scaup
Scientific Name: *Aythya affinis*
Status: none
Regional Distribution: Common winter visitor throughout region. Rare to uncommon in summer, when most numerous at the Salton Sea.
Residency Status in San Diego Bay: Abundant winter visitor, very rare in summer. In San Diego County, Lesser Scaups are most abundant on San Diego Bay.
Foraging Guild: Bottom Feeding Diver. Prefers foraging in water < 20 feet. Eats mollusks, crustaceans, aquatic insects, and aquatic vegetation.
Preferred Habitat for Scaup Species in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Scaup Species in North San Diego Bay:

Convair Lagoon
Shoreline northeast of Naval Air Station, near aircraft carrier berths
Coronado shoreline southeast of aircraft carrier berthing area (high foraging value)

Common Name: Old Squaw
Scientific Name: *Clangula hyemalis*
Status: none
Regional Distribution: Rare but regular winter visitor along the coast, primarily from November to March. Remains casually into summer. Casual at the Salton Sea; six records elsewhere in the interior.
Residency Status in San Diego Bay: Rare winter visitor, casual in summer, occurring primarily on San Diego and Mission Bays. An individual was observed on two surveys in North Bay
Foraging Guild: Bottom Feeding Diver.
Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only in North Bay two times

Common Name: Surf Scoter
Scientific Name: *Melanitta perspicillata*
Status: none
Regional Distribution: Abundant winter visitor and spring transient along coast; uncommon in summer. Uncommon spring transient, rare fall transient and winter visitor

at the Salton Sea; rare in summer. Flocks of spring transients are also noted irregularly on lakes in and near the southern part of the mountain areas. Rare transient elsewhere in the interior.

Residency Status in San Diego Bay: Abundant winter visitor, in 1993 most abundant species overall for combined North and Central Bay study areas. Reported as fairly common to common in summer, but was rare during summer of 1993 in North Bay. Surf Scoters occur in greatest abundance in the county on San Diego Bay.

Foraging Guild: Bottom Feeding Diver. Dives to depths of 6-30 feet. Feeds more heavily on mollusks throughout the year than any other animal foods; also eats some crustaceans, marine worms, fishes, eelgrass, sea urchins and sand dollars.

Preferred Habitat for Species in North San Diego Bay :

1° Shallow water and shoreline along North Island side of bay

2° Shallow water and shoreline on Mainland side of bay

High Use Areas for Species in North San Diego Bay:

North Island shoreline across from Shelter Island

Point Loma shoreline near bait barges

Shelter Island bayside shoreline southwest of fishing pier

Open water north of the west end of Coronado Bay Bridge

Common Name: Bufflehead

Scientific Name: *Bucephala albeola*

Status: none

Regional Distribution: Fairly common winter visitor in all areas; locally common along the coast (e.g. around San Diego). Casual in summer, with most records from the Salton Sea.

Residency Status in San Diego Bay: Very common winter visitor, very rare in summer.

Foraging Guild: Bottom Feeding Diver. Crustaceans, snails, and other mollusks and some aquatic vegetation when in salt water habitats.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shorelines on both sides of bay

2° Marinas and pier areas along Mainland side of bay

High Use Areas for Guild in North San Diego Bay:

Shallow water and shoreline west of the entrance to Harbor Island West Basin

North Island shoreline across from Shelter Island

Convair Lagoon

Coronado shoreline southeast of the aircraft carrier berthing area

Common Name: Red-breasted Merganser

Scientific Name: *Mergus serrator*

Status: none

Regional Distribution: Common winter visitor along the coast, uncommon through the summer. In interior, status complex, but primarily an uncommon spring transient and rare fall transient.

Residency Status in San Diego Bay: Common winter visitor, uncommon in summer. In the county, Red-breasted Mergansers are most numerous on San Diego Bay.

Foraging Guild: Water Column Diving Guild. Eats mostly small fishes; also eats crustaceans and aquatic insects.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, bait barges, piers, and floating docks to north

Bayside shoreline of Shelter Island

Portions of shoreline along northeast edge of North Island Naval Air Station

Pier between Commercial Basin and Harbor Island West Basin

Convair Lagoon.

Common Name: Osprey

Scientific Name: *Pandion haliaetus*

Status: CDFG Species of Special Concern at nesting sites.

Regional Distribution: Rare to uncommon year-round visitor; most widely noted in fall and winter on the coast and in migration in the interior. Has nested sporadically in recent years. Formerly more numerous.

Residency Status in San Diego Bay: Uncommon fall and winter visitor, rare in spring and summer, two old nesting records.

Foraging Guild: Plunge Diver. Usually hunts from 30-100 feet in air. Eats fish almost exclusively, although also eats small vertebrates, including small birds.

Preferred Species Habitat in North San Diego Bay :

1° Shallow water and shorelines, especially on North Island side of bay

2° Marinas and pier areas along Mainland side of bay

High Use Areas for Species in North San Diego Bay:

Number of sightings rather low for North Bay (18) but most were along North Island shoreline.

Common Name: Peregrine Falcon
Scientific Name: *Falco peregrinus anatum*
Status: Federally Endangered. State Endangered
Regional Distribution: Primarily a rare fall transient and winter visitor along the immediate coast, with a few pairs remaining to nest in the northwestern portion of the region and in San Diego Bay. Even rarer in the interior, where its status is complex. Has undergone a sharp decline in the last several decades.
Residency Status in San Diego Bay: Rare fall and winter visitor; casual in late spring and early summer. Formerly a rare breeding resident, then extirpated. Documented nests on Coronado Bay Bridge (1989 to present) and in 1993 in Central Bay on large crane at Port Authority's dock near the Sweetwater Channel.
Foraging Guild: Predator. Eats a wide variety of small to medium size birds, especially doves and pigeons, but also shorebirds, waterfowl, and passerines. Also known to occasionally eat mammals, beetles, dragonflies, and butterflies.
Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed 4 times in North Bay

Common Name: American Coot
Scientific Name: *Fulica americana*
Status: none
Regional Distribution: Common breeding summer resident and abundant winter visitor on bodies of water throughout the region.
Residency Status in San Diego Bay: Abundant migrant and winter visitor, breeding status on San Diego Bay undetermined.
Foraging Guild: Generalist. Dabbles or may dive 10-25 feet. Eats mostly aquatic vegetation, but also terrestrial vegetation, mollusks (especially snails), worms, berries, and fruit.
Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

North Island shoreline at northeast corner of Naval Air Station and across from Shelter Island

Common Name: Black-bellied Plover
Scientific Name: *Pluvialis squatorola*
Status: none
Regional Distribution: Common winter visitor along the coast, with smaller numbers of non-breeding birds remaining through summer. Fairly common transient and slightly less numerous as winter visitor at Salton Sea. Generally, a rare transient elsewhere in the interior.
Residency Status in San Diego Bay: Very common to abundant migrant and winter visitor, also locally common as a non-breeding summer visitor.
Foraging Guild: Prober. Eats marine worms and insects, small mollusks, crabs and other marine invertebrates.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Western Snowy Plover
Scientific Name: *Charadrius alexandrinus nivosus*
Status: Proposed as threatened by the federal government. CDFG Species of Special Concern.
Regional Distribution: Fairly common, but somewhat local and declining resident on sandy coastal beaches (including some of the Channel Islands); numbers on the coast are augmented in winter. Primarily a summer resident in the interior, nesting at the Salton Sea and at various alkali lakes.

Residency Status in San Diego Bay: Uncommon migrant and winter visitor, uncommon but localized breeding resident. Has been known to breed in San Diego Bay at North Island, Silver Strand State Beach, Delta Beach, and the Sweetwater River mouth. A total of 7 breeding pairs documented at the Salt Works in 1993.

Foraging Guild: Prober. Western snowy plovers forage primarily on the wet sand at the beach-surf interface, where they feed on small crustaceans, marine worms, insects and amphipods.

Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed once in North Bay

Common Name: Semipalmated Plover

Scientific Name: *Charadrius semipalmatus*

Status: none

Regional Distribution: Common transient and uncommon (to locally common) winter visitor along the coast. Transient through the interior, generally rare except at the Salton Sea where common in spring and fairly common in fall. A few remain locally through the summer.

Residency Status in San Diego Bay: Common spring and fall migrant, fairly common winter visitor.

Foraging Guild: Prober. Eats marine worms, small mollusks, small crustaceans, eggs of marine animals and insects.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Killdeer
Scientific Name: *Charadrius vociferus*
Status: none
Regional Distribution: Common breeding resident near water, irrigated fields, and lawns throughout region; largely withdraws from the colder areas in winter, but numbers are greatly augmented elsewhere at this season. Breeds locally on the Channel Islands.
Residency Status in San Diego Bay: Very common resident, occupying a wide variety of habitats.
Foraging Guild: Prober. Primarily eats insects; also eats a variety of invertebrates.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Greater Yellowlegs
Scientific Name: *Tringa melanoleuca*
Status: none
Regional Distribution: Fairly common transient and uncommon to fairly common winter visitor along the coast and in the Salton Sea area. Primarily a transient elsewhere in the region.
Residency Status in San Diego Bay: Fairly common to common fall migrant, fairly common winter visitor and spring migrant, casual in summer.
Foraging Guild: Prober. Eats fishes, aquatic and other insects and their larvae, snails, crabs, worms, tadpoles.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Willet
Scientific Name: *Catoptrophorus semipalmatus*
Status: none
Regional Distribution: Common to abundant transient and winter visitor along the coast and at the Salton Sea, remaining fairly commonly through the summer as a non-breeder. Uncommon transient through the rest of the regional. May nest occasionally in the Owens Valley.
Residency Status in San Diego Bay: Very common to abundant migrant and winter visitor, locally common to very common as a non-breeding visitor in summer.
Foraging Guild: Prober. Eats aquatic insects, marine worms, small crustaceans, small mollusks, small fishes.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Wandering Tattler
Scientific Name: *Heteroscelus incanus*
Status: none
Regional Distribution: Fairly common spring transient and uncommon fall transient and winter visitor to rocky coastal areas. Casual at the Salton Sea; also recorded twice in the interior of the coastal lowlands and once (spring) in the arid interior/desert area.
Residency Status in San Diego Bay: Uncommon migrant and winter visitor, casual in summer.

Foraging Guild: Prober. In winter eats principally mollusks, crustaceans, and marine worms.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Spotted Sandpiper

Scientific Name: *Actitis macularia*

Status: none

Regional Distribution: Fairly common winter visitor in the coastal lowlands, Salton Sea area, and the Colorado River Valley. Primarily a transient through the coastal lowlands and an uncommon transient and summer resident in the mountain areas. Also nests very locally in the coastal lowlands.

Residency Status in San Diego Bay: Uncommon to fairly common migrant and winter visitor.

Foraging Guild: Prober. In bay primarily eats fish, crustaceans, and mollusks.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Whimbrel

Scientific Name: *Numenius phaeopus*

Status: none

Regional Distribution: Common transient and fairly common winter visitor along the coast, with non-breeding birds remaining uncommonly through the summer. Abundant spring transient and common fall transient at the Salton sea, with few remaining through the summer. Generally a rare to casual transient (mostly spring) in the rest of the interior, although large flocks may be noted in spring in the Antelope Valley. Common transient and winter visitor on the Channel Islands from late July to mid-May.

Residency Status in San Diego Bay: Common to very common fall migrant, uncommon to fairly common winter visitor, fairly common spring migrant, rare to uncommon in summer.

Foraging Guild: Prober. Eats insects, worms, spiders, small mollusks, amphipods, and crustaceans.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Long-billed Curlew

Scientific Name: *Numenius americanus*

Status: Federal Category C Candidate. CDFG Species of Special Concern.

Regional Distribution: Uncommon to locally fairly common, or even common, transient and winter visitor along the coast. Common winter visitor in the Salton Sea area, and fairly common at this season in the Antelope Valley. Otherwise, generally a rare transient through the interior. Has nested once in the Owens Valley.

Residency Status in San Diego Bay: Fairly common to common fall migrant, uncommon to fairly common winter visitor and spring migrant, uncommon and local in summer.

Foraging Guild: Prober. Eats insects, worms, crustaceans, mollusks, and toads.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Marbled Godwit

Scientific Name: *Limosa fedoa*

Status: none

Regional Distribution: Common winter visitor along the coast, remaining uncommonly through the summer as a non-breeder. Fairly common transient and winter visitor at the Salton Sea, with small numbers remaining through the summer. Generally a rare transient elsewhere in the interior.

Residency Status in San Diego Bay: Very common to abundant migrant and winter visitor, locally common to very common in summer.

Foraging Guild: Prober.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Ruddy Turnstone
Scientific Name: *Arenaria interpres*
Status: none
Regional Distribution: Fairly common to common transient and uncommon to locally common winter visitor along the coast, with a few remaining through the summer. Uncommon spring transient and rare fall transient at the Salton Sea; casual transient elsewhere in the interior.
Residency Status in San Diego Bay: Common to very common migrant and winter visitor; fairly common as a non-breeding summer visitor on San Diego Bay.
Foraging Guild: Prober. Eats amphipods, worms, crustaceans, mollusks, insects and their larvae.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Black Turnstone
Scientific Name: *Arenaria melanocephala*
Status: none
Regional Distribution: Common winter visitor along rocky coastlines, including those of the Channel Islands. Casual spring transient in the interior, with seven records from the Salton Sea and one from the Colorado River.
Residency Status in San Diego Bay: Common migrant and winter visitor, rare through mid-summer.
Foraging Guild: Prober. Eats barnacles, slugs, small mollusks, crustaceans, and other small marine animals.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Surfbird
Scientific Name: *Aphriza virgata*
Status: none
Regional Distribution: Fairly common but very local winter visitor, fairly common spring transient, and uncommon and local fall transient along rocky coasts and jetties. Casual in the interior: three April records from the Salton Sea.
Residency Status in San Diego Bay: Uncommon to fairly common fall migrant and winter visitor; fairly common to common spring migrant; casual in summer.
Foraging Guild: Prober. In winter eats soft part of barnacles and other crustaceans, and small mollusks.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Red Knot
Scientific Name: *Calidris canutus*
Status: none
Regional Distribution: Common transient and winter visitor along the coast in the vicinity of San Diego County; otherwise generally a rare to uncommon transient and very rare winter visitor along the coast. Fairly common spring transient and uncommon fall transient at the Salton Sea; only five records elsewhere in the interior, plus two for the inland portion of the coastal lowlands.
Residency Status in San Diego Bay: Very common to abundant but localized migrant and winter visitor, common to very common but localized in summer.

Foraging Guild: Prober. Eats primarily mollusks, some crustacean eggs, small fishes, and marine worms.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Sanderling

Scientific Name: *Calidris alba*

Status: none

Regional Distribution: Common to abundant transient and winter visitor along the immediate coast and on the Channel Islands, remaining uncommonly through the summer. Fairly common transient and rare to uncommon winter visitor at the Salton Sea. Very rare transient elsewhere in the region.

Residency Status in San Diego Bay: Common to very common winter visitor, abundant spring and fall migrant, fairly common through summer.

Foraging Guild: Prober. In the Bay eats primarily marine invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Western Sandpiper

Scientific Name: *Calidris mauri*

Status: none

Regional Distribution: Common to abundant transient throughout, except on the Channel Islands (where uncommon); uncommon to locally common winter visitor along the coast. Fairly common in winter at the Salton Sea, but casual elsewhere in the interior at this season.

Residency Status in San Diego Bay: Abundant migrant and winter visitor, rare during the brief period in summer between spring and fall migration.

Foraging Guild: Prober. Eats small mollusks, insects, worms, and crustaceans and other marine invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Least Sandpiper

Scientific Name: *Calidris minutilla*

Status: none

Regional Distribution: Very common and widespread transient and winter visitor; most numerous in the coastal lowlands and the Salton Sea area. Non-breeding birds remain casually through the summer.

Residency Status in San Diego Bay: Very common to abundant migrant and winter visitor, very rare in summer.

Foraging Guild: Prober. Eats small mollusks, small crustaceans (especially amphipods), worms, insects and their larvae.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Dunlin
Scientific Name: *Calidris alpina*
Status: none
Regional Distribution: Common winter visitor along the coast. Fairly common spring and fall transient at the Salton Sea, remaining uncommonly through the winter. Elsewhere in the interior and uncommon transient, being largely absent in winter.
Residency Status in San Diego Bay: Very common to abundant migrant and winter visitor, accidental in summer.)
Foraging Guild: Prober. Eats amphipods and other crustaceans, marine worms, mollusks, and insects.
Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)
2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline
Shoreline area in East Basin of Harbor Island
Convair Lagoon shoreline
Shoreline along north edge and tip of Ballast Point

Common Name: Short-billed Dowitcher
Scientific Name: *Limnodromus griseus*
Status: none
Regional Distribution: Common transient along the coast and at the Salton Sea. Rare to locally uncommon transient, mainly in fall, through the rest of the region. Spring and fall passage is earlier than in the Long-billed. Winters only along the coast, where generally scarce, but locally common.
Residency Status in San Diego Bay: Locally abundant migrant and winter visitor, fairly common as local non-breeder in summer.
Foraging Guild: Prober. Eats mollusks, crustaceans, marine worms, aquatic insects and spiders.

Preferred Guild Habitat in North San Diego Bay :

1° Shallow water and shoreline on North Island side of bay (especially for foraging)

2° Marinas and pier areas along Mainland side of bay (especially for resting)

High Use Areas for Guild in North San Diego Bay:

Numerous locations along the North Island shoreline

Shoreline area in East Basin of Harbor Island

Convair Lagoon shoreline

Shoreline along north edge and tip of Ballast Point

Common Name: Parasitic Jaeger

Scientific Name: *Stercorarius parasiticus*

Status: none

Regional Distribution: Fairly common transient and uncommon winter visitor off the coast, mainly within 4-5 km of shore. Rather rare inshore and around the Channel Islands. Casual in summer. Rare fall transient at the Salton Sea; casual at that season along the Colorado River.

Residency Status in San Diego Bay: Fairly common migrant and winter visitor, casual in summer within 4-5 km of shore, but rarely does this species enter San Diego Bay. Single individuals were observed on two different surveys in North Bay.

Foraging Guild: Generalist, kleptoparasitic.

Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed 2 times in North Bay

Common Name: Bonaparte's Gull

Scientific Name: *Larus philadelphia*

Status: none

Regional Distribution: Common to abundant winter visitor along the coast and adjacent inshore waters. Primarily a transient through the interior, being common during spring at the Salton Sea and locally on lakes in the southern portion of the mountain areas.

Residency Status in San Diego Bay: Abundant migrant and winter visitor; irregularly uncommon as a non-breeding summer visitor. Eighteenth most abundant species in North Bay during 1993 (excluding most gull and shorebird species which were grouped).

Foraging Guild: Generalist. In winter eats primarily fishes; also eats crustaceans and marine worms.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

North Island shoreline at northeast corner of Naval Air Station and across from Shelter Island

Common Name: Heerman's Gull

Scientific Name: *Larus heermanni*

Status: none

Regional Distribution: Common non-breeding visitor along the immediate coast; only uncommon to fairly common in spring, when breeding takes place in Mexico. Rare and irregular post-breeding visitor to the Salton Sea; casual elsewhere in the interior (seven records).

Residency Status in San Diego Bay: Abundant non-breeding visitor in summer, fall, and winter; uncommon to locally common in spring. This was the most abundant species in North Bay during 1993 (excluding most other gull and shorebird species which were grouped).

Foraging Guild: Generalist. Primarily eats fishes, crustaceans, and mollusks; also scavenges along shore.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

North Island shoreline at northeast corner of Naval Air Station and across from Shelter Island

Common Name: Western Gull

Scientific Name: *Larus occidentalis*

Status: none

Regional Distribution: Common resident along the immediate coast, breeding locally. Abundant resident on and around the Channel Islands. Wanders only a short distance inland on the coastal slope. One record for the Colorado River Valley.

Residency Status in San Diego Bay: Reported as abundant to very abundant throughout the year as a non-breeder; with a few pairs nesting locally. In 1993, 40 gull nests were counted in North Bay.

Foraging Guild: Generalist. Eats fishes; scavenges along beaches for dead fishes, clams, shrimps, worms; catches small mammals; may force pelicans and cormorants to give up their catches of fish; also eats mollusks that it may drop from the air to open and expose soft internal parts.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

North Island shoreline at northeast corner of Naval Air Station and across from Shelter Island

Common Name: Gull-billed Tern

Scientific Name: *Sterna nilotica*

Status: California Department of Fish and Game Species of Special Concern at nesting colonies.

Regional Distribution: Fairly common summer resident at the Salton Sea, with six late fall and early winter records. Unrecorded in California away from the Salton Sea until 1980's.

Residency Status in San Diego Bay: This species was unrecorded in coastal California until the 1980's. This species has now been seen every summer in south San Diego Bay and has been found nesting in the Saltworks. The 10 breeding pairs were documented in 1993. Gull-billed Terns have also been seen somewhat regularly roosting at the mouth of the Sweetwater River.

Foraging Guild: This species was included in plunge diver category based on taxonomy as there were no insectivorous foraging guilds in this study. Gull-billed Terns are

insectivores and feed primarily over salt marsh and adjacent mud flats with the basins of the Chula vista Wildlife Reserve and the area south of Emory cove being some of the most frequently used foraging areas (Copper, pers. obs.).

Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed 2 times in North Bay

Common Name: Caspian Tern

Scientific Name: *Sterna caspia*

Status: Considered a Sensitive Species at nesting colonies by California Department of Fish and Game.

Regional Distribution: Fairly common to common transient and summer visitor along the coast, breeding at San Diego Bay. Fairly common but local in winter. Very common to abundant transient and common summer visitor at the Salton Sea; formerly bred there. Rare to uncommon transient through the remainder of the region.

Residency Status in San Diego Bay: Common to locally abundant resident, with one breeding colony at the south end of San Diego Bay. A minimum estimate of 280 pairs of caspian terns nested at the Salt Works in 1993. This species was 22nd in abundance for North San Diego Bay in 1993 (excluding shorebird and most gull species which were grouped).

Foraging Guild: Plunge Diver. Eats primarily small fishes; also eats aquatic invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Pier between Commercial Basin and Harbor Island West Basin

Bayside shoreline of Shelter Island

Several locations along North Island shoreline

Common Name: Royal Tern

Scientific Name: *Sterna maxima*

Status: none

Regional Distribution: Fairly common but somewhat local winter visitor along the coast and over offshore waters. More numerous around the Channel Islands and the San

Diego area, where numbers of non-breeding birds remain through summer. Has attempted to nest twice in San Diego.

Residency Status in San Diego Bay: Fairly common visitor in fall, winter, and spring, uncommon in summer. A minimum of 10 pairs of breeding Royal Terns were at the Saltworks in South San Diego Bay in 1993.

Foraging Guild: Plunge Diver. Eats primarily small fishes; also eats aquatic invertebrates.

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Pier between Commercial Basin and Harbor Island West Basin

Bayside shoreline of Shelter Island

Several locations along North Island shoreline

Common Name: Elegant Tern

Scientific Name: *Sterna elegans*

Status: Federal Category 2 Candidate. California Department of Fish and Game Species of Special Concern at nesting colonies.

Regional Distribution: Common post-breeding visitor along the coast, primarily from July through October; lingers very exceptionally to late December and January. One nesting colony at San Diego Bay where birds arrive in March.

Residency Status in San Diego Bay: Abundant summer resident in the single nesting colony at the south end of San Diego Bay; otherwise, a fairly common to common visitor in spring and early summer, becoming abundant in late summer and early fall, then uncommon to rare by late fall. An estimated 312-427 breeding pairs of elegant terns were at the Salt Works in South San Diego Bay in 1993. Seventh most abundant species observed in North Bay during 1993 (excluding shorebirds and most gulls which were grouped)

Foraging Guild: Plunge Diver. Eats almost exclusively small fishes.

Preferred Habitat for Species in North San Diego Bay

1° Intermediate water depth habitats along both sides of bay (for foraging)

2° Shallow water and shorelines on both sides of bay, marinas and pier areas on Mainland side of bay (for roosting)

High Use Areas by Species in North San Diego Bay:

Pier inside east entrance to the Commercial Basin (roosting site)
Pier between Commercial Basin and Harbor Island West Basin (roosting site)
North Island Navy pier across bay from bait barge area (roosting site)
Area around bait barges, north of Submarine Base (foraging)
Shoreline west of entrance to Commercial Basin (foraging)
North edge of Ballast Point (foraging)

Common Name: Forster's Tern
Scientific Name: *Sterna forsteri*
Status: Considered a Sensitive Species at nesting colonies by California Department of Fish and Game.
Regional Distribution: Common year-round visitor along the coast, with a breeding colony south of San Diego. Rather common summer resident at the Salton Sea (mostly non-breeding), remaining uncommonly through winter. Transient through the remainder of the region, commonest along the Colorado River.
Residency Status in San Diego Bay: Common to abundant resident, with one breeding colony at the south end of San Diego Bay. A total of 510 pairs were documented at the Salt Works in 1993. Twelfth most abundant species in North Bay study area (excluding shorebirds and most gulls which were grouped).
Foraging Guild: Plunge Diver. Eats small fishes, insects (taken in flight or on surface of water), dead fishes, live and dead frogs.
Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north
Pier between Commercial Basin and Harbor Island West Basin
Bayside shoreline of Shelter Island
Several locations along North Island shoreline

Common Name: California Least Tern
Scientific Name: *Sterna antillarum browni*
Status: USFWS: Endangered. CDFG: Endangered at nesting colonies.

Regional Distribution: Fairly common but local summer resident along the coast, primarily from late April through August. Casual spring and summer visitor to the Salton Sea; four records for the Colorado River Valley.

Residency Status in San Diego Bay: Locally common summer resident and migrant. Fourteenth most common species in North Bay during 1993.

Foraging Guild: Plunge Diver. Thought to feed almost exclusively on small fishes.

Preferred Habitat for Species in North San Diego Bay

1° Deep Water habitat in center of bay (foraging)

2° Intermediate depth water along Mainland side of bay (roosting and foraging)

High Use Areas by Species in North San Diego Bay:

Open water anchorage south of the entrance to Commercial Basin (roosting)

Deep water channel near northeast edge of the Naval Air Station (foraging)

Southeast edge of Harbor Island (foraging)

Deep water channel northeast of Coronado and southwest of the 10th Ave. Marine Terminal

Common Name: Black Skimmer

Scientific Name: *Rynchops niger*

Status: CDFG Species of Special Concern at nesting colonies.

Regional Distribution: Fairly common summer resident at the Salton Sea; small (but increasing) numbers, has recently become resident at the south end of San Diego Bay. Sporadic visitor elsewhere along the coast, with one record for the Colorado River Valley and one (possibly two) for the interior of the coastal lowlands.

Residency Status in San Diego Bay: Common resident on San Diego Bay, breeding in the Saltworks; rare elsewhere on the coast of San Diego County. A minimum of 326 breeding pairs were documented at the Salt Works in 1993. Ranked as 31st most abundant species out of 45 species observed in North Bay (excluding most gulls and shorebirds which were grouped).

Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay

2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north

Pier between Commercial Basin and Harbor Island West Basin

Bayside shoreline of Shelter Island

Several locations along North Island shoreline

Common Name: Rhinoceros Auklet
Scientific Name: *Cerorhinca monocerata*
Status: CDFG Species of Special Concern at nesting colonies.
Regional Distribution: Common to abundant winter visitor offshore from the northern border of the region south to the northern Channel Islands; fairly common from there south to the Mexican border. A few non-breeders regularly remain through the summer; may breed off Santa Barbara County.
Residency Status in San Diego Bay: Rarely seen from shore (uncommon to fairly common winter visitor, rare summer straggler offshore). Two individuals seen in North Bay.
Foraging Guild: Water Column Diver. Eats mainly fishes; also eats marine invertebrates.
Preferred Habitat and Use Areas for Species in North San Diego Bay :

Not determined: this species was only observed 2 times in North Bay

Common Name: Belted Kingfisher
Scientific Name: *Ceryle alcyon*
Status: none
Regional Distribution: Uncommon to fairly common winter visitor to aquatic habitats, with the greatest numbers occurring along the coast and in the Colorado River Valley. Primarily a transient in the mountainous areas and over much of the arid sections and deserts. Rare breeder, mainly on the coastal slope.
Residency Status in San Diego Bay: Fairly common during migration and winter and rare in summer. Ranked as 29th most abundant out of 45 species observed in North Bay (excluding most gulls and shorebirds which were grouped).
Preferred Guild Habitat in North San Diego Bay :

1° Marinas and pier areas along Mainland side of bay
2° Shallow water and shorelines on both sides of bay

High Use Areas for Guild in North San Diego Bay:

North end of Submarine Base, beaches, bait barges, piers, and floating docks to north
Pier between Commercial Basin and Harbor Island West Basin
Bayside shoreline of Shelter Island
Several locations along North Island shoreline

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APPENDIX C

SAN DIEGO BAY WATERBIRD STUDY
ANNOTATED BIBLIOGRAPHY

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SAN DIEGO BAY WATERBIRD STUDY
ANNOTATED BIBLIOGRAPHY

Advanced Sciences, Inc. 1992. Draft. Terrestrial Biological Survey and Inventory of Navy Property On Point Loma, San Diego, California. Prepared for the Officer in Charge of Construction. *(Annotations on bird sections only).*

This report was prepared for the purpose of updating the 1981 "Terrestrial Biological Survey and Inventory of Navy Property on Point Loma" (Woodward-Clyde Consultants 1981). A total of 12 field surveys for wildlife were conducted during June, July, August, and September of 1992. The authors determined migratory bird usage on Point Loma Navy lands through "literature review and agency contacts." Due to access restrictions, field surveys on the southernmost portion of the Naval Submarine Base were limited. A table in the report lists "wildlife observed or detected on Point Loma." No abundances are noted. The list includes data gathered in the above surveys as well as Woodward-Clyde data from 1981, sightings from Claude G. Edwards (1987, 1988) and Pacific Southwest Biological Services, Inc. (1988). California Brown Pelican (*Pelecanus occidentalis californicus*), Western Snowy Plover (*Charadrius alexandrinus nivosus*), California Least Tern (*Sterna antillarum browni*), and American Peregrine Falcon (*Falco pereginus anatum*) are discussed.

Allen, J. N. 1980. The Ecology and Behavior of the Long-billed Curlew in Southeastern Washington. Wildlife Monographs 73.

This study examines in depth the nesting ecology and behavior of the Long-billed Curlew on a breeding area relatively free from disruptive human activity. The scope includes two summers of fieldwork in 1976 and 1977 and a post breeding season survey of the major National Wildlife Refuges in Washington, southern Idaho, Utah, Nevada, California, and Oregon. Long-billed Curlew responses to disturbance are briefly discussed.

Anderson, D. W., and J. O. Keith. 1980. The human influence on seabird nesting success: conservation implications. Biological Conservation 18: 65-80.

Based on studies of brown pelicans (*Pelecanus occidentalis californicus*) and Heermann's gulls (*Larus heermanni*), disturbances by recreationists educational groups local fishermen and scientists alike can be seriously disruptive and damaging to breeding seabirds in the Gulf of California and off the west coast of Baja California.. Similar instances have been identified throughout the world—the problem is not difficult to document but it is difficult to eliminate. The increasing human-seabird contacts on islands in the Gulf of California and along the west coast of Baja California raise serious questions and immediate concern about the continued preservation of nesting colonies of marine birds in those areas. Conservation measures must consider the extreme sensitivity of many seabirds to the inter-specific and intra-specific behavioral imbalances created by human disturbances. In some cases total exclusion of humans may be required; in others limited access might be possible under closely managed conditions at certain times of the year. A symbiotic relationship between seabird conservation legitimate research and tourism should be the desired goal.

Andrecht, K. L. 1990. Development of a Coastal Salt Marsh in South San Diego Bay. The Chula Vista Wildlife Reserve.

"The Chula Vista Wildlife Reserve contains about 14 acres of shallow subtidal mud flats, about 35 acres of regularly inundated intertidal mud flats, about 11 acres of periodically inundated salt flats, and about 12 acres of supratidal sand and dune substrates. Tidal meanders and ponded areas have formed within the lower mud flats of the Reserve's interior basins, and shallow subtidal and lower intertidal mud flats have formed within the Reserve's water area. The habitat types developed on the Reserve were intended to accommodate the recovery plans for various endangered species, especially for the California Least Tern, the Light-footed Clapper Rail, and the Belding's Savannah Sparrow. "The Reserve's tidal basins and water areas have been used by numerous species and individuals of migratory over-wintering waterfowl and annual shorebirds. "The California least tern utilized the Reserve's coastal sand dune areas during the 1980-1985 and 1988-1990 nesting seasons, and the Reserve provided for the highest tern nesting activity in all of San Diego Bay in 1981, 1982 and 1983." "The Belding's savannah sparrow has utilized the Reserves mud flat, salt marsh and salt flat vegetation

and maritime sage scrub fringe areas for foraging and cover since 19985. Belding's savannah sparrow nesting at the Reserve is assumed, but has not yet been verified."

Atkinson-Willes, G. 1969. Wildfowl and recreation: a balance of requirements. British Water Supply 11:5-15.

The author accepts human disturbance of waterfowl as a given and proposes compromises by recreationists to maintain the important role of Great Britain as wintering habitat for European waterfowl. Suggestions for compromises are offered. Effects of sailing, canoeing, rowing, water-skiing, speedboating, hydroplaning, fishing, bird-watching, picnicking, and shooting on waterfowl and how resource use might be partitioned are addressed. The publication has no literature-cited section.

Austin, J. E. 1988. Winter ecology of Canada geese in northcentral Missouri. Ph.D. dissertation, University of Missouri, Columbia. 284 pp.

Canada geese (*Branta canadensis*) tended to spend more time in agricultural habitats, where they were more vulnerable to disturbances than in seasonal wetlands in the refuge interior or the water roost sites. Vigilance of waterfowl did not differ by habitat in the hunting season, thus the effects of disturbances by hunters are far-reaching. All use of wetlands in late fall occurred in the refuge interior, which is not hunted. However, in response to gunshots from the hunting zone, geese in the refuge interior often ceased other activities and, at least briefly, became alert or vigilant. Habituation of Canada geese to disturbances in some locations may account for the lower vigilance of geese on pastures in winter. These pastures seemed to be traditionally used by geese and may be considered safe fields. Geese seemed to avoid or leave locations where excessive disturbances restricted feeding and where they did not habituate to disturbances.

Baker, M. C. and A. E. Miller Baker. 1973. Niche relationships among six species of shorebirds on their winter and breeding ranges. Ecological Monographs 43: 193-212.

The dynamics of the organization of a community of six species of migrant predatory shorebirds (Least Sandpiper, Semipalmated Sandpiper, Dunlin, Short-billed Dowitcher, Lesser Yellowlegs, and Semipalmated Plover) was appraised by studying foraging behavior and habitat utilization under winter conditions in southern Florida and under

summer conditions in the eastern Canadian Arctic. Eight foraging methods, defined primarily on the basis of how the bill is used and the pattern of locomotion, constitute the behavioral repertoire of the species. Each foraging method is correlated with a particular rate of locomotion (distance/time) and rate of feeding (pecking or probing/time). Feeding and locomotion rates seem independent of air temperature, number of conspecifics, and total number of shorebirds foraging nearby. Instead, the seasonal changes in these rates are probably related to food density. On the basis of these findings, differences in rates of feeding and locomotion between species is due to higher food density in summer on the breeding grounds and more selective foraging. Each foraging method in combination with a particular microhabitat defines a statistically different resource. During the winter, on intertidal habitats of southern Florida, shorebirds on the whole exhibit a low behavioral and microhabitat diversity and low resource overlap between species. The small niche breadth in winter is probably a response to food limitation, and each species exists in its exclusive niche where it is optimally adapted and therefore has high foraging efficiency. In summer tundra ant taiga habitats of the Arctic, shorebirds generally have a higher behavioral and microhabitat diversity (broader niche) and higher overlap between species. Exceptions to these general patters exist among the study species. Seasonal differences in prey density prey behavior, time available for foraging, feeding and locomotion rates, and the pattern of resource partitioning imply that shorebird populations are regulated through competitive processes occurring on their wintering habitats. Conclusions concerning coexistence mechanisms in migratory bird species and residents in seasonal environments may be erroneous if populations are studied only in the breeding season.

Bartlet, G. A. 1987. Effects of disturbance and hunting on the behavior of Canada goose family groups in eastcentral Wisconsin. Journal of Wildlife Management 51:517-522.

Disturbances of roosting areas increased separation of family members of Canada geese in 1979 and may have contributed to the large number of family members shot during the hunting season. The cohesiveness of family groups was disrupted after a family member was shot. Families (after hunting losses) and random groups used the same roosting areas less as the season advanced. Intact family groups used the same roosting areas at the same rate throughout the season. A disintegration of family structure seemed to be related to the extent of disturbance and hunting pressure during the years of this study.

Batten, L. A. 1977. Sailing on reservoirs and its effects on water birds. Biological Conservation 11:49-58.

Despite intensified sailing, mallards *(Anas platyrhynchos),* common pochards *(Aythya ferina),* and tufted ducks *(A. fuligula)* still used the Brent reservoir in autumn and winter because part of the shallow and marshy reservoir was not accessible to boats. During autumn 1975, Canadian pondweed *(Elodea canadensis)* choked the northern arm of the reservoir and precluded boating after August, resulting in a build-up of 169 common pochards, 30 tufted ducks, 17 northern shovelers *(Anas clypeata),* and 12 gadwalls *(A. strepera).* Distances at which flocks of ducks moved from an oncoming dinghy were an estimated 275 m for tufted ducks and 450 m for common pochard. The dinghy came within 100 m of small groups of smew *(Mergellus albellus).* Mallards behaved like smews. Green-winged teals *(A. crecca),* Eurasian wigeons *(A. penelope),* and northern shovelers were more sensitive than mallards. Green-winged teals and Eurasian wigeons stopped using the reservoir. Perhaps screening vegetation on reservoir banks and large vegetated rafts would reduce disturbance.

Belanger, L., and J. Bedard. 1989. Responses of staging snow geese to human disturbance. Journal of Wildlife Management 53: 713-719.

In spring and fall of 1985-87 the authors studied the effects of human disturbance on staging snow geese *(Chen caerulescens atlantica)* in the Montmagny bird sanctuary, Quebec. They recorded 652 disturbances (any event that flushed all or a part of the snow goose flock) in 471 h of observation. Rate of disturbance was higher in fall (1.46 per h) than in spring (1.02 per h; $p < 0.001$). The entire flock flushed in response to 20% of the disturbances. Mean time in flight was 56 and 76 sec in fall and spring ($p = 0.049$). Transport-related activities, particularly low-flying aircraft, caused 45% of all disturbances in spring and fall. Snow geese stopped feeding in response to 40% of all disturbances ($p \geq 0.05$). Mean time to resume feeding was 726 sec in fall compared with 122 sec in spring ($p \leq 0.001$). Level of disturbance on a fall day affected the use of the sanctuary by snow geese the following day ($p \leq 0.01$). When disturbances exceeded 2.0 per h, 50% fewer snow geese were present the next day. Low-level aircraft flights over goose sanctuaries should be strictly regulated.

Belanger, L., and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging snow geese *(Chen caerulescens atlantica).* Journal of Wildlife Management 54:36-41.

Energetic cost of anthropogenic disturbance of fall-staging snow geese in Quebec was estimated. Two responses of birds to disturbance were considered: (1) birds fly away but promptly resume feeding after a disturbance (Response A), and (2) birds interrupt feeding altogether (Response B). Daylight foraging time decreased by 4% to 51% depending on disturbance levels. Average rate of disturbance (1.46 per hour) in Response A resulted in a 5.3% increase in hourly energy expenditure (HEE) combined with a 1.6% reduction of hourly metabolizable energy intake (HMEI). In Response B, HEE increased by 3.4% and HMEI decreased by 2.9% to 19.4%. A 4% increase in night feeding could compensate for energy losses from sole disturbance flights (Response A), but a 32% increase in nighttime feeding was required to restore energy losses incurred in Response B. No increase in daily feeding rate was observed between days with different disturbance levels ($P > 0.05$). Authors concluded that anthropogenic disturbance had significant energetic consequences for fall staging greater snow geese.

Bell, D.V., and L W Austin. 1985. The game fishing season and its effects on overwintering wildfowl. Biological Conservation 33:66-80.

The trend in Great Britain toward extending the angling season may lead to increased encounters between anglers and wintering wildfowl. This paper considers the effects on wildfowl from the start of angling in March at Llandegfedd Reservoir. The reservoir is large, but anglers and waterfowl exploit the same restricted areas. Green-winged teals (Anas *crecca),* Eurasian wigeons *(A. penelope),* mallards (A. *platyrhynchos),* and common pochards *(Aythya ferina)* were driven from their usual feeding or roosting sites and departed from the reservoir prematurely. Temporary reserve areas are suggested at Llandegfedd Reservoir for wildfowl at the start of the angling season. The correlation coefficient between waterfowl numbers and availability of open grassland in each area shows the effect of angling in the following tabulation:

Species	Before angling activity	After angling activity
Wigeon	0.729*	0.038
Teal	0.784*	-0.034
Pochard	0.601*	-0.138

Berger, T. R. 1977. The Berger report: northern frontier, northern homeland. Living Wilderness 41:4-33.

On the staging grounds, snow geese *(Chen caerulescens)* are highly sensitive to human presence, noise, and aircraft. Snow geese did not feed closer than 2.41 km (1.6 miles) from a device simulating noise of a compressor station, and birds flying over it diverted their course by 90° or more. Snow geese show evidence of being disturbed by an aircraft by flushing at a mean distance of 2.57 km (1.6 miles) from small aircraft, 4.02 km (2.5 miles) from large aircraft, and 3.70 km (2.3 miles) from small helicopters. They also flushed in response to aircraft flying at altitudes of 2,440-3,050 m (8,000-10,000 feet), the maximum height at which the test flights were conducted. Deliberate harassing chased flocks of snow geese from a 8.05 km by 16.09 km (5 mile by 10 mile) area in 15 min. Snow geese may avoid an area as large as 32.18 km (20 square miles) around an operating drill rig, 45.05 km (28 square miles) around an operating compressor station, and 402.25 km (250 square miles) around an airstrip during takeoff and landing of aircraft.

Berry, R. F. 1988. Disturbance to tundra swans by barge and boat traffic. Loon 60:92.

About 750 tundra swans *(Cygnus columbianus)* resting on the Wisconsin side of Pool 5 in the Spring Lake area of the Mississippi River left the water surface and departed from the area in a downstream direction because of the passage of a tow (barge). In another instance, about 2,500 tundra swans in the Weaver Bottoms between Swan and Mallard islands and Minnesota 14 were disturbed by two small boats; all observable birds left the Weaver Bottoms, formed V's and departed in a downstream direction.

Boag D. A., and V. Lewin. 1980. Effectiveness of three waterfowl deterrents on natural and polluted ponds. Journal of Wildlife Management 44:145-154.

In 1976, three types of waterfowl deterrent (a model falcon, a moving series of reflectors suspended from a frame, and a human effigy) were mounted on floats and tested for efficacy in deterring water fowl from entering a series of small natural ponds in the boreal forest of Alberta. Only the effigy seemed to be effective; diving ducks of the genus *Aythya* were affected most. In 1976, the human effigy was tested on an artificial tailings

pond that received aqueous and bituminous effluent from an oil sands extraction plant near Fort McMurray, Alberta. Twenty-seven effigies were deployed over the 150-ha pond. Their effectiveness was judged by comparing the number of dead waterfowl in this pond in 1975 without deterrents and in 1976 with deterrents. The number of dead waterfowl found in 1976 was lower than expected. Researchers assumed that this decline was due to the presence of the effigies.

Boland, J. M. 1988. The Ecology of North American Shorebirds: latitudinal distributions, community structure, foraging behaviors, and inter specific competition. Ph.D. dissertation. UCLA.. *Annotations on chapters 5, 6, and 7 only.*

Boland hypothesizes that differences in prey characteristics (i.e., distributions, abundances and diversities) can account for the observed differences in shorebird community structure across habitats. Christmas Bird Counts from 1981 to 1983 in coastal sites from 9°N to 59°N were analyzed along with a detailed study of shorebird number and prey in two estuaries (Morro Bay, California and Willapa Bay, Washington). His results support the general conclusion that the abundance of single species of shorebirds, on local scales (i.e., within estuaries), are determined by the abundances of their preferred prey. Boland discusses the interactions among shorebird foraging behaviors, diets, and prey availability and groups the species into foraging modes. The species covered are: Least Sandpiper, Dunlin, Dowitcher sp., Willet, Marbled Godwit, Long-billed Curlew, Greater Yellowlegs, Semipalmated Plover, and Black-bellied Plover. Field work was conducted at Morro Bay, California, between November 1984 and October 1986. Using two "firm mud" areas, bird counts were taken (between four and nine days) for each season. Mud cores were analyzed to determine the vertical distribution and abundance of prey in the sediment. Boland demonstrates that shorebird distributions, diets and foraging behaviors are strongly influenced by prey size, type, abundance and distribution. Boland found that "seasonal changes in shorebird behaviors, distributions and abundances were consistent with the competition predictions." Those competition predictions concern food limitation and interspecific competition. "If birds are food limited: (1) they will respond numerically to changes in food supply; and (2) their numbers and biomass in each habitat will be correlated more closely with the amount of food there during times of food shortage than in times of plenty. If birds experience interspecific competition then: (3) during times of plenty, species will converge on abundant resources and exhibit high overlaps in resource use, but during lean times overlaps between species will decrease and each species will use the resources for

which it is best adapted." Data was collected between November 1984 and October 1986 at Morro Bay during fall, winter and spring. Core samples were analyzed for prey species and abundance and birds were censused.

Briggs, K.T., W.B. Tyler, D.B. Lewis, and D.R. Carlson. 1987 Bird communities at sea off California: 1975 to 1983. Studies in Avian Biology No. 11.

Seabird populations off California were studied during two three-year periods: Southern California from 1975 through early 1978, and central and northern California from 1980 through early 1983. Aerial surveys provided almost all data in Central and Northern California and about half in the south; ship surveys provided the remainder. Periodic coastal surveys assessed proportions of populations ashore. The seabird fauna is dominated by about thirty species. The authors include accounts of 62 species in which they emphasize data concerning the California nesting avifauna and species whose estimated total populations exceeded 20,000 individuals. Some birds using San Diego Bay and included in these species accounts: Red-throated Loon; Pacific Loon; Common Loon; Eared Grebe/Horned Grebe; Western Grebe/Clark's Grebe; Brown Pelican; Double-crested Cormorant; Brandt's Cormorant; Pelagic Cormorant; Brant; Surf/White-winged Scoter; Parasitic Jaeger; Bonaparte's Gull; Heerman's Gull; Mew Gull; Ring-billed Gull; California Gull; Herring Gull; Western Gull; Glaucous-winged Gull; Royal Tern; Elegant Tern; and Forster's Tern.

Brooks, W. S. 1967. Organisms consumed by various migrating shorebirds. Auk 84:128-130.

Ten species of shorebirds were collected from a shallow, mud-bottom pond near Champaign, Illinois (except the plover, which was taken in a field near Fisher, Illinois), and the stomach contents analyzed: American Golden Plover, Common Snipe, Greater Yellowlegs, Lesser Yellowlegs, Pectoral Sandpiper, Least Sandpiper, Dunlin, Stilt Sandpiper, Semipalmated Sandpiper, and Wilson's Phalarope. A table lists the organisms in each bird's stomach.

Brown, W., and M. A. Brown. 1981. Nesting biology of the white-winged scoter. Journal of Wildlife Management 46:38-46.

White-winged scoters *(Melanitta fusca)* are easily disturbed by human interference such as the recreational boating on lakes that white-winged scoters prefer for breeding. According to the senior author, recreational boaters stopped at islands and disrupted nesting, and water ski enthusiasts and power boaters ran over hens and broods.

Burger, J., and M. Gochfeld. 1991. Human activity influence on diurnal and nocturnal foraging of sanderlings (*Calidris alba*). Condor 93: 259-265.

The foraging behavior of Sanderlings (*Calidris alba*) were studied in the winter of 1986, 1988 and 1990 in Florida to determine whether the presence of people influenced foraging behavior, and whether foraging behavior varied as a function of time of day. A focal animal sampling approach was used. For all three years, the models explaining the greatest variation in seconds per minute devoted to feeding included the number of people within 100 m of foraging Sanderlings. Although the number of people within 10 m of foraging Sanderlings during the day did not increase from 1986 to 1990, the number of people within 100 m rose dramatically, and foraging time per minute decreased. Sanderlings continued to feed through dusk into night and the time devoted to forging and to aggression was greater at night, while the time devoted to avoiding people was less at night than during daylight or dusk.

Burger, J. 1981. The effect of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

Jamaica Bay Refuge is part of the Gateway National Seashore and administered by the National Park Service. The paper includes many references made to human disturbance of loons, gulls, cormorants, and herons. Disturbances were tallied for aircraft, and for people walking, digging worms, riding horseback, jogging, and working. Ducks and brants *(Branta bernicla)* usually went to the water when disturbed on land and often were not disturbed when on the water. Birds generally did not respond to subsonic jets, but always responded to the supersonic transport jets by flushing. Many birds returned to where they had been prior to the disturbance.

Burger, J., et al. 1977. Effects of tide cycles on habitat selection and habitat partitioning by migrating shorebirds. Auk 94: 743-758.

Assemblages of feeding shorebirds were studied in three intertidal habitats on the coast of New Jersey during August to document how species segregate spatially both among and within habitats and to determine the effects of tidal cycles on these patters. The habitats were a sandy beach facing the ocean proper (outer beach), a sandy beach on the mainland side of a barrier island (inner beach), and a small mudflat adjacent to a Spartina alterniflora salt marsh. Most species fed in more than one habitat, but only two, *Charadrius semipalmatus* and *Calidris canutus,* used all three habitats regularly. Within habitats, most species exhibited strong preferences for the wettest areas, but differences were found among species in degrees of preference. The least amount of partitioning occurred on the inner beach, where birds crowded into a small zone near the water's edge and had frequent agonistic encounters suggesting intense competition. Shore bird feeding activity was partly a function of tide time: each habitat had a characteristic temporal pattern of use by shorebirds related to tide time rather than diel time; observed within habitats were species-characteristic feeding activity rhythms that were also a function of tide time. Feeding by most species peaked during the first 2 hours after low tide on the outer beach and mudflat. The results are discussed in terms of feeding strategies and interspecific competition.

Burton, R. A., and R. J. Hudson. 1975. Activity budgets of lesser snow geese wintering on the Fraser River Estuary, British Columbia. Wildfowl 29 ~ 117.

Disturbance and changes in food availability may alter the feeding routine of snow geese *(Chen caerulescens).* One critical factor is the efficiency of feeding in relation to the amount of available time. Disturbed and undisturbed, time in flight was at least 0.26 h per day. However, during periods of excessive wind or harassment, this level increased up to threefold. Flight was 1.0% of all time spent in major activities. Nocturnal feeding occurred not only during the hunting season. Fluctuating food availability because of changing tide levels influenced nocturnal feeding more than harassment by hunters. The early autumn migrants invariably first settled at Brunswick Point in October. This marsh was used day and night for a short time, but hunting pressure during the day soon forced the snow geese onto the Reifel Refuge. The availability of food at Brunswick Point apparently caused them to return each night.

California Department of Fish and Game. 1993. California Least Tern Breeding Survey 1992 Season. Author and Principal Investigator: Carolee Caffrey.

In 1992, approximately 2,106 pairs of the endangered California Least Tern (*Sterna antillarum browni*) nested at 38 sites along the coast of California, from the San Francisco Bay area in the north, south to the Mexican border. This 15 % increase over 1991 breeding population size continues the trend since 1987 of continued growth of the population, and is directly attributable to the efforts of people working on behalf of recovery of the species. The statewide total of 2,106 pairs is the highest number recorded since systematic monitoring began in 1973, and represents a greater than three-fold increase over the estimated 600 pairs of that year. The increase in the number of nesting sites over 1991 (34) and 1990 (30) reflects both the expansion of terns into new areas adjacent to already established sites and the return of terns to areas used historically but not in the recent past. The increase in the number of breeders was somewhat eclipsed by the much reduced statewide production of fledglings. The total of 1,362-1,448 fledglings produced in 1992 is lower than the numbers produced by 1,830 pairs in 1991 (1,729-1,839) and 1,706 pairs in 1990 (1,487-1,676). Low fledgling production per pair in 1992 (0.65-0.59) was attributed to both predation and the deleterious effects of El Niño on food availability. Breeding failure and success was strikingly localized, and sites hit hardest by both predation and a shortage of food were located in the southern portion of the State (in San Diego County). Eight sites had relatively high fledgling production per pair ($\geq$ 1); fledglings produced at four of those eight sites (NAS Alameda, Venice Beach, Seal Beach, Santa Margarita River North Beach) comprised 65% of the total produced statewide. Because an annual fledgling to pair ratio of less than 0.7 results in a decline in the size of the breeding population two years later, and past El Niño events have been shown to affect the population dynamics of terns over a protracted period, the combined effects of predation and low food availability on Least Tern reproductive success in 1992 are likely to hinder population growth for several years to come.

	PAIRS	NESTS	FLEDGLINGS	FLED/PAIR
North Island NAS	49 (28)	52	5	.10 (.89)
Delta Beach: North	38 (35)	40	20-30	0.53-.79 (.57)
Delta Beach: South	1 (0)	1	1	1
D Street Fill	135 (46)	135	14-24	0.10-.18 (.87)
Chula Vista Wldlf Res	20 (1)	20	16-21	0.80-1.05 (0)
Saltworks	8 (31)	16	≥5	≥0.63 (.32)
Tijuana River: North	4 (1)	5	7	1.75 (0)
South	39 (63)	65	31	0.80 (.44)

California Department of Fish and Game. 1992. California Least Tern Breeding Survey 1991 Season. Authors: Scott M. Johnston and Bryan S. Obst.

In 1991, an estimated 1830 pairs of California Least Terns (*Sterna antillarum browni*) nested in California at sites from San Francisco Bay south to the Tijuana River Mouth. This number continues an apparent trend of a recently escalating population, first observed in 1990. Nineteen ninety marked a huge increase in population (36%) from the two previous years, and in 1991 the number is 6.8% higher than in 1990. The number of nesting pairs in 1991 is the highest since systematic monitoring began in 1973. The net number of breeding colonies used from 1990 to 1991 dropped by two, with three sites unused and one new site occupied. Actual nesting sites increased from 30 in 1990, to 34 in 1991, a result of monitoring reporting changes, habitat perturbation, and real expansion. Population increases were observed at most established colonies throughout the state, but especially in San Diego and Orange Counties. Disturbance by human intrusion (pedestrians or vehicles) remained a widespread problem, especially in Santa Barbara, Ventura, and southern San Diego Counties."

California Department of Fish and Game. 1992. California Least Tern Breeding Survey 1990 Season. Authors: Bryan S. Obst and Scott M. Johnston.

In 1990, an estimated 1706 pairs of California Least Terns (*Sterna antillarum browni*) nested in California, at sites from San Francisco Bay south to the Tijuana River mouth. This number represents a marked increase (approx. 36%) over 1f988 and 1989 population estimates and is the highest number recorded since systematic monitoring was begun in 1973. The number of breeding sites decreased from 29 in 1989 to 28 in 1990, with four sites that had been occupied in 1989 going unused and two new sites being discovered.

Population gains resulted from increases at established colonies throughout the state, but especially in Los Angeles, Orange, and San Diego Counties. Disturbance by human intrusion (pedestrians or vehicles) remained a widespread problem, especially at sites in San Luis Obispo, Santa Barbara, Ventura, and southern San Diego counties.

Areas concerning San Diego Bay:	1990 estimated No. of pairs (fledglings)
Naval Training Center	0 (0)
Lindbergh Field	0 (0)
Chula Vista Wildlife Res.	70 (26-38)
D Street fill	0 (0)
North Island NAS	38 (20-25)
Saltworks	25 (8-12)
Delta Beach	45 (54)
Tijuana River	72 (16-39)

California Department of Fish and Game. 1989. California Least Tern Field Study 1988 Breeding Season. Principal Investigator: Barbara W. Massey.

In 1989, 1240 pairs of California Least Terns *(Sterna antillarum browni)* bred at 28 sites in the state, about the same number as in 1988 (1253 pairs). The number of breeding sites was the same, but several were new this year, and several used in 1988 were not in use in 1989. Productivity was way down, with an estimated 764 fledglings (fledgling/pair ratio = 0.59), as compared to 1130 in 1988 (f/p ratio = 0.9). Mean clutch size was reduced (1.93+0.49 in 1988; 1.84+0.48 in 1989), an indicator of problems with the food supply. Nesting by younger adults (age 2 ~ 3 years) was behind schedule and much reduced, factors also linked to food supply. The major cause of egg and chick loss was predation, with American Kestrel, Northern Harrier, American Crow, Striped Skunk, and ground squirrel causing the most serious losses. Despite major predator control programs at several colonies in San Diego County, fledgling production was low. Human disturbance continued to harm the colony at Tijuana Slough. A study conducted at Venice resulted in a technique for doing standardized fledgling counts on a statewide basis.

Areas concerning San Diego Bay:	1988 estimated No. of pairs (fledglings)
Naval Training Center	1 (1)
Lindbergh Field	80 (30)
Chula Vista Wildlife Res.	24 (30-40)
D Street fill	19 (0)
North Island NAS	20 (4)
Saltworks	17 (15)
Delta Beach	7 (10)
Tijuana River Mouth	40-47 (24-36)

Areas concerning San Diego Bay:	1989 estimated No. of pairs (fledglings)
Naval Training Center	0 (0)
Lindbergh Field	9 (0)
Chula Vista Wildlife Res.	28 (5-8)
D Street fill	2 (?)
North Island NAS	24 (13-14)
Saltworks	28 (2-4)
Delta Beach	33 (20)
Tijuana River Mouth	49 (17-23)

California Department of Fish and Game. 1988. California Least Tern Field Study 1988 Breeding Season. Principal Investigator: Barbara W. Massey.

In 1988 1253 pairs of California Least Terns *(Sterna antillarum browni)* nested at 28 sites in the state. This was an increase of 300 pairs over the 1987 population, and was primarily due to a large contingent of young, first-time breeders. The population returned this year to its 1983 level, indicating recovery from the devastating effects of the El Niño of 1982-83. Productivity was high, with a mean fledgling/pair ratio of 0.9 for the state, as compared with 0.67 in 1987. Predation was the major cause of egg and chick loss. Red fox, American Kestrel, Northern Harrier, American crow and skunks were the predators identified as causing the most serious losses. Close watching of colonies and effective predator control contributed to the success of the breeding season.

Areas concerning San Diego Bay:	1987 estimated No. of pairs (fledglings)
Naval Training Center	11 (0)
Lindbergh Field	50 (50-70)
Chula Vista Wildlife Res.	0 (0)
D Street fill	28 (10)
North Island NAS	6 (3-5)
Saltworks	21 (4)
Delta Beach	28 (10)
Tijuana River Mouth	21 (13-19)

California State Coastal Conservancy. 1989. The coastal wetlands of San Diego County.

Non-technical overview of wetland systems in San Diego County. Functions as a lay educational guide. Current status, historical perspective, and projected future of the wetlands are covered, along with a break down of the separate areas in the system and the wildlife values and problems of each of those areas. Also included are the names and addresses of organizations active in wetland conservation and education.

Campbell, L. H. 1978. Patterns of distribution and behavior of flocks of seaducks wintering at Leith and Musselburgh, Scotland. Biological Conservation 14 ~ 124.

During 1972-73, while the retaining walls for land reclamation at the new sewage works were under construction, considerable activity on the shore affected greater scaup *(Aythya marila),* common goldeneye *(Bucephala clangula),* and common eiders *(Somateria mollissima)* between Leith and Seafield sewers. Observed change in distribution pattern was a short-term response to localized increases in disturbance levels.

Campbell, L. H., and H. Milne. 1977. Goldeneye feeding close to sewer outfalls in winter. Wildfowl 28:81-85.

Common goldeneyes *(Bucephala clangula)* were obviously sensitive to sudden loud noises. On 11 occasions (for example, blasting or ship sirens), the ducks immediately took flight and left the bay. Usually ducks returned to the bay within 10 minutes of a disturbance, but on 6 days, no birds returned after 2 h and fewer than 10 of the original

flock returned on the remaining 5 days. Large vessels anchored in the bay did not disturb the ducks, whereas smaller boats approaching the flock caused the birds to take flight, usually to the southern part of the bay, from where they gradually returned when the boat had departed. Regular disturbance to birds in the sewer was caused by passers-by on the sea-wall. When approaching from the east, people were visible some distance from the flock, which merely swam farther offshore. However, from the west, passers-by tended to come into view suddenly close to the sewer, and the birds usually took flight.

Campredon, D. 1981. *Hivernage du canard siffleur Anas penelope L. en Camargue [France] stationnements et activites* (Wintering of the widgeon *[Anas penelope* L] in the Camargue region of [France] wintering grounds and their activities). Alauda 49:161-193.

Eurasian wigeons *(Anas penelope)* were disturbed by natural predators 361 times (82.7%), by people 19 (3.4%), by planes 19 (3.4%), and by unknown causes 68 times (10.4%). A greater percentage of a flock was disturbed by people (61.6%) and by planes (49.6%) than by other types of disturbances. Time spent in flight per disturbance by predators varied from 8 sec to 68 sec whereas disturbances by people lasted 34 sec, and by airplanes, 9 sec. Disturbances by people were chiefly by hunters, anglers, and pilots of aircraft-specially helicopters at low altitude. People disturbed the ducks during the day, and avian predators mostly at night. Predators caused localized displacements, but people on a small body of water caused total evacuation. If the disturbance occurred on a larger body of water, ducks regrouped in the middle. Ducks were very sensitive to anglers who went into the water. Human disturbances modified the periodicity of ducks' activities and seriously curtailed feeding.

Collins, C. T., P. H. Baird, B. W. Massey. 1990. Banding of Adult California Least Terns at Camp Pendleton Marine Base 1987-1990: Unpublished summary report prepared for the Natural Resources Management Branch, Southwestern and Western Divisions Naval Facilities Engineering Command, San Diego and San Bruno, CA.

"An intensive program of banding of adult California Least Terns was initiated at Camp Pendleton in 1987 and continued annually through 1990". The unique combinations of colored plastic bands that were given to each bird made it possible to obtain "visual recoveries" in subsequent years, to determine sex of marked birds via behavior, and to

examine intra-colonial and inter-colony nest-site fidelity.The annual return rate of adults ranged from 65%-72% from 1988 to 1990. Because all adults were not observed each year, the actual return rate may be somewhat higher. Adult survival estimates will have to take into account inter-colony movements of adults which may be higher in some years than in others, as seemed to be the case in 1989.

Combs, D. L. 1987. Ecology of male mallards during winter in the Upper Mississippi alluvial valley. Ph.D. dissertation, University of Missouri, Columbia. 223 pp.

Hunting was probably the primary cause of habitat shifts during early winter from Unit A and Greentree reservoirs on the Duck Creek Wildlife Management Area to areas not hunted on the Mingo National Wildlife Refuge. During all 3 years of this study, mallards *(Anas platyrhynchos)* used Unit A extensively before and after waterfowl hunting season but little during the season. Non-hunting disturbance (e.g., vehicular traffic) may have also influenced the distribution of mallards in the Mingo Swamp and warrants additional research. Lack of hunting probably reduced vigilance during early spring, and habitat shifts to unhunted areas on the Mingo National Wildlife Refuge may have influenced a mid- winter decline in vigilance during 1985-86. Alert behavior was also greater in shallow habitats than in open water zones where disturbance was minimal because of distance from roads.

Cooke, A. S. 1987. Disturbance by Anglers of birds at Grafham Water. ITE Symposium 19:15-22.

Grafham Water in Cambridgeshire is one of the most important wintering sites for waterfowl in Britain. Sailing there has relatively little effect on waterfowl because it is only intermittent and disturbance is more or less confined to deep water that most waterfowl avoid. However, anglers on the bank and in boats arrive in large numbers on every day during the angling season, and often fish the shallow, sheltered bays and creeks that birds favor. Detailed observations and results are presented for effects of angling on numbers and distribution of waterfowl, grebes *(Podiceps* and *Tachybaptus),* and Eurasian coots *(Fulica atra);* for an increase of waterfowl at the conclusion of the angling season; for effects of the close of angling on distribution of wildfowl species; for tolerance distance by mallards *(Anas platyrhynchos)* in specific areas in relation to disturbance and changes after the angling season; for comparative approachability of water birds by area

of the reservoir; and for overall ranking of vulnerability of species based on bird counts and controlled approach studies. Ranking for Grafham may not be applicable elsewhere.

Copper, E. California Least Terns Nesting and Fledging Data for San Diego Bay Locations 1973-1985.

Nesting and fledging data for such locations as: San Diego Bay; Lindbergh Field; Saltworks; Sweetwater River; Grand Caribe Isle; Fifth Avenue Marina; Naval Training Center; North island Naval Air Station; Delta Beach; Crown Isle; and CVWR. Also included are other locations in the state of California.

Copper, E. 1986. An interim report on the foraging activity of the California Least Tern in North San Diego Bay. Draft Environmental Impact Report. Sunroad Marina, Harbor Island. Report by Phillips, Brandt, Reddick. Prepared for San Diego Unified Port District.

A California least tern foraging study was conducted from 14 May 1986 to 25 June 1986. The study area included the East and West Basins of Harbor Island, the outer shoreline of Harbor Island, and the shoreline of San Diego Bay from the Laurel Street crescent to Convair Lagoon. Least terns were found to forage at all the stations surveyed. The higher levels of foraging activity found at Laurel Street were most likely a result of this station's location in the immediate vicinity of an active nest site at Lindbergh Field. The high levels of foraging activity on outer Harbor Island cannot be immediately explained by any of the factors examined. The lowest levels of foraging activity were in the West Basin. The East Basin exceeded the West Basin in every measure of foraging activity.

Cronan, J. M., Jr. 1957. Food and feeding habits of the scaups in Connecticut waters. Auk 74:469-468.

Human activity had a strong effect on feeding lesser scaup *(Aythya affinis).* During the hunting season, lesser scaups foraged less in areas that were heavily hunted. During the fall and spring, not many lesser scaups foraged where people were fishing or boating. During mid-winter, when a comparatively balmy Saturday or Sunday encouraged human activity along the shore, the lesser scaups were not present on their usual foraging grounds.

Davis, R. A., and A. N. Wiseley. 1974. Normal behavior of snow geese on the Yukon-Alaska North Slope and the effects of aircraft-induced disturbance on this behavior, September, 1973. Chapter II in W. W. H. Gunn, W. J. Richardson, R. E. Schweinburg, and T. D. Wright (eds.). Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biological Report 27.

Up to 400,000 snow geese *(Chen caerulescens)* congregate on the North Slope to accumulate energy for fall migration. The authors documented undisturbed behavior and evaluated effects of overflights by aircraft on 175 flocks of snow geese observed at five camps along the North Slope. During 663 hours of observation, geese experienced 73 natural disturbances and 163 non-experimental overflights by aircraft. Experimental overflights at 2.5-h intervals with a Cessna 185 and a Bell 206-B helicopter were also made. Undisturbed snow geese spent 57% of daylight hours feeding (juveniles, 65-70%). Fixed-wing aircraft and helicopters flushed snow geese with equal frequency, but helicopters flushed geese at greater distances and fixed-wing air- craft elicited longer flights from geese. Snow geese responded variably to increased frequencies of overflights by aircraft. Non-experimental disturbances by aircraft averaged one per four daylight hours and decreased the geese's time spent feeding by 2.6%. Experimental overflights at 2-h intervals by fixed-wing air-craft decreased feeding time and could cause a reduction of 20.4% in energy reserves for juveniles; a helicopter decreased feeding time 9.5%.

Decision Systems. 1992. Shelter Island Plan Amendment. Driscoll Boatyard Expansion Project. Draft Environmental Impact Report for San Diego Unified Port District.

Original data of birds observed during six surveys in March, 1992, Shelter Island Commercial Basin. Data include list of species, abundance, and activity.

Dennis, D. G. and R. E. Chandler. 1974. Waterfowl use of the Ontario shorelines of the southern Great Lakes during migration. Pages 58-65 in H. Boyd (ed). Canadian Wildlife Service studies in eastern Canada, 1969-73. Canadian Wildlife Service Report 29.

Boat traffic is low in several bays and large numbers of diving ducks are able to feed undisturbed. Baited sanctuaries throughout the marshes increased the carrying capacity for dabbling ducks *(Anas)* and Canada geese *(Branta canadensis).* Many redheads *(Aythya americana)* and canvasbacks *(A. valisineria)* are present during spring and autumn in one section of the Detroit River near the mouth of the Canard River, which has limited boat traffic. Although marsh habitat seems to be of fair quality, human disturbance and absence of suitable sanctuaries cause lower use by waterfowl than expected. Some dabbling ducks use the area less during autumn because of power boat traffic. Although humans disturb diving ducks during autumn too, the birds can rest on the open waters of Lake Erie during times of peak disturbance on the bay. Dabbling duck habitat is of low quality, except in the Grand River marshes, where heavy hunting pressure and lack of suitable sanctuaries cause most of the dabbling ducks to leave shortly after opening day of the hunting season.

Dennis, D. G., G. B. McCullough, N. R. North, and R. K. Ross. 1984. An updated assessment of migrant waterfowl use of the Ontario shorelines of the southern Great Lakes. Pages 37-42 in S. G. Curtis, D. G. Dennis, and H. Boyd (eds). Waterfowl studies in Ontario, 1973-81. Canadian Wildlife Service Occasional Paper 54,.

Limited waterfowl use during both spring and autumn is due to scarcity of aquatic vegetation, although disturbance by pleasure craft also contributes. Populations of mallards *(Anas platyrhynchos)* and Canada geese *(Branta canadensis)* increased chiefly from more use of legal baiting by hunting clubs. Establishment of the St. Clair National Wildlife Area in 1974 increased use by American black duck (A. *rubripes).* Use by redheads (Ay*thya americana),* canvasbacks (A. *valisineria),* and common mergansers *(Mergus merganser)* increased much during spring and autumn as a result of extensive disturbance by boat traffic in the better habitat along the east shore of Lake St. Clair. Although increased ship traffic in the Outer Bay because of the Nanticoke Industrial Development will not greatly disturb waterfowl, increased potential for an oil spill exists for large portions of the continental populations of canvasbacks and redheads. Shooting

pressure forces most birds to leave shortly after opening of the hunting season. Lesser scaups (A. *affinis)* are moderately disturbed by increased power boat traffic.

Dennis D. G. and N. R. North. 1984. Waterfowl use of the Lake St. Clair marshes during migration in 1968-69, 1976-77, and 1982. Pages 43-62 in S. G. Curtis, D. G. Dennis, and H. Boyd (eds). Waterfowl studies in Ontario, 1973-81. Canadian Wildlife Service Occasional Paper 64.

Larger local populations of mallards *(Anas platyrhynchos)* and Canada geese *(Branta canadensis),* more baited sanctuaries, more food plants from higher lake levels, and a national wildlife area closed to hunting increased use of the Lake St. Clair marshes by waterfowl. Destruction of habitat from agricultural drainage, increased boat traffic from a new marina in wetlands, increased public hunting on areas that had previously been hunted at a low intensity, and declining populations of American black ducks *(A. rubripes)* and ruddy ducks *(Oxyura jamaicensis)* reduced waterfowl use of 51% of the area.

Denson, E. P. 1964. Comparison of waterfowl hunting techniques at Humboldt Bay, California. Journal of Wildlife Management 28:103-120.

The behavior of birds hunted by scullers differed radically from day to day. Sometimes nearer ducks leapfrogged no more than 188.2 m (200 yards), whereas at other times, entire flocks rose and moved for 1.6 km or more. Scullers disturbed birds and made them more difficult to approach, but movement of flocks of brants *(Branta bernicla)* by scullers were temporary and probably benefited shooters in open-water and shore blinds. Waterfowl suffered far more harassment from amateur crab fishermen and pleasure boaters with high-powered outboard motors. Daily pressure by hunters on the spit and the harassment by boaters are chiefly responsible for eliminating the brant population, which once spent November and December on Humboldt Bay. A sector of the bay should be closed to boats from October through April, when large numbers of waterfowl are present. An area of 81-121.5 ha (200-300 acres), less than 10% of the bay, should protect the birds.

Dillon S. T. 1956. A nine-year study of fall waterfowl migration on University Bay, Madison, Wisconsin: Part 1. Transactions of the Wisconsin Academy of Science, Arts and Letters 45:31-57.

Fishing influences the use of the bay by waterfowl. This sport is extremely popular during the fall and the passage of boats through the bay is often a source of considerable disturbance. On very calm days all species of water-fowl present tend to gather on the open waters of the lake. This may reflect a preference on the generally increased boat traffic.

DuBowy, P. J. 1988. Waterfowl communties and seasonal environments: temporal variability in interspecific competition. Ecology 69: 1439-1453.

Controversy over the role that interspecific competition plays in structuring avian communities has polarized the debate into two alternative points of view. One school of thought, exemplified by Wiens (1977), de-emphasizes the role that competition plays in structuring communities, while the opposing school, exemplified by Schoener (1982), invokes competition as a driving force in resource partitioning and community structure. To test these alternative arguments. I examined a guild of dabbling ducks *(Anas* spp.) that co-occur throughout the year. Species-pairs exhibited significantly lower overlap values for foraging, habitat utilization, and food items during winter than summer. In addition, food resources (both relative and absolute abundances) were lower during winter than summer. From these data the author infers that the intensity of interspecific competition and its effect on waterfowl community structure is seasonal, with greater resource limitation and, therefore, resource partitioning during "lean" winter months than during "fat" summer months. Consequently, on a yearly cycle, avian communities may exhibit periods of intense interspecific competition, alternating with times of resource abundance where competition may be insignificant or absent.

Edington J. M. 1980. Recreation and wildlife. Nature in Wales Newsletter 3:10-16.

Edington reviews wildlife-based (bird-watching, angling, and shooting), aesthetic (scenic), and active recreation (climbing, caving, skiing, and sailing). He discusses disturbances of overwintering waterfowl from overzealous birdwatchers, observation

blinds, protective legislation, shooting, lead shot, angler's weights, discarded nylon lines, predator control, trampled vegetation, and sailing.

Edwards, R., and D. Bell. 1985. Fishing in troubled waters. New Science 1446, 7 March: 19-21.

At the Llandegfedd reservoir in the Usk Valley, where the angling season has recently been advanced by 2 weeks to 20 March, anglers choose parts of the reservoir that birds such as green-winged teals *(Anas creaca)* and Eurasian wigeons (A. *penelope)* also prefer. The reservoir is an important trout fishery, but also supports the highest number of overwintering waterfowl in South Wales. As a result of the anglers' intrusion, these birds gathered in the center of the reservoir during the day, away from the shallow areas and shore where they would normally feed on grasses and herbs. Birds dispersed from the site after a few days, possibly because of increased sailing activity in central areas. The number of Eurasian wigeons, for example, fell from over 400 to about 60 within a week. This contrasted with a much more gradual emigration from a nearby undisturbed site at Slimbridge on the Severn Estuary.

Einarsen, A. S. 1965. Black brant, sea goose of the Pacific coast. University of Washington Press, Seattle. 142 pp.

An airplane at 1 or 2 miles may cause either single or flocked brants *(Branta bernicla)* to take to the air. In some areas, boating continually molests foraging birds. During the last 5 years, high-speed boats are common from British Columbia to San Quintin Bay in northern Baja California. The use of power dredges intimidates foraging birds in daylight and tends to destroy eelgrass beds. A disturbance was observed on Mission Bay, San Diego Harbor, on 19 January 1958. Here at low tide the brant geese find sanctuary only in small elbows off the main channel in the bay, where they could drift up a mud-bottomed slough for perhaps a few hundred yards (a few hundred meters); but the continual traffic of high-speed boats, traveling at 12.9-64.4 kph (8-40 mph), kept the birds from foraging on eelgrass beds or occupying open water in the channel. Boating on Humboldt Bay, California, is also forcing brants to spend nights on the ocean. The losses are profound. Sleeping brants drift unconsciously into the breakers where the heavy sand content beast them down to the ocean floor. They wash ashore dead.

Engineering-Science. 1987. Least tern utilization of Ballona Lagoon. Prepared for Silver Strand Marina Association. October. 9 pp.

This tern foraging study compared the relative use of three foraging areas near the Venice Beach tern colony. The ocean waters directly adjacent to the colony was the primary foraging area. Use of the adjacent lagoon and marina were used secondarily relative to the ocean site. Seasonal use of the undeveloped lagoon and marina was similar. The lagoon was used more during the courtship period and the marina was used more during the late nestling and fledgling periods.

Engineering-Science. 1987. Winter Waterbirds of Ballona Lagoon. Prepared for Silver Strand Marina Association, Marina del Rey, California.

This study was conducted during ten days of observation between mid-October, 1986 and mid-January, 1987. Waterbirds were censused hourly, usually between 0800 and 1700 hours. The lagoon was divided into four sections. Each section was counted separately. Thirty four species of waterbirds were observed with 21 species recorded on at least 6 days which "would indicate their regular utilization of the lagoon during winter." Tables include species observed with dates of observation.

ERC Environmental and Energy Services Co. (ERCE) [Ogden]. 1989. Mission Bay least tern foraging ecology study. Prepared for DPR, City of San Diego. September.

The distribution of least terns and other tern species in Mission Bay was documented during the 1989 least tern breeding season. A total of 1782 10-minute point count surveys among 33 stations indicate that least tern foraging is highly variable in both time and space. Lission Bay channel and Fiesta Island were used most extensiviely during the pre-chick stages of the breeding cycle. These areas continued to be used throughout the season, but other areas, notably the San Diego River flood control channel abd the nearshore ocean area at the river mouth, received increased utilization after egg hatching. There were several areas with high incidence of plunge-diving activity. Most of plunge-diving areas (19 of 25 areas) were associated with eelgrass beds having greater than 25 percent cover. The bait barge area was also used extensively. The distribution of other terns species was similar to that of least tern.

Evenson, D., C. Hopkins, and G. Martz. 1974. Waterfowl and waterfowl hunting at Houghton Lake. Michigan Department of Natural Resources, Wildlife Division, Information Circular 171, Lansing. 7 pp.

Disturbances of waterfowl on Houghton Lake during early fall and the hunting season of 1972 were caused by at least six different sources including boats, anglers, hunters, this study, aircraft, and a bald eagle *(Haliaeetus leucocephalus).* At least 85% of the disturbances were by boats and 53% by hunters. More ducks are disturbed by hunting than other disturbances, primarily because more ducks are on the lake during the hunting season. During the hunting season of 1972, an estimated 408,000 waterfowl were disturbed on the lake. Individual birds were disturbed more than once per day. When the number of birds disturbed is compared with the duck-use days for the season (408,000:268,000), each duck and American coot *(Fulica americana)* was disturbed an average of 1.6 times per day. Disturbance rates were about 1.5 times greater on weekends than during the week. However, in 1972, ducks were never driven off the lake because of harassment.

Erwin, R. M. 1980. Breeding habitat use by colonially nesting waterbirds in two Mid-Atlantic U.S. regions under different regimes of human disturbance. Biological Conservation 18: 39-51.

More than 80% of the beach-nesting seabirds (common tern, least tern, black skimmer, and herring gull) in coastal Virginia nest on natural barrier island beaches, while in New Jersey the vast majority nest on dredge deposition material or natural marsh islands. This contrast probably results from the differences in human disturbance in the two regions. Although 75% of all oceanfront in New Jersey allows unrestricted recreation, about 85% of the Virginia beaches are "protected" under the ownership of several conservation agencies. Attendant with changes in habitat utilization in New Jersey, competitive interactions have apparently intensified with herring gulls usurping tern and laughing gull nest sites. Other implications are discussed.

Evenson, D. E. 1974. Migratory waterfowl use of Houghton Lake, Michigan. M.S.. thesis, University of Michigan, Ann Arbor. 106 pp.

Disturbances from occupied hunting blinds and boats caused birds to seek refuge on open waters during the day and were more significant in keeping ducks from the middle

grounds than from any other location on the lake. In pre-season counts, ducks on the middle grounds were 20.7% of duck-use days. After hunting started, only 7.4% of the duck-use days were on the middle grounds.

Evenson, D. E., and C. X. Hopkins, Jr. 1973. Waterfowl at Houghton Lake: including an analysis of the influence of food resources and disturbances on waterfowl use. Technical Bulletin 73-3, Michigan Department of Natural Resources, Lansing. 69 pp.

The largest disturbances in 1972 with an average of 1,502 birds were caused by hunters with blinds on their boats. The second largest disturbance factor was the authors' observations. The value of 372 birds per disturbance is probably out of proportion to the actual effect of disturbance on the lake because all disturbances by the authors were tallied. Hunters who used floating blinds were the most numerous type of hunters on the lake and caused an average disturbance of 232 birds. Non-hunting disturbance caused fewer and smaller disturbances than hunters during the hunting season. However, before the opening of the hunting season, anglers created five disturbances with an average of 537 birds per disturbance.

Fancher, J. M. 1992. Population status and trends of the California least tern. Transactions of the Western Section of the Wildlife Society 28: 59-66.

At the time of its Federal and State listing as endangered in 1970, there were estimated to be about 600 breeding pairs of the California least tern (*Sterna antillarum browni*) nesting in california. In the first decade of recovery efforts, emphasis was on protection and/or establishment of designated nesting areas. Statewide annual monitoring of the breeding sites and estimates of the breeding population began in 1973, with estimates of fledgling production beginning in 1978. By 1980, the tern's breeding population had doubled to 1160 pairs with 16 nesting sites supporting 20 or more pairs and a total of 31 sites used in that year. In 1982, the severe oceanographic phenomenon, involving the northerly extension of tropically warmed surface waters and declines in some southern California fishery resources, known as El Niño, contributed to a decline in the least tern breeding population to a low of 944 pairs in 1987. The emphasis of species management since 1980 has been nesting site management and reduction of predation impacts in order to increase reproductive success. By 1990, the Statewide breeding population was

estimated to be 1708 pairs with 20 nesting sites supporting 20 or more breeding pairs and a total of 28 sites used in that year.

Ferreira, C A. 1973. Study of Sweetwater Marsh Vegetation and Waterfowl Bayfront Usage. For the Chula Vista Planning Department.

An approximate count of shorebirds using the marsh on December 14, 1972. No species breakdown.

Figley, W. K. and L. W. Vandruff. 1982. The ecology of urban mallards. Wildlife Monograph 81. The Wildlife Society, Washington, D.C. 40 pp.

During January-March, many mallards *(Anas platyrhynchos)* were wary of humans and often flew up 60 m in advance of an approaching boat. They were reluctant to take food from people. During the rest of the year, ducks in the lagoon were much less apprehensive and paid little attention to moving boats. Increased wariness during winter may be due to an increased number of wild migrant birds in the Angelholm flock. One of seven factors contributing to severe brood losses in the lagoon was the capturing and scattering of broods by people. Cats and dogs destroyed 28 mallard ducklings on a small campus pond in 1974, and 13 in 1975.

Fraser, M. W. 1987. Reactions of sea-ducks to windsurfers. British Birds 80:424.

On 22 June 1981, the author was watching a flock of 400 common eiders *(Somateria mollissima)* about 200 m from shore and about 220 black scoters *(Melanitta nigra)* 400 m from shore. Suddenly the common eiders took off eastward to the open sea and a few seconds later, the black scoters followed them. The author then noticed that a windsurfer had come into view from around a rocky headland 500 m to the west and 250 m from the shore. Ten minutes after he had disappeared, the common eiders returned, but not the black scoters. In contrast to the sail and engine-powered dinghies and small boats, the appearance of the windsurfer created instant flight by the birds. The editor of this journal article added a footnote in which he suggested that based on his observations on the Ythan Estuary, Grampian, ducks, mainly common eiders, long-tailed ducks *(Clangula hyemalis),* red-breasted mergansers *(Mergus serrator),* common goldeneyes *(Bucephala clangula)* and Eurasian wigeons *(Anas penelope),* became acclimated to wind surfers and therefore did not react as severely to them as reported by the author.

Frederick, R. B., W. R. Clark, and E. E. Klaas. 1987. Behavior, energetics, and management of refuging waterfowl: a simulation model. Wildlife Monograph 96. The Wildlife Society, Washington, D.C. 3 pp.

A stochastic simulation model designed to test alternative management schemes on refuging waterfowl populations was constructed from data on fall-migrating snow geese *(Chen caerulescens)* at the DeSoto National Wildlife Refuge. Components of the model include population level, food density and distribution, foraging flight characteristics, feeding rates, activity and energy budgets, migration rates, and effects of weather, hunting pressure, and land management practices on the system. Data were collected to test the model's validity. Refuge population level was not sensitive to shifts (+20%) in the input values of 25 selected parameters, but hunting mortality and daily foraging distances were sensitive to several combinations of parameter perturbations. Model outcome was most sensitive to changes in digestive efficiency, mean food density, and the proportion of refuge fields in which food was available. n other experiments with the model, increased hunting pressure caused significantly ($p < 0.05$) increased hunting mortality and reduced the refuge population. The effect of hunting was less important in reducing waterfowl population size than the associated disturbance of feeding snow geese by hunters.

Fredrickson, L. H., and F. A. Reid. 1988. Waterfowl use of wetland complexes. Pages 1-6 *in* Managing waterfowl habitats: breeding, migrating, wintering. Gaylord Memorial Laboratory, University of Missouri, Puxico, Missouri. U.S. Fish and Wildlife Service, Office of Information Transfer, Fort Collins, CO.

Refuge management may require manipulation of soil and water to produce habitat structure or essential foods. Production of foods does not assure their use by waterfowl. Foods are accessible only if appropriate water depths are maintained during critical time periods, habitats are protected from disturbance, and habitats that provide protein and energy are close together. Disturbance is particularly important, and recognition of the influence of disturbance on access to and acquisition of needs throughout the annual cycle is essential. Subtle disturbances by bird watchers, researchers, and refuge activities during critical biological events may be as detrimental to waterfowl populations as hunting or other water-related recreation such as boating. At certain locations, predators

or activities associated with barge traffic, oil exploration, or other industrial or military operations are detrimental to waterfowl.

Gill, R. E. and L. R. Mewaldt. 1983. Pacific Coast Caspian Terns: dynamics of an expanding population. Auk 100: 369-381.

Nesting distribution, age-related seasonal movements, survivorship, and mechanisms of population expansion in Pacific Coast Caspian Terns (*Sterna caspia*) were examined primarily through analysis of 412 recoveries of birds banded as juveniles between 1935 and 1980. Since the beginning of this century, the population has shifted from nesting in numerous small colonies associated with freshwater marshes in interior California and southern Oregon to nesting primarily in large colonies on human-created habitats along the coast. Colonies at Grays Harbor, Washington and San Francisco and San Diego bays, California account for 77% of the current Pacific Coast population (6,000 pairs), which has breeding and wintering areas separate from those of populations east of the continental divide. Factors promoting both first-time breeders and older adults to join new and often distant colonies are discussed.

Gore, J. A., and M. J. Kinnison. 1991. Hatching success in roof and ground colonies of least terns. Condor 93: 759-762.

Eight colonies of least terns were studied in northwest Florida in 1989. Four colonies were on roofs and four colonies were on the ground. Findings were of greater hatching success in nests on roofs versus those on the ground. This was contradicted somewhat by the absence of significant differences in colony productivity between roof and ground sites. The small sample sizes may have prevented differences between the colony types from being detected as significant at the 0.05 level. The relatively high probabilities (P=0.01) obtained with the small samples suggest that real differences in productivity exist between roof and ground colonies with roof colonies being more productive. The main point is not whether the roof colonies are of equal productivity or more productive, but that they are not unproductive or inferior as had often been presumed. Only one egg in all of the roof colonies was impacted by a predator. Predators were common in the ground colonies.

Heitmeyer, M. E. 1985. Wintering strategies of female mallards related to dynamics of lowland hardwood wetlands in the Upper Mississippi Delta. Ph.D. dissertation, University of Missouri, Columbia. 376 pp.

Wintering mallards *(Anas platyrhynchos)* in the Mingo Basin changed their habitat use, daily time budgets, and food habits in response to human-related disturbance, mainly hunting, but also vehicular and foot traffic. Refuge areas were especially important during hunting seasons as evidenced by concentrations of mallards on certain areas. Effects of disturbance by hunters are not entirely known. Disturbance seems most detrimental to mallards in late winter and spring.

Henry, W. G. 1980. Populations and behavior of black brant at Humboldt Bay, California. M.S. thesis, Humboldt State University, Arcata. 111 pp.

Use of specific areas and daily flight activity by brants *(Branta bernicla)* were influenced by tidal level, food availability, time of day, and particularly by disturbance from hunters. Densities of brants were lower in areas with human activity than in undisturbed areas. In response to open-water hunting, brants left the bay and flew to the ocean where food was scare. Brants were particularly susceptible to disturbance by aircraft, especially helicopters. Flights below 300 m often caused flocks to move to the ocean. Denying the birds an undisturbed feeding place during the day could result in a loss of energy and a lowering of body weight when the birds need to prepare for northward migration and breeding.

Hume, R. A. 1976. Reactions of goldeneyes to boating. British Birds 69178-179.

Unlike elsewhere in late winter and early spring, the abundance of waterfowl did not increase at Chasewater, and in the winter of 1974-75 the abundance was much lower in late January than in December, almost certainly because of the increased frequency of midweek boating. Repeated observations revealed that common goldeneyes *(Bucephala clangula)* often fly when people on the shore approach closer than 100 or 200 m, but invariably settle again elsewhere on the water. A single sailing dinghy, however, may be sufficient to cause more than 60 common goldeneyes to take flight and most to leave entirely within a few minutes. Remaining birds then fly up each time the boat approaches to within 300-400 m and generally leave within an hour. The appearance of a powerboat

causes instantaneous flight by most birds. If the boat traverses the length of the reservoir, all remaining birds leave within minutes.

Kaiser, M. S. and E. K Fritzell. 1984. Effects of river recreationists on Green-backed heron behavior. Journal of Wildlife Management 48:561-567.

This study's objective was to determine the behavior of green-backed herons in relation to the level of recreationist activity on the Ozark National Scenic Riverways (ONSR). Surveys of heron abundance were conducted on 55 occasions on four river sections; 431 sightings of green-backed herons were made and 526 recreationist groups recorded. The authors results showed use of the rivers by the herons was affected by recreational activity. Increased human activity decreased heron use. Backwater areas , those not directly on the waterways, did not seem to be affected by the increase in human activity. However, backwater areas do not serve as concentration areas for herons attempting to escape disturbance on the main river channel. The authors concluded: "Because green-backed herons spent most of their time on the river foraging(Kaiser 1982), displacement from the river channel for long periods may adversely affect the energy budget of herons when demand for food is high. Thus backwater areas on the streams are an important habitat component for green-backed herons, but these areas will not alleviate any detrimental effects from extended periods of human disturbances when the river channel is unavailable to herons.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. Wildlife Society Bulletin 19:242-248.

Spring and fall disturbances to migrating canvasbacks were studied in 1986 and 1987. During the study, 94% of the disturbances were from recreational boating activity. On Lake Poygan during spring, boating disturbance was an important factor contributing to the 48-53% of daylight hours that canvasbacks spent away from feeding areas. Spring disturbance may have an impact on canvasback populations by impacting their acquisition of nutrient reserves and, therefore, their productivity as in several other species of waterfowl. Although canvasbacks flew longer after disturbance, a greater percentage of each flock tended to return directly to feeding areas during fall 1987 than during the other seasonal periods. In contrast, the lowest percentage returned to feeding areas after each disturbance in spring 1986, corresponding with the highest disturbance rate. Management options are discussed.

Keller Environmental Associates Inc. 1991. City of Chula Vista Midbayfront LCP no. 8, Environmental Impact Report. Appendix C. Biological Resources--Midbayfront. Prepared by Pacific Southwest Biological Services, Inc., 164 pp.

Botanical and zoological field investigations on 116 acres of the Chula Vista Bayfront including the Sweetwater Marsh, Vener Pond, "E" Street Marsh, "F" and "G" Street Marsh, and the adjacent shoreline of San Diego Bay. Bird surveys were conducted on six days between July and September 1989. Species observed are listed; no abundances are given. A review of species previously observed on the site and species accounts are provided. Savannah Sparrows were surveyed on four days in May. The population was estimated at 15 pairs. A focused study of avian flight over the site was conducted between October 1989 and April 1990. "Most waterbird species exhibited a high tenacity for flights along the wetland/upland fringes and across open wetlands. Flights were found to be generally low level localized movements between wetland areas. Flights of shorebirds tended to be extremely low in elevation with 80.7 per cent of the small shorebird flights and 89.7 per cent of all large shorebird flights occurring below 26 feet. Terns and other aerial fish foragers tended to exhibit primarily low altitude flights with 86.1 per cent of all flight activities occurring below 51 feet."

Korschgen, C. E., L. S. George, and W. L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildlife Society Bulletin 13:290-296.

Disturbances of canvasbacks *(Aythya valisineria)* by recreational boaters were studied on the upper Mississippi River to determine frequency of disturbance and possible effects on energy of the birds. Twenty-nine random observation periods during morning (30 minutes before sunrise to 1200 h) and afternoon (1200 h to sunset) were used to determine numbers, dominant activity, and distribution of the birds on the staging area. Recreational boating that created disturbance, flock size, and duration of response were recorded. An average of 17.2 boats per day resulted in 5.2 disturbances per day. Anglers created 42% of the disturbances. Mean flock size of disturbed canvasbacks was 12,474. Disturbances lasted an average of 4.43 minutes each. Diving ducks left the staging area 19 times during the fall because of human disturbance. Birds may be forced to fly up to 1 h each day because of disturbance. Energetic costs of the disturbances are unknown, but may be detrimental if the abundance of canvasbacks significantly increases and requires

more food, production of American wild celery *(Vallisneria americana)* significantly decreases, disturbances become more severe, or foods at other migration areas deteriorate.

Kramer, D. 1984. The effects of recreational activities on the winter wildfowl population at Priory Park Lake, Bedford, during the winter of 1982-83. Ardea 1983 - 84:34-46.

Counts of wintering wildfowl were made at a 26-ha gravel pit lake before and after sailing and sail-boarding; abundance of wildfowl with and without disturbance were compared. Recreation on the lake was restricted to a particular zone between 1 November and 28 February 1983. The effect of a disturbance-free zone on the behavior and distribution of waterfowl was noted. Before zoning, sailing displaced nearly all waterfowl from the lake. During the first month of zoning, sailing still caused a significant reduction in number of birds and species, but thereafter, nearly all species tolerated the presence of sail-boards and dinghies and remained on the lake in similar abundance as on undisturbed days. Species included northern shovelers *(Anas clypeata)*, green-winged teals *(A. crecca)*, Eurasian wigeons *(A. penelope)*, mallards *(A. platyrhynchos)*, gadwalls *(A. strepera)*, common pochards *(Aythya ferina)*, tufted ducks *(A. fuligula)*, Canada geese *(Branta canadensis)*, common goldeneyes *(Bucephala clangula)*, long-tailed ducks (old-squaw, *Clangula hyemalis)*, and mute swans *(Cygnus olor)*. Results in this paper are similar to those in the publication by the same author reviewed below.

Kramer, D. 1986. The effects of recreational activity on wintering wildfowl populations at Priory Park Lake, Bedford. Bedfordshire Naturalist 41:21-26.

A 25-ha lake was selected and a disturbance-free zone created. Two visits per day were made on 39 occasions between 18 September 1982 and 28 February 1983. Canada geese *(Branta canadensis)* were present only once and the flock was obviously alarmed by the first launched boat and departed immediately. Eurasian wigeons *(Anas penelope)* did not seem to be disturbed by the sailing. Mallards *(A. platyrhynchos)* were affected by the sailing and deserted the lake. Walking, jogging, fishing, or dog-walking people along the lakeshore had little effect, except when a dog owner deliberately sent a dog into the water and when the sudden movement of a person breaking into a fast run caused a party of 10 common goldeneyes *(Bucephala clangula)* to depart from the lake. Before zoning, a low

level of disturbance resulted in near total departure of all water birds and some species such as the green-winged teal *(A. crecca)* took flight as soon as a single sailboard or dinghy was launched, whereas common pochards *(Aythya ferina)* and tufted ducks *(A. fuligula)* departed as soon as the craft approached within about 80 m of the flocks. Common pochards and tufted ducks continued to be disturbed by sailing for several weeks (common pochards for 6 weeks) after the refuge was zoned. Learning probably took place.

Kramer, G. W., L. R. Rauen, and S. W. Harris. 1979. Populations, hunting mortality and habitat use of black brant at San Quintin Bay, Baja California, Mexico. Pages 242-264 in R. L. Jarvis and J. C. Bartonek (eds). Proceedings of the Symposium on Management and Biology of Pacific Flyway Geese,. Northwest Section, The Wildlife Society, Washington, D.C.

Use of specific areas of the bay and daily flights by brants *(Branta bernicla)* were disturbed particularly by hunting. On days without hunting, brants left deep-water areas and flew to eelgrass beds. Brant usually did not fly at other times except when disturbed by aircraft, anglers, or boaters. Disturbance by hunters resulted in five to six times more flights than on corresponding nonhunting days. Flights were more frequent, occurred sooner after hunting began, and involved more birds during the 16 January-28 February 1975 portion of the hunting season (spring migration) than earlier. The intensity of movement to the ocean was significantly related to the level of human disturbance. Most brants took flight as aircraft approached and remained airborne until the aircraft passed, but only few ducks and shorebirds reacted similarly. The authors think that departing brants abandoned San Quintin Bay as a stopover area and recommended stricter law enforcement; making herding illegal; continuing rest days during the hunt on Monday, Tuesday, and Wednesday; reducing the bag limit; establishing a refuge area; and avoiding ecological changes that affect eelgrass.

Liddle, M. J., and H. R. A. Scorgie. 1980. The effects of recreation on freshwater plants and animals: a review. Biological Conservation 17:183-206.

This paper is a review of the effects of recreation on freshwater plants and animals. The paper makes a distinction between water- and shore-based activities and between physical and chemical effects. Effects of water-based recreation, mainly from boating, are discussed in terms of wash, turbulence and turbidity, propeller action, direct contact,

disturbance to animals, and pollution from outboard motors and sewage. Effects from shore-based activities, such as angling and swimming, include trampling and associated effects, as well as effects of sewage and other chemicals. Management of recreation is also considered. Information on the effect of recreation is greater on plants than on animals, but the authors consider that further research is required in both fields. Some possible approaches are presented. This review and the section on disturbance are extensive.

Manning, J. 1993. Seabird and waterfowl censusing at San Diego Bay, California. Progress Report. Bay and Estuary Program. Carlsbad Field Office. U. S. Fish and Wildlife Service.

Brief status report of weekly censusing of the central and southern portions of San Diego Bay began in May 1993 and intended to continue through April of 1994. The results of these surveys are complemented by an extensive censusing effort of the north Bay by Ogden Environmental and Energy Services Co., Inc. for the U. S. Navy. Upon completion, this project will allow for San Diego Bay to be compared to neighboring bays and estuaries with regard to its ecological importance to local and migratory bird species on the southern California coast.

Manning, J. 1993. Survey of colonial nesting habitats at Western Saltworks: A prelude to habitat management and enhancement strategies. Bay and Estuary Program. Carlsbad Office. U. S. Fish and Wildlife Service.

Descriptions of dike morphology and habitat associated with nesting areas of Forster's tern, caspian tern, elegant tern, and black skimmer along the man-made dike complex at the Western Saltworks. This preliminary report describes the present status and preliminary results of an extensive survey of nesting habitats. A final report is expected by February 1994.

Mathews, G. V. T. 1982. The control of recreational disturbance. Chapter 42, pages 325-330 in D. A. Scott (ed). Managing wetlands and their birds: a manual of wetland and waterfowl management. Proceedings 3rd Technical Meeting on Western Palearctic Migratory Bird Management, Biologische Station Rieselfelder Munster, Federal Republic of Germany, 12-15 October 1982.

Water-based recreationists increased sevenfold in the last 30 years. In Britain, nearly 4 million anglers, half a million boaters, half a million birdwatchers, and other millions affect wetlands. Activities that cause disturbance to waterfowl in order of decreasing disturbance include: those involving rapid movement and loud noise (power boating, water skiing, cruising); those involving movement but little noise (sailing, wind surfing, rowing, canoeing); those involving little movement or noise (underwater swimming); and those carried out largely from the banks (fishing, birdwatching, informal). Boats must be kept at least 300 m from a waterfowl area. Banks are more easily zoned than water itself, and bird areas must be strictly off limits to anglers. The paper also addresses accommodation of birdwatchers and use of wetland display centers to educate the general public.

Macdonald, K.B., R.F. Ford, E.B. Copper, P. Unitt, and J.P Haltner. 1990. South San Diego Bay Enhancement Plan. Volume Two. Birds of San Diego Bay, Historical Data and 1988-894 Surveys. Prepared for San Diego Unified Port District.

Original data collected for six seasonal periods in June, August and November of 1988, and February, April and June of 1989. Separate bird surveys were conducted at a series of 26 stations that encompassed the entire shoreline of South San Diego Bay (except the salt evaporation ponds). Additional censuses were conducted by boat. During the study 127 species of birds were recorded. The station with the greatest diversity was the end of the D Street Fill at the mouth of the Sweetwater River. The lowest species diversity among the shoreline stations were the interior dredged channels of Coronado Cays and the developed portion of Chula Vista Marina. Included are graphs of species richness and abundance for each station covering all survey dates. Each station is briefly commented upon. Narrative paragraphs on the great majority of species recorded during the 1988-89 censuses summarize key observations for each species' occurrence and distribution in South San Diego Bay. Tabulated data sets follow the narratives.

Minsky, D. 1989. Physical and Social Aspects of Nest Site Selection in Colonies of the California Least Tern. Master's Thesis. California Sate University, Long Beach.

Nest site selection was examined at 11 Least Tern colonies (19 colony-years) in southern California. There was a ten-fold range of nest densities and four-fold range of inter-nest (nearest-neighbor) distances at these colonies. Nest density was not related to type of colony site, predation levels, or human disturbance. Nests typically occurred away from colony peripheries. Least Terns avoided vegetation, but preferred debris, near their nests. Substrate particles larger than 0.5 mm were found in significantly higher proportions at nests than at random points. The colony-specific differences in physical characteristics, and their annual variation, limit any generalizations about their importance. Nesting was demonstrated to be temporally synchronized. There was also evidence that age cohorts nested together, and that inter-seasonal nest site fidelity exists. Social factors, although more difficult to demonstrate, appear to be more important than previously realized in the nest site selection process.

Naval Facilities Engineering Command. 1992. Milcon Project P-187. Small Craft Berthing Pier. Naval Amphibious Base. Prepared by Southwest Division, 1220 Pacific Highway, San Diego, CA.

Eelgrass and infauna survey of 365 ft. by 350 ft. area of the Naval Amphibious Base, Coronado, CA. General observations on fishes, macroinvertebrates and algae were recorded by biologist divers while surveying eelgrass meadows. No original bird data. Approximately 0.9 miles from the proposed site is the nearest known nesting location of the California least terns at Delta Beach. "In 1991, this nesting site supported 35 pairs of Least Terns and fledged between 15 and 25 young (Least Tern Recovery Team 1991 unpub. data)." In 1985, systematic foraging surveys were conducted at 32 stations adjacent to Naval facilities on San Diego Bay (Copper 1987), and tern foraging areas were identified. The project site is located within a tern foraging area. "California brown pelicans are often found roosting on the ocean beach and bay side of NAB Coronado and have also been observed foraging in nearshore marine waters where they plunge dive for fish (Grizzle 1989)."

Naval Facilities Engineering Command (Code 2031), Western Division. No date (post-1985). Draft. Environmental Assessment, Berthing/Repair Pier 12, Project MCON P-209, Naval Station, San Diego, California.

No original bird data. Discussion of California Least Tern uses Copper's 1985 observations. Concerns center around California Least Terns foraging in the area. "Based on the findings and recommendations of Copper's study, foraging at the site should be considered important to the species, and the loss of foraging area during the breeding season considered a significant effect." Under mitigation measures, "the Navy should restrict the time frame of the project-related dredging and pile driving aspects of pier construction to the period between October and April [to avoid turbidity in the foraging waters during California least tern breeding season]."

Ogilvie, M. A., and G. V. T. Mathews. 1969. Brant geese, mudflats and man. Wildfowl 20:119-125.

This paper covers the decline of brants (*Branta bernicla*), control of hunting, habitat conservation, total world population, human caused changes of the landscape, and so on. Considerable discussion focuses on the adverse effects of disturbance from an airport. The authors believe the future of brants is in doubt because of various human caused changes.

Owens, N. W. 1976. Responses of wintering brant geese to human disturbance. Wildfowl 27:152.

Effects of human disturbance on distribution and behavior of wintering brants *(Branta bernicla bernicla)* in Essex were assessed. Brant avoided disturbed areas and places with poor visibility in early winter, but used them later when favored areas became depleted of food. Brants became partially habituated to the proximity of people and to some loud noises, but did not habituate to small, low-flying aircraft. Disturbance could be ameliorated or reduced by restricting access of people to the sea wall in certain areas around high tide and by controlling low-flying aircraft in the area.

Owens, N. W. 1977. Responses of wintering brant geese to human disturbance. Wildfowl 28:5-14.

Large boats and yachts rarely disturbed brant *(Branta bernicla),* but small boats with noisy outboards caused them to fly. In 168 h of observation, human disturbance caused some birds to fly an average of once every 81 min. Forty eight percent of disturbances were by people, most of whom were on shore; 39% by aircraft, chiefly small planes; 9% by loud noises; and 4% by small boats. Disturbances by aircraft caused about twice as many brants to fly as disturbances by people ($d = 5.3$; $p < 0.001$). Aircraft caused about 1.6 times as much disturbance as people. Without disturbance, brants spent an average of 1.1% of their time in flight. Total time spent flying correlated with the amount of flying caused by disturbance ($r = 0.93$; $n = 11$; $p < 0.001$). Disturbances on weekends stopped brants from foraging for as much as 11.7°/0 of their time and increased time spent flying as much as sevenfold. Overall, disturbance would probably have been unimportant if adequate food was available. However, food shortages probably prevented full compensation for disturbance.

Pacific Southwest Biological Services, Inc. 1989. Kona Kai Club Redevelopment, Shelter Island.

Fifteen bird surveys between April 27,1989-July 7, 1989 were conducted at the Kona Kai property on Shelter Island with its focus on the water areas. The survey area was divided into 8 subareas. Each subarea was observed for 30 minutes on each of the 15 visits to the site. Included in the report are data on the species observed, abundance, and activity. "The season during which observations of bird activities were made is unfortunately not ideal to assess utilization of intertidal habitat by wading shorebirds." Surveys conducted by K. W. Merkel, D. A. Mayer, and D. J. Grout.

Pacific Southwest Biological Services. 1988. Final Report of Investigation into the Sensitivity of the North End Site of the Naval Submarine Base, San Diego, California, and the ability of the Site to Support Proposed Milcons P-112, P-103, P-054, P-088, P-111, and P-083.

In 1988 on January 12, 15, and 22, fourteen and a half hours of surveys for birds and mammals were conducted on the North End Site, Point Loma Submarine Base. A table lists the birds, numbers observed, and in what habitat they were found.

Parry, M. L 1987. Multi-purpose use of waters. Pages 66-71 in P S. Maitland and A. K. Turner (eds). Angling and wildlife in freshwaters. Proceedings of a symposium organized by the Scottish Freshwater Group and the British Ecological Society. University of Stirling, 30 October 1985. ITE Symposium 19.

This is a general summary of some human disturbances to waterfowl and descriptions of the use and conflicts at several reservoirs as examples. Key words are roosting or feeding waterfowl, birdwatchers, water-based recreation, boating, time-zoning of use, space zoning, refuge, flight, energetic costs, anglers, water fowl counts, scare distance for mallards *(Anas platyrynchos),* and compensatory conservation.

Pedroli, J-C. 1983. Activity and time budget of tufted ducks on Swiss lakes during winter. Wildfowl 33:105-112.

When ice covered the bird sanctuary, tufted ducks *(Aythya fuligula)* sometimes rested on open water near Neuchatel, the feeding ground of the Bas-lac region. Boat traffic for hunting, fishing, and sport was dense and produced major disturbances. Disturbances were similar in Vaumarcus and Yvonand, but considerably greater than in the bird sanctuary. Boat traffic was again the main source of disturbance. Frequent storms forced anglers to take in their nets at night, which greatly disturbed feeding ducks. These nocturnal disturbances were probably responsible for the decrease in the number of birds in the Bas-lac region. The duration of foraging was more or less constant throughout winter and the only increase was between the end of November and the end of December when boat traffic on the lake increased disturbance and flights that cost energy. On Lake Neuchatel, the foraging site with the least disturbance was occupied first with the greatest

number of wintering ducks. Movement of ducks toward other foraging sites was caused by disturbance at night.

Platter-Rieger, Mary F. 1981. 1980 Nesting Success of Great Blue Herons on Point Loma, San Diego, California. NOSC Technical Note 1017. Prepared for Western Division, Naval Facilities Engineering Command.

The breeding colony of Great Blue Herons on Point Loma is located on Navy Submarine Support Facility property. Seventy four Great Blue Herons nested in the heronry in 1980 and 55 were fledged, representing 2.12 young fledged per successful nest. "Eggshell thinning and breakage were present in the heronry, although extreme shell thinning occurred in only two or three nests. Data from the first half of the 1981 breeding season indicates that most egg damage was probably caused by stress from nearby road construction [during breeding season in 1980]." Early in February 1980, construction of an access road for a steam plant destroyed 15 of the 26 trees used for heron nesting. The disturbance was halted early enough and for long enough to allow successful nesting in 1980.

Platter-Rieger, M. 1991. 1991 Great Blue Heron and Black-crowned Night Heron Census for Naval Submarine Base, San Diego, California. Unpublished Technical Report. Naval Oceans Systems Center, San Diego, California.

This report was prepared for the purpose of updating the 1981 Terrestrial Biological Survey and Inventory of Navy Property on Point Loma (Woodward-Clyde Consultants 1981). In 1990 and 1991, the Point Loma heronries produced approximately 61 and 49 active great blue heron nests, respectively, and 166 and 112 active Black-crowned Night Heron nests, respectively. The great blue heron colony produced 71 fledglings in 1991. Aspects of great blue heron and black-crowned night heron ecology, site history, and response to disturbance are discussed.

Point Reyes Bird Observatory. 1990. Shorebird Numbers in Wetlands of the Pacific Flyway: A Summary of Spring and Fall Counts in 1988 and 1989. Prepared by Gary W. Page, Lynne E. Stenzel, Janet E. Kjelmyr, and W. David Shuford.

In 1989, the entire wetland system and bays of coastal of San Diego County were included in this shorebird survey. With few exceptions, areas were surveyed in both spring and fall. Spring counts were timed to coincide with the peak occurrence of Arctic-nesting shorebirds as they concentrated at staging areas south of their breeding grounds. In fall, with migration more protracted, the timing of peak numbers in any one year is more difficult to predict. Consequently, peak numbers in fall are more difficult to obtain through a single census than in spring. Census dates in 1989 were centered on the weekends of 22-23 April and 19-20 August. All surveys were conducted by volunteers. Results are presented in orders of magnitude.

Prudy, K. G., G. R. Goff, D. J. Decker, G. A. Pomerantz, and N. A. Connelly. 1987. A guide to managing human activity on National Wildlife Refuges. Human Dimensions Research Unit, Department of Natural Resources, Cornell University, Ithaca, New York; U. S. Fish and Wildlife Service, Fort Collins, Colo. 57 pp.

Various disturbances of 20 species of wildlife were reported by managers of 16 wildlife refuges in Region 5, including: shorebirds (61.5%), waterfowl (16.9%), great blue herons *(Ardea herodias)* (12.8%), deer *(Odocoileus* spp.) (5.4%), eastern bluebirds *(Sialia sialis)* (2.0%), loggerhead turtles *(Caretta caretta)* (1.4%), and herons (0.7%). Disturbances (148 instances) varied by species and by refuge, but most often (41.3%) lowered reproduction, and caused aberrant behavior or stress (16.2%), reduced use of apparently preferred refuge habitat (13.5%) and use of refuge (12.8%), and caused direct mortality (11.5%) and indirect mortality (4.7). Refuge manager's perception of the importance of disturbances by species was shorebirds (73%), waterfowl (17%), birds of prey (16%), deer (5%), bluebirds and herons (no data), and loggerhead turtles (2%). Overall, managers considered disturbances of great importance 58.5% of the time, of moderate importance 22.1%, and of minor importance only 19.5% of the time. Exploring on foot was involved in 48.0% of the disturbances, and driving on beaches was involved in 20.9% of the disturbances. In 83% of the 16 refuges, direct mortality was from hunting, and in 50% it was from driving on roads. In 100% of the 16, indirect mortality was from feeding or petting; lowered

productivity was from harassing wildlife, collecting eggs, and littering. In 50% of the 16, reduced use of the refuge was from hiking-bicycling-jogging and sunbathing-swimming. Reduced use of preferred habitat was from exploring on foot in 18% and from hunting in 17% of the refuges. Aberrant behavior and stress was from feeding-petting in 50% and from wildlife observation on foot in 29% of the refuges.

Quammen, M. L. 1982. Influence of subtle substrate differences on feeding by shorebirds on intertidal mudflats. Marine Biology 71: 339-343.

Shallow-feeding shorebirds, dowitchers (*Limnodromus griseus* and *L. scolopaceus*), western sandpipers (*Calidris mauri*), dunlin (*C. alpina*) and American avocets (*Recurvirostra americana*), reduced the density of their prey in mudflats with little sand but not in mudflats with a moderate admixture of sand An Experiment in Upper Newport Bay, southern California, during October and November 1979 to explain the difference in density is described. The results suggest that sand interferes with the detection and or capture of prey that are similar in diameter to small sand grains and explains the differences in the effects of predation by these birds seen on mudflats with a moderate admixture of sand compared to the effects on mudflats with little sand. Differential success in prey capture between the microhabitat and the nest (rather than a reduction in competition, as suggested by some authors) might explain the different use of such habitats.

RBR & Associates. 1982. Draft Environmental Impact Report. Underwood Landing Hotel, Shelter Island.

No bird data. Species list of invertebrates found on surface and in core samples of intertidal area at Underwood's Landing. The landing "includes approximately 14,000 square feet of intertidal habitat in an area roughly 375 feet by 35 feet."

Reish, D. J. (Ultrasystems, Inc.). 1979. Focused Environmental Impact Report, 18-Hole Golf Course, City of Coronado.

Reish lists the birds "in the U. S. Navy Radio Receiving Facility that have been reported by the personnel of the Imperial Beach Radio Receiving Facility 1978-march 1979 and a "list of birds and mammals in Imperial Beach Radio receiving Facility Reported by the Audubon Society on February 23, 1978." Reish and C. A. Phillips on March 29, 1979 listed their sightings at the facility for reptiles, birds, and mammals. Common names are

used for mammals and reptiles. No abundance information. Reish discusses the status and needs of the Light-footed Clapper Rail, Belding's Savannah Sparrow, and the Least Tern. Maps indicating the breeding areas of these birds in San Diego Bay are included. No sources are quoted for this information.

Sincock, J. R. 1966. Back Bay - Currituck Sound data report. Waterfowl studies, Vol. 2. U. S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, Md. 62 pp.

Disturbance affected use of foraging sites by diving ducks *(Aythya* spp.) more than use of foraging sites by dabbling ducks *(Anas* spp). Disturbance was the primary factor that kept diving ducks from using foraging sites. Use by diving ducks of foraging sites with good food and high disturbance was highest in the posthunting season and less than average during the hunting season. This differs from high use by diving ducks of foraging sites in natural or established sanctuaries during the hunting season and sharply reduced use of such areas by diving ducks after the hunting season. Data suggest that diving ducks have low tolerance of disturbance. When disturbance was above average, Canada geese *(Brant canadensis)* used only one area with above average frequency—probably because of heavy baiting. The only other areas with above average use by Canada geese during the hunting season in either year were in the refuge or in the sanctuary or where disturbance was low. Disturbance of Canada geese on the Back Bay-Currituck Sound is definitely affected by disturbance. Use of the entire area by dabbling ducks and American coots *(Fulica americana)* apparently was about equally affected by food conditions and disturbance.

Stadtlander, D. 1993. Breeding Activity of Colonial Nesting Birds and Western Snowy Plovers at the Western Salt Works, San Diego Bay, California. A Preliminary Report of the Bay and Estuary Program, Carlsbad Field Office, U. S. Fish and Wildlife Service.

The Western Salt Works, situated at the southern portion of San Diego Bay bordering the cities of Chula Vista and Imperial Beach, were monitored. The monitoring of the salt works dikes began 15 March 1993 and continued through 13 September 1993. Areas were searched an average of two times per week with a total of 52 visits. Data gathered included: nests initiated; egg laying dates, eggs within individual nests; mean clutch sizes; predation evidence; and overall hatching success. A minimum estimate of 280 pairs of caspian terns (*Sterna caspia*) nested at the Salt Works in 1993 with an overall hatching

success of 77.3%. Two previous studies documented nesting attempts of caspian terns at the Western Salt Works. During 1965 and 1966, Kirven (1969) documented the number of caspian tern nests to be 382 and 351 respectively. Hatching success for 1966 was 81.3%. In 1980-1981 Schaffner (1982) estimated 400 breeding pairs. A minimum number of 10 breeding pairs royal terns (*Sterna maxima maxima*) with nests totaling 13 in 1993. One egg in each nest documented. Elegant tern (*Sterna elegans*) nests numbered 511 in 1993 with 77.2% hatching success rate. The 1993 breeding pairs are estimated at 312-427. This number is down from the 1980 and 1981 estimates (Schaffner 1982) of 607 and 861 breeding pairs, respectively. Eleven gull-billed tern nests were documented with 79.2% hatching success in 1993. A total of 326 pairs of black skimmers (*Rynchops niger niger*) nested at the Salt Works in 1993 with 68.9% hatching success. A 1993 estimate of 7 breeding pairs of western snowy plovers nested in the Salt Works in South San Diego Bay. Sixteen eggs hatched for a 59.3% hatching success.

Stadtlander, D. and J. Konecny. 1993. Bird census of Western Salt Works and adjacent wetlands, San Diego Bay, California. A preliminary report of the Bay and Estuary Program. Carlsbad Field Office. U. S. Fish and Wildlife Service.

From 10 February 1993 to 8 September 1993, weekly surveys of the Salt Works in the extreme south end of San Diego Bay were conducted between 0700 and 1100 hours. These surveys will continue until February 1994. Ninety eight bird species were identified. This includes 22 species of shorebirds, 17 species of waterfowl, 14 species of gulls/terns, and 6 species of egrets/herons. A total of 252, 451 individuals were counted over this same time period. Red-necked phalaropes (63,097) and western sandpipers (47,255) comprised approximately 44% of the total birds counted. Black-bellied plovers, killdeer, and marbled godwit were the most frequently occurring shorebirds. Lesser scaup was the most numerous waterfowl species with a total of 11,015 individuals. Generally, overall numbers were lowest in May and June and higher during early spring and late summer. Species richness (total number of species) was highest in the early spring.

Thompson, J. D. 1973. Feeding ecology of diving ducks on Keokuk Pool, Mississippi River. Journal of Wildlife Management 33:367-381.

From 1966 through 1968, relations between diving ducks (*Aythya* spp.) and their food resources on the Keokuk Pool (Pool 19) of the Mississippi River were examined. This

information is useful as a baseline from which to measure the effects of channelization on food resources of diving ducks. Each year, nearly 20 million diving duck days were recorded by aerial and ground census. Night dispersal and feeding were very important to diving ducks because disturbances caused the concentration of 90% of the waterfowl on 28% of the study area during daytime.

Thompson, J. D. 1969. Feeding behavior of diving ducks on Keokuk Pool, Mississippi River. M.S. thesis, Iowa State University.

Most hunting on the Keokuk Pool (Pool 19) was done on back-waters, but in 1967 about 25 blinds were built over open water. Flocks of diving ducks were disturbed by shooting and by movements of hunters between blinds and landing areas. The Keokuk Pool sustains a commercial fishery. Much fishing occurs during summer, but also in late spring and throughout fall when trot-lines and trammel nets are fatal to diving waterfowl which become entangled in them. Fishing disturbs large flocks of diving ducks and flushes them from one section of the pool to another. In fall, the highest disturbance was in the upper section of the pool where the abundance of birds was lowest. Many birds foraged until disturbed by hunters, anglers, or barges. If disturbance continued throughout the day, waterfowl concentrated on the lower section of the pool where disturbance was the least. The lower section, particularly the area with the greatest percentage of diving ducks during the day, became depleted of food if large flocks fed there.

Tuite C. H., P R. Hanson, and M. Owen. 1984. Some ecological factors affecting winter wildfowl distribution on inland waters in England and Wales, and the influence of water-based recreation. Journal of Applied Ecology 21:41-62.

Multiple regression analyses were used to compare distributions of nine common species of waterfowl in Britain with six independent variables of the ecology in inland waters. Large sites tended to hold more waterfowl than smaller sites. Waterfowl used bodies of water with convoluted shorelines more than those with straight shorelines, because many large reservoirs are primarily roosts that have relatively simple shorelines. Chi-square analyses were used to examine the observed number of birds by different water-based recreation. Species most susceptible to disturbance from recreation were northern shovelers *(Anas clypeata)*, green-winged teals *(A. crecca)*, and common goldeneyes *(Bucephala clangula)*. Most tolerant were mallards *(A. platyrhynchos)*, common pochards *(Aythya ferina)*, tufted

ducks *(A. fuligula)*, and mute swans *(Cygnus color)*. Coarse fishing, sailing, and rowing reduced the abundance of wildfowl in winter the most. The presence of birdwatchers was associated with higher-than-expected numbers of most species.

U. S. Fish and Wildlife Service. 1976. Environmental impact assessment: effect of boating on management of Ruby Lake National Wildlife Refuge. Portland, Oregon.

After boating was allowed on Ruby Lake National Wildlife Refuge, nesting success by redheads *(Aythya americana)* dropped from 92% to 83% and from 91% to 57% by canvasbacks *(Aythya ualisineria)*. Nesting success by both species in control areas remained relatively high.

U. S. Fish and Wildlife Service. 1980. FWS/OBS-80/37. Catalog of California Seabird Colonies.

This catalog is a summary of the location, size, and species composition of seabird colonies along the California coast. It documents more than 260 nesting areas with a total estimated population of nearly 700,000 birds. Included is a section on threats to seabirds and appendices on the archiving of the field data as well as viewpoints from which several colonies can be observed without causing disturbance. Seventeen species of seabirds from six families are discussed in this report. Some species that occur in San Diego Bay and are discussed: brown pelican; double-crested cormorant; brant's cormorant; pelagic cormorant; and western gull. In addition to population information in the maps and tables provided, species accounts discuss aspects of the natural history of each of the above species, emphasizing the California populations.

Population information for six additional species which could also be affected by coastal development and pollution has been included in the maps and tables. All the known locations of Least Tern colonies are identified in this catalog, "although yearly surveys by the California Department of Fish and Game will soon render this data obsolete." Identified also are coastal breeding sites of the caspian tern, forster's tern, and black skimmer. The single known California nesting location of the elegant tern in San Diego Bay is also identified along with locations of known Heermann's gull nest sites.

U. S. Fish and Wildlife Service. 1987. Migratory nongame birds of management concern in the United States: the 1987 list. Office of Migratory Bird Management, Washington, D.C. 27 pp. + app.

From a list of major threats to listed species, human disturbance was viewed as the second greatest threat, being mentioned in 20 of the references and identified as a problem for 13 species. Species most harmed by human disturbance are the marsh-wading birds, birds of prey, and marine-shore birds; and species associated with coastal and freshwater wetlands and beaches. Species most often mentioned as suffering from human disturbance were common loons *(Gavia immer)*, trumpeter swans *(Cygnus buccinator)*, snowy plovers *(Charadrius alexandrinus)*, and roseate terns *(Sterna dougallii)*.

U. S. Fish and Wildlife Service. 1988. Natural Resource Management Plan, Naval Submarine Base, Point Loma, San Diego, California.

This report concerns the fish and wildlife habitat management for the Subase. Habitat types are discussed, and sensitive birds "known or expected" to occur at the subase are listed. A 1987 bird species list of the Point Loma area compiled by Claude G. Edwards is included in the appendix. The report is a compilation of existing information with no original data collected nor any abundances cited.

Vos, D. K., F. A. Ryder, and W. D. Graul. 1985. Response of breeding great blue herons to human disturbance in northcentral Colorado. Colonial Waterbirds
8: 13-22.

Reactions of nesting great blue herons *(Ardea herodias)* to human disturbance were studied during 1980-82 at heronries in northcentral Colorado. Sixty-seven percent of all human intrusions caused no herons to flush from their nests (minimal response). Local responses (temporary abandonment of nests) were elicited towards 27% of the human disturbances but only 6% resulted in a general response (temporary colony-wide nest abandonment). Herons were most disturbed by land-related activity. Heron response to human activity changed as the breeding season progressed each year. Fledging success ranged from 2.65 to 2.82 young/nesting attempt/ colony and from 2.82 to 2.96 young/successful nest/colony, and was sufficient to maintain a stable population. Recommendations to reduce human disturbance of breeding great blue herons are discussed.

Ward, D. H., and R. A. Stehn. 1989. Response of brant and other geese to aircraft disturbance at Izembek Lagoon, Alaska. U. S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center. Final report to the Minerals Management Service. Anchorage, Alaska. 193 pp.

Brant *(Branta bernicla)*, Canada geese *(Branta canadensis taverneri)*, and emperor geese *(Chen canagica)* interrupted foraging and flew up in response to helicopters. Disturbance by aircraft may be harmful to brants. During 1,912 h of daylight observations, 1.07 potential disturbances occurred per hour. Aircraft (0.57 per hour) and persons on foot (0.08 per hour) were the most frequent human-related disturbances. Of all disturbances, bald eagles *(Haliaeetus leucocephalus)* and boats elicited the greatest responses from brants. Canada and emperor geese responded most to bald eagles and persons on foot. According to data grouped by altitude and lateral distance to the flock, brants and emperor geese reacted similarly to different types of aircraft and were more responsive than Canada geese. Noise rather than visual cues triggered responses. For each additional daily disturbance by aircraft throughout a 54-day fall staging period, the predicted total weight gain is reduced by 7.4 g, equivalent to energy expended in 53 minutes or 73 km of migratory flight. Ten daily disturbances reduced body weight by 4% from the expected departure weight at the Izembek Lagoon.

WESTEC Services, Inc. 1982. Natural Resources Inventory of the Naval Amphibious Base, Coronado, San Diego, California.

"A total of 63 bird species over a sampling period of 3 days were observed on the ocean side property in October and November of 1981." A table lists species, highest single day count, and habitat (ocean, beach, or flying).

WESTEC Services, Inc. 1981. Final Environmental Assessment Petroleum Oil Lubricant Line (POL) and Land Acquisition--Project P-043, Naval Station, San Diego.

No original data. Discusses briefly the four bird species which the federal government lists as endangered and that occur in the vicinity of the proposed project: California brown pelican, american peregrine falcon, light-footed clapper rail, and California least tern. The California brown pelican "is not expected in the tidal channel associated with the project."

"The small extent of marsh habitat and potential exposure to predators preclude the use of the immediate area about the project by" the light-footed clapper Rail. "The project area has never been used by Least terns for nesting. The project area and the immediate offshore area are not included in proposed critical habitat for the species (USFWS, 1979b). The species may fish in the Seventh Street and Chollas Creek tidal channels."

WESTEC Services, Inc. 1981. Biological Report on the California least tern (*Sterna albifrons browni*) at Naval Air Station North Island.

The study reviews the general breeding biology of the California least tern with particular focus on the subspecies' historical and present endangered status at NAS North Island. Tables on nesting data 1973-1980 as well as extensive discussion included.

WESTEC Services, Inc. 1973. Thermal Distribution and Biological Studies for the South Bay Power Plant (San Diego Gas & Electric Company). Final Report, Volume 5A, Biological Measurements.

No original bird data. Eighteen subtidal stations for biological sampling of benthic plants and benthic invertebrates were established in the south San Diego Bay area. Fifteen of these 18 biological station locations corresponded well to those of the pre-1972 studies conducted by Ford in 1968 with Environmental Engineering Laboratory. This allowed direct comparisons of data obtained at key locations during the pre- and post- 1972 studies. The species composition, distribution abundance, and size of benthic plants and invertebrates are discussed at length.

White-Robinson, R. 1982. Inland and saltmarsh feeding of wintering brant geese in Essex. Wildfowl 33:113-118.

Disturbance of brants *(Branta bernicla)* can be measured by the number of times per hour a flock is disturbed and the resultant amount of time it spends flying. Disturbance levels on the saltmarsh may have been biased because of the occasional testing of explosives at a nearby factory for which no correction could be made. Flights in response to disturbance were more frequent on the saltmarsh, but lasted a shorter time than those on farmland. Refuge areas on permanent pasture and saltmarsh combined with intensive hazing of the birds over sensitive crops will maximize the benefit to the birds and considerably reduce

their energy expenditure. If the value of feeding in refuge areas is improved, the rate of energy intake is expected to increase and further attract birds to these areas.