

AVIFAUNA
OF
SOUTH SAN DIEGO BAY:
the Western Salt Works
1993-1994



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INTRODUCTION

Coastal wetlands along the Pacific Flyway provide foraging and resting areas for a multitude of wetland dependent birds species. San Diego Bay (Bay) which is part of this chain of wetlands has been subjected to severe development pressures in the form of dredging, filling, and waterfront construction. Presently, one of the last remaining strongholds which supports significant numbers of water dependent birds is located in the southern portion of the Bay where extensive tidal mudflats still exist and human disturbance is relatively lower.

Historical documentation of the significance of the Bay for water associated species has been reported (see annotated Bibliography in South San Diego Bay Enhancement Plan Vol II, 1990). Much of the recent information regarding avifaunal presence within the Bay has been limited to shorebird presence and/or has excluded the majority of the Western Salt Works evaporation ponds (Jurek 1974, Macdonald et al. 1990, Page et al. 1992). As part of a continuing effort to investigate the avifauna of San Diego Bay, the U.S. Fish and Wildlife Service Coastal Ecosystems Program undertook a year-long weekly census of water associated birds. Our surveys encompassed all but two ponds of the Western Salt Works facility and included associated mudflats as well as the southwestern shoreline of the Bay. Initially, the Chula Vista Wildlife Preserve (the southeastern shoreline) was also included in our censusing effort but after two surveys access was revoked by the San Diego Port District which controls this property.

The primary purpose of this investigation is to provide current baseline information which can be used to evaluate existing wildlife values within the southern portion of the Bay. In addition, the data gathered during this study will provide an initial framework of information for future management considerations. Although there are many factors which determine species composition and abundance at a given location including general population trends, variations in seasonal migrations, and tidal fluctuations, survey data collected during this investigation provide useful information regarding seasonal occurrence, relative abundance, and the distribution of individual species found within the study location.

STUDY AREA

The study area was located within the southern-most portion of San Diego Bay and included the Western Salt Works, the County of San Diego Marine Biology Study Area, and Emory Cove (Figure 1). The entire study site encompassed approximately 700 hectares. Habitats found within these locations included tidal mudflat, pickleweed (*Salicornia* spp.) marsh, and salt evaporation ponds. Intertidal mudflat bordered the northernmost perimeter of the salt pond dikes and was contiguous with the tidal mudflat adjacent to the Marine Biology Study Area and Emory Cove. Pickleweed marsh was prevalent at the Marine Biology Study Area and along the base of several dikes within the Western Salt Works, especially where tidal inundation occurred. The 36 evaporation ponds of the Western Salt Works were in varying states of water level and salinity. Operational procedures used by the Western Salt Works are

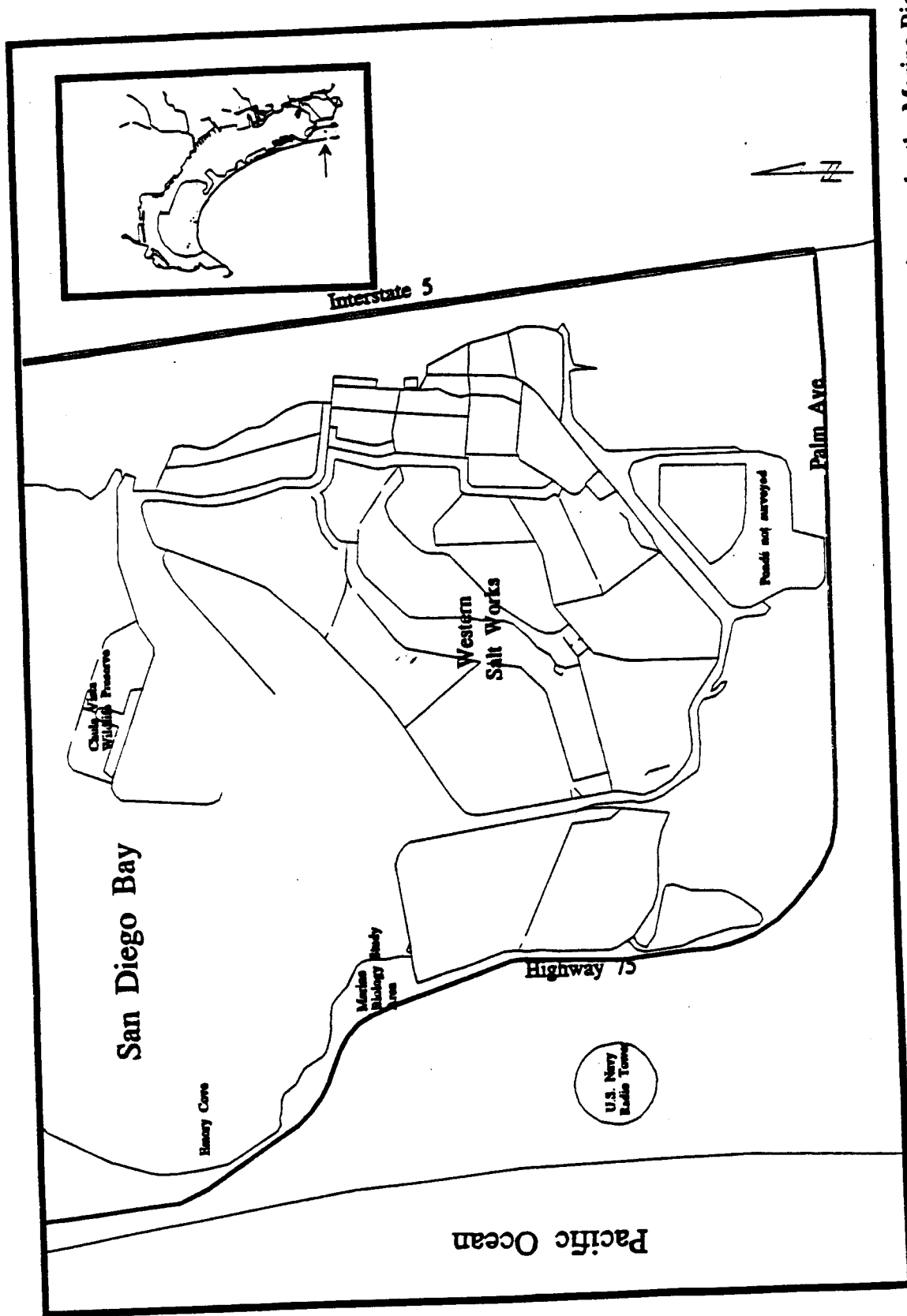


Figure 1. Areas surveyed within the south San Diego Bay included the Western Salt Works evaporation ponds, the Marine Biology Study Area, Emory Cove and adjacent mudflats.

provided in Appendix A while Figure 2 identifies the stage of individual ponds within the salt extraction process.

METHODS

The study area was divided into four survey routes. Each route was further divided into survey units or cells with a total of 44 cells encompassing the entire study area. The majority of these cells were defined by the salt evaporation ponds themselves although several ponds were subdivided for convenient counting (Figure 3). Arbitrary breaks utilizing stationary objects were used to define tidal areas along the Marine Biology Study Area and the mudflats adjacent to the Salt Works ponds. Biologist walked each survey route using binoculars and a spotting scope to identify species and count the number of individual birds per numbered cell. Birds located on dikes were entered into the nearest adjacent pond. Standardized data sheets were used to record these data as well as the survey date, time start and stop, estimated temperature and wind, and percent cloud cover. Tidal information was obtained using the computer program Tideline in which the minimum start time and maximum stop time of the four survey routes was used to indicate tidal condition during individual survey dates (Appendix B). Surveys focused primarily on water-associated species but raptors were also included as well as notations on the presence of sensitive species. A total of 52 surveys were conducted beginning on February 17, 1993 and ending February 9, 1994. Surveys were performed every Wednesday between 0700 and 1100 with the majority of the surveys being completed within three hours. Units 14 and 38 were censused simultaneously. Ponds 16 and 17 were not surveyed adequately during May, June, and July 1993 so as to avoid disturbing nesting black skimmers and several tern species. On July 21 and August 11, 1993 cells 39-43 were not surveyed because of insufficient staff. Area for individual survey units was calculated by digitizing a 7 minute USGS topographical map. For summary purposes, species were categorized into generalized groups or guilds which were defined by species having similar morphological or behavioral characteristics. Because the study area was delimited in both time and space and the constituent species enumerated and identified, species richness was used to provide a measure of species diversity (Magurran 1988).

SPECIES OVERVIEW

Over the course of the year-long investigation, 94 species were identified and a grand total of 522,553 birds recorded (Table 1, Figure 4). On average, 10049 birds were utilizing the study area per survey date which extrapolates into a yearly average of 3.7 million bird use days. Within the 7 groupings or guilds of birds present at the study site, shorebirds and waterfowl were the primary contributors to overall species diversity with 27 and 22 species represented respectively. The third largest contributor to overall species diversity was the gull/tern guild which was represented by ten gull species, seven tern species and the black skimmer. Although the grebes and loons were represented by only seven species, this group was the fourth largest in overall magnitude.

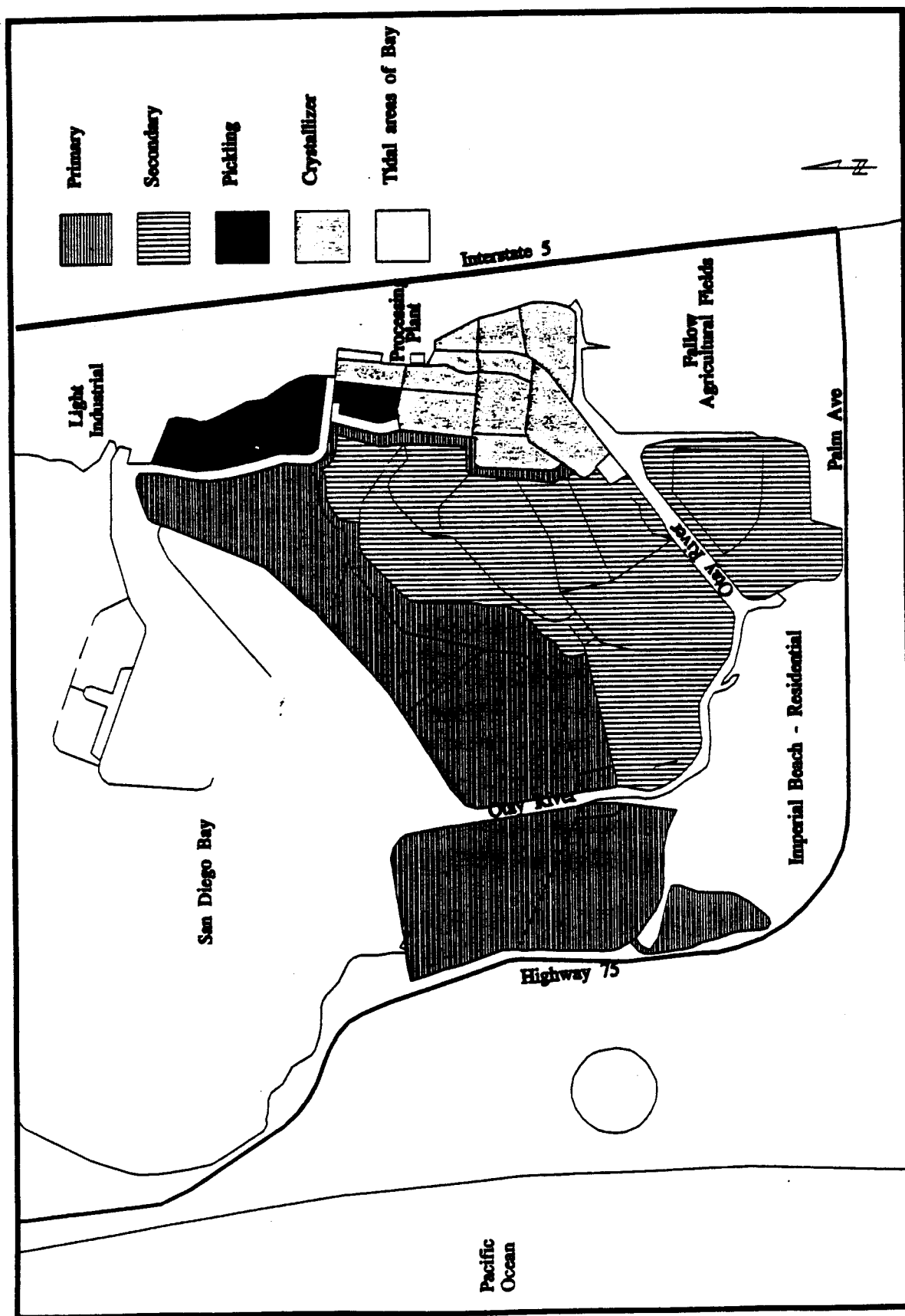


Figure 2. Stages of the salt extraction process for the Western Salt Works.

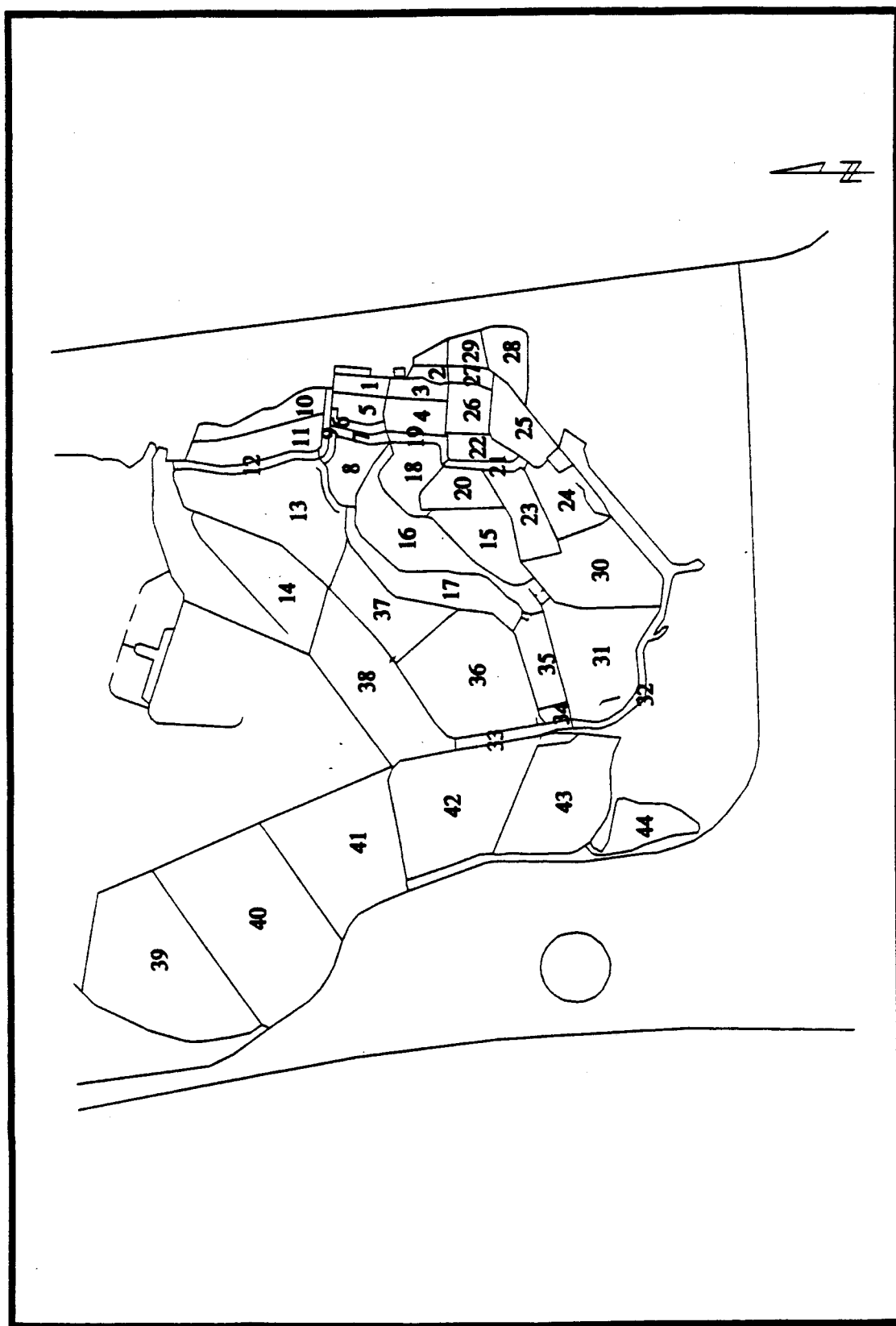


Figure 3. Numbered survey units within the study area.

Table 1. Summary of the total number of species and abundance for each guild within the study area.

	Number of Species	Total
Pelican/cormorant	3	15566
Grebe/loon	7	42975
Heron/egret	8	3253
Waterfowl	22	43126
Shorebird	27	366596
Gull/tern	18	50890
Raptor	9	147
Grand Total	94	522553

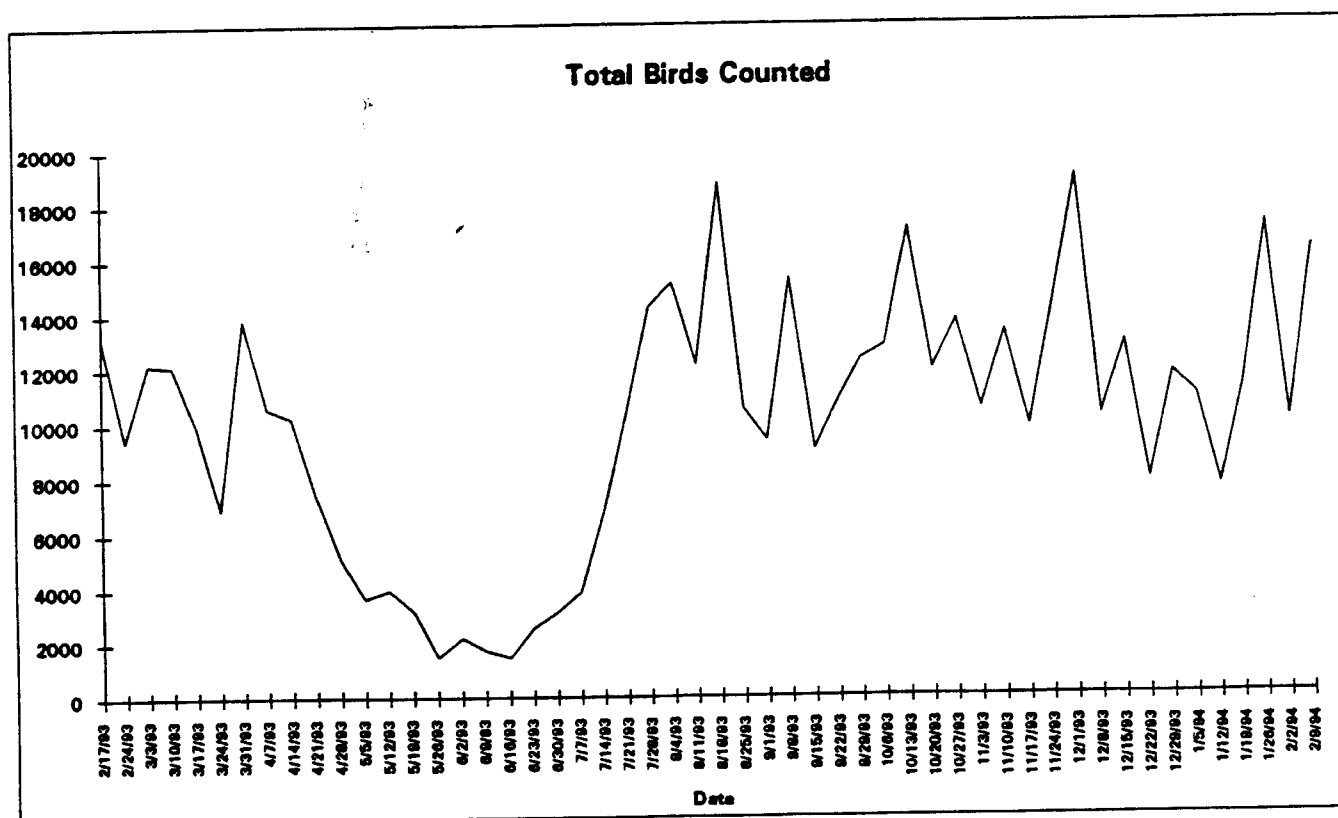


Figure 4. Number of birds counted on individual survey dates.

Total abundance for the entire study area peaked to nearly 19000 individuals in mid-August and again during early December. Both peaks are attributed to a substantial number of shorebirds most notably by the red-necked phalarope in August and western sandpiper in December. Although abundance was relatively lower during the summer months, the study area remains an important breeding ground for terns and several shorebird species.

Pelicans and Cormorants

Pelicans and cormorants comprised approximately 3% of the overall total individuals observed at the study area. Of the three species represented by this group, the double-crested cormorant was most abundant followed by the brown pelican. American white pelicans were also documented within the study area but were much less abundant than the other two constituents of this group. While the members of this guild were represented throughout the entire year, peak abundance occurred in mid-October and mid-November (Figure 5)

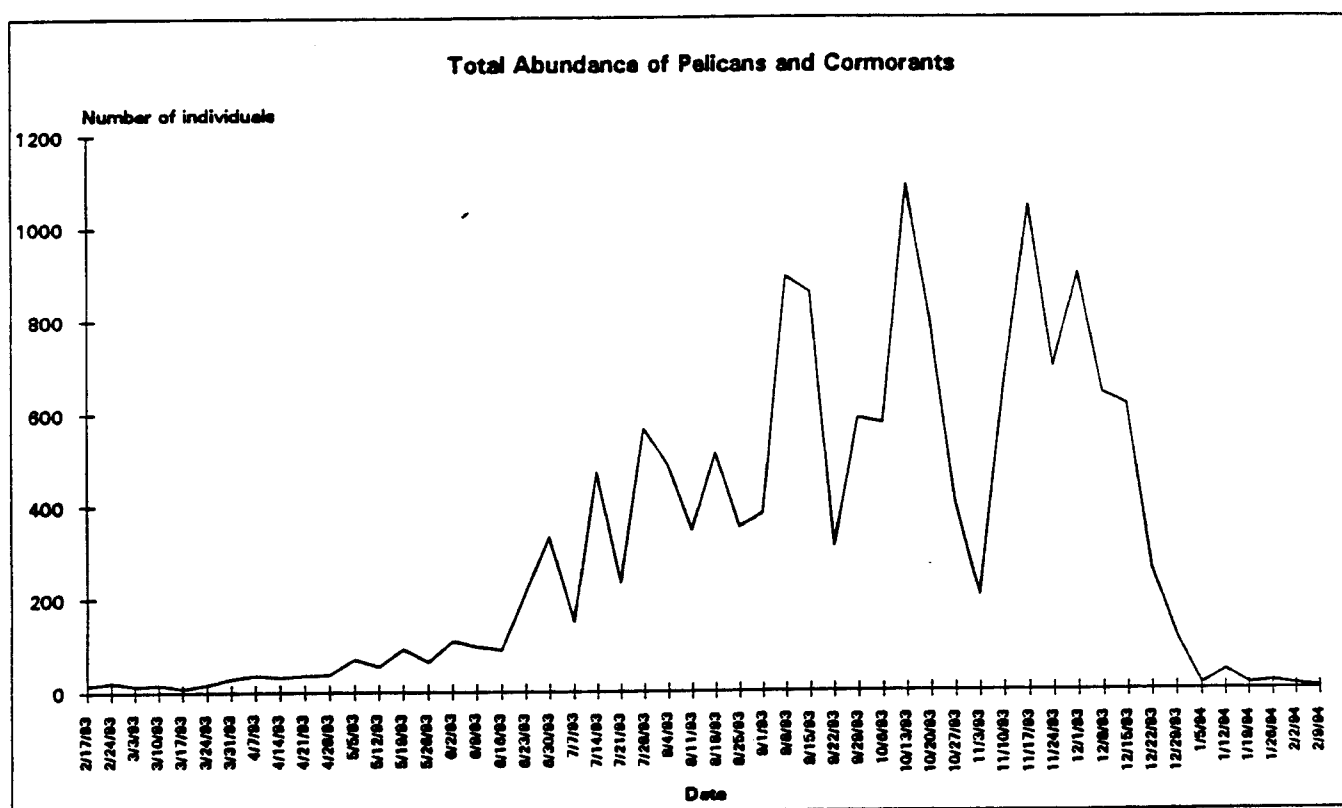


Figure 5. Total abundance of pelicans and cormorants for each survey date.

Grebes and Loons

Eight percent of the total individuals recorded belonged to this guild represented by 7 species (5 grebe and 2 loon). Of these, the eared grebe was most abundant. Eared grebes were often found within the Salt Works ponds and the number of individuals generally exceeded over a thousand for much of the fall and winter months. Western and Clark's grebes were also present in numbers as high as 173 and 73 respectively. Several visits by individual red-throated loons and a common loon were also documented. Seasonally, this group was nearly absent from the study site beginning in mid-May through mid-August (Figure 6).

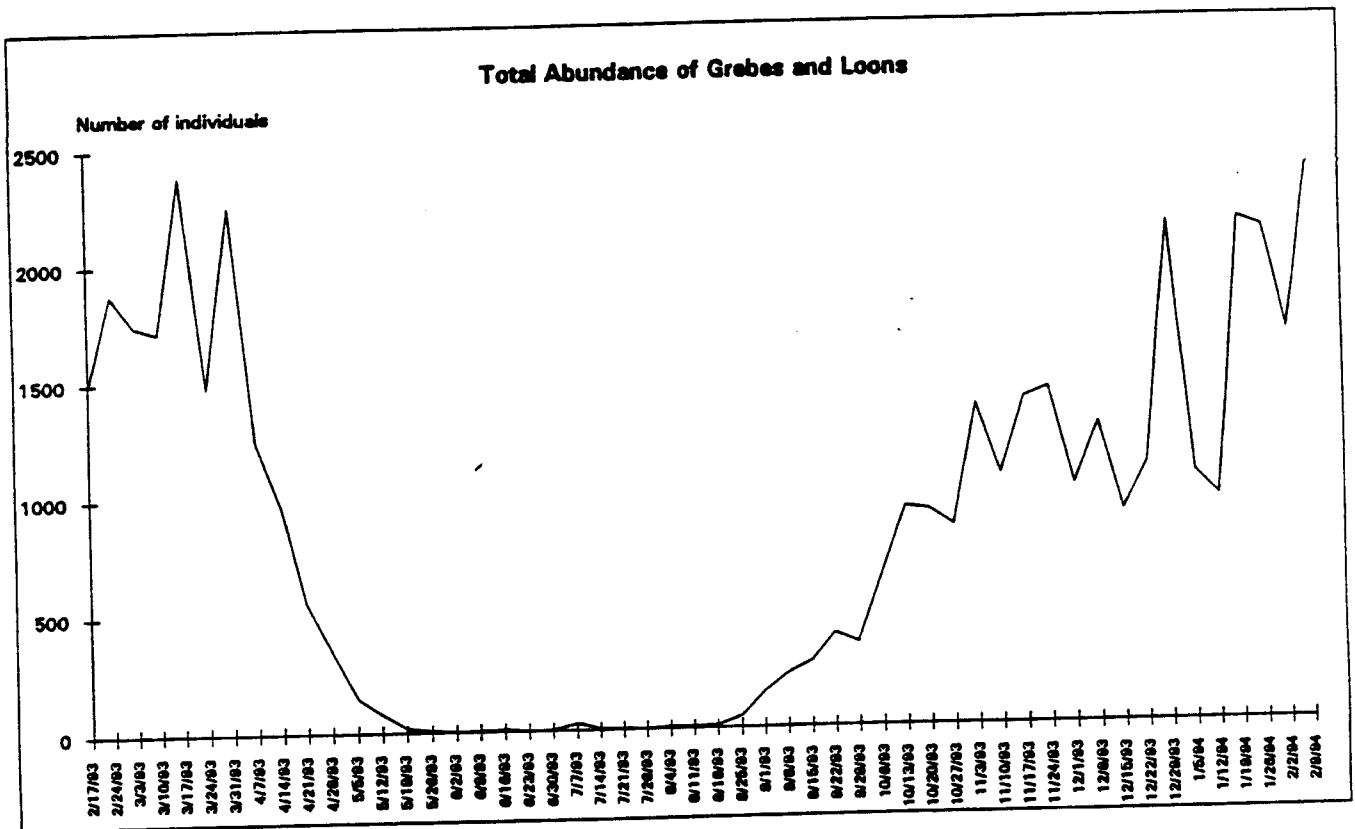


Figure 6. Total abundance of grebes and loons for each survey date.

Hérons and Egrets

Although this group contributed to less than one percent of the overall total abundance, herons and egrets were present at the study site throughout the year (Figure 7). Snowy egrets were most abundant relative to other members of this group followed by great egrets and blue herons. In addition, three species considered rare visitors to San Diego Bay were also

observed. An individual reddish egret was present at the study area from September to December while one to two little-blue herons were recorded during March through November. A single tricolored heron was observed in October 1993.

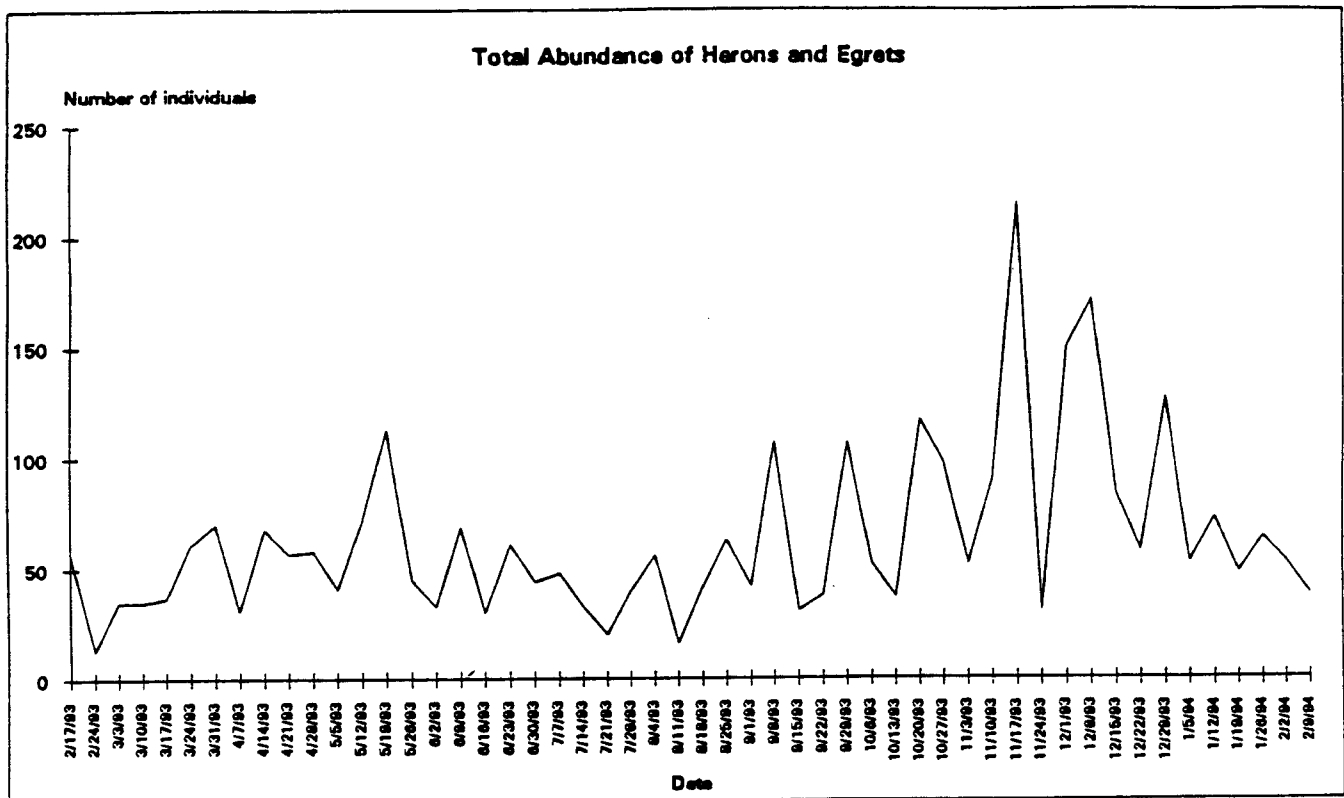


Figure 7. Total abundance of herons and egrets for each survey date.

Waterfowl

Waterfowl were represented by 22 species and comprised 8% of the overall total abundance. Seasonally, waterfowl were most abundant during the fall and winter months (Figure 8). In February 1993, the number of lesser scaup exceeded 4000 individuals during a single survey. High counts for bufflehead, American wigeon, ruddy ducks, and brant were 976, 456, 414, 319, respectively. Surf scoters were also prevalent exceeding 700 birds during a single observation period. Red-breasted mergansers were recorded during the winter months with a high count of 184 individuals occurring in December. Although the majority of waterfowl species were absent from the study area during the summer months, this group was represented at the study area by the mallard and gadwall during the breeding season.

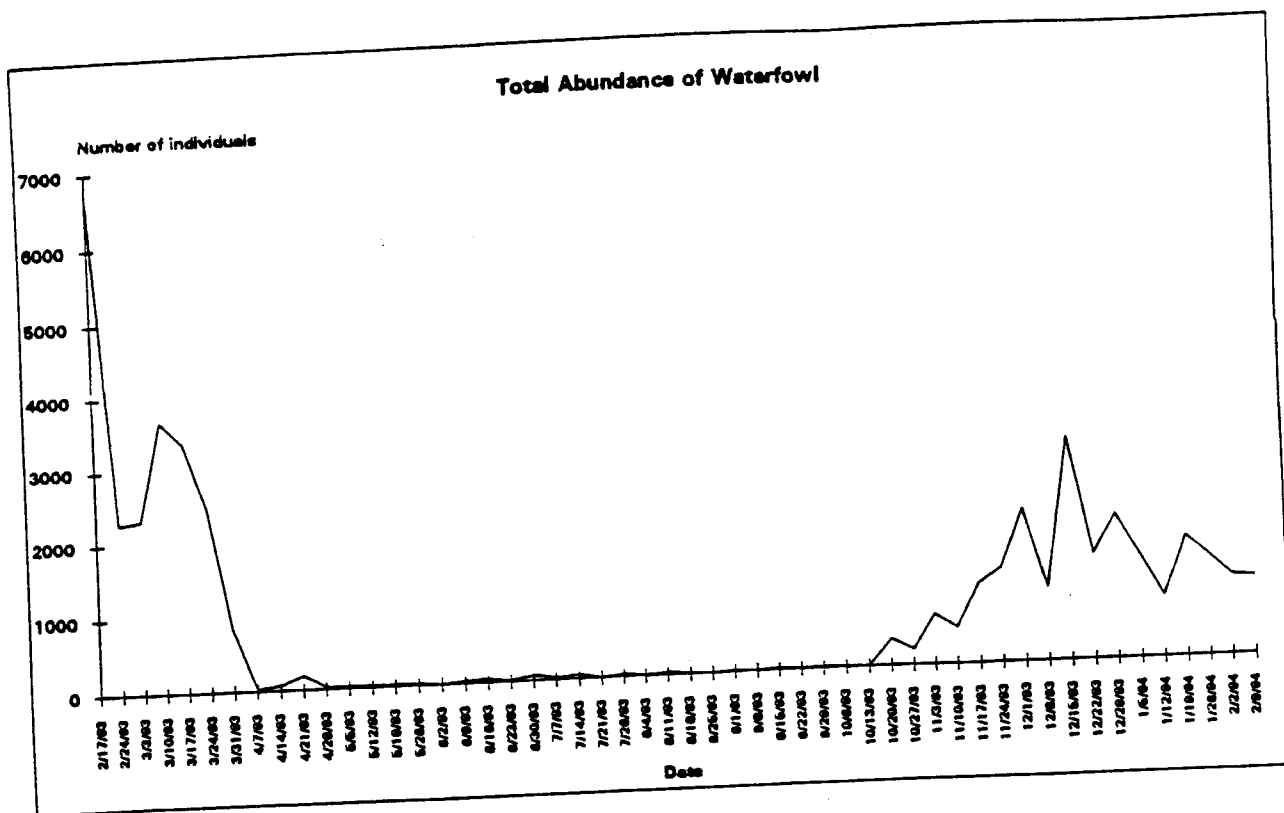


Figure 8. Total abundance of waterfowl for each survey date.

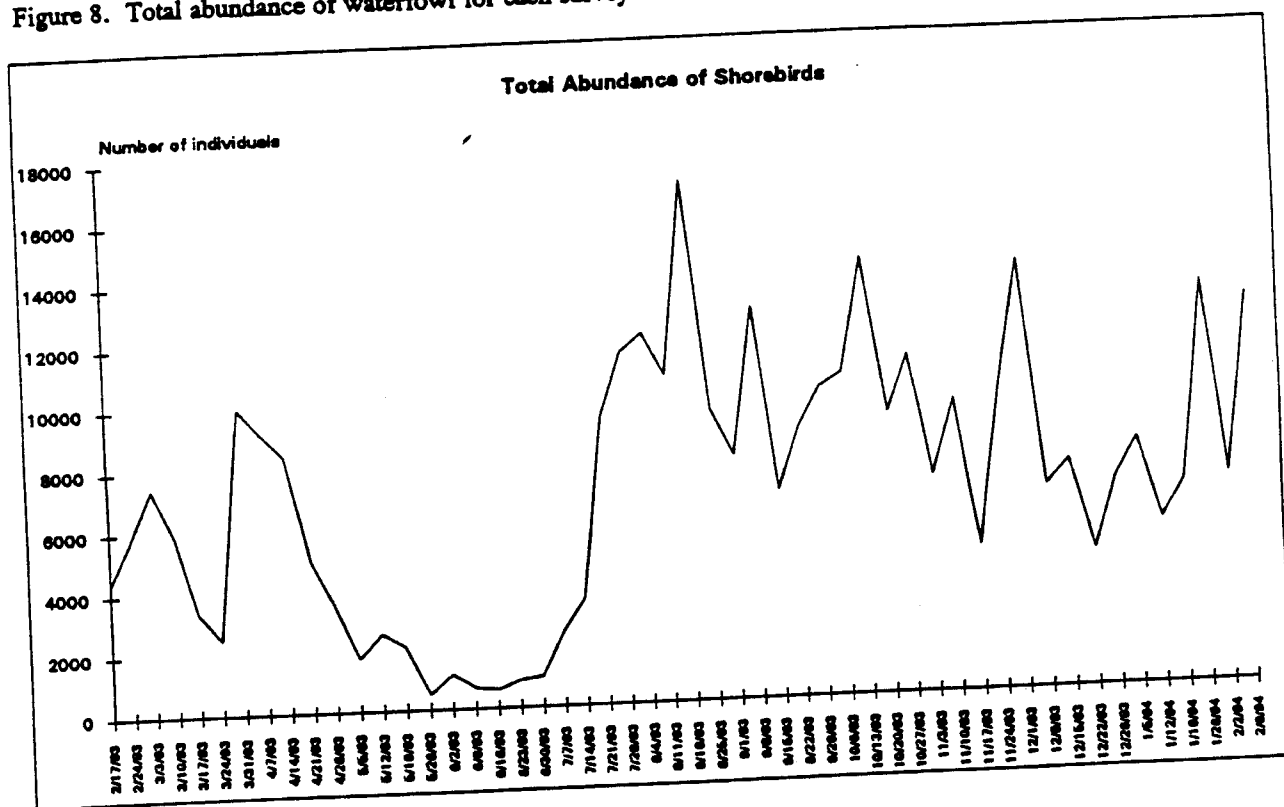


Figure 9. Total abundance of shorebirds for each survey date.

Shorebirds

Peak shorebird abundance occurred in August which coincides with the fall migratory period for these taxa (Figure 9). Twenty-seven species of shorebirds accounted for 70% of the overall total abundance with the red-necked phalarope and western sandpiper contributing significantly to this group's magnitude. Two species of phalaropes were present within the Salt Works ponds primarily during July, August, and September. Red-necked phalaropes numbered in the thousands and peaked at almost 11,000 birds during a single count in August. Wilson's phalaropes were much less common with a peak of 400 individuals in July. Of all the species encountered during this study, the western sandpiper was the most abundant with total individuals exceeding 112,000 over the course of the year long survey. Other shorebirds which occurred in high numbers included the willet (28,073 individuals), marbled godwit (32,099 individuals), dowitcher (14,655 individuals), black-bellied plover (17,295 individuals), and black-necked stilt (14,864 individuals). Uncommon shorebird species observed included surfbird, pectoral sandpiper, and Pacific golden plover.

Gulls and Terns

Terns and black skimmers were most abundant during the breeding season at which time they utilize the Salt Works dikes for nesting and the Bay and offshore waters for foraging (Figure 10). Tern species present at the study area outside the breeding season included the Caspian tern, Royal tern, and Forster's tern. Western gulls and ring-billed gulls were present throughout the seasons and frequently formed large roosts along the dikes of the Salt Works facility. California gulls, Heermann's gull and Bonaparte's gulls also utilized the study area for roosting and foraging. Several species considered uncommon or rare occurrences for San Diego Bay included black tern, Thayer's gull, Franklin's gull, glaucous-winged gull, and parasitic jaeger.

Raptors

Although raptors were not the focus of this investigation, their presence was noted since many of the birds of prey forage within the study area. An individual peregrine falcon, a Federally listed endangered species was observed during 12 of the 52 surveys. The majority of these observations occurred during February and March. Several raptors including the American kestrel, osprey, northern harrier, and red-tailed hawk were frequently sighted. Individual burrowing owls, short-eared owl, Cooper's hawk, merlin, and sharp-shinned hawk were also found within the Salt Works environs.

Sensitive Species

While censusing the study area, observations of listed species as well as species believed to be in decline were recorded. Three species listed as Federally endangered, the brown pelican, California least tern, and the peregrine falcon were recorded within the study area as well as

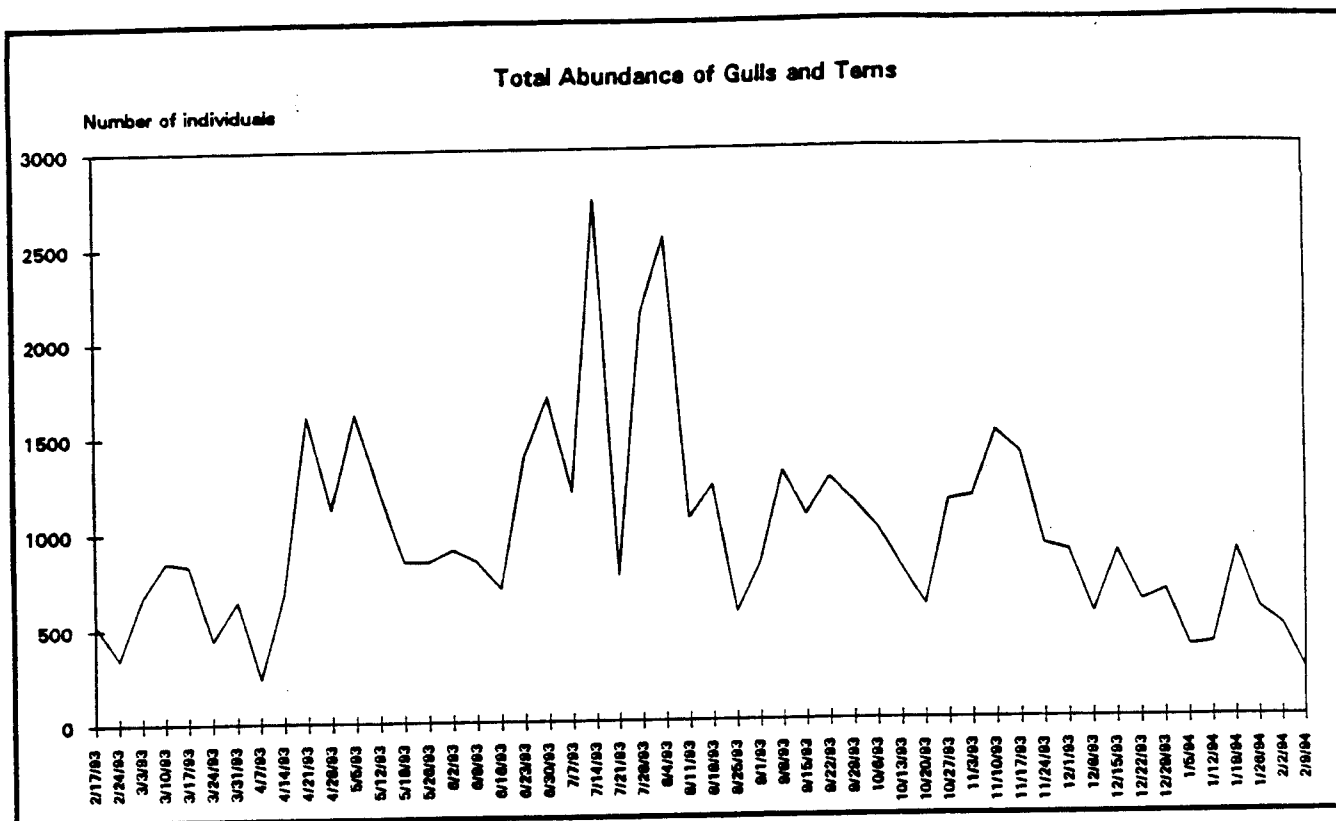


Figure 10. Total abundance for gulls and terns for each survey date.

the western snowy plover which is Federally listed as threatened. Numerous sensitive species were also documented as breeders including the California least tern, elegant tern, gull-billed tern, black skimmer, western snowy plover, double-crested cormorant, California horned lark, and Belding's savannah sparrow (Stadtlander 1994, this study). A summary of these sensitive species which were observed during this investigation and their current status is provided in Table 2.

INDIVIDUAL SPECIES PROFILES

Appendix C details the results of our year-long survey. A descriptive narrative accompanied by a pictorial presentation of individual species relative abundance, seasonal occurrence, and distribution within the study site is provided. For those species which were seen on only one occasion, only a descriptive annotation is presented. Reported high counts represent the total number of an individual species seen during a single survey throughout the study area. Terminology used to categorize seasonal occurrence of each species is as follows: breeder (confirmed as nesting within the study area), resident (species present during non-migratory periods), and transient/migrant (species enroute during migration). Seasonal graphs portray

Table 2. Summary of sensitive species documented within the study area.

SPECIES	FEDERAL STATUS	STATE STATUS
Brown Pelican	Endangered	Endangered
California Least Tern	Endangered	Endangered
Peregrine Falcon	Endangered	Endangered
Western Snowy Plover	Threatened	Species of Special Concern
Elegant Tern	Category 2 Candidate	Species of Special Concern
Black Tern	Category 2 Candidate	Species of Special Concern
Reddish Egret	Category 2 Candidate	Species of Special Concern
Belding's Savannah Sparrow	Category 2 Candidate	Endangered
Large-billed Savannah Sparrow	Category 2 Candidate	Species of Special Concern
California horned lark	Category 2 Candidate	Species of Special Concern
Gull-billed Tern	Recommended Cat. 2	Species of Special Concern
Burrowing Owl	Recommended Cat. 2	
Double-crested Cormorant		Species of Special Concern
Osprey		Species of Special Concern
Northern Harrier		Species of Special Concern
Sharp-shinned Hawk		Species of Special Concern
Cooper's Hawk		Species of Special Concern
Merlin		Species of Special Concern
Short-eared Owl		Species of Special Concern
Long-billed Curlew	Category 3 Candidate	Species of Special Concern
California Gull		Species of Special Concern
Black skimmer		Species of Special Concern
Common loon		Species of Special Concern

monthly averages with extension bars exhibiting the monthly high and low counts for the entire study area. Figures for distributional information represent individual species occurrence within a specific survey cell over the course of 52 surveys.

SUMMARY OF SURVEY UNITS

Of the 44 survey units, cell 31 had the highest total abundance. Two species, the red-necked phalarope and eared grebe, occurred in high concentrations which significantly contributed to the overall abundance of this secondary treatment pond. The only pickling pond considered to have a high abundance was cell 11 which not only was second in overall total abundance but had the highest number of individuals per hectare of all the survey units. Survey units 20 and 18 both secondary treatment ponds were second and third, respectively, in bird density.

Roosting shorebirds are responsible for the greater number of birds within these three locations. Due to tidal influence, water surface and exposed mudflat varied greatly during counts of the tidally influenced cells. Although survey unit 40 was third in highest total abundance, the majority of the tidal survey units were lower in density. Cells which had the least number of birds included most of the crystallizing ponds and three tidal channels. The low numbers in the crystallizing ponds is most likely attributed to extreme saline conditions and salt harvesting activities. Low abundance within three of the tidal areas (cells 6, 9, and 12) may be a result of the smaller linear size of these survey units and the arbitrary break made for survey purposes between cells 9 and 12 which were actually contiguous with one another. Species diversity was greatest within survey unit 38 and was followed by cells 14, 40, and 43. All of these survey units contained extensive tidal mudflats except for primary treatment pond 43 which, as a result of fluctuating water levels in the salt extraction process, had large areas of exposed mud. A depauperate avifauna was exhibited in all 10 crystallizer cells. Number of species, total individuals, survey unit size, density, and cell description relative to the salt extraction process is summarized for each numbered survey unit (Table 3). In addition, the total number of species found within individual survey units and the density of birds for each cell are displayed in Figures 11 and 12. Abundance for each survey unit by individual survey date is provided in Appendix D.

INDIVIDUAL SURVEY CELLS

Cell 1

A grand total of 426 individuals representing 10 species were recorded for this location. Only shorebirds and gulls were found within cell 1 which is a crystallizer pond for the salt extraction facility.

Cell 2

A total of 54 individuals were recorded over the entire year of surveys for cell 2. Species diversity was the lowest of all areas surveyed with only 3 species, the marbled godwit, American avocet, and killdeer, found within this location. The 37 individuals reported on October 27, 1993 were solely comprised of killdeer. Cell 2 is a harvesting pond and the extremely low number of individuals and species diversity is indicative of a sterile environment caused by extreme salinity.

Cell 3

A total of 42 individuals comprising 4 species was recorded for cell 3. The depauperate number of birds utilizing this location is most likely attributed to the high salinity of this crystallizer pond.

Cell 4

Birds were recorded within cell 4 on only six occasions. Four species of shorebirds, the western gull, and mallard were identified at this location. The infrequent use of this crystallizer pond is attributed to extreme saline conditions and salt harvesting activities

Table 3. Number of species, total individuals, size, and description of individual survey units.

UNIT	#SPECIES	TOTAL INDIV.	SIZE (ha.)	INDIV/HA	DESCRIPTION
1	10	426	3.3	129	Crystallizer
2	3	54	1.9	28	Crystallizer
3	4	42	3.6	12	Crystallizer
4	6	158	6.5	24	Crystallizer
5	25	4766	4.3	1108	Pickling
6	14	581	1.8	323	Secondary
7	28	3535	2.5	1414	Primary
8	34	8540	7.6	1124	Secondary
9	18	193	1.6	121	Tidal
10	26	3890	8.0	486	Pickling
11	39	46693	11.8	3957	Pickling
12	27	485	3.8	128	Tidal
13	57	23073	36.2	637	Primary
14	66	33016	48.2	685	Tidal
15	38	9626	13.7	703	Secondary
16	42	14241	23.5	606	Secondary
17	45	13383	16.8	797	Primary
18	39	19249	9.6	2005	Secondary
19	26	806	2.2	366	Primary
20	35	21416	8.5	2520	Secondary
21	21	304	2.2	138	Primary
22	12	145	5.0	29	Crystallizer
23	46	9953	10.8	922	Secondary
24	46	20451	11.9	1719	Secondary
25	14	131	10.2	13	Crystallizer
26	6	264	6.6	40	Crystallizer
27	13	270	2.5	108	Crystallizer
28	12	1379	7.9	175	Crystallizer
29	5	561	3.8	148	Crystallizer
30	54	44279	25.6	1730	Secondary
31	54	48025	29.2	1645	Secondary
32	44	2650	14.0	189	Tidal
33	56	5157	3.9	1322	Tidal
34	30	1242	1.5	828	Primary
35	40	4273	9.3	459	Primary
36	50	12998	39.2	332	Primary
37	51	23452	17.8	1318	Primary
38	67	18924	33.1	572	Tidal
39	51	12425	56.9	218	Tidal
40	63	37780	63.6	594	Tidal
41	57	14625	42.6	343	Tidal
42	54	16788	44.0	382	Primary
43	59	30999	32.2	963	Primary
44	57	11309	10.3	1098	Primary

SSM Vnet

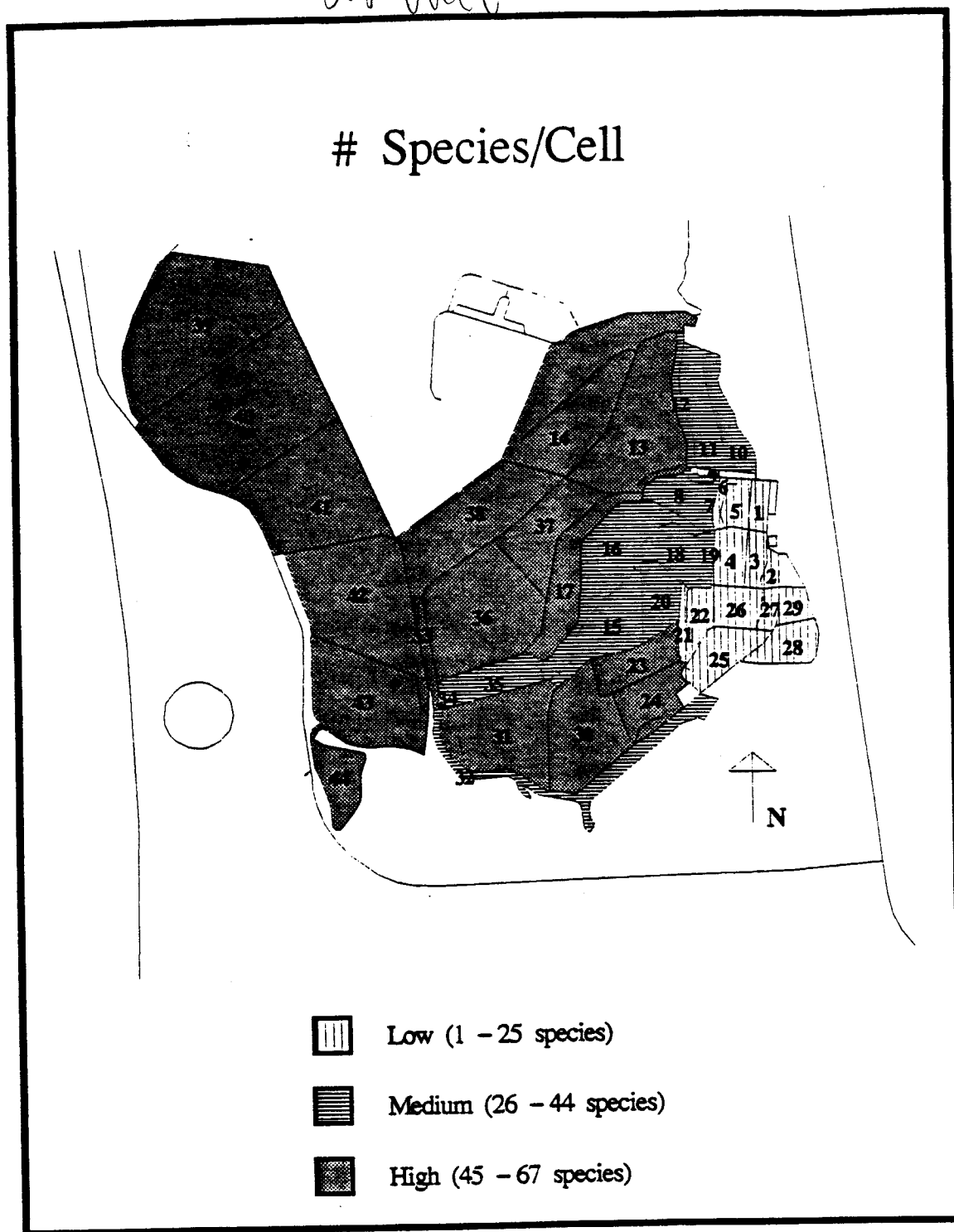


Figure 11. Total number of species found within individual survey units.

Bird Density

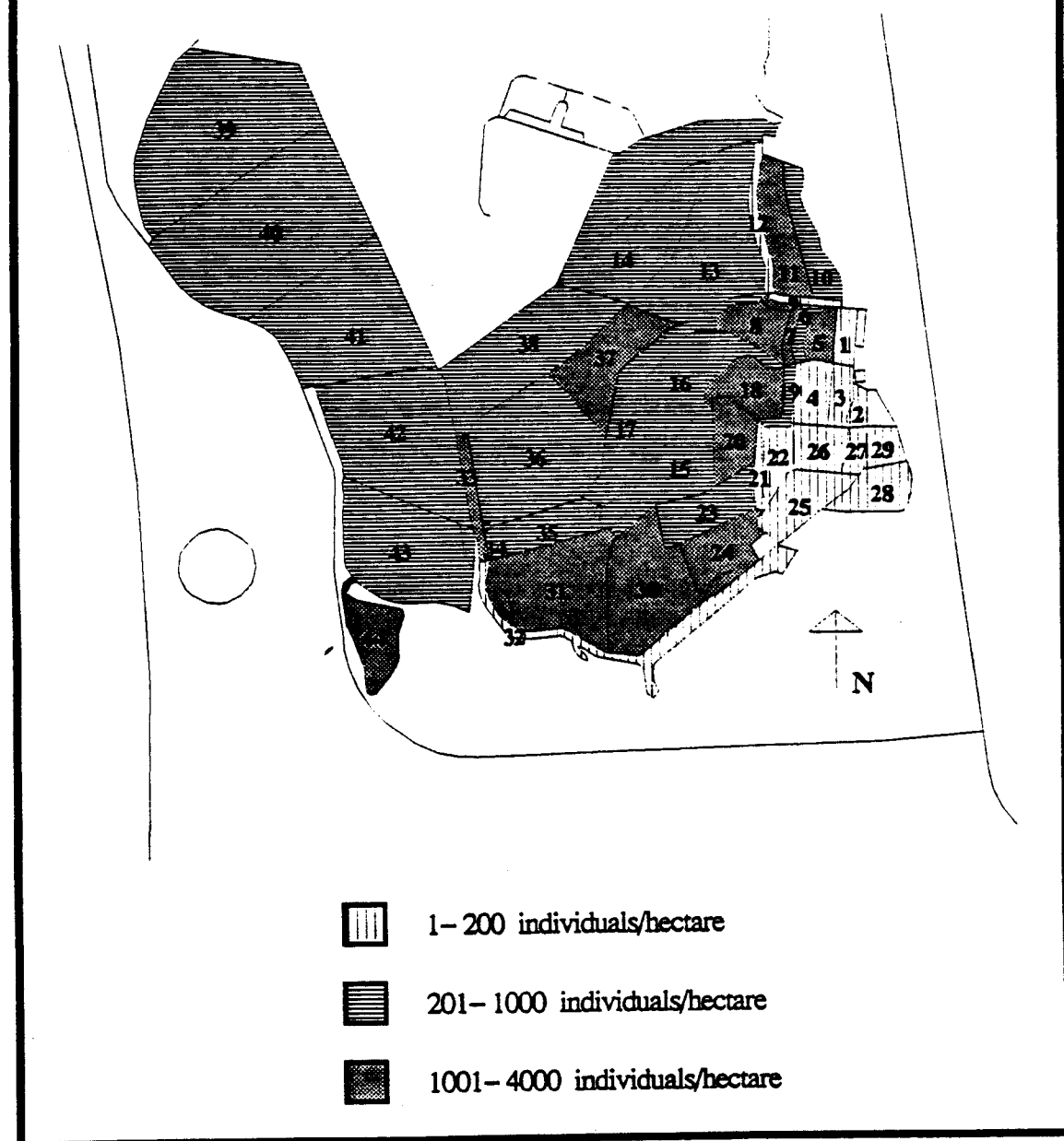


Figure 12. Density of birds observed within individual survey units.

Cell 5

The number of species and individuals appeared to have varied with the water level of this pickling pond. Most species utilized this cell as a loafing area, however, foraging activity by sandpipers was observed on occasion.

Cell 6

Fourteen species and 581 individuals were observed within this location over the entire study period. The small amount of area which encompassed this survey unit may have attributed to fewer species and total individuals detected.

Cell 7

A total of 3535 birds comprising 28 species was recorded within this survey unit. Shorebirds were most abundant, especially during late July through early November, followed by grebes which were most prevalent in mid-February and April.

Cell 8

Of the 34 species reported within this secondary treatment pond, the eared grebe was most abundant. Shorebirds and gull/tern comprised 35% and 5% of the total 8540 birds counted at this location.

Cell 9

Shorebirds were the most abundant species found within this narrow channel defined as survey cell 9. Lower species diversity and total abundance relative to other tidally influenced survey locations was most likely attributed to the physical size of this area as well as the dense (*Salicornia* spp.) vegetation which predominated the channel.

Cell 10

The shorebirds and gulls reported within this survey location were most often seen loafing on the dike separating cell 10 and 11. In general, the use of this area appeared to be determined by tide i.e. if mudflat was not available at tidally influenced areas more birds were reported loafing within cell 10. It is also interesting to note the lack of birds observed within the pond itself especially towards the southern edge which adjoins urban development.

Cell 11

Of the 3 pickling ponds (cells 5, 10, and 11), cell 11 had the highest species diversity with 39 species observed. Total abundance was also greater with 46,693 individuals recorded. Shorebirds occurred most often and in greater numbers during August through November. Similar to cell 10, the majority of birds appeared to utilize this location as a roosting site when mudflats at tidal areas were inundated. This would account for the high density of birds found within this survey unit. Foraging activity by shorebirds was also observed at this location and appeared to be related to fluctuating water levels controlled by the salt evaporation process.

Cell 12

Water from the bay directly enters this channel which is contiguous with survey cell 9. A total of 480 individuals comprising 24 species was recorded. Herons and egrets were often seen foraging within this location.

Cell 13

Among survey locations, cell 13 ranked 5th for the highest number of species encountered (57 species) and 8th for total abundance (23073 individuals). The seasonal abundance of shorebirds during June and July is attributed to the large number of red-necked phalaropes which utilized this location. Cell 13 is a primary pond in the salt extraction process and while water levels fluctuated by way of exposed shoreline, this cell always contained water.

Cell 14

Cell 14 ranked 2nd for the greatest species diversity (66 species) and 5th for overall total abundance (33016 individuals). This survey location contained a narrow band of Salicornia spp. marsh adjacent to the Salt Works dike and extensive mudflat where the majority of birds were located within this survey unit. As would be expected, the number of mudflat foragers or open water users present depended on tidal conditions. Cell 14 also contained a breakwater spit where birds roosted including pelicans, terns and gulls, as well as shorebirds.

Cell 15

Species diversity (38 species) and total abundance (9613 individuals) was moderate relative to other survey areas. Water levels of this secondary salt processing cell fluctuated as indicated by the two most commonly occurring groups of birds, the grebes and shorebirds.

Cell 16

A total of 14241 individuals comprising 42 species were recorded within this location. As with the other secondary ponds, the water levels of this pond fluctuated as a result of the salt extraction process. Although species diversity was high, total abundance was moderate relative to the other survey areas especially when considering the larger physical size of this cell.

Cell 17

Species diversity was high (45 species) and total abundance moderate (13383 individuals) relative to other survey areas. The large number of roosting shorebirds present on 26 January 1994 contributed significantly to the overall abundance of this location. Nesting terns and black skimmers along the dikes of this cell comprised the majority of the gull/tern group during June and July.

Cell 18

A total of 19248 individuals comprising 39 species were recorded for cell 18. The majority of birds within this location were shorebirds followed by gull/terns and pelican/cormorants. Cell 18 is a secondary salt treatment cell and was subjected to various water levels controlled

during the salt extraction process.

Cell 19

Cell 19 is a narrow channel of the secondary treatment process for salt extraction. Total abundance was low (806 individuals) and species diversity moderate (26 species).

Cell 20

Species diversity was moderate (35 species) and total abundance high (21415 individuals) for this secondary salt treatment cell in which water levels were controlled by the salt extraction process.

Cell 21

Both species diversity (21) and total abundance (304) were low relative to other areas surveyed. This survey location was contiguous with cell 19 yet exhibited lower numbers of shorebirds and gull/terns although the number of grebes and waterfowl were comparable.

Cell 22

Cell 22 is a crystallizer pond where salt is harvested. The low number of species (12) and individuals (145) encountered within this survey unit is attributed to extreme saline conditions.

Cell 23

Within cell 23, species diversity was high (23 species) and total abundance moderate (9953 individuals). Shorebirds comprised 82% of the total individuals recorded followed by grebes (8%) and waterfowl (7%).

Cell 24

Both species diversity (46 species) and total abundance (20451 individuals) were high for this secondary salt treatment cell. Water levels were dictated by the salt extraction process. When water levels were low, exposing land masses within the cell, shorebirds and gulls were observed roosting within this area. Shorebirds also were observed foraging at this location.

Cell 25

As with all the crystallizing ponds of the salt extraction process, the species diversity (14 species) and total abundance (127 individuals) was low. The 60 individuals reported on March 3, 1993 were all American avocets. Many of the crystallizing ponds including cell 25 were used by roosting gulls.

Cell 26

The low species diversity (6 species) and total abundance (264 individuals) within cell 26 is attributed to the extreme saline conditions and harvesting activities of this crystallizing cell. The number of roosting shorebirds present on February 24, 1993 was most likely attributed to high tide conditions.

Cell 27

Both species diversity (13 species) and total abundance (270 individuals) was low within this crystallizing cell.

Cell 28

Total abundance was moderate (1379 individuals) while species diversity was low within this crystallizing cell. Shorebirds comprised almost 75% of the birds observed while gulls, represented on one occasion, constituted the other 25%.

Cell 29

Both total abundance (561 individuals) and species diversity (5 species) was low within this crystallizing cell. Shorebirds comprised 100% of the birds observed at this location.

Cell 30

Cell 30 had the third highest total abundance (44279 individuals) as well as a high species diversity (54 species). Water levels fluctuated within this secondary treatment pond varying the amount of land exposure. Shorebirds and grebes together comprised 95% of the birds utilizing this location. Roosting and foraging activity by shorebirds and grebes was noted.

Cell 31

Of all the survey areas, cell 31 had the highest total abundance (48025 individuals) and a high species diversity (54 species). Several species are responsible for the high abundance including the red-necked phalarope and eared grebe which, when present at the Salt Works, were highly concentrated. For example on July 24, 1993, the pond was noted as full and the number of red-necked phalaropes exceeded 3000 individuals significantly contributing to the overall abundance of shorebirds for that particular day. The dikes surrounding cell 31 and the spit located within the pond was a favorite roosting spot for gulls, terns, and shorebirds. Longer legged shorebirds such as the marbled godwit and black-necked stilt were often seen foraging within this survey unit.

Cell 32

Both species diversity (44 species) and total abundance (2650 individuals) were moderate. This linear survey unit partially encompasses the Otay River and is tidally influenced. Salicornia spp. and Spartina spp. line the channel while mudflat exposure is dependent on tidal conditions. Cell 32 was used primarily as a foraging area for a majority of species especially the herons and egrets.

Cell 33

This survey unit, an extension of cell 32, was high in species diversity (56 species) and moderate in total abundance (5157 individuals). Cell 33 was used primarily as a foraging area for most species.

Cell 34

Physically, cell 34 was the smallest survey unit (1.5 ha.) yet species diversity (30 species) and total abundance (1242 individuals) were moderate. Nesting black skimmers and Forster's terns on the dikes within this location were the sole contributors to the gull/tern abundance during April and May. Herons and egrets utilized this area for roosting and foraging. In general, water was present within this survey unit for the entire survey period.

Cell 35

Cell 35 is contiguous with survey cell 17. Both species diversity (40 species) and total abundance (4273 individuals) were moderate for this primary treatment area. The most significant contributor to overall abundance was from the gull/tern group which comprised 78% of the individuals recorded within this location. Of this group, the elegant tern is responsible for the high bird numbers during late July and early August when this general area was used as a roosting site for adults and fledglings.

Cell 36

Species diversity was high (50 species) and total abundance moderate (12998 individuals) for this survey unit. Water levels did not appear to fluctuate greatly within this primary treatment pond which for the most part remained full during the survey period. Both the pelican/cormorant and gull/tern groups contributed significantly to the overall abundance. Double-crested cormorants nested on the abandoned barge within the pond and they, along with brown pelicans, roosted on the dike separating cells 36 and 37. Several species of terns which nested heavily along the surrounding dikes also contributed to the overall abundance of cell 36. Herons and egrets were most often found within this location foraging at the water's edge or roosting along the dikes. Foraging by tern's, pelicans, and cormorants was also noted within this location.

Cell 37

Although water level changes were noticed by the amount of exposed shoreline, this survey cell was generally full during the survey period. Cell 37 was both high in species diversity (51 species) and total abundance (23452 individuals). As with cell 36, roosting pelicans and cormorants were present on the surrounding dikes as well as nesting terns. The higher number of shorebirds present during July and August is a result of the high concentration of phalaropes. Waterfowl including bufflehead, American wigeon, and ruddy ducks were present during February to mid-March 1993 as well as a large number of red-breasted merganser (82 individuals) appearing in early December.

Cell 38

Cell 38 had the highest species diversity (67 species) of all survey units and was twelfth in total abundance (18924 individuals). Shorebirds and waterfowl contributed 76% and 14% respectively to the overall abundance. Cell 38 was used as a foraging and roosting area for most species depending on tidal conditions. During periods of low tide, shorebirds foraged extensively on the exposed mudflat while egrets, herons, and terns foraged in shallow pools

left by receding water.

Cell 39

Species diversity (51 species) was high and total abundance (12425 individuals) moderate within this tidally influenced survey unit. As with other tidally influenced survey areas, foraging by shorebirds was extensive during periods of mudflat exposure. Surf scooters, scaup, and brant comprised the majority of waterfowl present at this location. The greater number of gull/terns during late March is a result of elegant terns staging and courting on the mudflat.

Cell 40

Cell 40 was the third highest in species diversity (63 species) and fourth in overall total abundance (37780 individuals). Both tidal mudflat and pickleweed marsh were available within this survey unit. The most abundant group of birds was the shorebirds which foraged on the mudflats and, to some extent, took refuge in the pickleweed during high tide conditions. Waterfowl (mostly surf scoter, scaup, and brant) were present in high abundance during mid-February 1993, then again in late fall 1993, and early winter 1994.

Cell 41

This tidally influenced survey location was high in both species diversity (57 species) and total abundance (14625 individuals). Waterfowl which comprised 50% of the number of individuals peaked at this location during February and March of 1993. Shorebirds were the next prominent group and, as would be expected, their presence at this location was determined by tidal fluctuation.

Cell 42

Species diversity (54 species) and total abundance (16788 individuals) were both high at this primary treatment pond. Waterfowl were the most abundant group comprising 74% of the individuals recorded at this location. Both peaks in waterfowl numbers were attributed to large rafts of lesser scaup. Foraging activity was noted for herons and egrets as well as terns. The dikes surrounding this cell were used by roosting gulls, pelicans, and cormorants.

Cell 43

This survey cell had the fourth highest species diversity (59 species) and was sixth for overall abundance (30999 individuals). Water fluctuations were more noticeable within this primary treatment pond and, at times, exposed land masses were present towards its southern end. These exposed areas were used by shorebirds for foraging and roosting. Herons, egrets, and terns were also often observed foraging in cell 43 while pelicans, cormorants, and gulls loafed on the surrounding dikes.

Cell 44

While total abundance (11309 individuals) was moderate, species diversity (57 species) was high for this primary treatment cell. Shorebirds comprised 70% of the total individuals with the gull/tern and waterfowl groups constituting 14% and 10% respectively. Cell 44 was

utilized as a foraging and roosting site for most species. The peak number of shorebirds roosting at this location during the February 9, 1994 survey was most likely attributed to extreme high tide conditions.

CONCLUDING REMARKS

In light of the loss of 70% of the coastal wetlands in California, areas such as San Diego Bay play a more substantial role in providing foraging and resting areas for wetland dependent species. The high species diversity within the southern portion of the Bay can be attributed to the varied habitats which still exist (i.e. open water, tidal mudflat, and salt marsh) and its location on the Pacific Flyway. The Bay is situated such that it is the northern range for a number of tropical species and is the southern extreme of many temperate species. On a more local level, the Bay supports a high abundance of birds. In 1988, a partial count of the salt ponds held 44.5% of the total shorebirds found within San Diego County during spring surveys (Warnock et al. 1989). Again the variety of habitats as well as the near absence of human disturbance contributes to the success of this area as a feeding/resting location.

During this investigation, south San Diego Bay provided feeding and resting areas for thousands of migratory birds. The extensive mudflat which exists in the southern portion of the Bay provides foraging habitat for a multitude of species. Western sandpipers, dunlin, marbled godwits, and willets are just a few of the species which utilize the mudflats for foraging. Although the crystallizing ponds of the Salt Works had a depauperate avifauna, many of the primary and secondary ponds provide foraging areas for such species as the red-necked phalarope and black-necked stilt. Eared grebes, the lesser scaup and other waterfowl utilize the open water habitat within the primary and secondary treated ponds of the Salt Works as well as the Bay itself during their migration between breeding and wintering grounds. While the dikes of the Western Salt Works are man made they provide relatively secluded nesting habitat for thousands of breeding terns and black skimmers as well as the western snowy plover, black-necked stilt, and American avocet. In addition, the dikes and half drained ponds of the Western Salt Works are used as loafing areas especially during high tide cycles.

With increased demand for naval facility expansion, recreational purposes, and waterfront development, conservation efforts will be needed to preserve the natural resources of San Diego Bay. The Bay's value to wildlife can only be maintained if the integrity of existing habitats remain intact. This can be accomplished by providing protection through proper land stewardship, planning future enhancement goals to increase the wildlife values of the Bay, and by cooperation among Federal, State and local agencies as well as other stakeholders to resolve potential land use conflicts.

ACKNOWLEDGMENTS

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APPENDIX A

SUMMARY OF WESTERN SALT OPERATIONS

Western Salt is situated in the extreme south end of San Diego Bay, on the west side of the City of Chula Vista. Approximately 12 kilometers south of the City of San Diego and two kilometers north of the City of Imperial Beach, the approximate center of Western Salt is 32 degrees and 36 minutes north latitude and 117 degrees and seven minutes west longitude.

The process of extracting industrial salt from seawater began in San Diego Bay immediately following the Civil War and continued until the facilities were destroyed by floodwater when the Otay Dam broke in 1916. Henry G. Fenton purchased the property and plant in 1922 and immediately put the plant back into operation and expanded its capacity.

The current salt extraction operation comprises approximately 1450 acres. Of this total, Western Salt owns 850 acres and leases an additional 600 acres from the California State Lands Commission. Total water surface area of the operation is approximately 1100 acres. Surface area of dike tops, roads, buildings, and work areas is 350 acres. The plant is comprised of network of earthen dikes, constructed from dredged sediment, which form a series of evaporation ponds. The approximately 36 evaporation ponds (Figure 2) are in varying states of water level and salinity. Intertidal mudflat of San Diego Bay borders the northernmost perimeter of salt pond dikes including approximately 306 acres of intertidal mudflats, 17 acres of eelgrass, and 31 acres of saltmarsh.

The evaporation ponds at Western Salt are divided into four categories (Figure 3) based on specific gravity (D), defined as the ratio of the mass of a sample of seawater to the mass of an equal volume of pure water. In San Diego Bay the average density of seawater has a D of approximately 1.025 (converted to three Baume on a hydrometer scale). Primary ponds have the lowest D ranging from three to six Baume and comprise approximately 530 acres of the operation. Depth of primary ponds are approximately three feet at center. Secondary ponds have the next highest D ranging from six to 16 Baume and cover approximately 308 acres. Secondary ponds are two to five feet deep at center. Pickling ponds encompass approximately 60 acres and have a specific gravity between 16 and 25.5 Baume. The highest specific gravity, ranging from between 25.5 and 29.5 Baume are located in the approximately 127 acres of crystallizer ponds. The length of the evaporation process is approximately 12 to 18 months depending on rainfall. Each crystallizing pond is harvested once per year.

Seawater is introduced into the primary pond system through tide gates located between the Otay River and pond 43. These gates are pressure regulated, opening and allowing intake of seawater when the tidal level in the river is higher than the pond level. As the tidal level in the river lowers, the water pressure on the pond side closes the gates. Seawater is transported from pond 42 to pond 36, under the Otay River by a 30 inch siphon pipe. The seawater then moves by gravity through each of the ponds in the primary system, reaching the end of the primary channel in pond 21.

Specific gravity of the developing brine increases in the secondary ponds and the seawater is mechanically transferred into pond 24 of the secondary system by a pump. Unlike the primary system, each pond in the secondary system is separated by a system of flumes and gates. Brine is moved through the secondary ponds by manually opening the gates, allowing the brine to move forward into the next pond in the series. Calcium sulfate, the smallest component by weight and the least soluble of the salts in seawater will begin to precipitate out in the secondary system. The brine solution continues to evaporate and reaches saturation with respect to sodium chloride (NaCl) at the end of the secondary process. A saturated NaCl solution at this point is approximately 10% of the volume originally introduced into the system.

Brine is mechanically pumped from pond eight in the secondary system to pond 11 in the pickling system. Specific gravity continues to increase and the brine is eventually pumped into ponds one and four of the crystallizer system. Each crystallizing pond is filled to a depth of approximately eight to 10 inches. At this point one cubic foot of brine has required the intake of approximately 9.6 cubic feet of seawater in the primary system. The brine has a specific gravity of 1.2 and NaCl has precipitated out and forms crystals that cover the crystallizing ponds.

When it is determined the NaCl product of a crystallizing pond is to be harvested, it is first drained of all unsaturated brine. At this point the product is 99.5% NaCl. The salt crystals are broken up and manipulated into piles by a frontend loader. The salt piles are loaded into tractor drawn dump trucks and the salt is delivered to the washer complex where it is washed and rinsed. Excess rinse water is transferred by pipe and discarded into pond eight. The NaCl product is then moved by conveyor belt to a stockpile where it is allowed to air dry and cure. From the stockpile, the salt is transferred to the mill, where it is sized and stored in silos. The product is bagged or shipped in bulk as needed to commercial and industrial users in southern California and other areas in the United States.

In addition to producing commercial grade NaCl, the Western Salt ponds also serve as habitat for a commercial brine shrimp operation. Brine shrimp production is limited to the secondary system due to salinity requirements of the shrimp. Shrimp eggs hatch in pond 30 beginning in mid-May. Mature brine shrimp are collected in ponds 15, 16, 17, 18, 20, and 31 through mid- December.

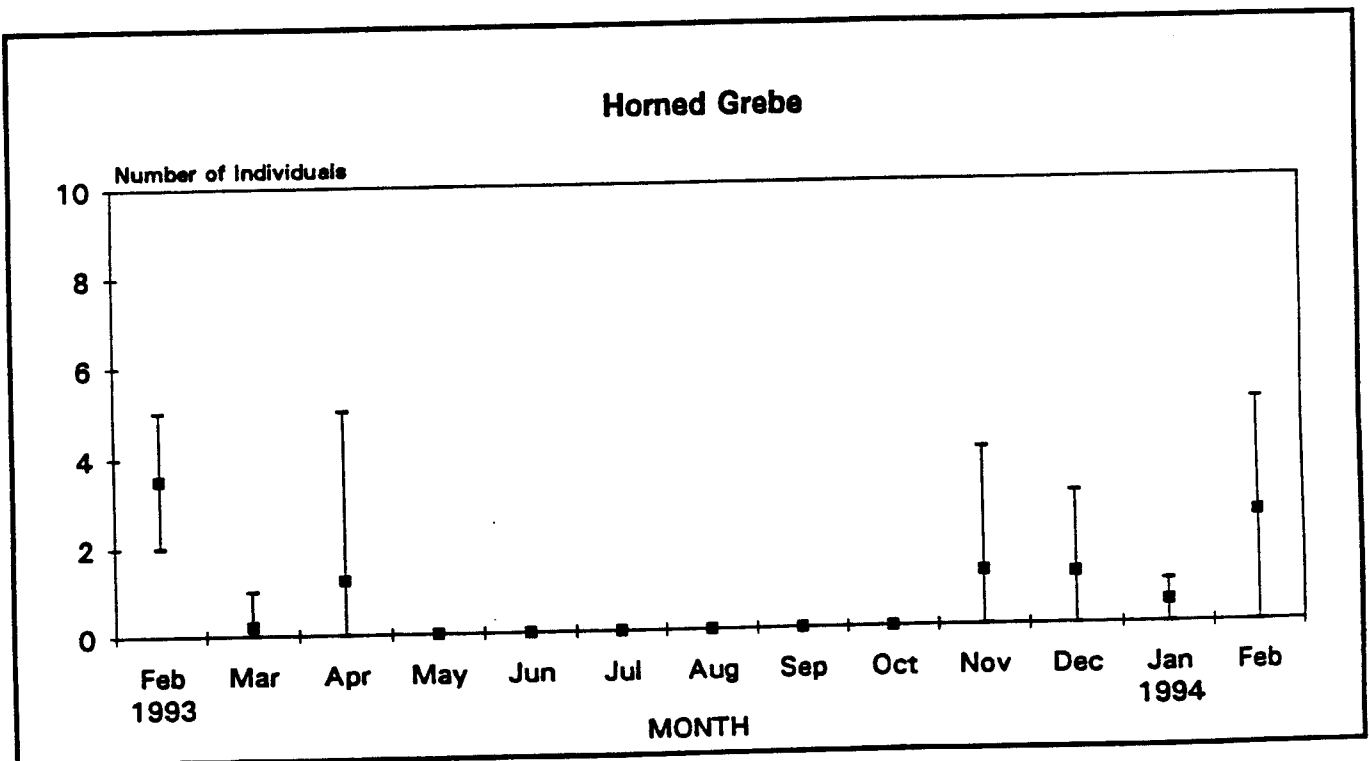
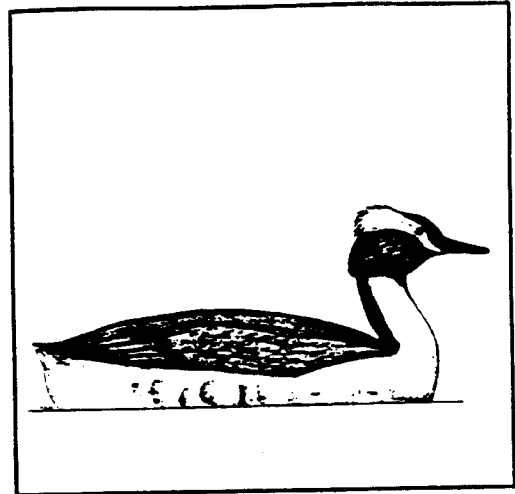
APPENDIX B

Appendix B. Date, time, and tidal conditions of individual survey periods.

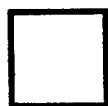
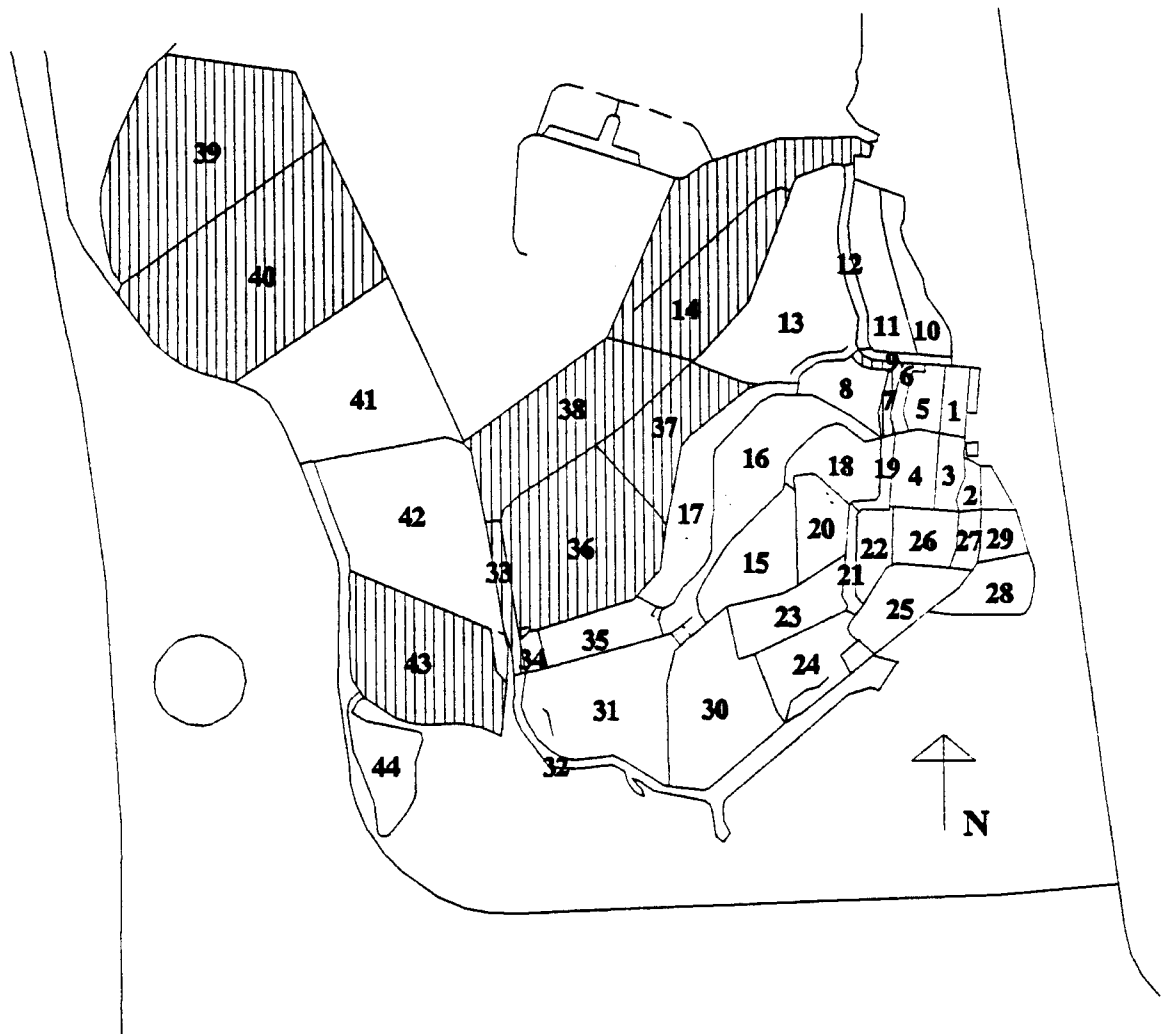
DATE	TIME START	TIME STOP	TIDE START	TIDE STOP	EBB/FLOW
2/17/93	0730	1144	6.0	0.75	EBB
2/24/93	0730	1130	2.75	4.75	CREST 4.8 AT 1029
3/3/93	0715	1100	4.2	0.2	EBB
3/10/93	0730	1100	2.25	5.25	CREST 5.4 AT 1040
3/17/93	0730	1100	4.4	0.75	EBB
3/24/93	0730	1050	3.1	4.4	CREST 4.8 AT 0948
3/31/93	0725	1045	2.0	0.1	LOW 0.2 AT 1038
4/7/93	0740	1050	1.75	5.3	CREST 5.3 AT 1047
4/14/93	0715	1050	3.25	0.5	EBB
4/21/93	0725	1120	2.5	4.0	CREST 5.3 AT 1009
4/28/93	0645	1000	1.5	0.0	LOW 0.1 AT 0937
5/5/93	0730	1040	2.8	4.8	CREST 4.9 AT 0957
5/12/93	0715	0920	1.5	0.6	EBB
5/19/93	0725	0940	3.1	4.1	CREST 4.1 AT 0926
5/26/93	0755	1005	-0.5	0.75	LOW -0.4 AT 0801
6/2/93	0720	1000	3.5	4.2	CREST 4.4 AT 0909
6/9/93	0730	1000	0.0	1.0	LOW 0.0 AT 0756
6/16/93	0715	0950	3.2	3.5	CREST 3.7 AT 0838
6/23/93	0745	1000	-0.75	3.1	FLOW
6/30/93	0730	0920	3.8	3.8	CREST 4.1 AT 0821
7/7/93	0730	0930	0.0	2.0	FLOW
7/14/93	0730	0930	3.3	3.0	CREST 3.4 AT 0742
7/21/93	0720	1010	0.0	4.5	FLOW
7/28/93	0730	0950	3.9	3.2	EBB
8/4/93	0730	1000	1.5	4.25	FLOW
8/11/93	0730	1000	3.0	3.0	LOW 2.9 AT 0924
8/18/93	0715	1020	2.0	5.9	FLOW
8/25/93	0730	1100	3.7	2.9	LOW 2.8 AT 1043
9/1/93	0735	1030	3.1	5.6	FLOW
9/8/93	0715	1010	2.9	3.8	FLOW

Horned Grebe (*Podiceps auritus*)

A high count of 5 individuals was recorded for this species during surveys conducted on February 17, 1993 and February 9, 1994 within cells 36 and 14 respectively. From one to two individuals were also found throughout the winter and spring months in cells 7, 14, 33, 36-40, and 43.



Horned Grebe



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

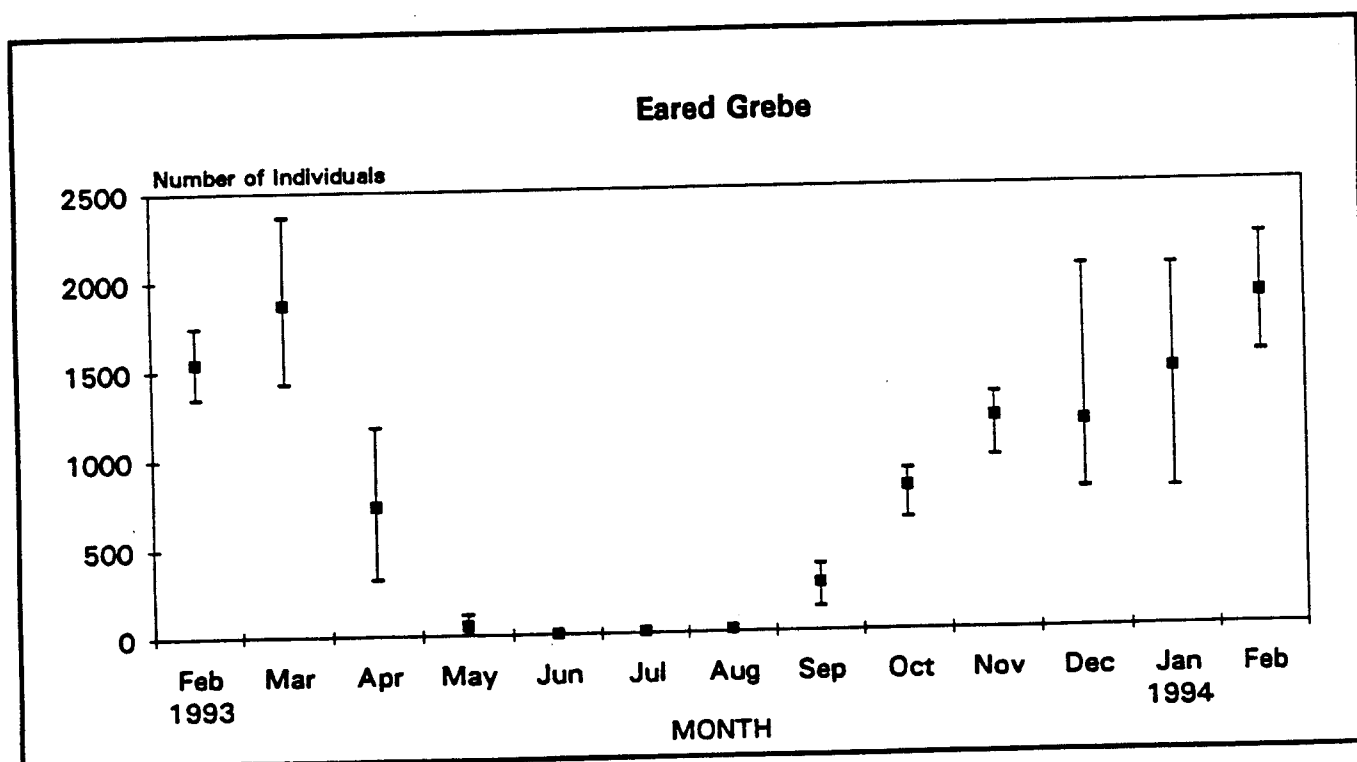
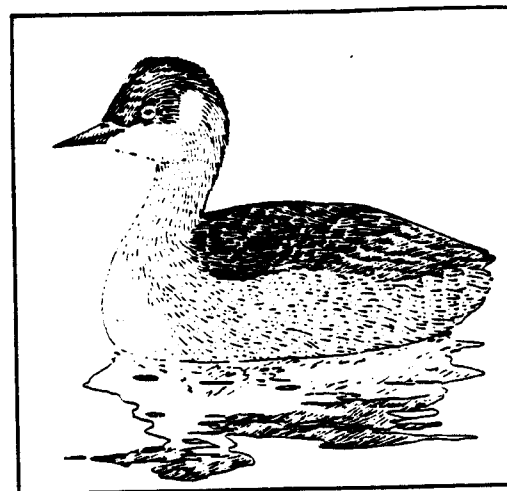


51 - 100% Occurrence

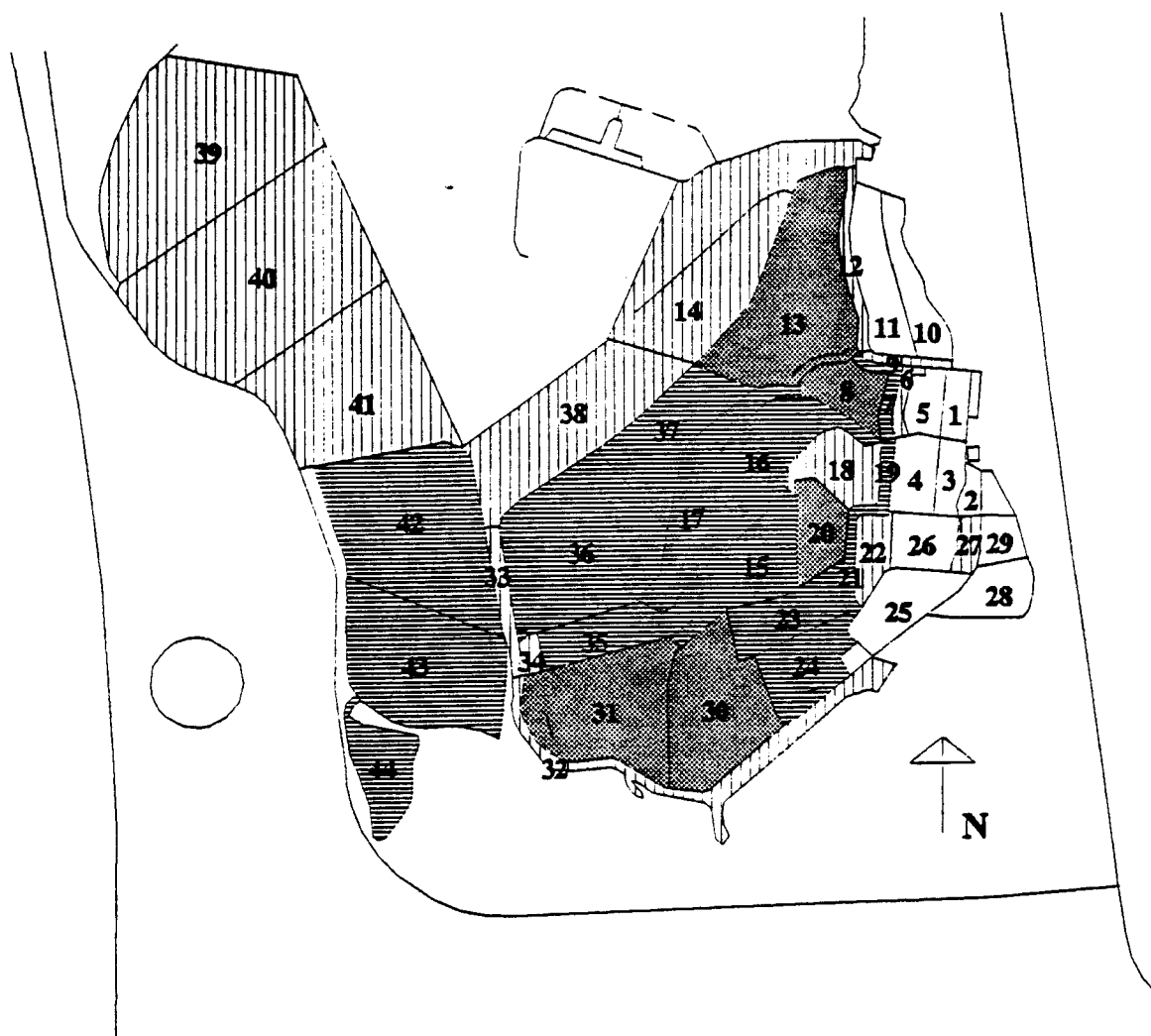
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Eared Grebe (*Podiceps nigricollis*)

The eared grebe, a winter resident, was most abundant relative to the other grebe species. Eared grebes were detected within 33 of the 44 survey units and generally exceeded over a thousand birds for much of the fall and winter months. The high count occurred during March 17, 1993 when a total of 2359 individuals were reported within cells 8 (300 individuals), 13 (172 individuals), 15 (75 individuals), 17 (10 individuals), 20 (275 individuals), 23 (35 individuals), 30 (560 individuals), 31 (520 individuals), 36 (155 individuals), and 37 (257 individuals). Eared grebes were virtually absent from the study area during the summer months although from 3 to 33 individuals did occur during this time frame.



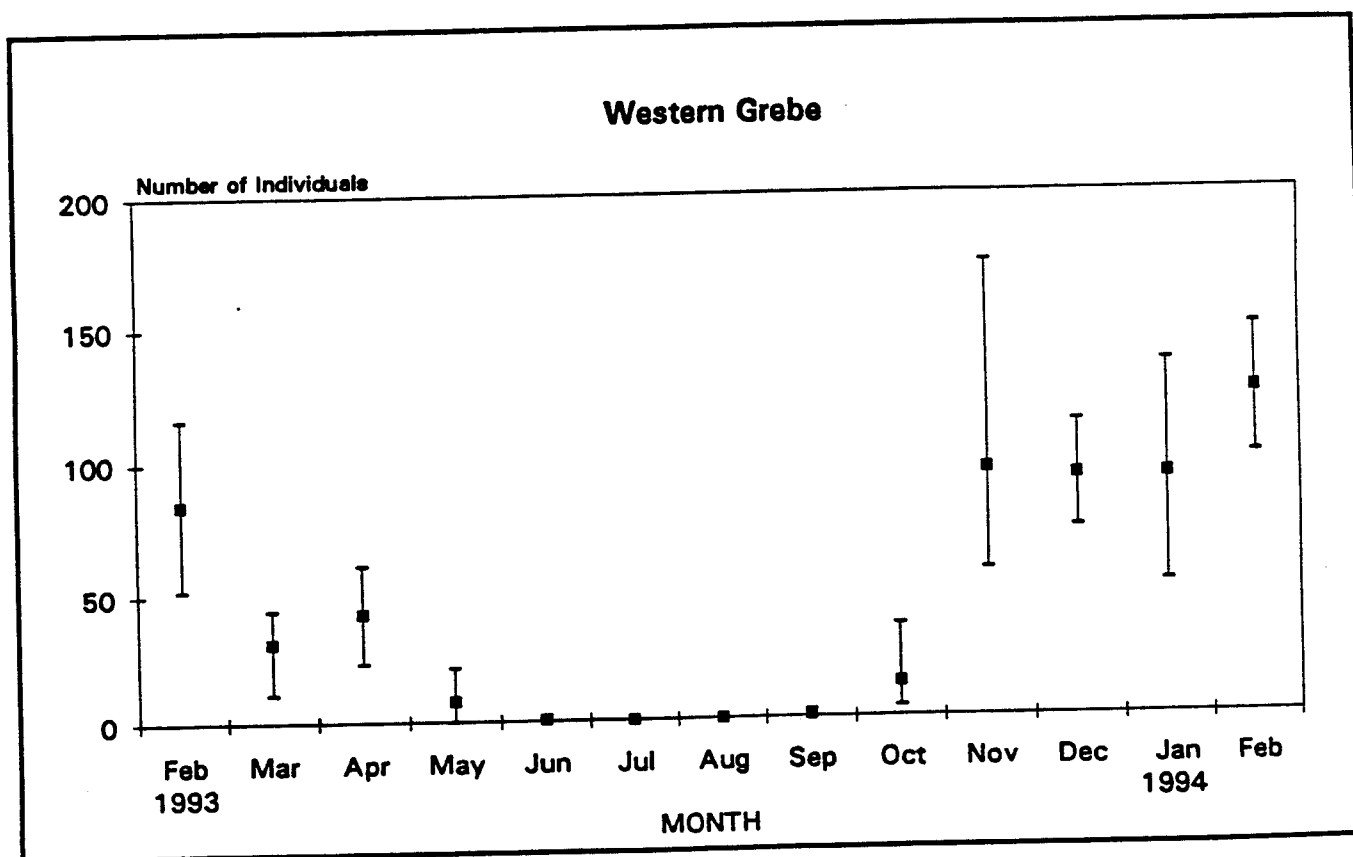
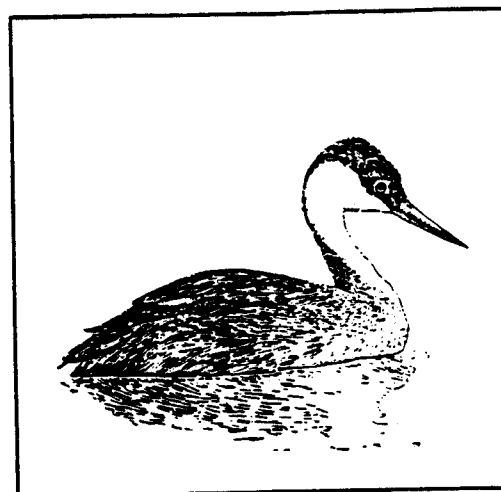
Eared Grebe



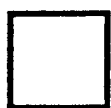
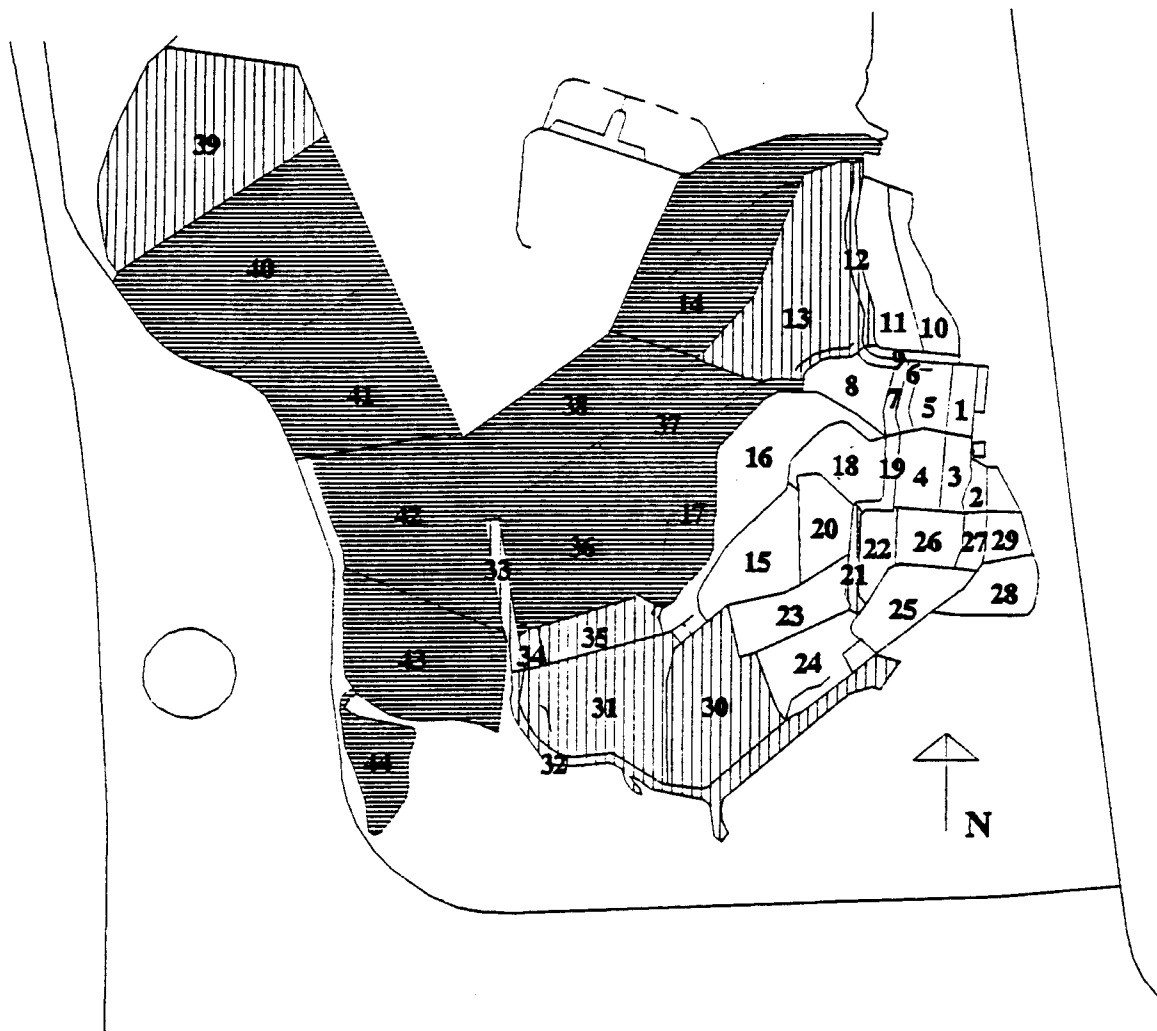
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Western Grebe (*Aechmophorus occidentalis*)

Over the course of the year, this winter resident was present during 65% of the surveys and was found within 20 of the 44 survey units. Western grebes were most frequently observed within cells 14, 17, 36, 38, and 41-44. Average monthly counts for the western grebe were relatively consistent during November through January suggesting a wintering population of approximately 90 birds within the study area. The high count of 173 individuals was recorded on November 17, 1993 of which 120 birds were located in cell 41.



Western Grebe



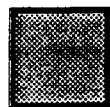
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence



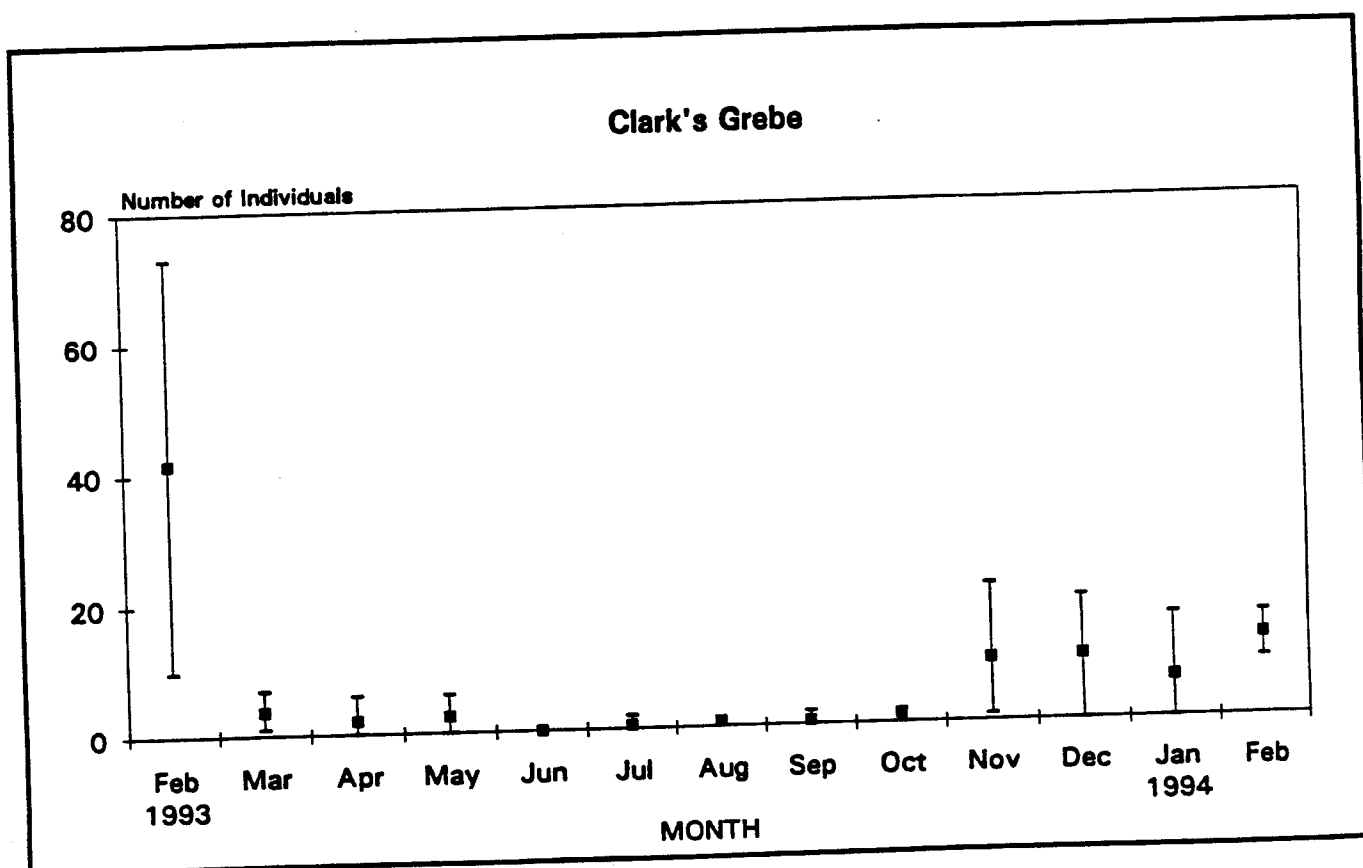
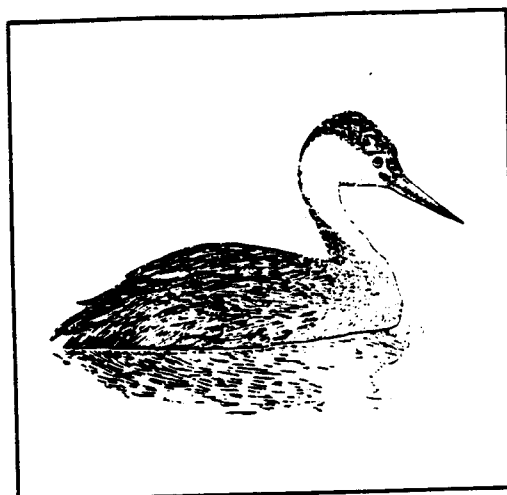
51 - 100% Occurrence

Percent occurrence and distribution within numbered survey cells.

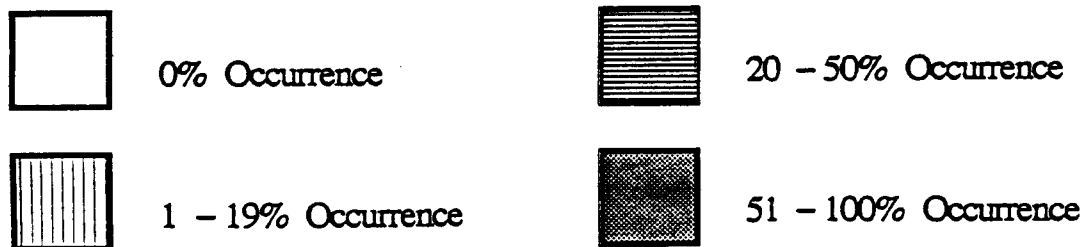
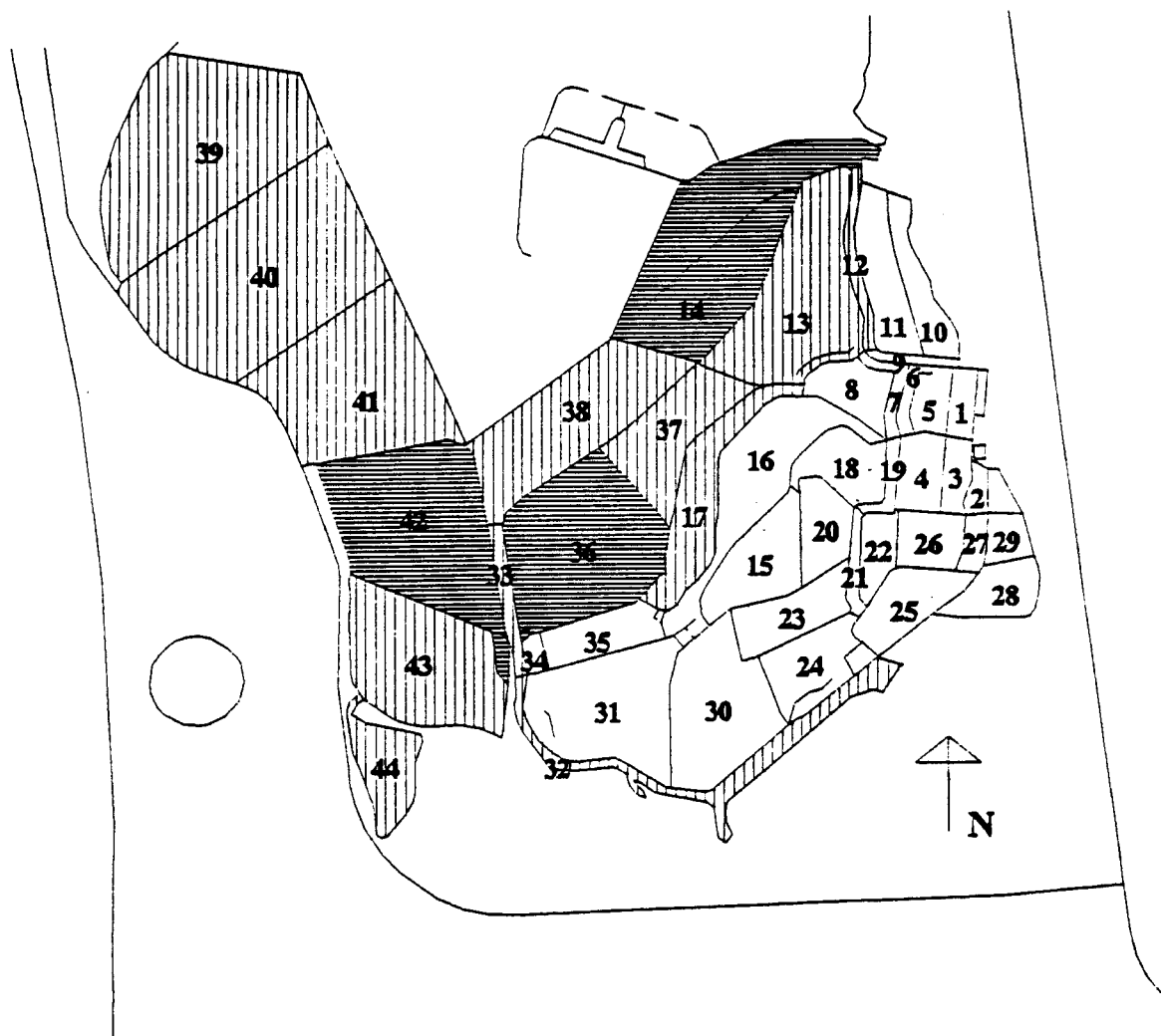
San Diego Bay, 1993-1994

Clark's Grebe (*Aechmophorus clarkii*)

Clark's grebes were present during 63% of the surveys and had a distribution similar to that of its close relative the western grebe. The high count for this winter resident was 73 individuals recorded on February 17, 1993 within cells 40-43.



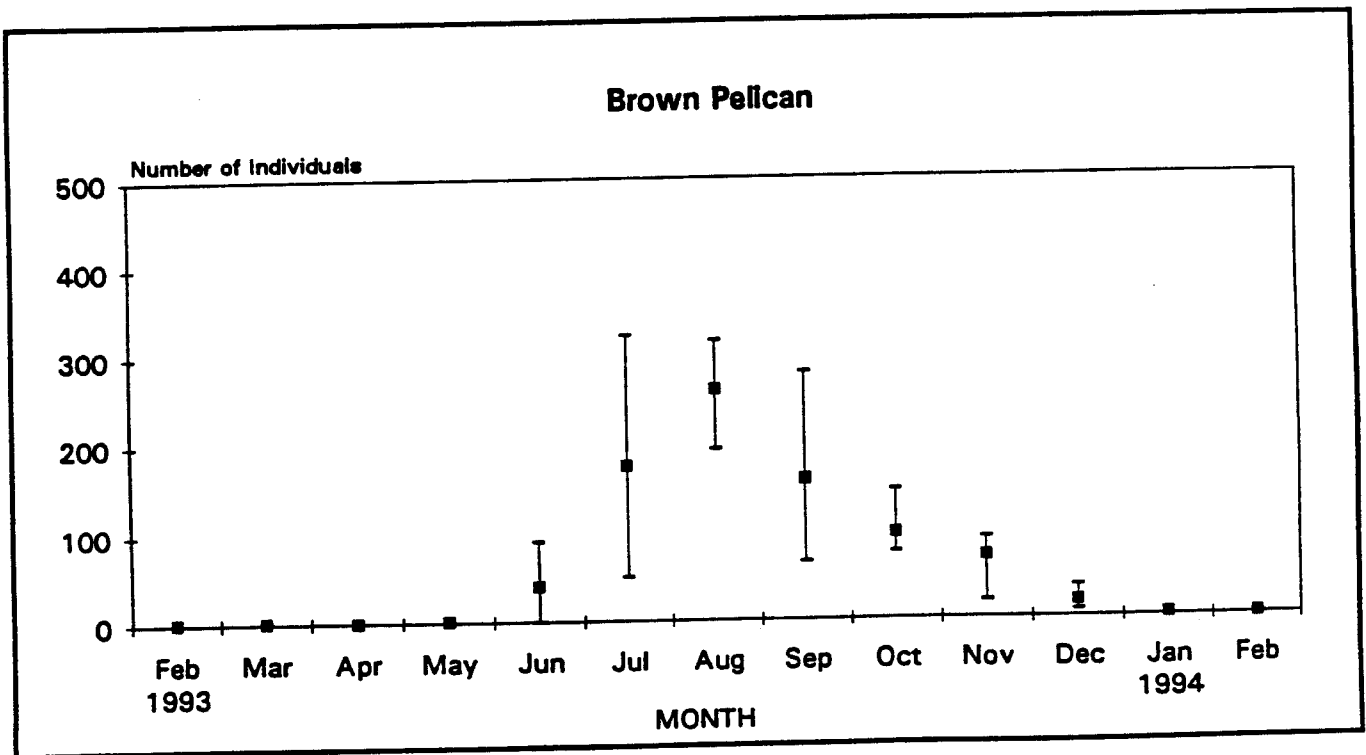
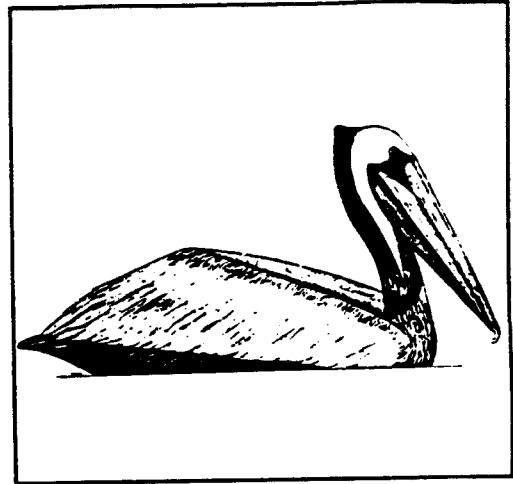
Clark's Grebe



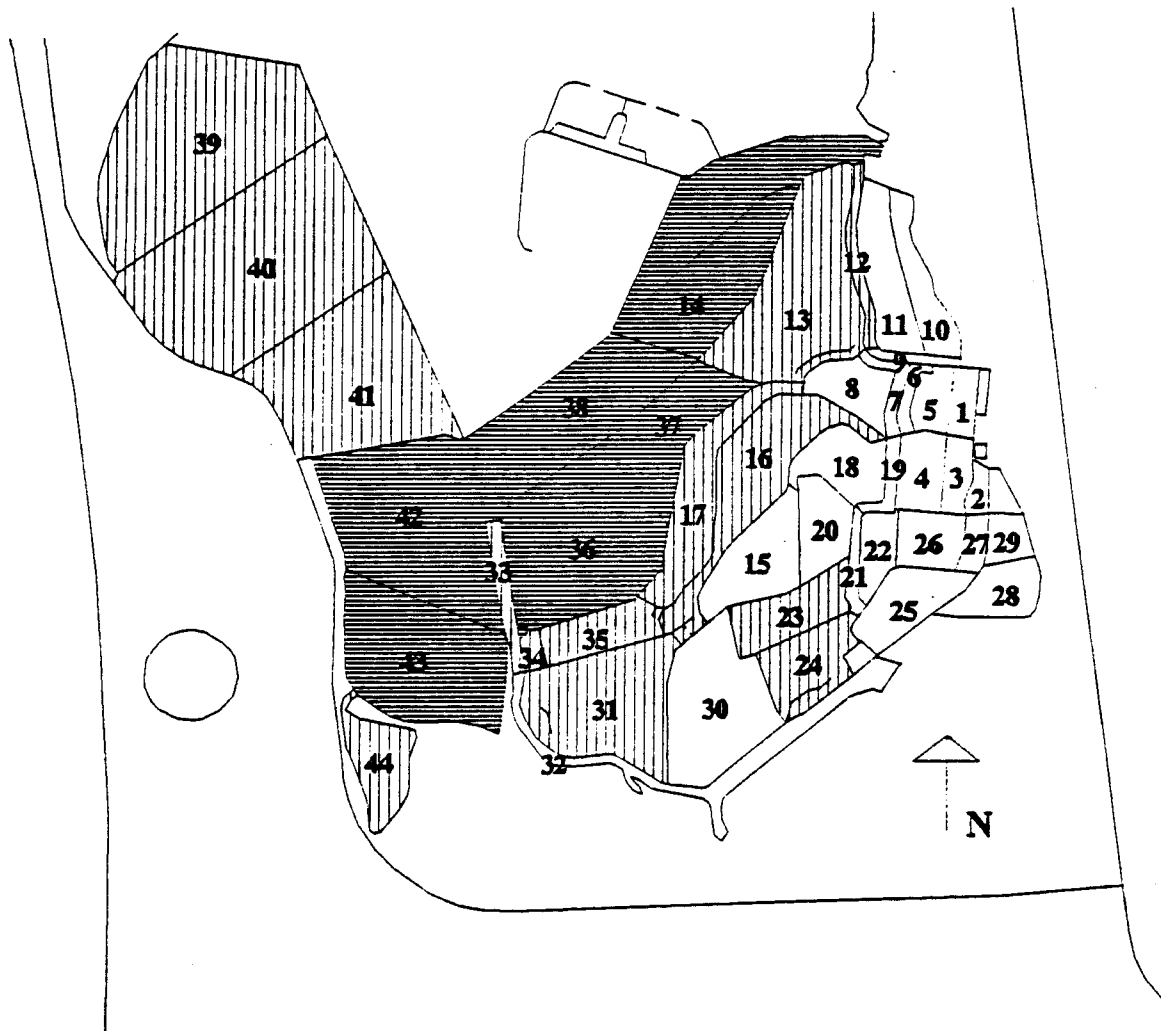
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Brown Pelican (*Pelecanus occidentalis*)

The brown pelican, a Federally listed endangered species, utilized the Salt Works dikes primarily as a roosting site although they also foraged in several of the ponds. Areas most frequently used by this species included the dikes separating cells 36/37 and 42/43 as well as the spit located within cell 14. Brown pelicans were present during June through December with the monthly average peak occurring in August. The high count for a single survey date was 323 individuals on July 28, 1993.



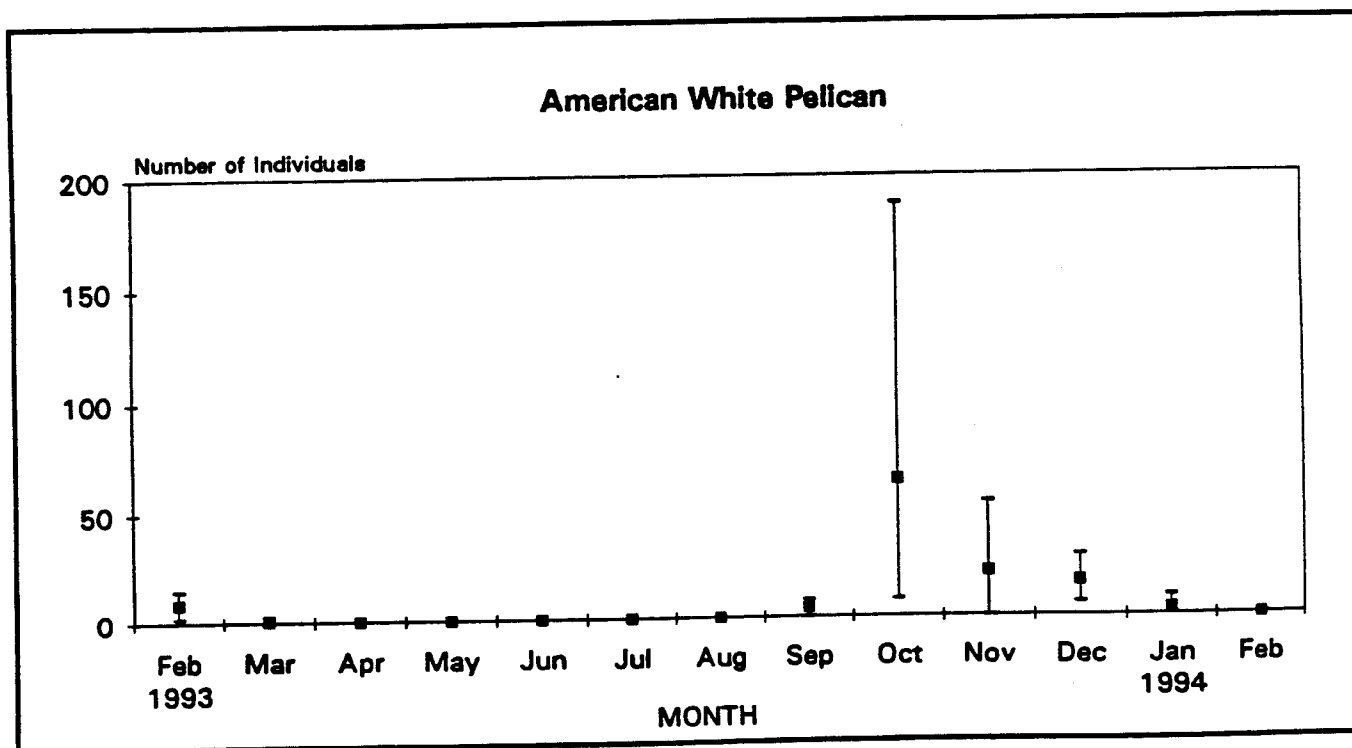
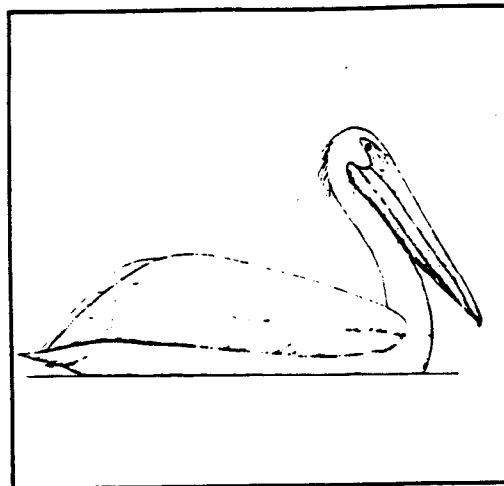
Brown Pelican



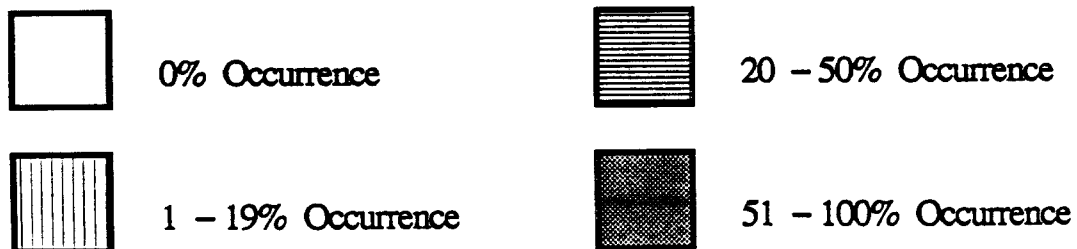
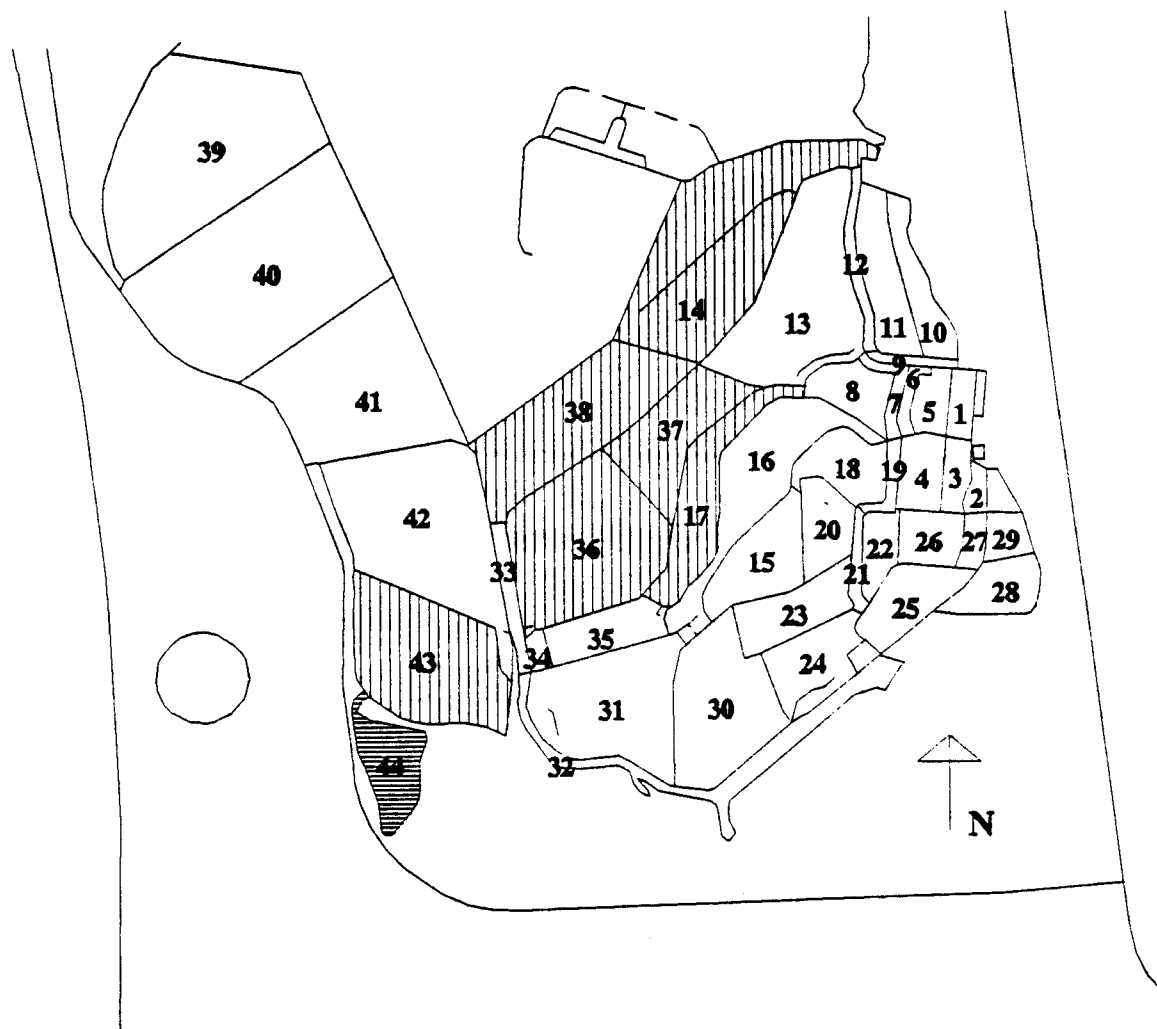
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

American White Pelican (*Pelecanus erythrorhynchos*)

American white pelicans were present during the fall and winter months. On October 20, 1993, a roosting flock of 175 birds was observed within cell 14 in addition to several individuals within cells 43 and 44. This resulted in a high count of 187 individuals. White pelicans were found in only 7 of the 44 survey units and were most frequently observed within cell 44.



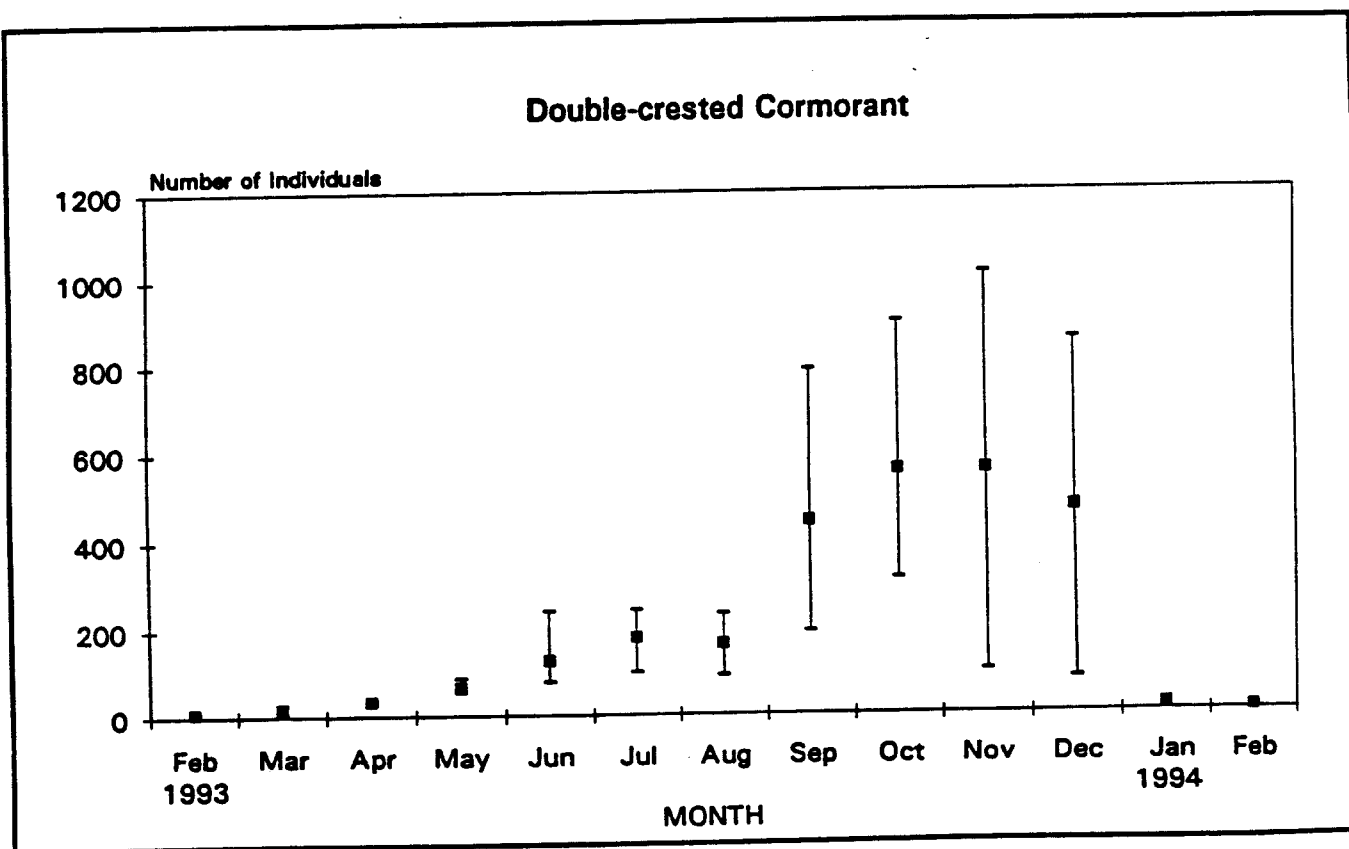
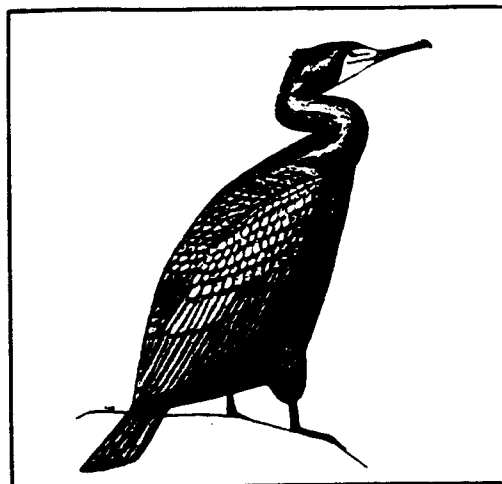
American White Pelican



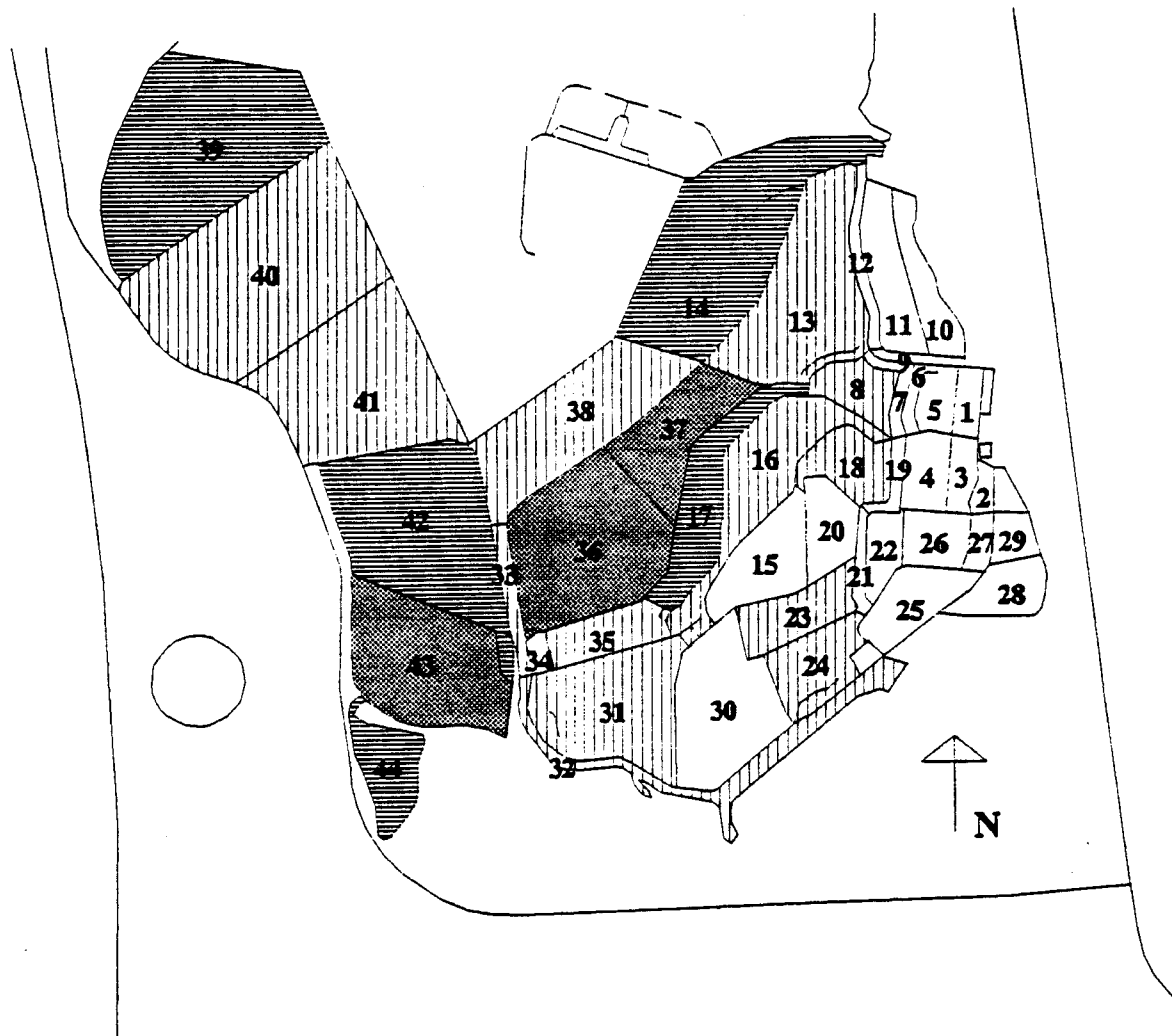
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Double-crested Cormorant (*Phalacrocorax auritus*)

Double-crested cormorants were present during all but one of the 52 surveys with higher numbers of individuals occurring in the late fall and early winter months. This species most frequently utilized the dikes and ponds within cells 36, 37, and 43. On November 17, 1993 the maximum count for double-crested cormorants was 1012 individuals distributed within cell 17 (100 individuals), 36 (5 individuals), 37 (887 individuals), 43 (18 individuals), and 44 (2 individuals). Double-crested cormorants nested on an abandoned barge within survey unit 36 and along the dike separating cells 17/37.



Double-crested Cormorant

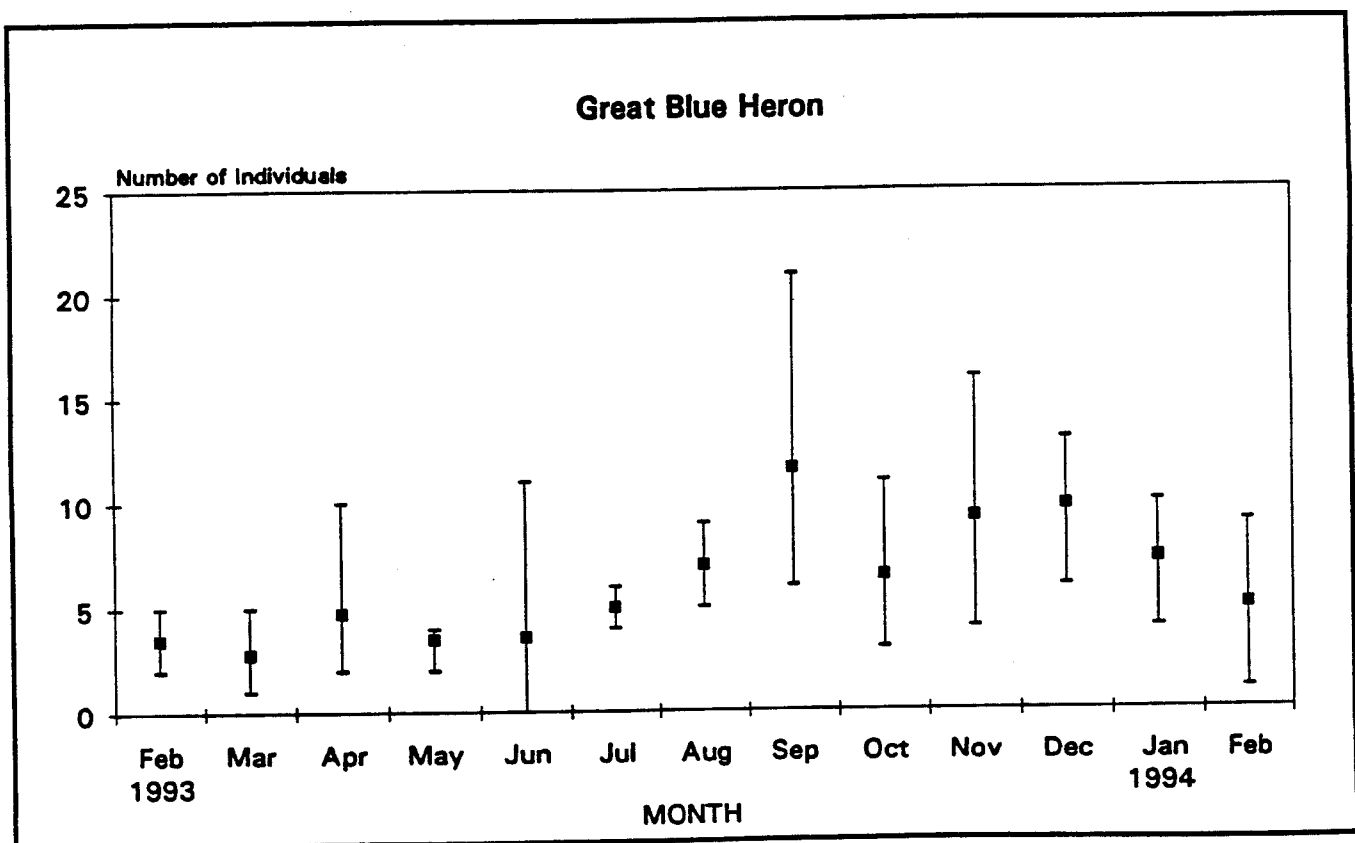
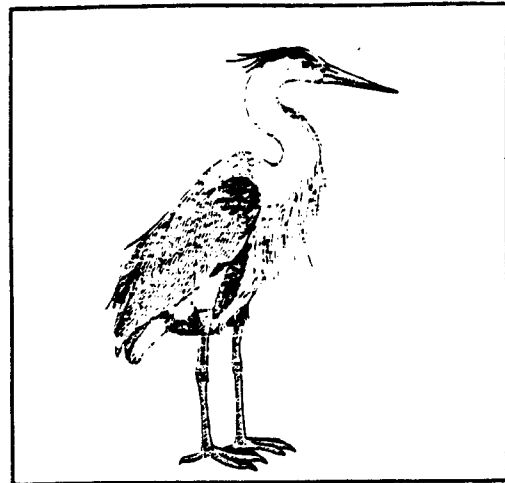


Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

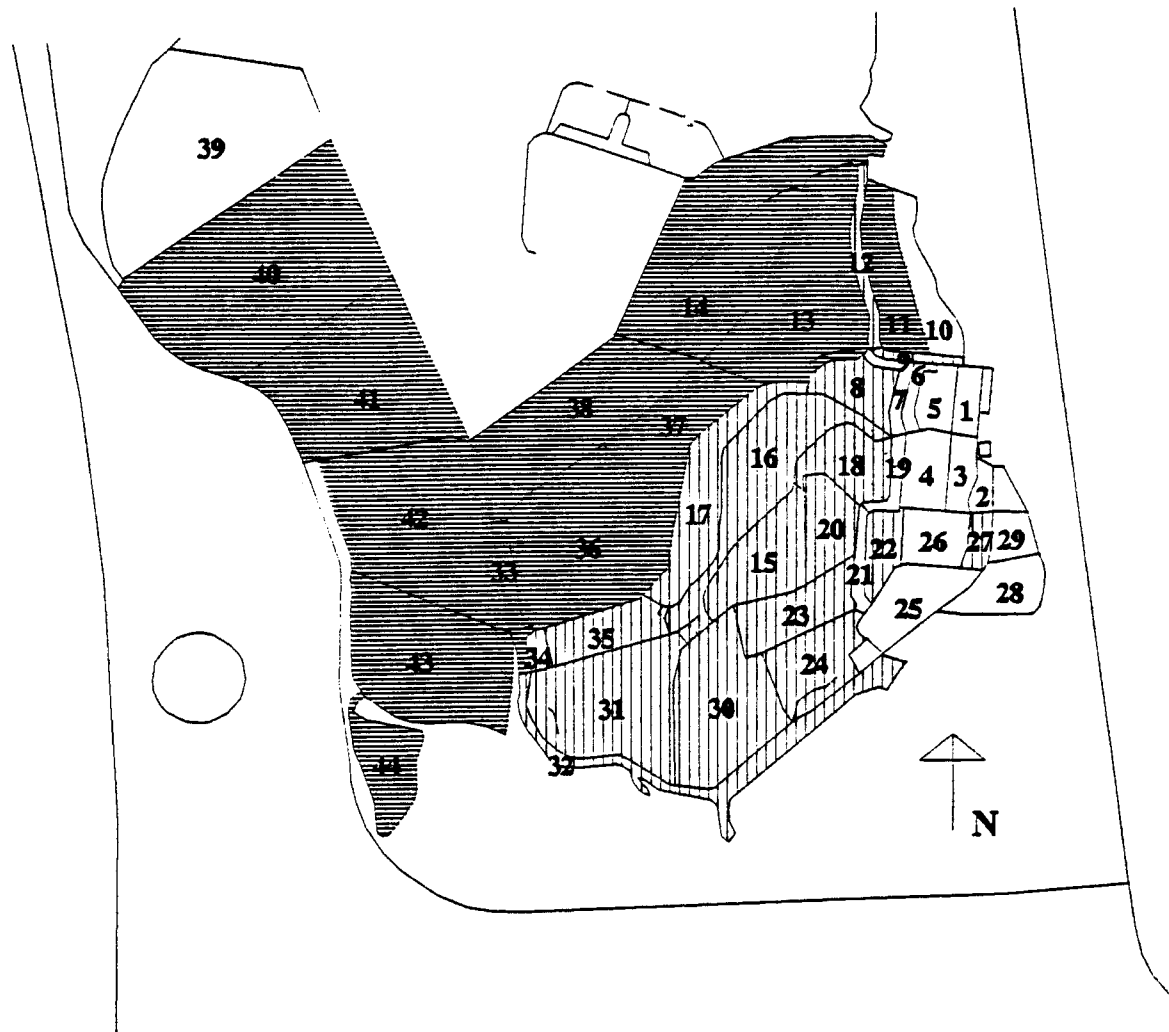
Great Blue Heron

(*Ardea herodias*)

The great-blue heron was present throughout the year with the number of individuals within a cell ranging from one to 16. This non-breeding year round resident was observed in 29 of the 44 survey units and was most frequently recorded within the outer survey cells of the Salt Works.



Great Blue Heron



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

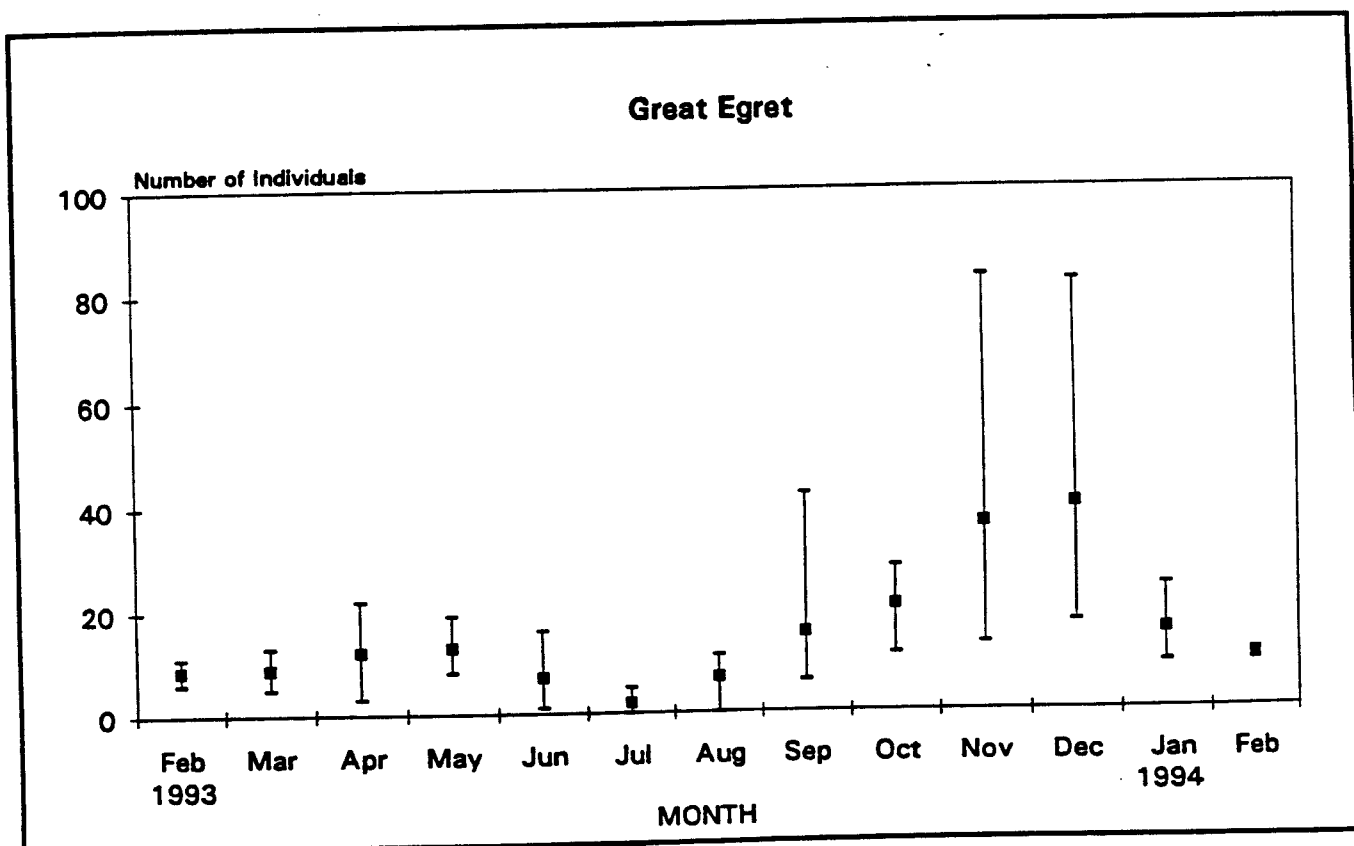
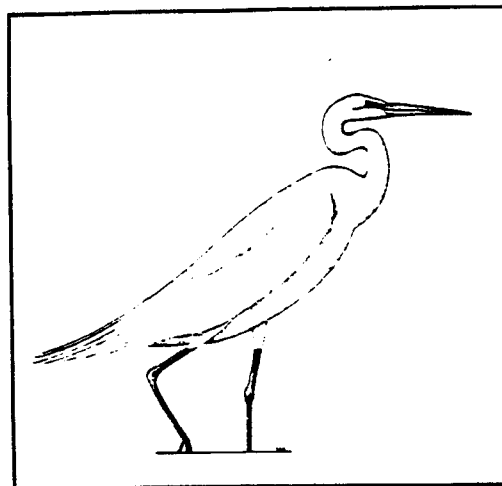


51 - 100% Occurrence

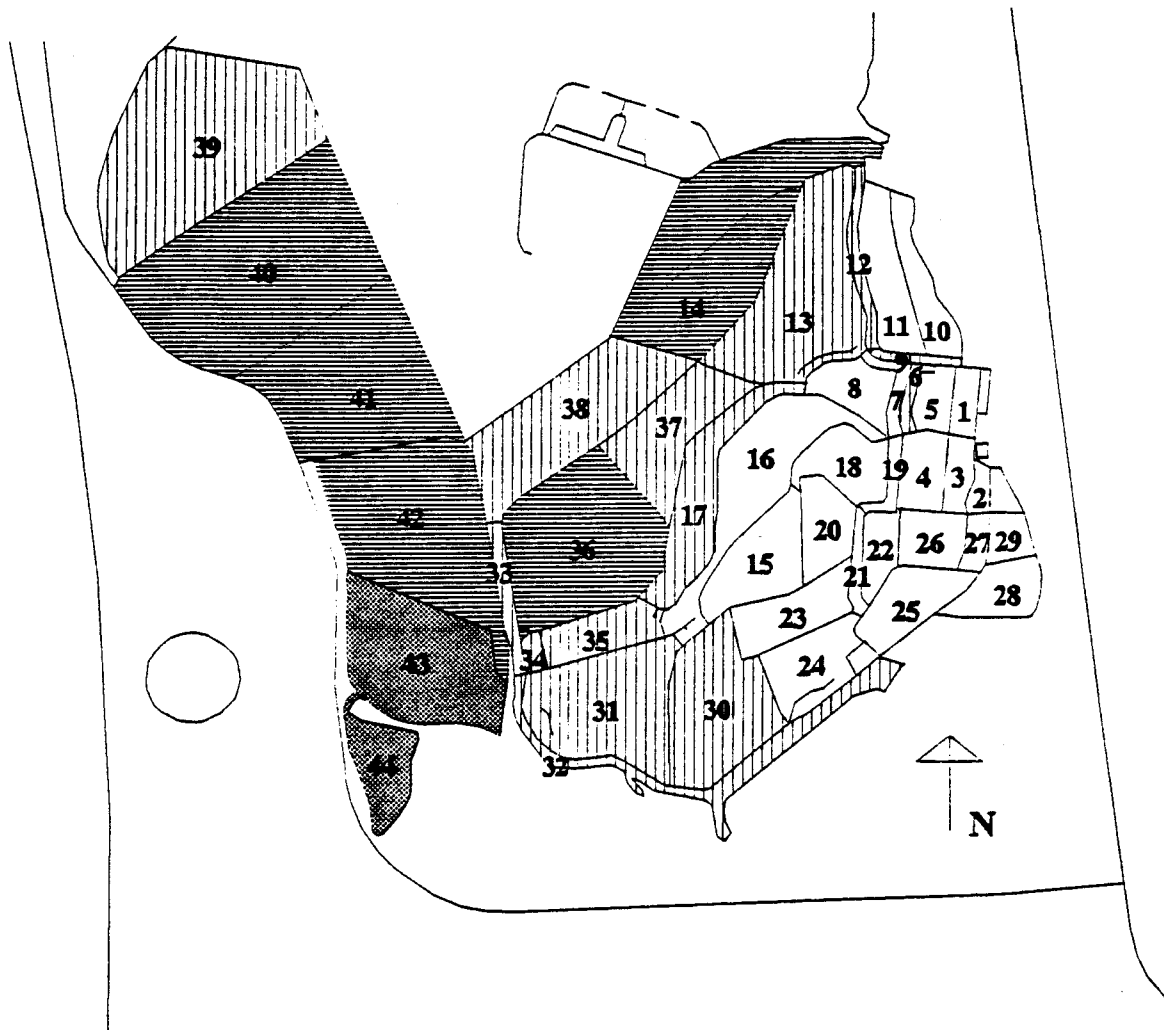
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Great Egret (*Casmerodius albus*)

This species was present during 94% of the surveys and had two seasonal peaks according to the monthly averages: one during May and the other in December. A high count of 83 individuals was recorded during the November 17, 1993 survey. Great egrets were observed in 20 of the 44 cells and were most frequently found within survey units 43 and 44.



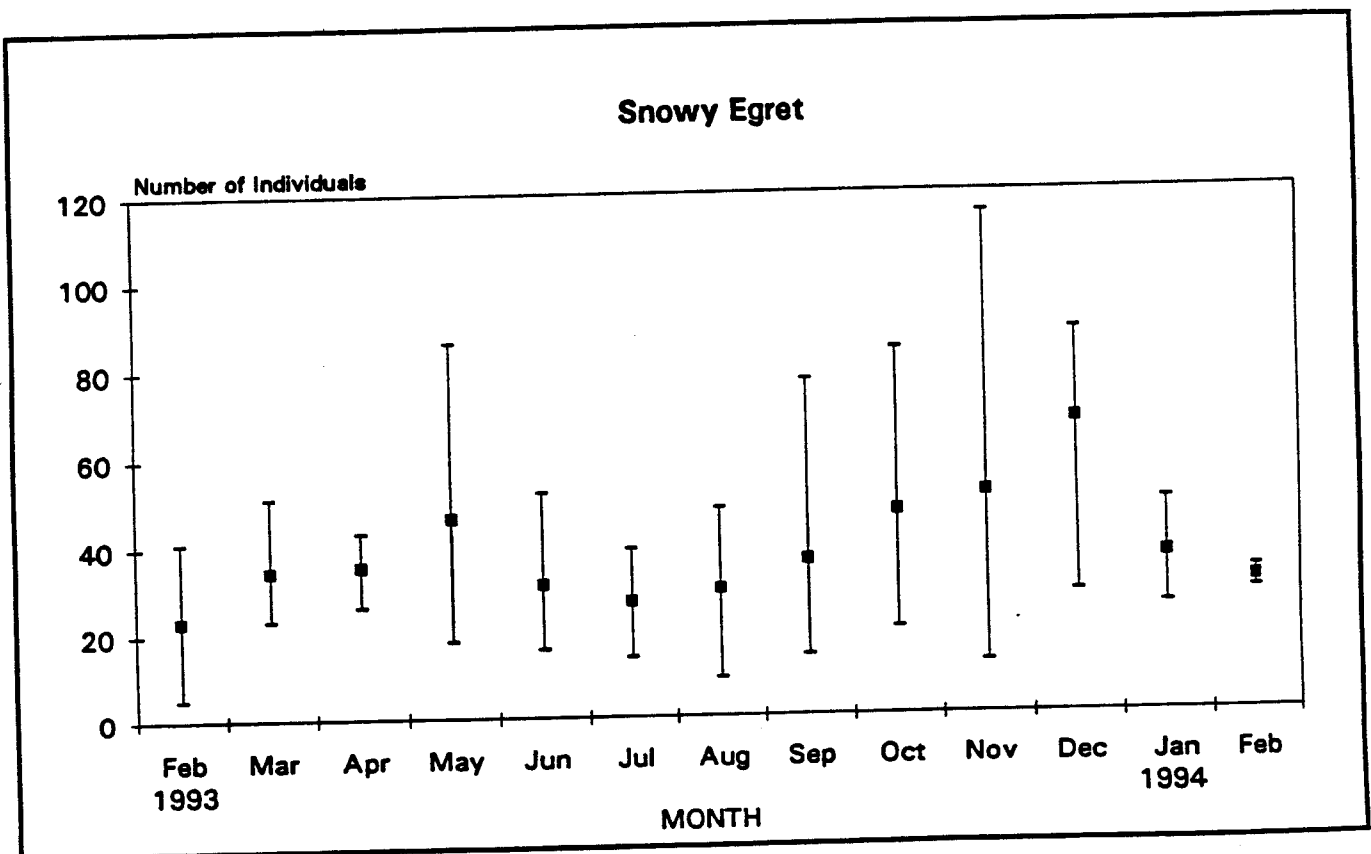
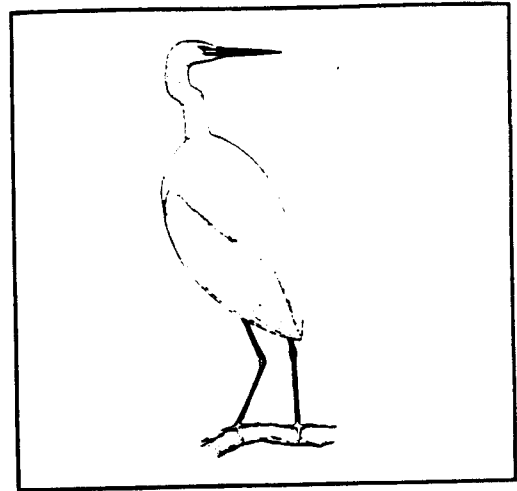
Great Egret



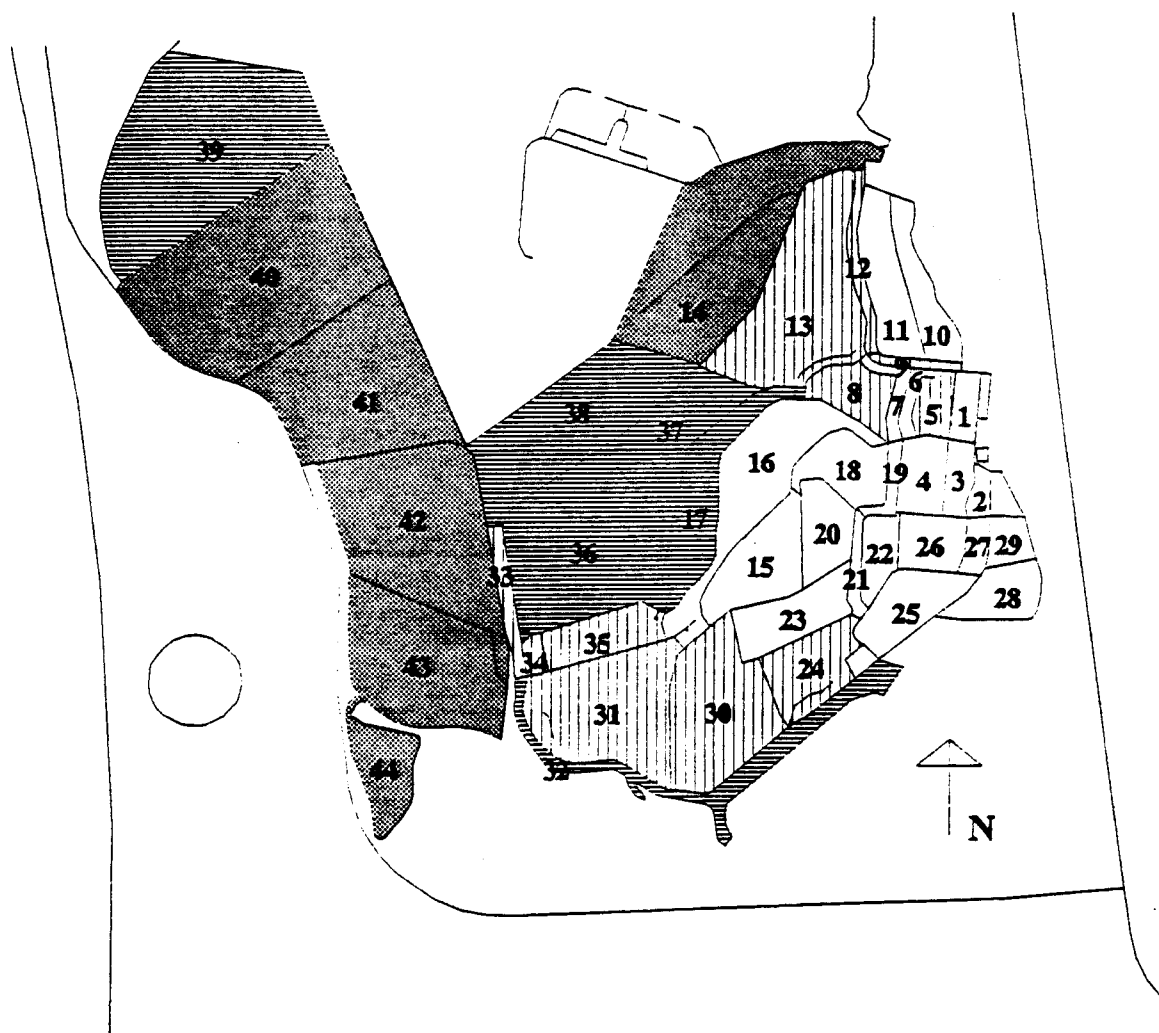
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Snowy Egret (*Egretta thula*)

Snowy egrets were present throughout the year with the occurrence of two seasonal peaks according to the monthly averages. The high count for this species was 115 individuals recorded during the November 17, 1993 survey. Snowy egrets were observed in 26 of the 44 survey units and were most often observed within cells 14, 36 and 40-44.



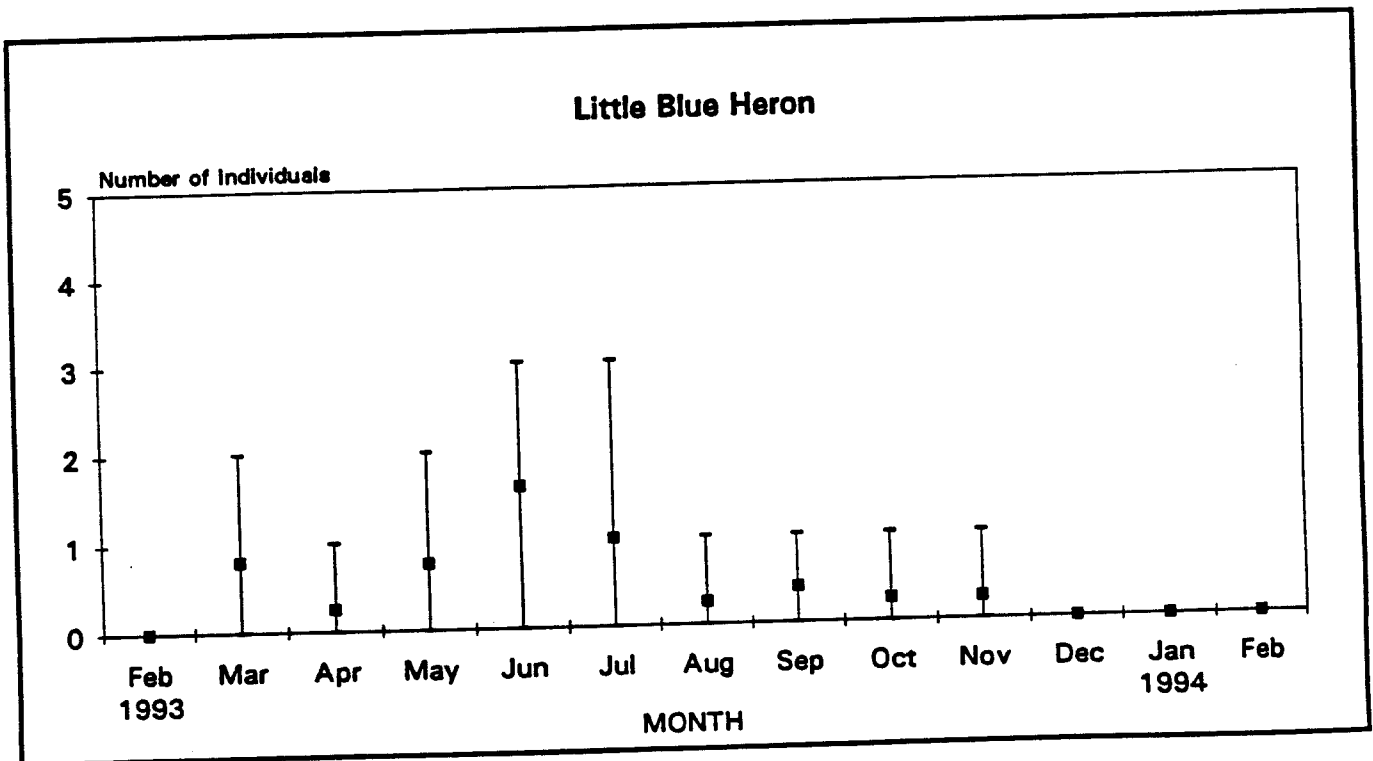
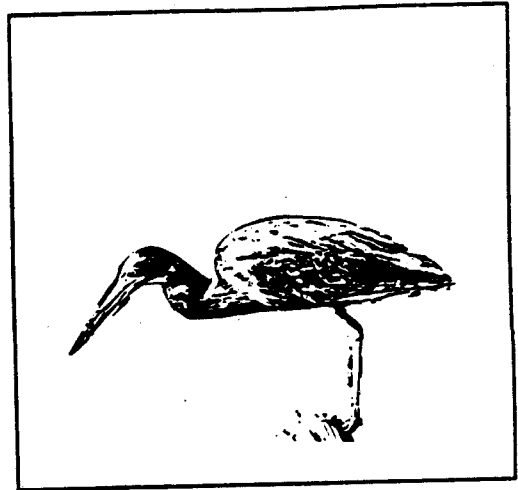
Snowy Egret



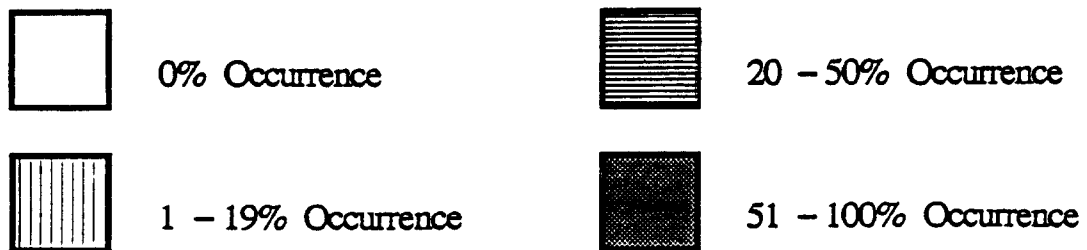
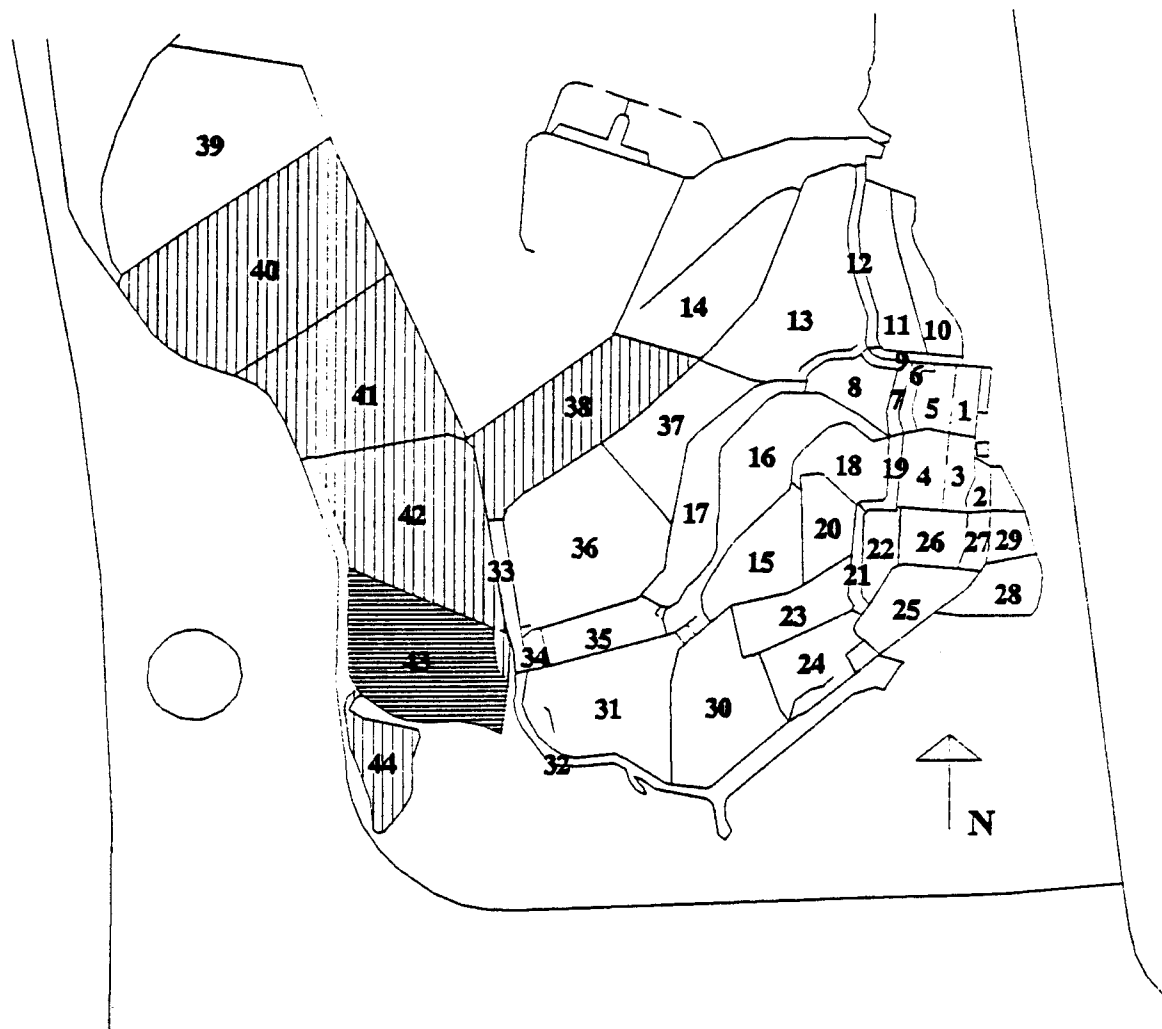
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Little Blue Heron (*Egretta caerulea*)

One to two little blue herons were recorded during March through November. These individuals were detected within cells 38 and 40-44 with the majority of sightings occurring in survey unit 43.



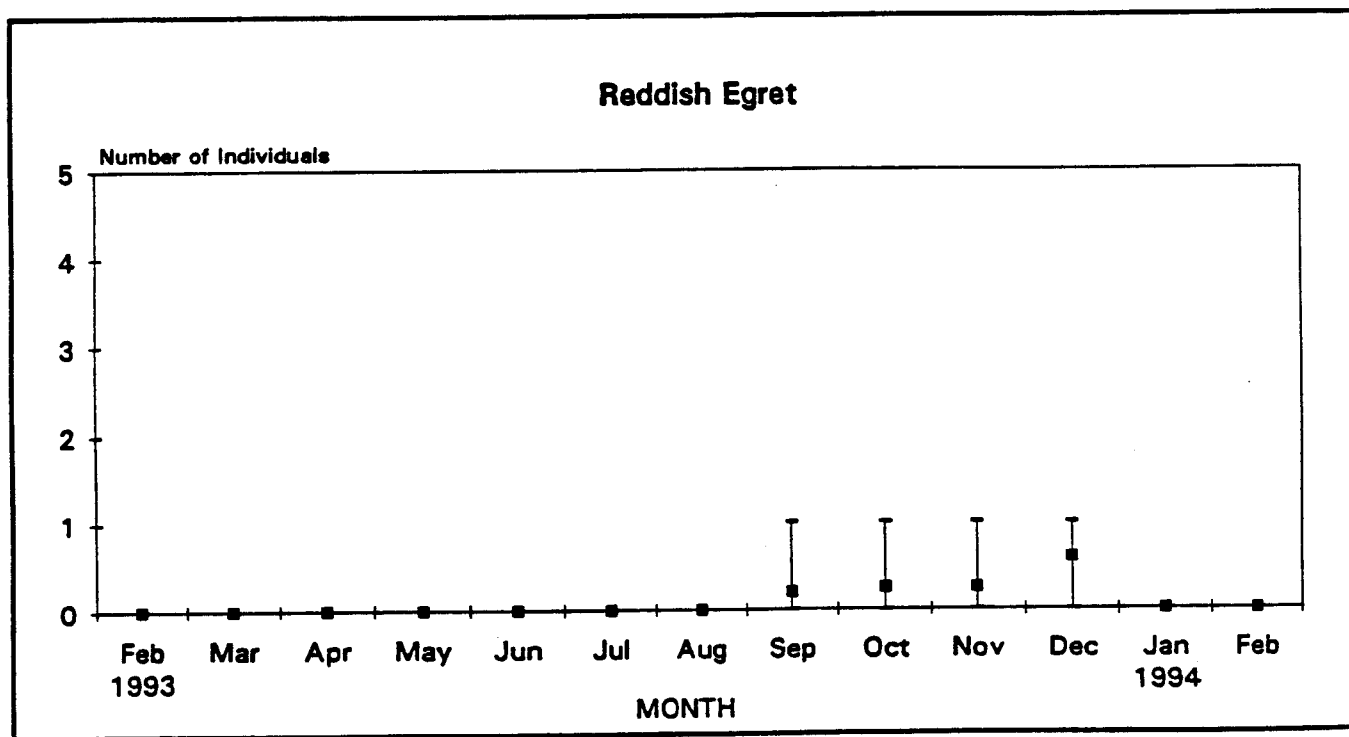
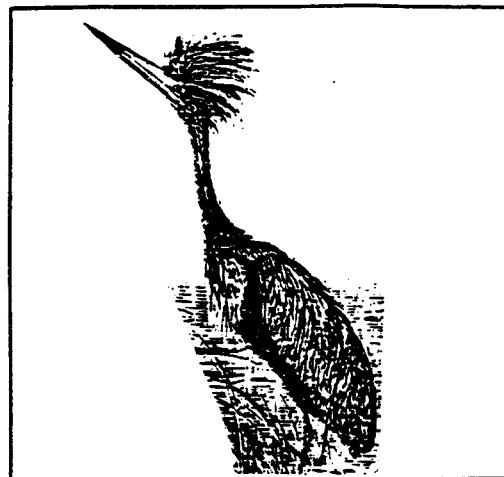
Little Blue Heron



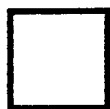
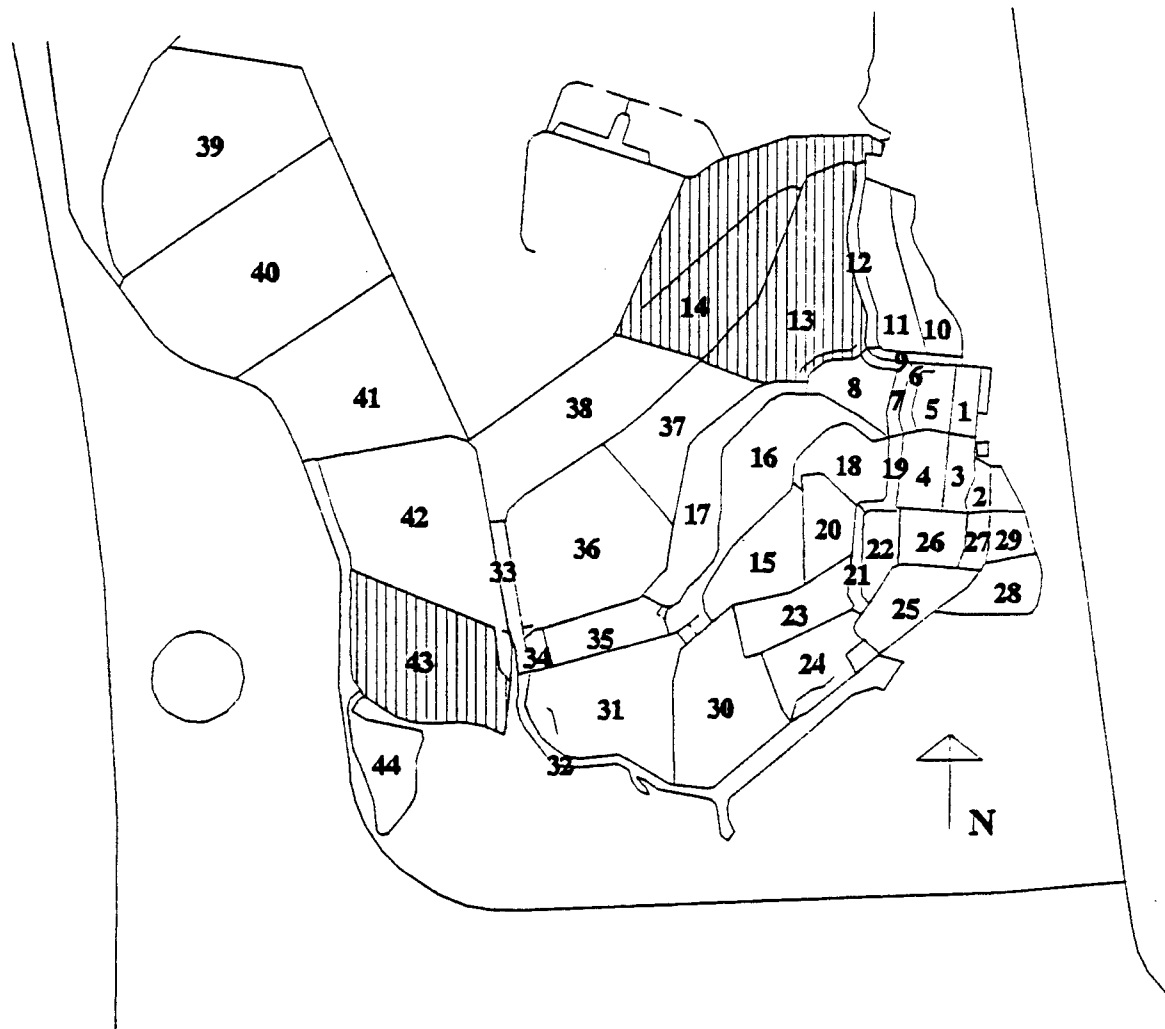
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Reddish Egret (*Egretta rufescens*)

An individual reddish egret was present at the study area from September through December and was observed only in cells 13, 14, and 43.



Reddish Egret



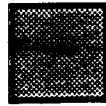
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

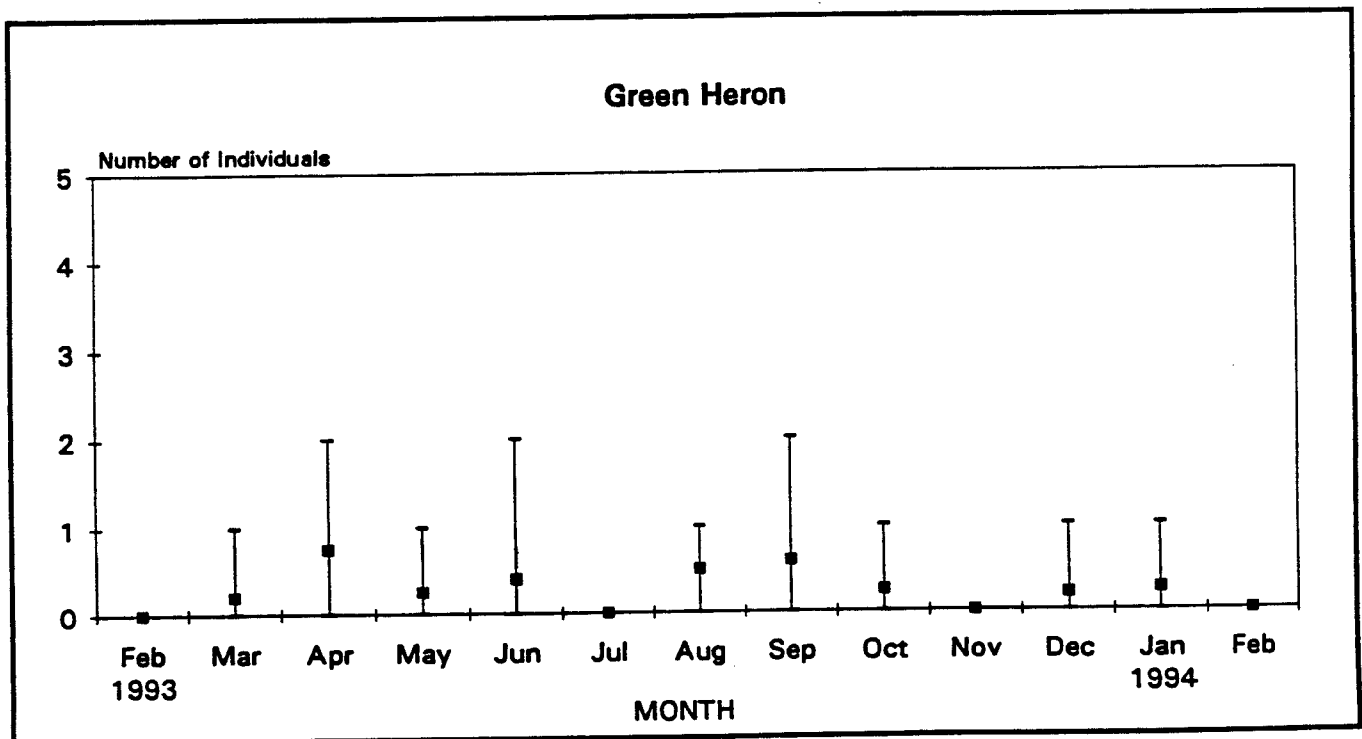
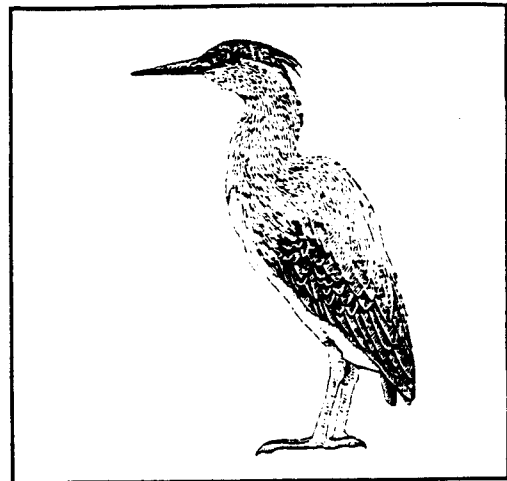


51 - 100% Occurrence

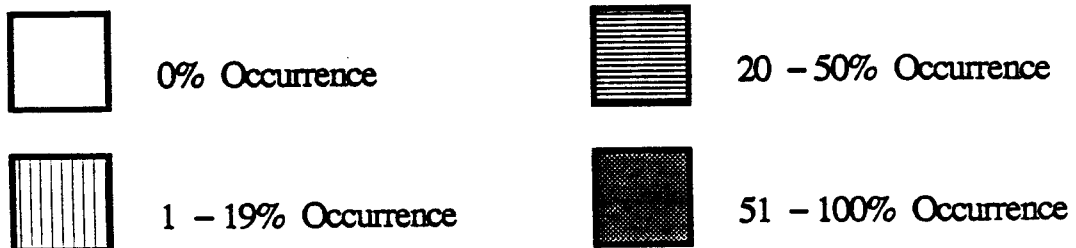
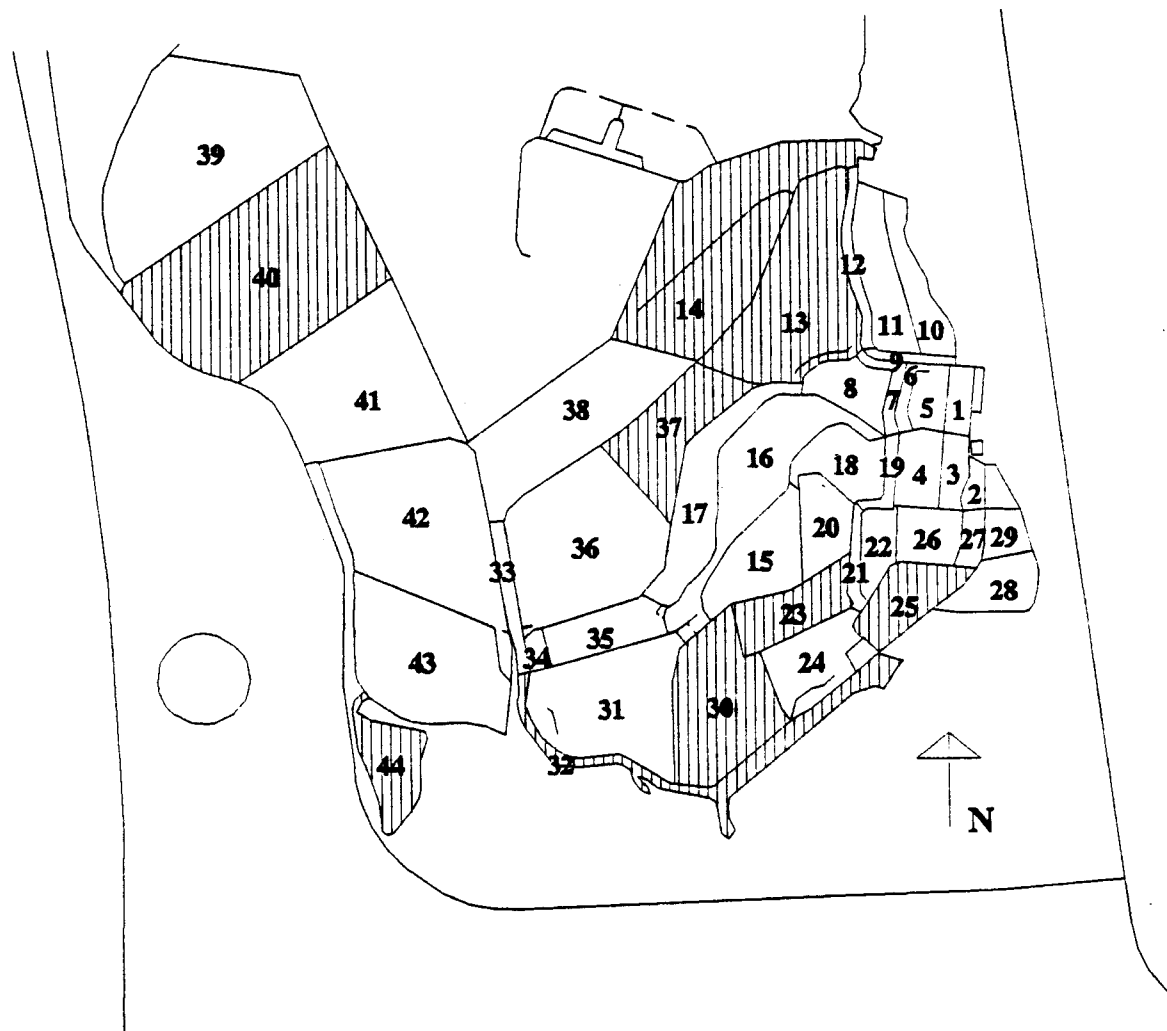
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Green Heron (*Butorides striatus*)

Sporadic observations of one to two individuals were recorded during the course of this investigation.



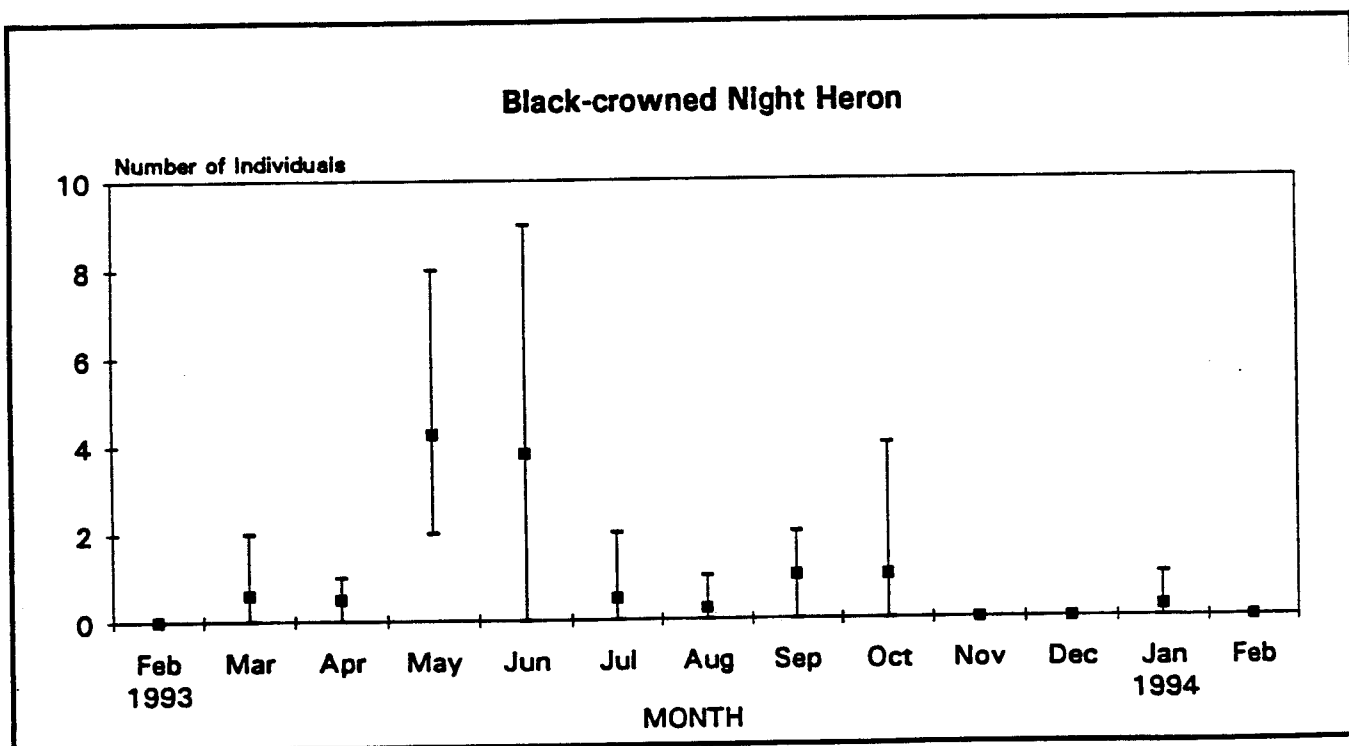
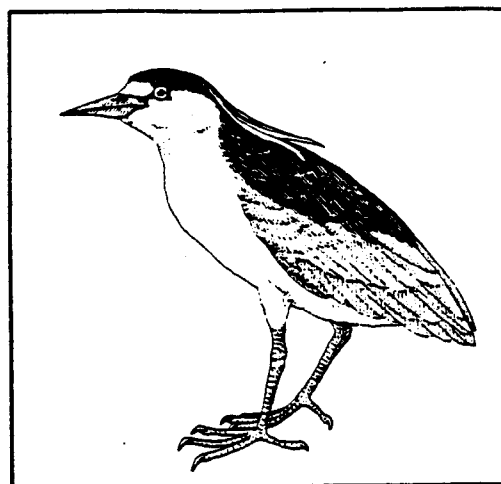
Green Heron



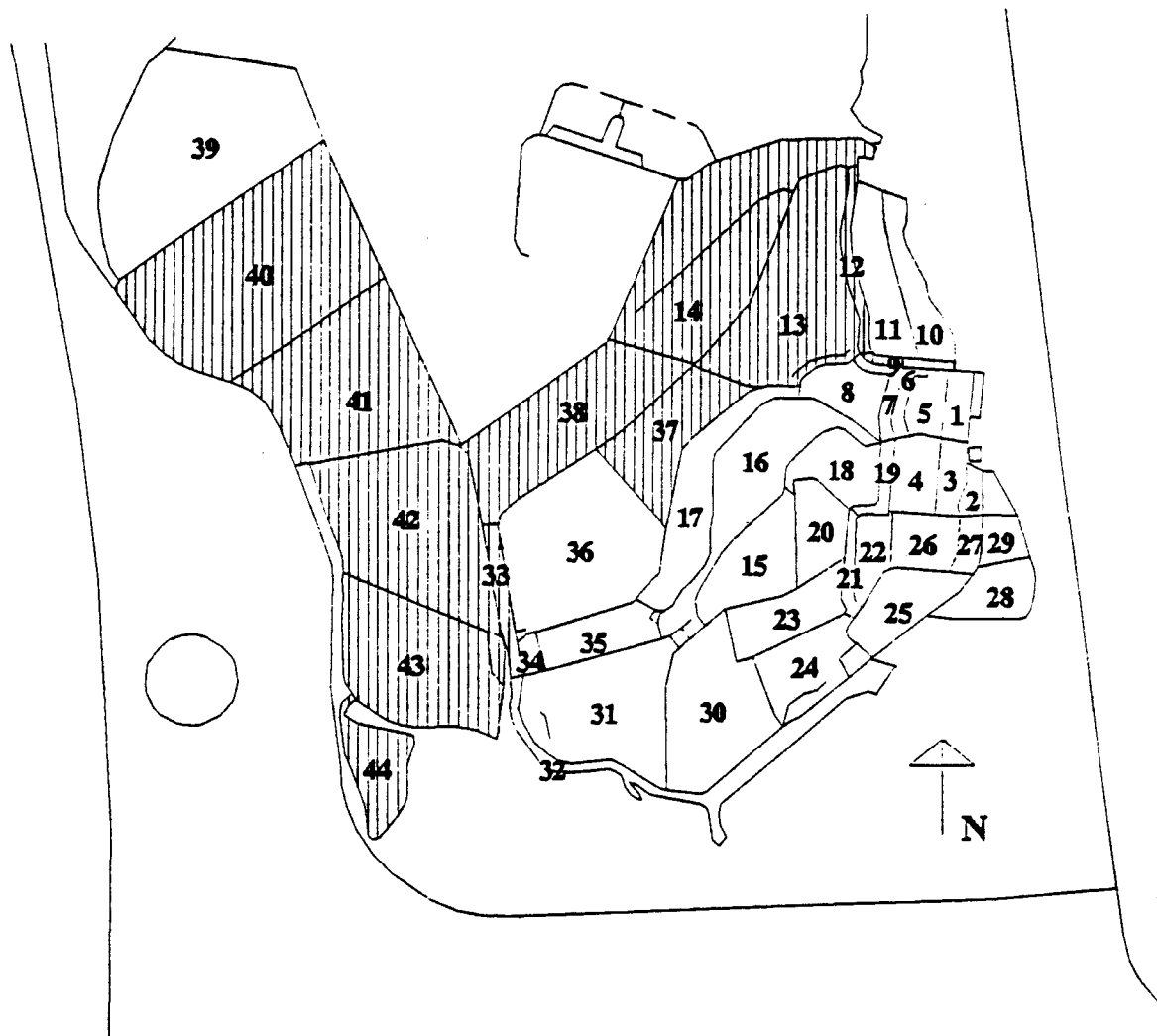
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Black-crowned Night Heron (*Nycticorax nycticorax*)

Over the course of the year, black-crowned night herons were present during 37% of the surveys. They were observed in 12 of the 44 survey units usually with one to three individuals present at a single location. During the June 23, 1993 survey, a high count of 9 birds was recorded of which six individuals occurred within cell 40, two within cell 37, and one within cell 43.



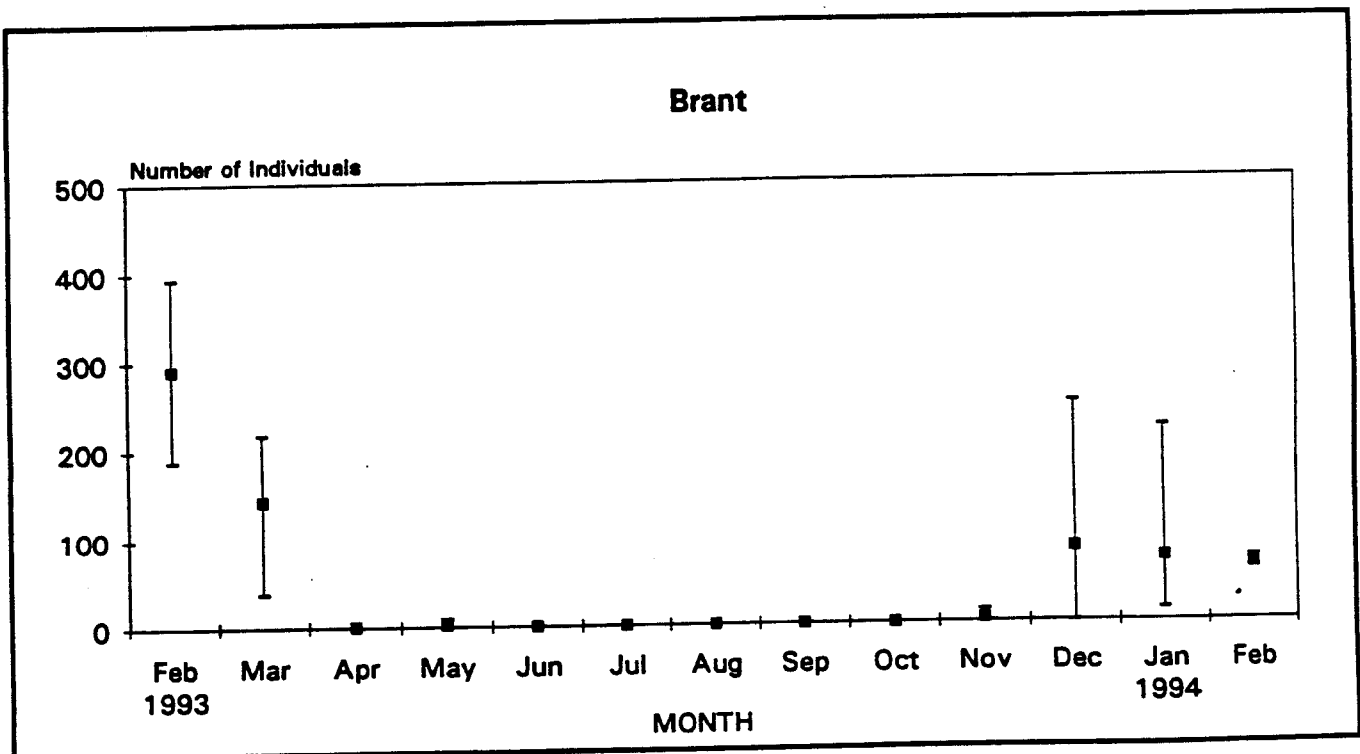
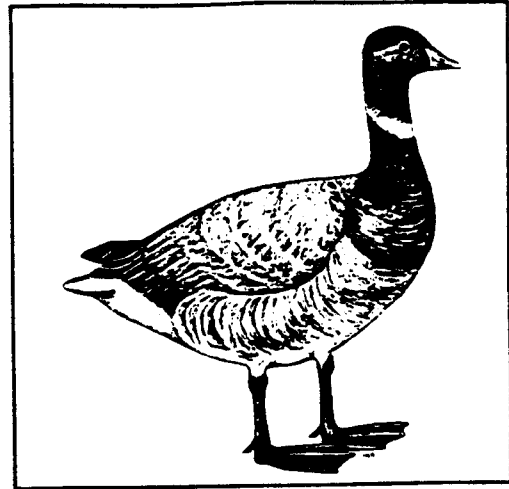
Black-crowned Night Heron



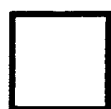
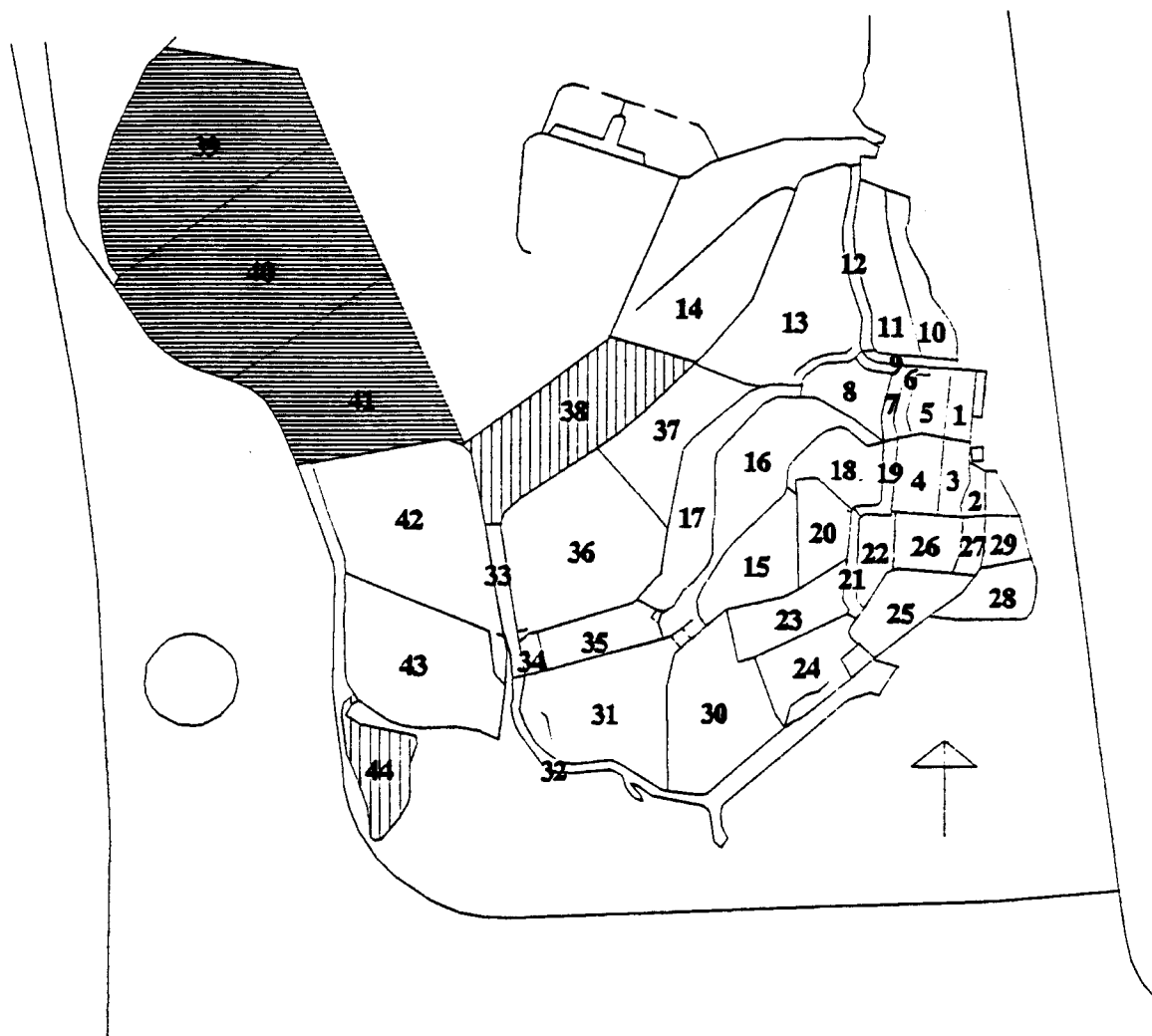
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Brant (*Branta bernicla*)

Brant were present during the late fall and winter months with several individuals observed at the study site in April and May. This winter resident was not observed within the confines of the Salt Works ponds which lack the eelgrass beds Brant are dependent upon. Brant were most frequently observed within San Diego Bay encompassing survey cells 39-41. A tarsal banded Brant located within cell 40 was identified as a bird banded at the Yukon Delta National Wildlife Refuge, Alaska in 1988.



Brant



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

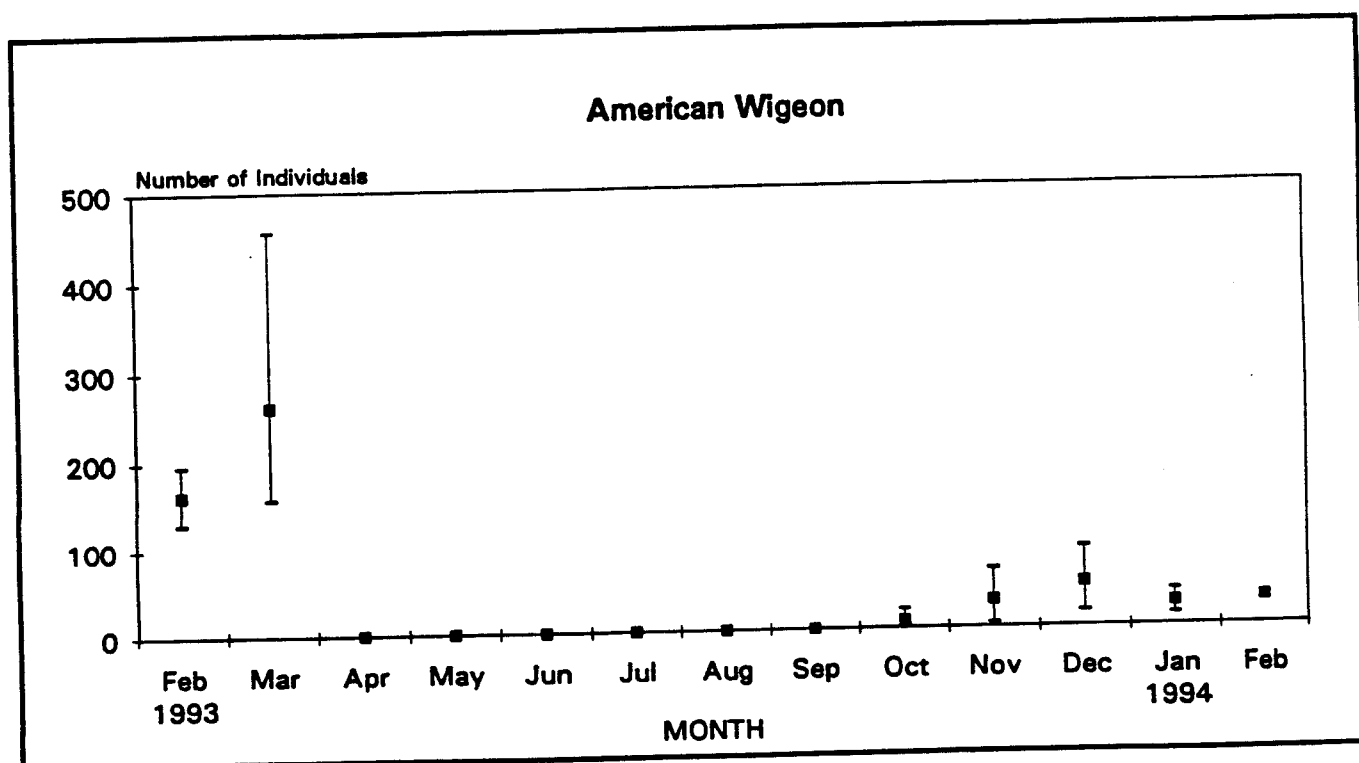
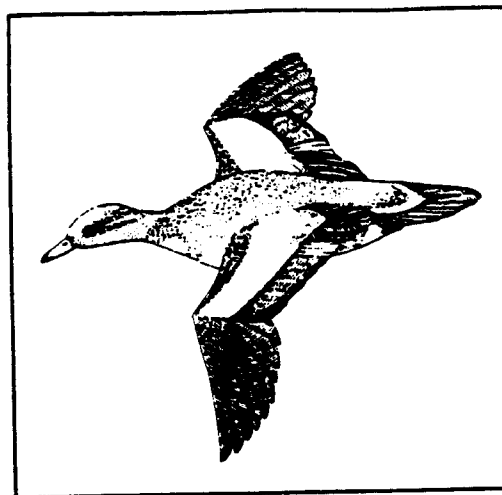


51 - 100% Occurrence

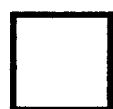
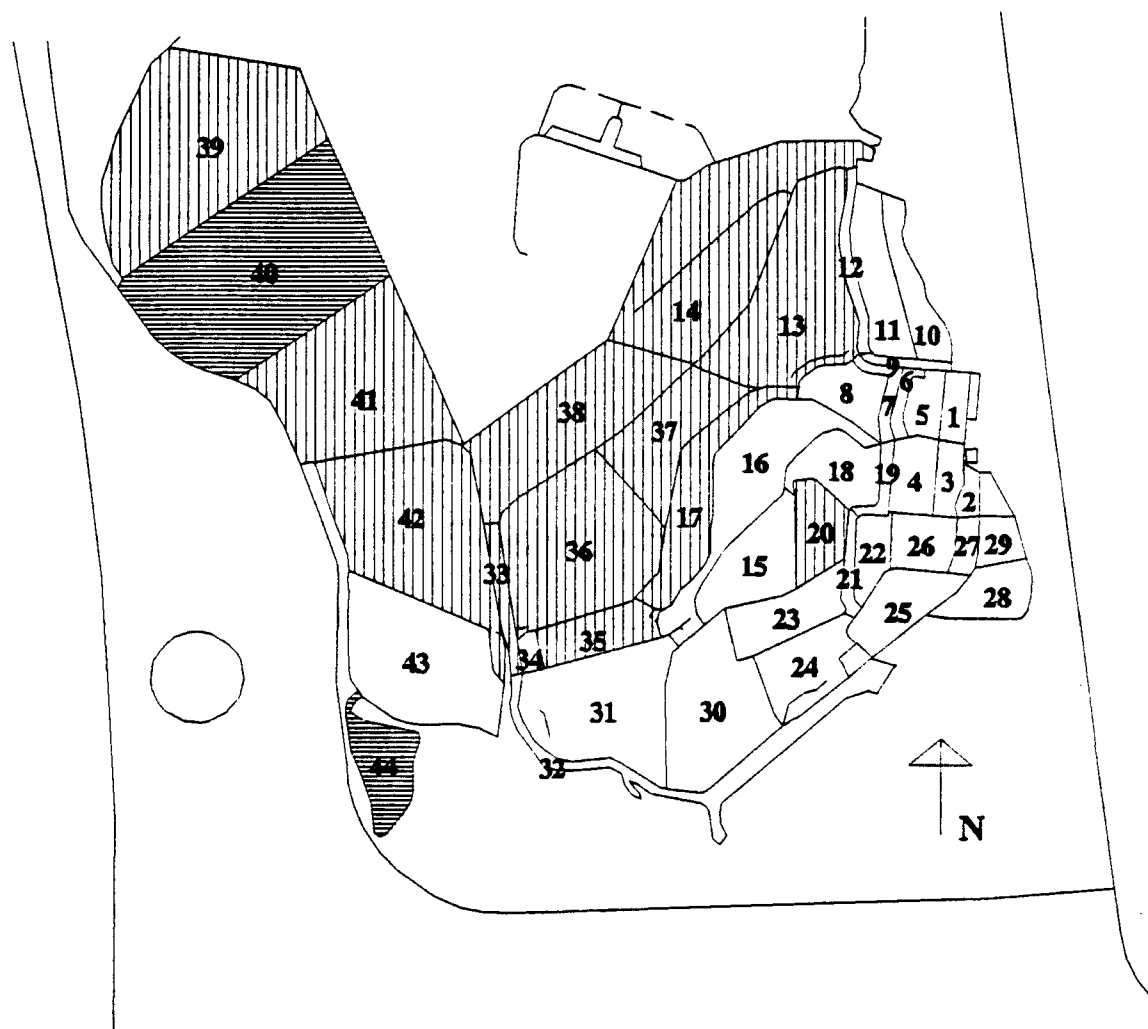
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

American Wigeon (*Anas americana*)

This species occurred in the late fall and was present throughout the winter months with a peak of abundance in March. American wigeons were most frequently recorded within cells 40 and 44. It is interesting to note that during 4 surveys in March, the number of individual American wigeon present within cell 38 ranged from 180 birds in the early part of March, peaked at 395, and dropped to 82 by the last survey date of the month. These variations are most likely attributed to migration as well as the tidal changes which during the March surveys ranged from 4.4 to 2.0.



American Wigeon



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

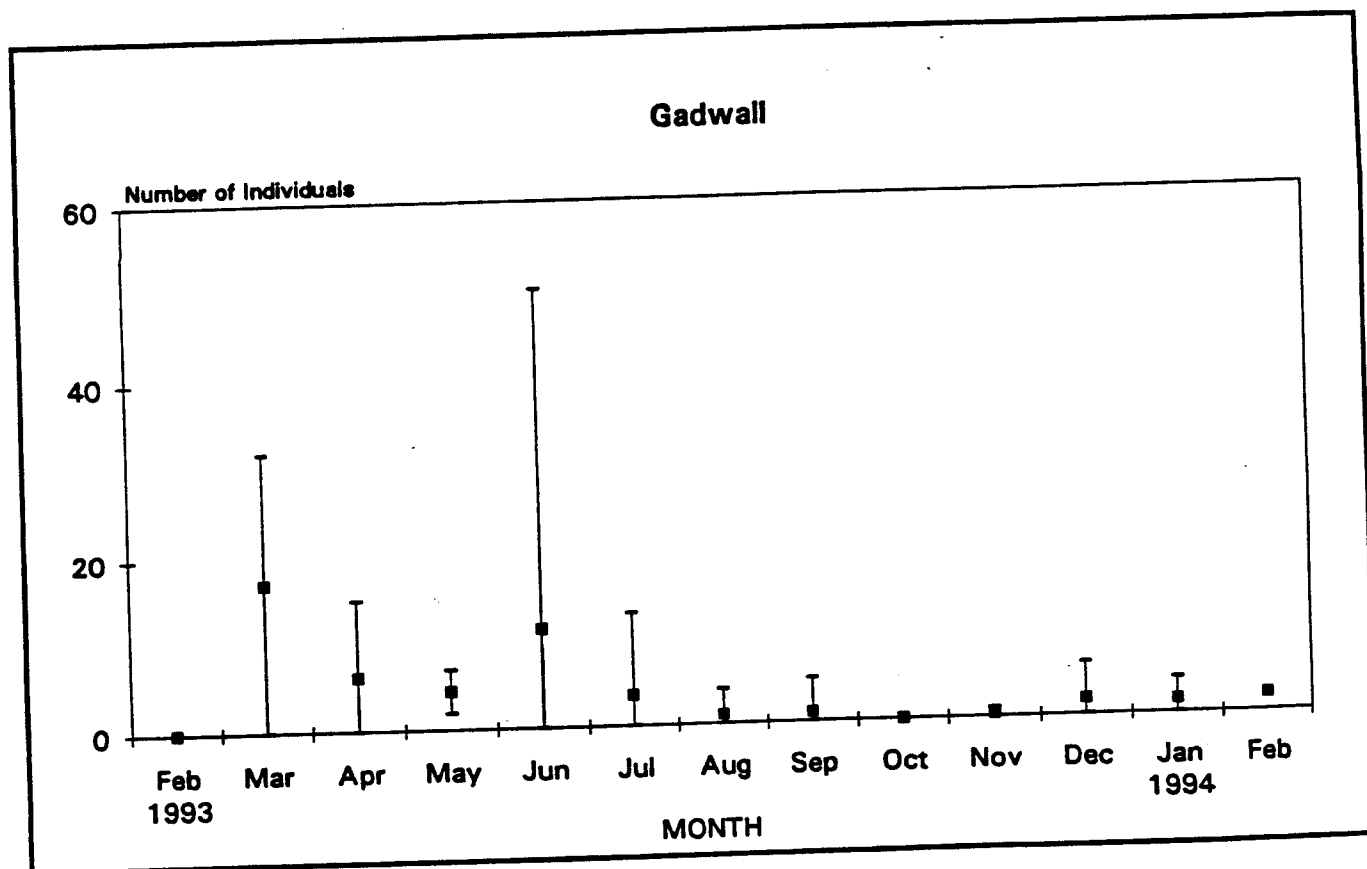
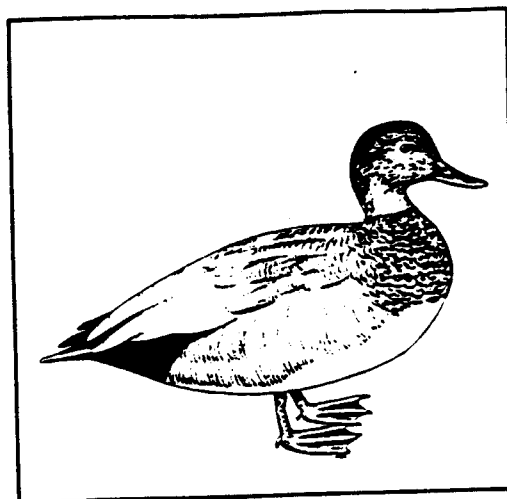


51 - 100% Occurrence

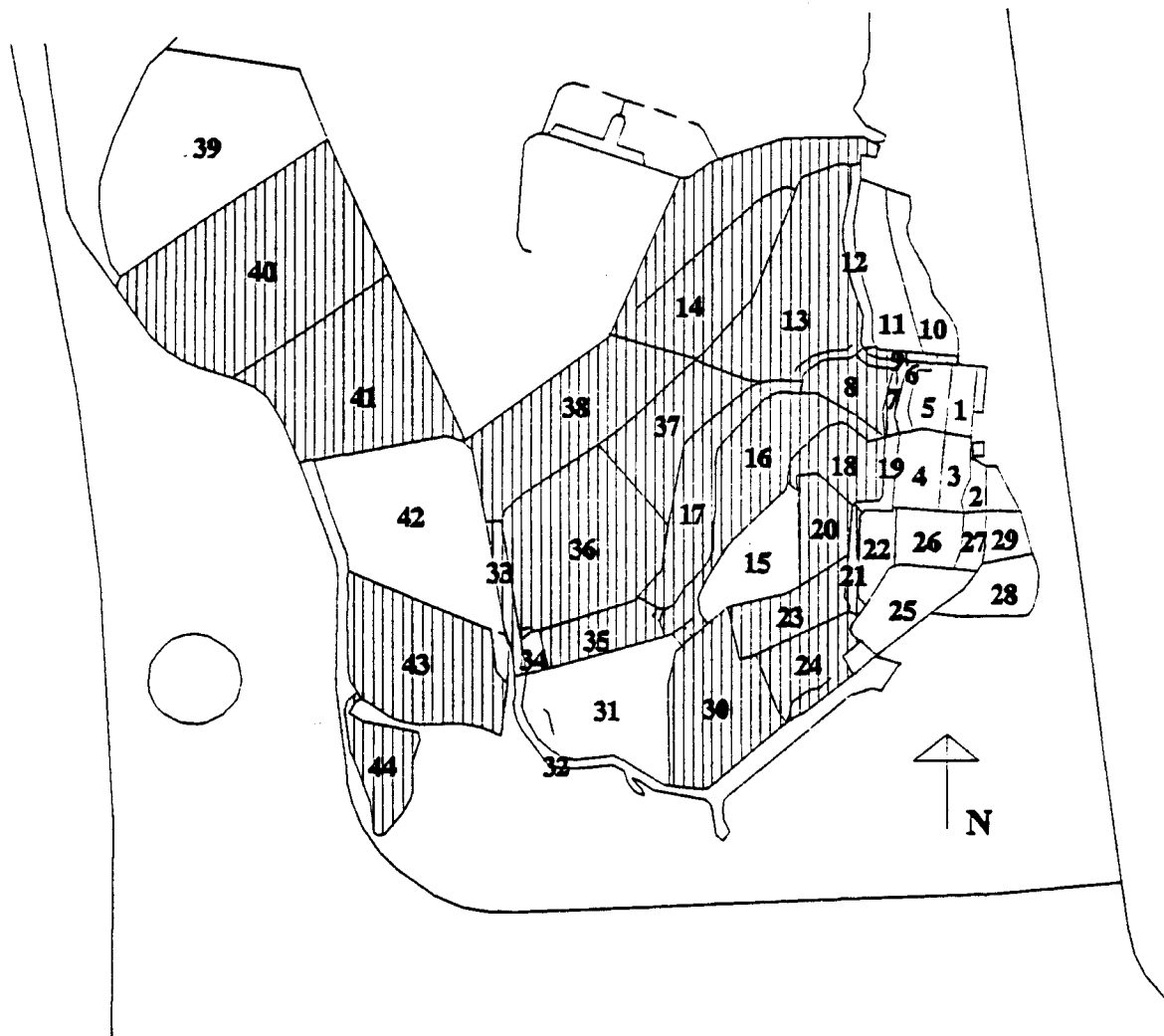
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Gadwall (*Anas strepera*)

Gadwall were present during 52% of the surveys and the number of individuals ranged from one to a high of 50 birds. This species was not encountered during October and only a single bird was observed at the study site in November. The high count in June is most likely attributable to the breeding population present at the Salt Works.



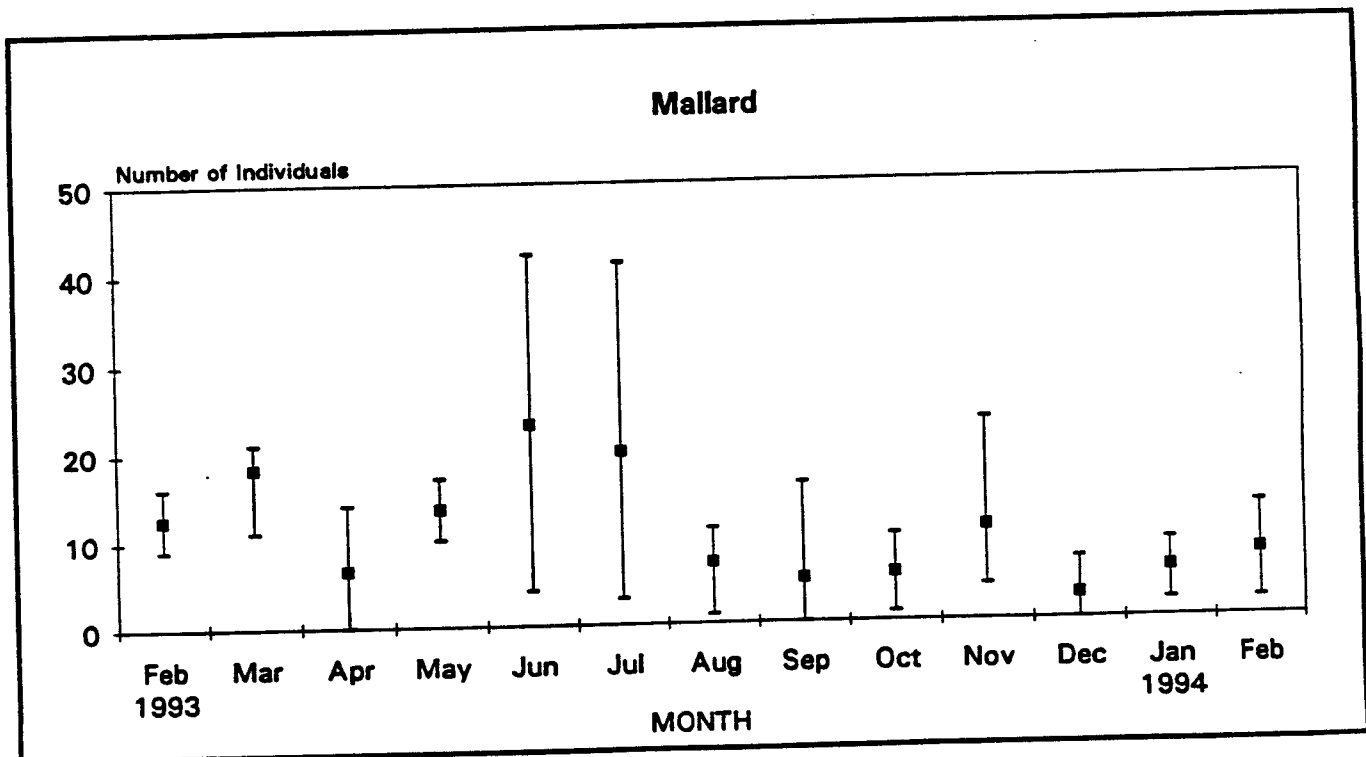
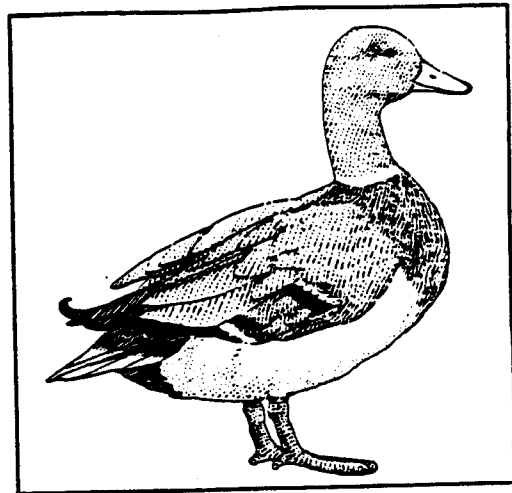
Gadwall



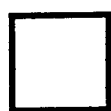
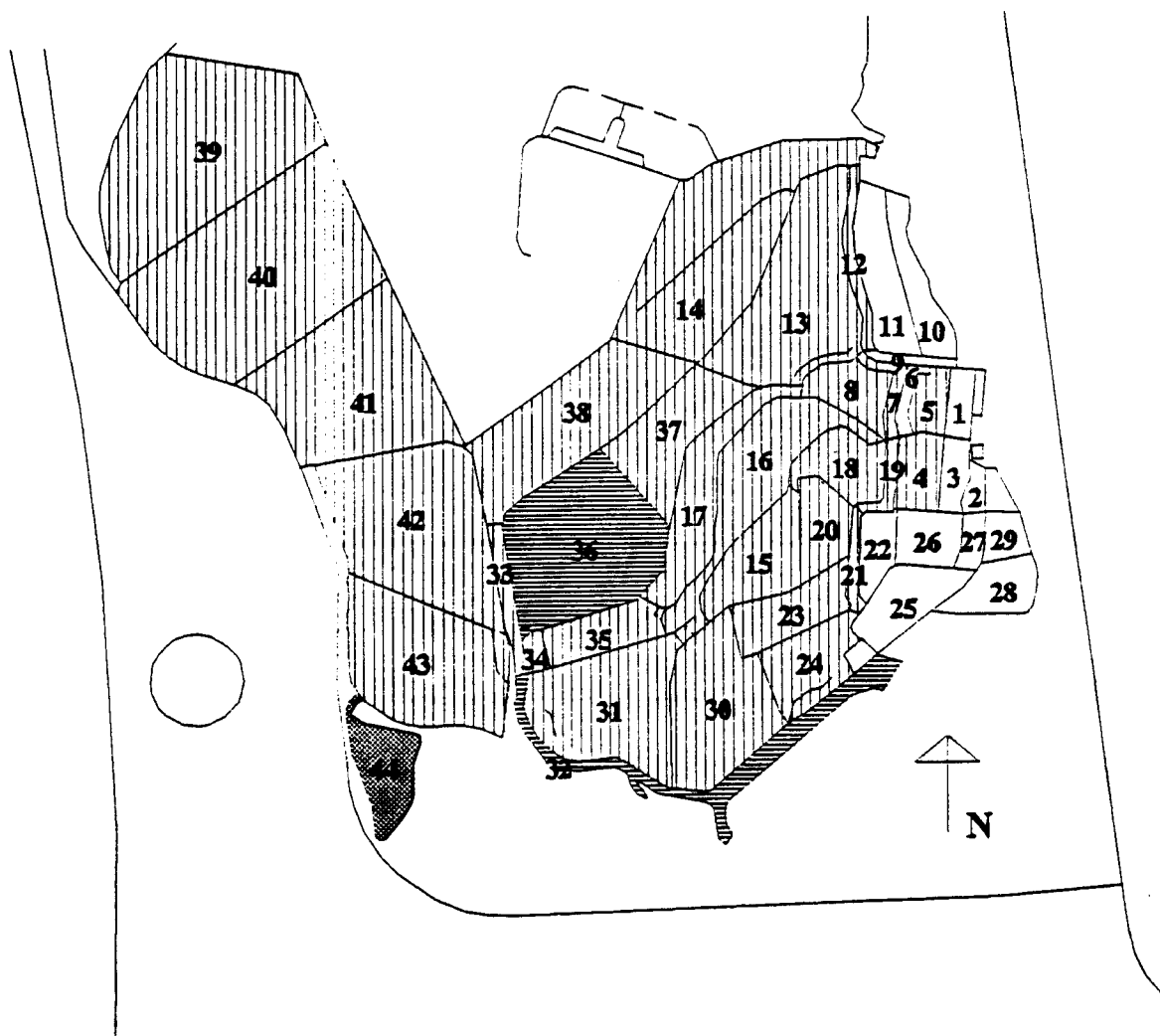
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Mallard (*Anas platyrhynchos*)

Mallards were observed in 31 of the 44 cells and were present during 88% of the surveys. The number of individuals ranged from one to 45 and were most frequently observed within cells 32, 36, and 44. Higher abundance during the summer months was most likely a result of the existing breeding population of this year round resident.



Mallard



0% Occurrence



1 - 19% Occurrence



20 - 50% Occurrence



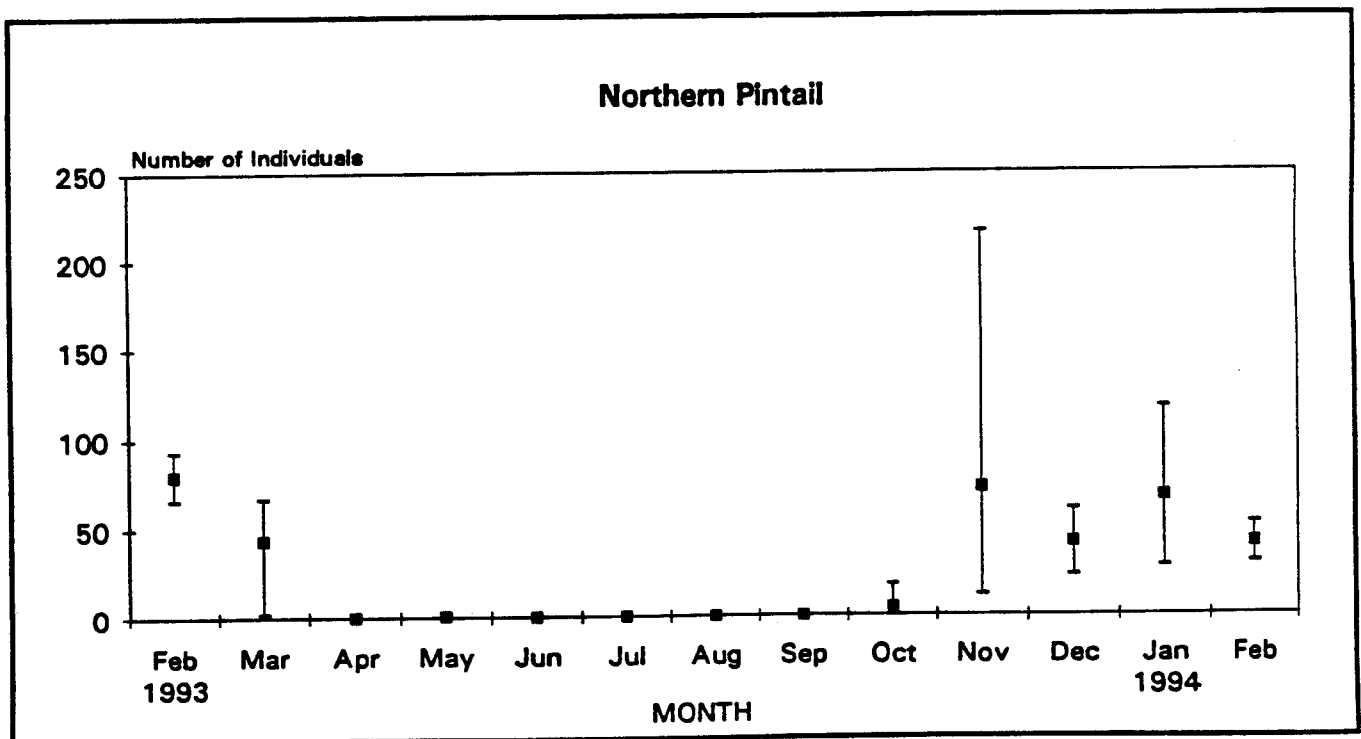
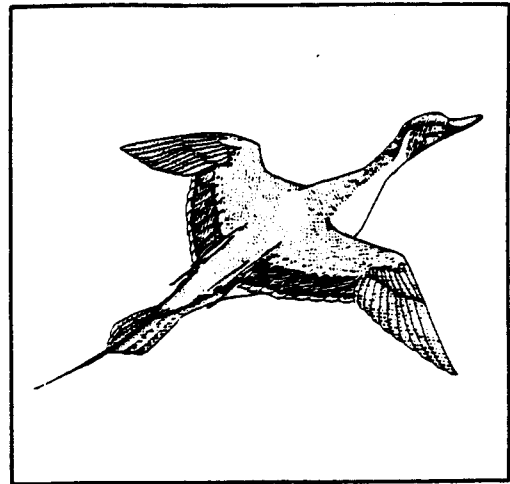
51 - 100% Occurrence

Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

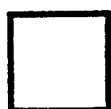
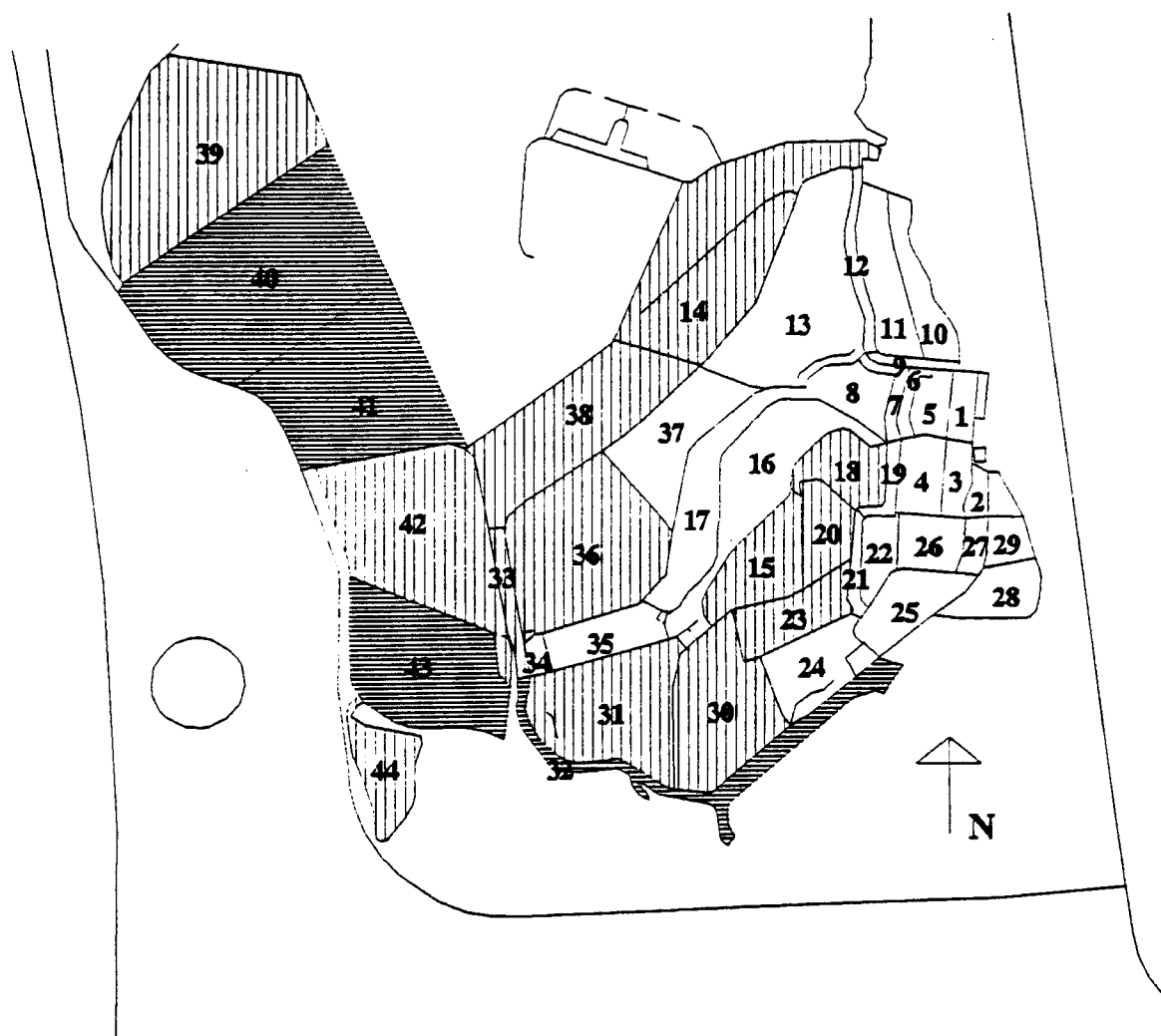
Northern Pintail

(*Anas acuta*)

Northern pintails were most abundant during fall migration and resided within the study area over the winter months. Peak abundance occurred during the November 17, 1993 survey in which 216 individuals were counted. This species was most frequently detected within survey units 32, 40, 41 and 43.



Northern Pintail



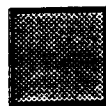
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence



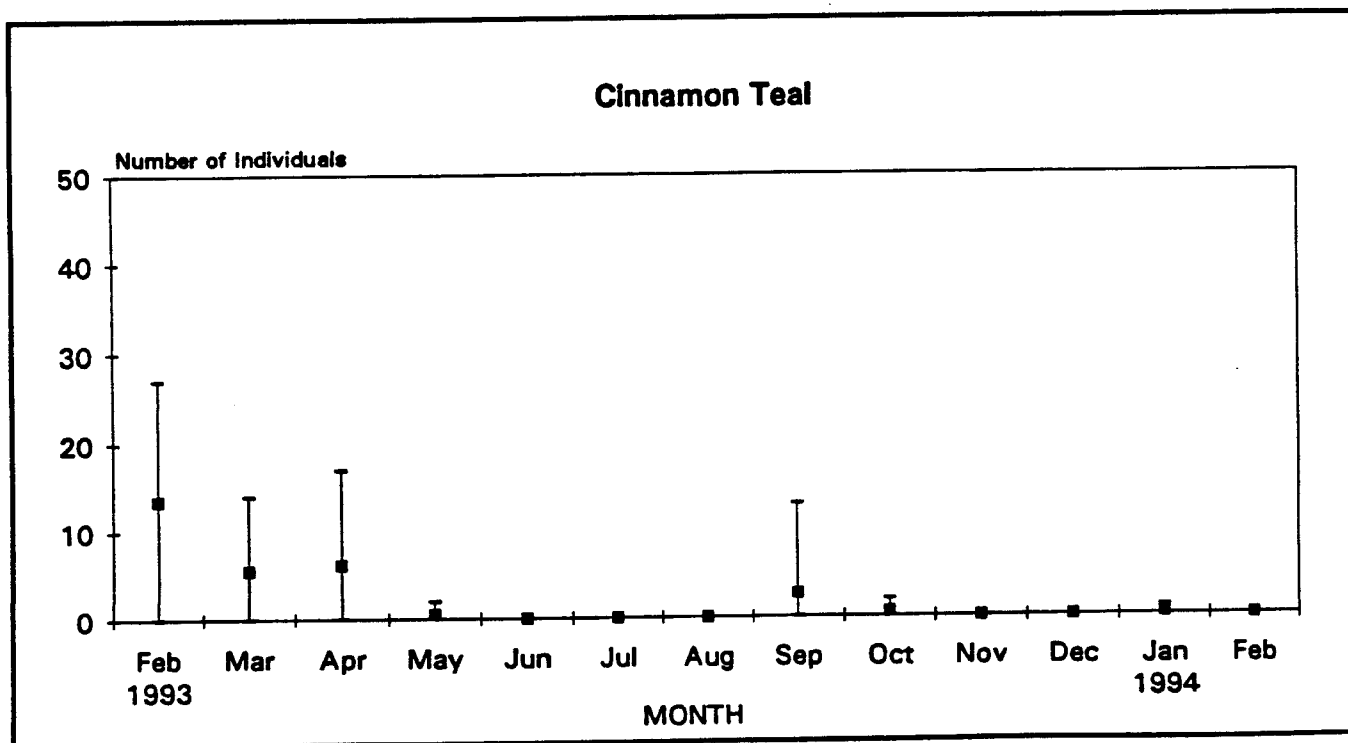
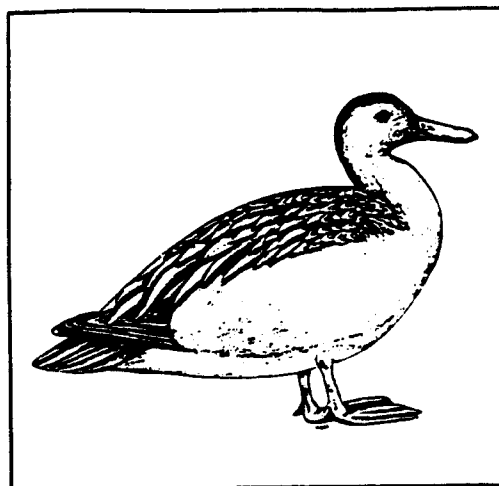
51 - 100% Occurrence

Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

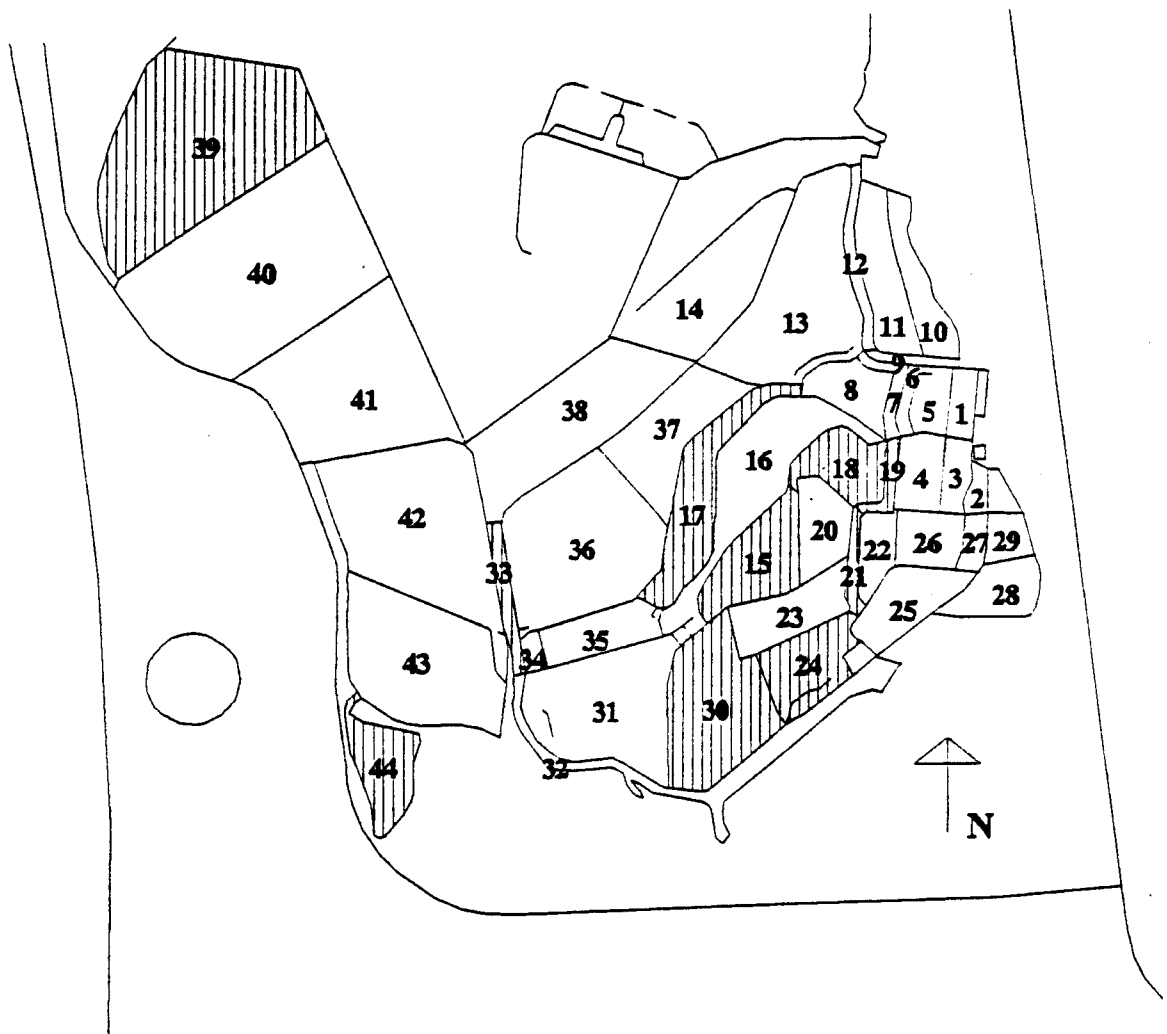
Cinnamon Teal

(*Anas cyanoptera*)

Cinnamon teal were present during the spring and fall migratory periods and were distributed in 10 of the 44 survey areas. The high count for this species was 27 individuals all located within cell 24 on February 24, 1993.



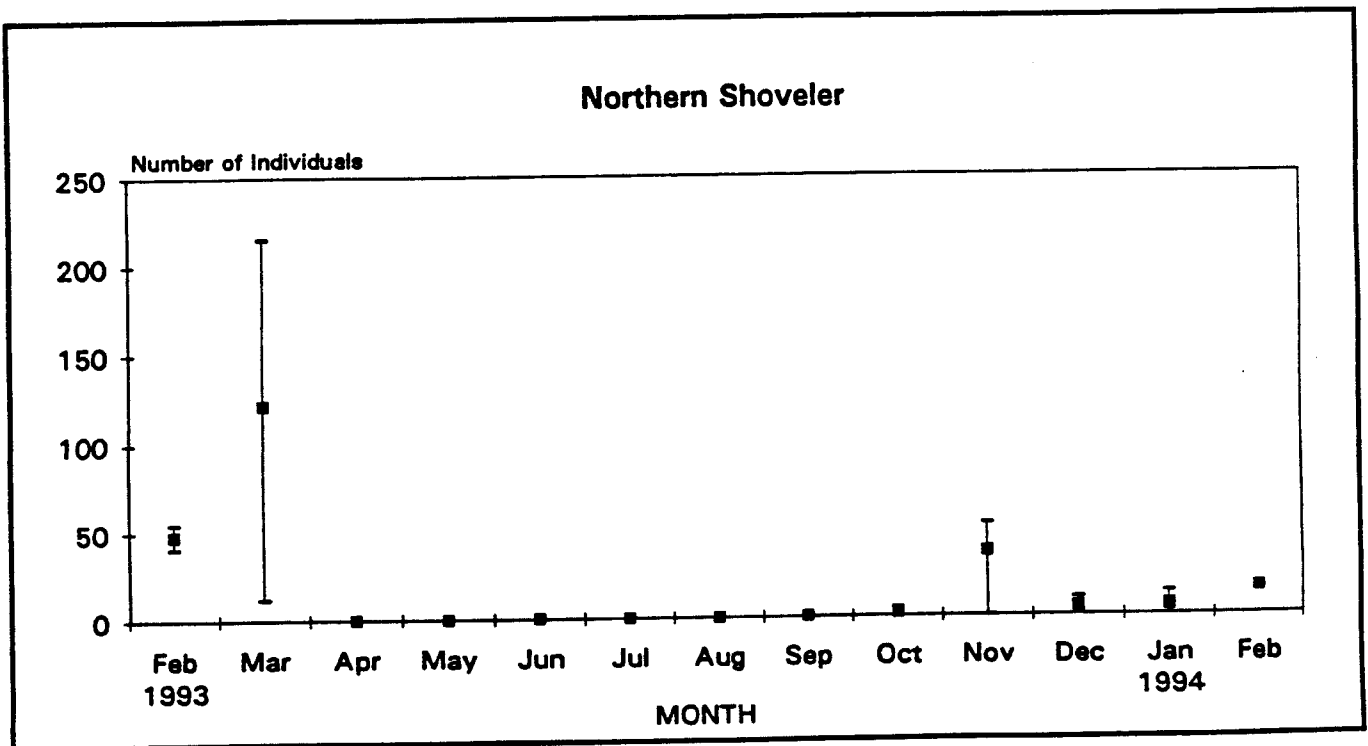
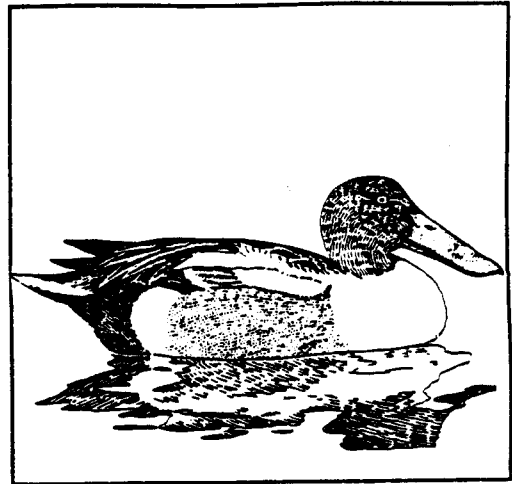
Cinnamon Teal



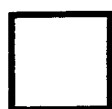
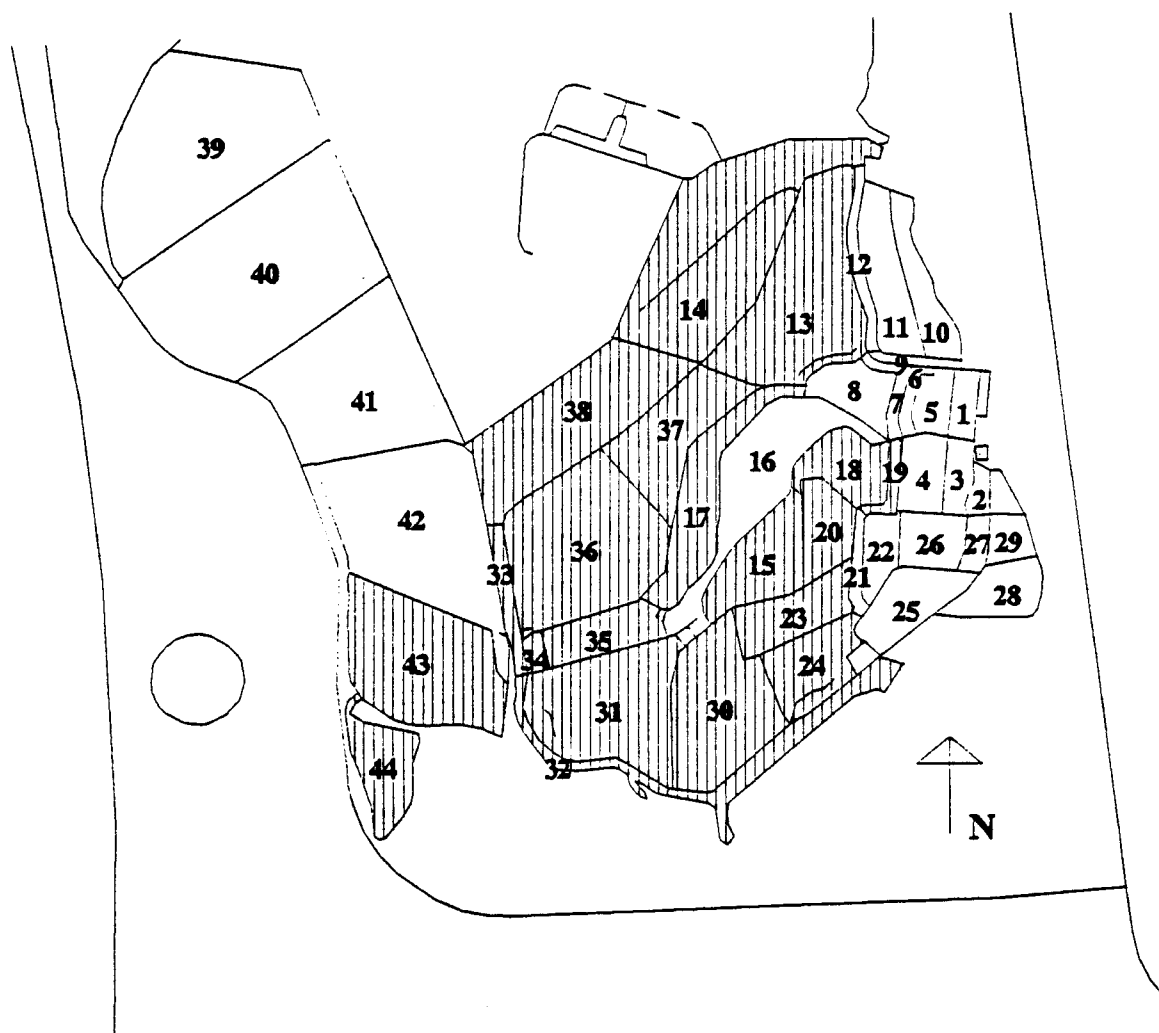
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Northern Shoveler (*Anas clypeata*)

This species was observed at 21 of the 44 survey units. While northern shovelers were present during both the fall and spring migratory periods, abundance was much greater in the latter. In addition, from two to 16 individuals overwintered at the study site. Peak abundance for the northern shoveler was reported on March 17, 1993 which included 200 individuals located within cell 20.



Northern Shoveler



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

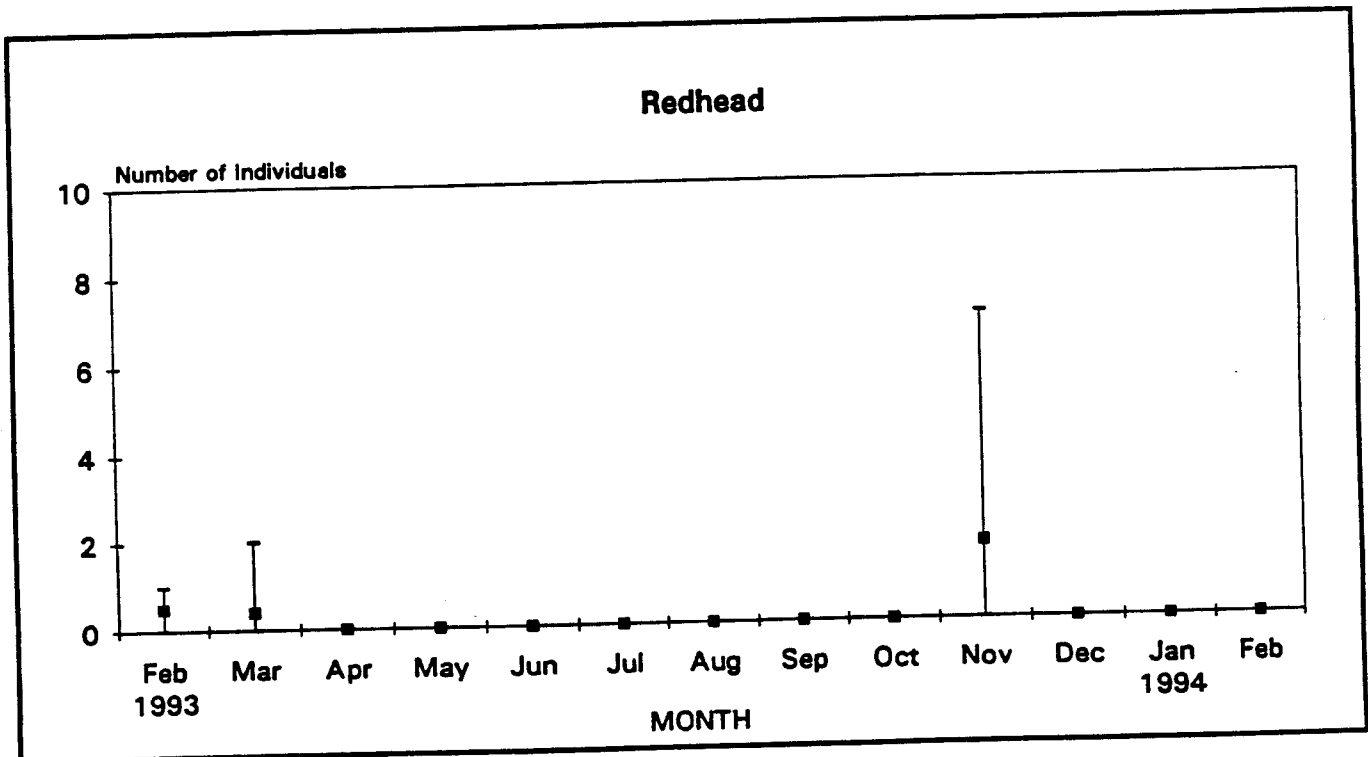
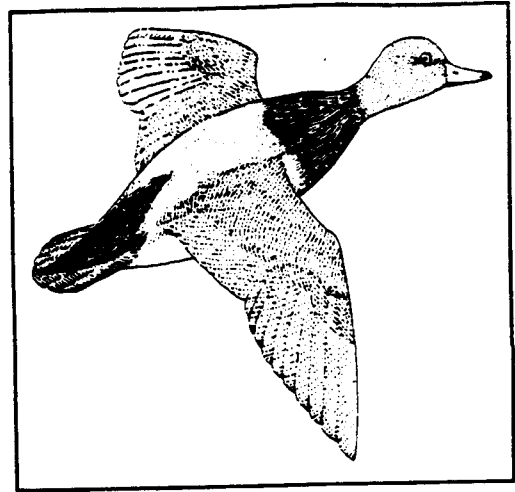


51 - 100% Occurrence

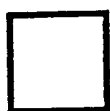
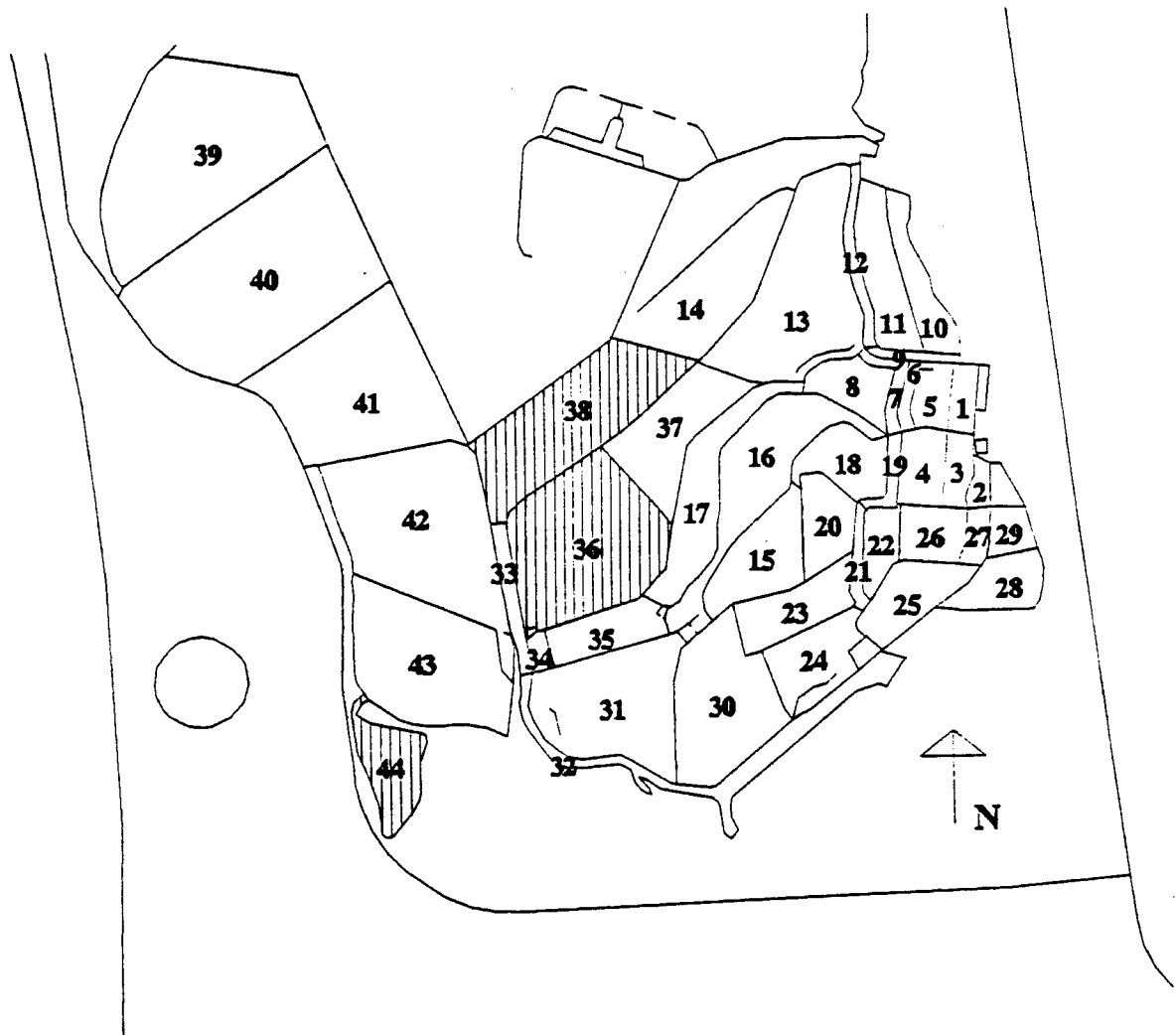
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Redhead (*Aythya americana*)

This species was encountered on only three occasions with a high of seven birds located within cell 38 during the November 24, 1993 survey.



Redhead



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

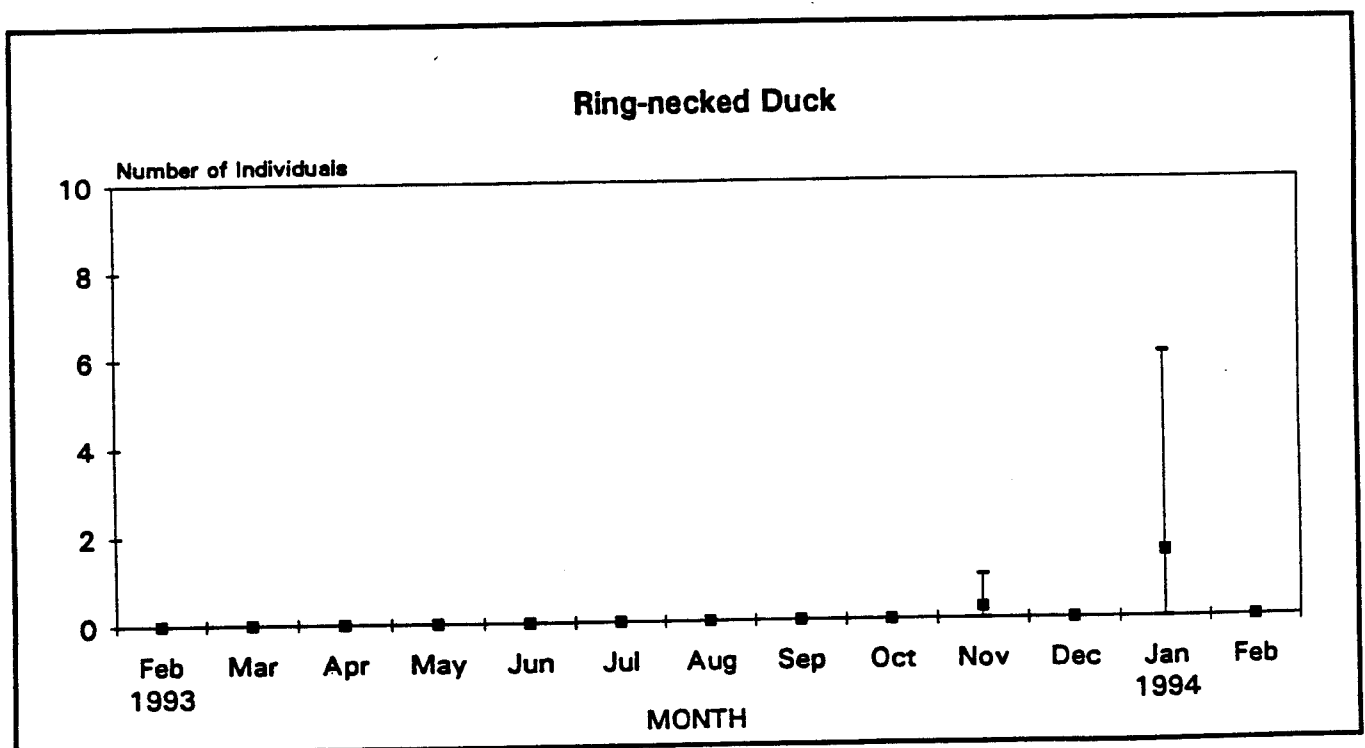
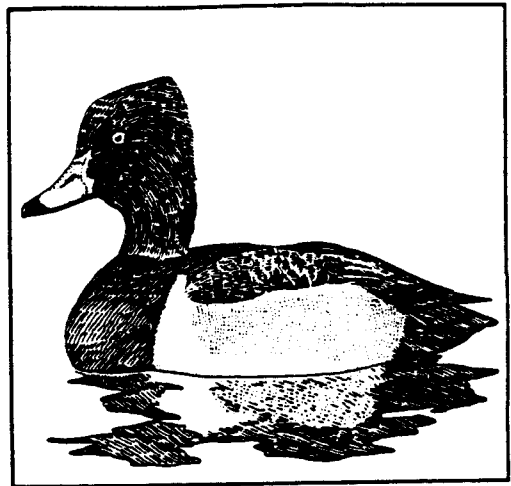


51 - 100% Occurrence

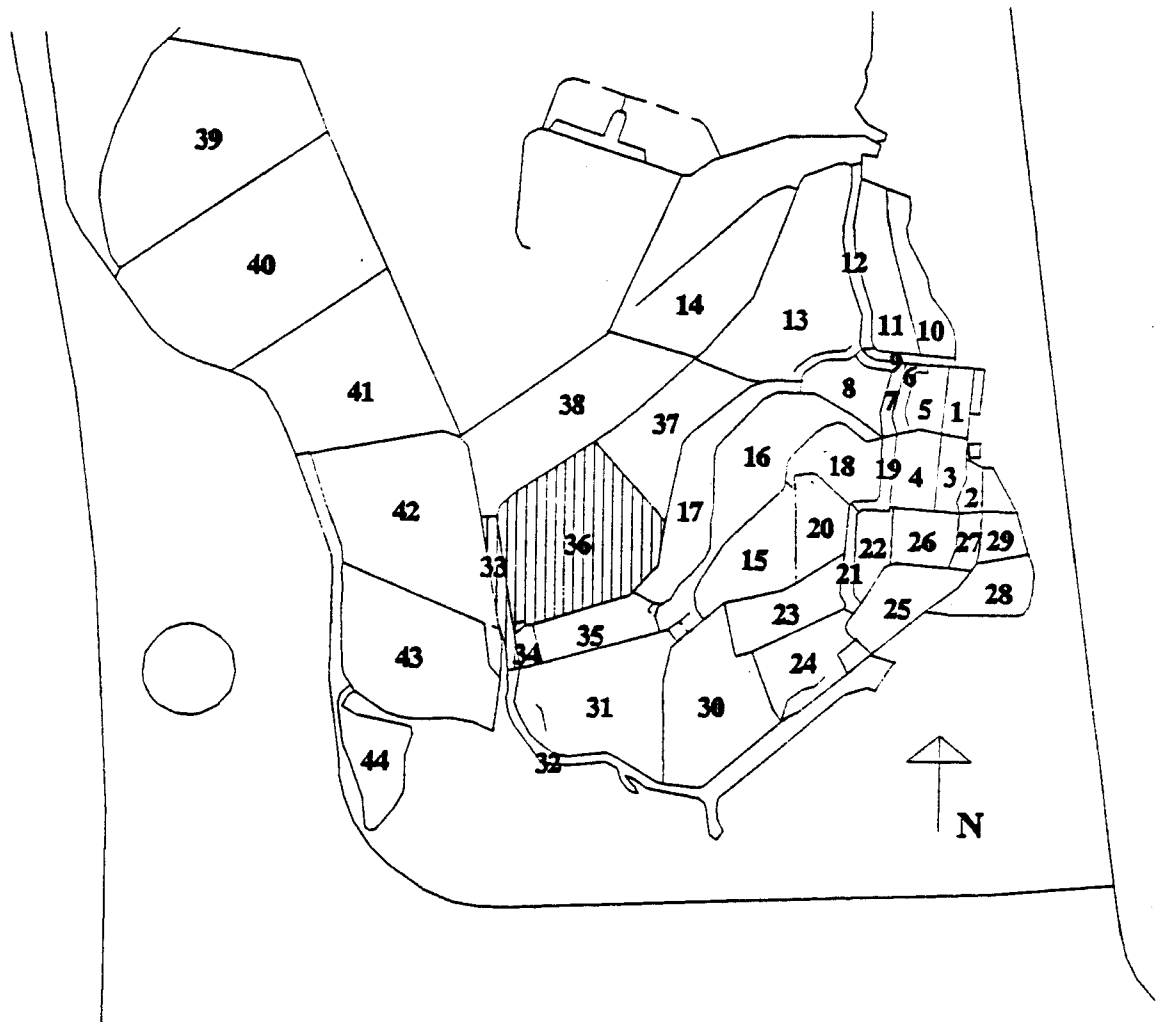
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Ring-necked Duck (*Aythya collaris*)

Ring-necked duck was observed on two occasions. An individual was detected within cell 36 on November 17, 1993 and six birds were reported from cell 33 on January 5, 1994.



Ring-necked Duck



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

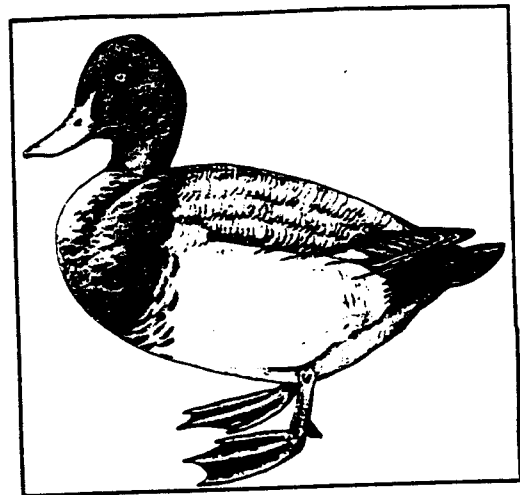


51 - 100% Occurrence

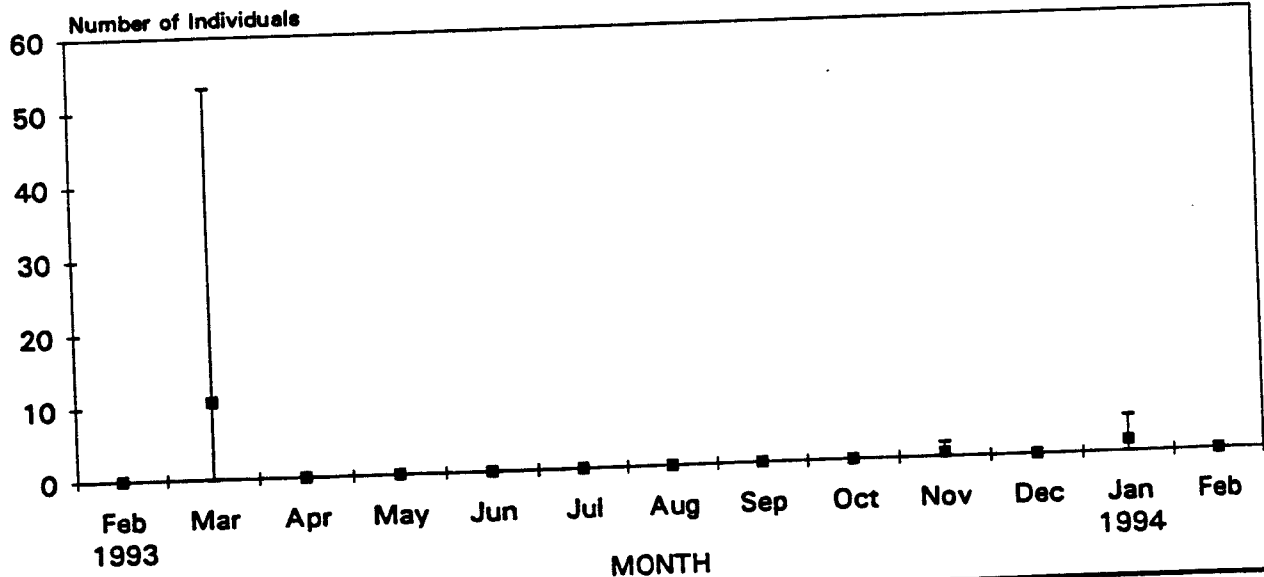
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Greater Scaup (*Aythya marila*)

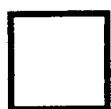
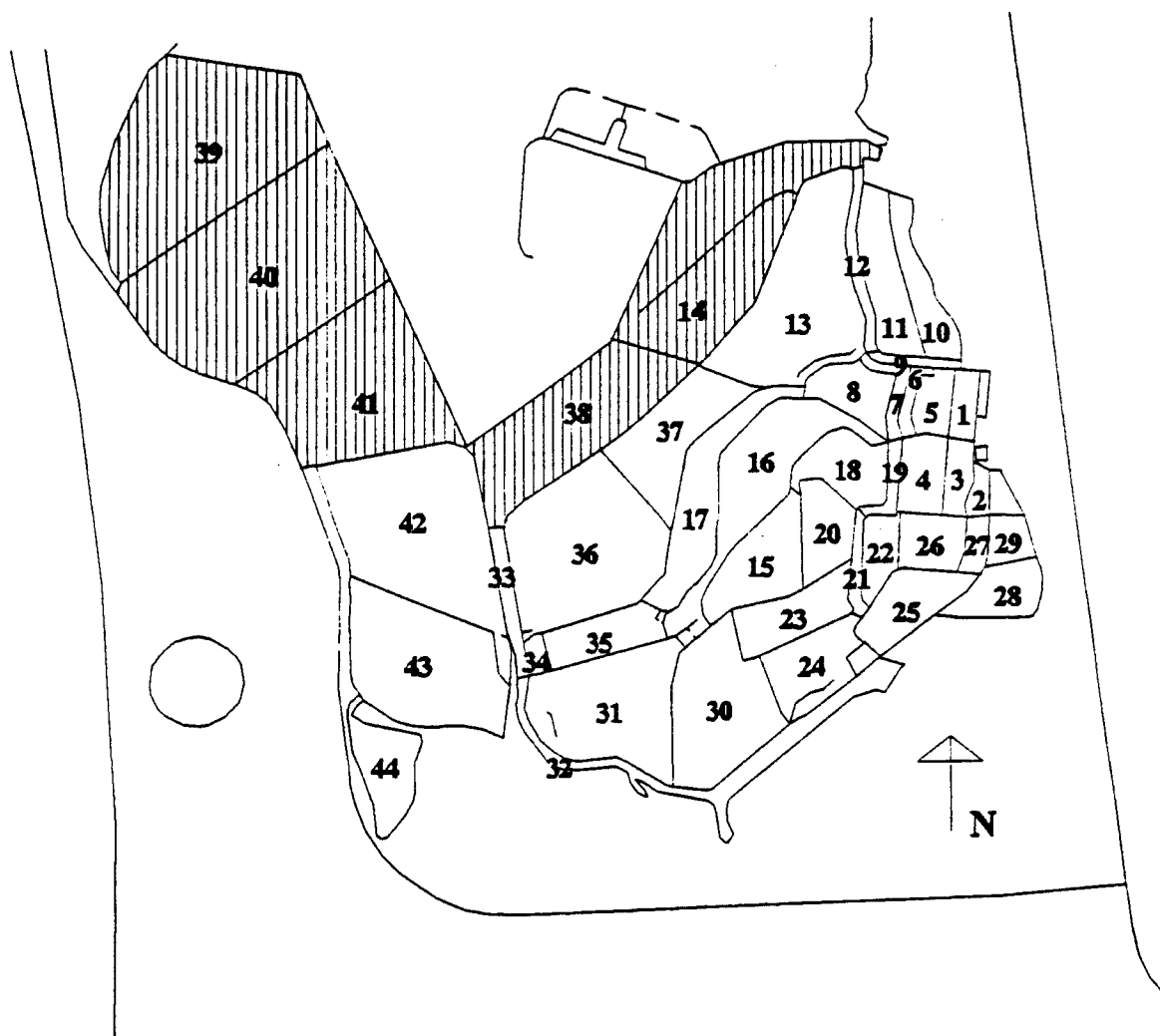
Greater scaup were detected at the study site during four surveys and were located only within cells which encompassed San Diego Bay. Individuals were present within survey units 14, 38, 39, 40 and 41. A high count of 53 birds was reported on March 3, 1993. Although this species is considered a rare winter visitor in San Diego, greater scaup may have been under represented in this survey because of the difficulty in distinguishing them from the more abundant lesser scaup.



Greater Scaup



Greater Scaup



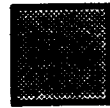
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

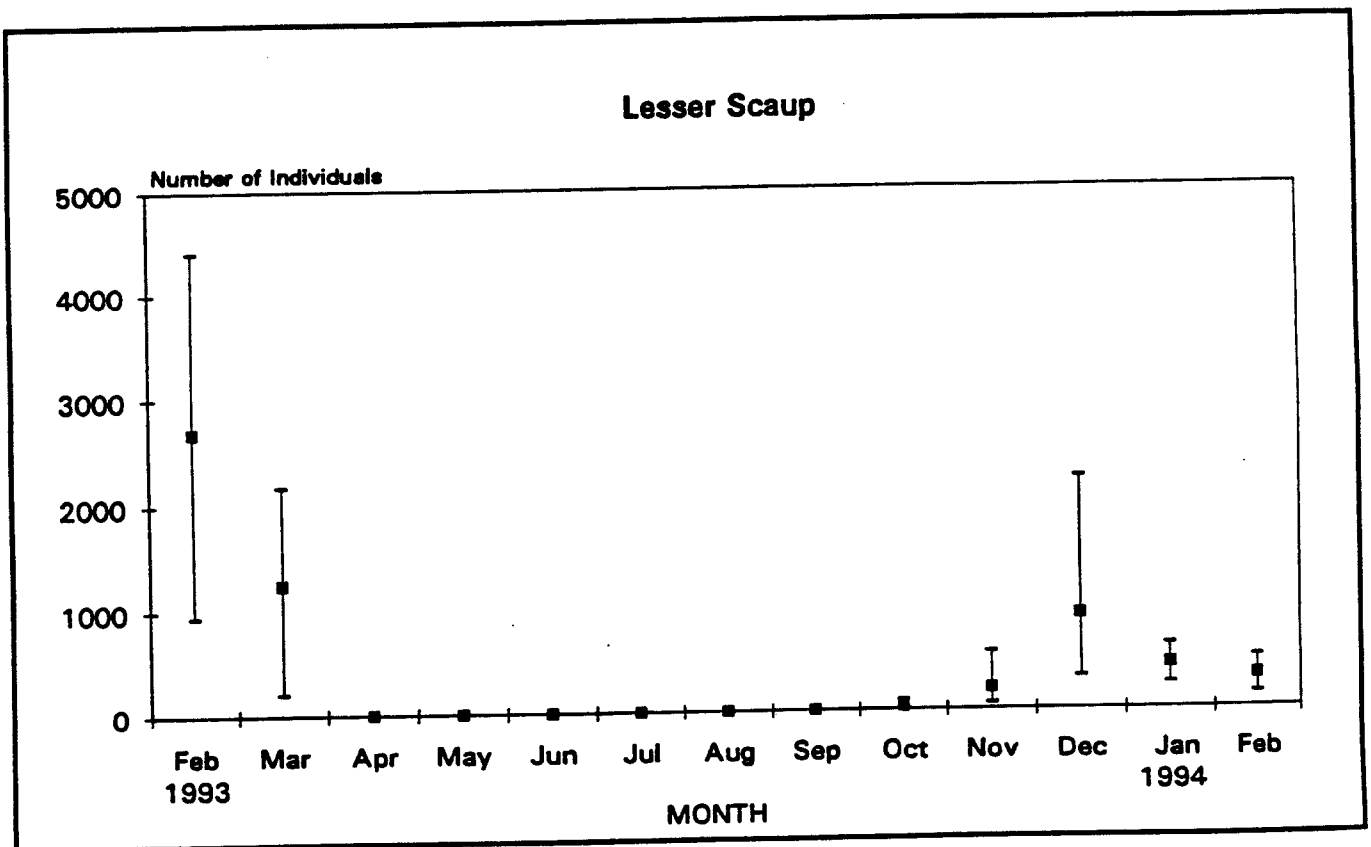
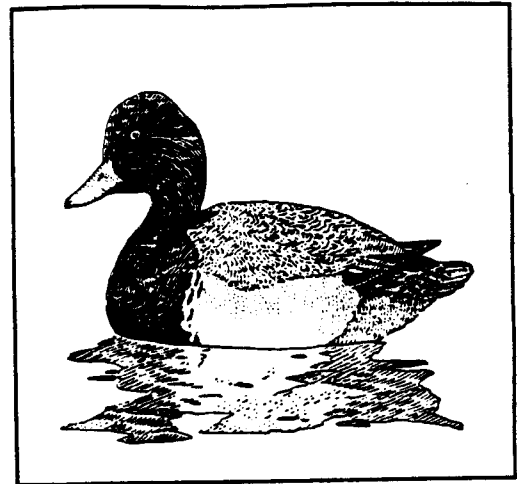


51 - 100% Occurrence

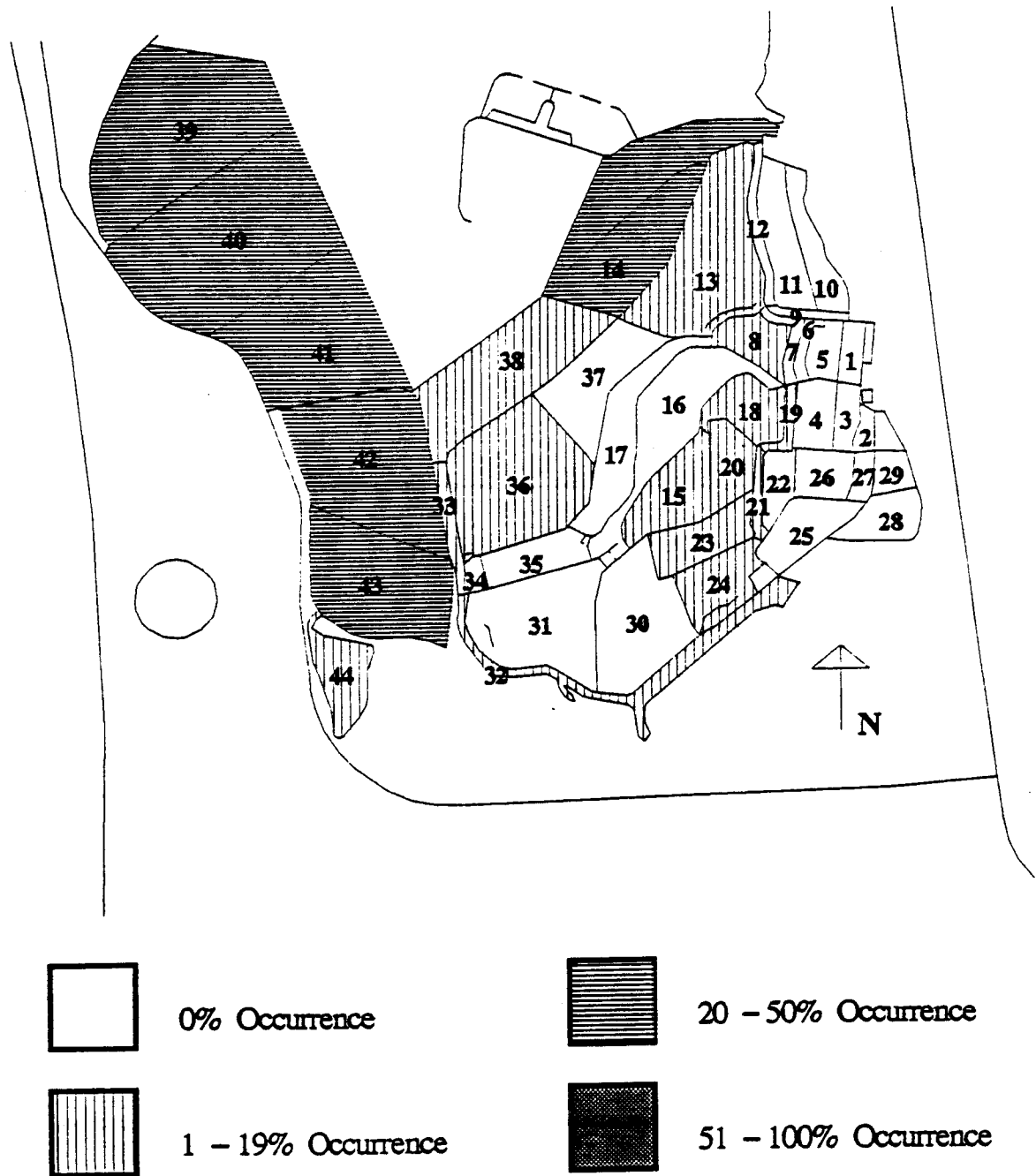
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Lesser Scaup (*Aythya affinis*)

Of the overall total abundance for waterfowl species, the lesser scaup comprised 45% of the individuals recorded. Peak abundance occurred during February 1993 at which time a high of 4409 individuals were present during a single survey. Although lesser scaup were found within 20 of the 44 survey units, they were most often observed within cell 14 and cells 39-43.



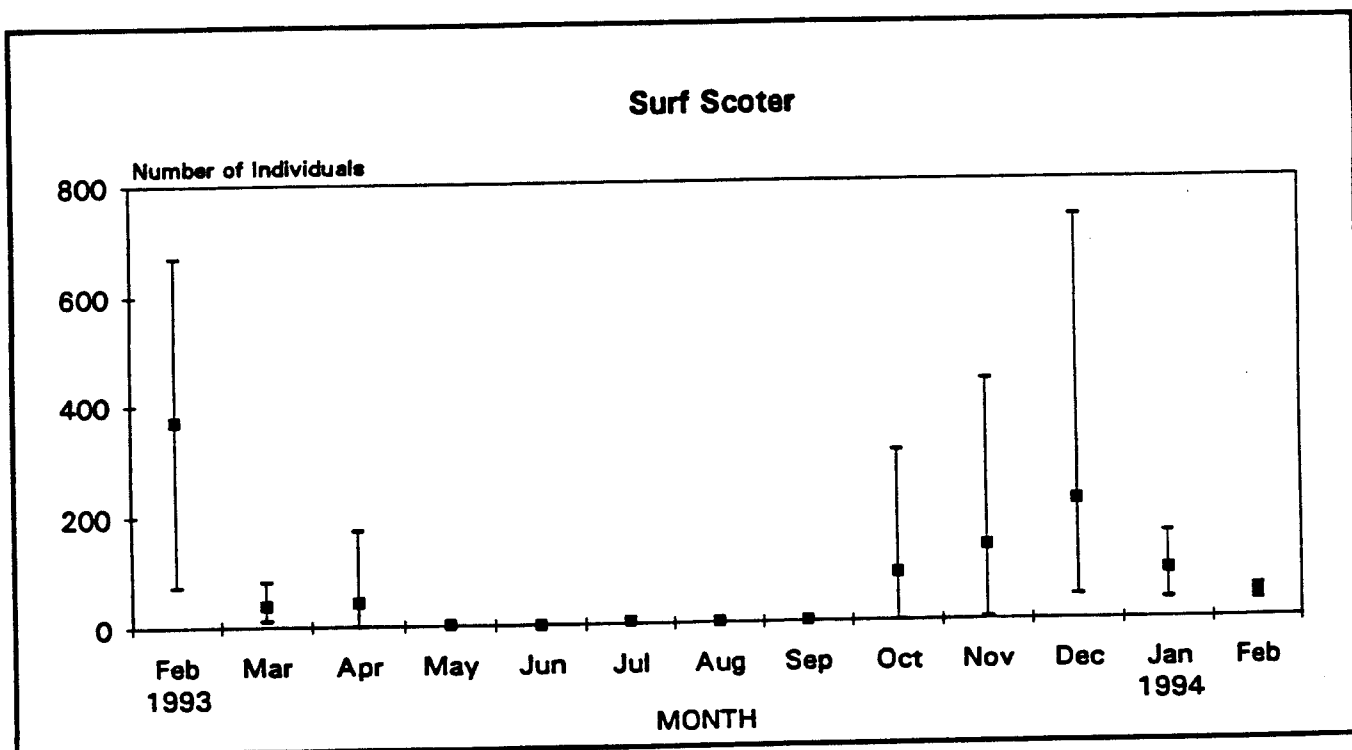
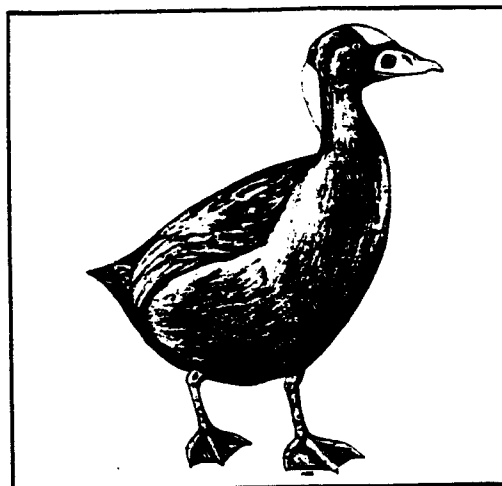
Lesser Scaup



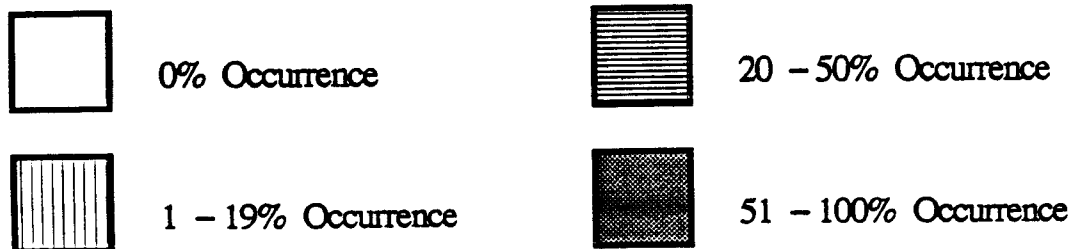
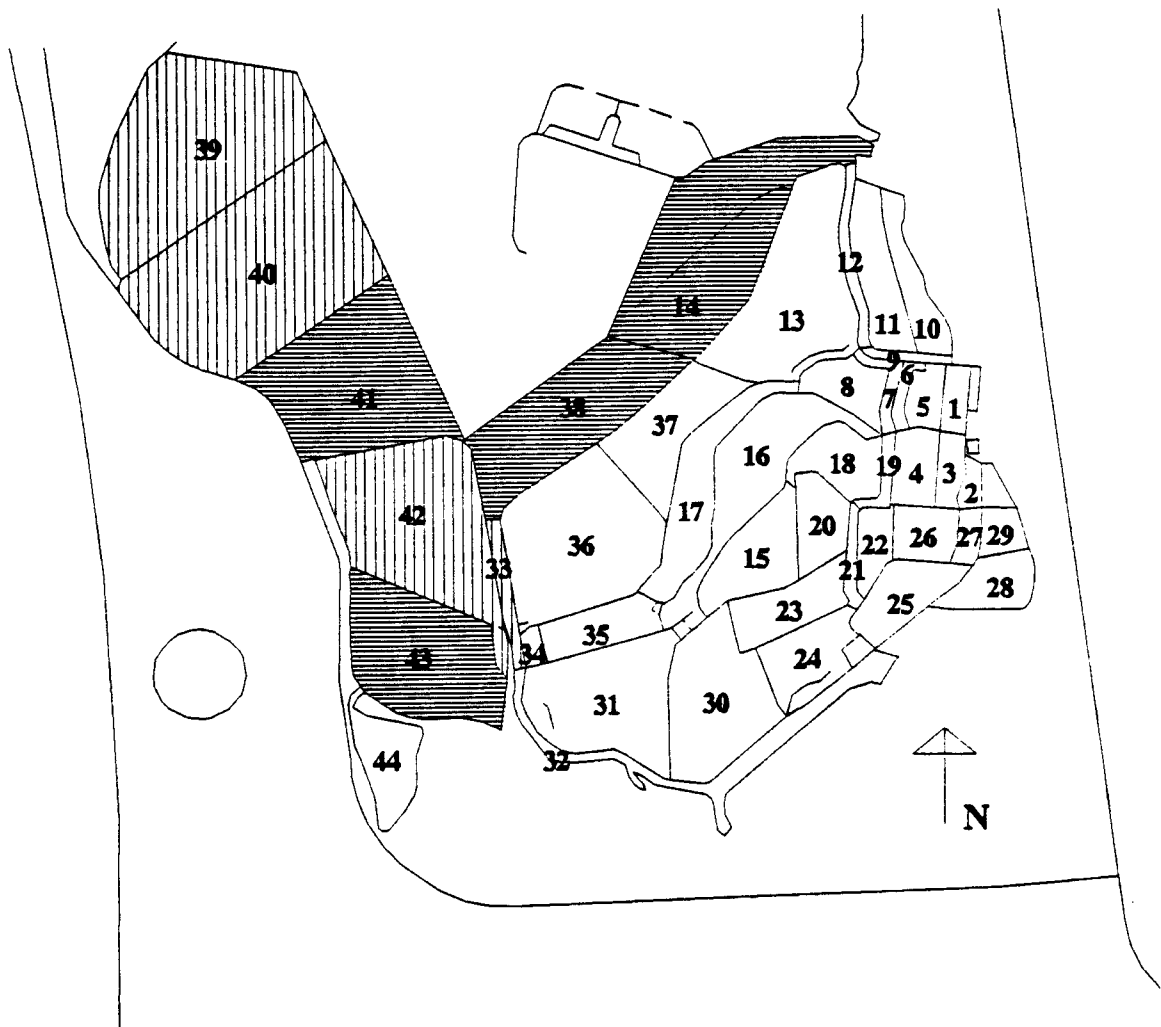
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Surf Scoter (*Melanitta perspicillata*)

Surf scoters were present at the study site during fall, winter, and early spring with peak abundance occurring in February 1993 and December 1993. Individuals were found within eight of the 44 survey units and were most frequently observed within cells 14, 38, 41, and 43. The high count for surf scoters occurred during the December 1, 1993 survey at which time over 700 individuals were recorded.



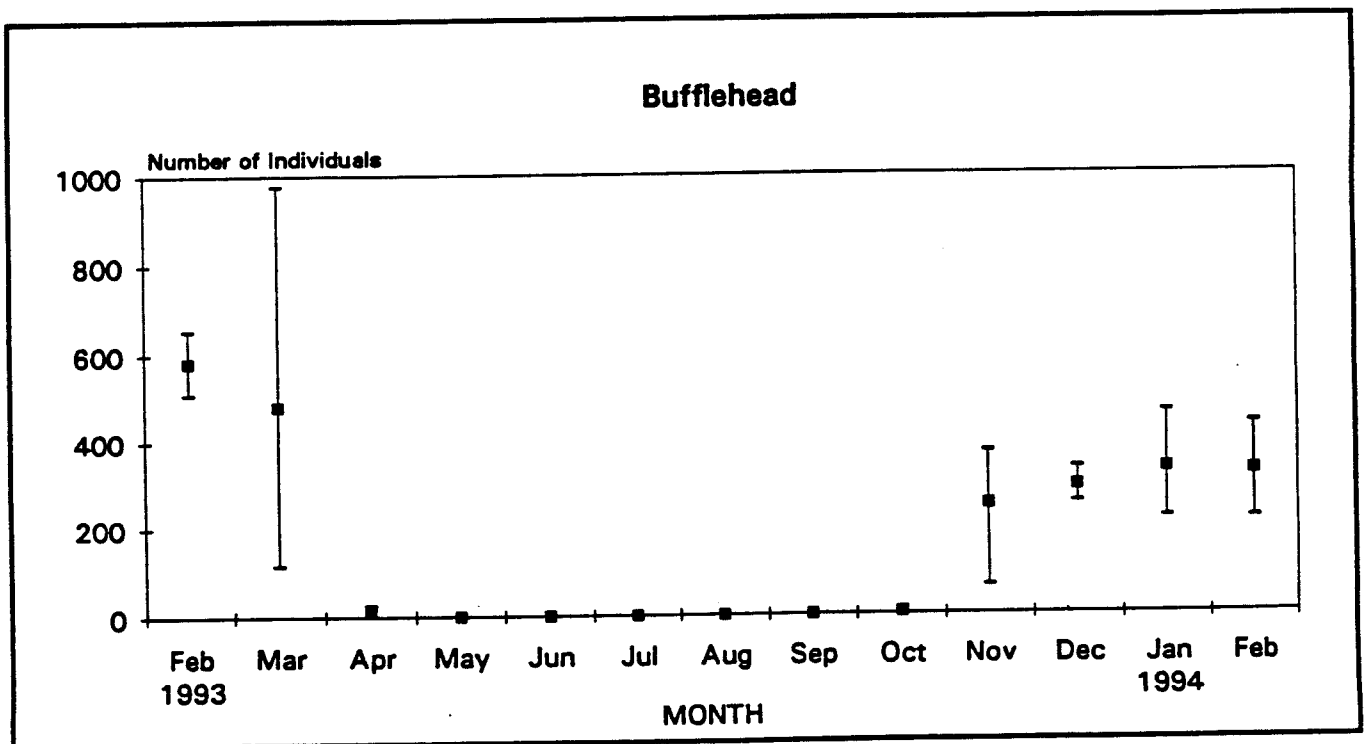
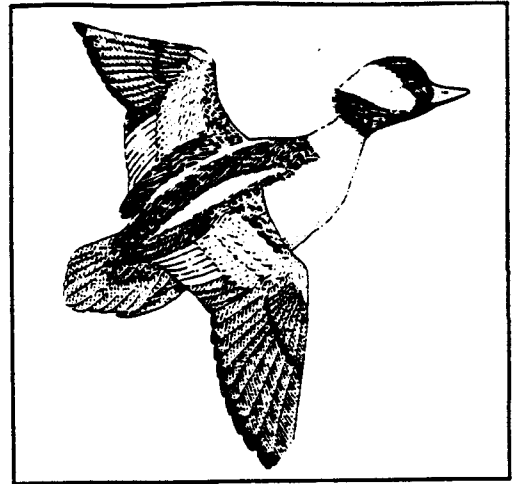
Surf Scoter



Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Bufflehead *(Bucephala albeola)*

Buffleheads were present during the fall, winter, and early spring months and were observed within 28 of the 44 survey units. Monthly averages remained relatively constant during the latter part of the survey year indicating a wintering population of approximately 300 individuals. The single survey high count of 976 individuals was recorded on March 3, 1993.



Bufflehead



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

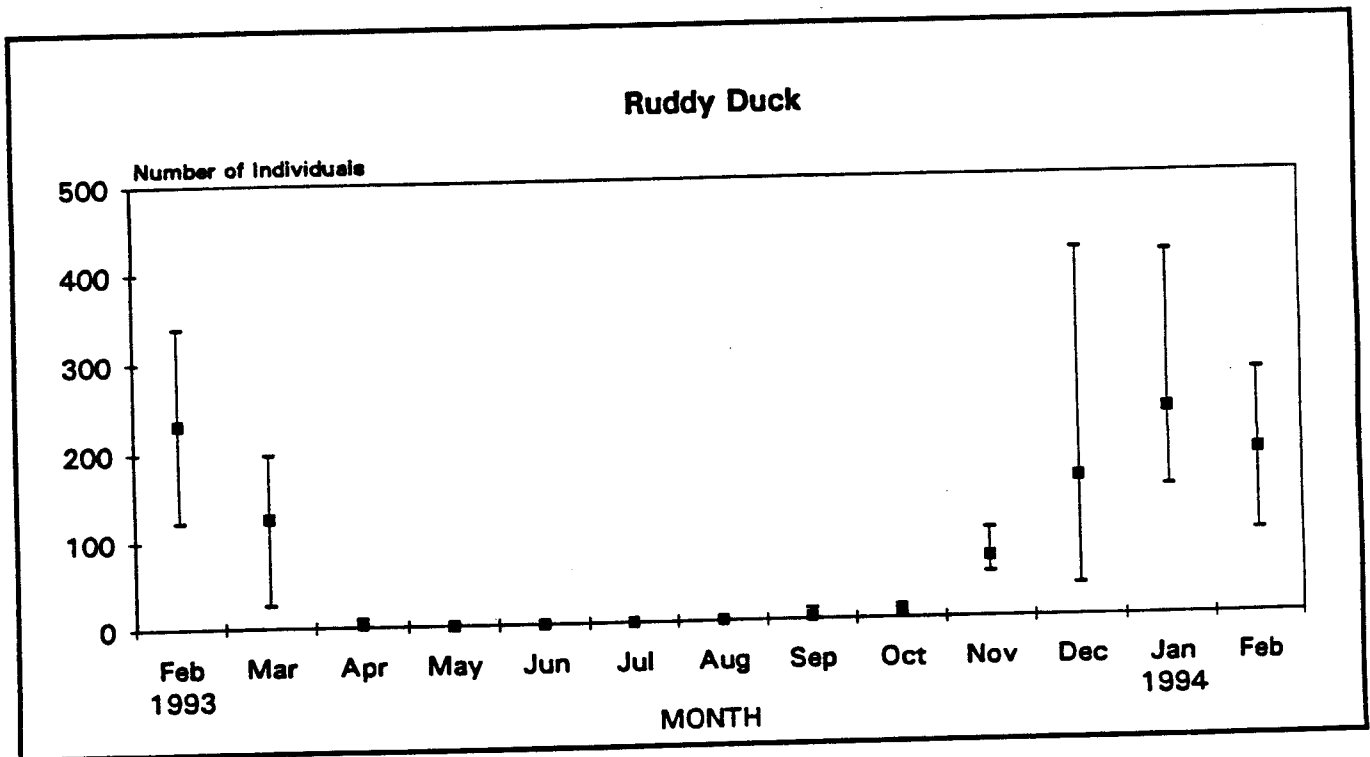
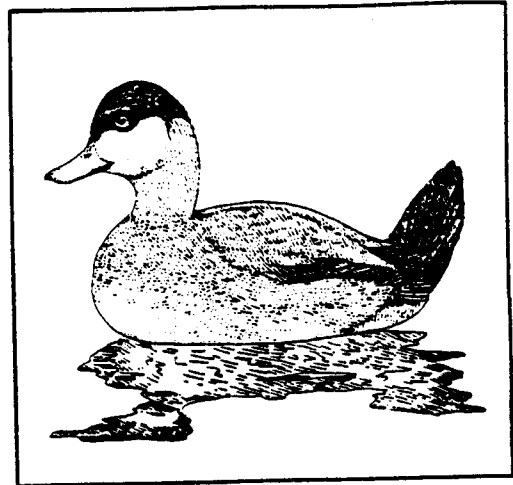


51 - 100% Occurrence

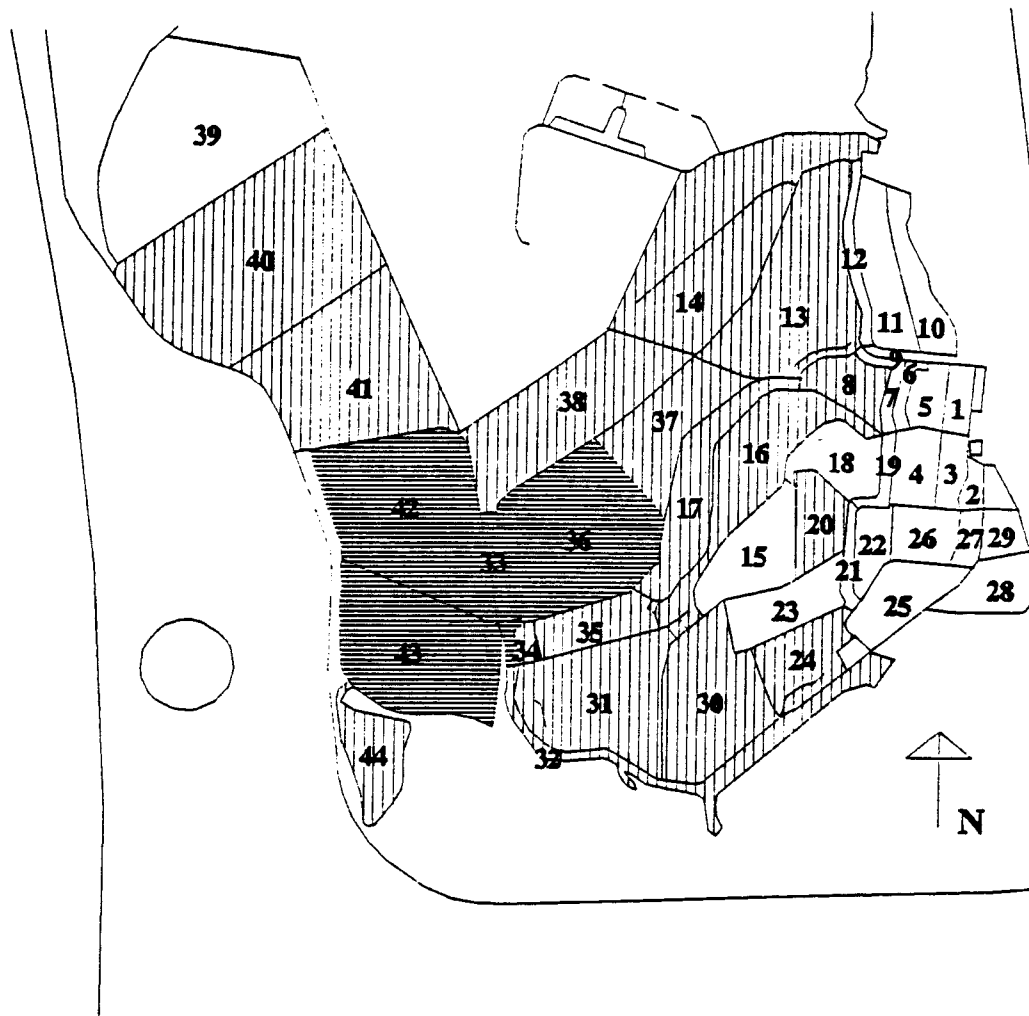
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Ruddy Duck (*Oxyura jamaicensis*)

Ruddy ducks were the third most abundant waterfowl species and were present at the study site during spring and fall migration as well as the winter months. Monthly averages peaked in January 1994 although the high count for this winter resident occurred in December 1993. Ruddy ducks were observed within 21 of the 44 survey units and were most frequently recorded within cells 33, 36, 42, and 43.



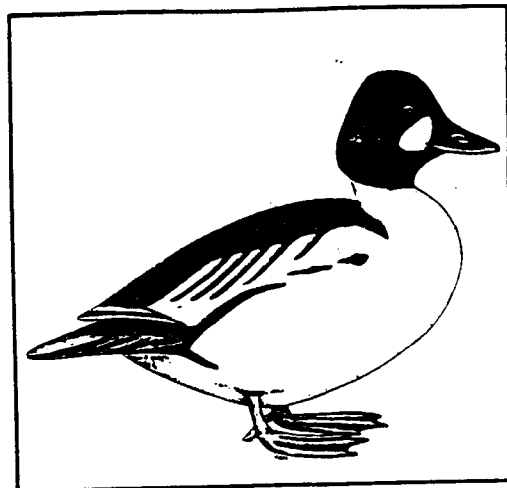
Ruddy Duck



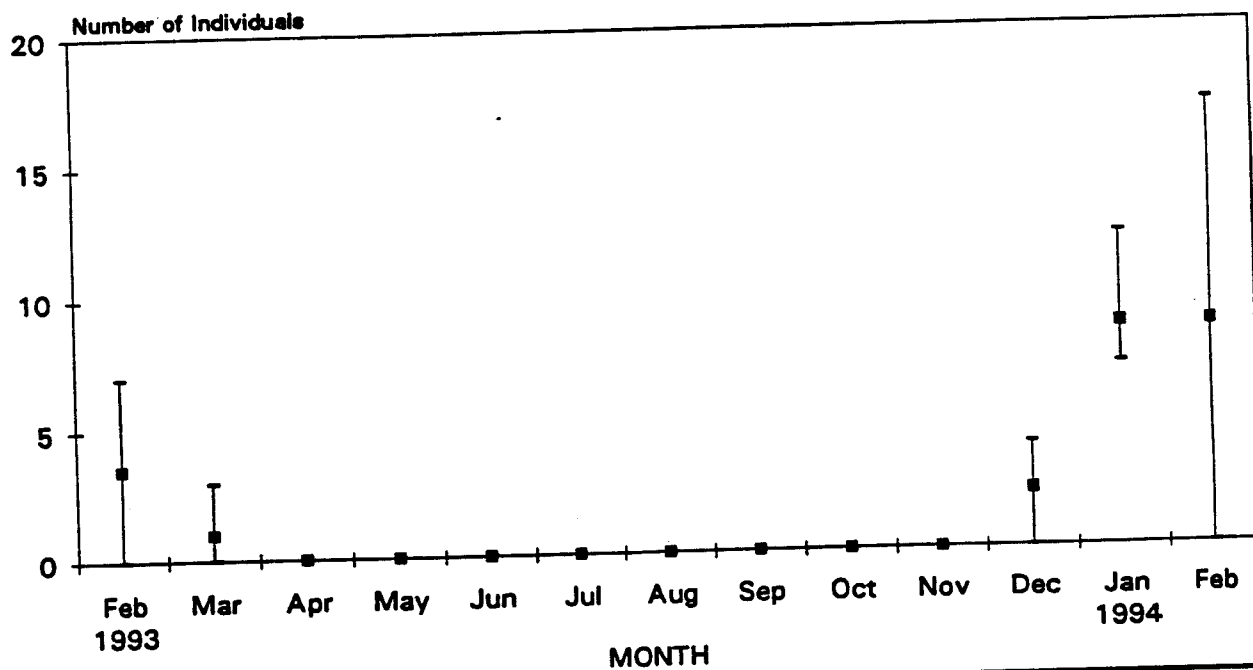
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Common Goldeneye (*Bucephala clangula*)

Common goldeneye was present at the study site during the winter months with the peak of abundance occurring during February 1994. This species was observed within seven of the 44 survey units with the number of individuals per cell ranging from one to fifteen.



Common Goldeneye



Common Goldeneye

The map displays the distribution of Common Goldeneye across 44 numbered sections in the Saginaw Bay area. The sections are numbered 1 through 44. The distribution is categorized by occurrence percentage, indicated by different shading patterns:

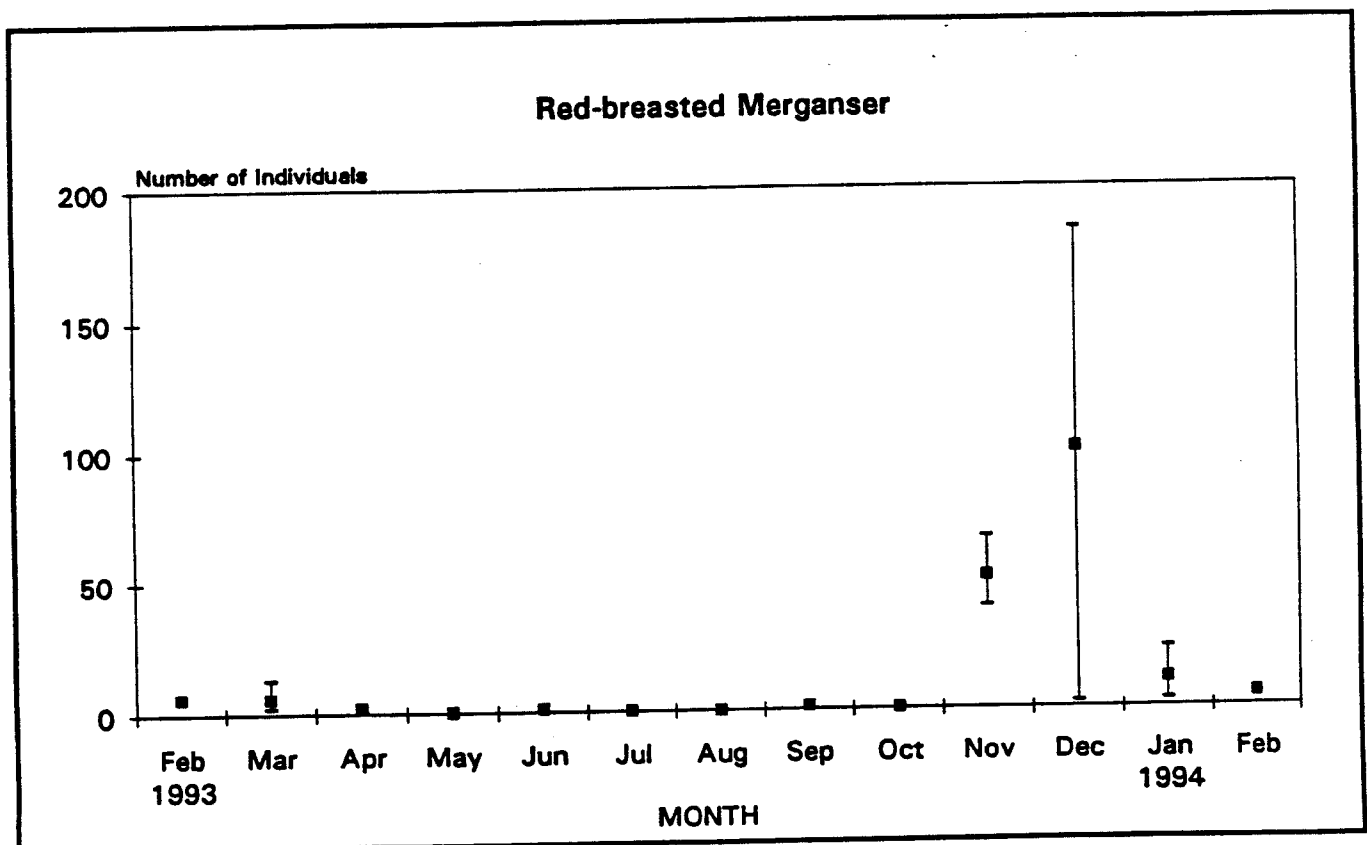
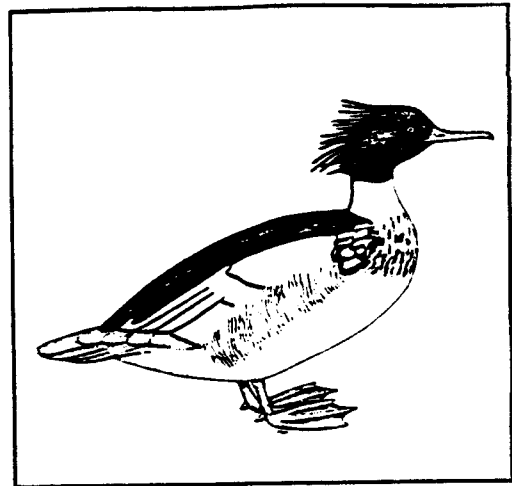
- 0% Occurrence: Unshaded (e.g., sections 39, 40, 41, 14, 13, 12, 11, 10, 8, 7, 6, 5, 1, 18, 19, 4, 3, 2, 20, 22, 26, 27, 29, 28, 25, 24, 35, 36, 37, 16, 17, 38, 43, 44, 39, 40, 41)
- 1 - 19% Occurrence: Vertical lines (e.g., sections 42, 33, 34, 32, 31, 30, 23, 21, 15, 20)
- 20 - 50% Occurrence: Horizontal lines (e.g., sections 38, 37, 16, 17, 36, 35, 34, 33, 32, 31, 30, 23, 21, 15, 20)
- 51 - 100% Occurrence: Solid black (e.g., sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44)

A north arrow is located in the lower right corner of the map area.

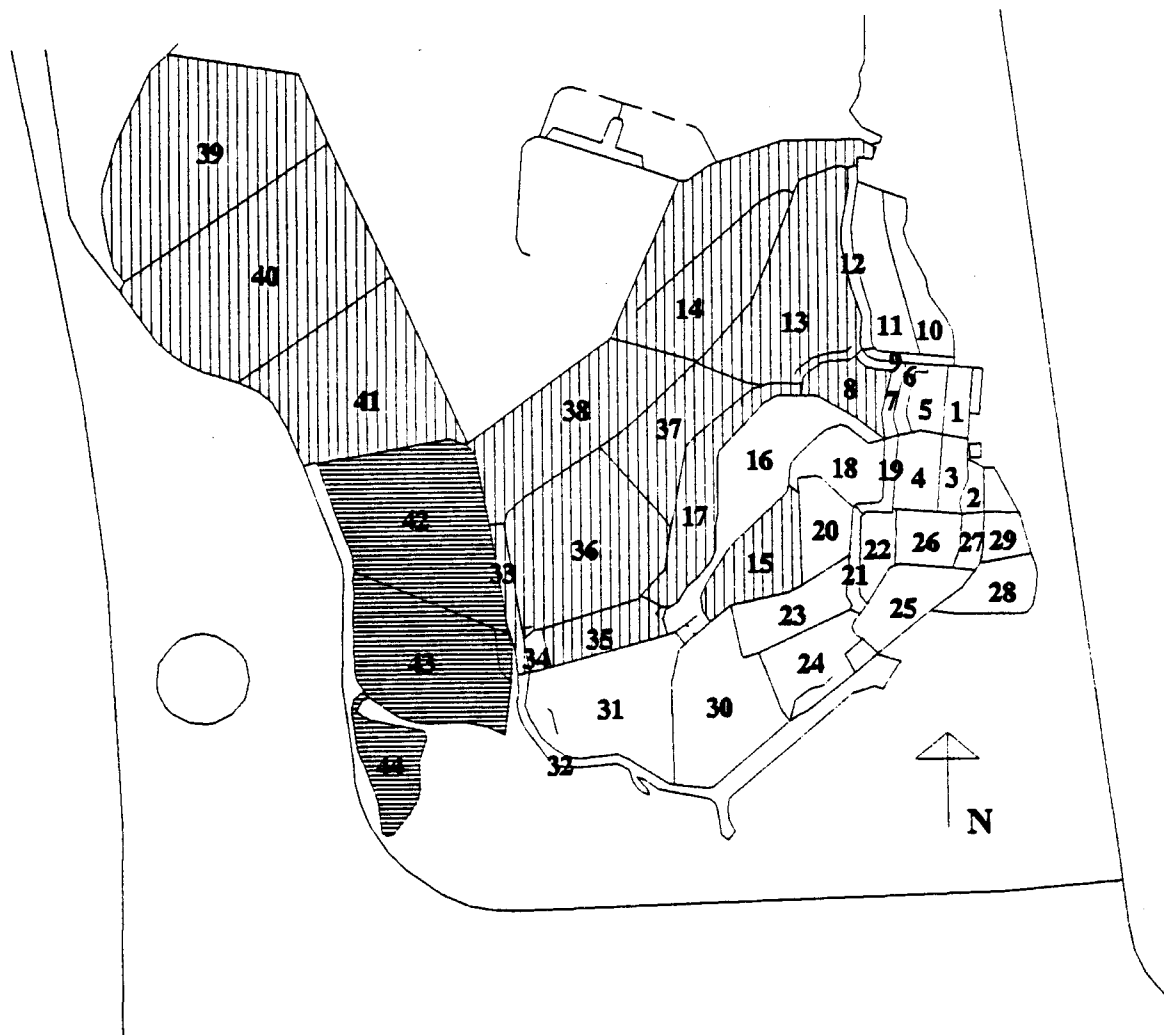
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Red-breasted Merganser (*Mergus serrator*)

Red-breasted mergansers were most notably present at the study site during late fall and winter. Red-breasted mergansers were found within 15 of the 44 survey units and were most frequently observed within cells 42 through 44. The high count for this species was 184 individuals reported during the December 29, 1993 survey.



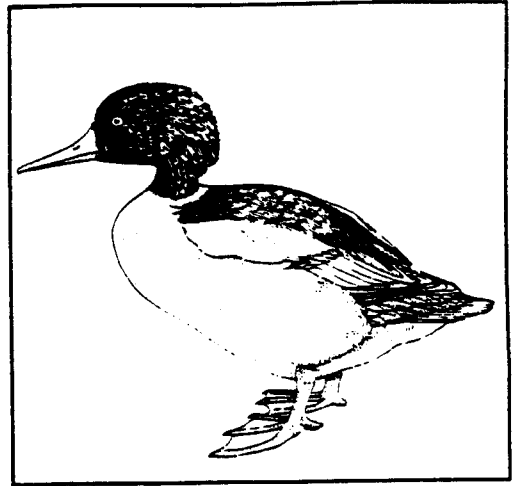
Red-breasted Merganser



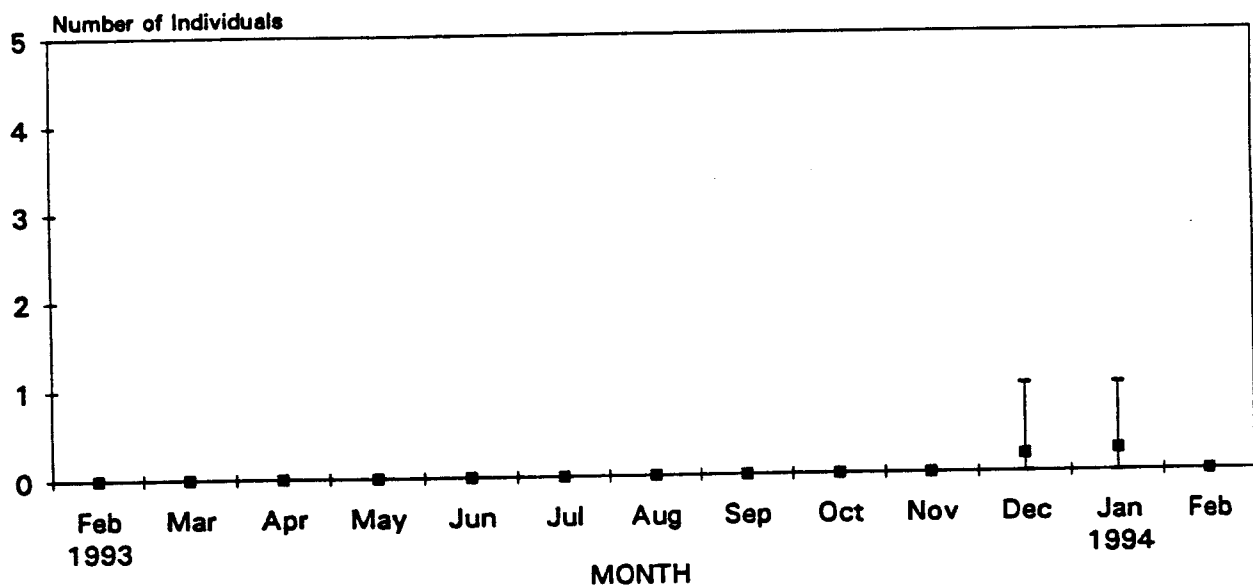
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Common Merganser (*Mergus merganser*)

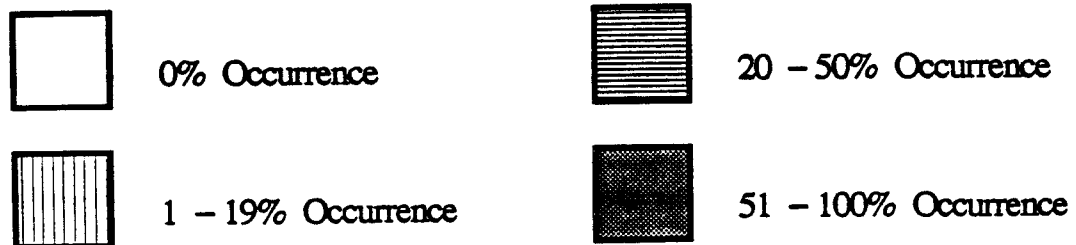
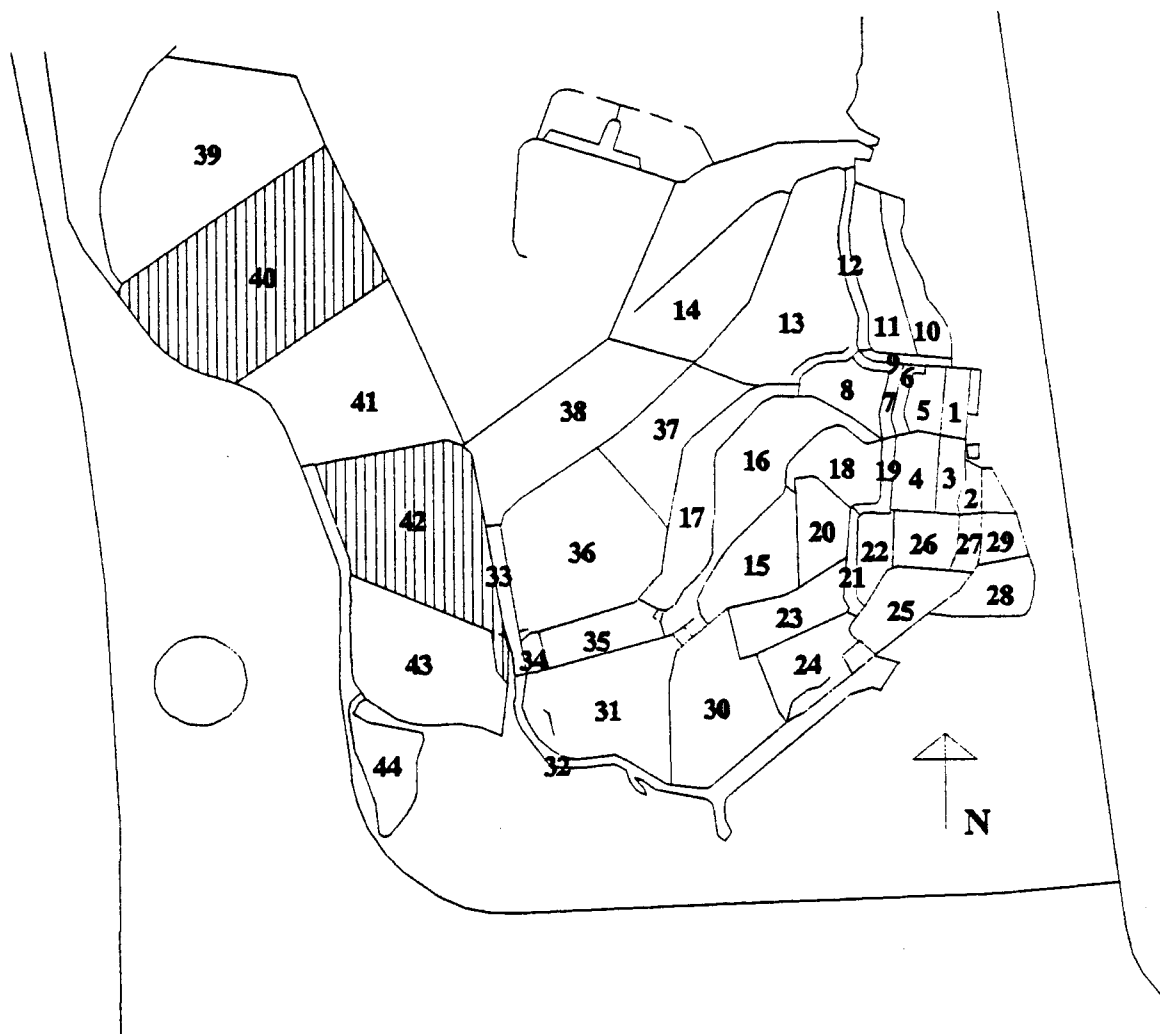
An individual common merganser was reported on two occasions. A single bird was noted during the December 29, 1993 survey within cell 40 and on January 5, 1994 within cell 42.



Common Merganser



Common Merganser

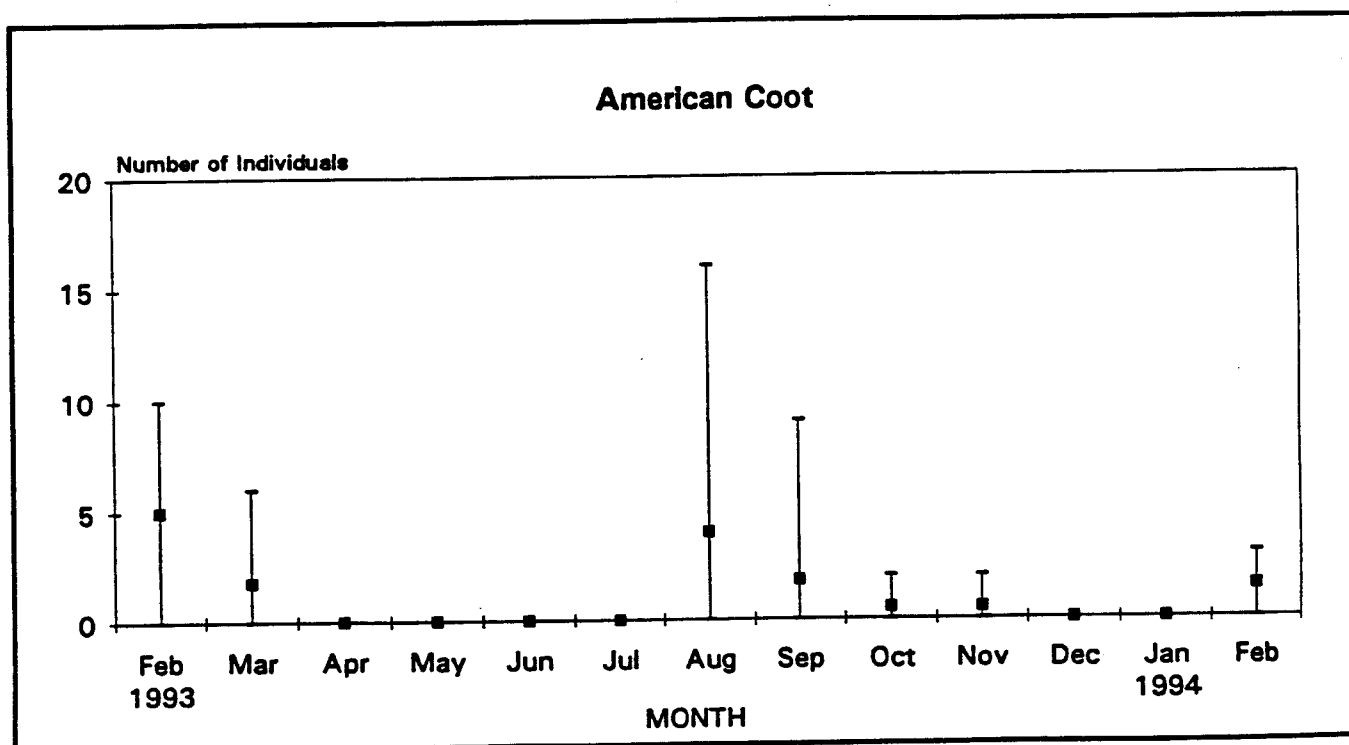
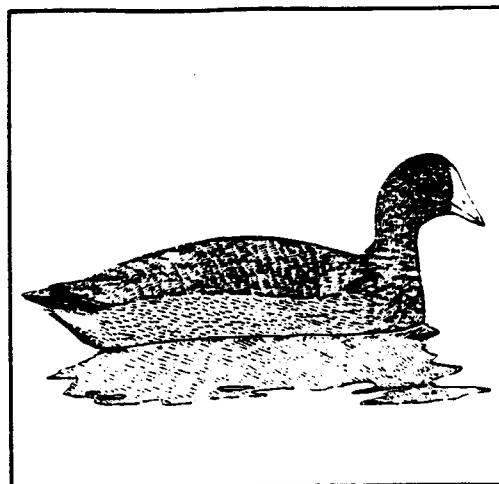


Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

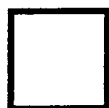
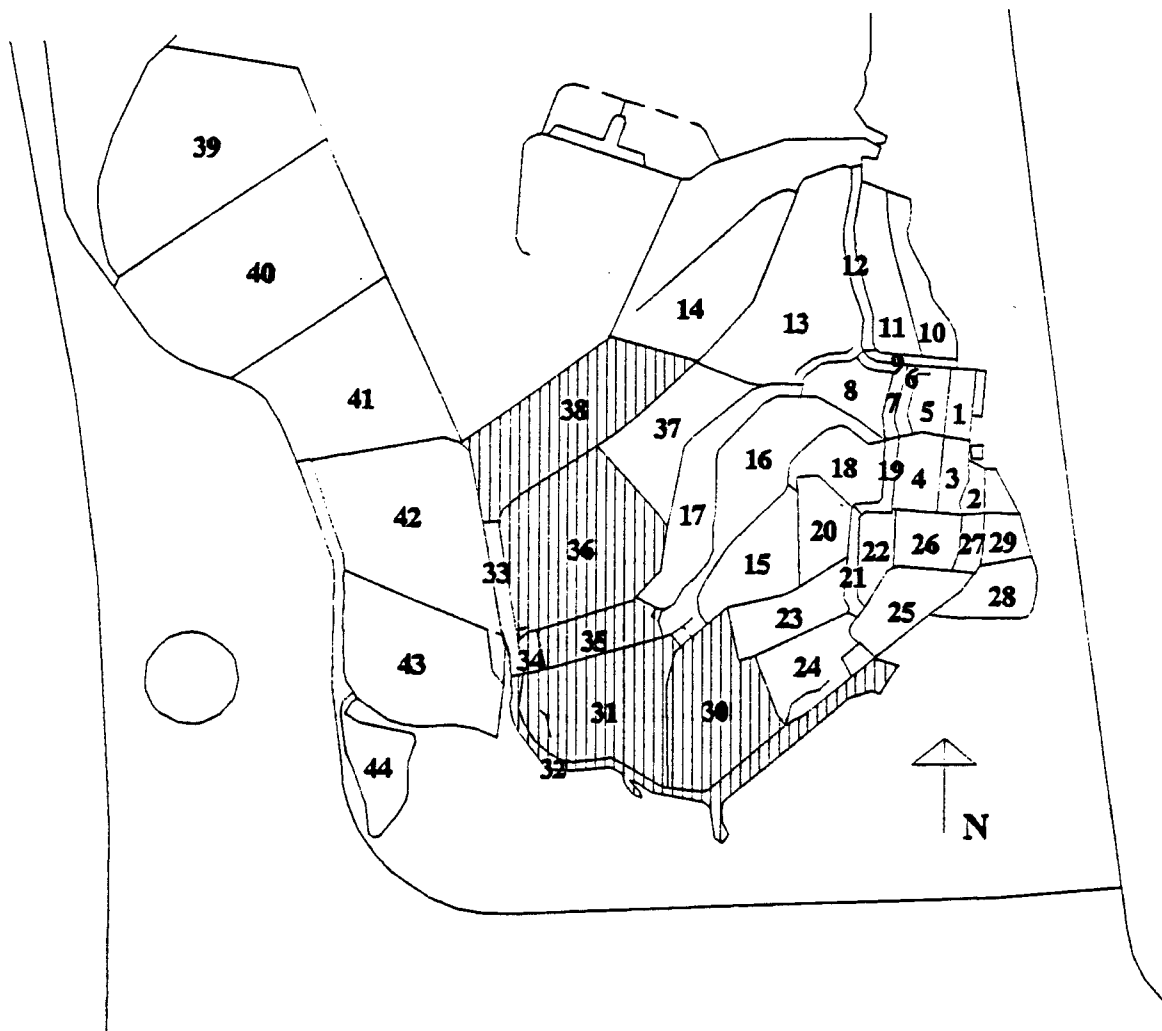
American Coot

(*Fulica americana*)

American coots were present during only 15% of the surveys and occurred in seven of the 44 survey units. The high count for this species was 16 individuals reported within cell 31 on August 11, 1993.



American Coot



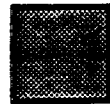
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

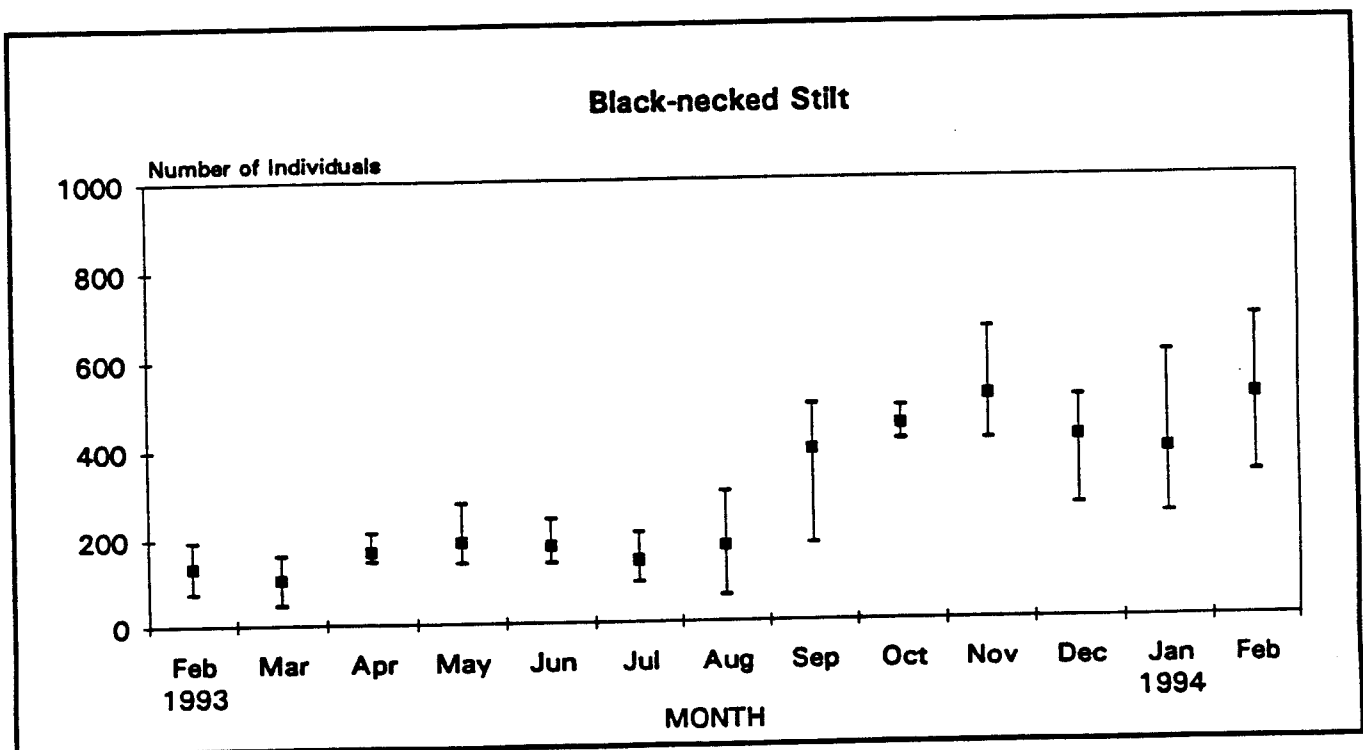
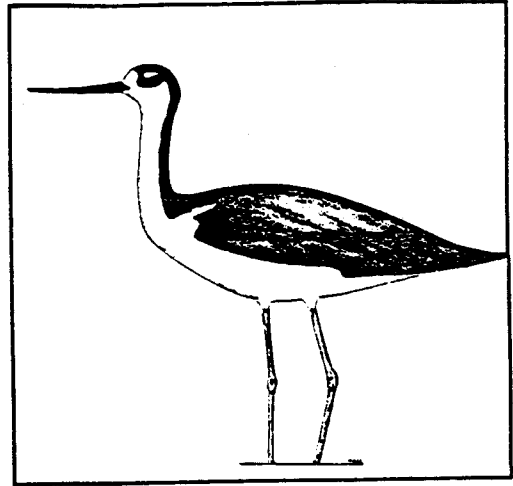


51 - 100% Occurrence

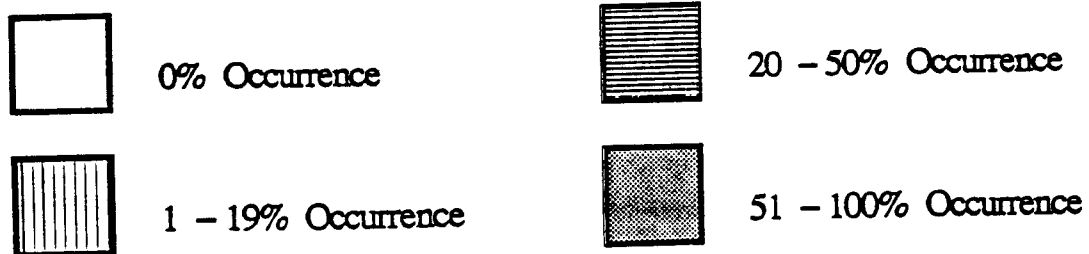
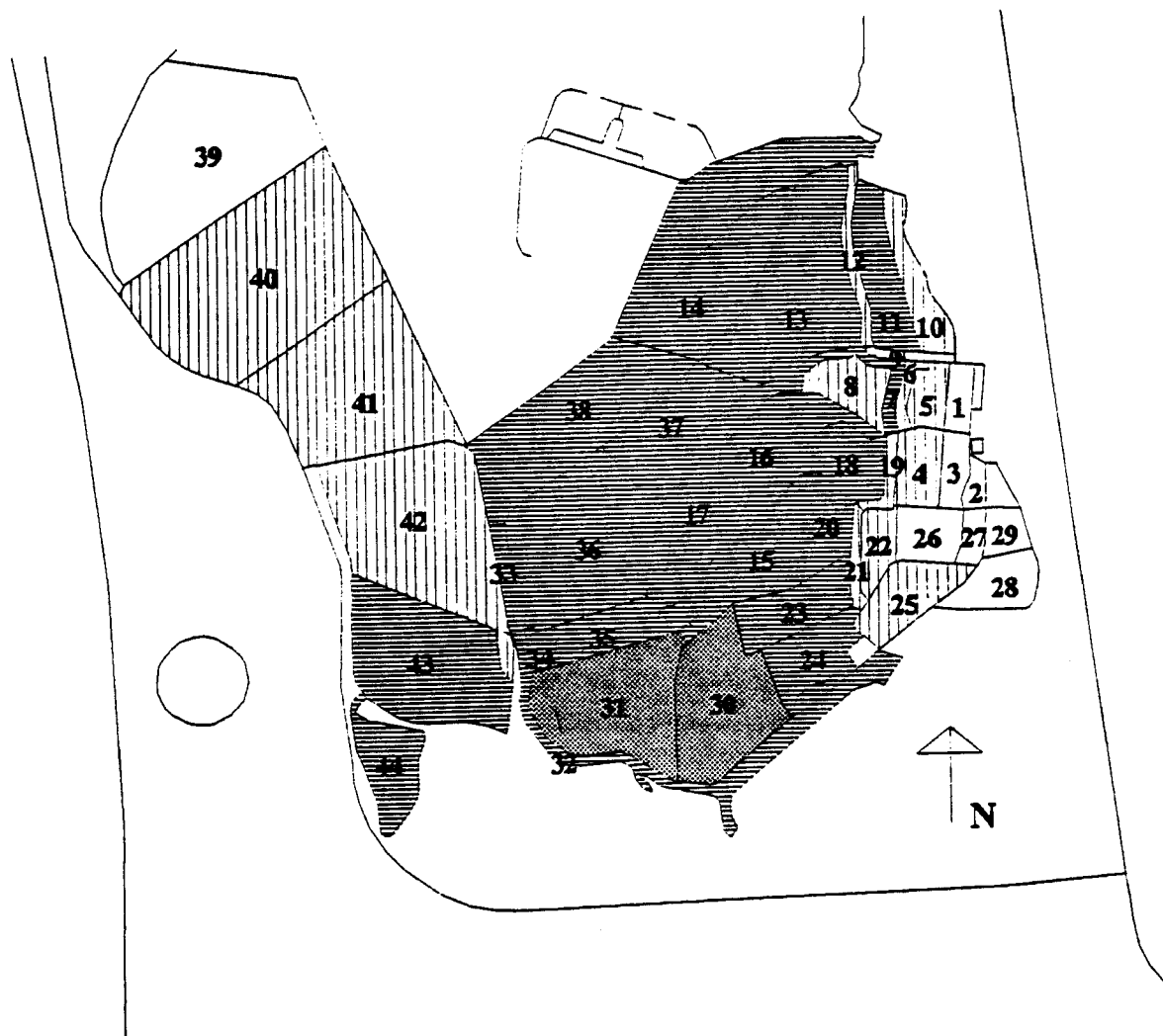
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Black-necked Stilt (*Himantopus mexicanus*)

As a year round breeding resident and fall transient, black-necked stilts were present during all surveys and were found within 36 of the 44 survey units. Of the 52 surveys conducted, black-necked stilts were recorded within cells 30 and 31 on 41 and 44 occasions respectively. These two cells also held the majority of birds during the high count of 663 individuals on November 24, 1993 and the 685 individuals recorded on February 9, 1994. Peak abundance for this species occurred in late fall with a breeding population present during the summer months.



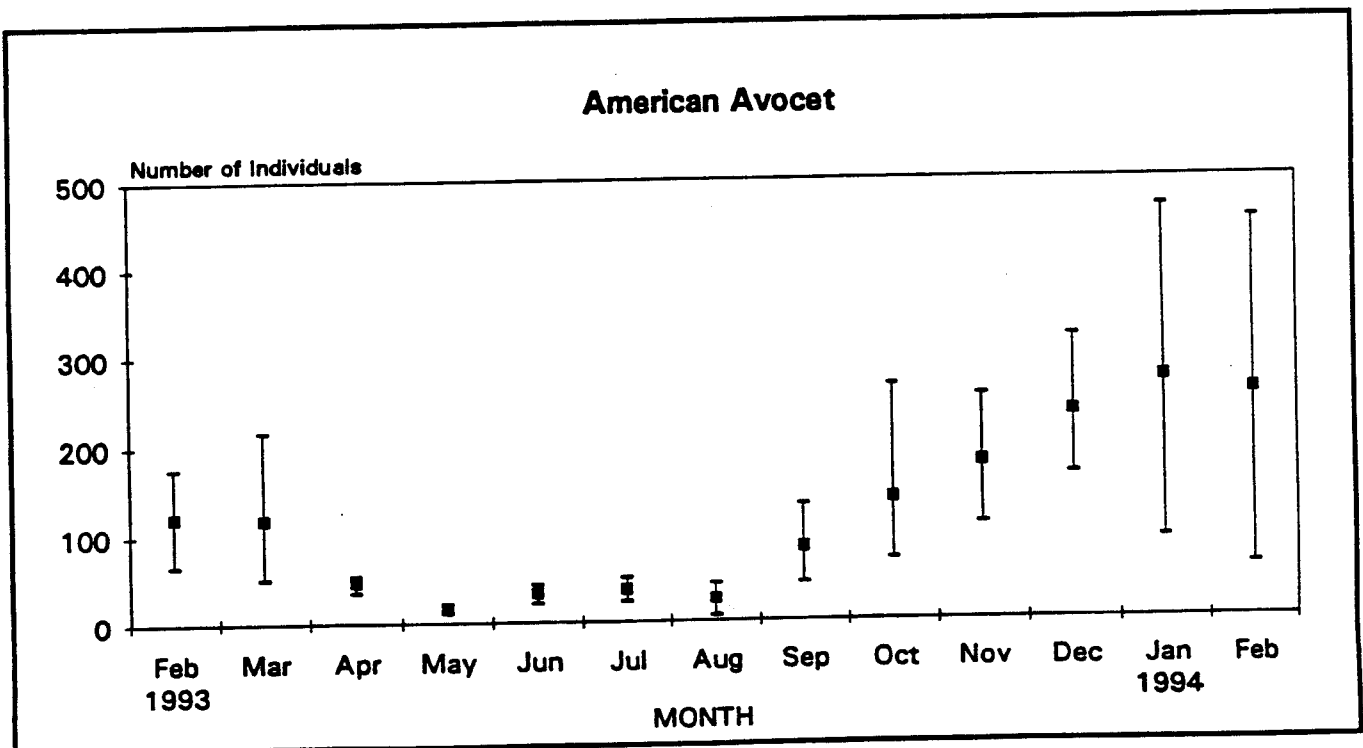
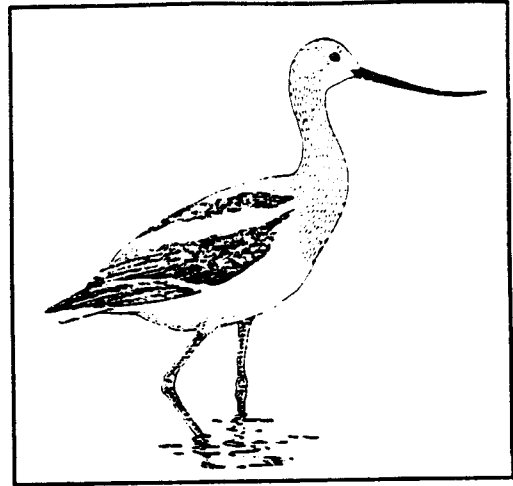
Black-necked Stilt



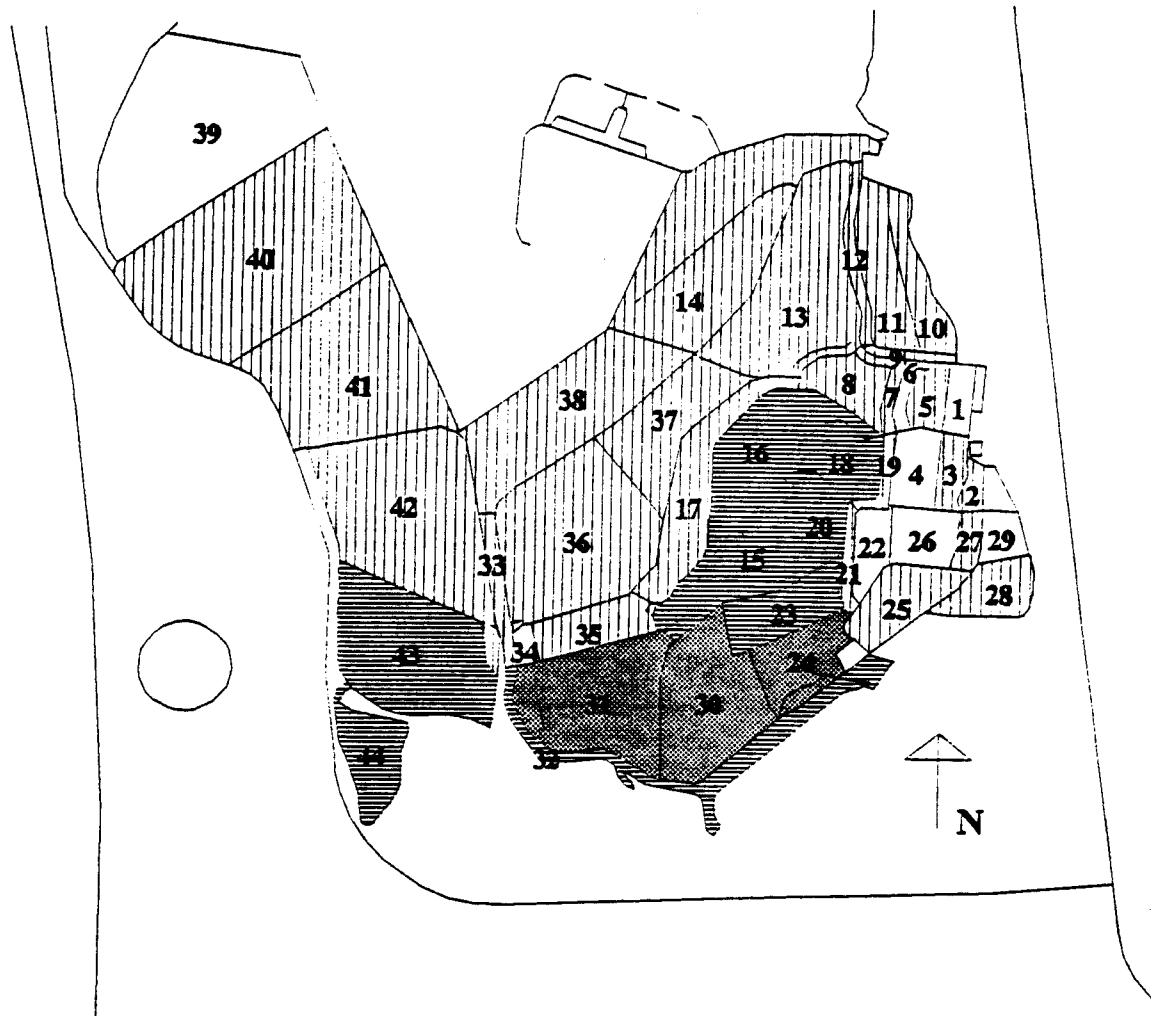
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

American Avocet (*Recurvirostra americana*)

American avocets were present during all surveys and were found within 36 of the 44 cells. Of the 52 surveys conducted, avocets were recorded within cells 31 and 30 on 41 occasions. American avocets are represented by a breeding population during the summer months although it is during fall migration and winter that the species is most abundant. Monthly averages increased beginning in September and continued until January at which time a single survey high count reached 467 individuals.



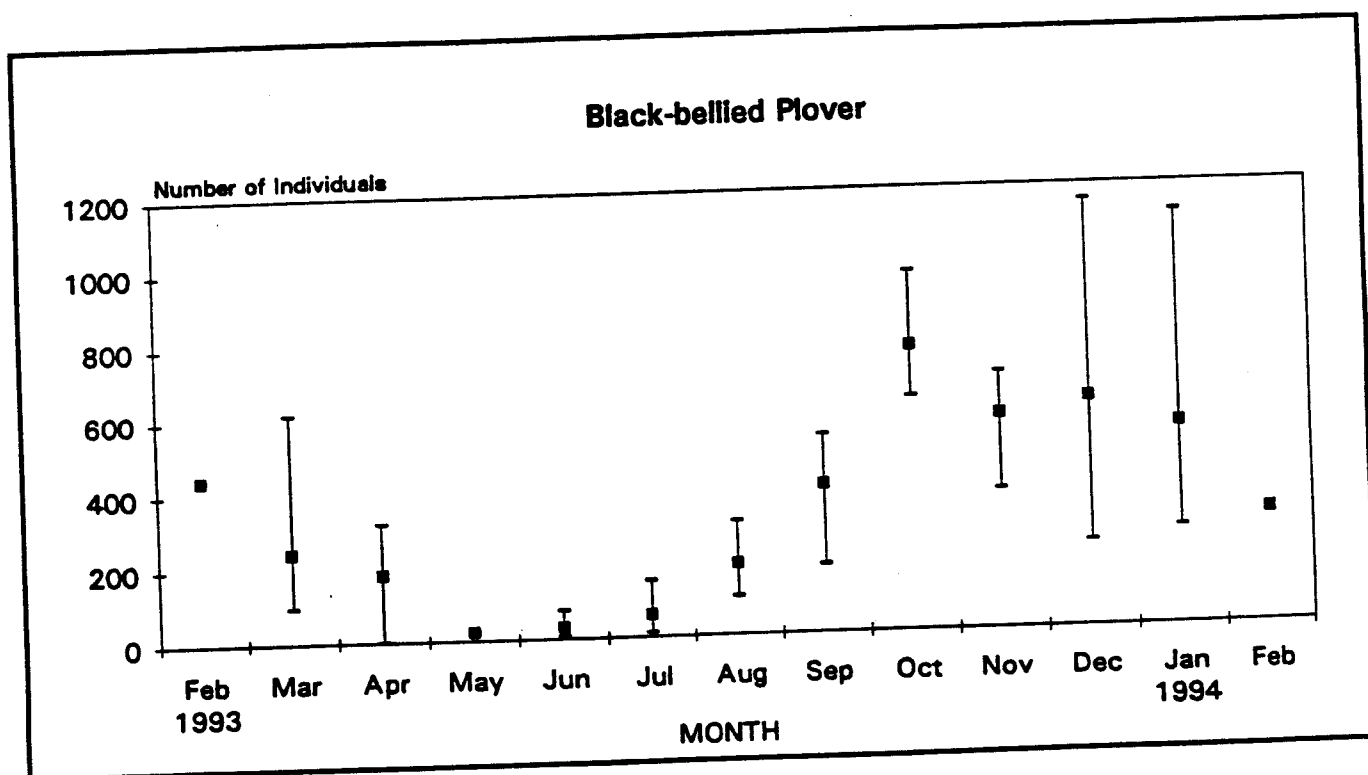
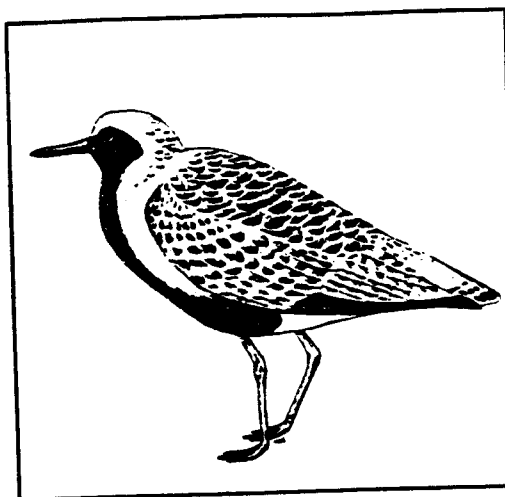
American Avocet



Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Black-bellied Plover (*Pluvialis squatarola*)

Black-bellied plovers were present during every survey and were found within 34 of the 44 cells. Survey units 14 and 40, both of which encompassed tidal mudflats, were the areas where this species occurred most often. Black-bellied plovers were most abundant during the fall and winter months with a smaller non-breeding population present at the study site in summer. Although monthly averages peaked in October, the high count for this species was 1155 individuals during the December 1, 1993 survey.



Black-bellied Plover

This map illustrates the distribution of Black-bellied Plover across the San Francisco Bay Area, divided into 44 numbered regions. The regions are shaded according to the percentage of occurrence, as defined in the legend below the map. A north arrow is located in the lower right corner of the map area.

Legend:

- 0% Occurrence: Unshaded box
- 1 - 19% Occurrence: Box with vertical lines
- 20 - 50% Occurrence: Box with horizontal lines
- 51 - 100% Occurrence: Box with a cross-hatch pattern

Map Data Summary:

Region Number	Occurrence Percentage
1	1 - 19%
2	1 - 19%
3	1 - 19%
4	1 - 19%
5	1 - 19%
6	1 - 19%
7	1 - 19%
8	1 - 19%
9	1 - 19%
10	1 - 19%
11	1 - 19%
12	1 - 19%
13	20 - 50%
14	51 - 100%
15	20 - 50%
16	20 - 50%
17	20 - 50%
18	20 - 50%
19	20 - 50%
20	20 - 50%
21	20 - 50%
22	20 - 50%
23	20 - 50%
24	20 - 50%
25	20 - 50%
26	20 - 50%
27	20 - 50%
28	20 - 50%
29	20 - 50%
30	20 - 50%
31	20 - 50%
32	20 - 50%
33	20 - 50%
34	20 - 50%
35	20 - 50%
36	20 - 50%
37	20 - 50%
38	20 - 50%
39	51 - 100%
40	51 - 100%
41	20 - 50%
42	20 - 50%
43	20 - 50%
44	20 - 50%

Black-bellied Plover

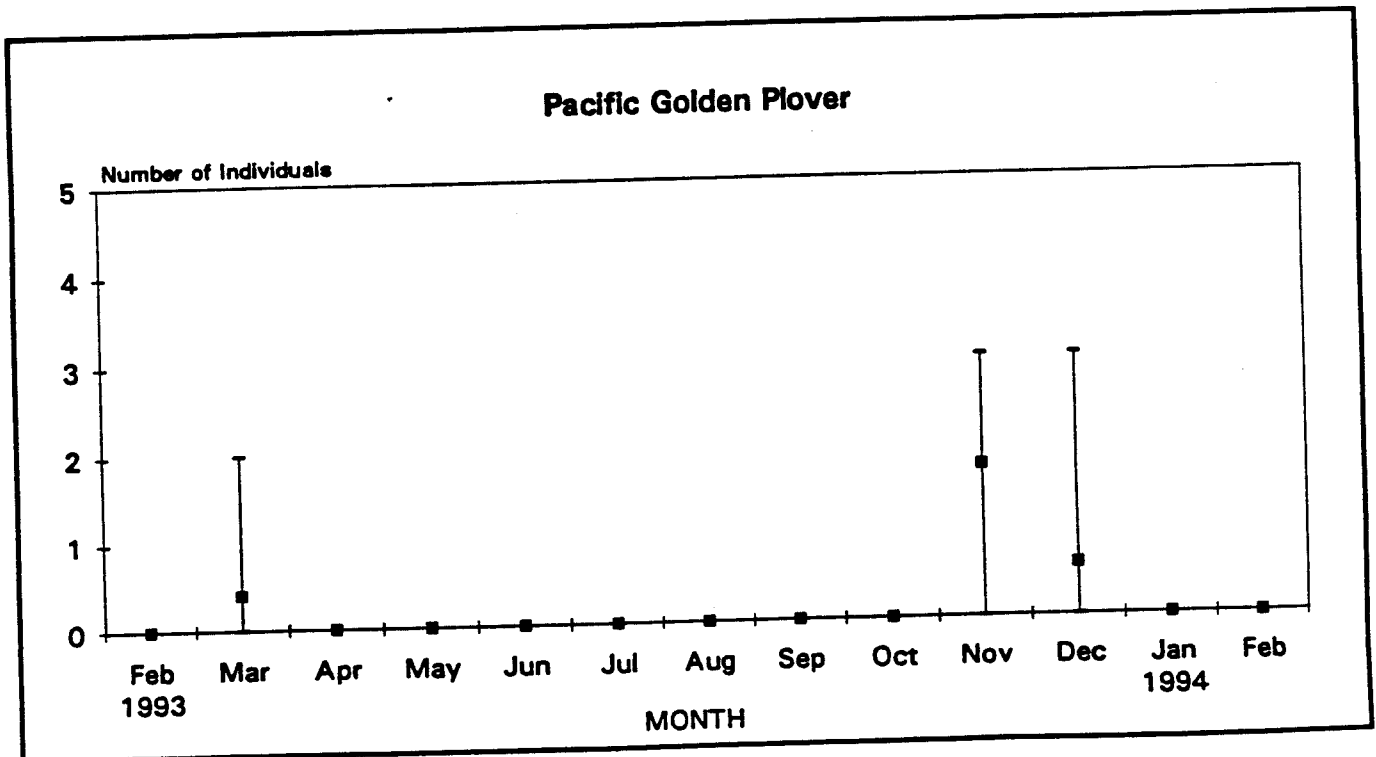
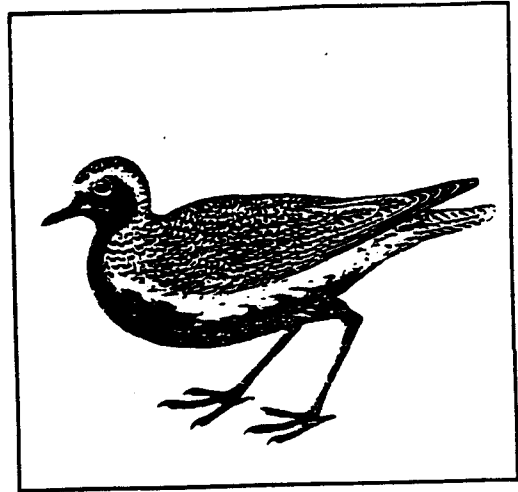
The map displays the distribution of Black-bellied Plover across the San Francisco Bay Area, divided into 44 numbered regions. The regions are shaded according to the following occurrence percentages:

- 0% Occurrence: Unshaded (white)
- 1 - 19% Occurrence: Vertical lines
- 20 - 50% Occurrence: Horizontal lines
- 51 - 100% Occurrence: Stippled/dotted pattern

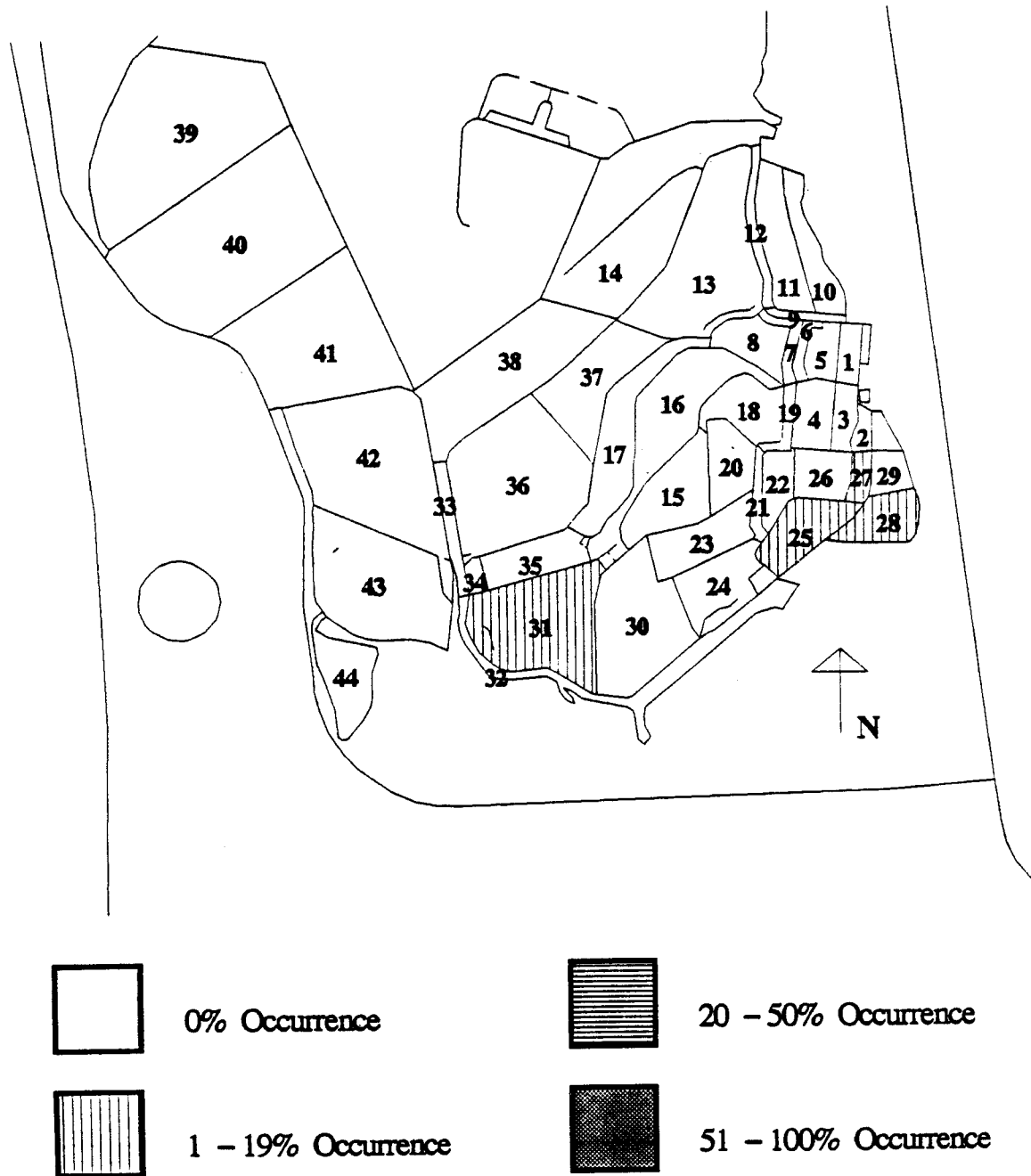
A north arrow is located in the lower right corner of the map area.

Pacific Golden Plover
(Pluvialis dominica fulva)

Two to three pacific golden plovers were recorded on five occasions within cells 25, 27, 28, and 31.



Pacific Golden Plover

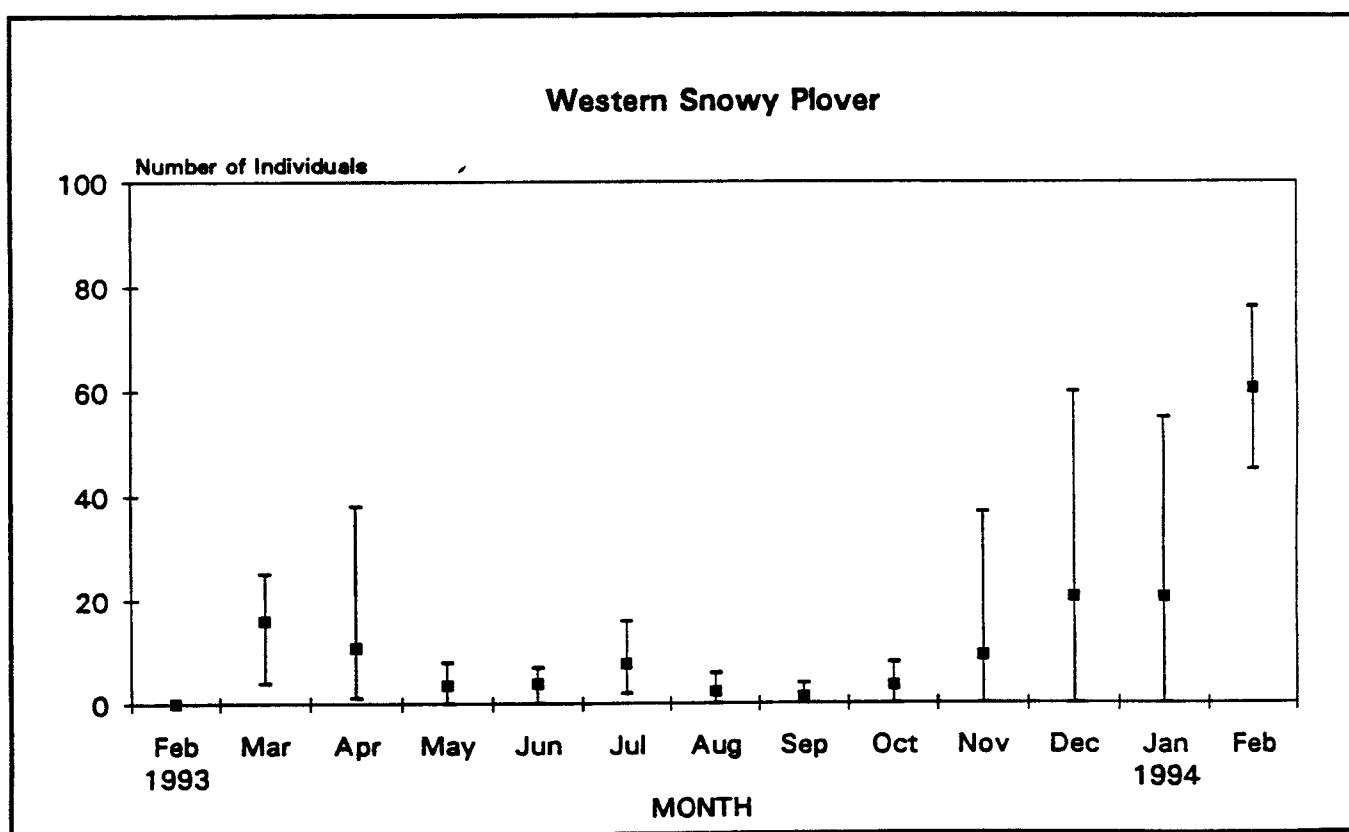
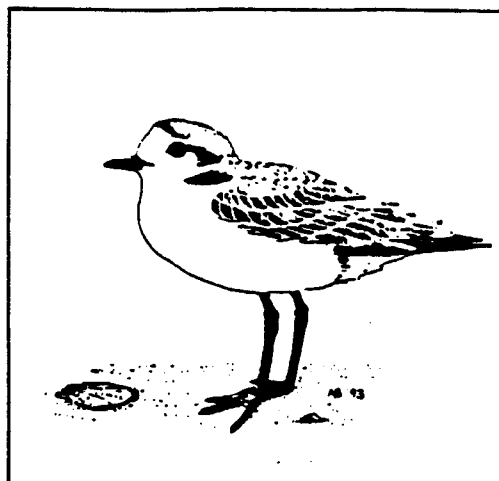


Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

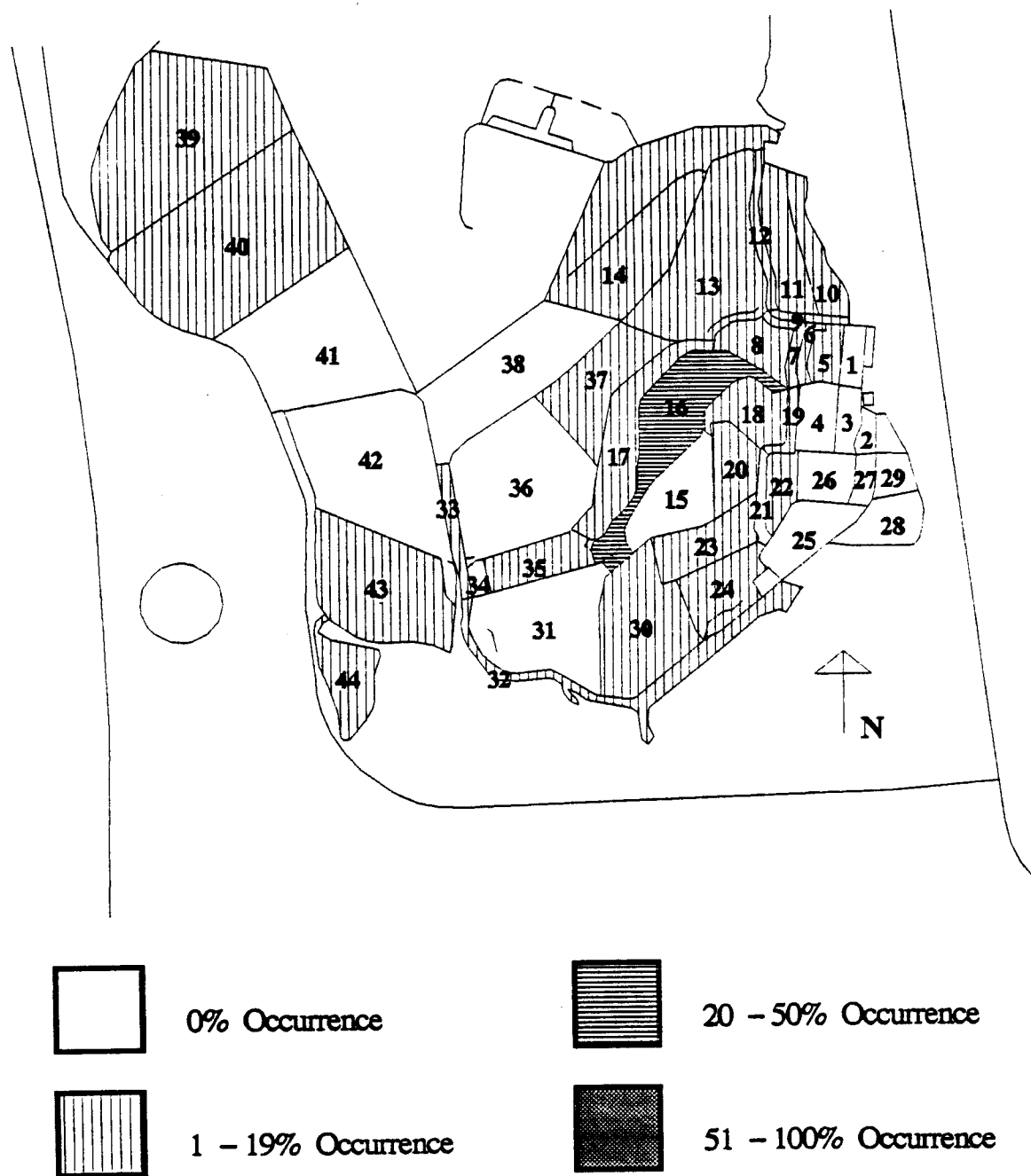
Western Snowy Plover

(*Charadrius alexandrinus nivosus*)

The coastal population of the western snowy plover is a Federally listed threatened species which nests along the Salt Works dikes. Snowy plovers were present throughout the seasons with an increase in abundance during late fall and winter. The high count for this species occurred on February 2, 1994 when a total of 76 birds were recorded. Of these individuals, 66 were observed roosting within survey unit 5. Areas where snowy plovers were observed foraging included cells 16, 20, and 40.



Western Snowy Plover

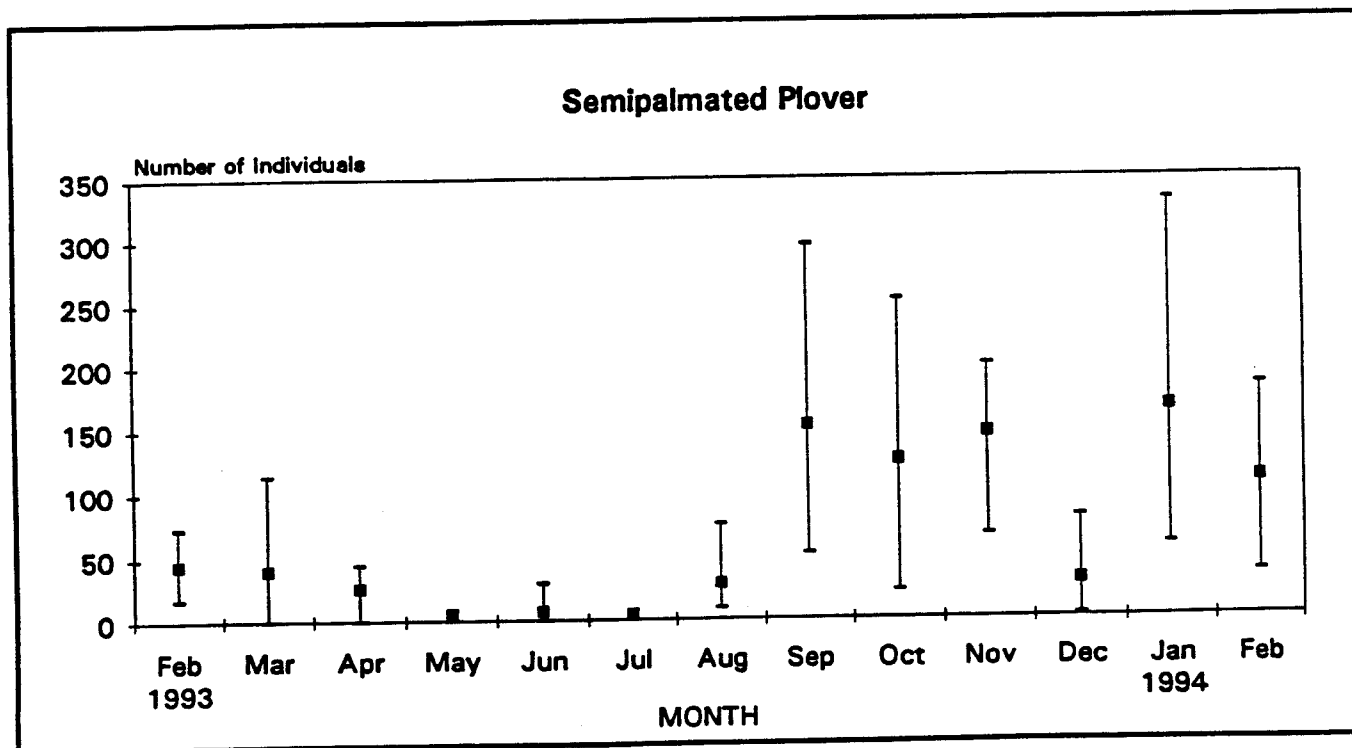
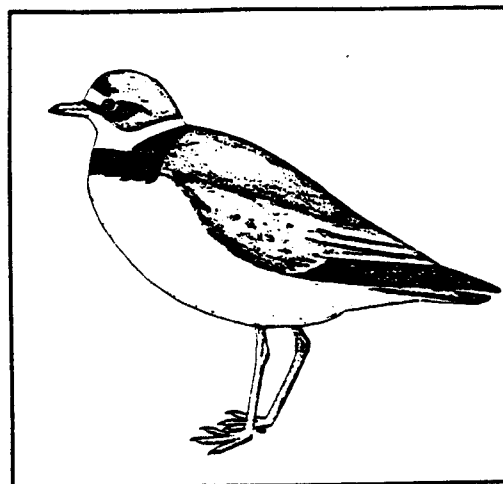


Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

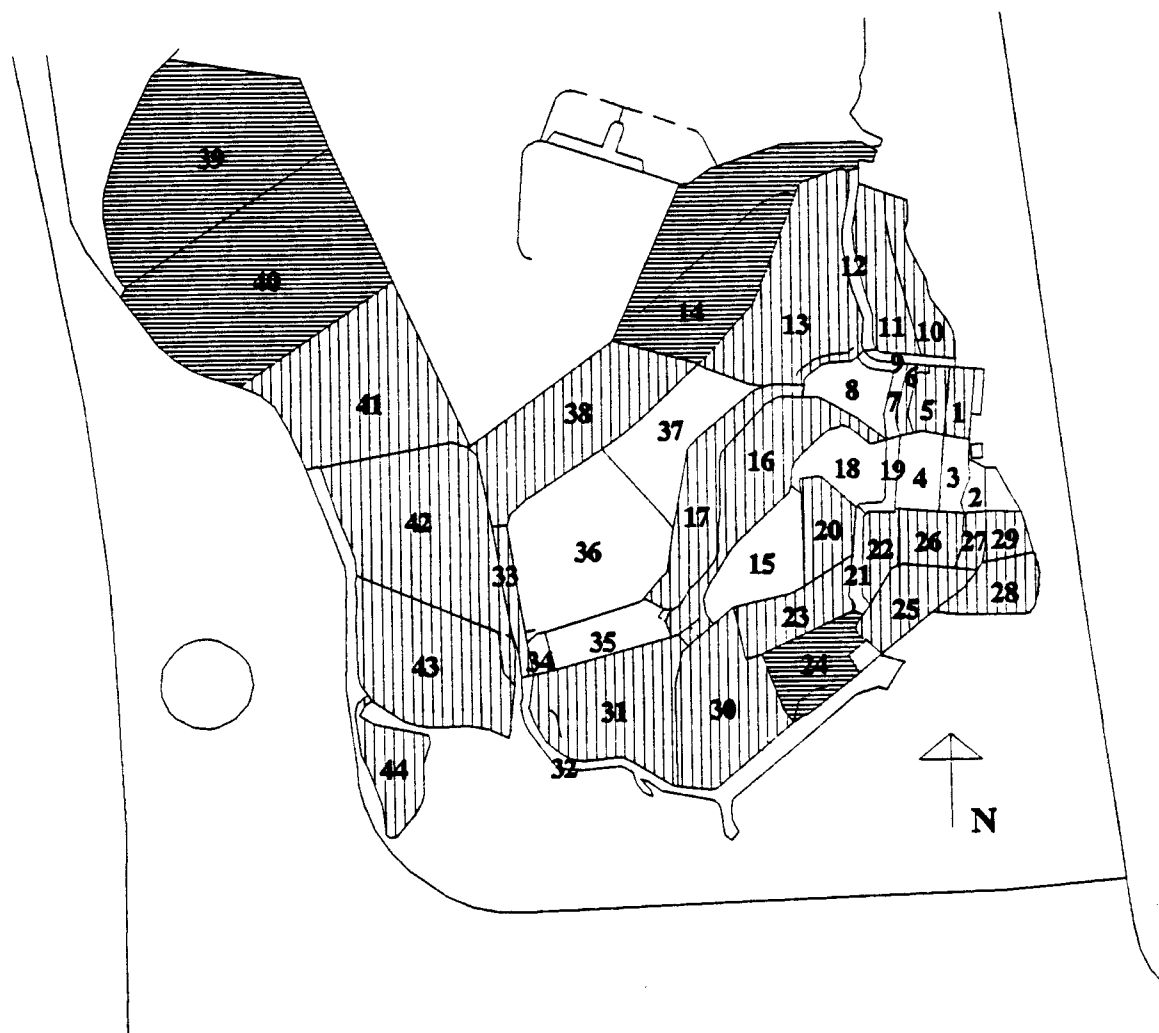
Semipalmated Plover

(*Charadrius semipalmatus*)

Semipalmated plovers were present during 85% of the surveys and were most frequently found in cells 14, 24, 39, and 40. Non-breeding semipalmated plovers were present at the study site during the summer months. Abundance increased in August and monthly averages held relatively constant throughout the months of September, October, and November. The high count for this species was 321 individuals reported on January 26, 1994. It is interesting to note that survey unit 28 had the highest number of semipalmated plovers (250 individuals) for a single location during the October 27, 1993 survey.



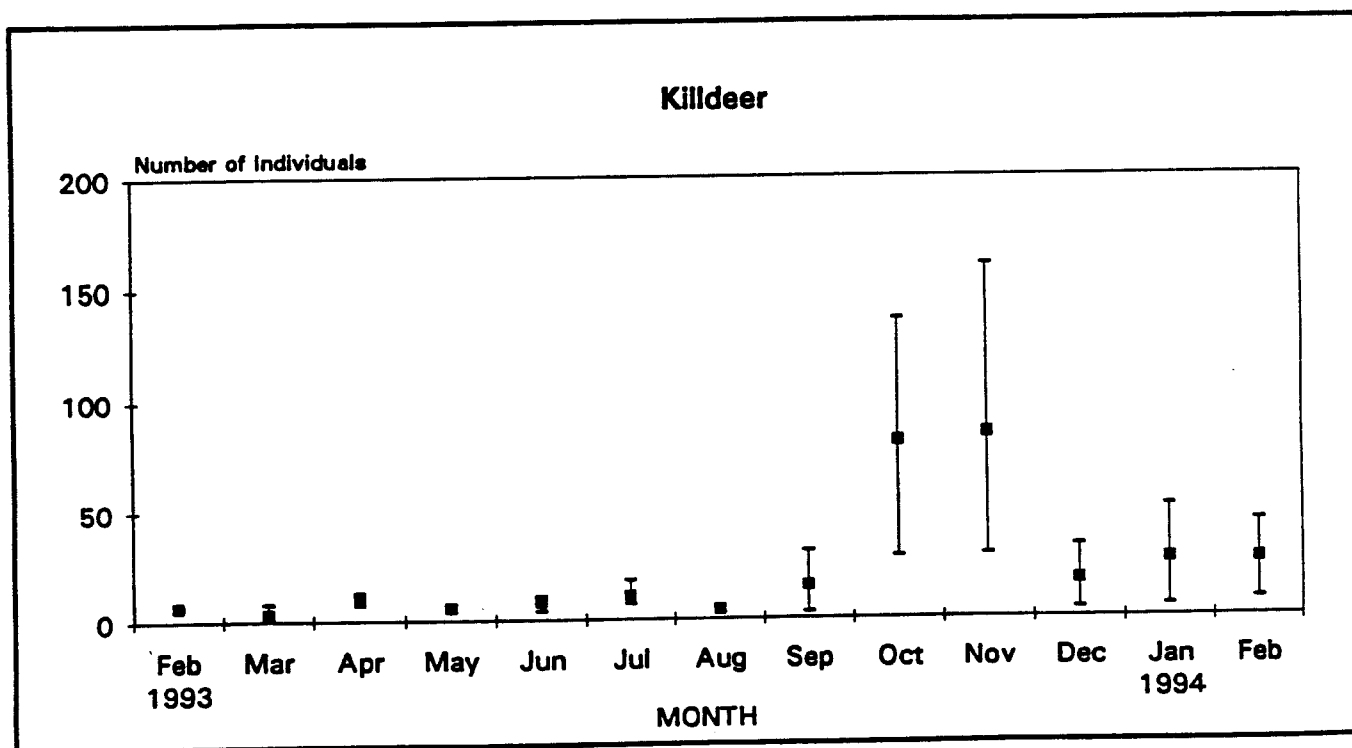
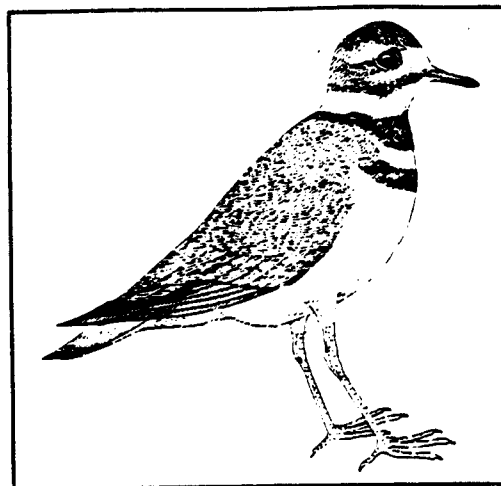
Semipalmated Plover



Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Killdeer (*Charadrius vociferus*)

This species was present throughout the year and was observed within 35 of the 44 survey units. Nesting killdeer were present along the dikes of the Salt Works during the spring and summer months. Peak abundance occurred during October and November with a high of 160 individuals reported on November 17, 1993.



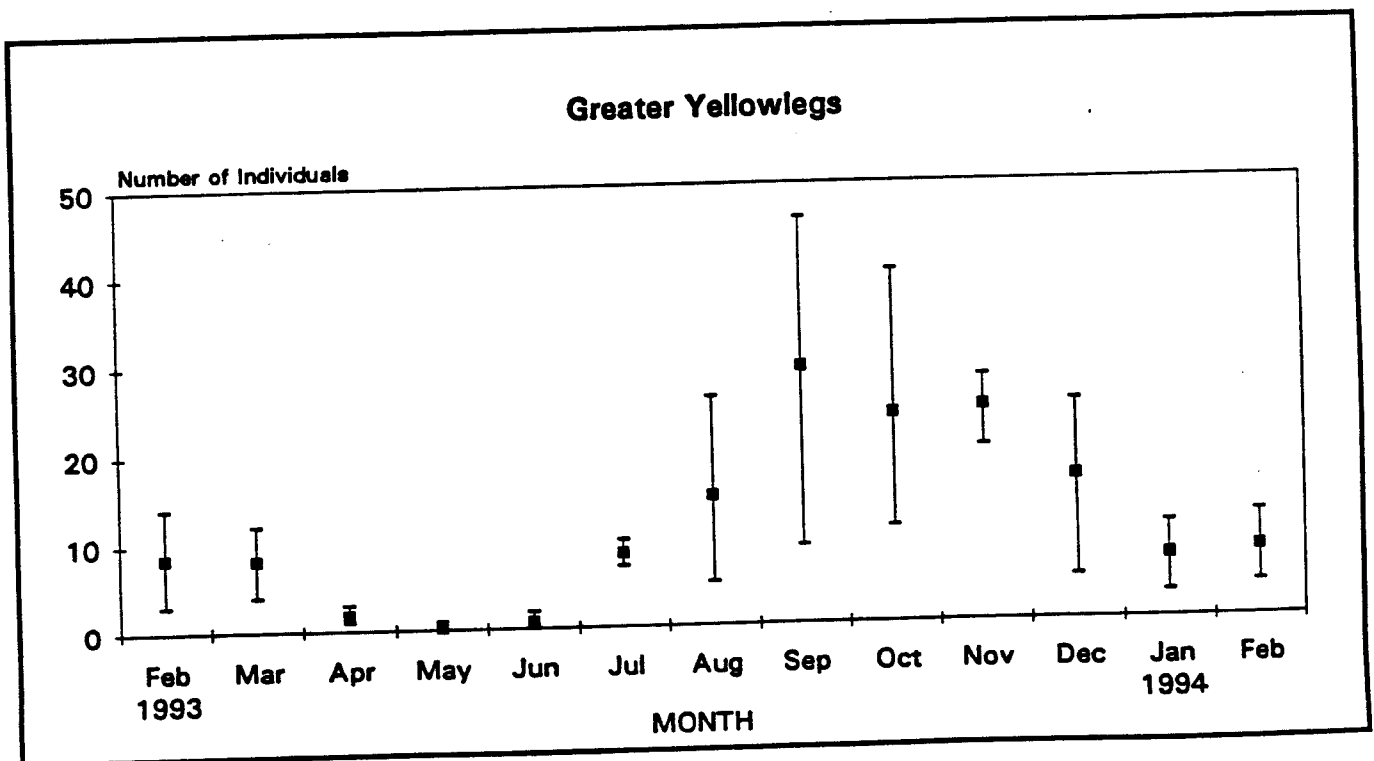
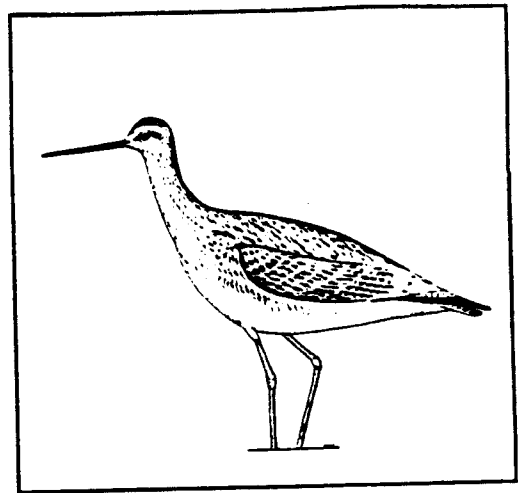
Killdeer



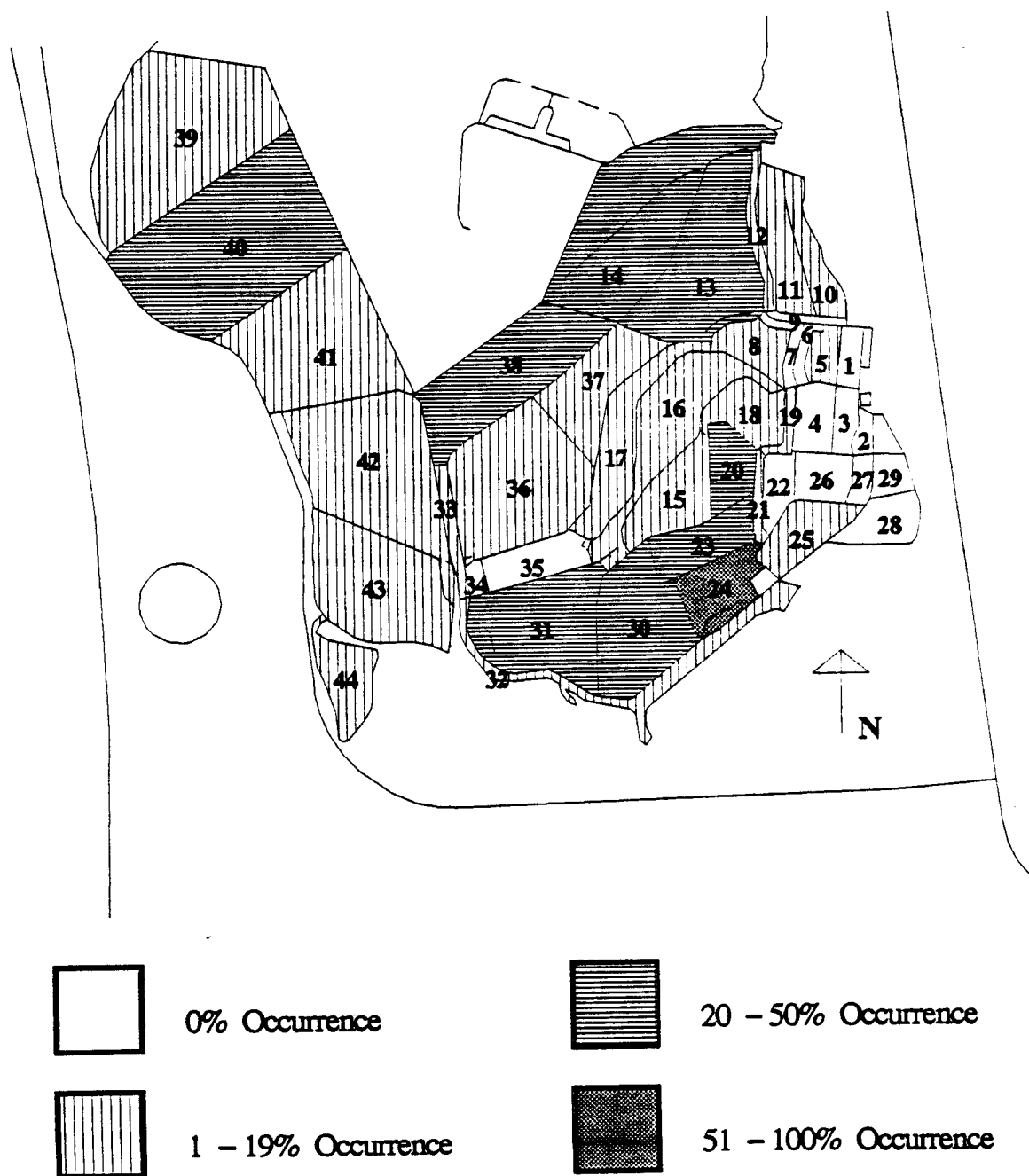
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Greater Yellowlegs (*Tringa melanoleuca*)

This species was present during 88% of the surveys and was found within 30 of the 44 survey units. Greater yellowlegs were most frequently observed within cell 24. Higher abundance for the greater yellowleg was most notable during the fall migratory period at which time a high of 46 individuals was recorded on September 15, 1993.



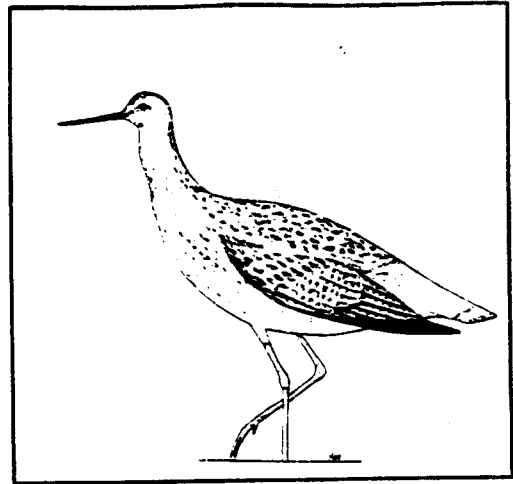
Greater Yellowlegs



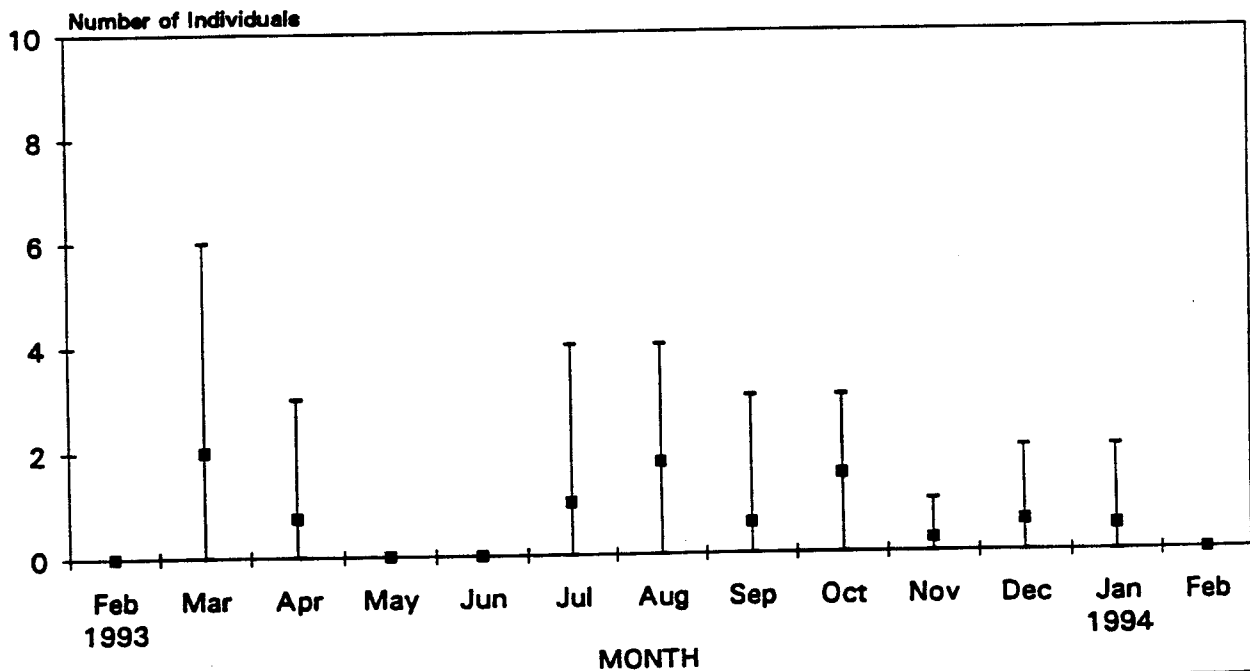
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Lesser Yellowlegs (*Tringa flavipes*)

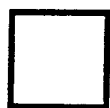
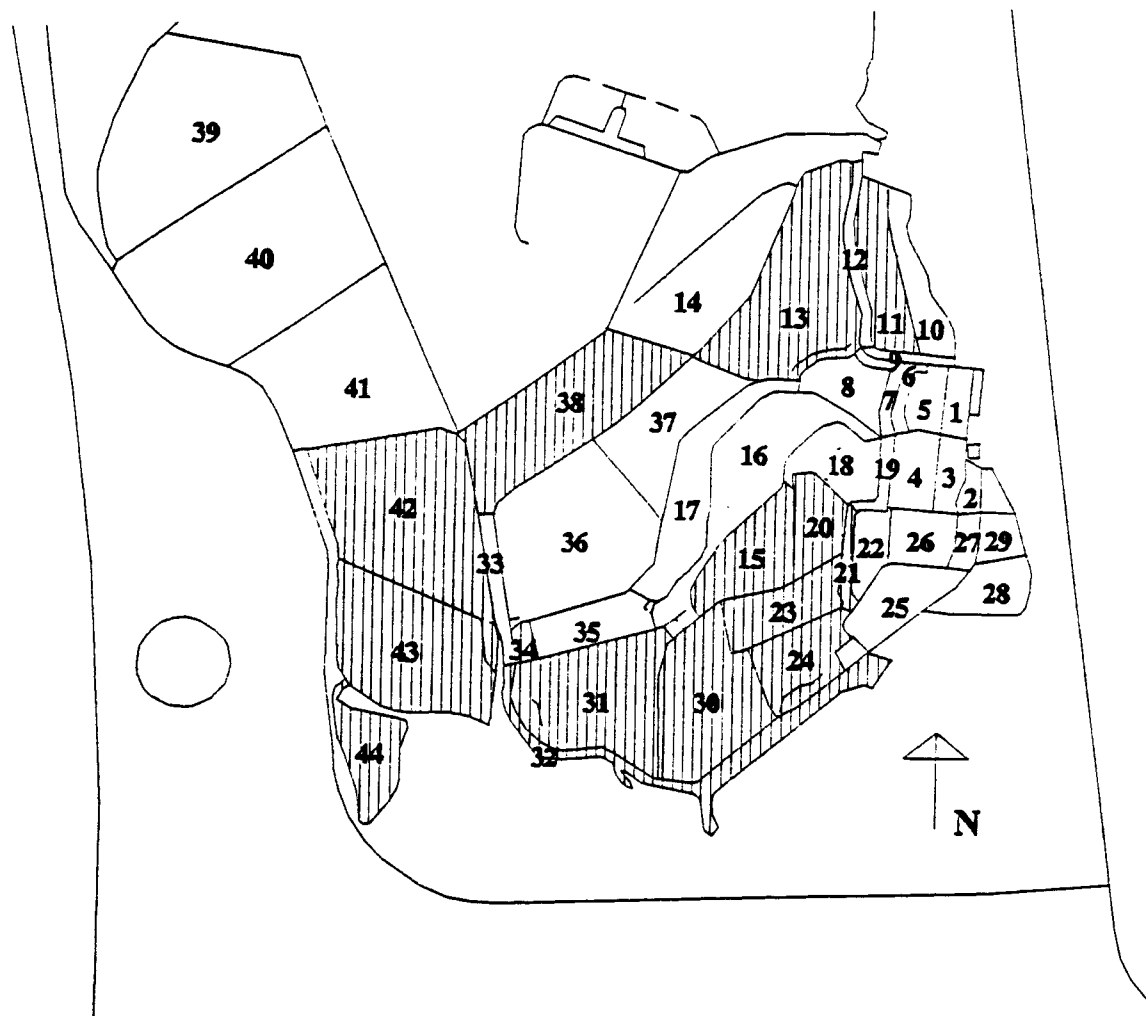
Lesser yellowlegs were present during 31% of the surveys and were found within 15 of the 44 survey units. Although the lesser yellowleg was less abundant than the greater yellowleg, the distribution of these two species was similar except for the absence of the lesser yellowleg from the central portion of the study site. The high count for this species was six individuals reported on March 3, 1993 of which four birds were located within cell 30 and two within cell 38.



Lesser Yellowlegs



Lesser Yellowlegs



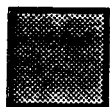
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

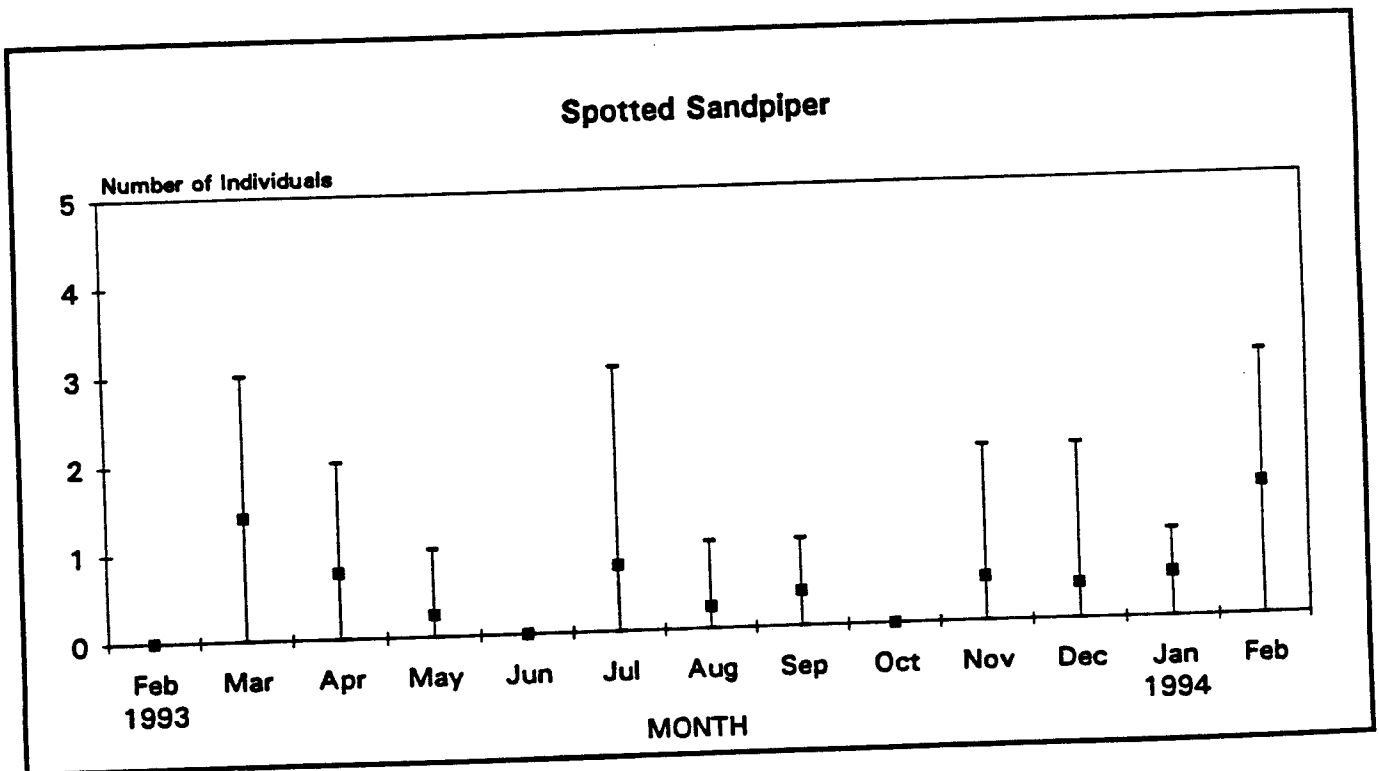
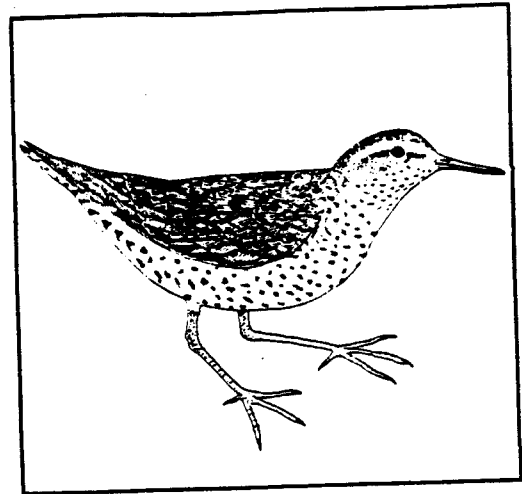


51 - 100% Occurrence

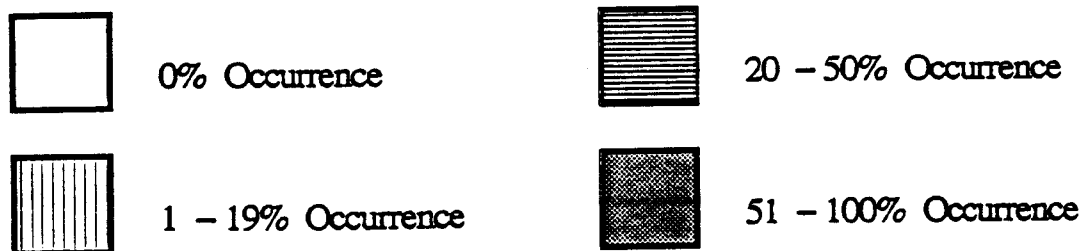
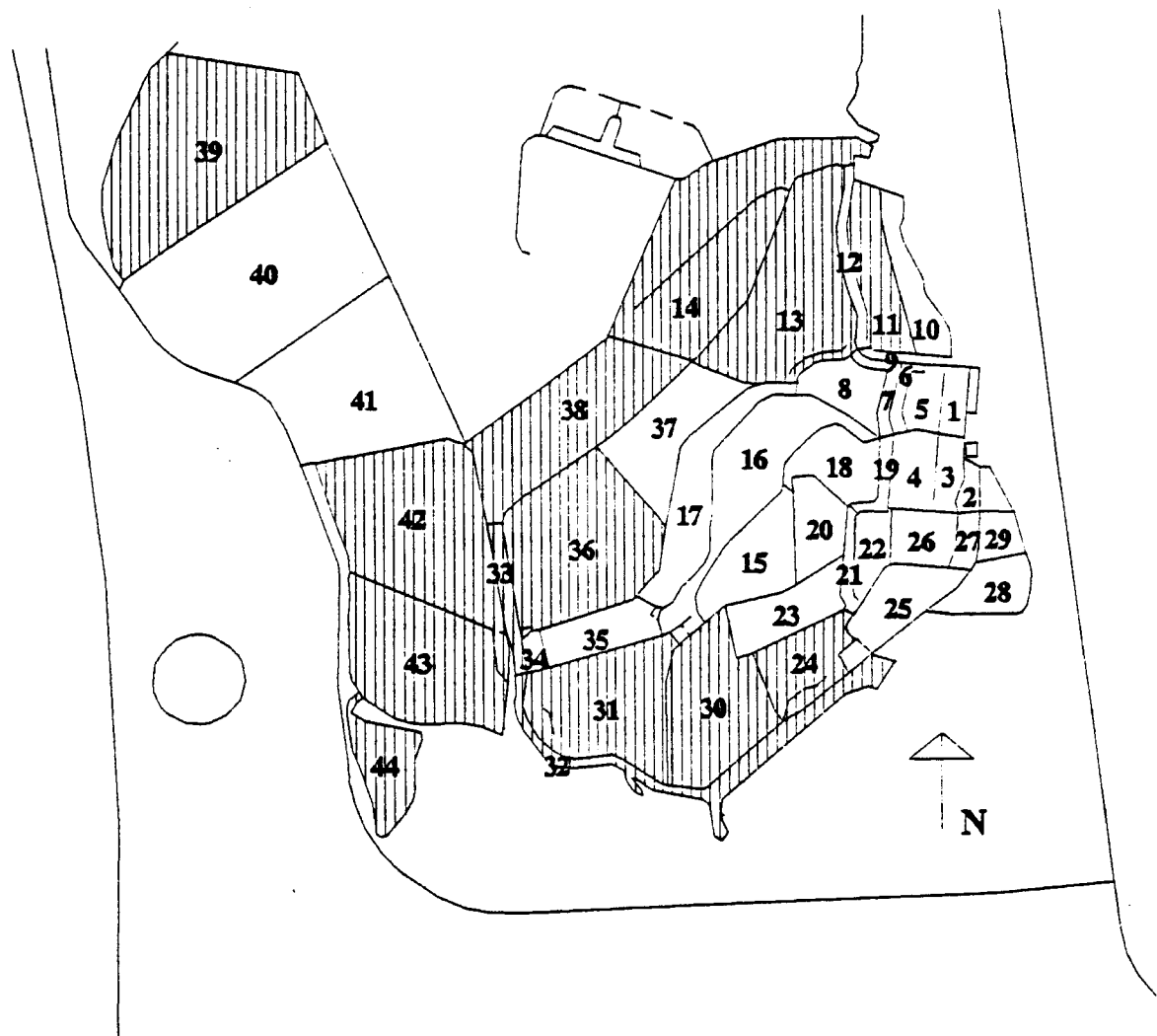
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Spotted Sandpiper (*Actitis macularia*)

This species was present throughout the year and was found within 15 of the 44 survey units. The number of spotted sandpipers per cell ranged from one to three individuals.



Spotted Sandpiper

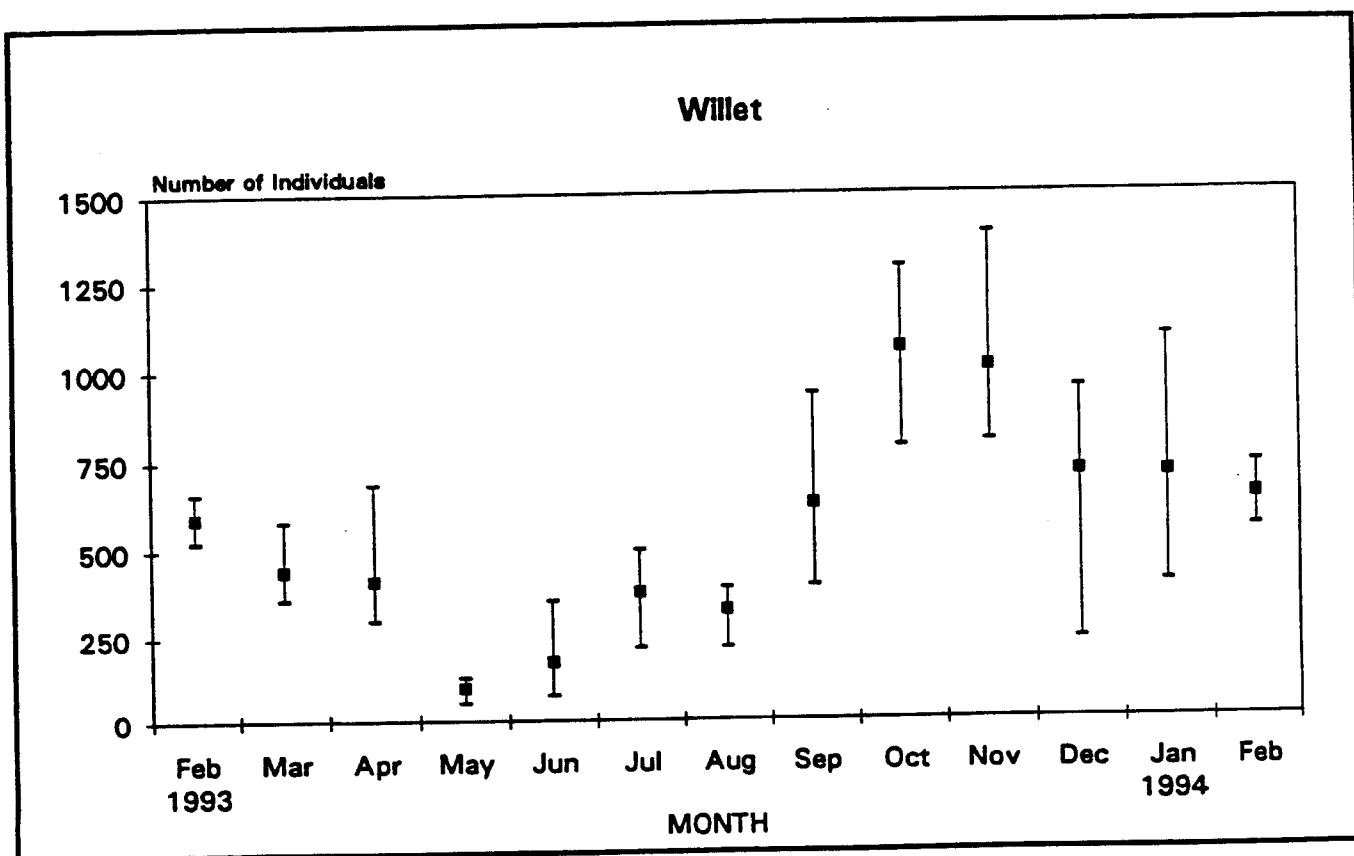
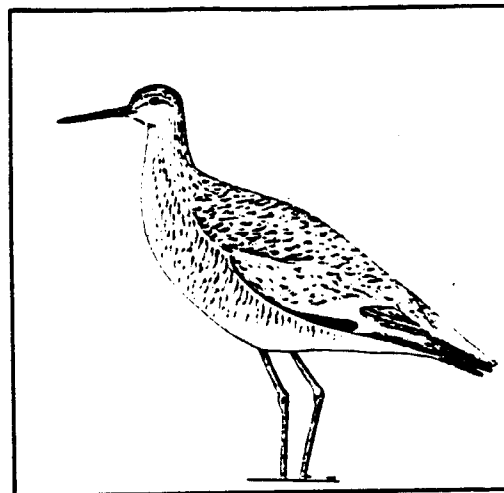


Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

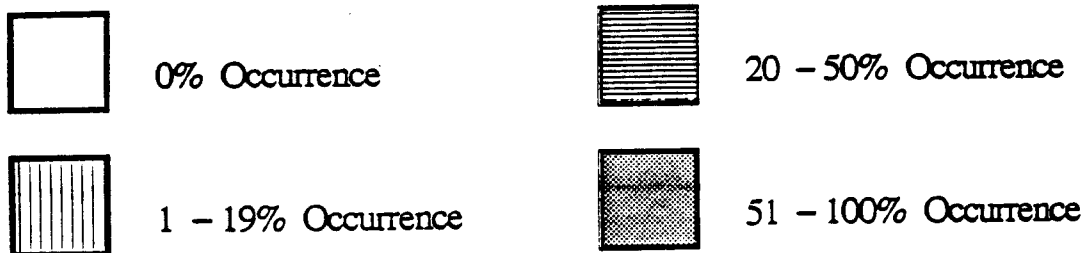
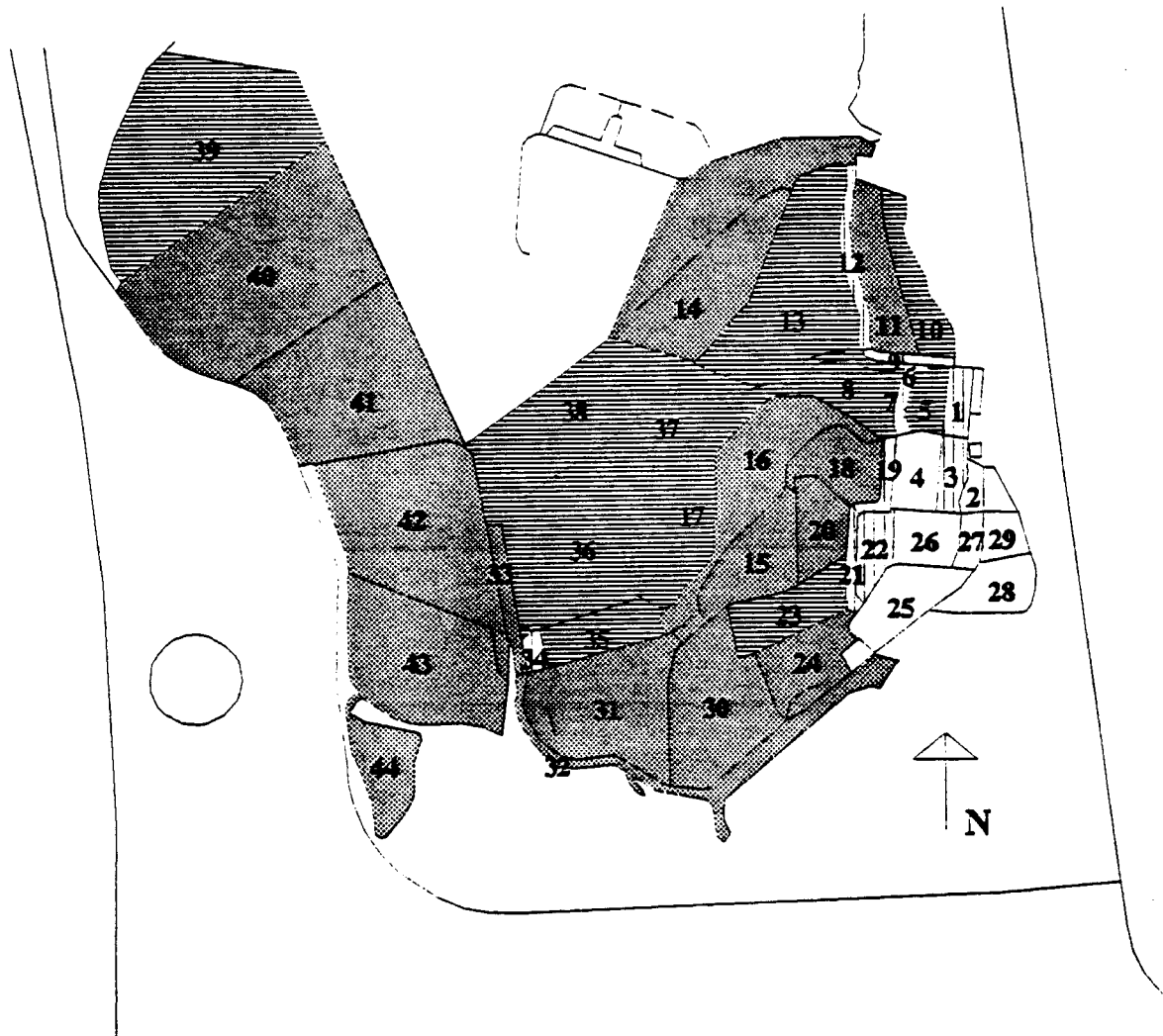
Willet

(*Catoptrophorus semipalmatus*)

Willetts were present during all surveys and were found within 36 of the 44 areas. Non-breeding birds were present within the study area throughout the summer with the peak of abundance occurring in the late fall and early winter months. A high count of 1385 birds was recorded during the November 3, 1993 survey.



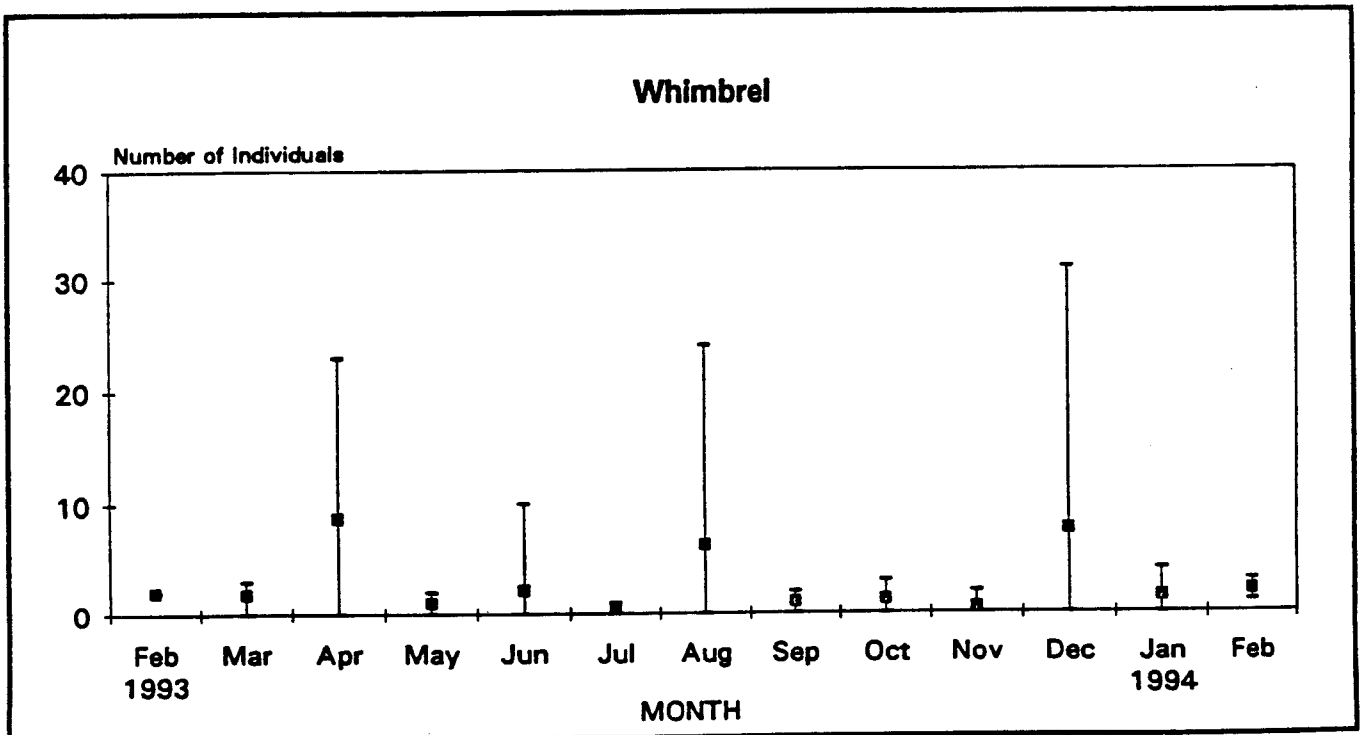
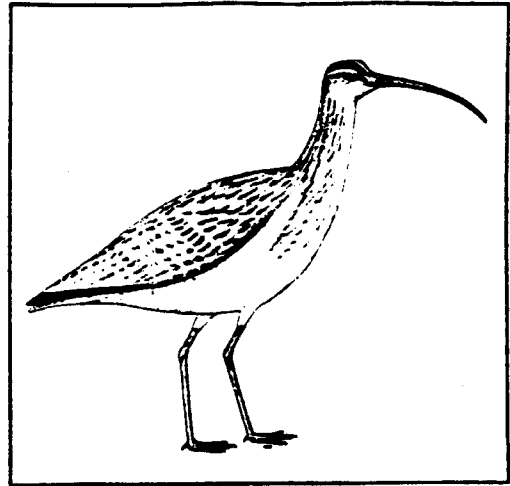
Willet



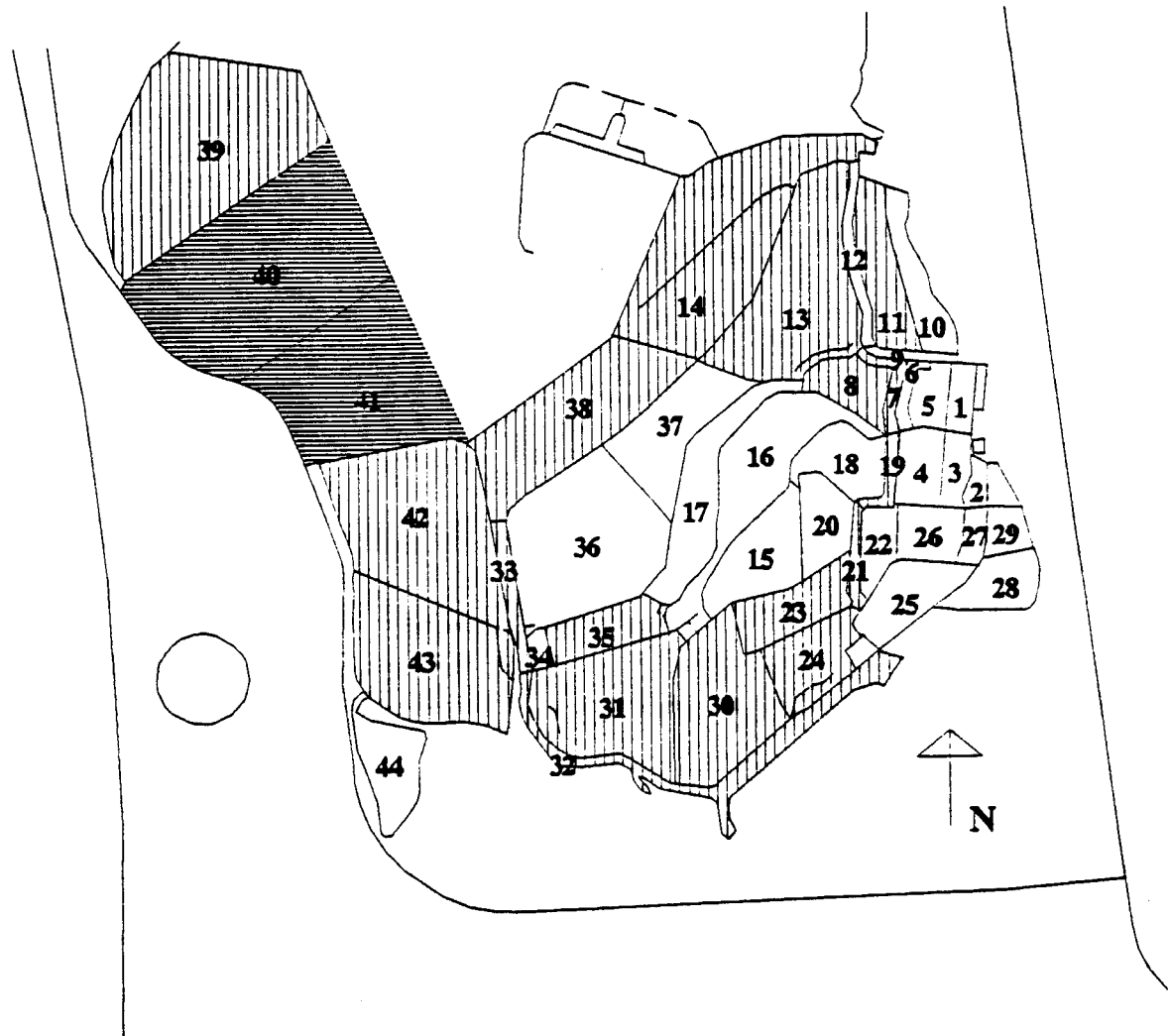
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Whimbrel (*Numenius phaeopus*)

This species was present during 58% of the surveys and was found within 19 of the 44 survey units. Whimbrels were most frequently encountered within cells 40 and 41 both of which contained tidal mudflats and a relatively large expanse of pickleweed marsh. Whimbrels often foraged on the mudflats and were observed taking refuge in the pickleweed during high tides. The high count for this species was 31 individuals during the December 15, 1993 survey.



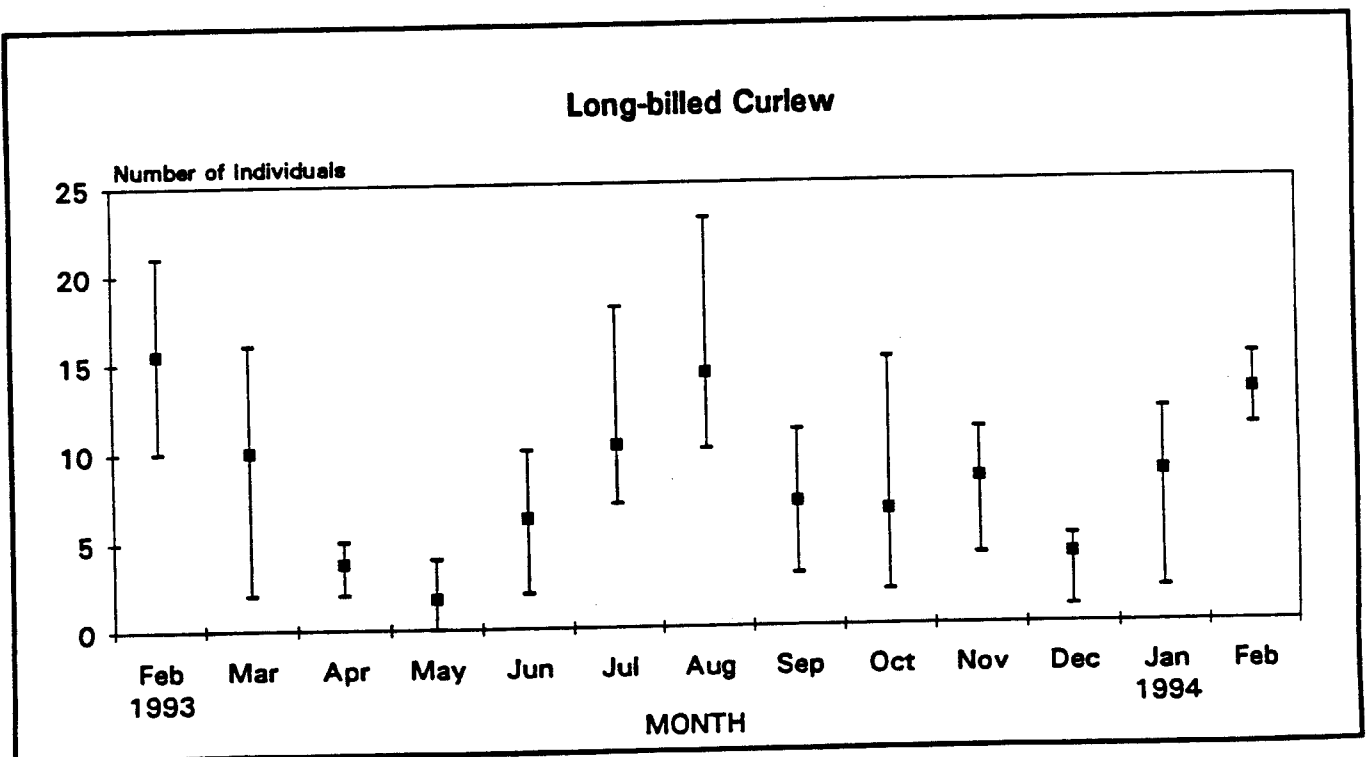
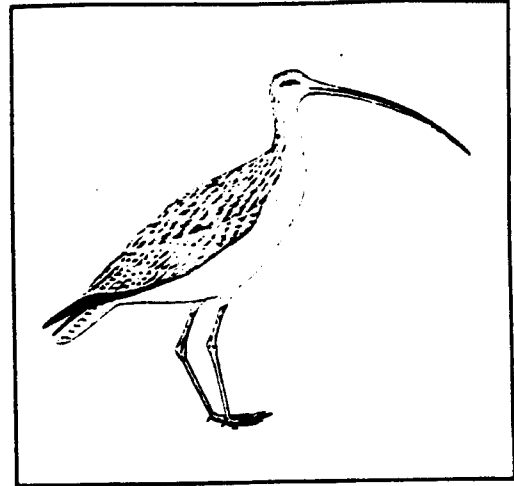
Whimbrel



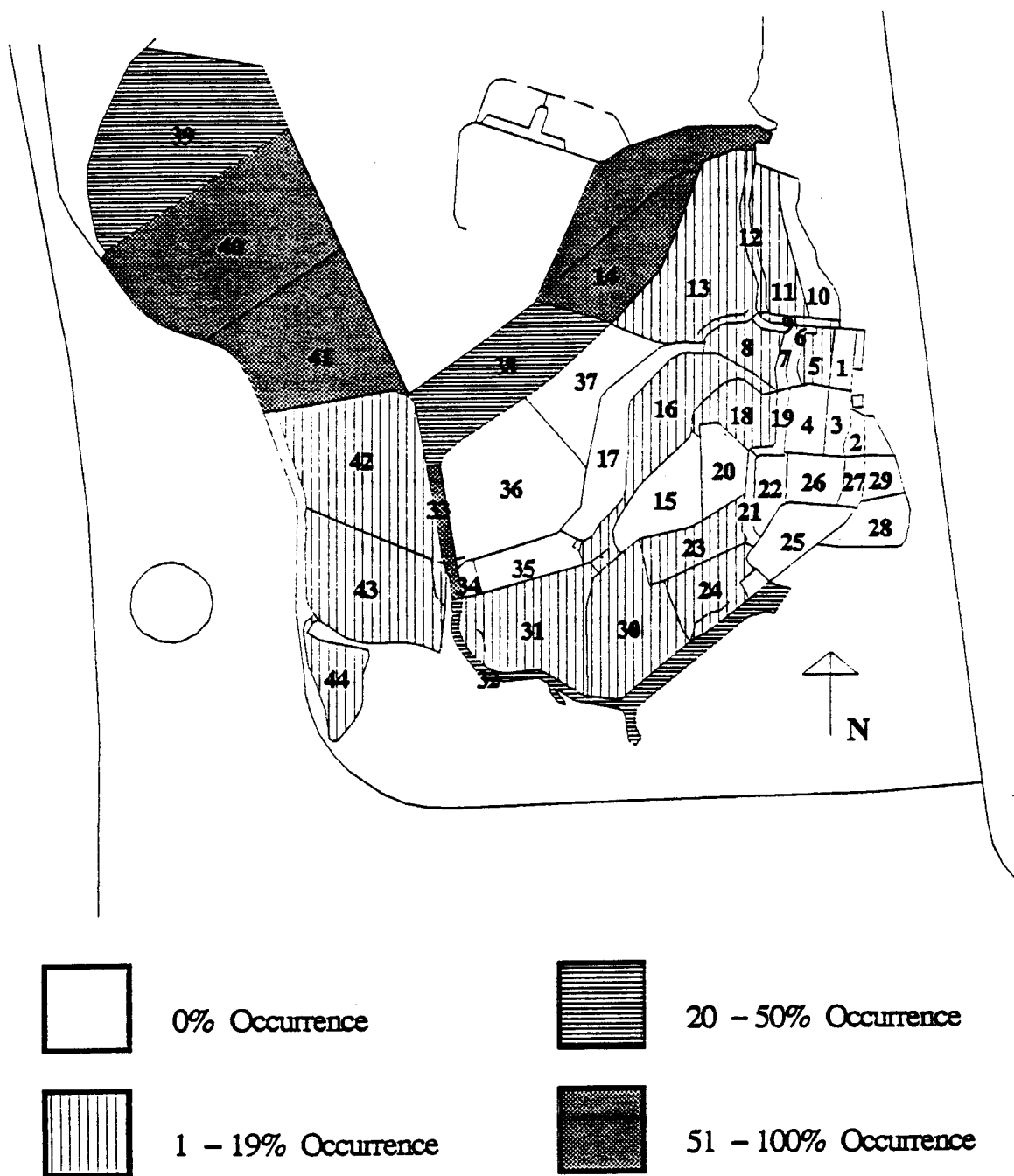
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Long-billed Curlew (*Numenius americanus*)

Long-billed curlews were present during 98% of the surveys and were found within 18 of the 44 survey units. This species occurred most often within the cells which were tidally influenced. The number of curlews observed within a single cell ranged from one to ten. Long-billed curlews were most abundant during the migratory periods in February and August. A high count of 23 individuals was recorded on August 25, 1993.



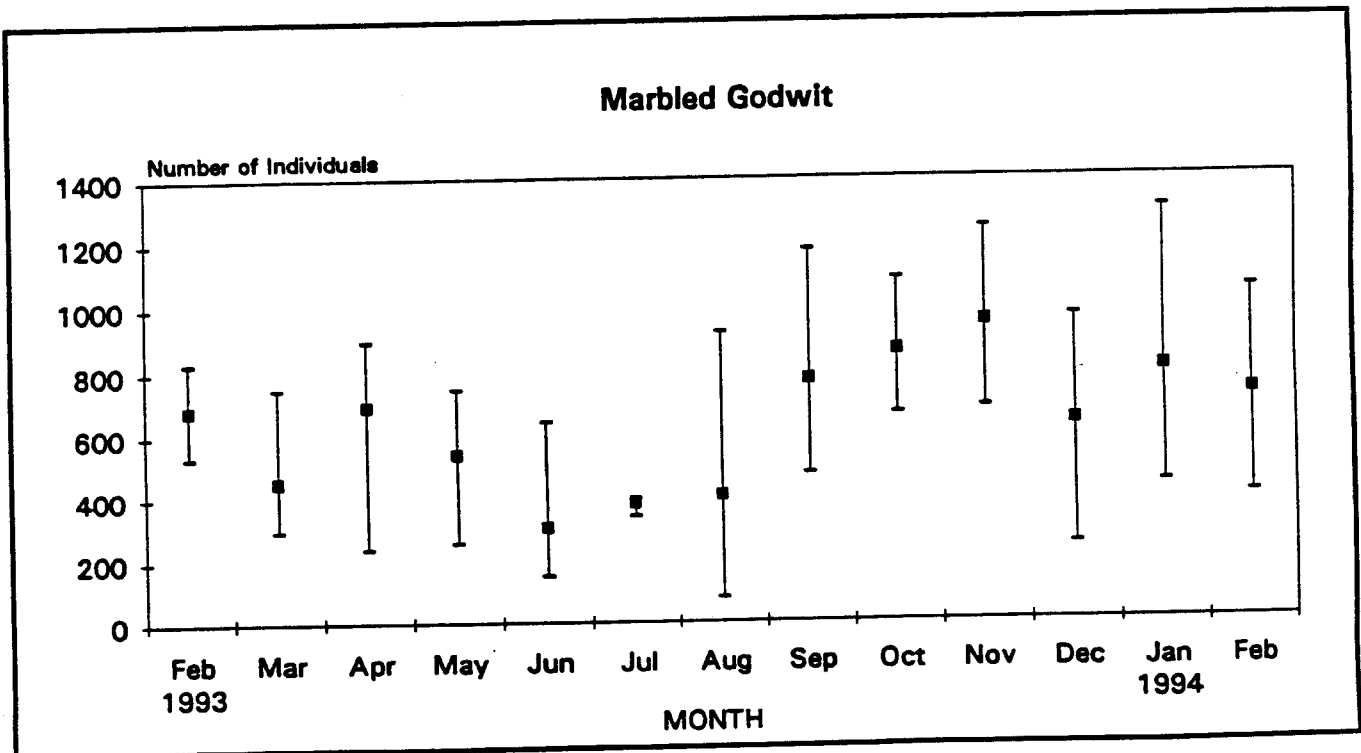
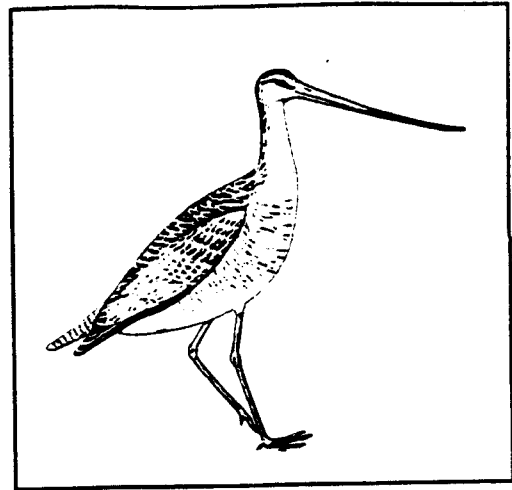
Long-billed Curlew



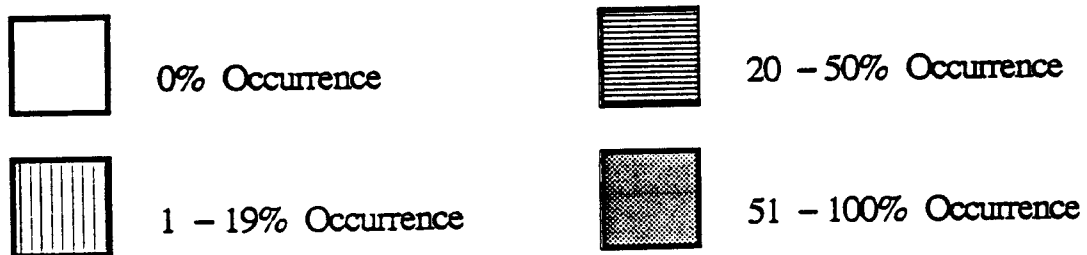
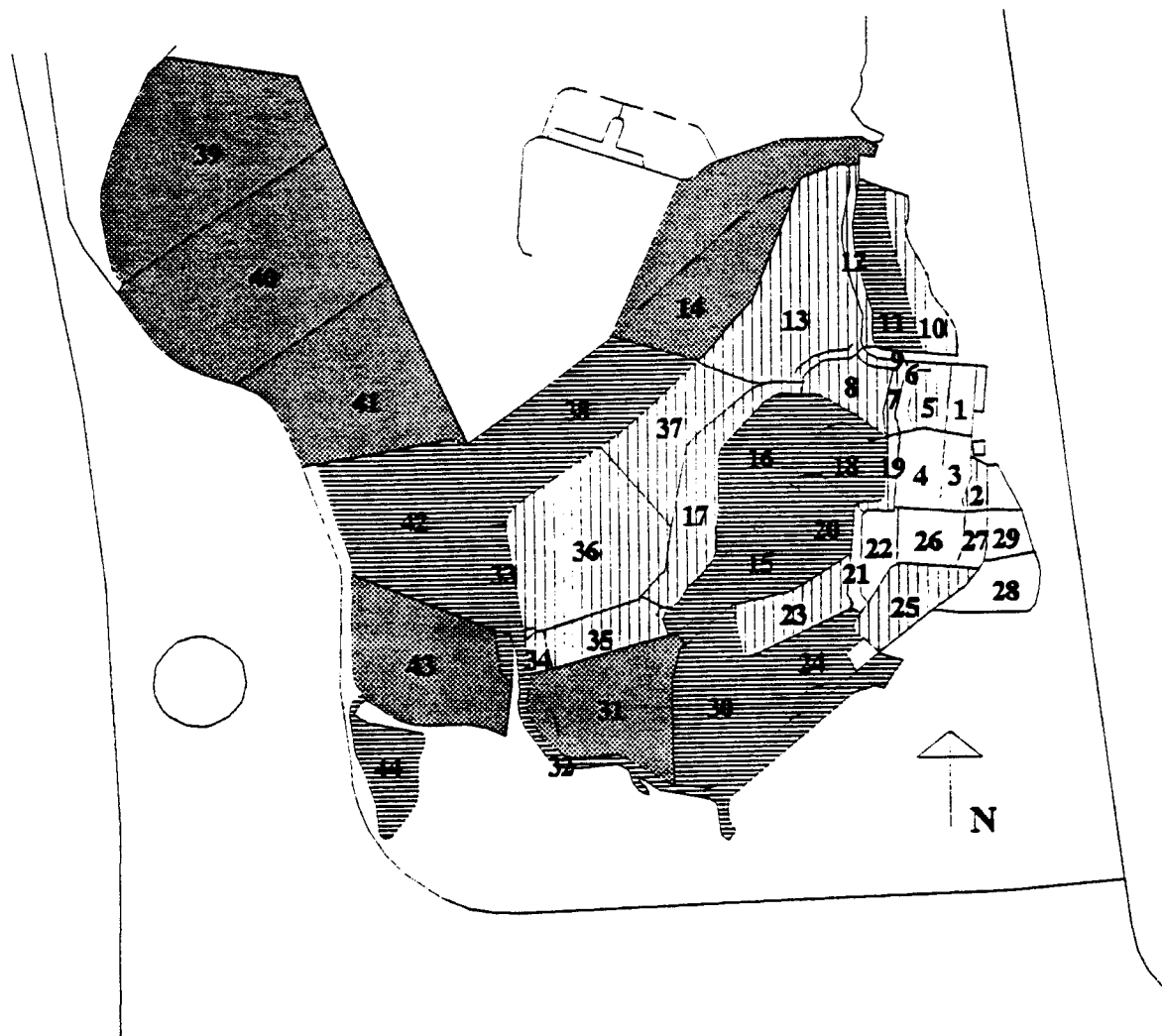
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Marbled Godwit (*Limosa fedoa*)

This species was present during all surveys and occurred within 33 of the 44 survey units. Non-breeding marbled godwit were present at the study site during the summer season. The number of individuals increased at the onset of shorebird migration in August with wintering birds remaining on location. While the monthly average for this species peaked in November, a high count of 1300 individuals was recorded during the January 26, 1994 survey.



Marbled Godwit

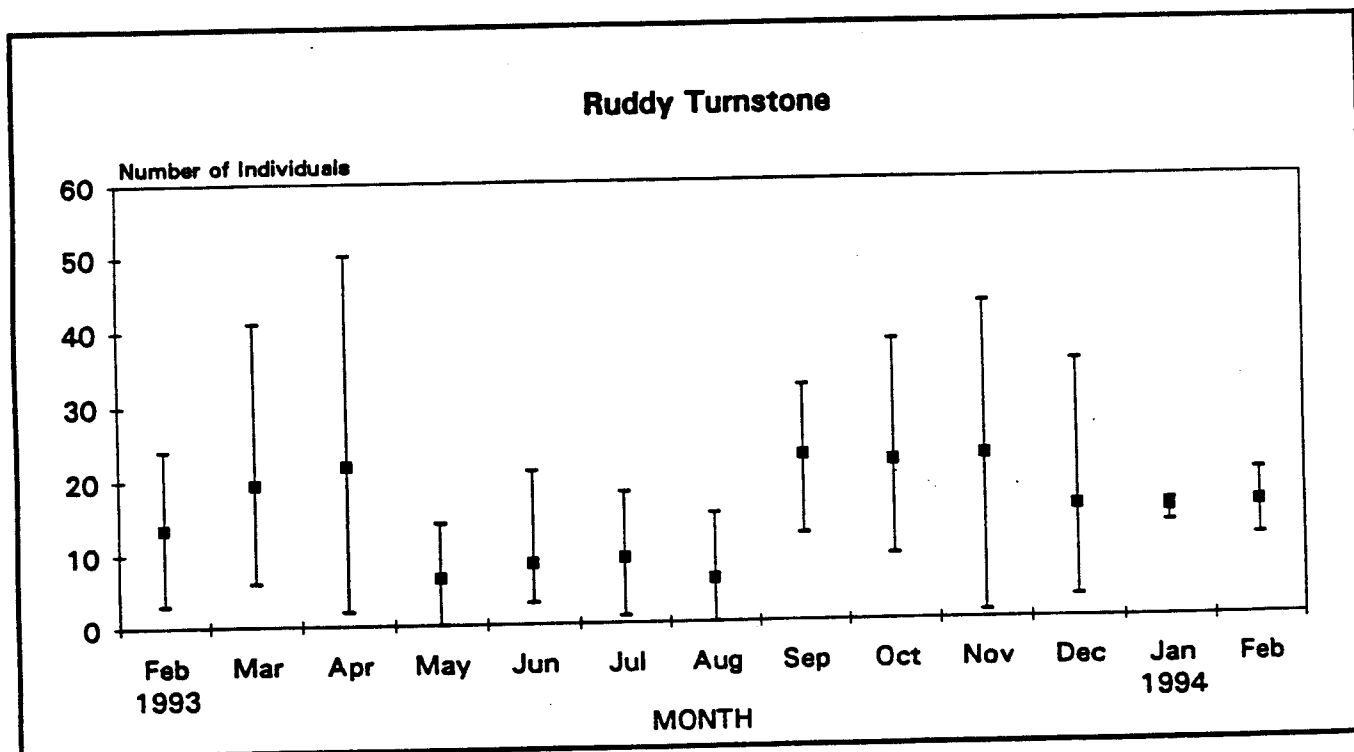
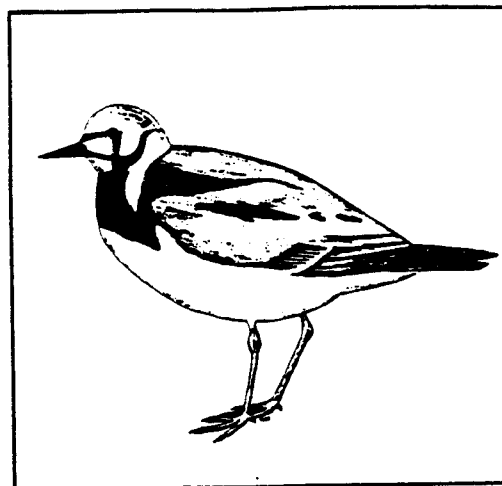


Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

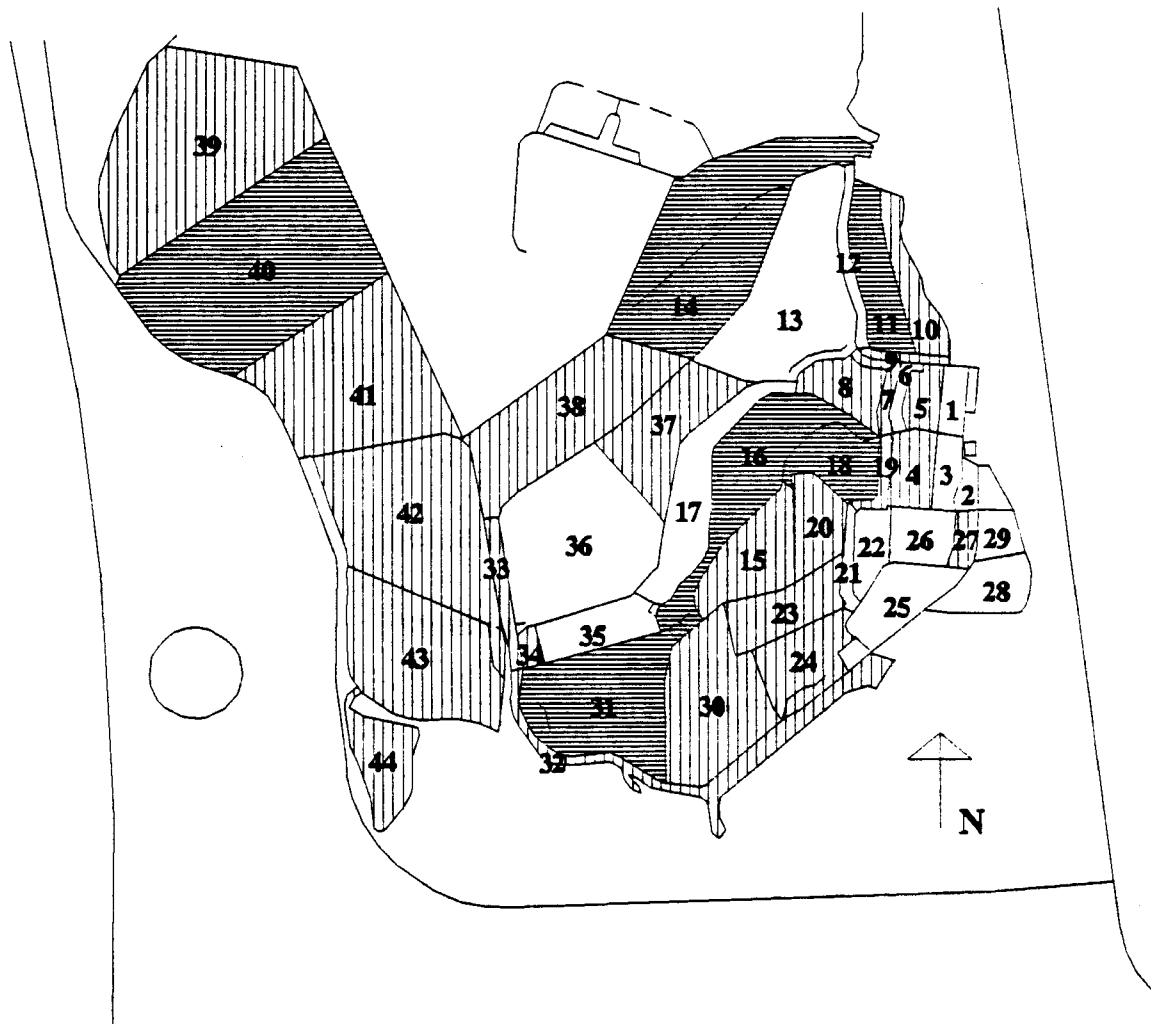
Ruddy Turnstone

(Arenaria interpres)

This species was present at the study site during 96% of the surveys and occurred within 29 of the 44 units. Ruddy turnstones were most abundant during both spring and fall migration with non-breeding birds present in the summer months. A high count of 50 birds was recorded on April 14, 1993 of which 42 were observed within survey unit 11.



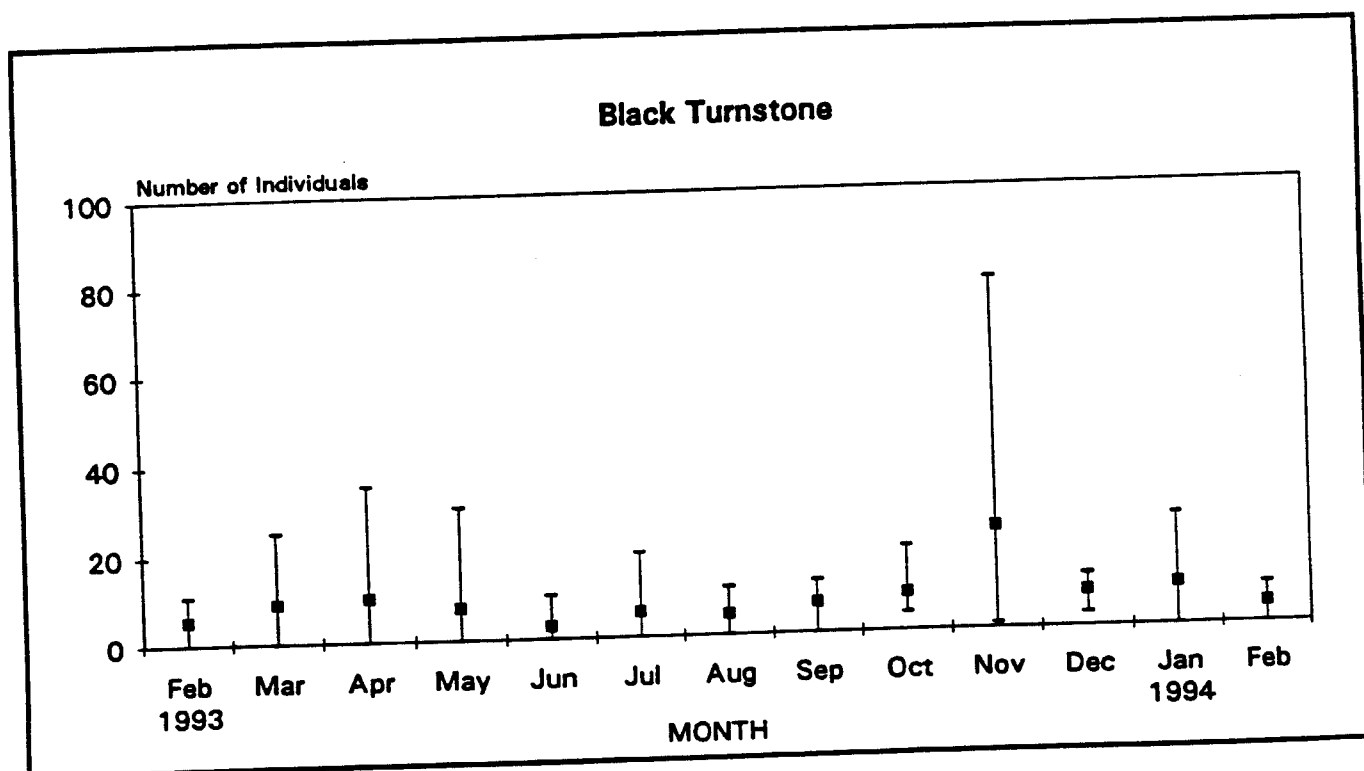
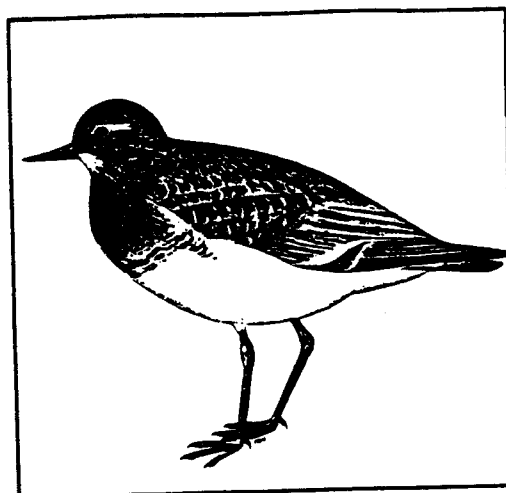
Ruddy Turnstone



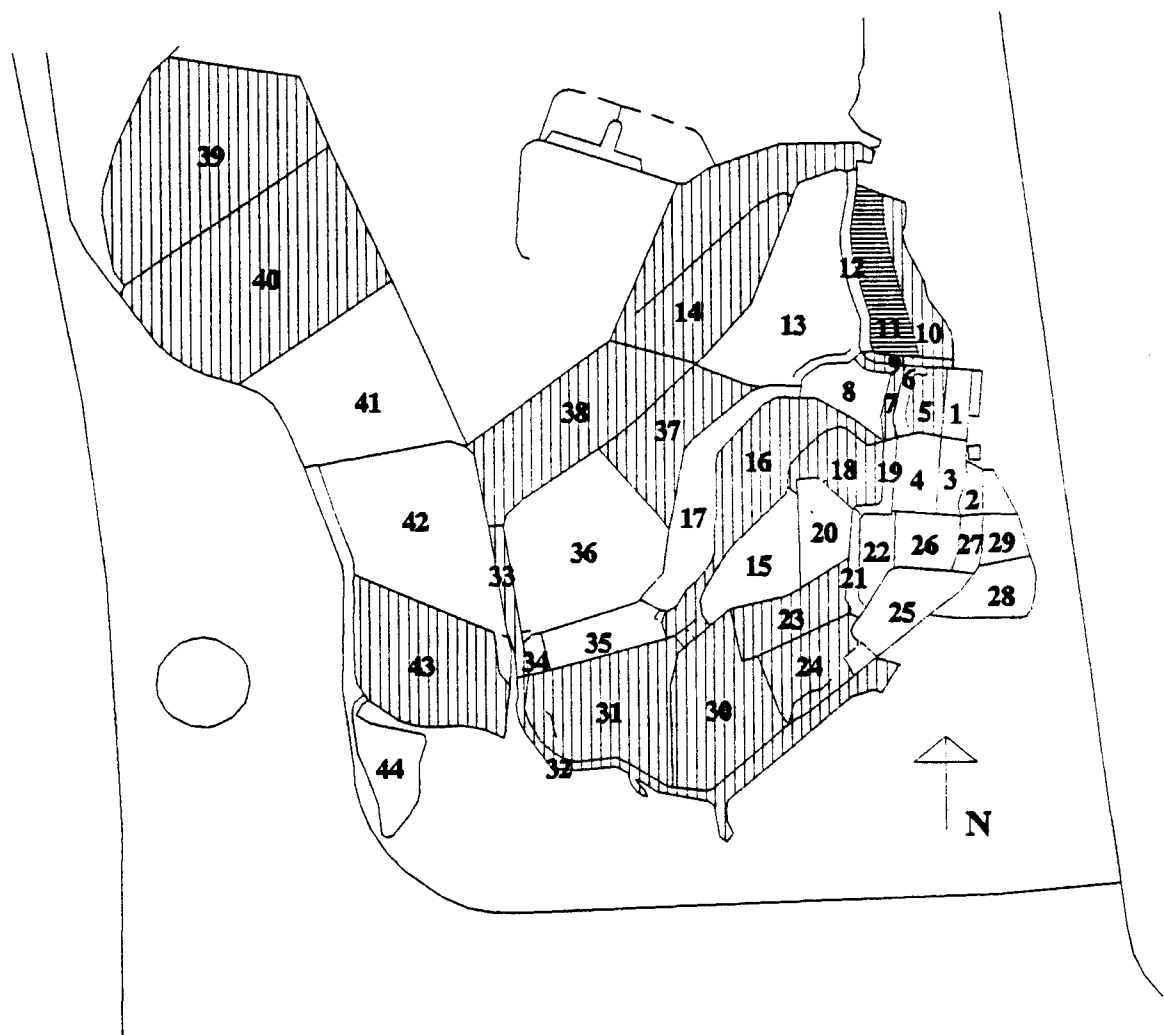
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Black Turnstone (*Arenaria melanocephala*)

Black turnstones were present throughout the seasons and occurred within 18 of the 44 survey units. This species was most frequently observed in cell 11. A high count of 79 birds was recorded during the November 3, 1993 survey.



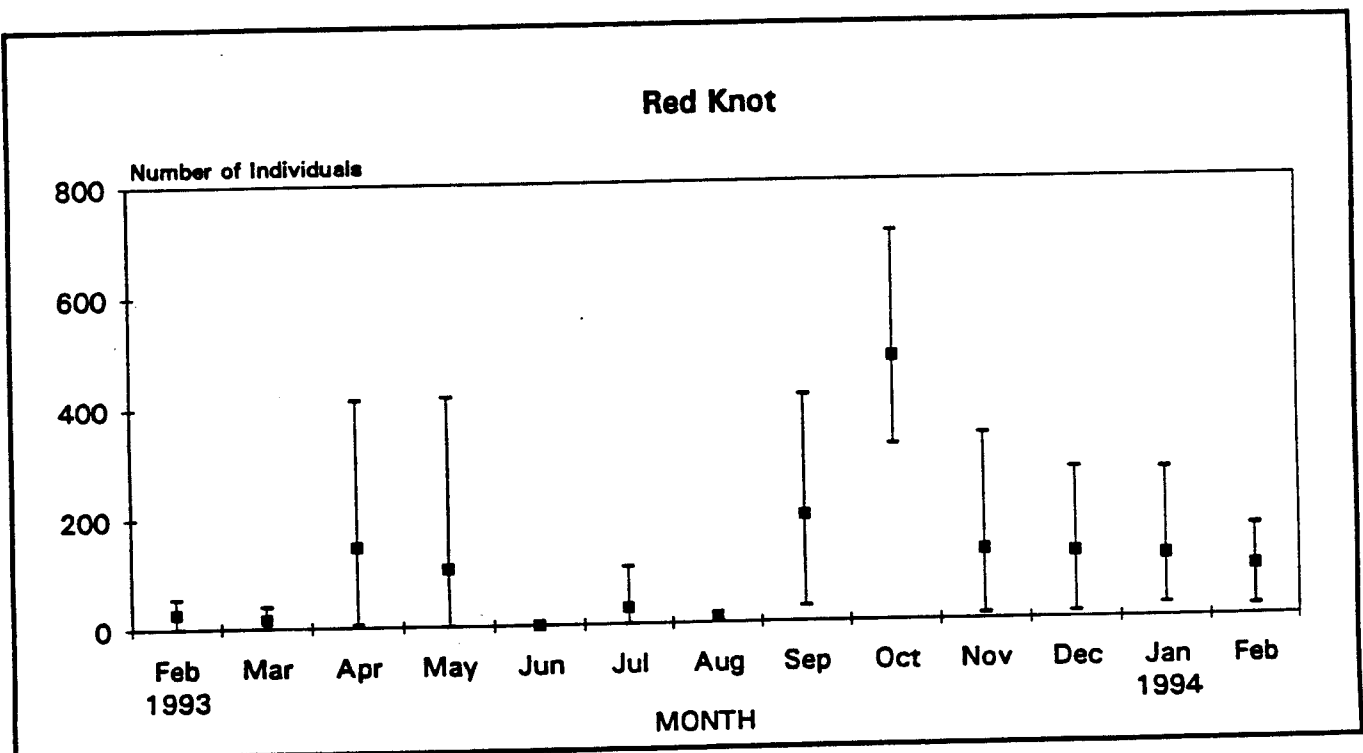
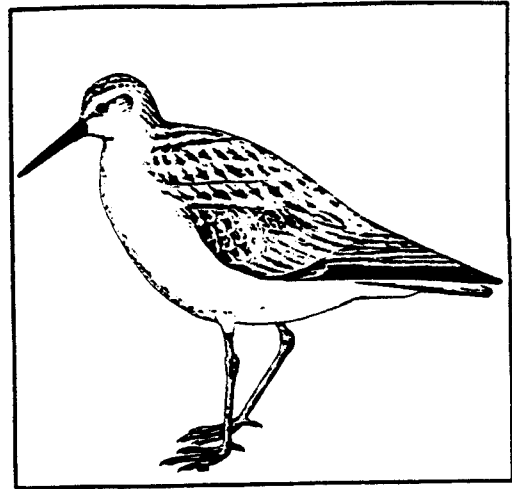
Black Turnstone



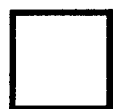
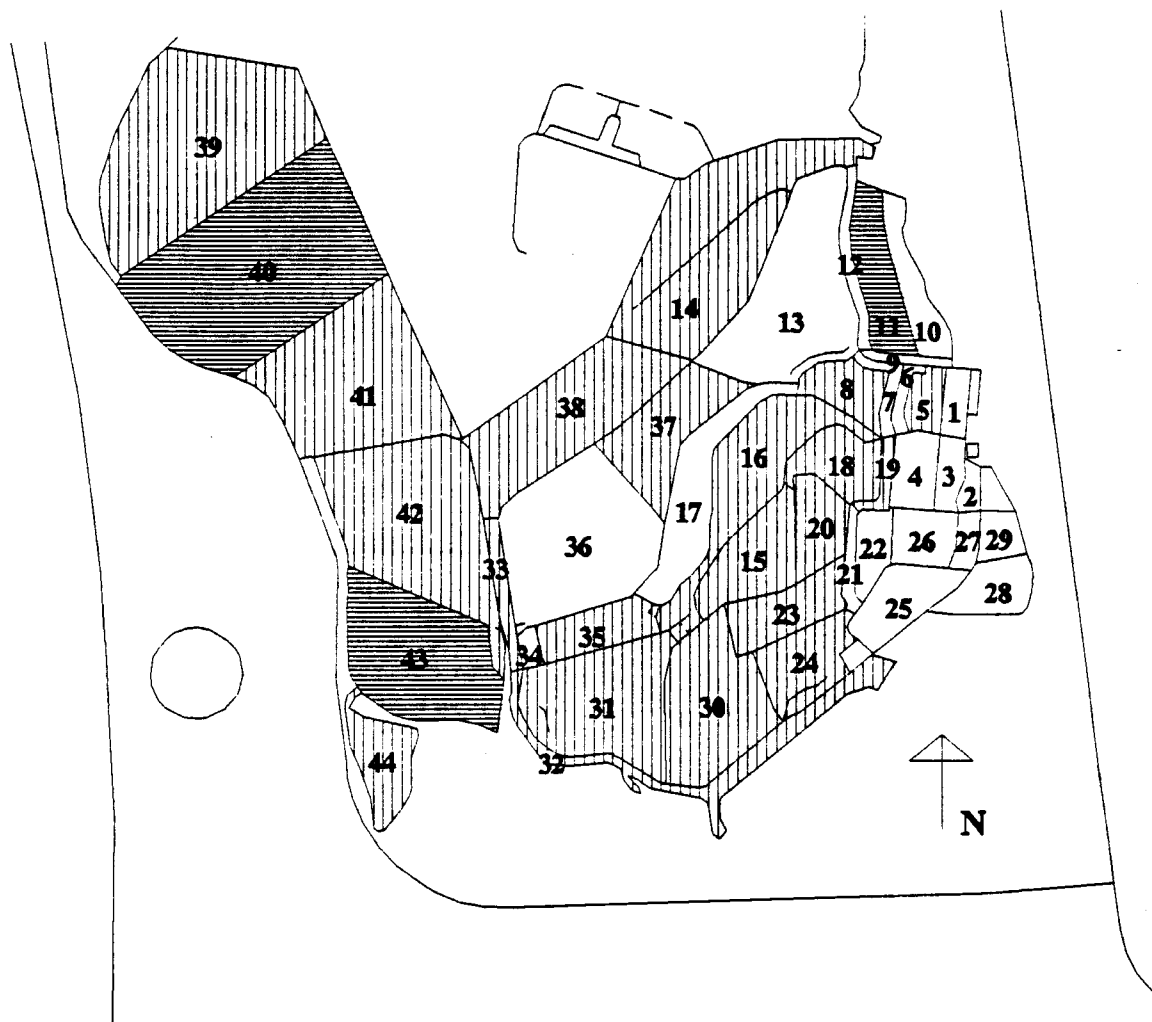
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Red Knot (*Calidris canutus*)

Red knots were most abundant during the spring and fall migratory periods with a number of individuals overwintering at the study site. The peak number of individuals occurred during October 1993 at which time a high count of 706 birds were recorded. Red knots were most often found within survey units 11, 40, and 43.



Red Knot



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

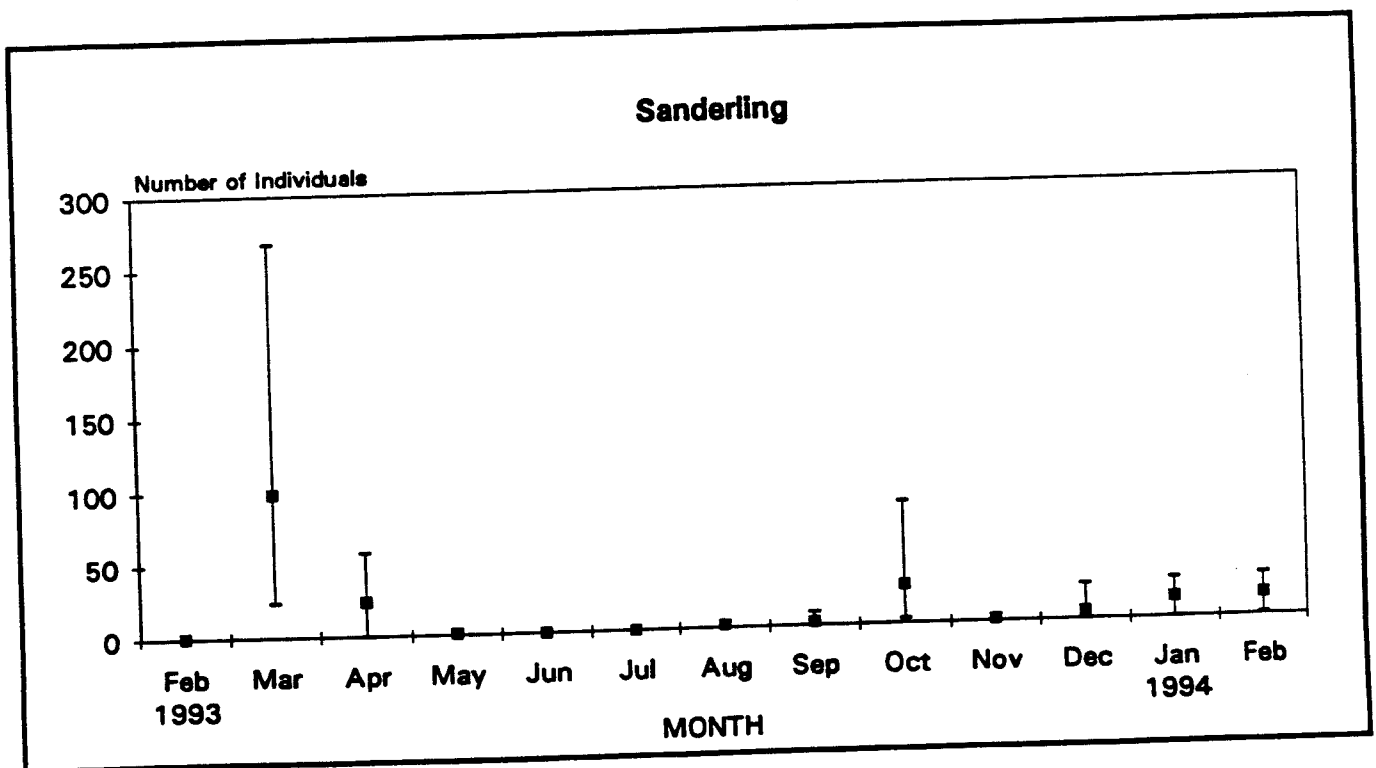
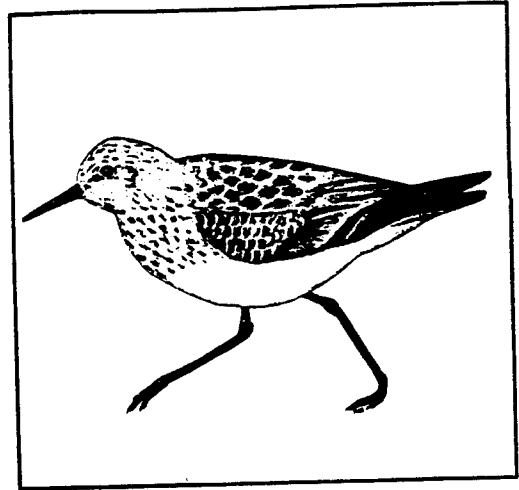


51 - 100% Occurrence

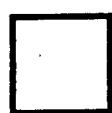
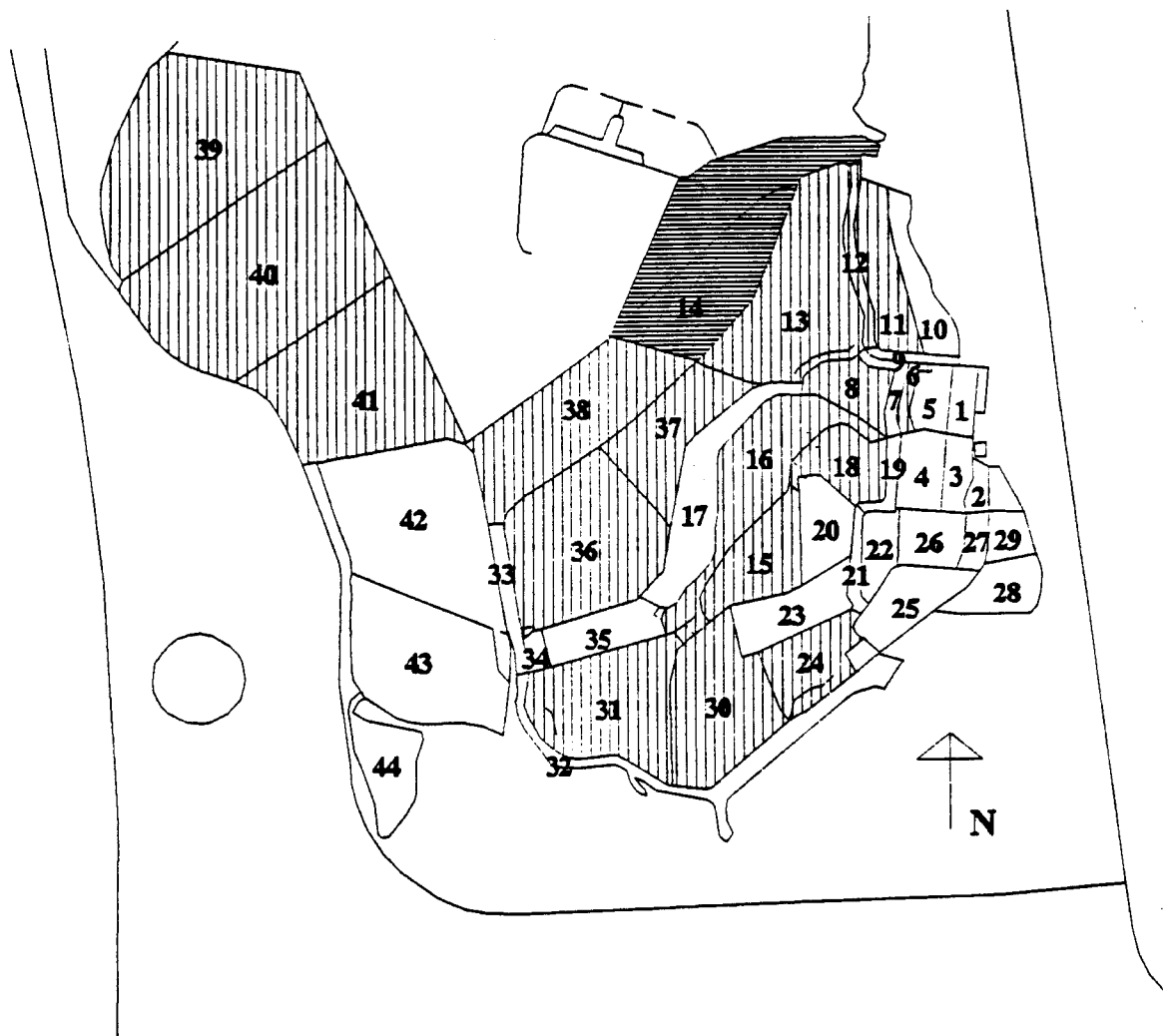
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Sanderling (*Calidris alba*)

Sanderlings were not present at the study site during June and July and only three individuals were detected in May and August. The high count for this species was 267 individuals recorded on March 17, 1993 of which 250 were located in cell 37. Sanderlings are usually associated with ocean beach front areas and this unusually high number of individuals may be attributed to a recording error.



Sanderling



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

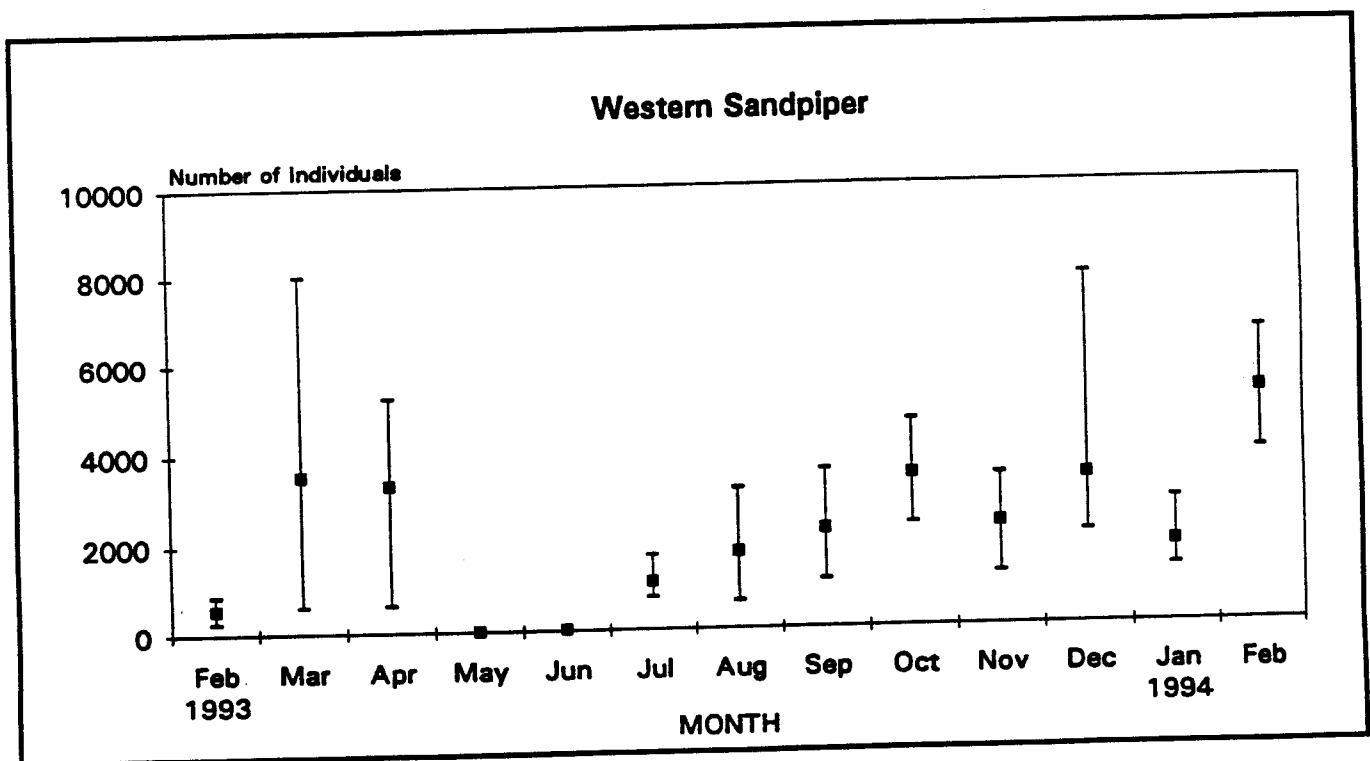
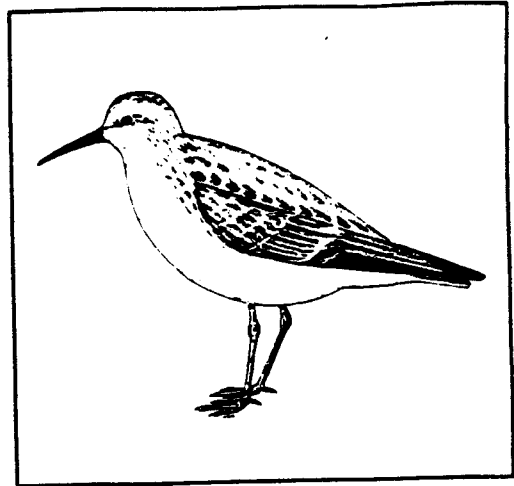


51 - 100% Occurrence

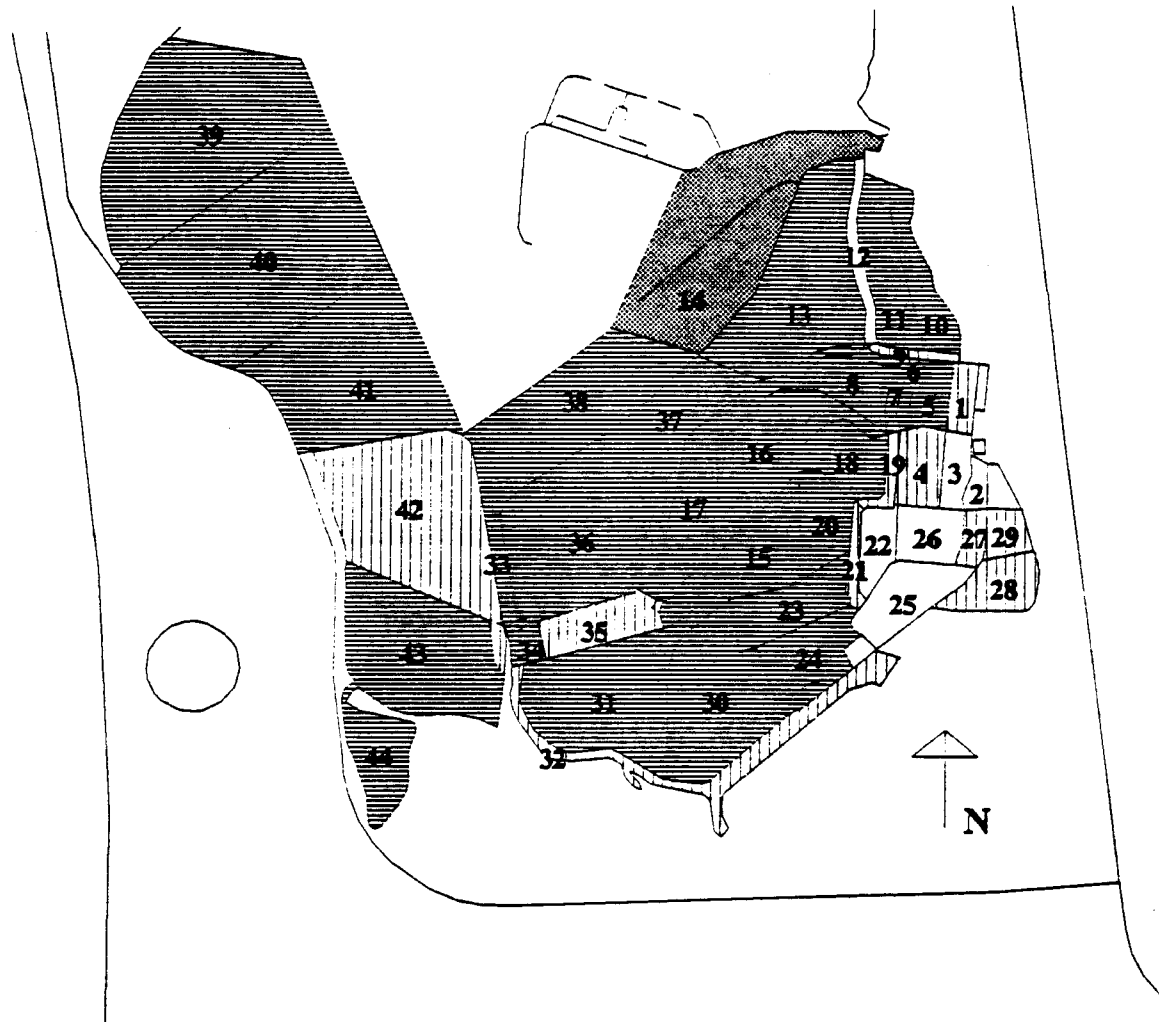
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Western Sandpiper (*Calidris mauri*)

Western sandpipers were present during 94% of the surveys and occurred in 27 of the 44 survey units. This species was absent from the study area during May and June. Peak monthly averages occurred in March and October coinciding with the period of spring and fall migrations. Western sandpipers comprised 30% of all shorebird species with a grand total of 112,115 individuals counted. High counts for individual survey dates were 8010 birds on March 3 and 7885 birds on December 1, 1993. (see also Peeps)



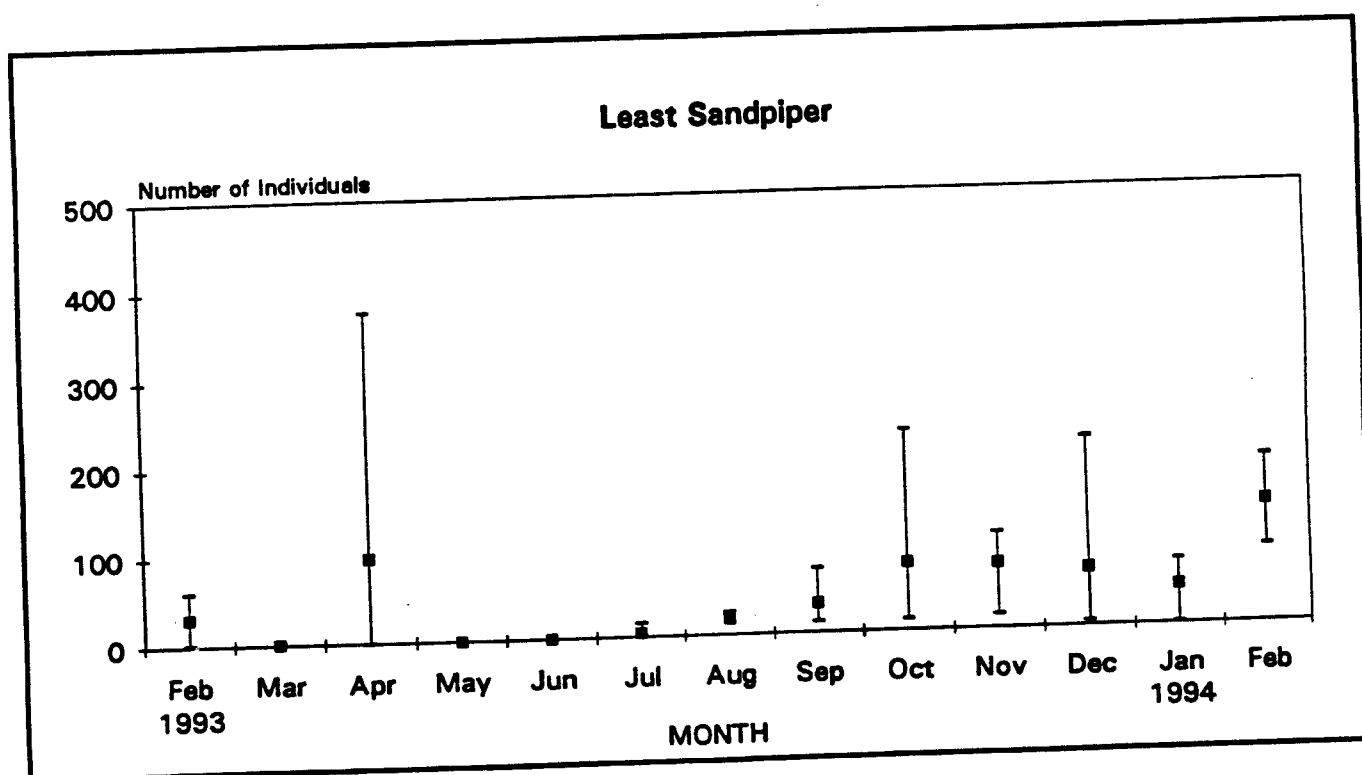
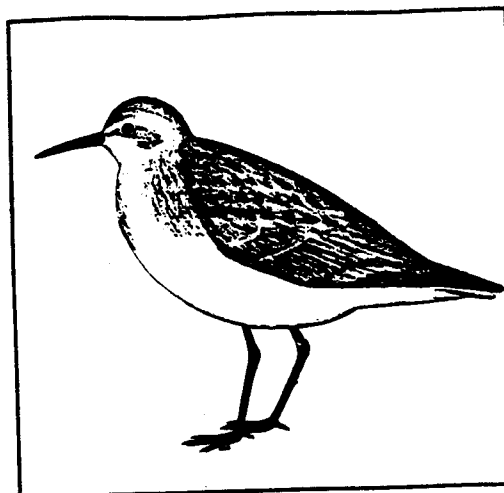
Western Sandpiper



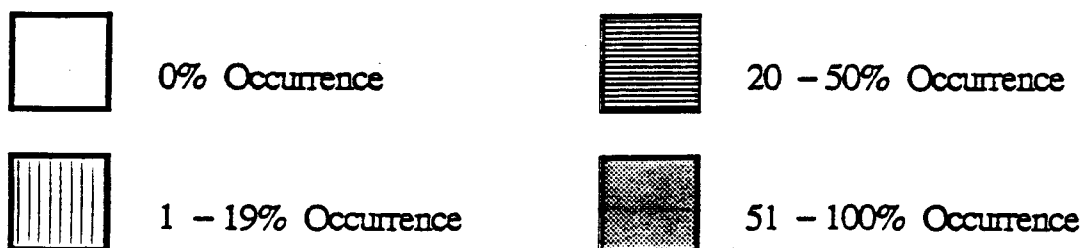
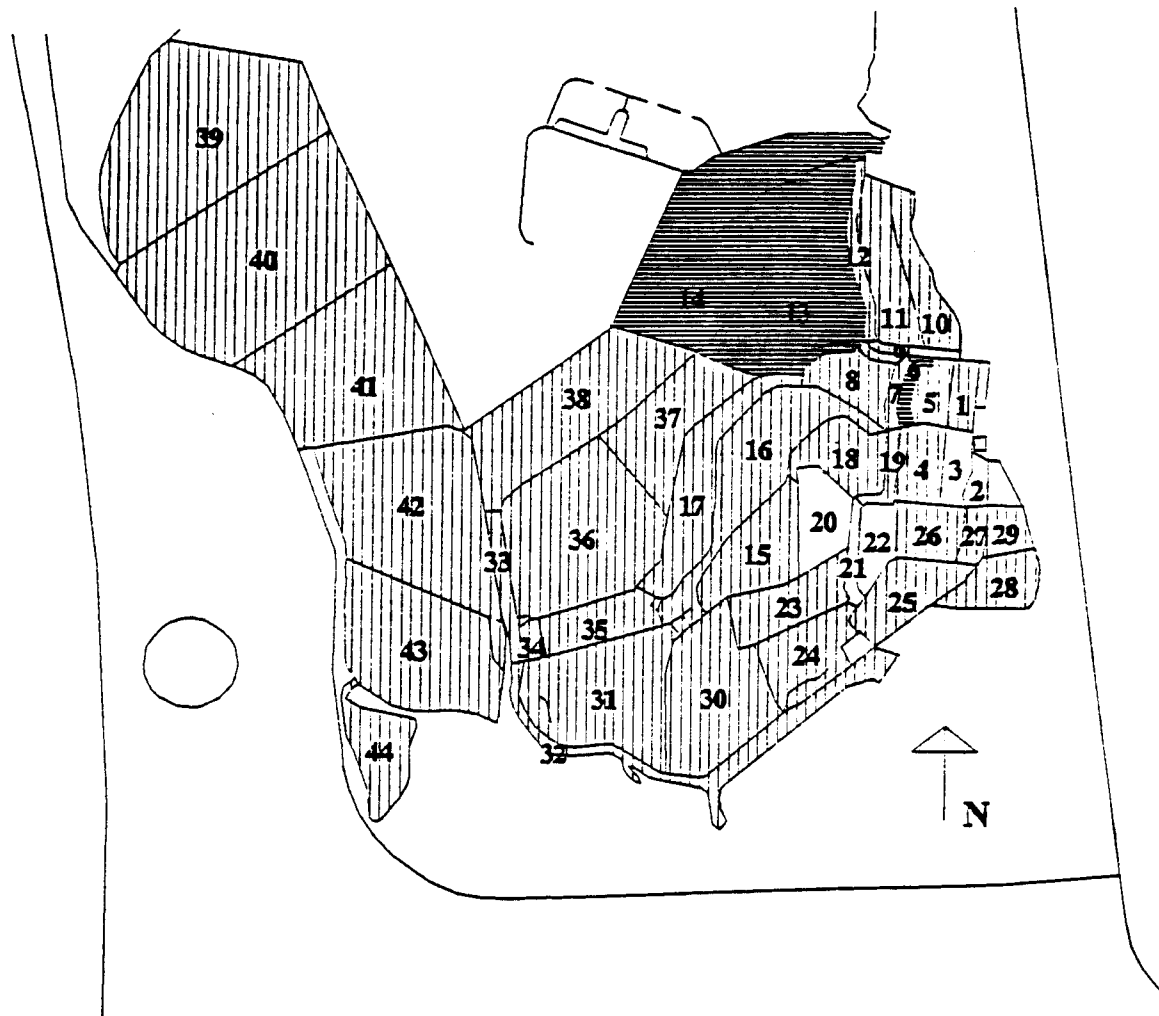
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Least Sandpiper (*Calidris minutilla*)

Least sandpipers were present during 73% of the surveys and occurred within 39 of the 44 survey units. Seasonal patterns were similar to that of the western sandpiper. The high count for this species occurred during the April 21, 1993 survey in which 375 individuals were reported. (see also Peeps)



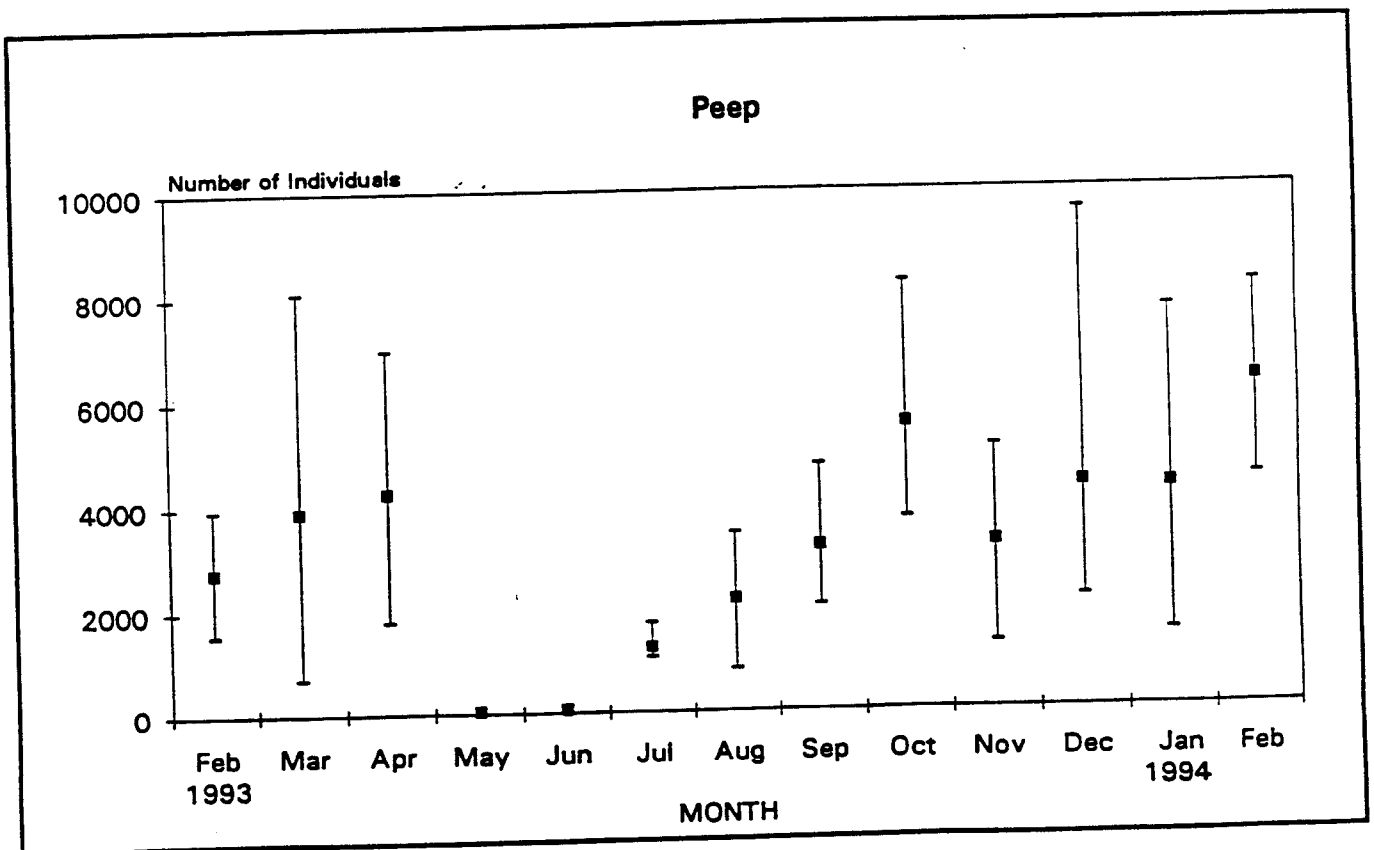
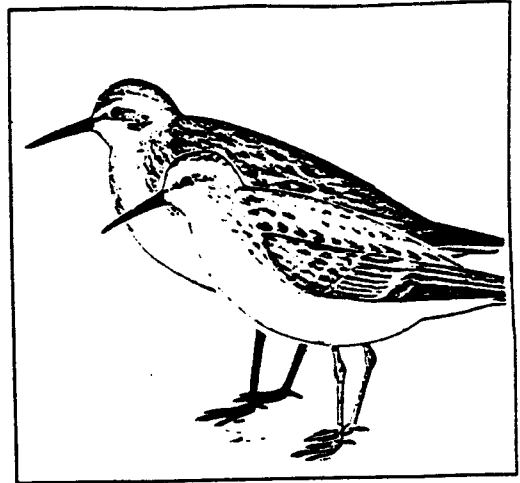
Least Sandpiper



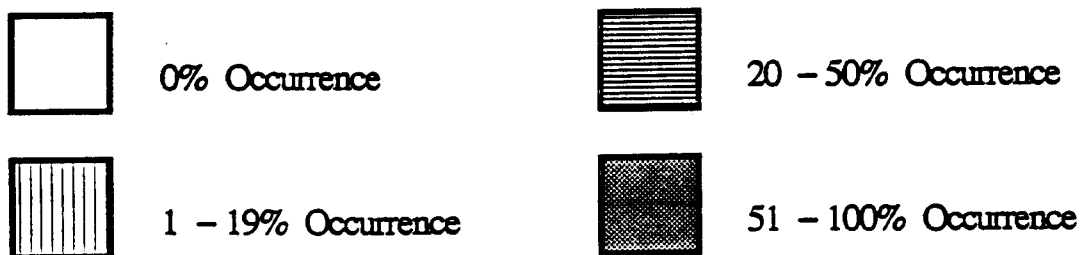
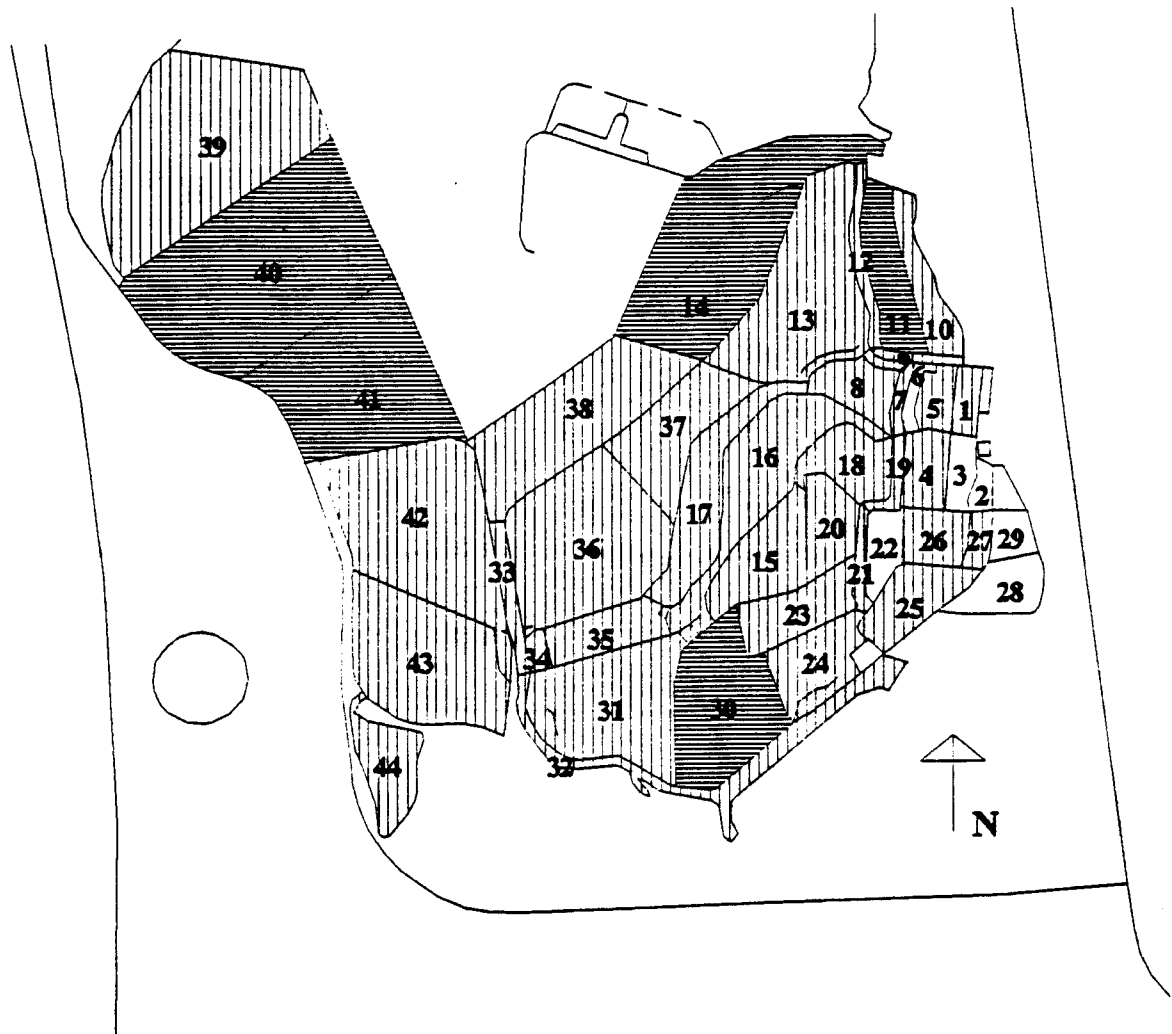
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Peeps (*Calidris spp.*)

Because of the difficulty of long distance identification of specific species namely the least and western sandpiper, the generic category of peeps was used if an observer could not identify these species to a specific epithet. The graph on this page portrays the combined identified least and western sandpiper as well as those which were categorized as peeps in order to portray a more accurate picture of seasonal abundance. The occurrence and distributional figure only displays those individuals which were identified as peeps. Note that there is no significant deviation from the distribution of peeps or the seasonal occurrence of those sandpipers which were identified to specific epithet.



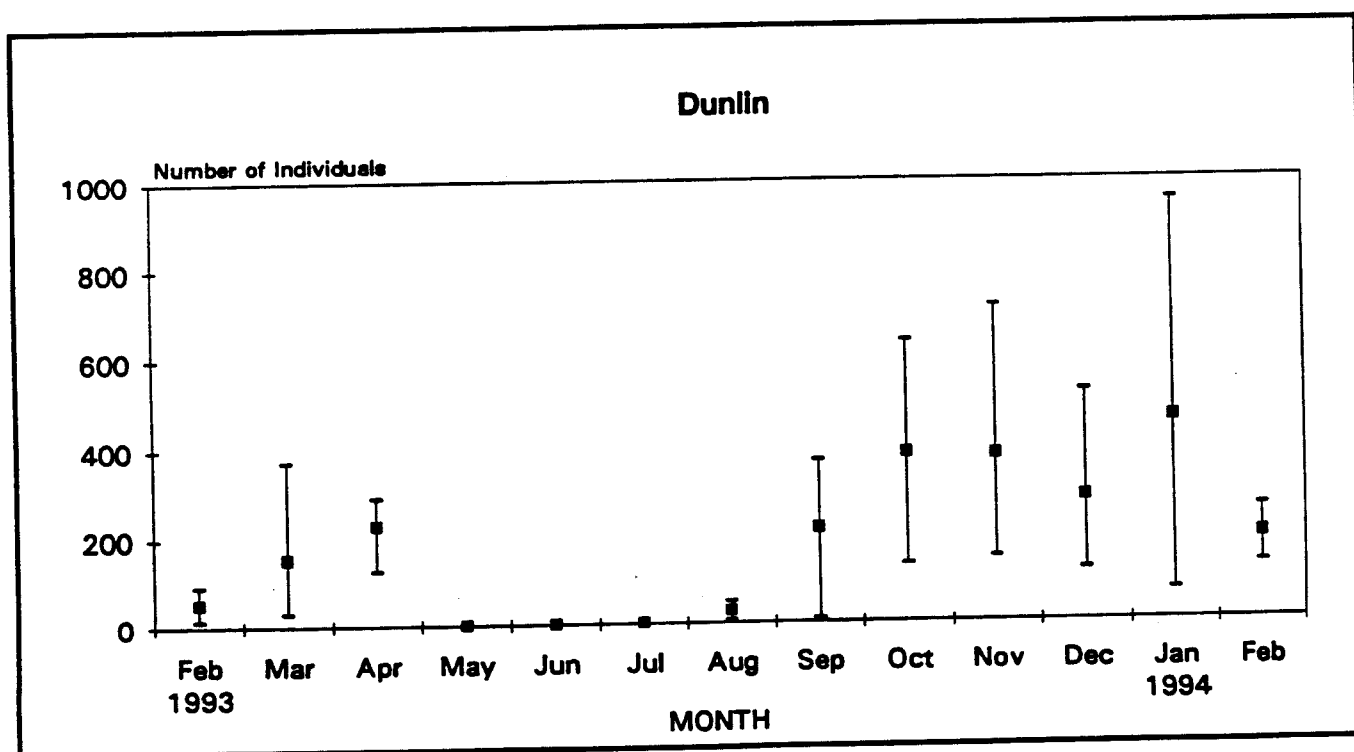
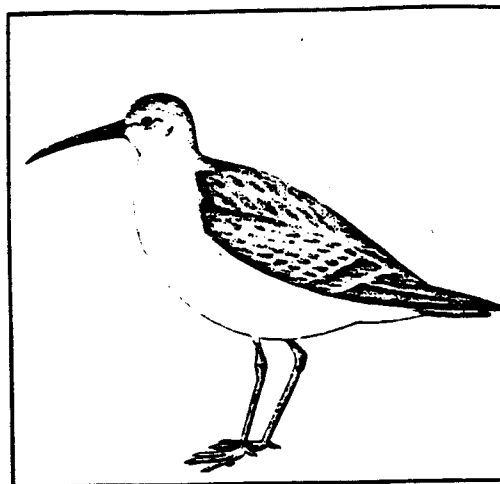
Peeps



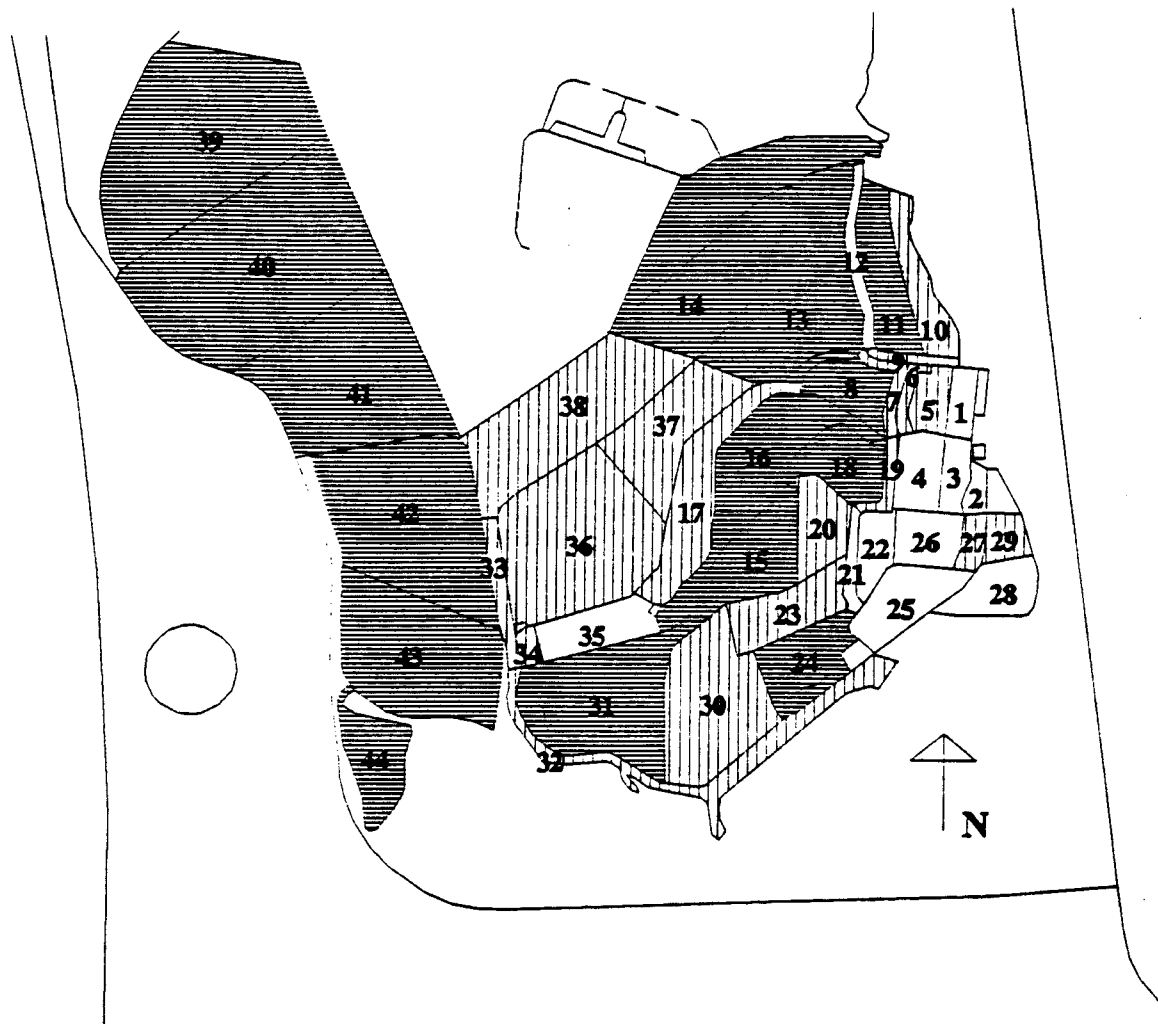
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Dunlin (*Calidris alpina*)

This species was present during 81% of the surveys yet was absent from the study area during May through July. Dunlin were observed in 33 of the 44 survey units. The increase in the number of individuals starting in August suggests the beginning of the fall migration which peaked in November. The high count for this species was recorded on January 26, 1994 during which time over 900 individuals were recorded.



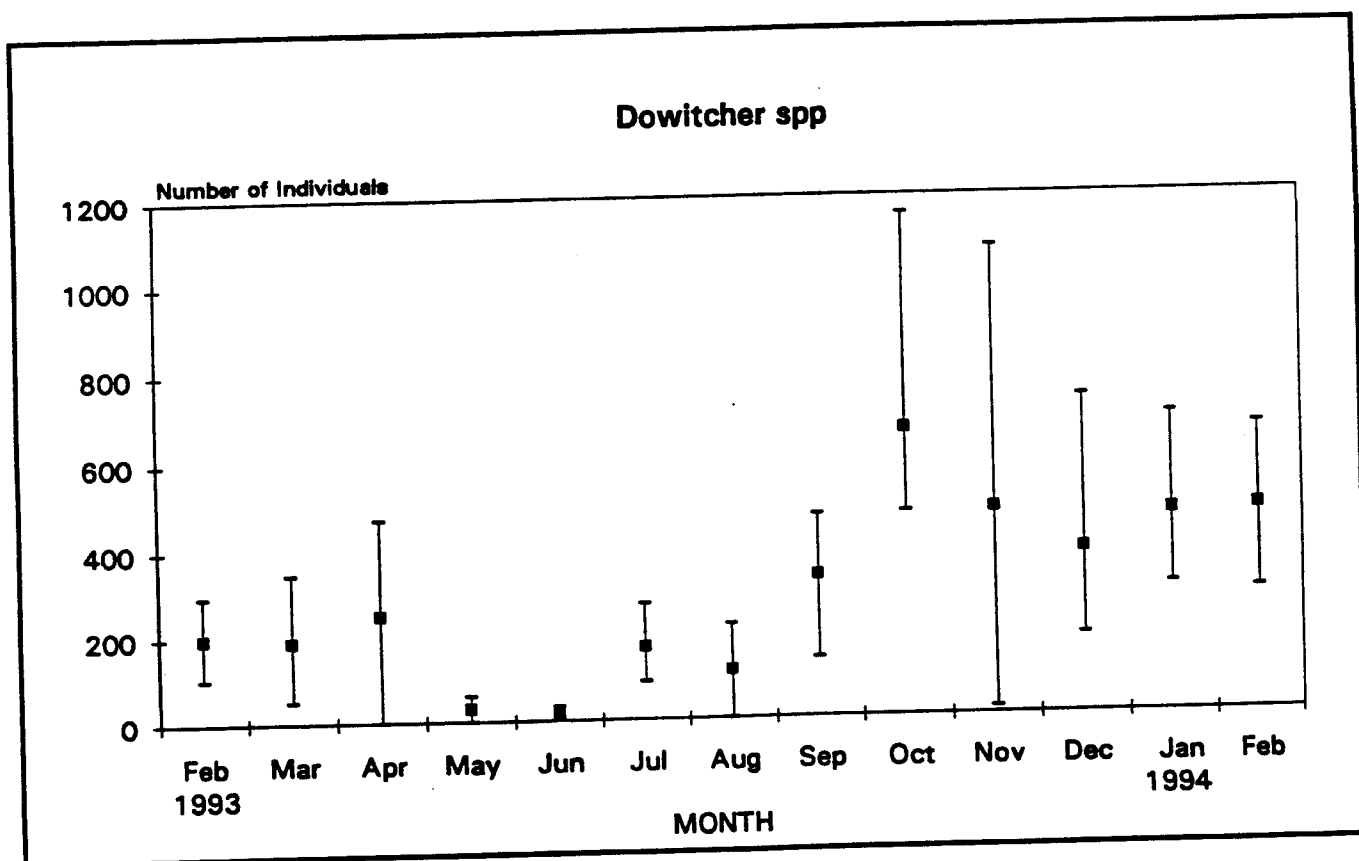
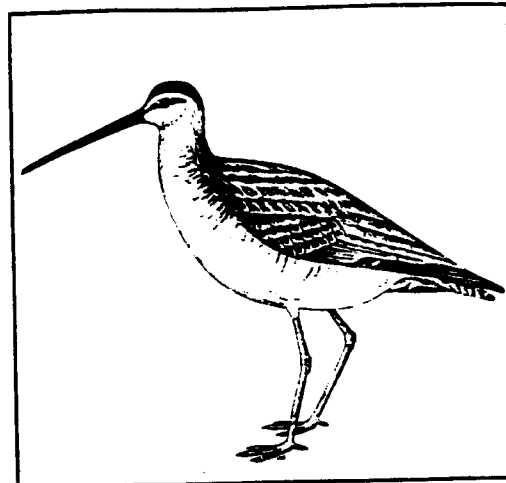
Dunlin



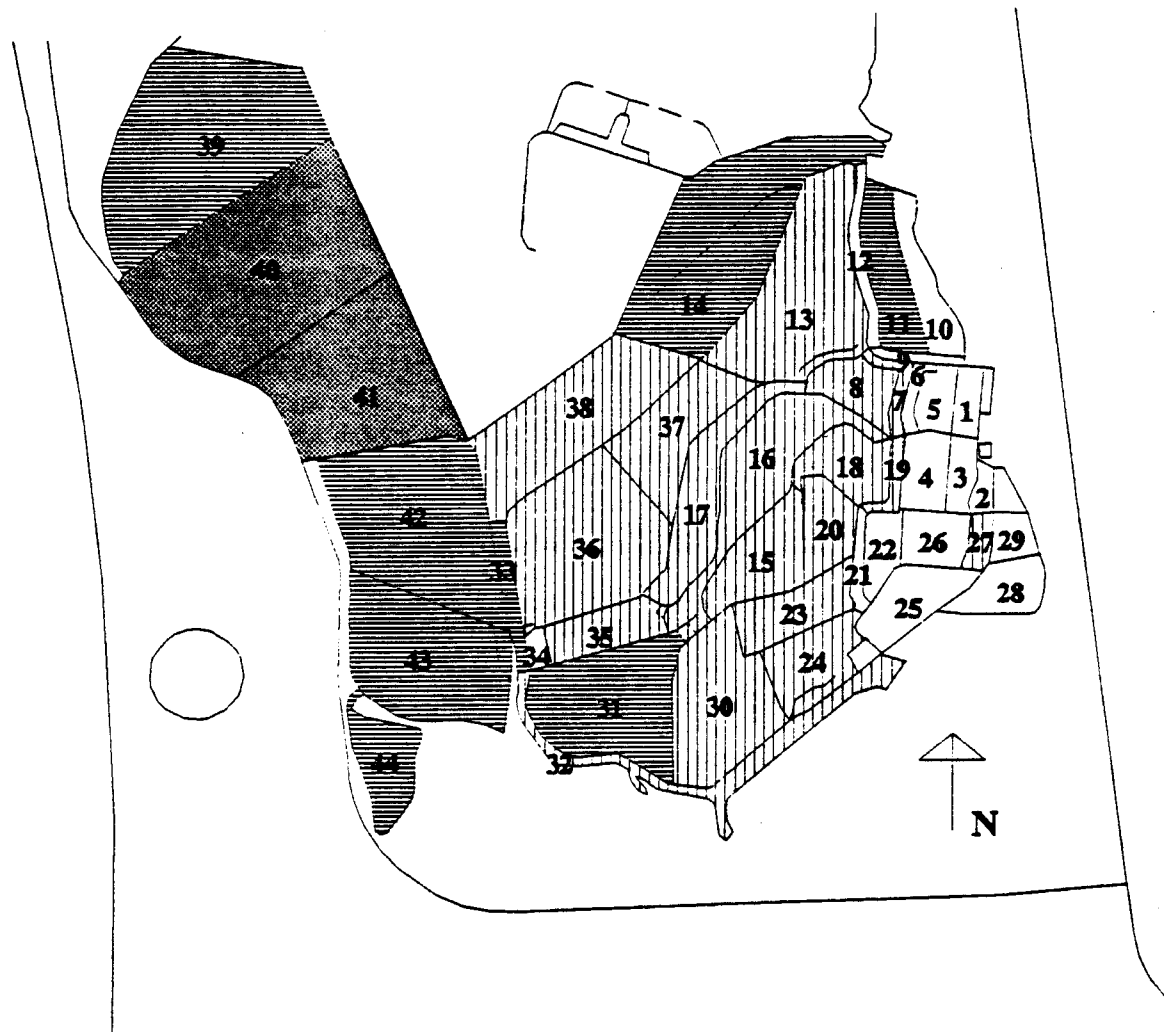
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Dowitcher (*Limnodromus* spp.)

Because of the difficulty in distinguishing between the short-billed dowitcher (*Limnodromus griseus*) and the long-billed dowitcher (*Limnodromus scolopaceus*) these two species were recorded simply as dowitchers. Dowitchers were present 94% of the surveys and were observed within 28 of the 44 survey units. This genus occurred most often within cells 40 and 41 both of which contained tidal mudflat. Peak abundance was reached during fall with a high count of 1156 individuals recorded on October 27.



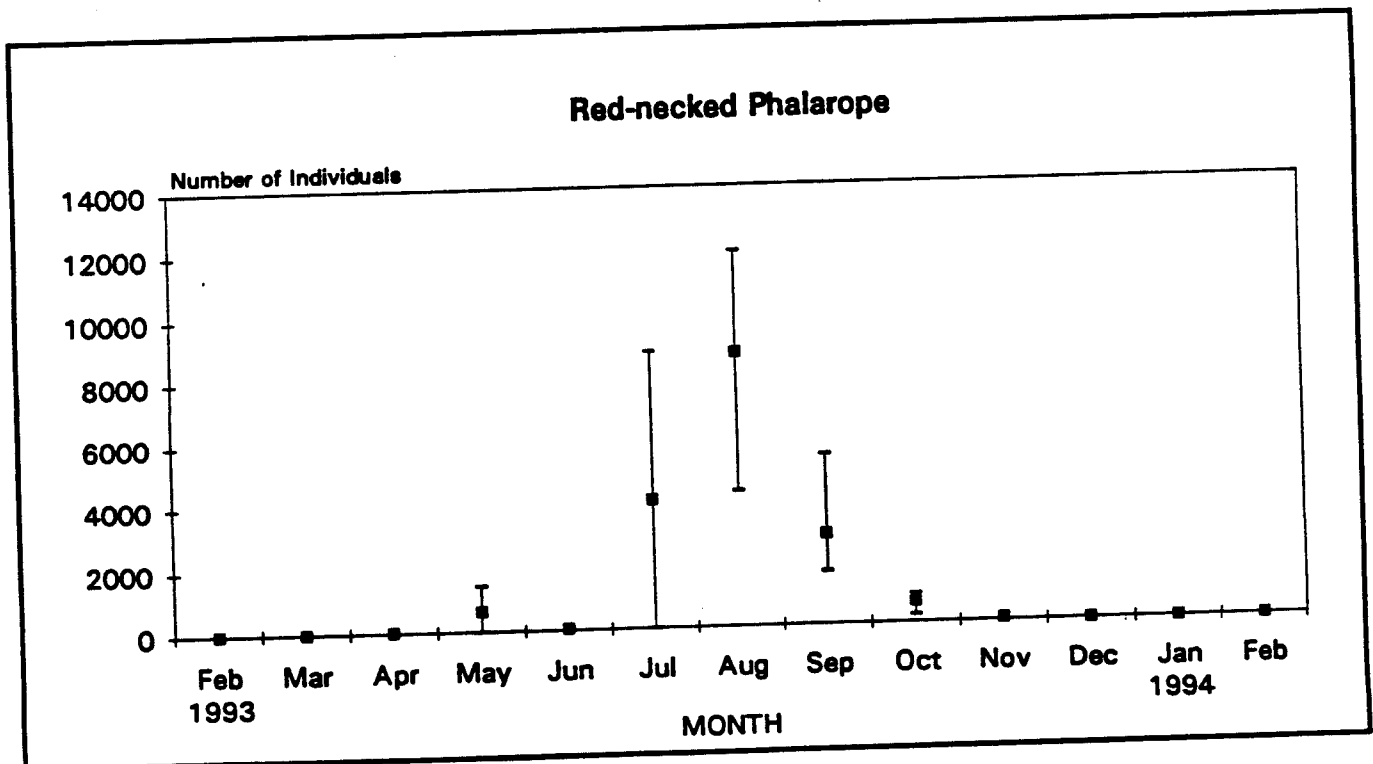
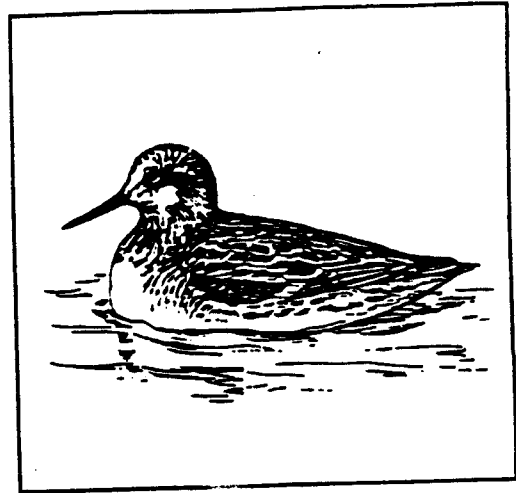
Dowitcher Species



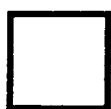
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Red-necked Phalarope (*Phalaropus lobatus*)

Red-necked phalaropes were distributed among 26 of the 44 survey areas. The appearance of the red-necked phalarope during July through October is representative of the fall migratory period for this species. Of all other species, the red-necked phalarope had the highest individual count for a single survey date. Over 11,000 individuals were present on August 18, with the majority of birds occurring within cells 13, 23, 30, and 37. These birds were most likely foraging on what appeared to be an abundant supply of brine shrimp (*Artemia* spp.).



Red-necked Phalarope



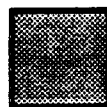
0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

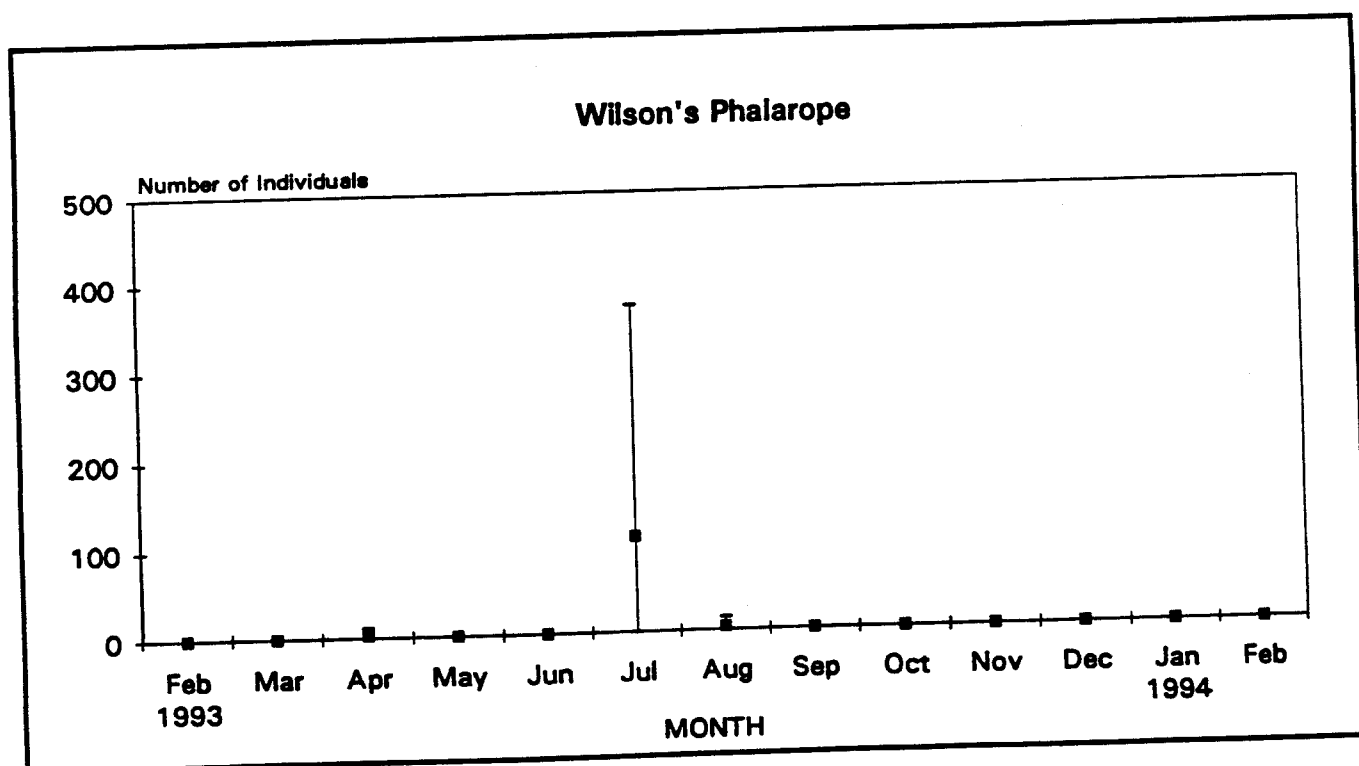
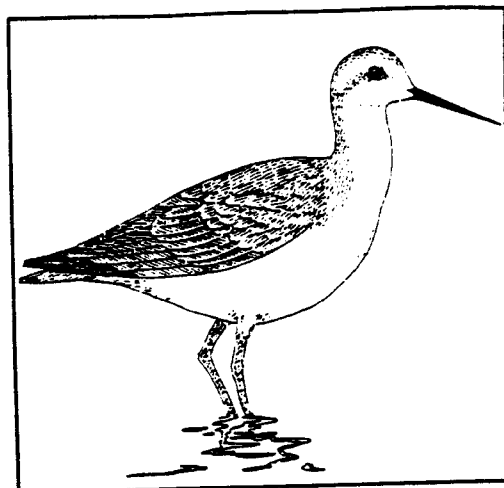


51 - 100% Occurrence

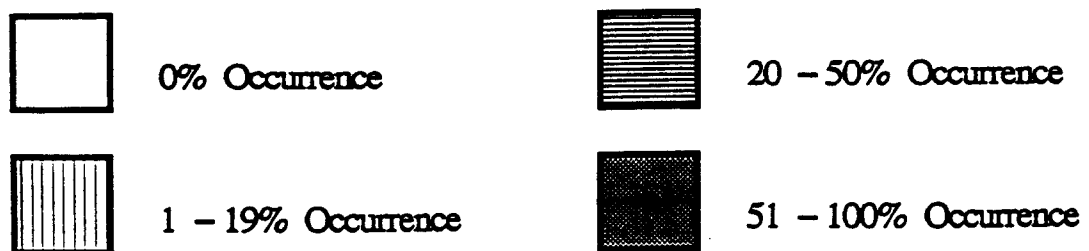
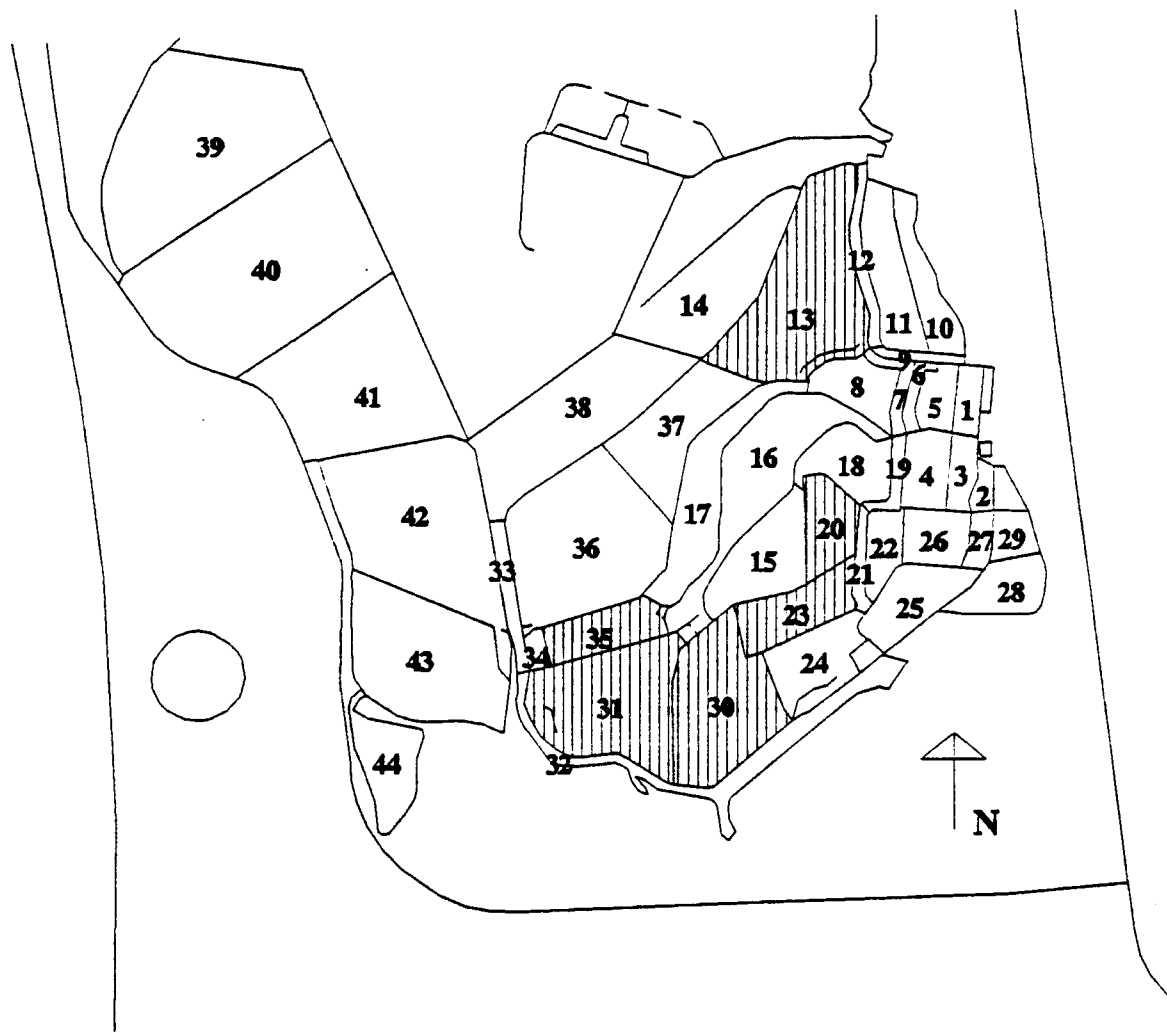
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Wilson's Phalarope (*Phalaropus tricolor*)

This species was much less abundant than the red-necked phalarope and was observed in only six of the 44 survey units. Wilson's phalarope reached a peak of abundance in July at which time a high count of 370 individuals was reported.



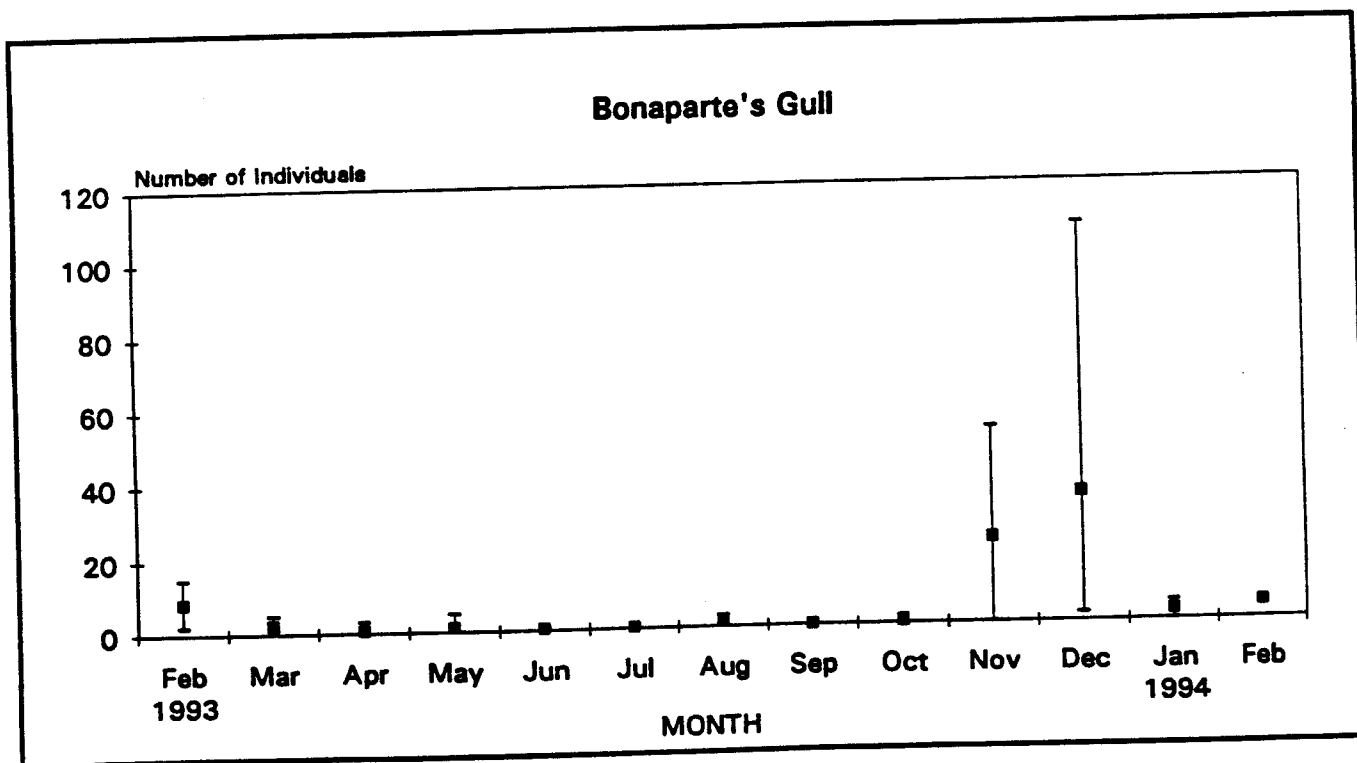
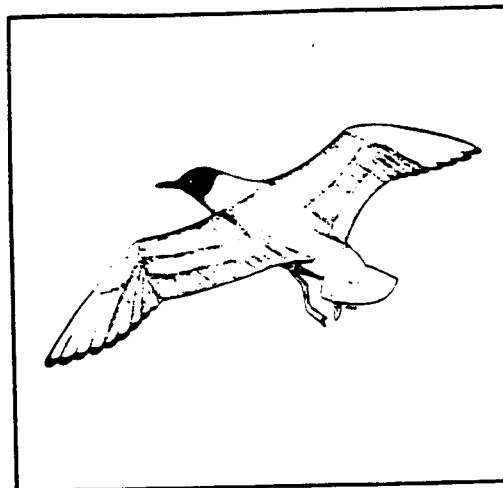
Wilson's Phalarope



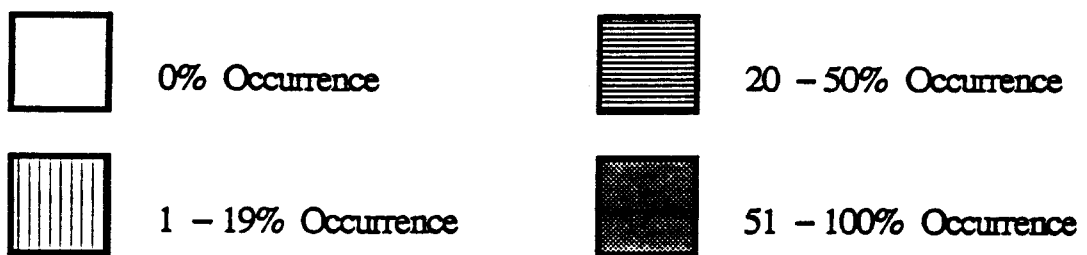
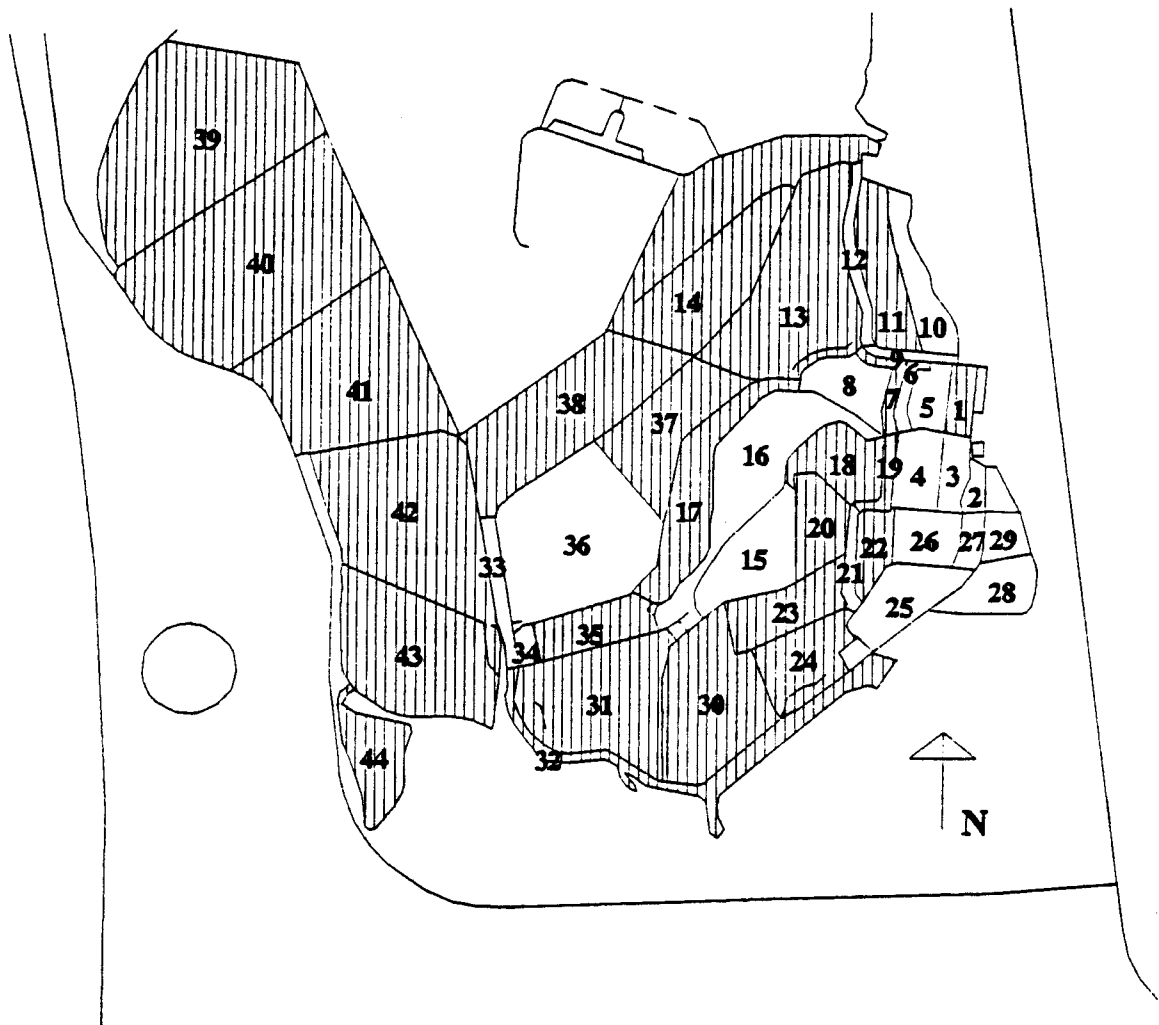
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Bonaparte's Gull (*Larus philadelphia*)

Bonaparte's gulls were present during 58% of the surveys and were found within 24 of the 44 survey units. Bonaparte's gull was most abundant during the fall and winter months. A high count of 108 individuals was recorded during the December 29, 1993 survey at which time 70 birds were located within cell 44.



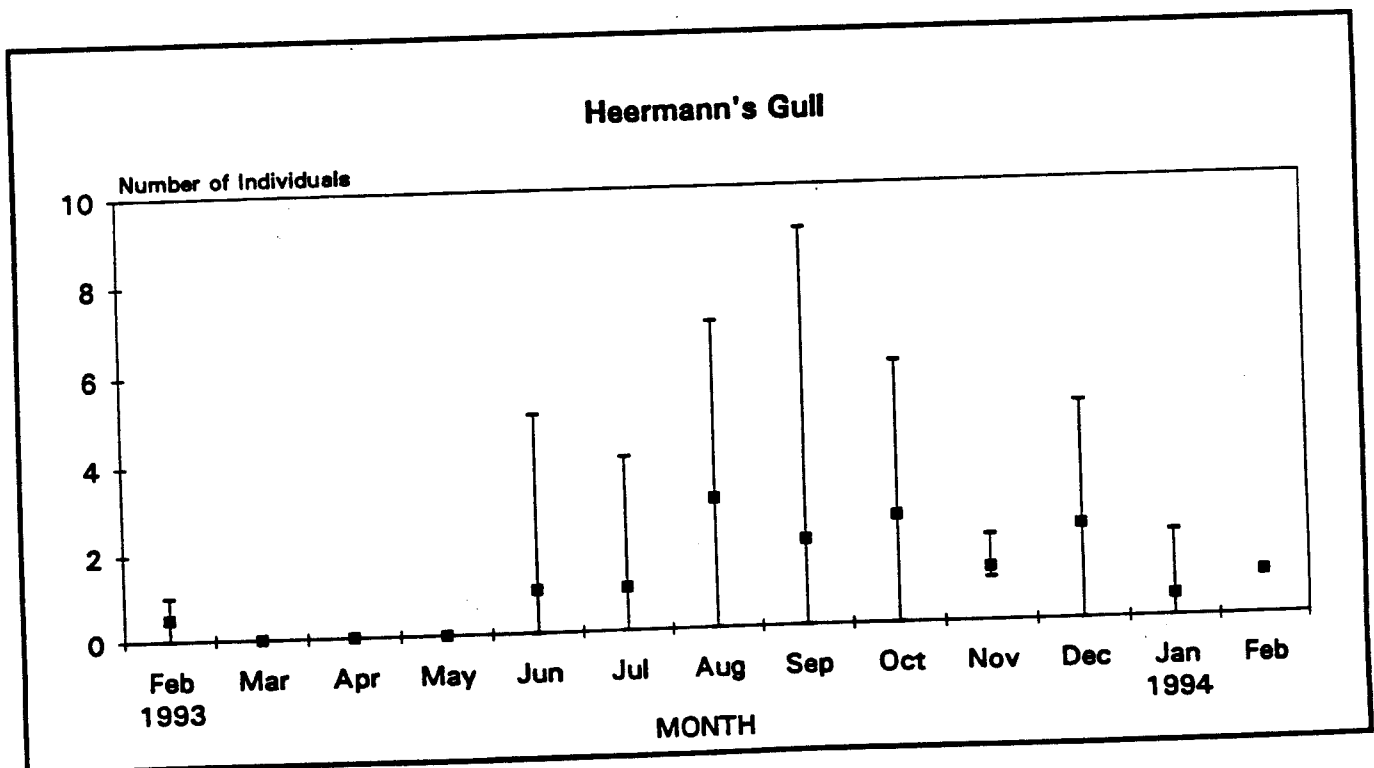
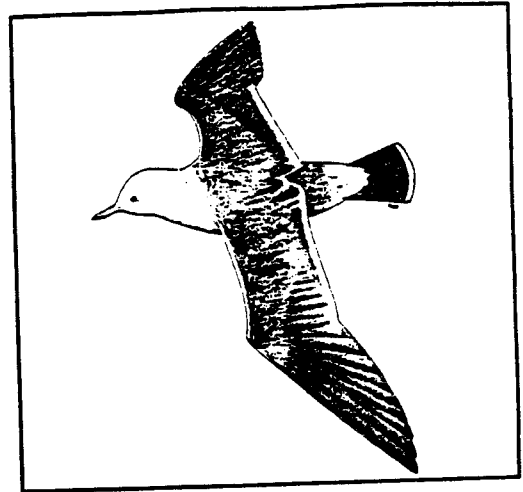
Bonaparte's Gull



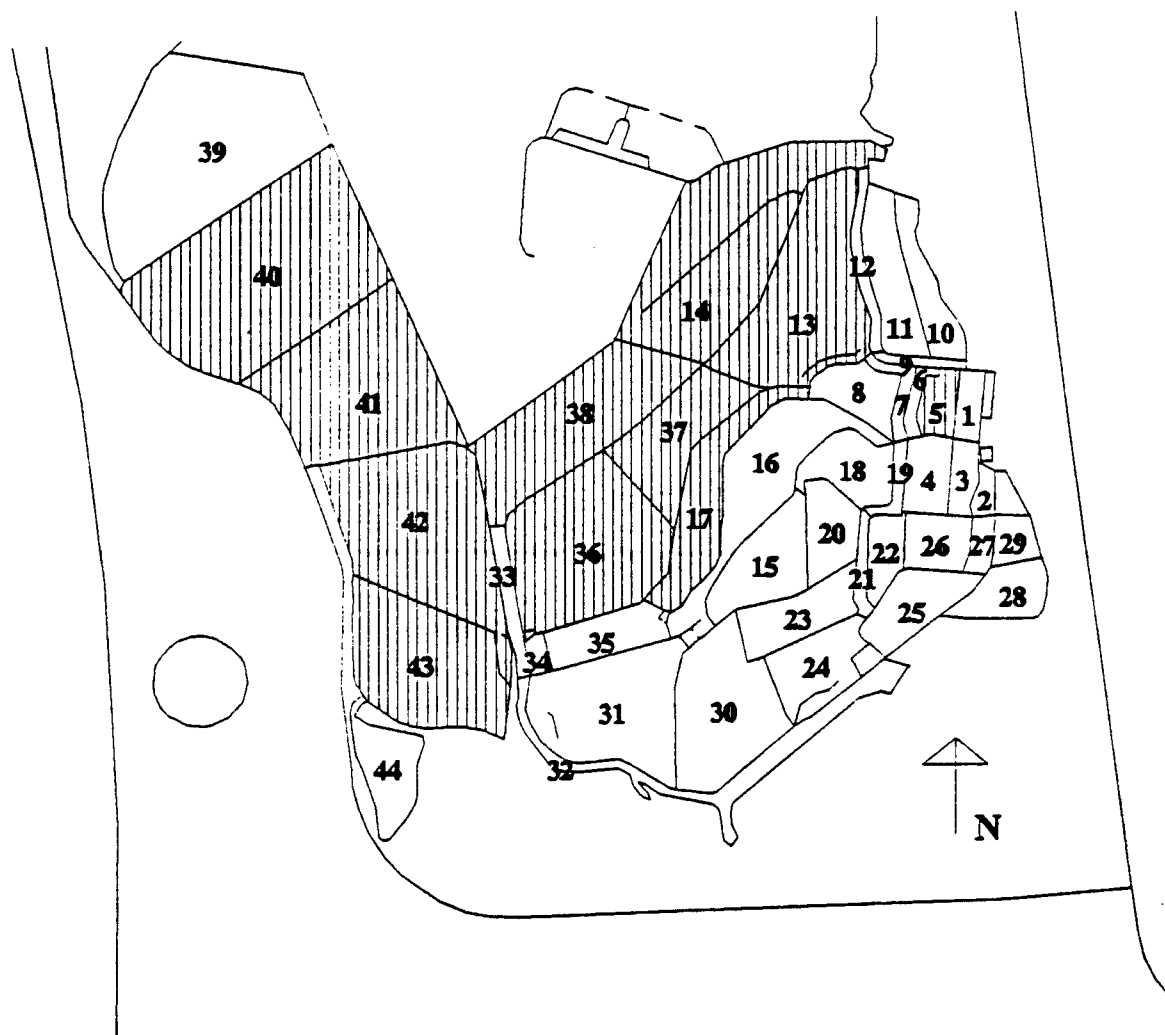
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Heermann's Gull (*Larus heermanni*)

Heermann's gulls were present during 38% of the surveys. From 2 to 9 non-breeding individuals were present during the summer months while several individuals were observed in the fall and winter. On only one occasion was this species found within the inner dikes of the Salt Works. It would appear that the Heermann's gull preferred areas closer to the open bay. As with most other gull species within the study area, Heerman's gull most often utilized the study area as a roosting site.



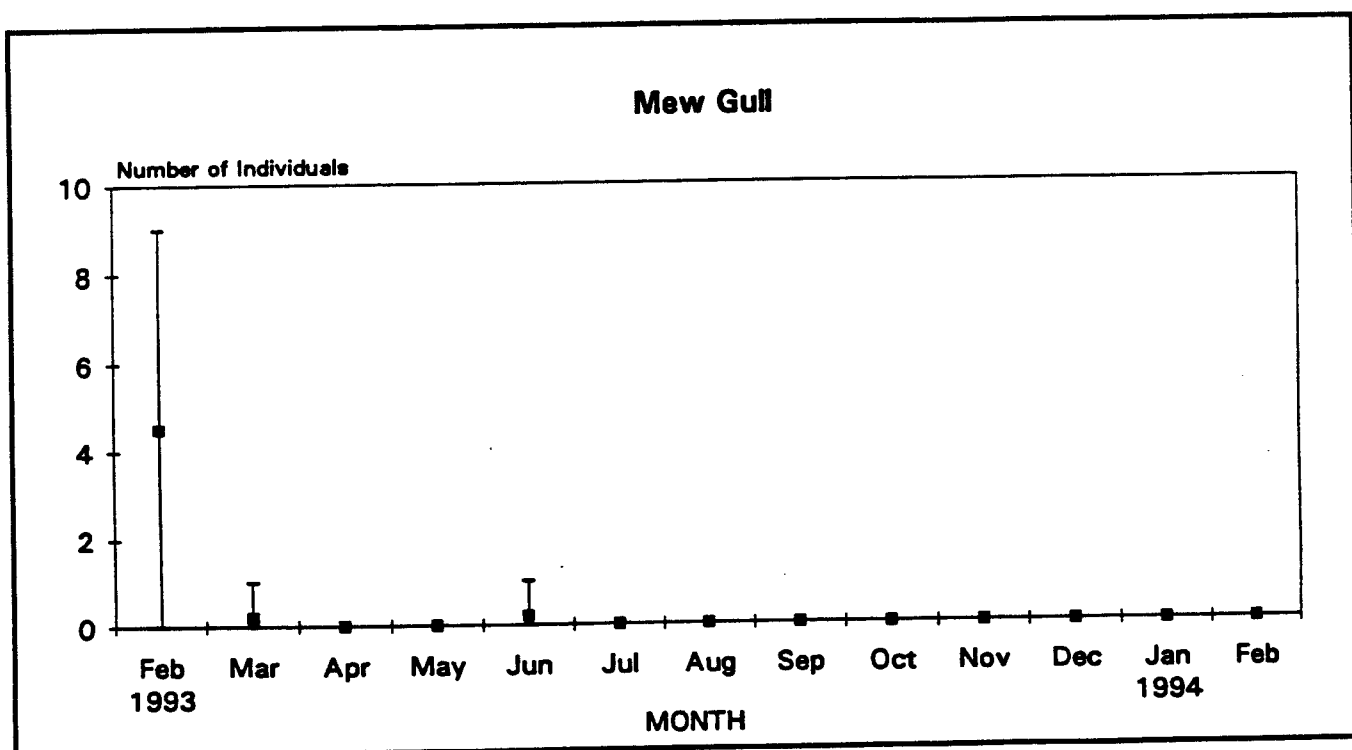
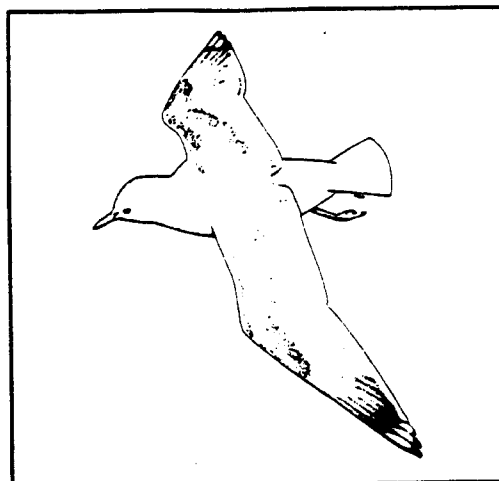
Heermann's Gull



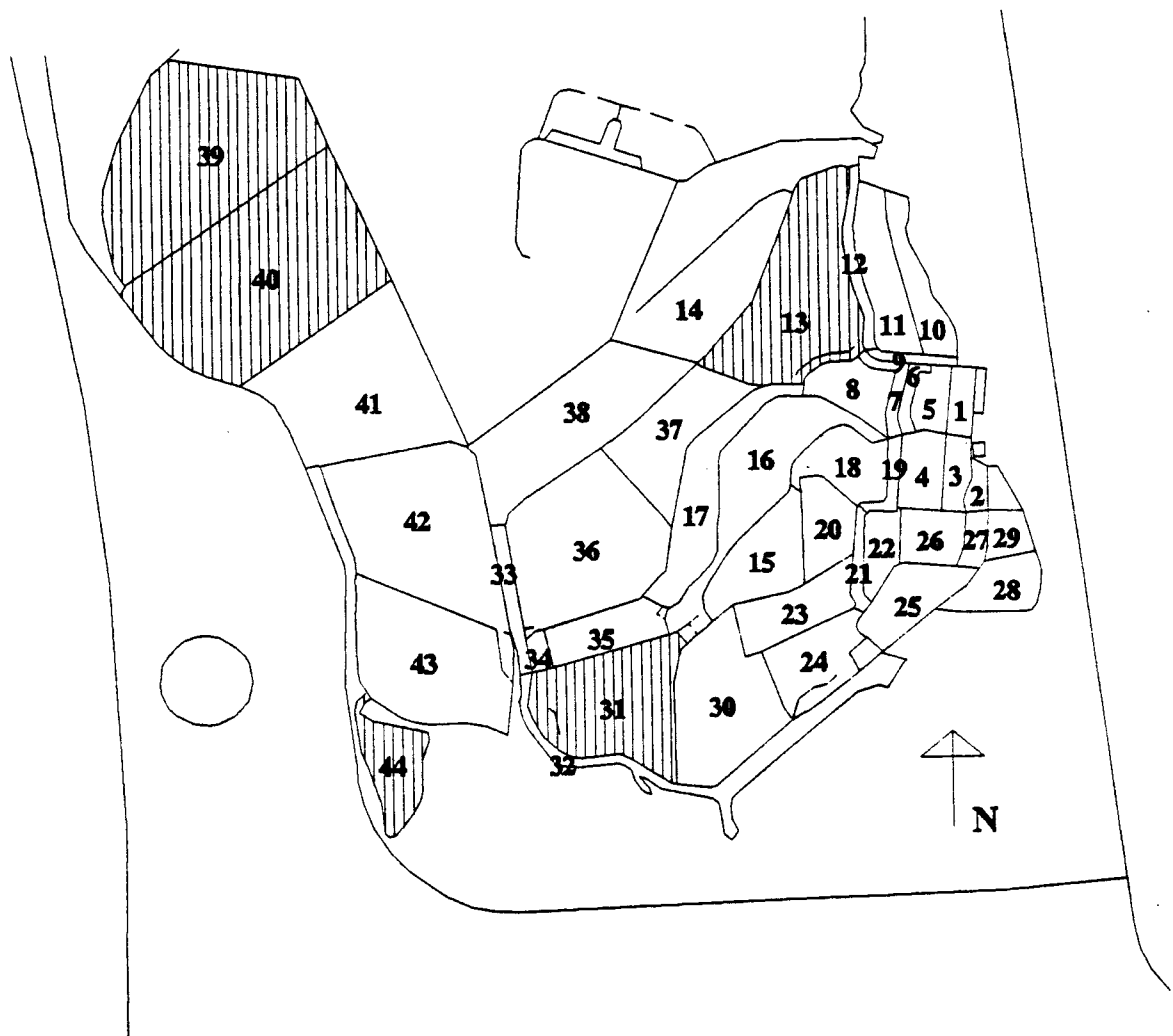
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Mew Gull (*Larus canus*)

This species was observed on 3 occasions with a high count of 9 individuals reported during the February 17, 1993 survey.



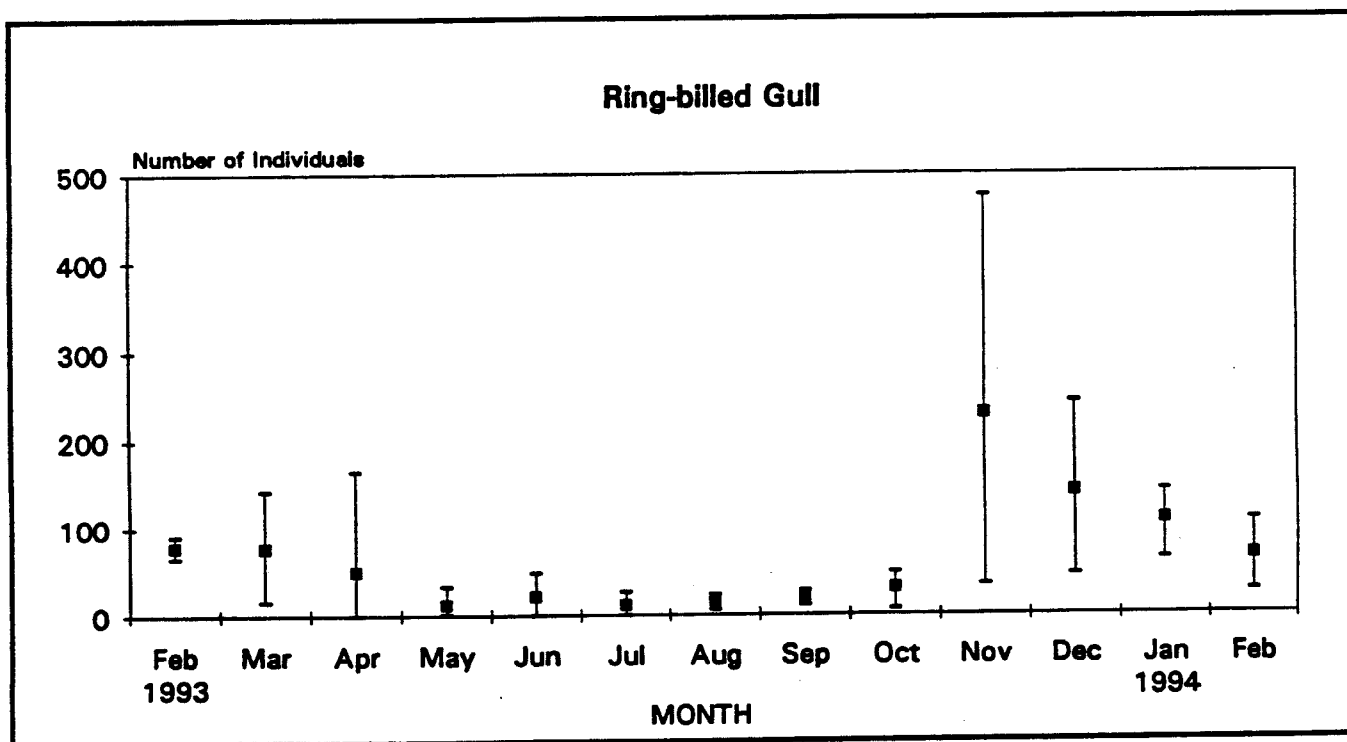
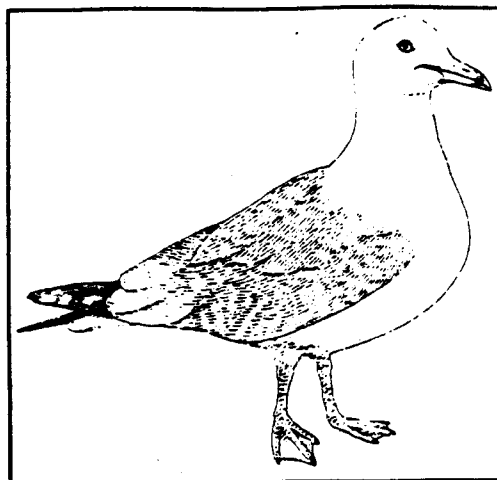
Mew Gull



Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Ring-billed Gull (*Larus delawarensis*)

This species was present during 94% of the surveys and was observed within 33 of the 44 survey units. Non-breeding individuals were present throughout the summer months with the peak of abundance occurring in November. Ring-billed gulls occurred most often along the dikes surrounding pond 43.



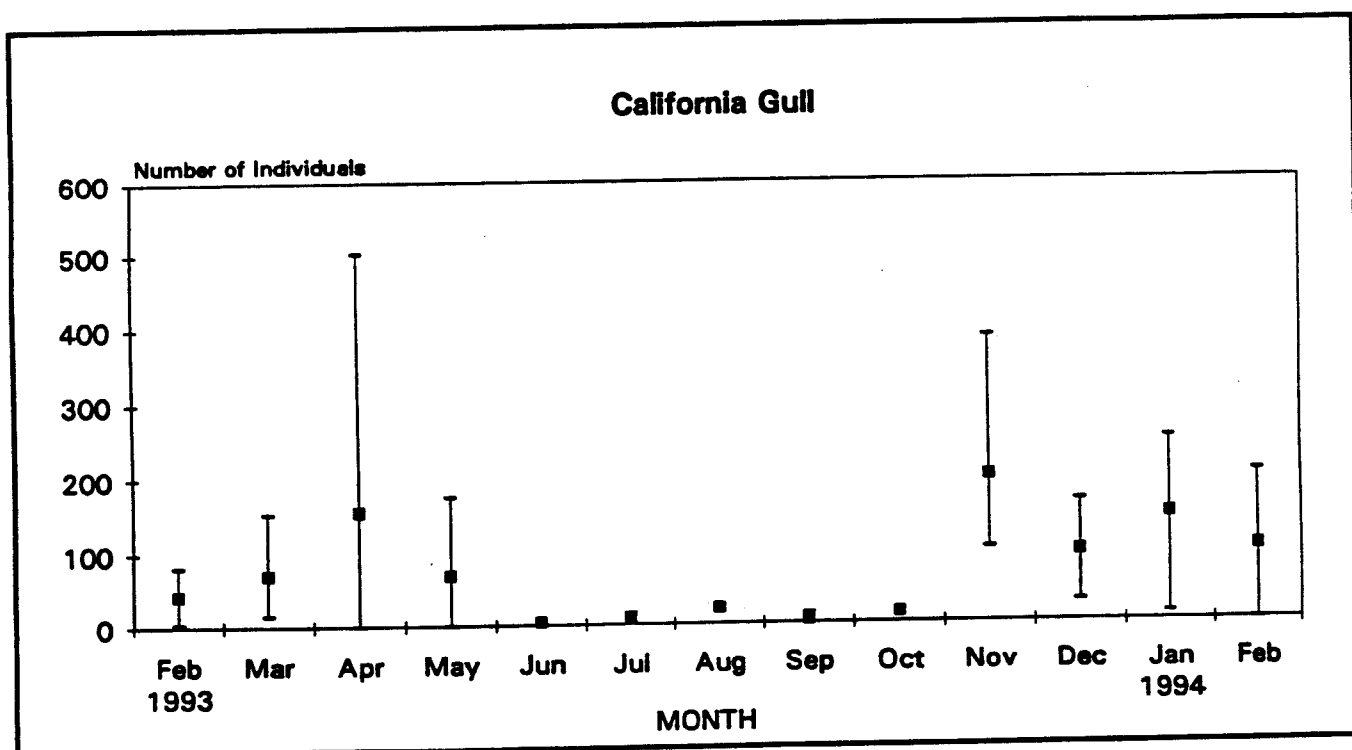
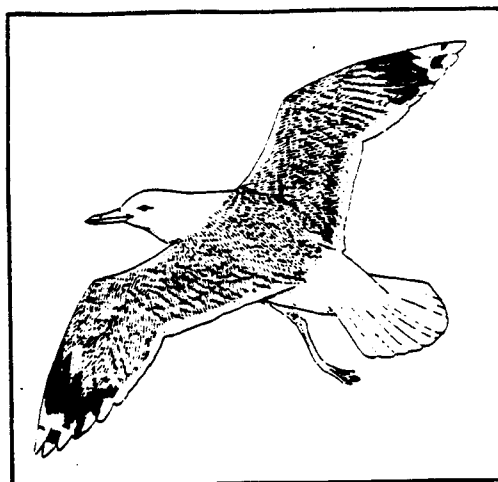
Ring-billed Gull



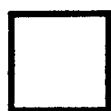
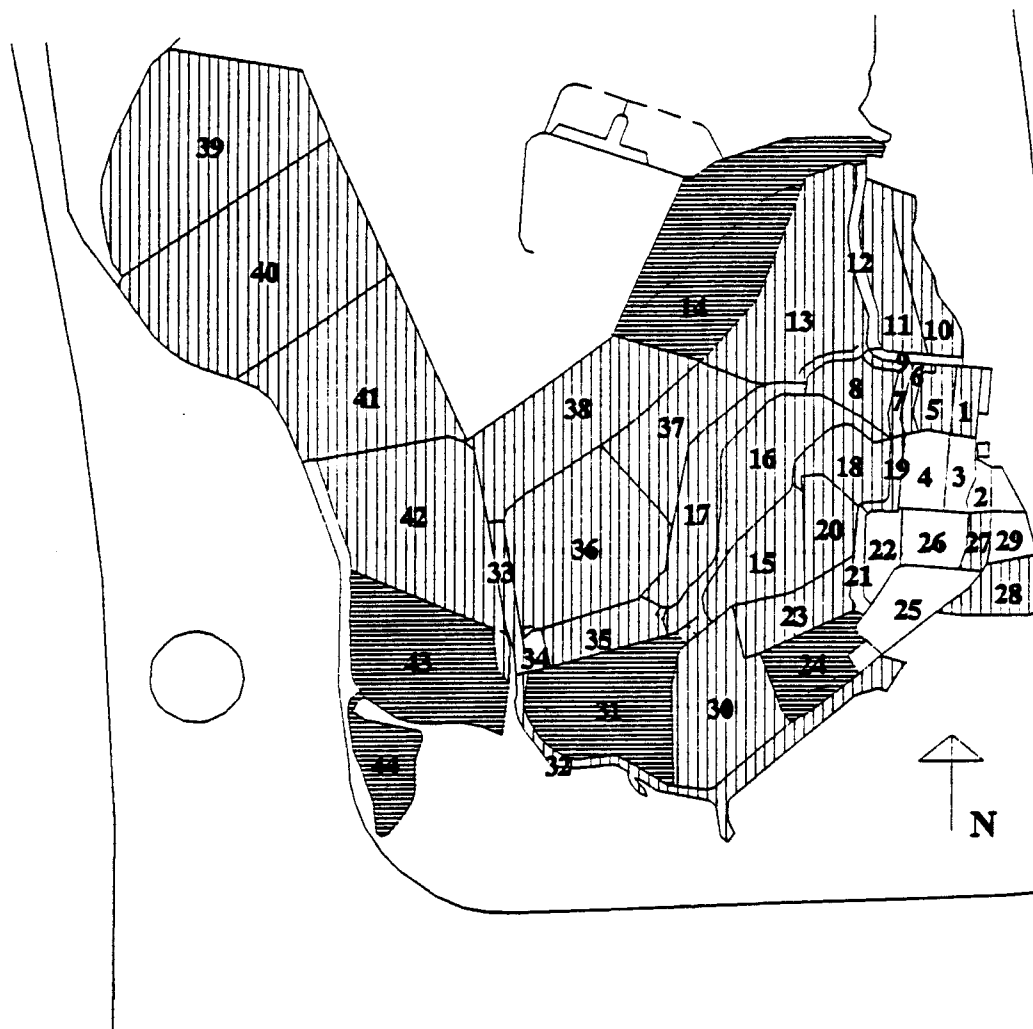
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

California Gull (*Larus californicus*)

The California gull was present during 92% of the surveys and was observed within 33 of the 44 areas. This species was most abundant during April and November suggesting the peak spring and fall migratory periods. The high count for California gulls occurred on the April 21, 1993 survey during which time 500 individuals were recorded within cell 16.



California Gull



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

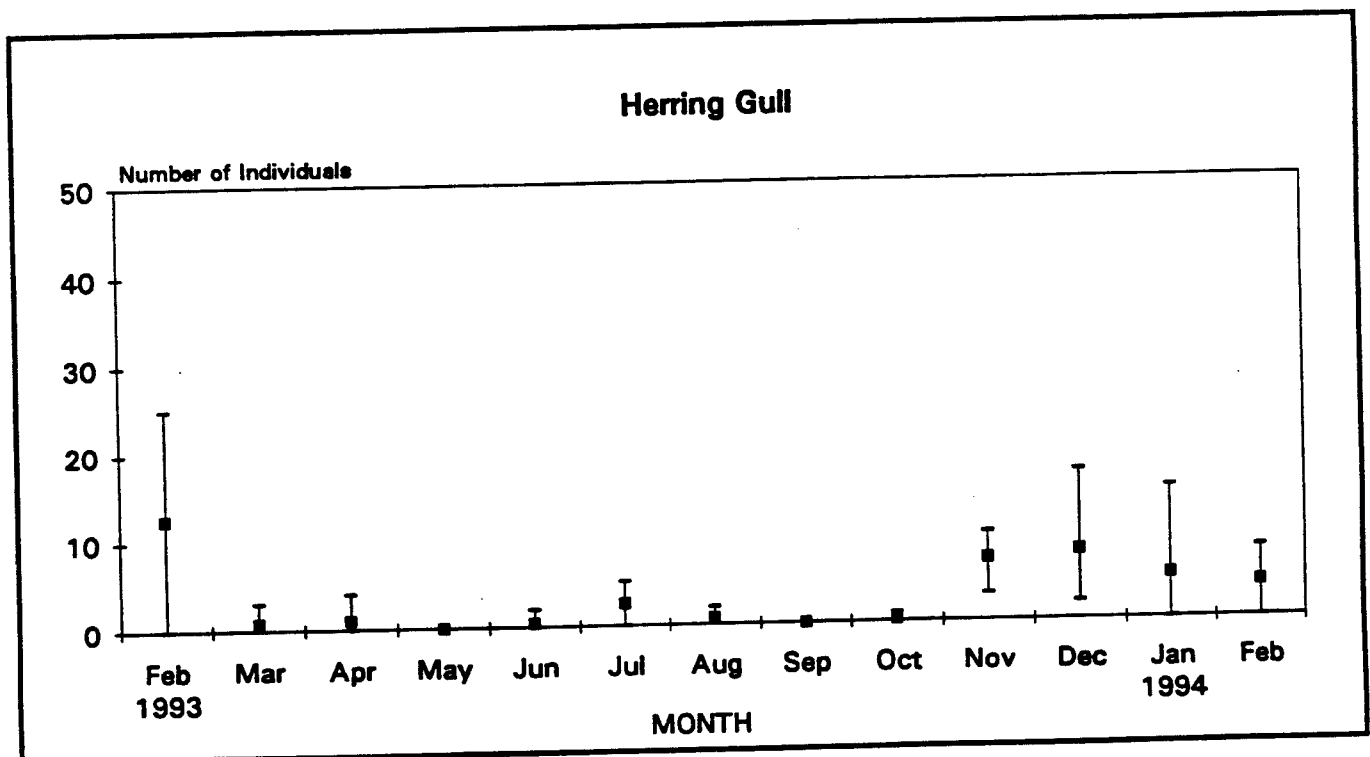
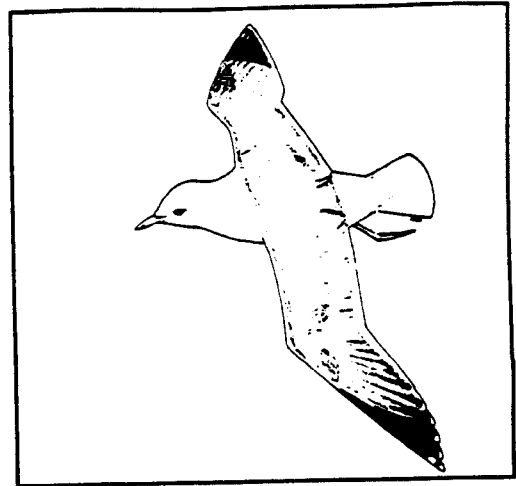


51 - 100% Occurrence

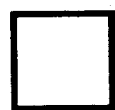
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Herring Gull (*Larus argentatus*)

This species was observed within 18 of the 44 survey units and occurred most often along the dike separating cells 31 and 32. The herring gull was most abundant during the winter months with only 2 to 5 individuals present in summer. A high count of 25 individuals was recorded during the February 17, 1993 survey.



Herring Gull



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

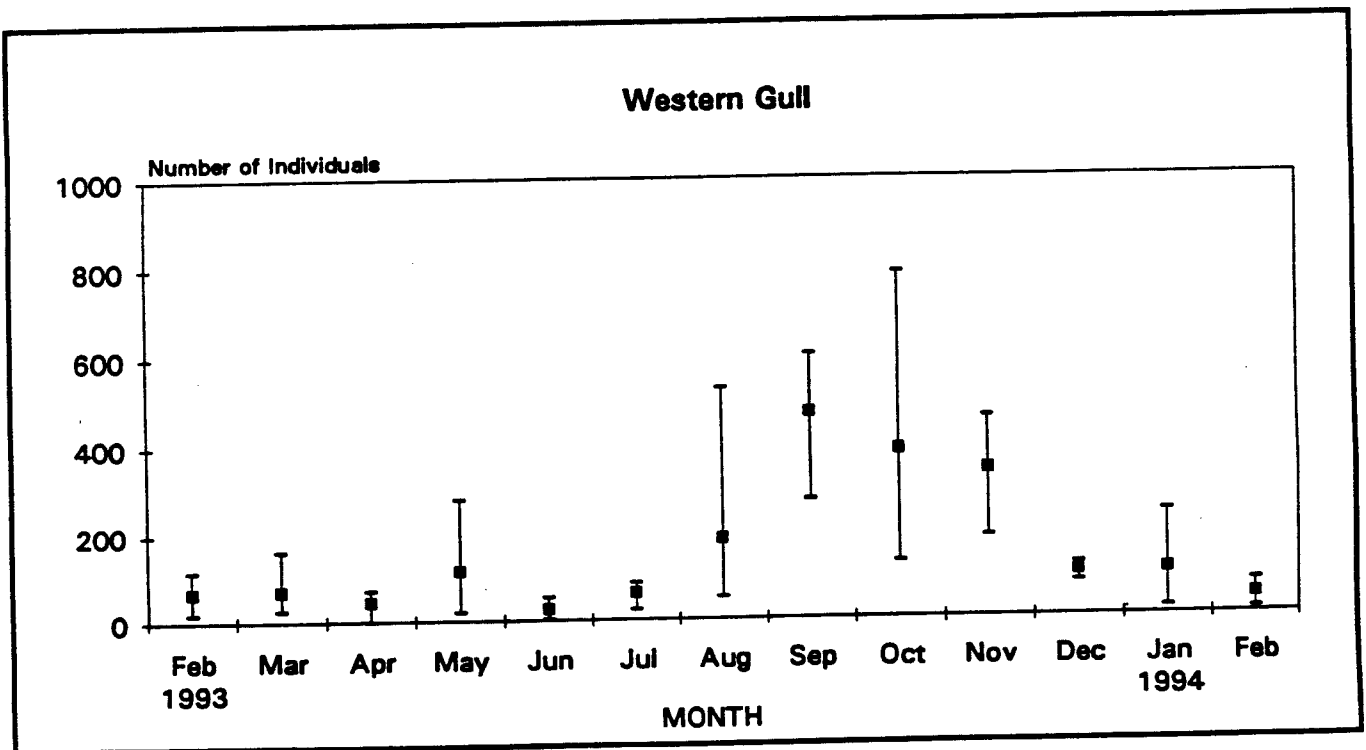
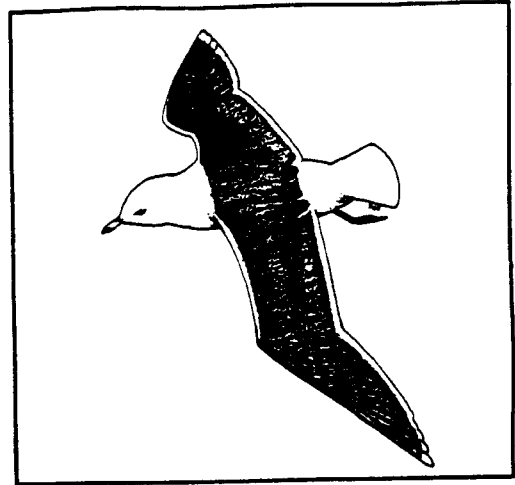


51 - 100% Occurrence

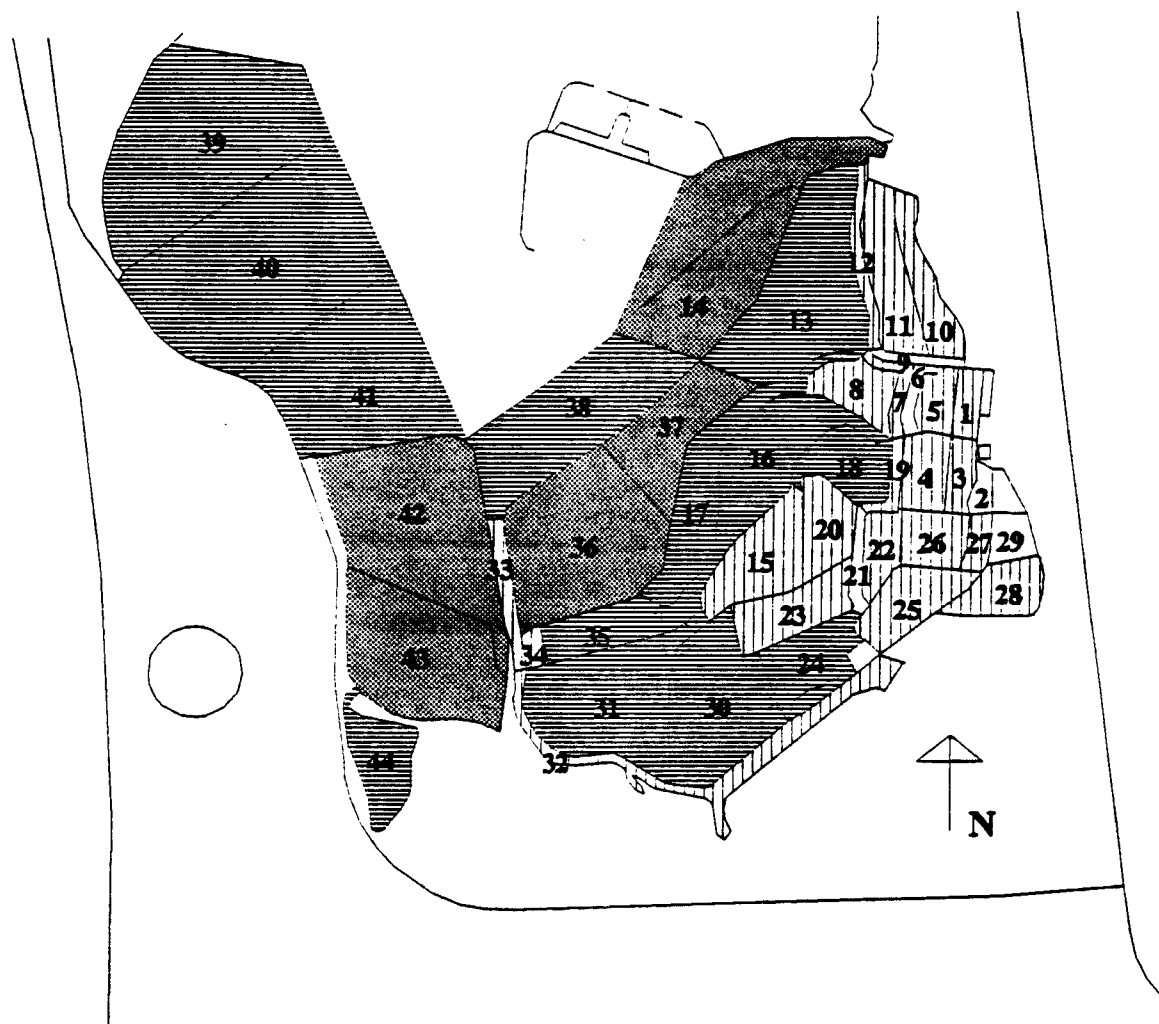
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Western Gull (*Larus occidentalis*)

Western gulls were the most abundant gull species within the study area. They were present during 98% of the surveys and were observed within 39 of the 44 survey units. Although monthly averages peaked during September, the high count of 784 individuals was recorded on October 27, 1993.



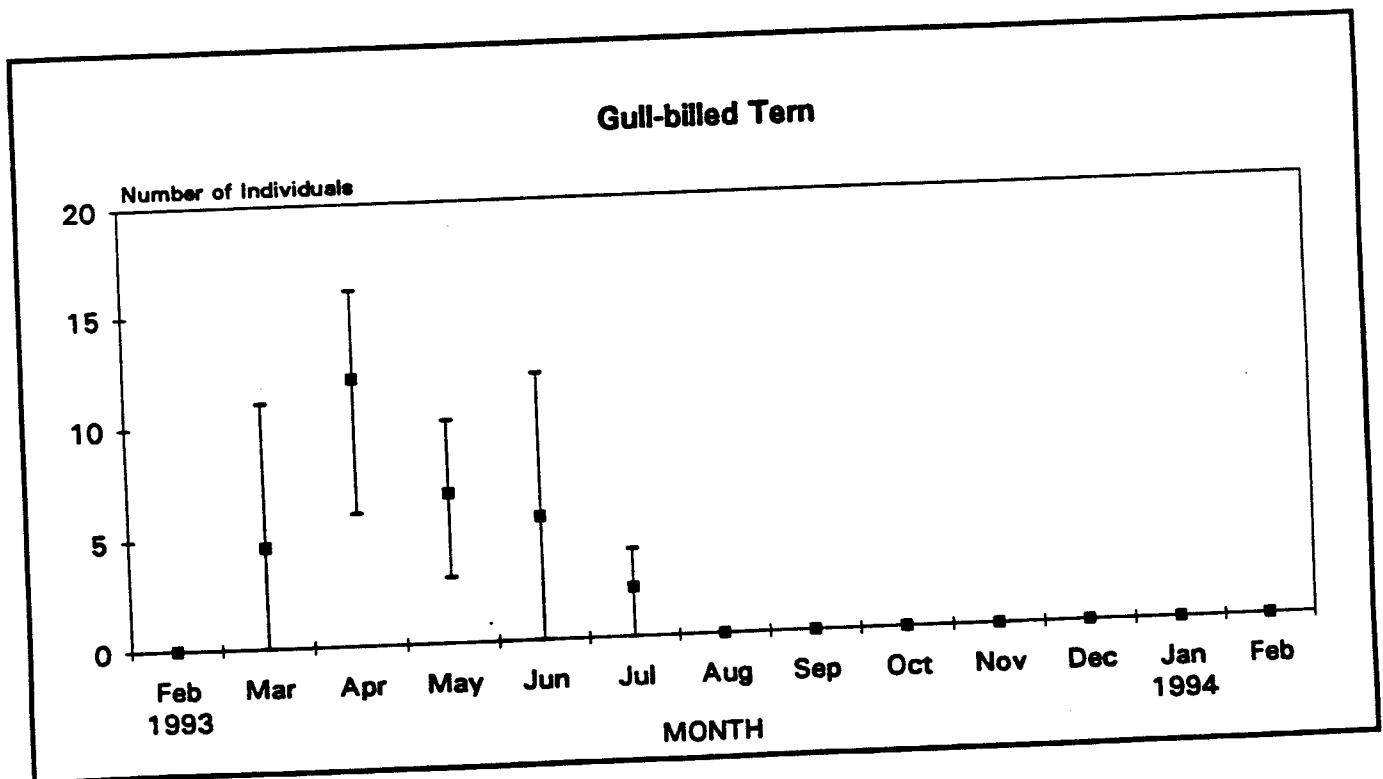
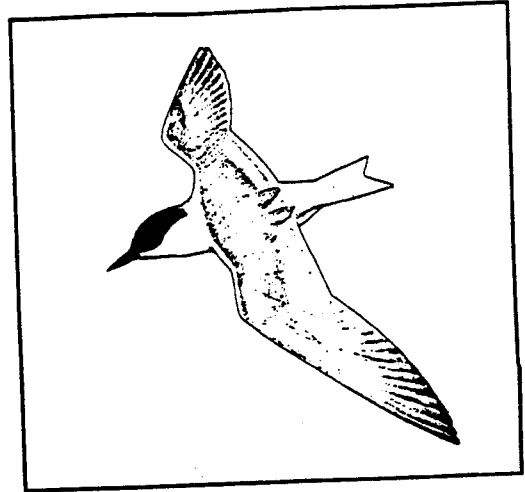
Western Gull



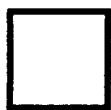
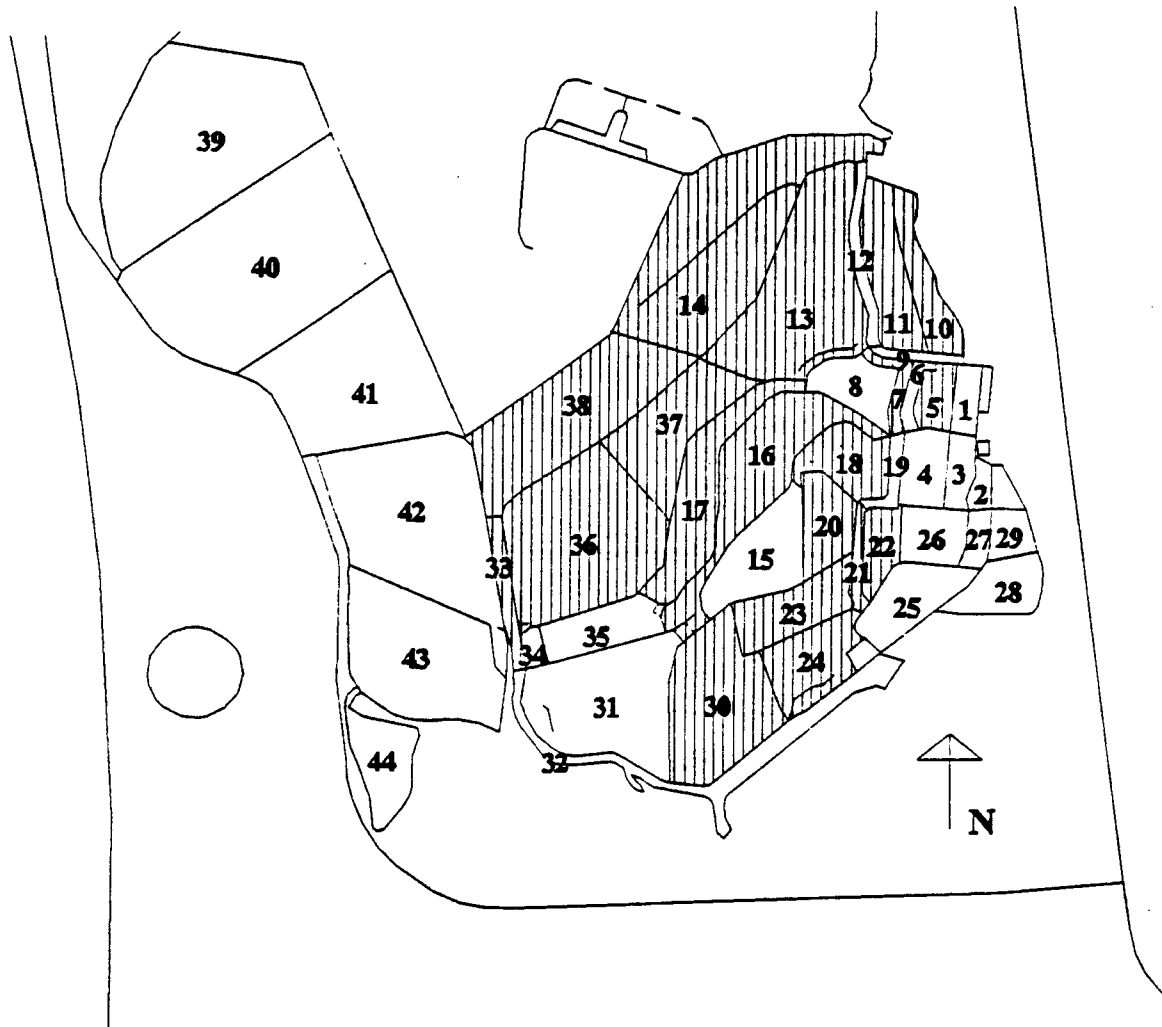
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Gull-billed Tern (*Sterna nilotica*)

Gull-billed terns were only present at the study area during the breeding season. This species was first observed on March 1 and was last observed during the July 21, 1993 survey. Gull-billed terns were recorded within 20 of the 44 survey units with nesting birds present along the dikes separating cells 16/18 and 8/16. A high count of 15 individuals was recorded during the April 7, 1993 survey. Gull-billed terns are known to breed at only two locations in the western United States which includes the Salt Works and the nesting population at the Salton Sea.



Gull-billed Tern



0% Occurrence



20 - 50% Occurrence



1 - 19% Occurrence

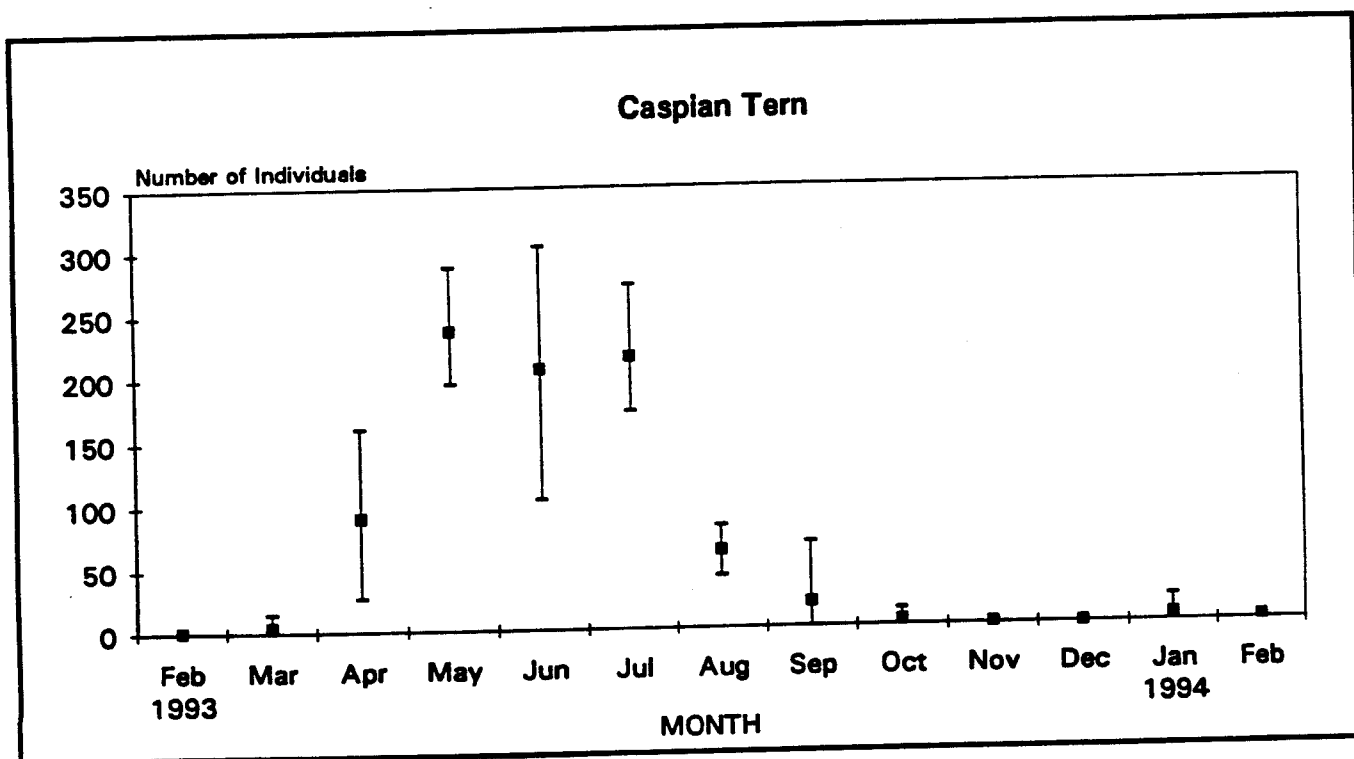
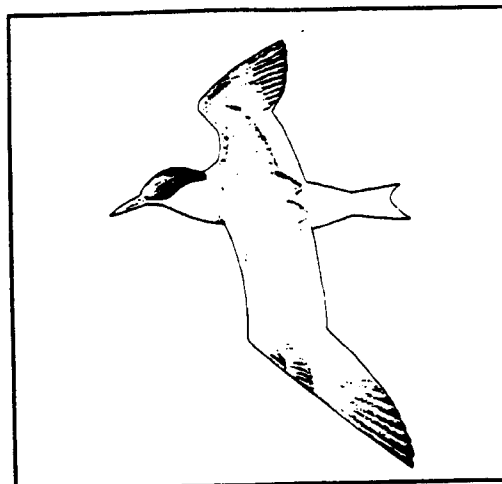


51 - 100% Occurrence

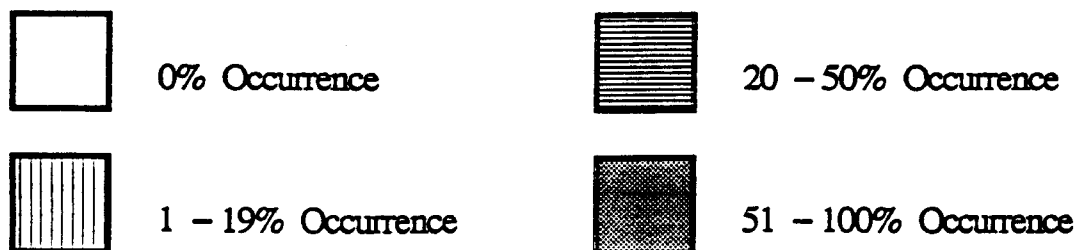
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Caspian Tern (*Sterna caspia*)

Caspian terns were present during 77% of the surveys and occurred within 21 of the 44 survey units. Peak abundance for this species occurred during the spring and summer when Caspian terns nested along the dikes of the Salt Works. A high count of 303 individuals was recorded during the June 2, 1993 survey. The high abundance during the nesting season and the scarcity of observations from November through February suggests that this species primarily uses the study area as a breeding site.



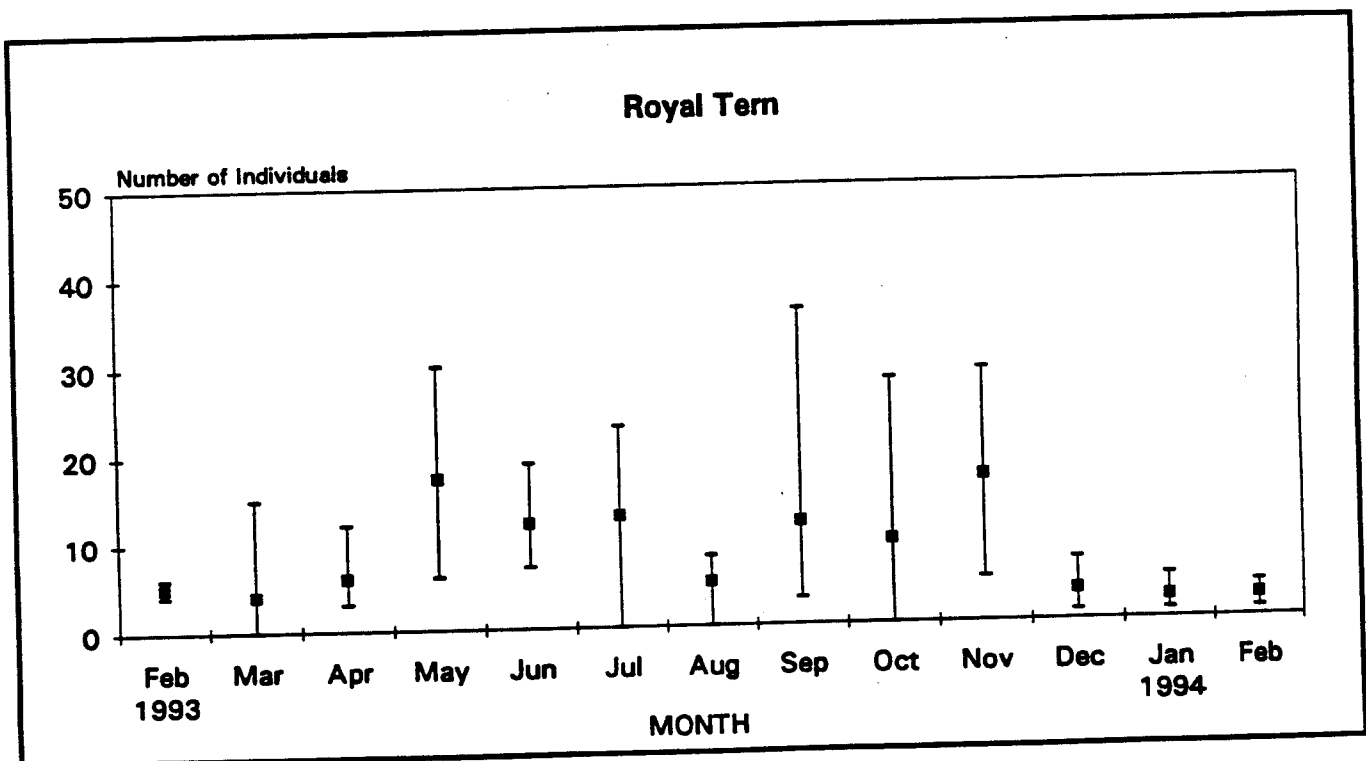
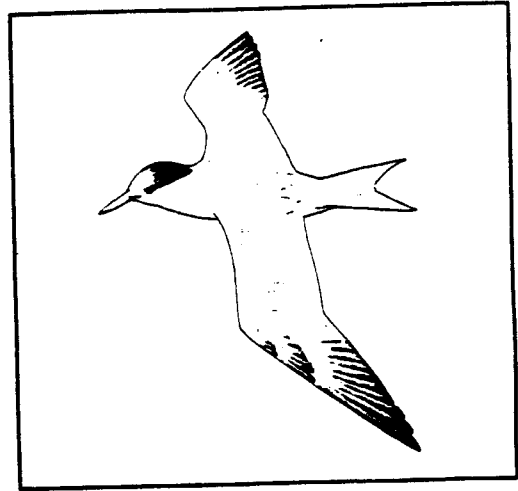
Caspian Tern



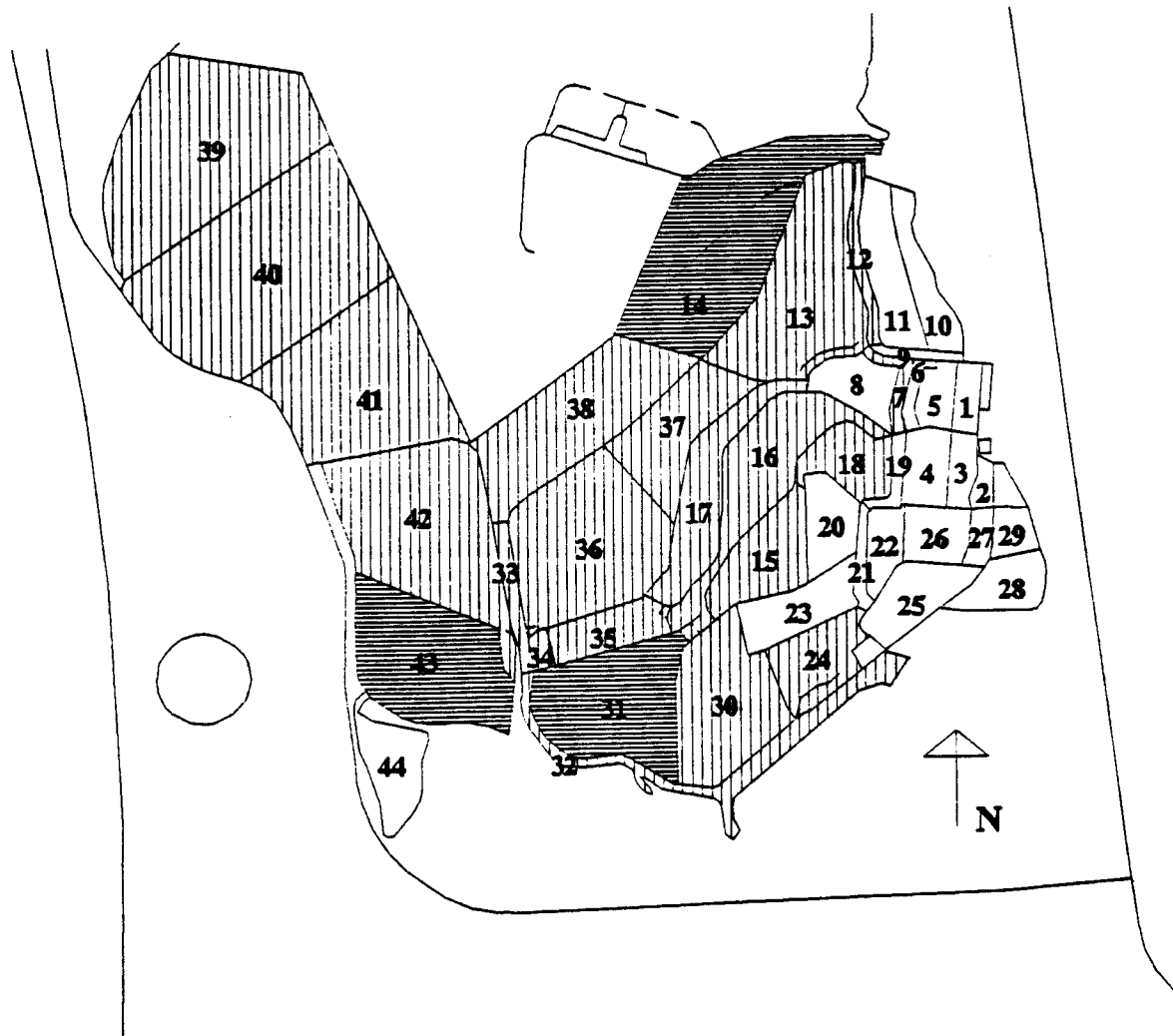
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Royal Tern (*Sterna maxima*)

Although present in small numbers, the royal tern was recorded throughout the year within the study area. This species most often occurred along the dikes of survey unit 43 and the spits located within cells 14 and 31. Only two to seven individuals were present during the winter months. Increases in abundance during the spring and summer months was a result of nesting royal terns while increases during the fall suggest an influx of migrants. The high count of 36 individuals was reported on September 15, 1993.



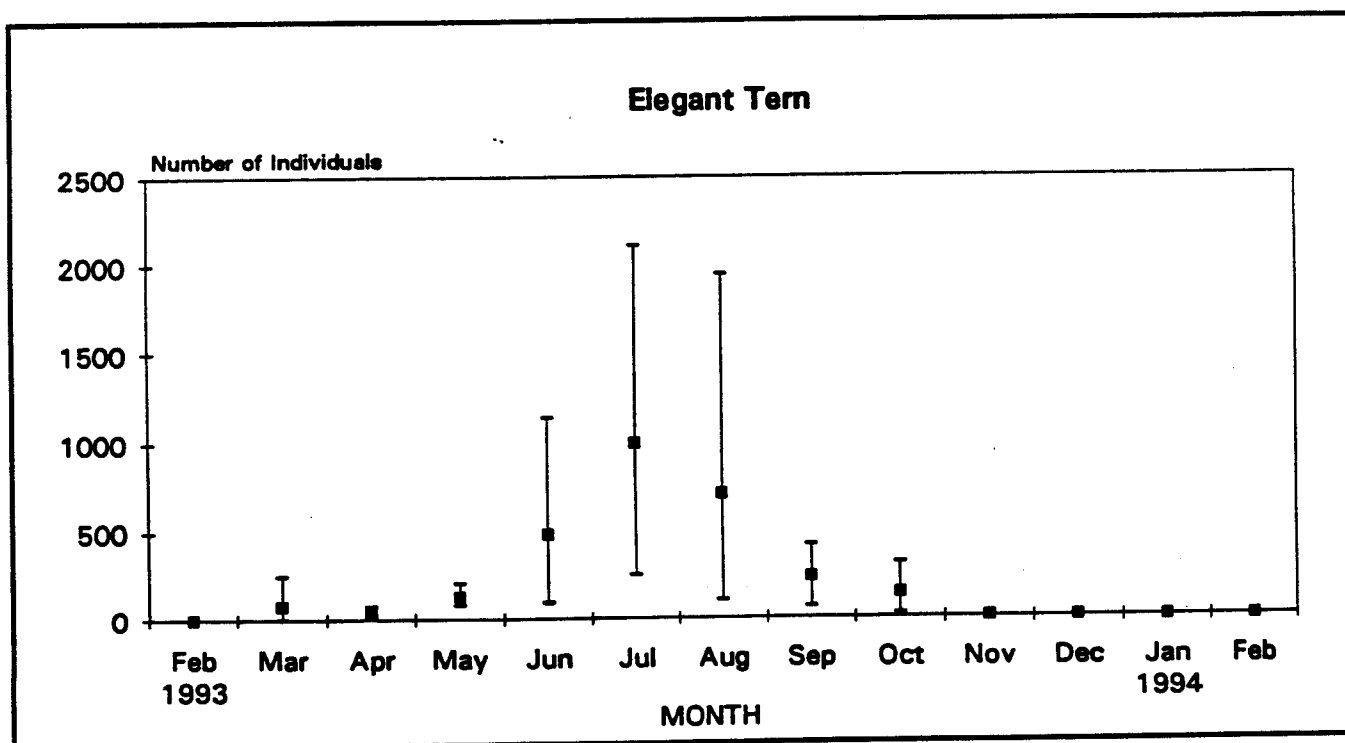
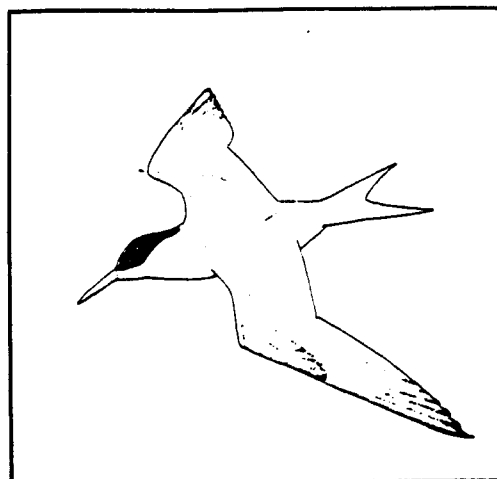
Royal Tern



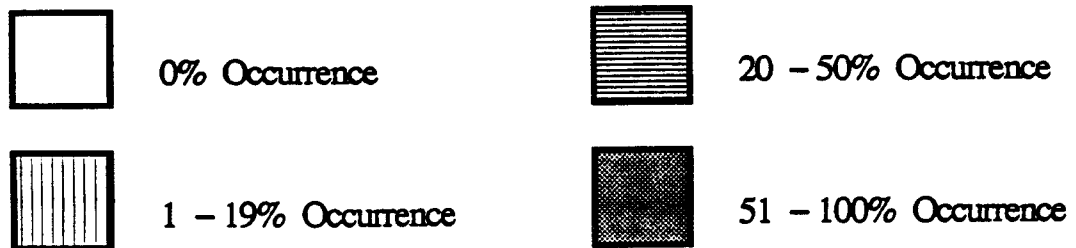
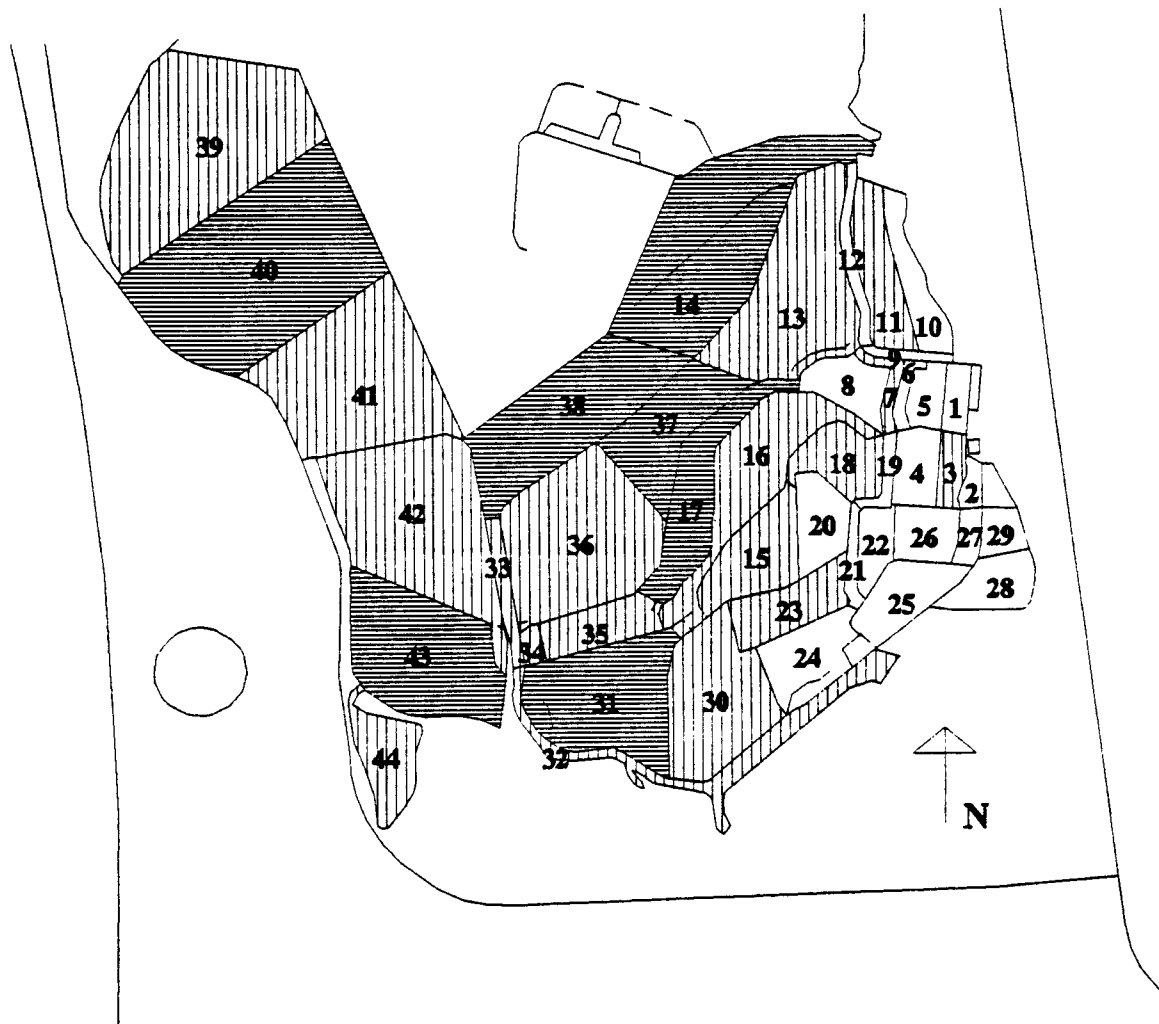
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Elegant Tern (*Sterna elegans*)

Elegant terns were observed at the study site from March through October. Prior to egg laying, staging and courtship displays were observed along the shoreline of cell 39 in late March. This species nested along the dikes separating ponds 17/37 and 15/16. Peak abundance occurred during July and August which included adults with recently fledged young. The high count of 2105 individuals was reported during the July 14, 1993 survey. The elegant tern breeds at only two locations in the United States and is listed as a Federal Category 2 candidate.



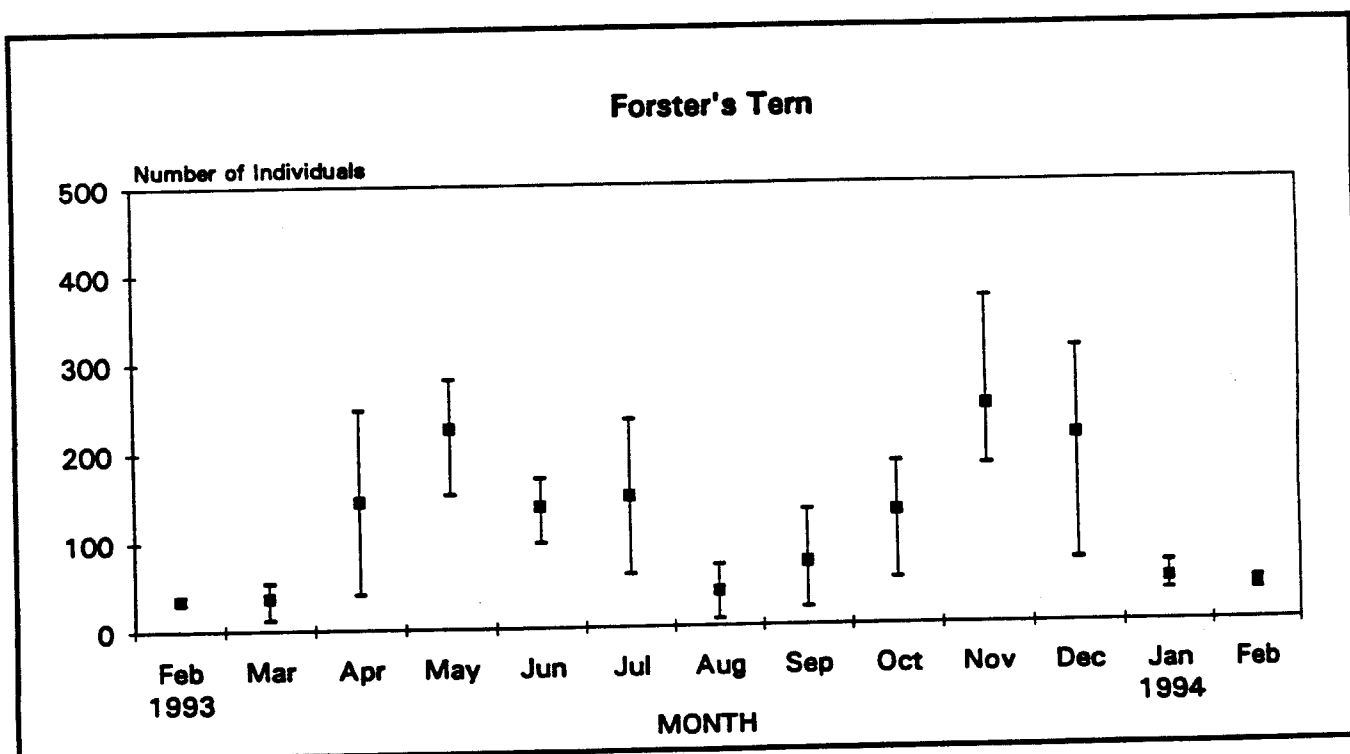
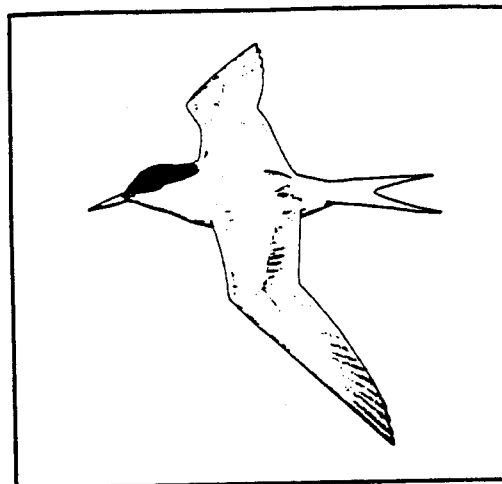
Elegant Tern



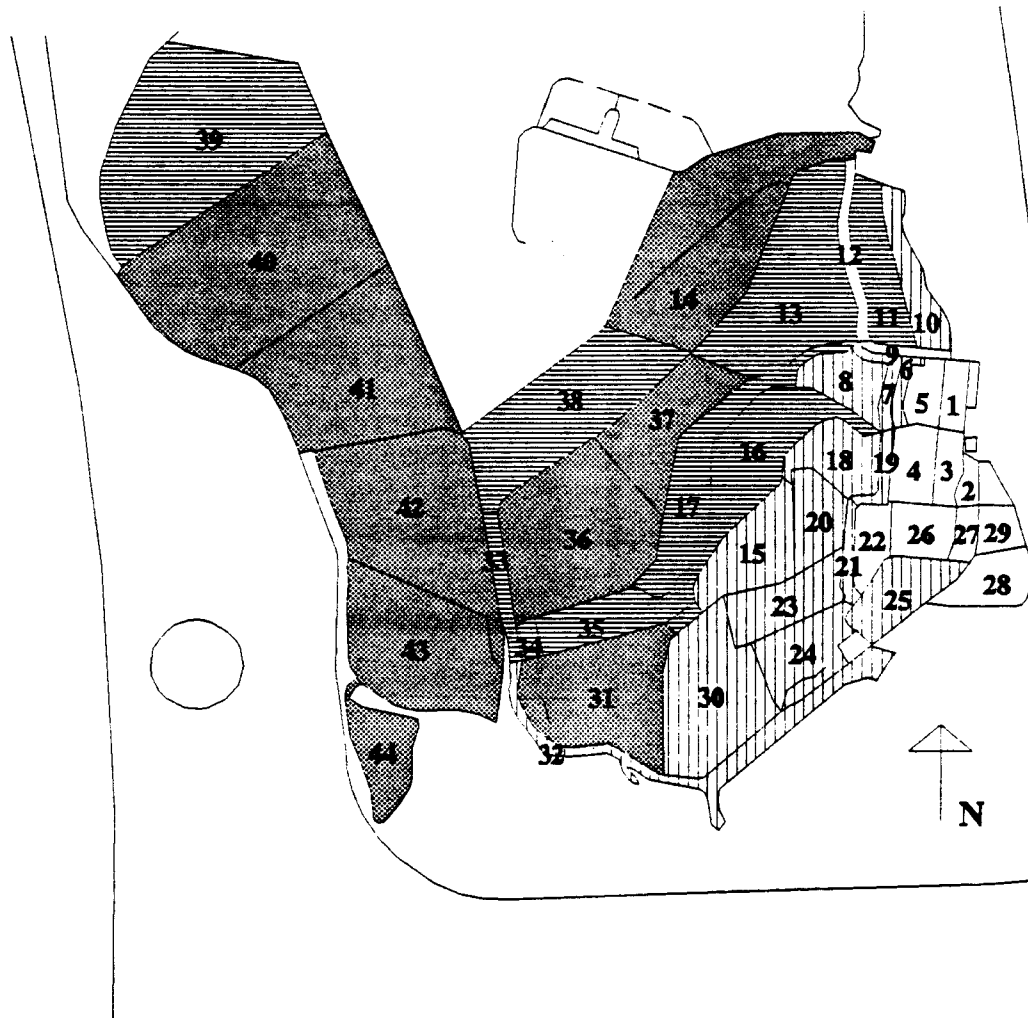
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Forster's Tern (*Sterna forsteri*)

Forster's terns were present throughout the year and were observed within 32 of the 44 survey units. Monthly averages peaked in May and November. Forster's terns are known nesters along the dikes of the Salt Works. The high count for this species was 368 individual recorded on November 3, 1993.



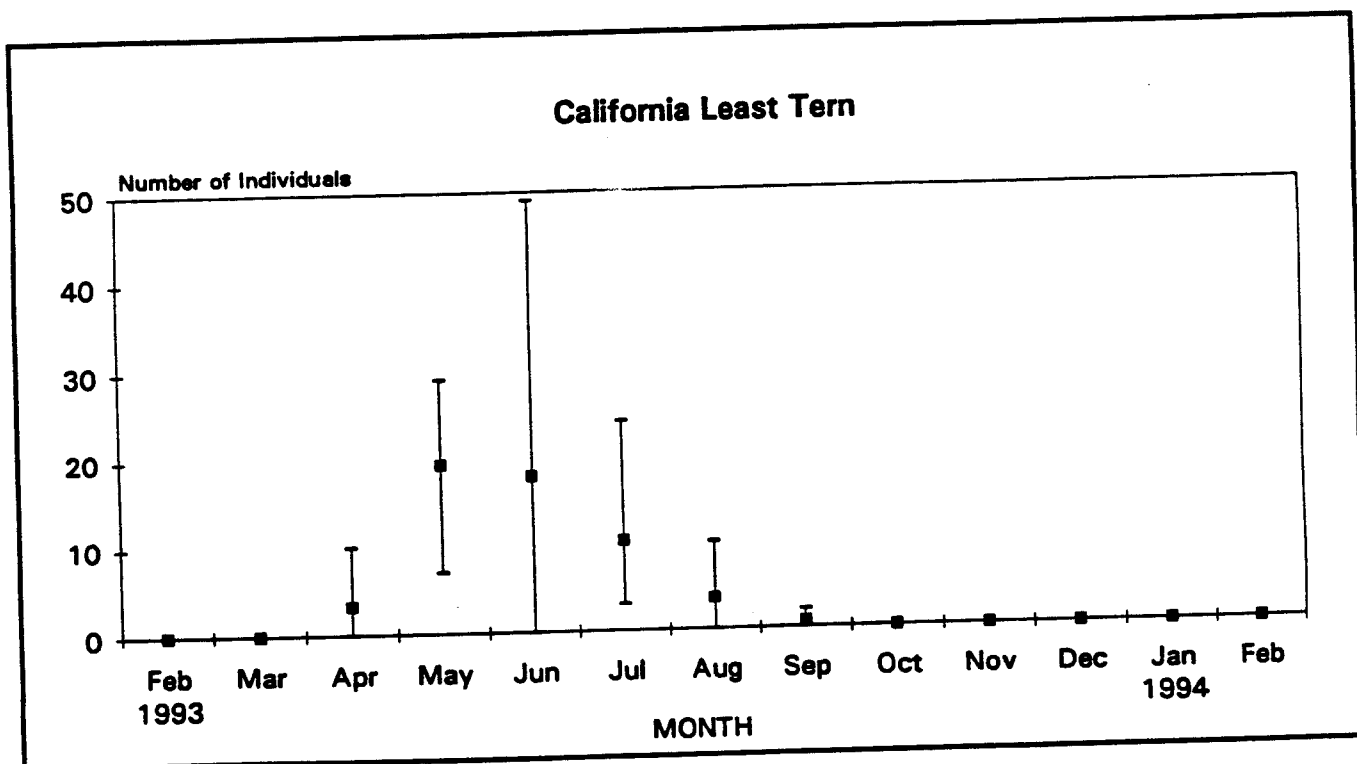
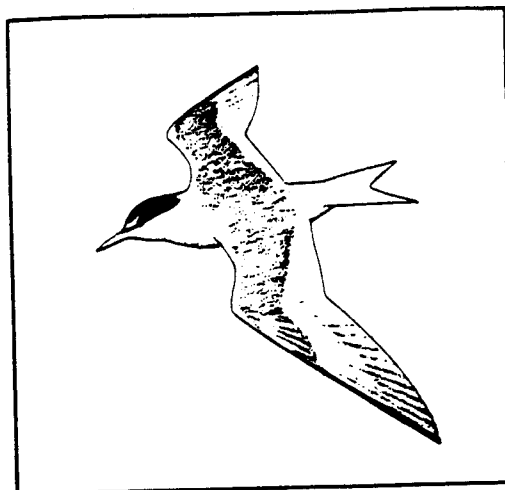
Forster's Tern



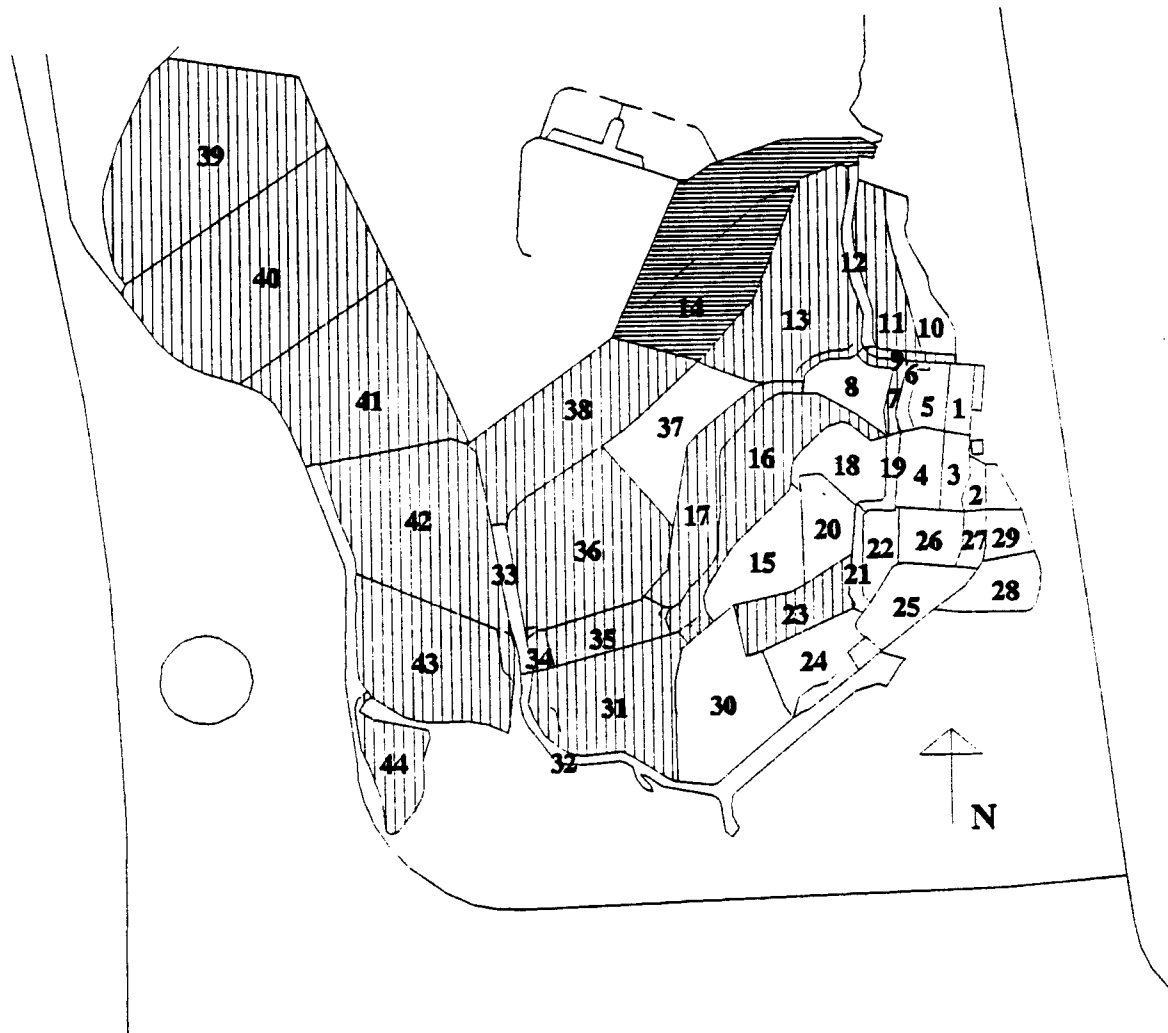
Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

California Least Tern (*Sterna antillarum browni*)

The California least tern is both a Federal and State listed endangered species which occurs in south San Diego Bay only during the breeding season. Least terns nested on the dikes between cells 8/13 and at the corner where cells 17, 35, and 16 converge. During the June 9 survey, a high count of 49 individuals was recorded of which 30 birds were observed loafing on the spit within cell 14.



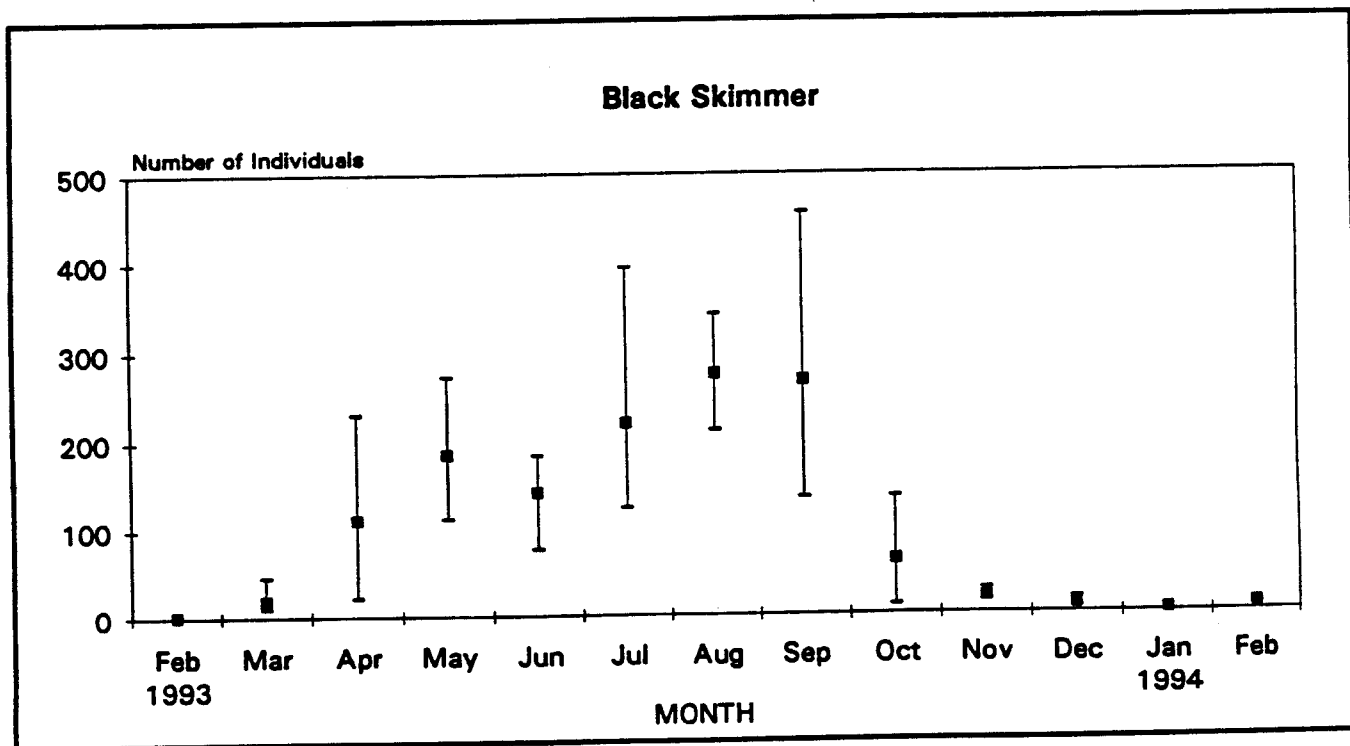
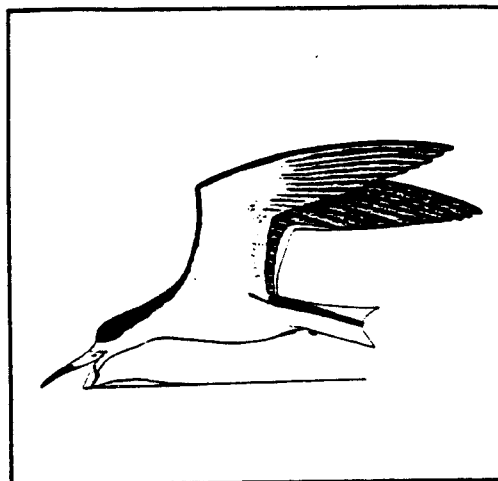
California Least Tern



Percent occurrence and distribution within numbered survey cells.
San Diego Bay, 1993-1994

Black Skimmer (*Rynchops niger*)

Black skimmers were most abundant during April through September with the high count of 455 individuals recorded on September 8. This species nested along several of the dikes within the Salt Works including the dikes between cell 35/36, 17/36, 16/17, and 15/16. Although black skimmers were observed throughout the study area, the spit within cell 31 was a favored roosting site. Several banded black skimmers were observed over the course of this investigation which were identified as birds banded at Bolsa Chica Ecological Reserve, Orange County. The black skimmer is a State listed Species of Special Concern.



The following species were detected on only one or two occasions during the year long survey:

Common Loon (*Gavia immer*)

Only one individual of this species was observed during the year-long survey. It was reported on November 3, 1993 within cell 42.

Tricolored Heron (*Egretta tricolor*)

A single tricolored heron was observed on October 6, 1993 within cell 16.

Snow Goose (*Anser caerulescens*)

On October 27, 1993 four snow geese were identified above cell 13. This species is rarely found within the environs of San Diego Bay and the individuals observed were most certainly fall transients.

Green-winged Teal (*Anas crecca*)

Green-winged teal were recorded on only one occasion. Six individuals, presumably winter transients, were observed within cell 43 on January 19, 1994.

Blue-winged Teal (*Anas discors*)

This species was encountered on one occasion during July when 4 individuals were present within survey unit 14.

Oldsquaw (*Clangula hyemalis*)

An individual female was observed twice within cell 13 and once within cell 14 during surveys conducted in December 1993.

Surfbird (*Aphriza virgata*)

A single individual was reported within cell 23 during the October 20, 1993 survey.

Pectoral Sandpiper (*Calidris melanotos*)

A single individual was reported in cell 11 during the August 15, 1993 survey.

Parasitic Jaeger (*Stercorarius parasiticus*)

An individual parasitic jaeger was noted on two occasions during November 1993.

Franklin's Gull (*Larus pipixcan*)

One observation of an individual was made during the March 3, 1993 survey within cell 38.

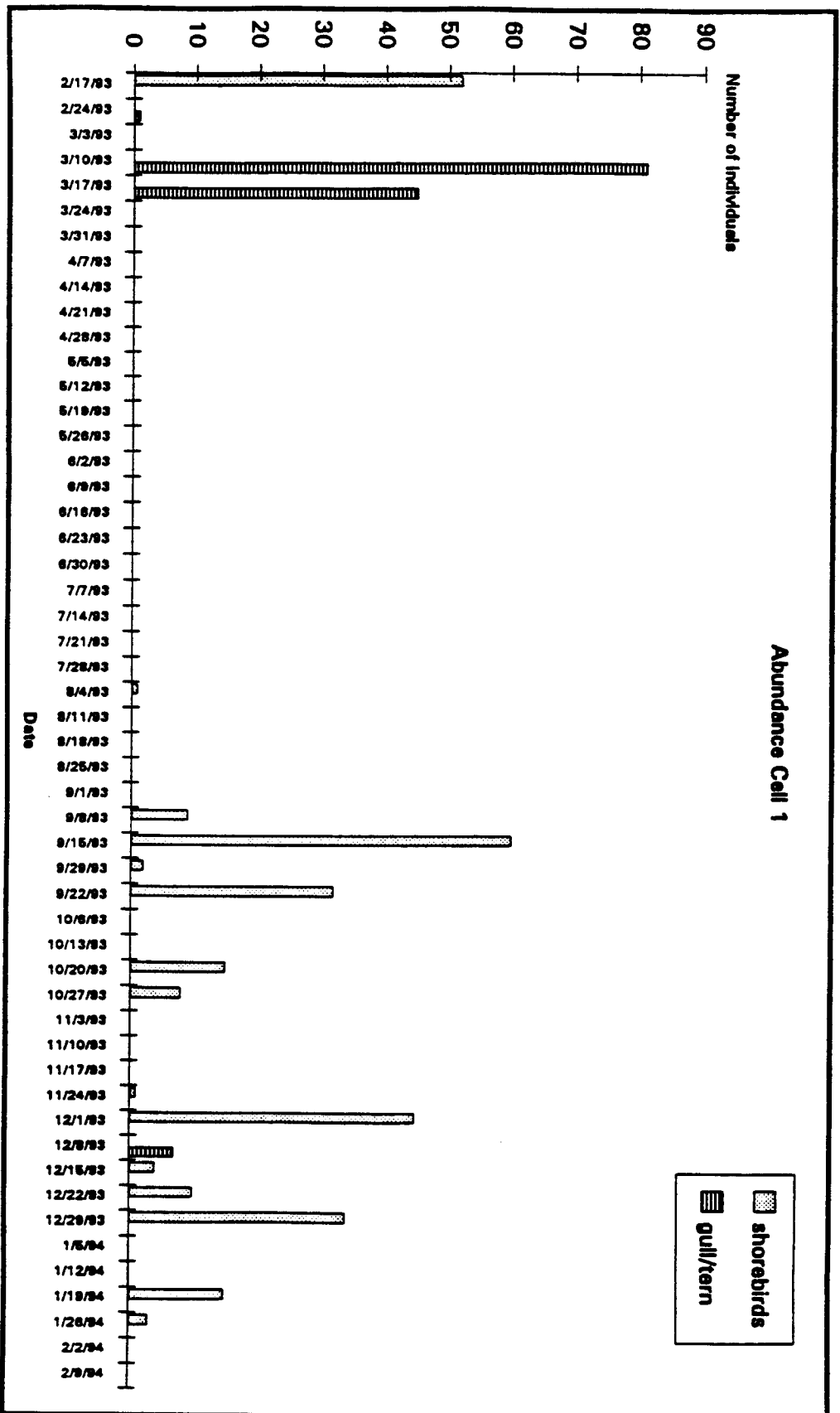
Glaucous-winged Gull (*Larus glaucescens*)

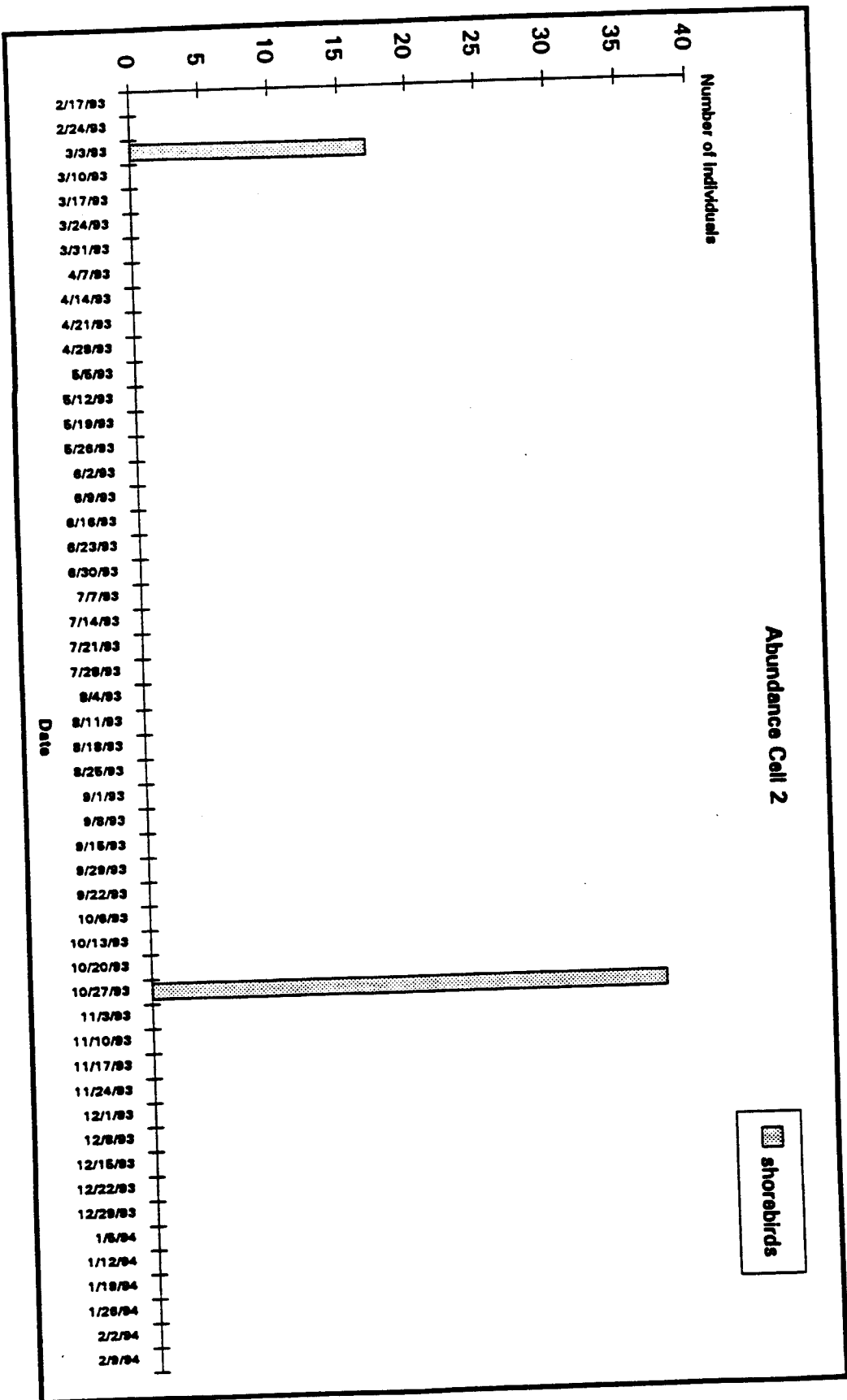
An individual was reported within cell 35 on March 17, 1993 and within cell 37 on January 26, 1994.

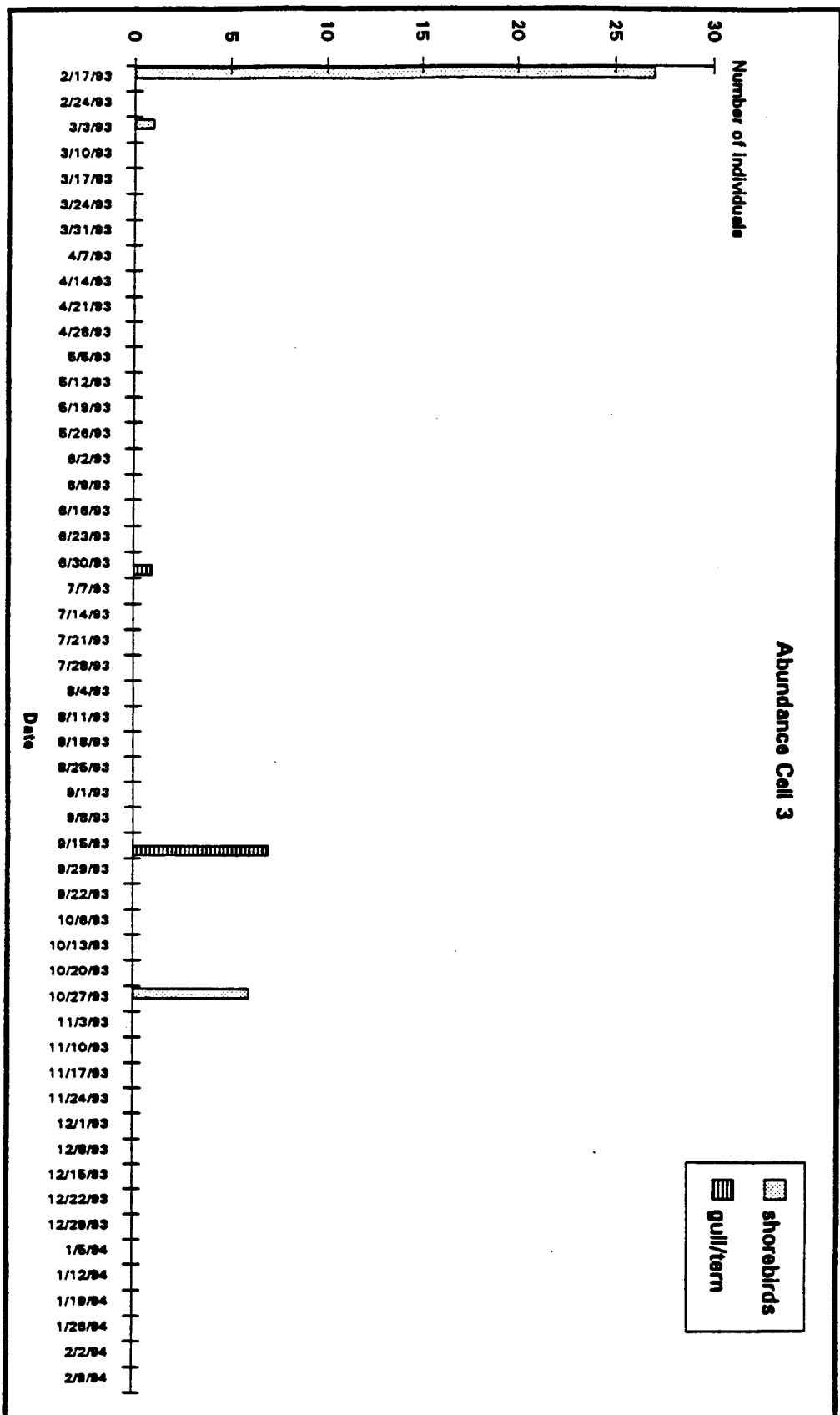
Black Tern (*Chlidonias niger*)

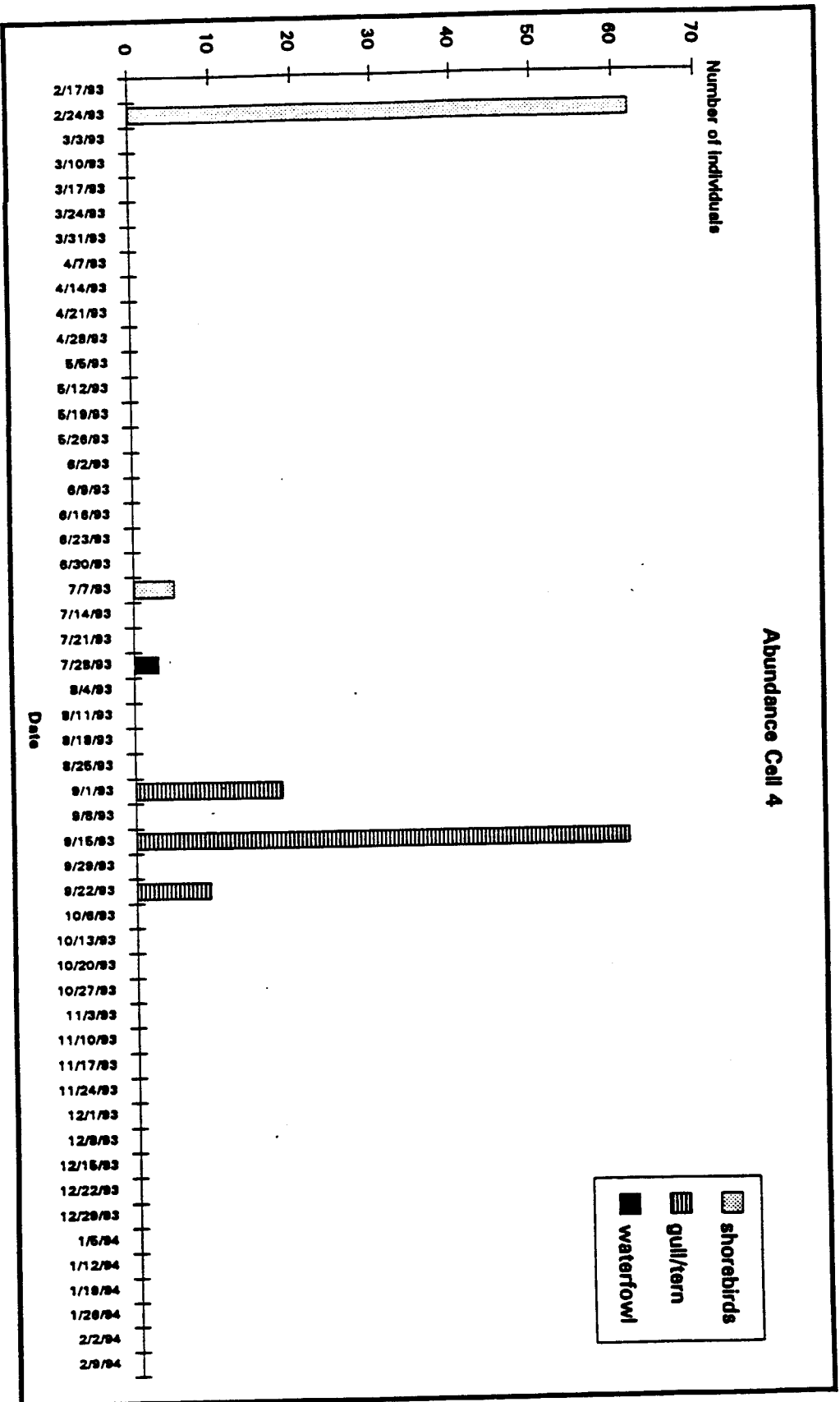
A single black tern was observed foraging within cell 30 on September 1, 1993. The black tern is a Category 2 candidate for Federal listing.

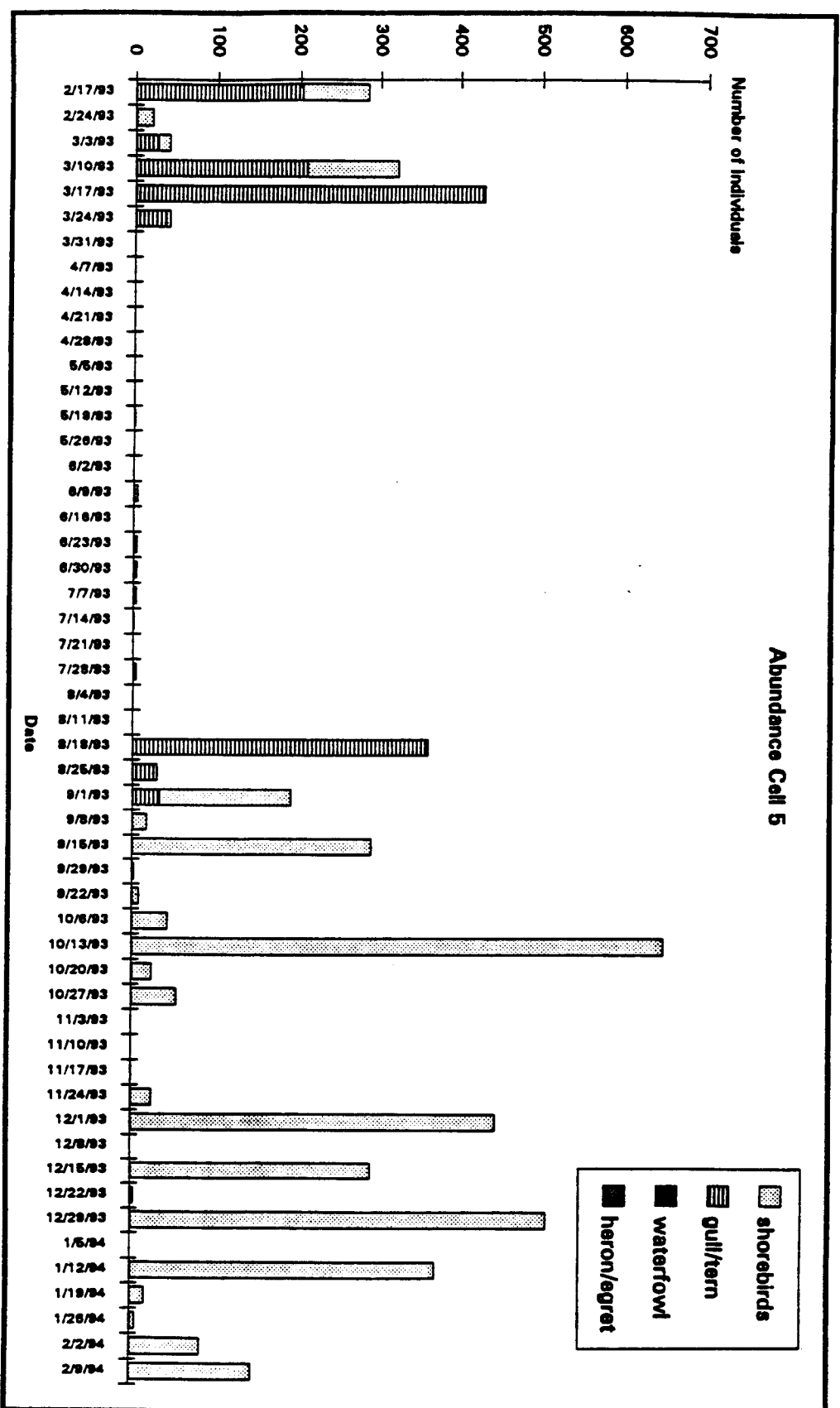
APPENDIX D

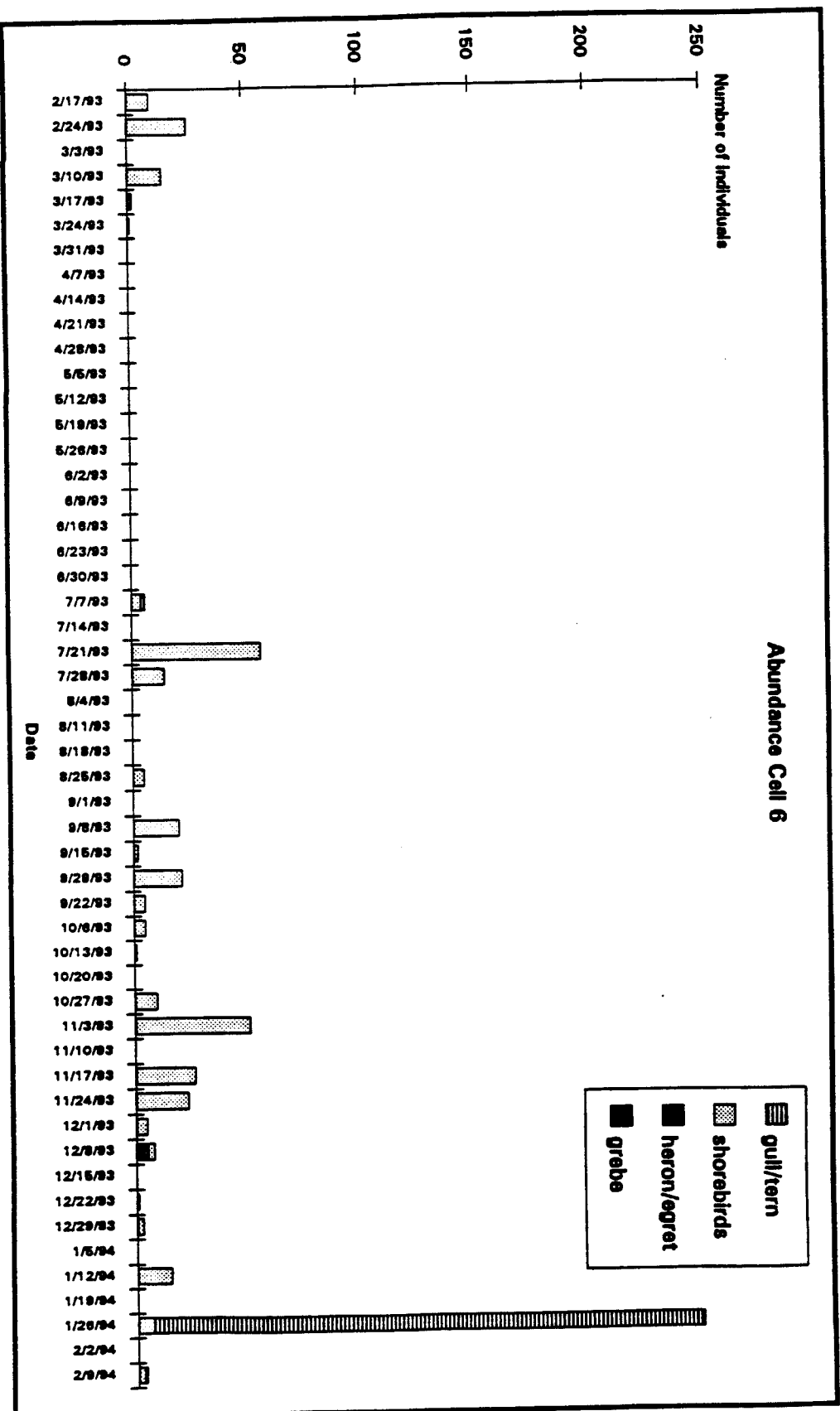


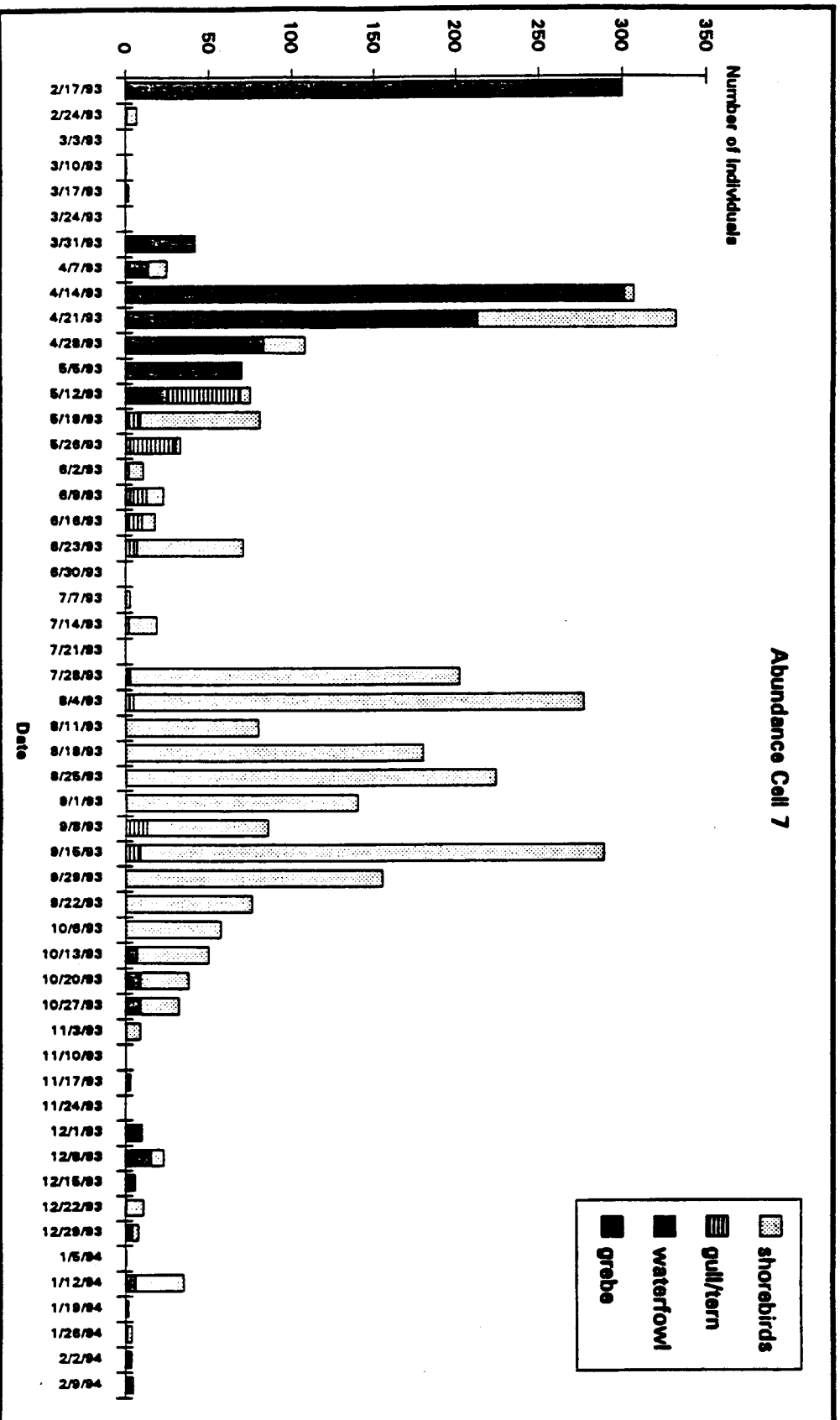


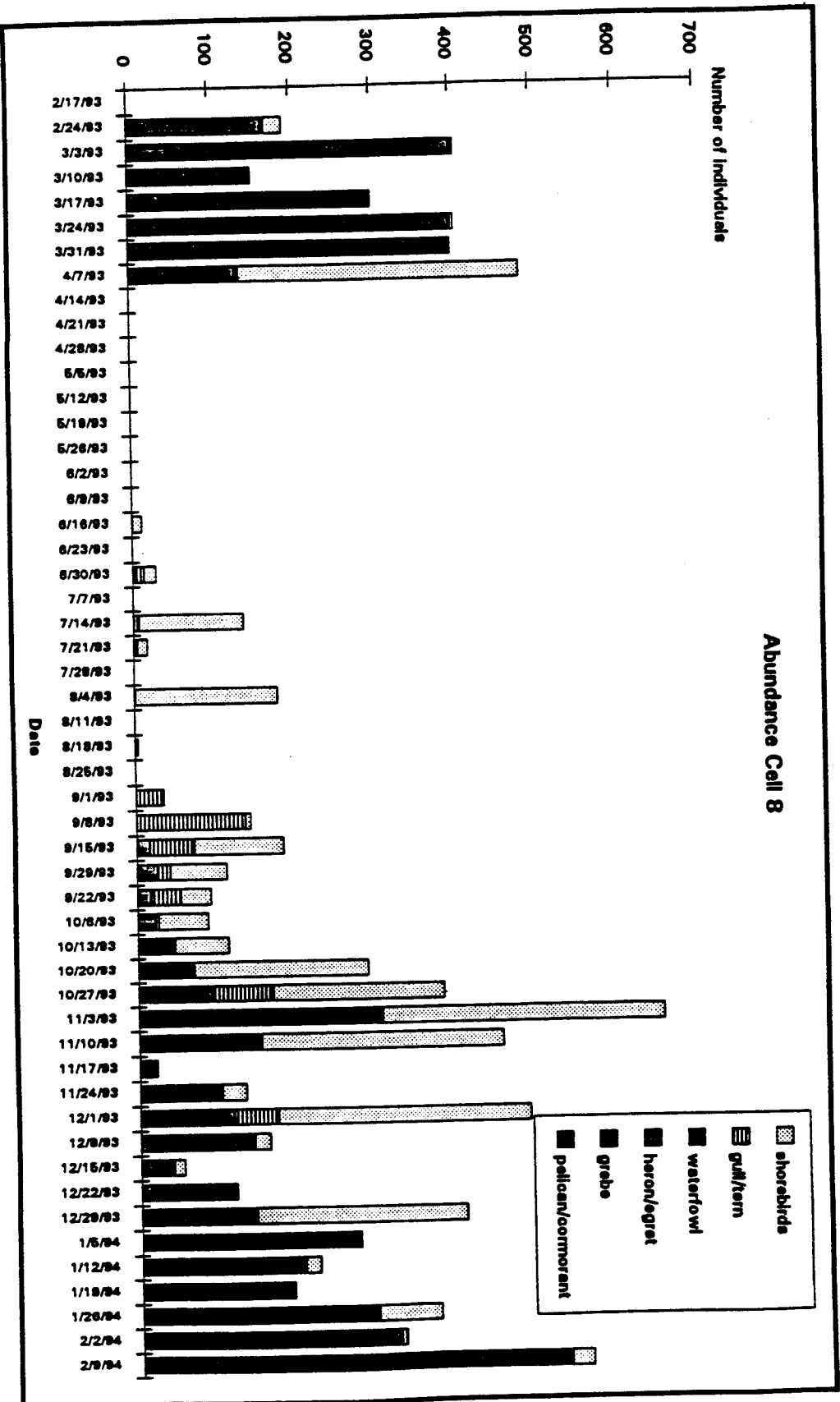


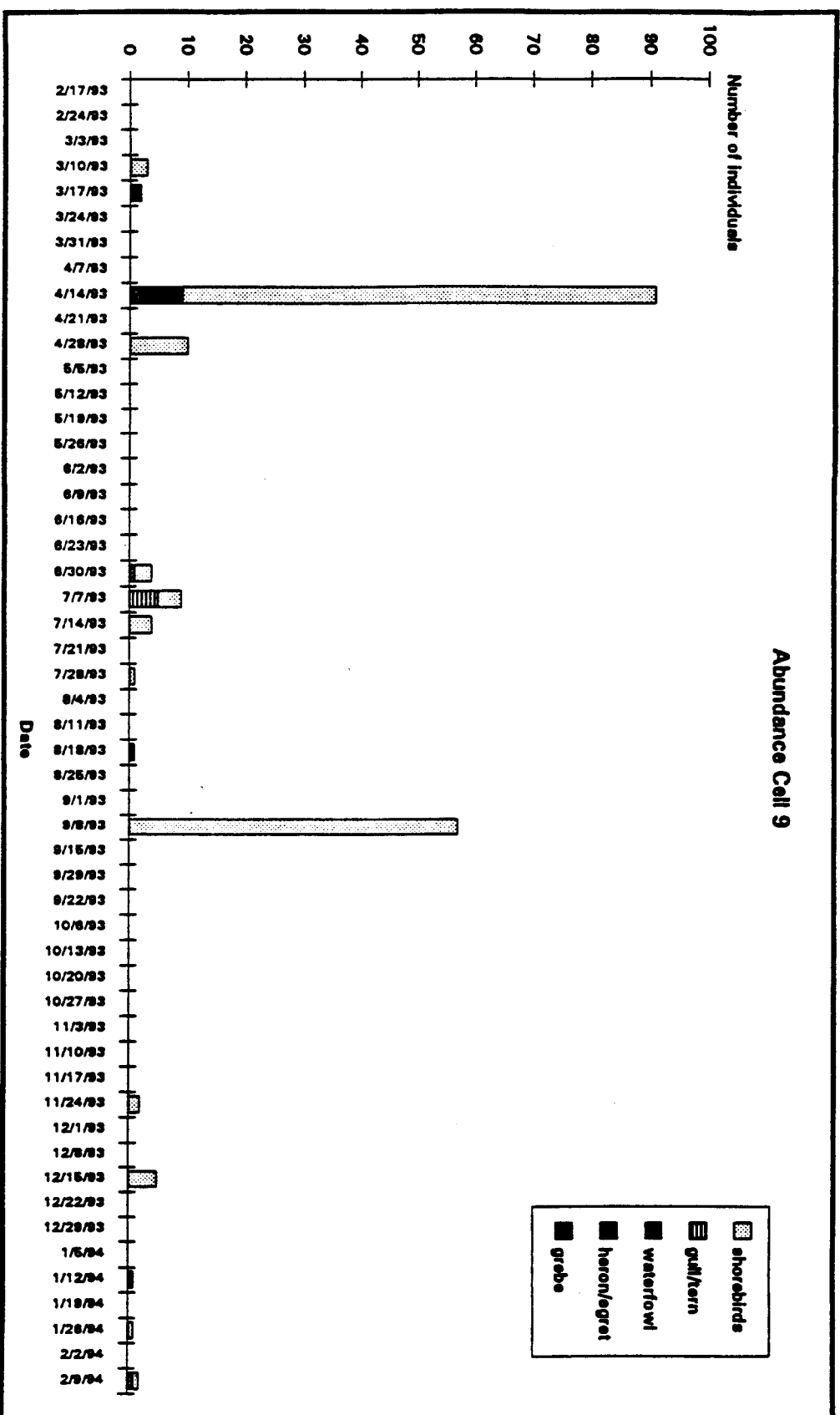


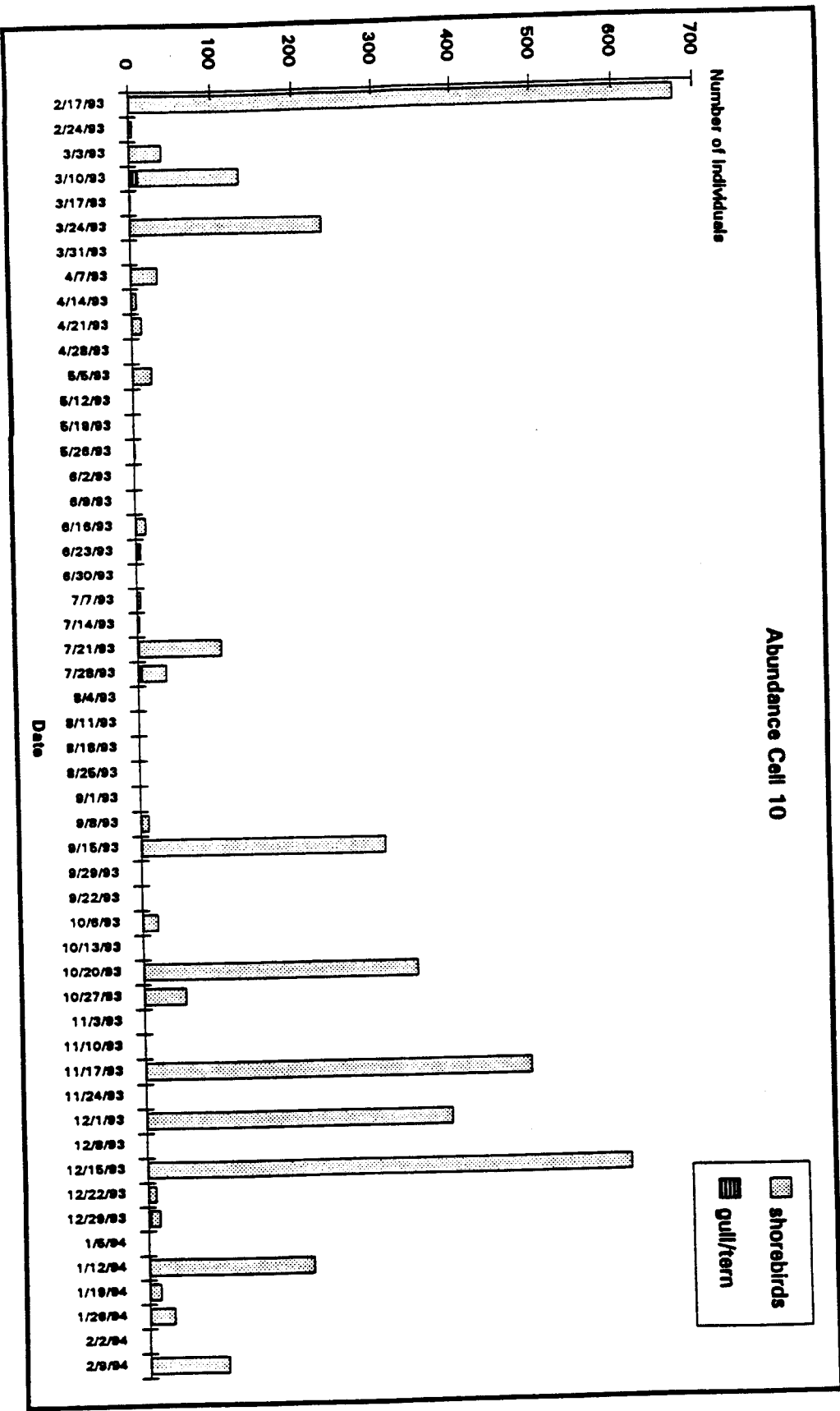


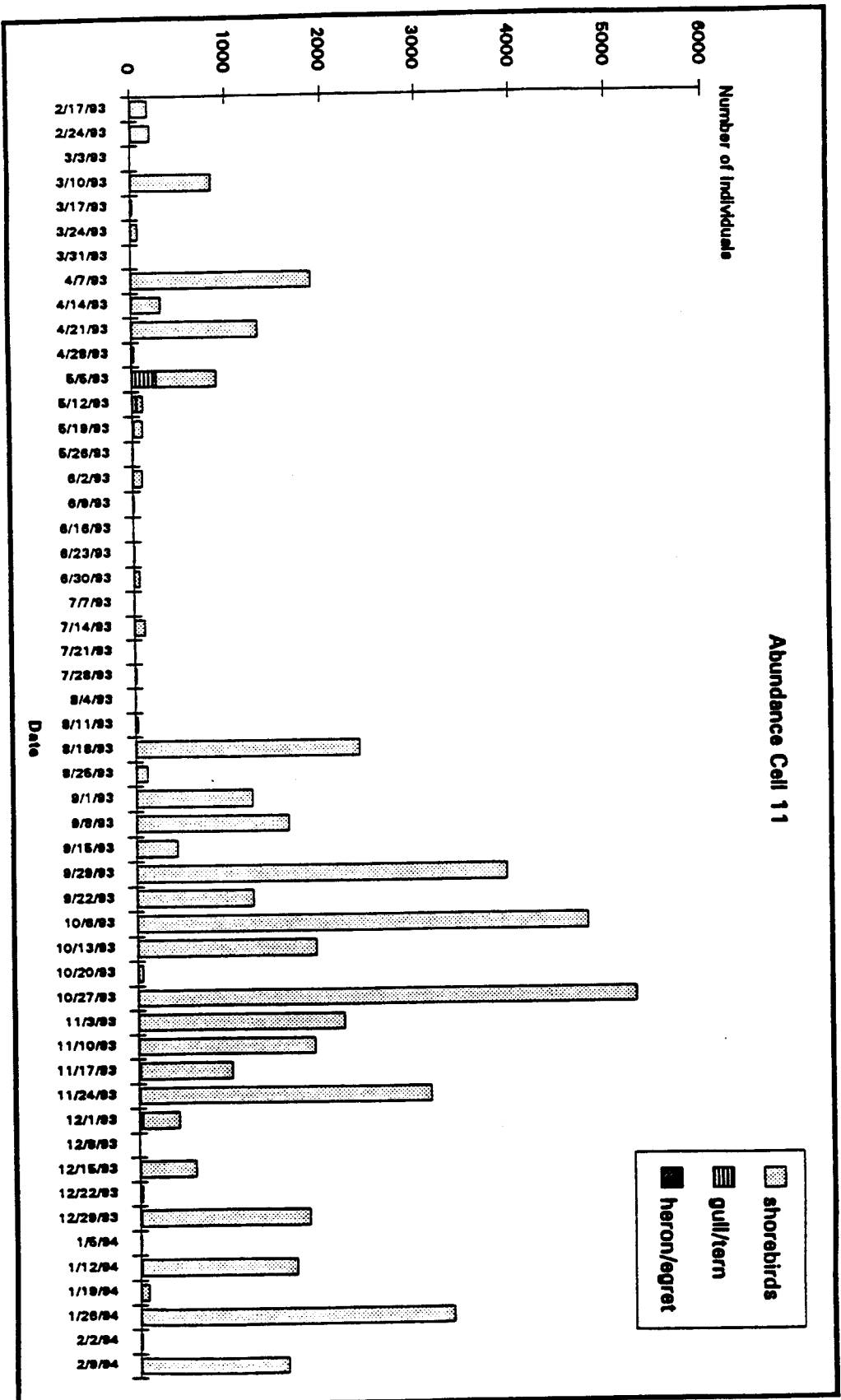


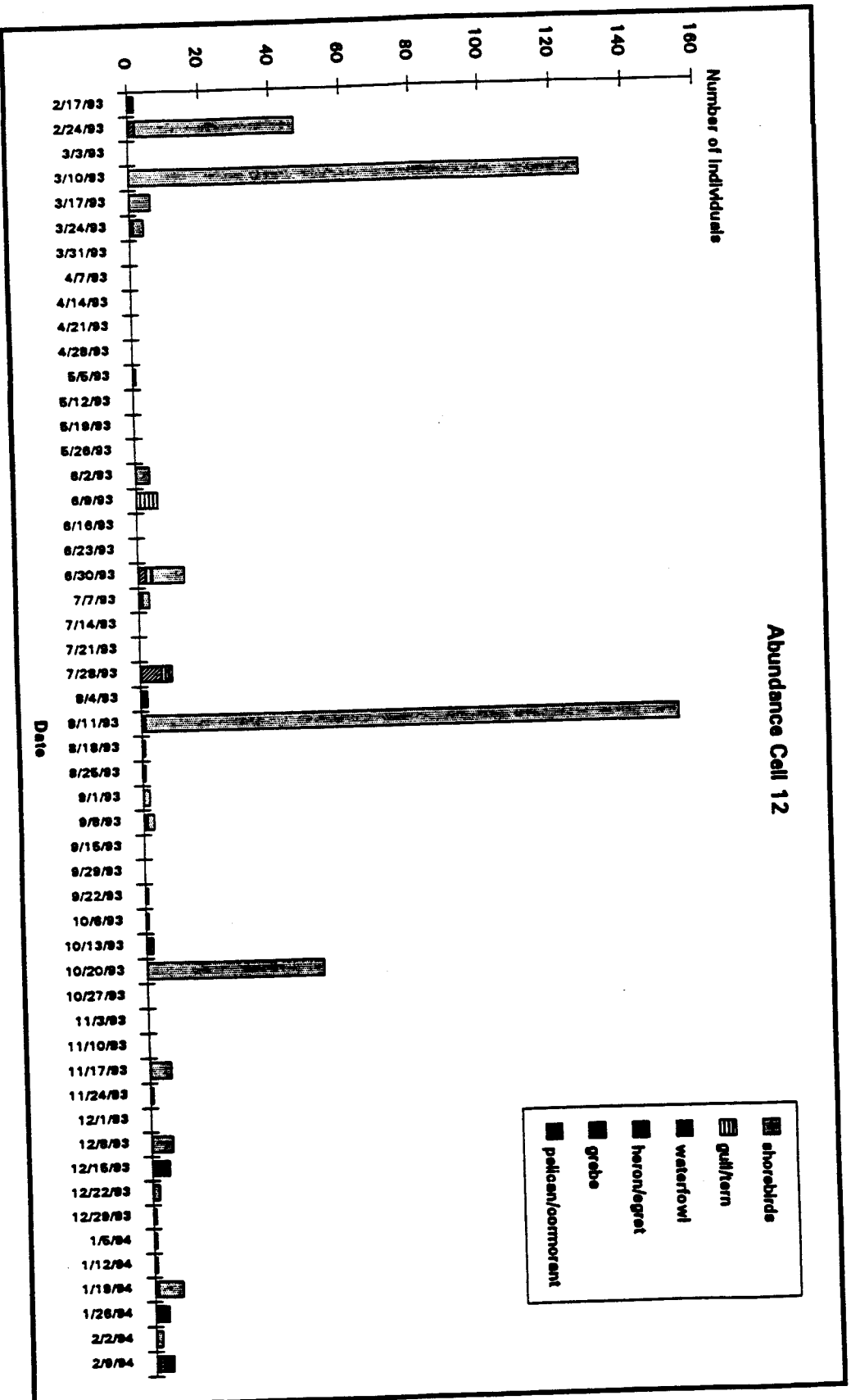


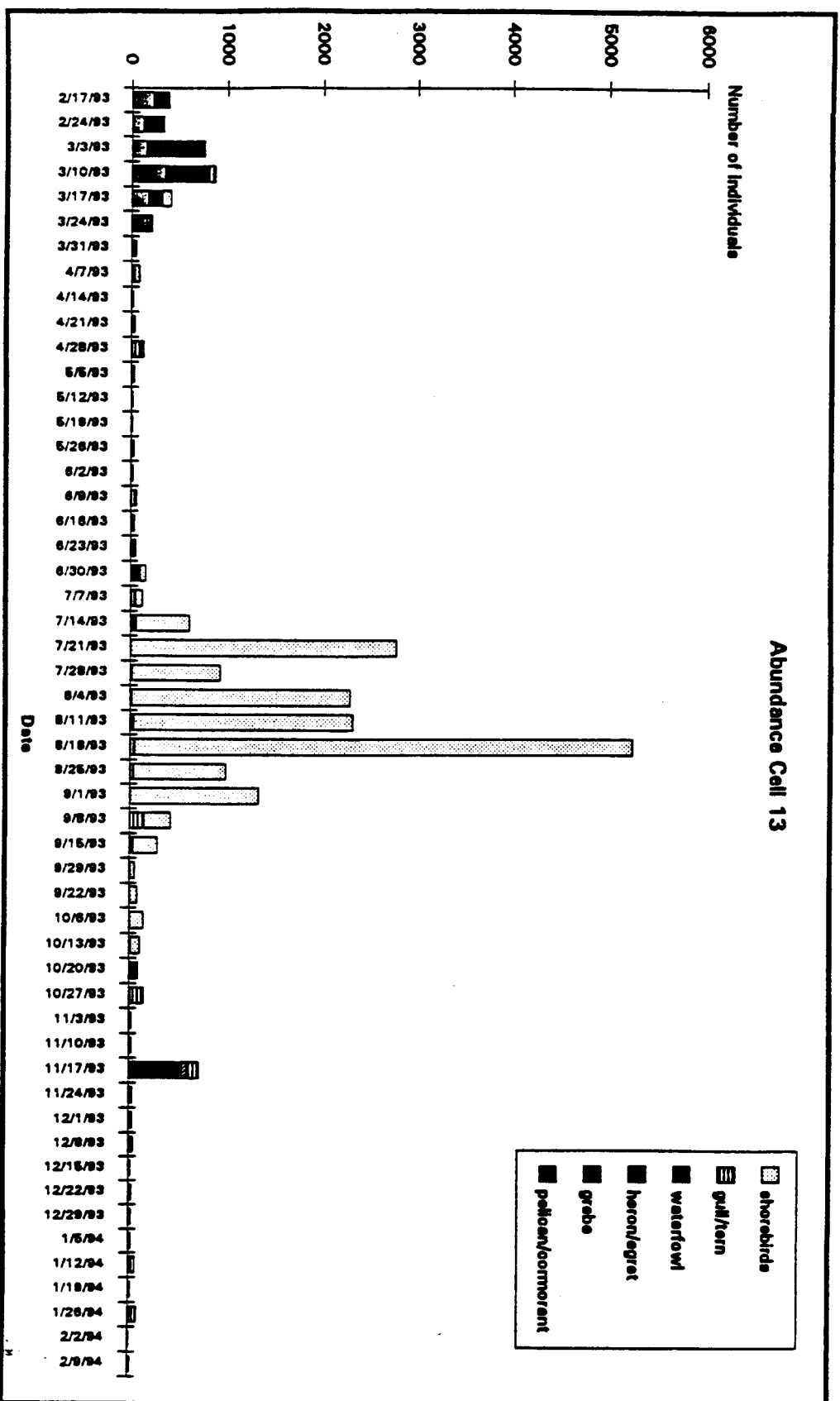


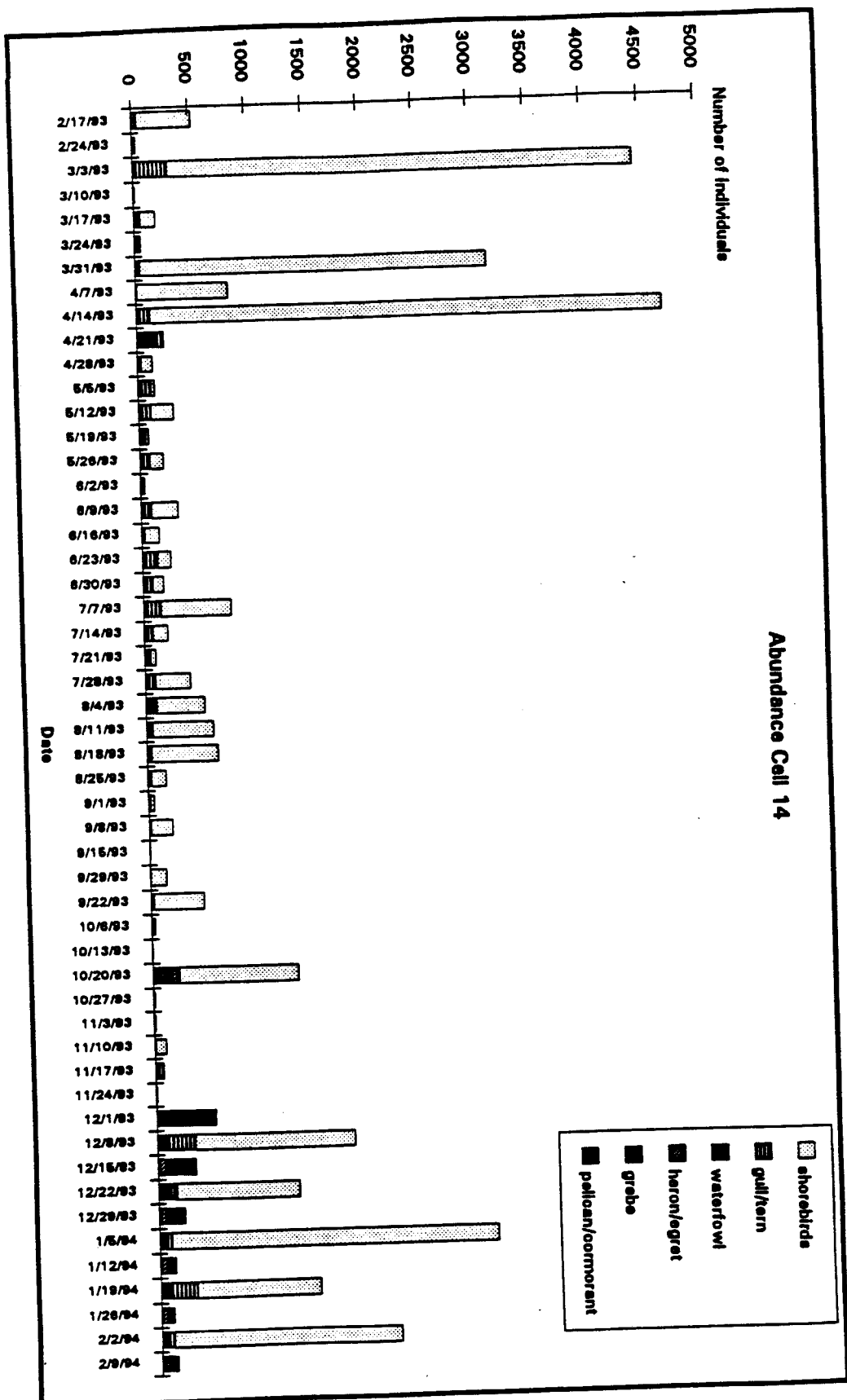


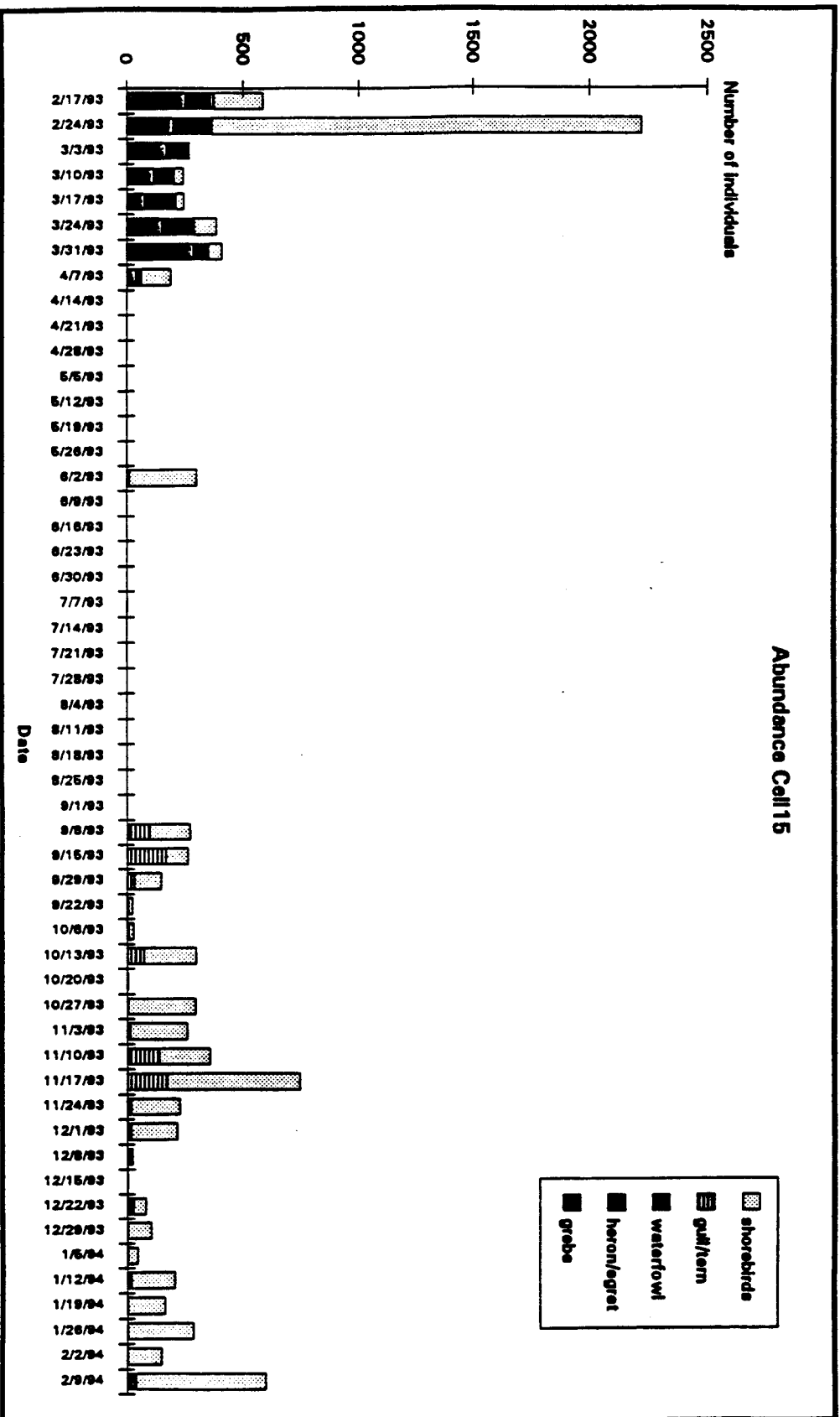


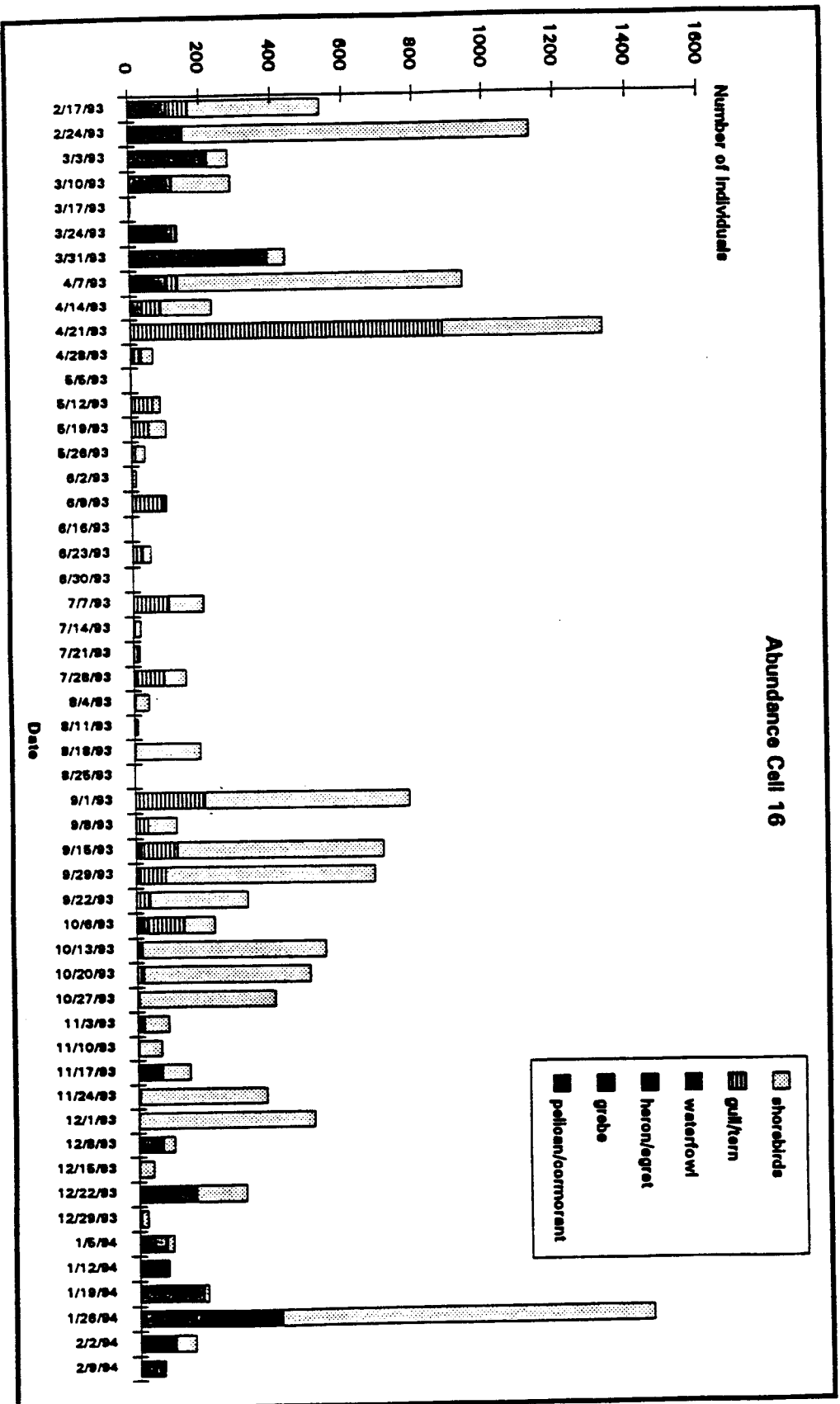


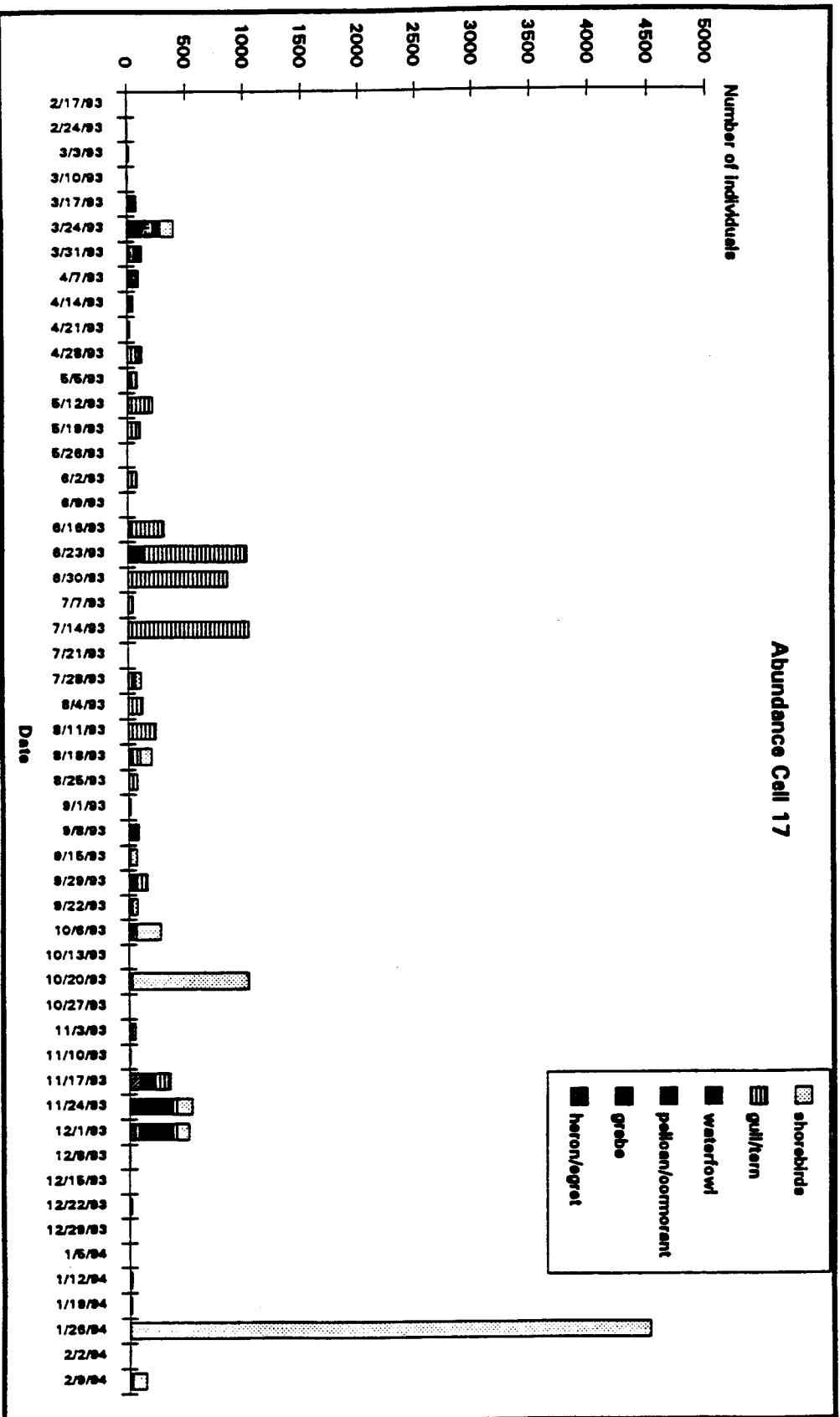


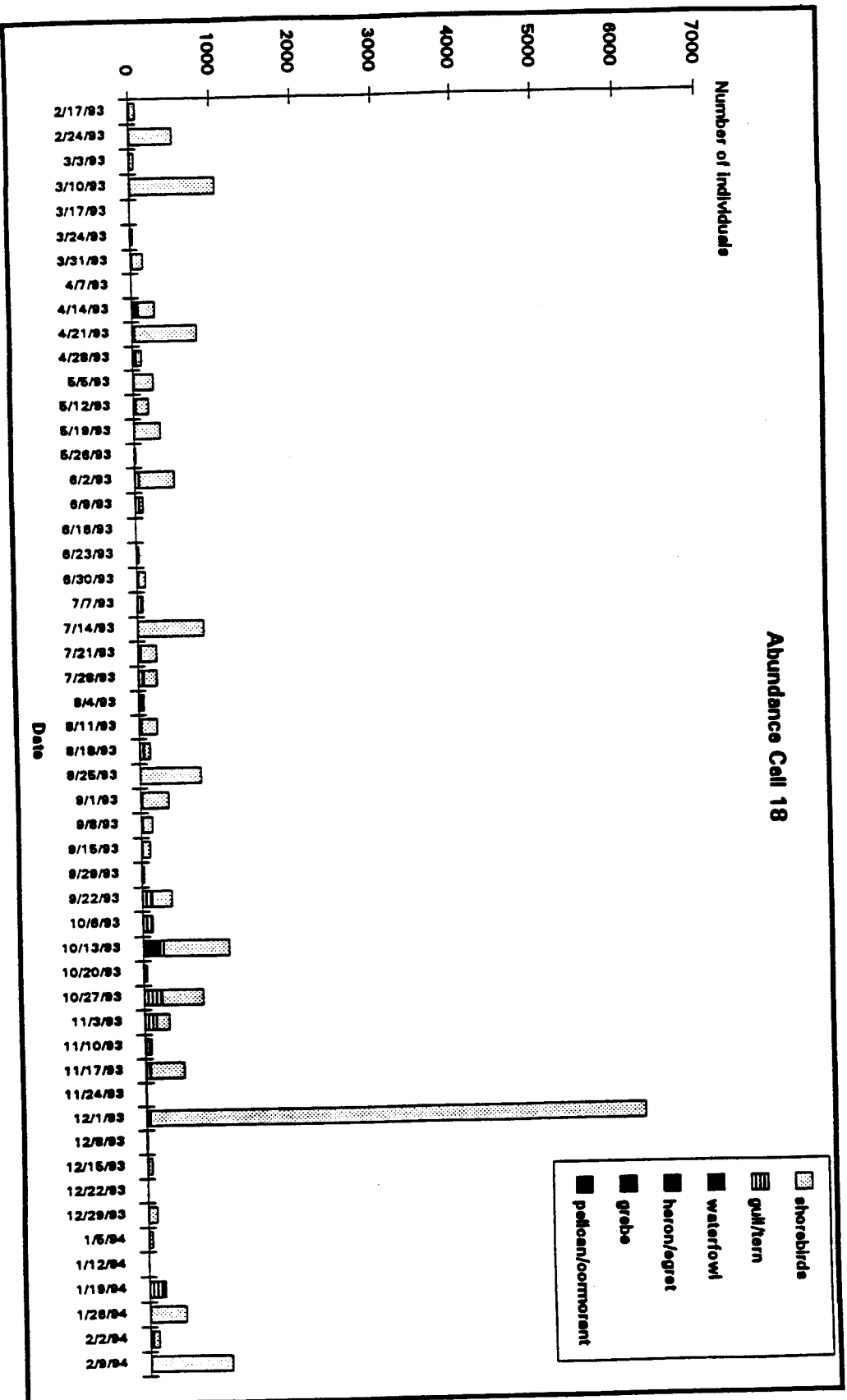




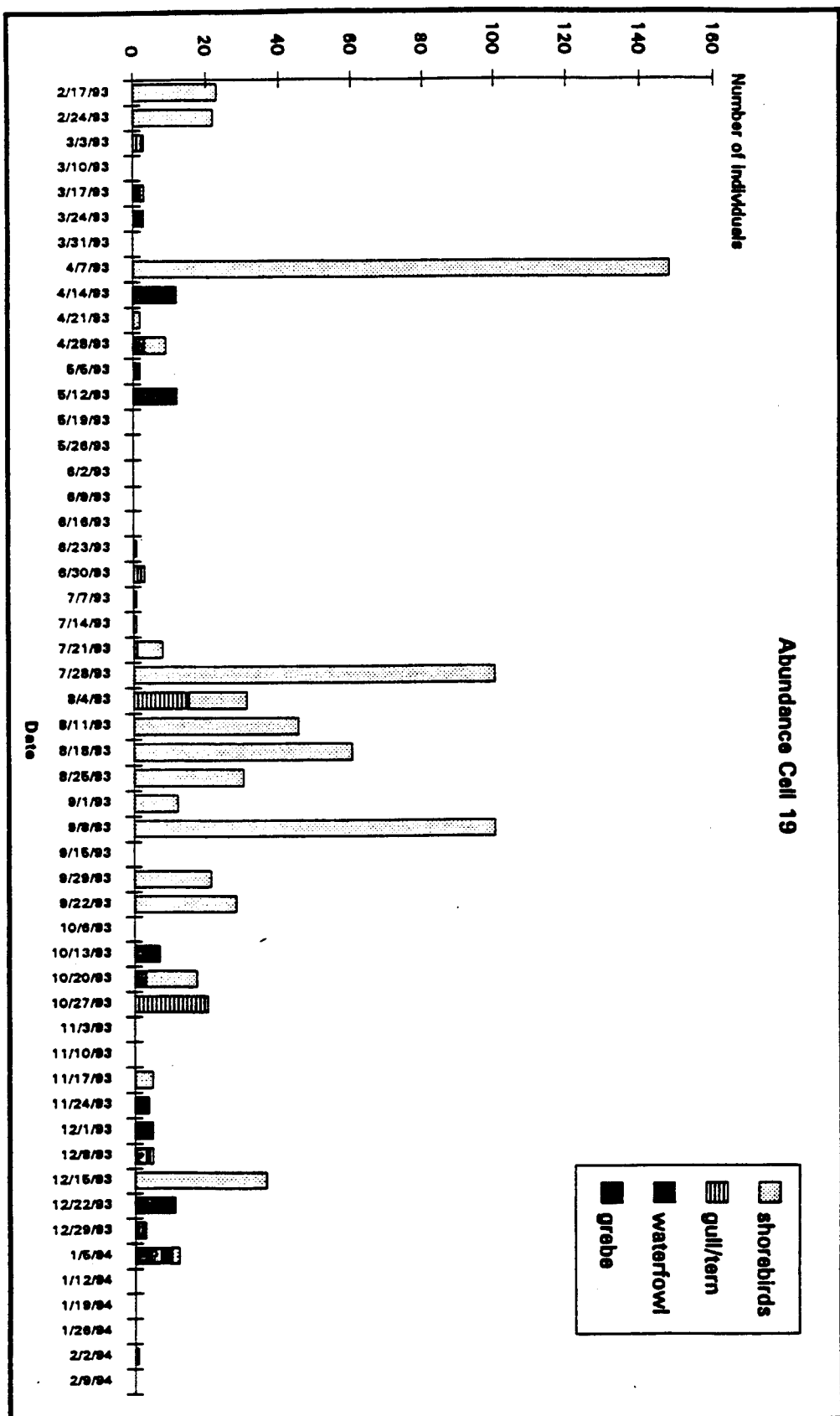


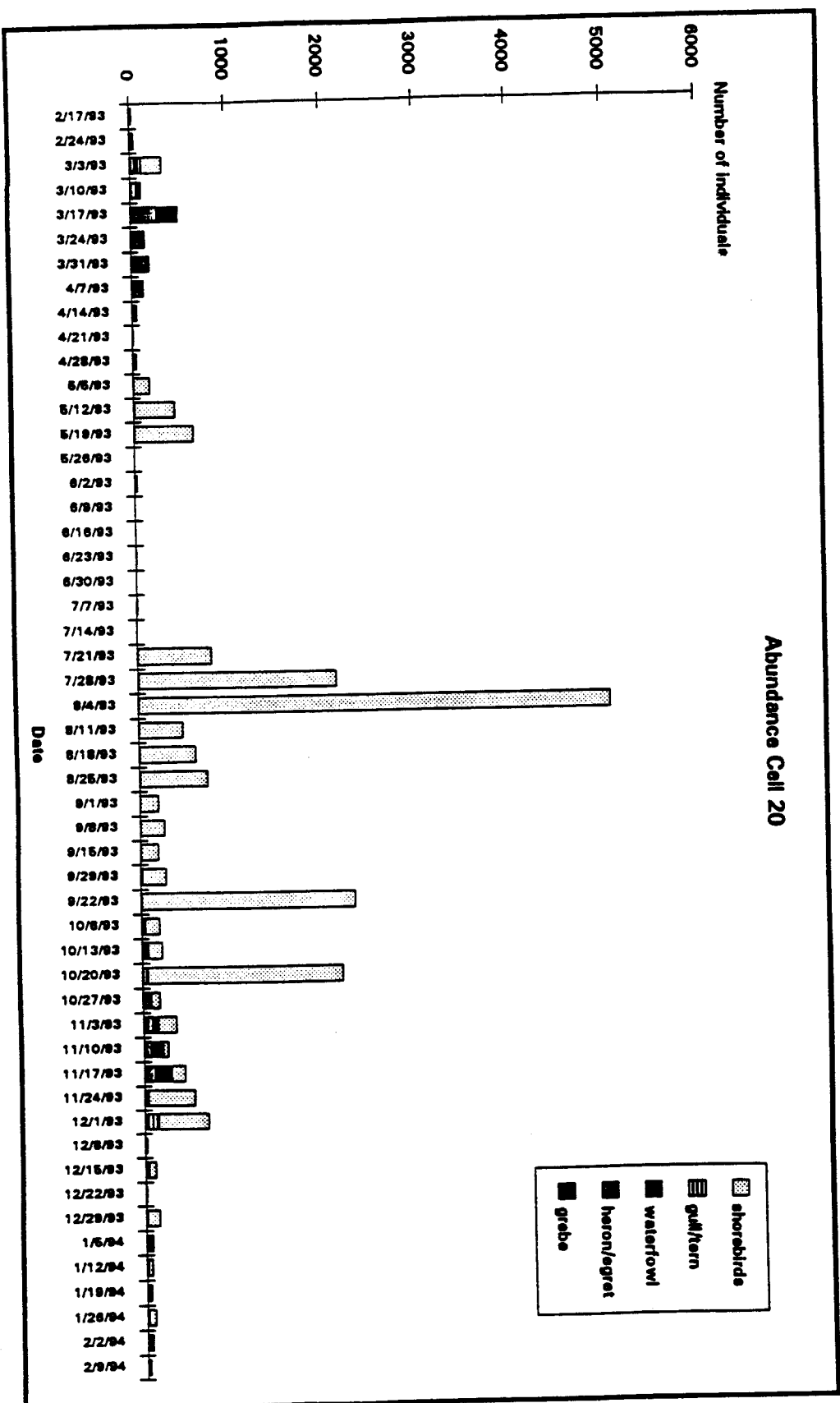


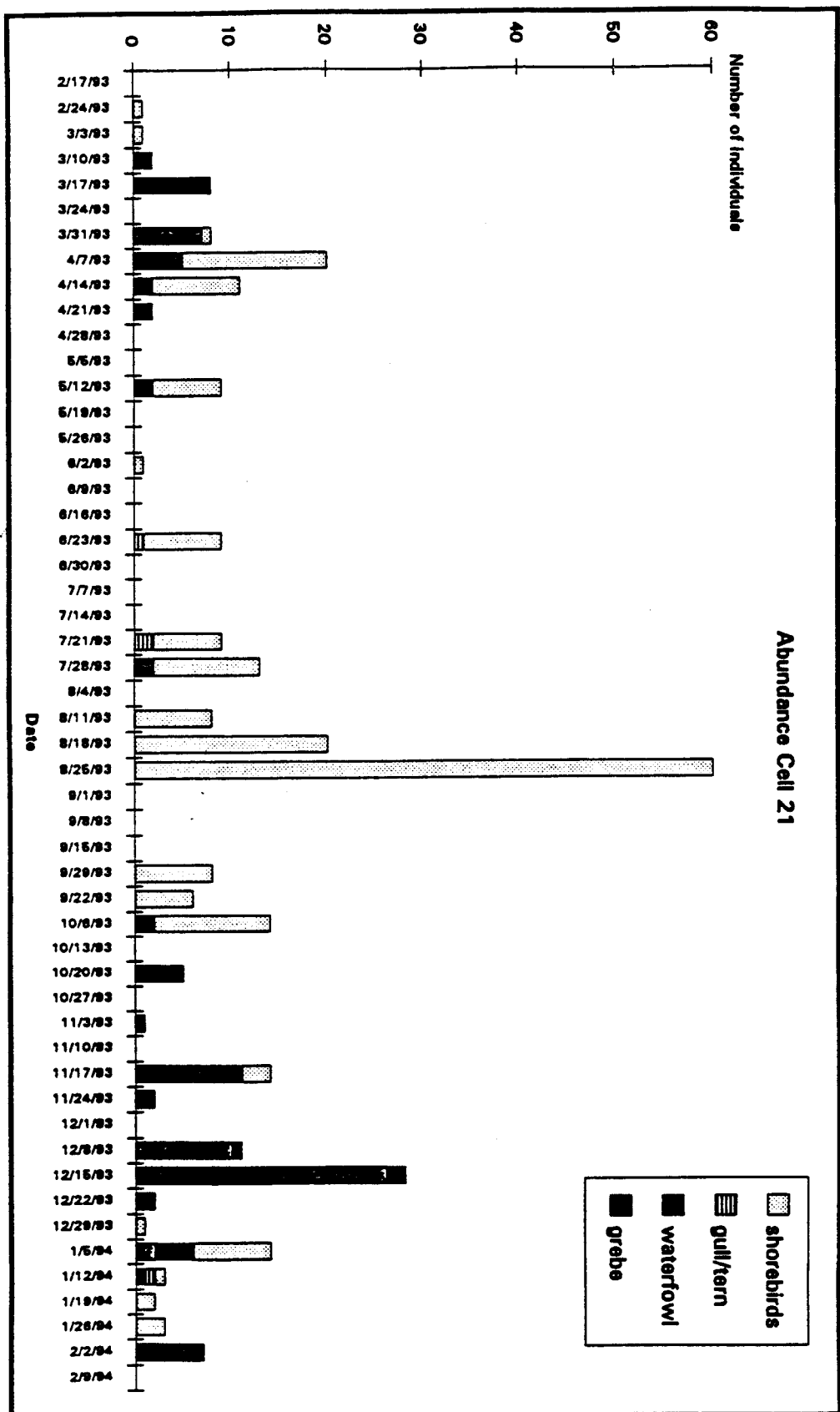


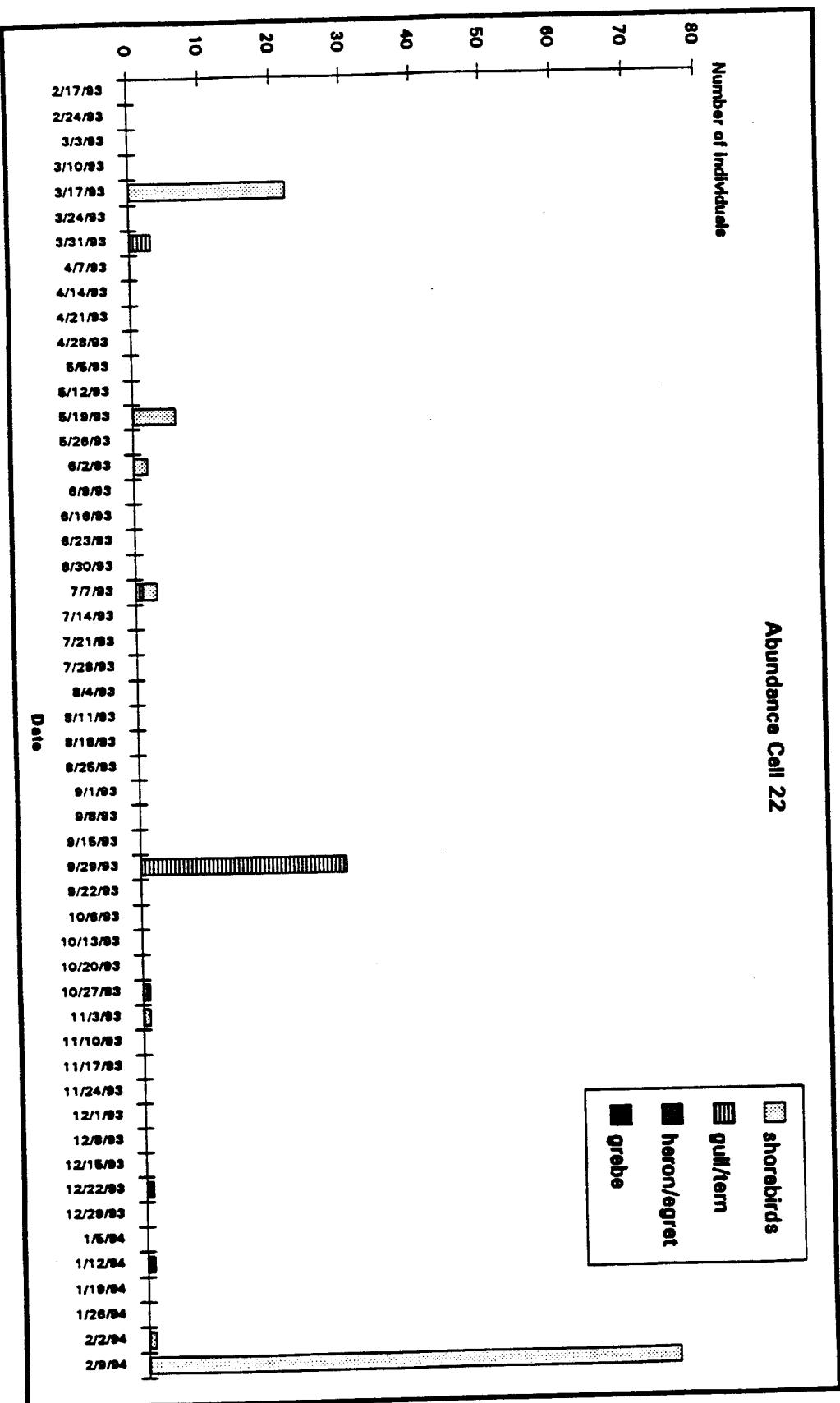


Abundance Cell 19

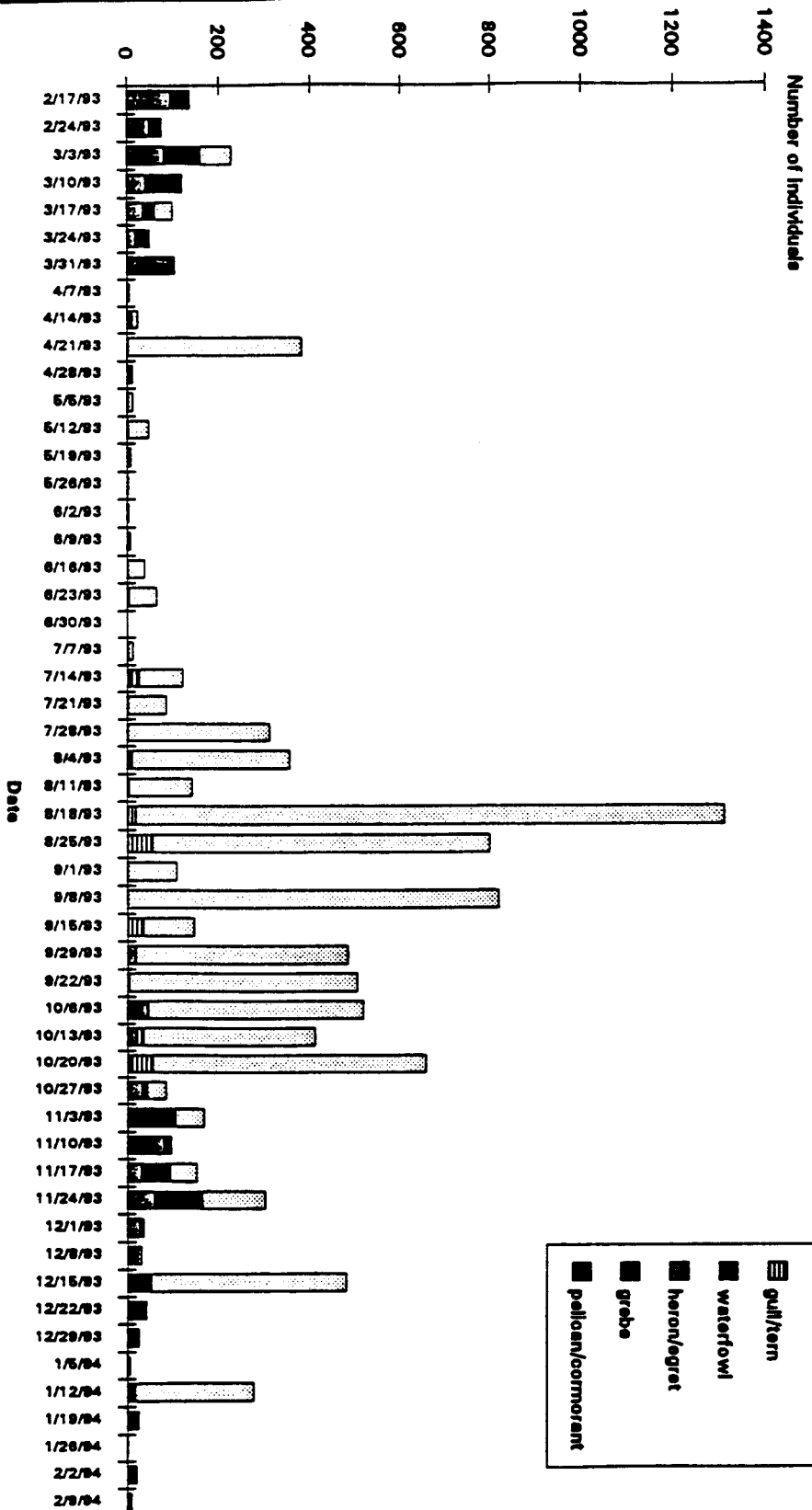


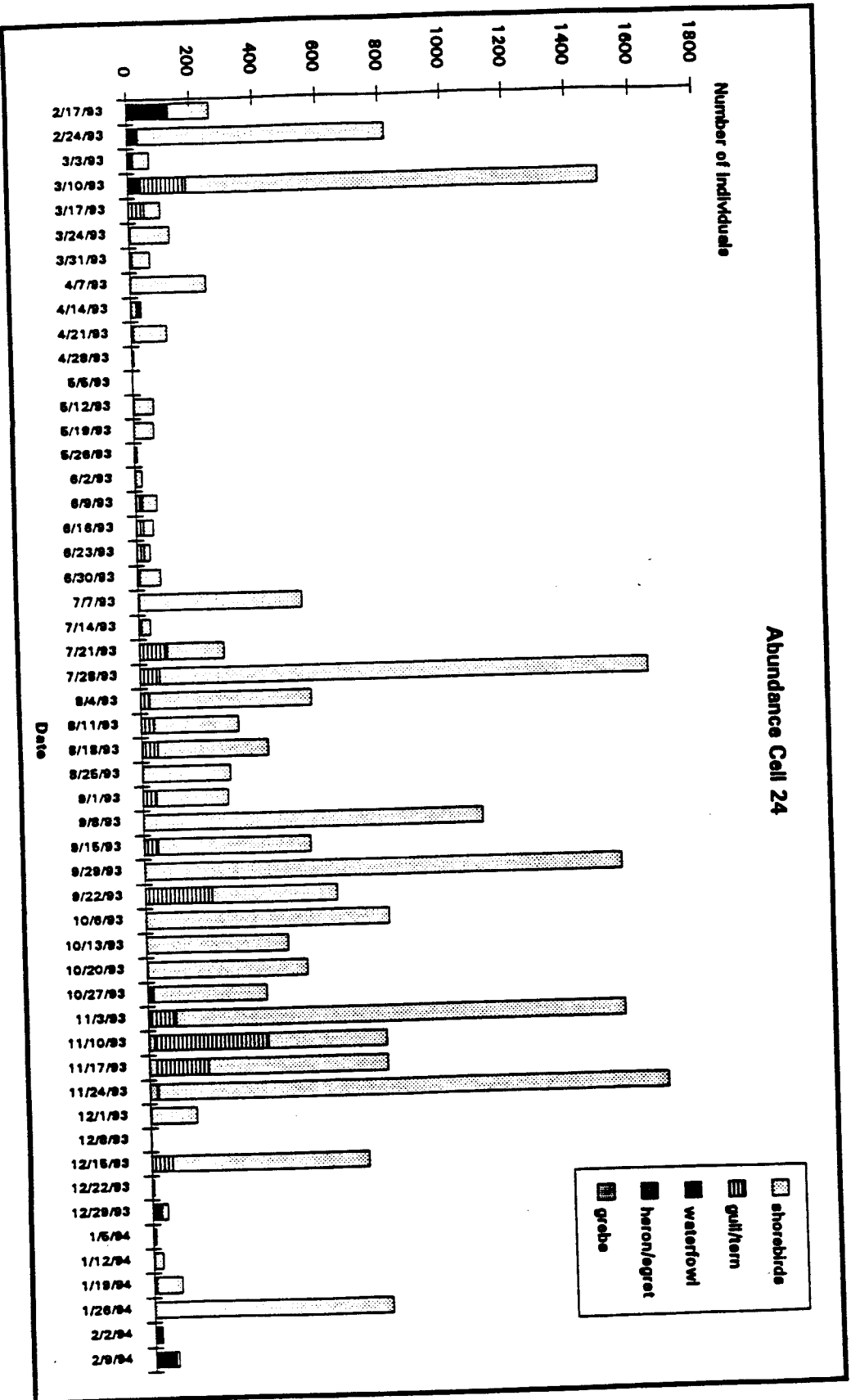


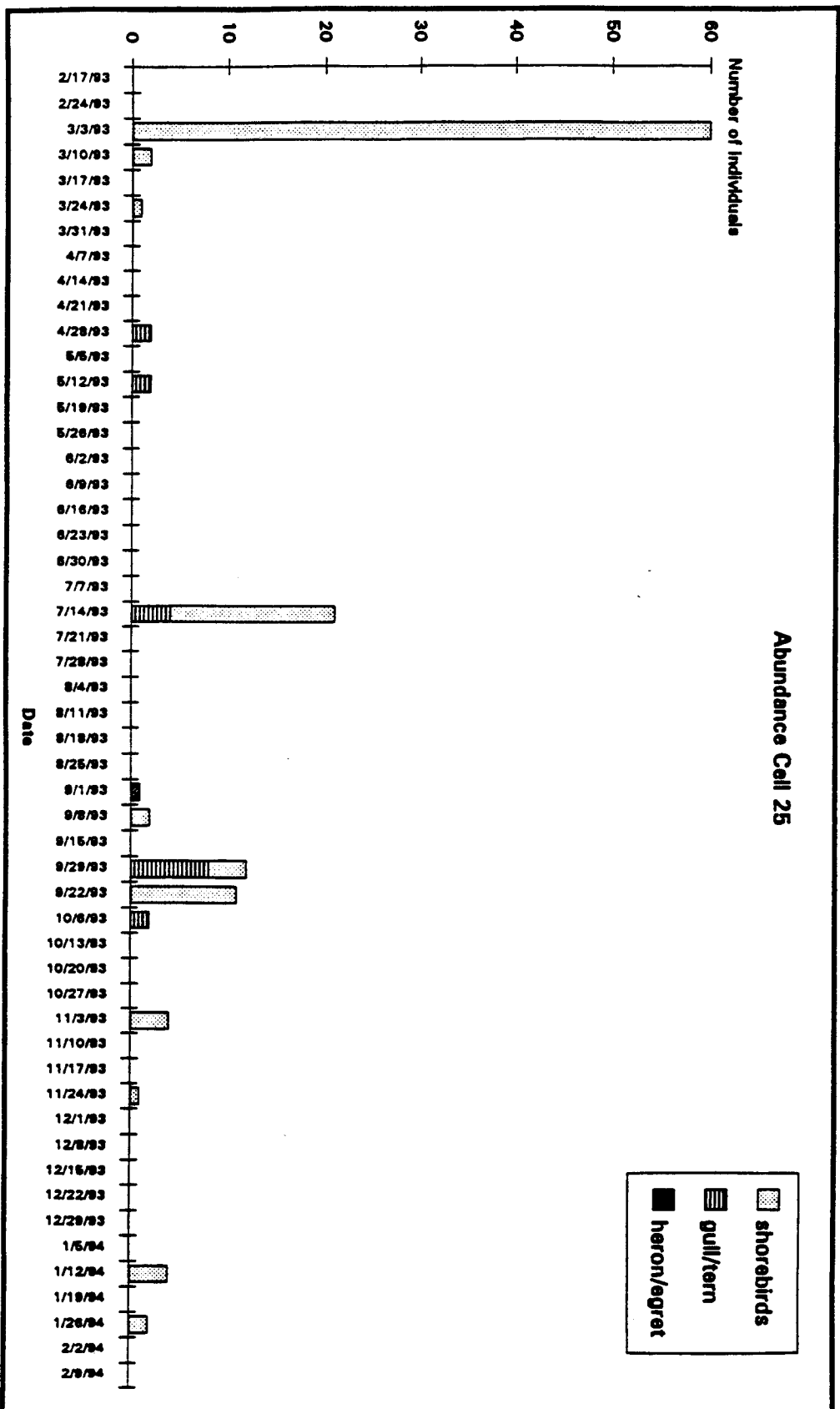


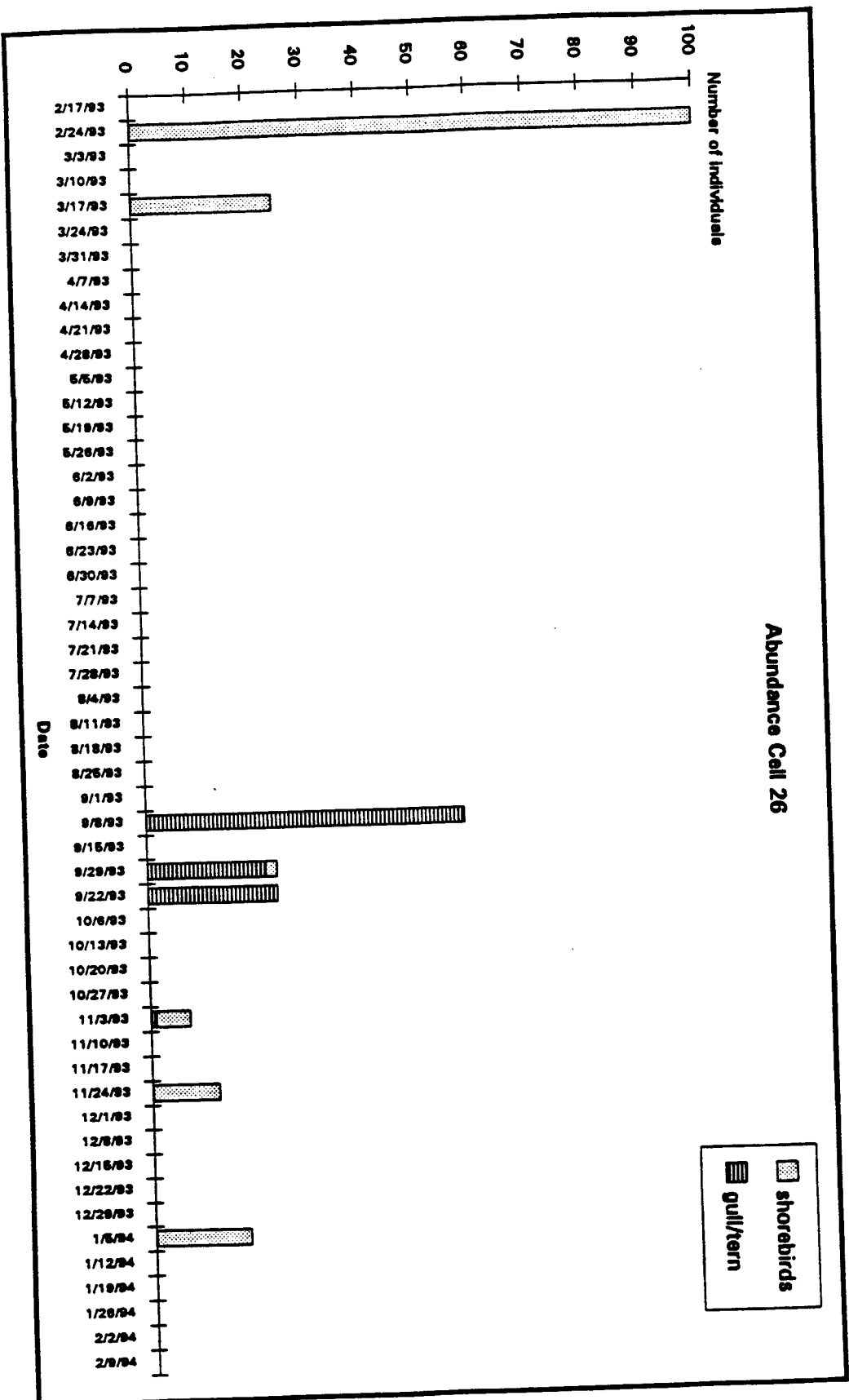


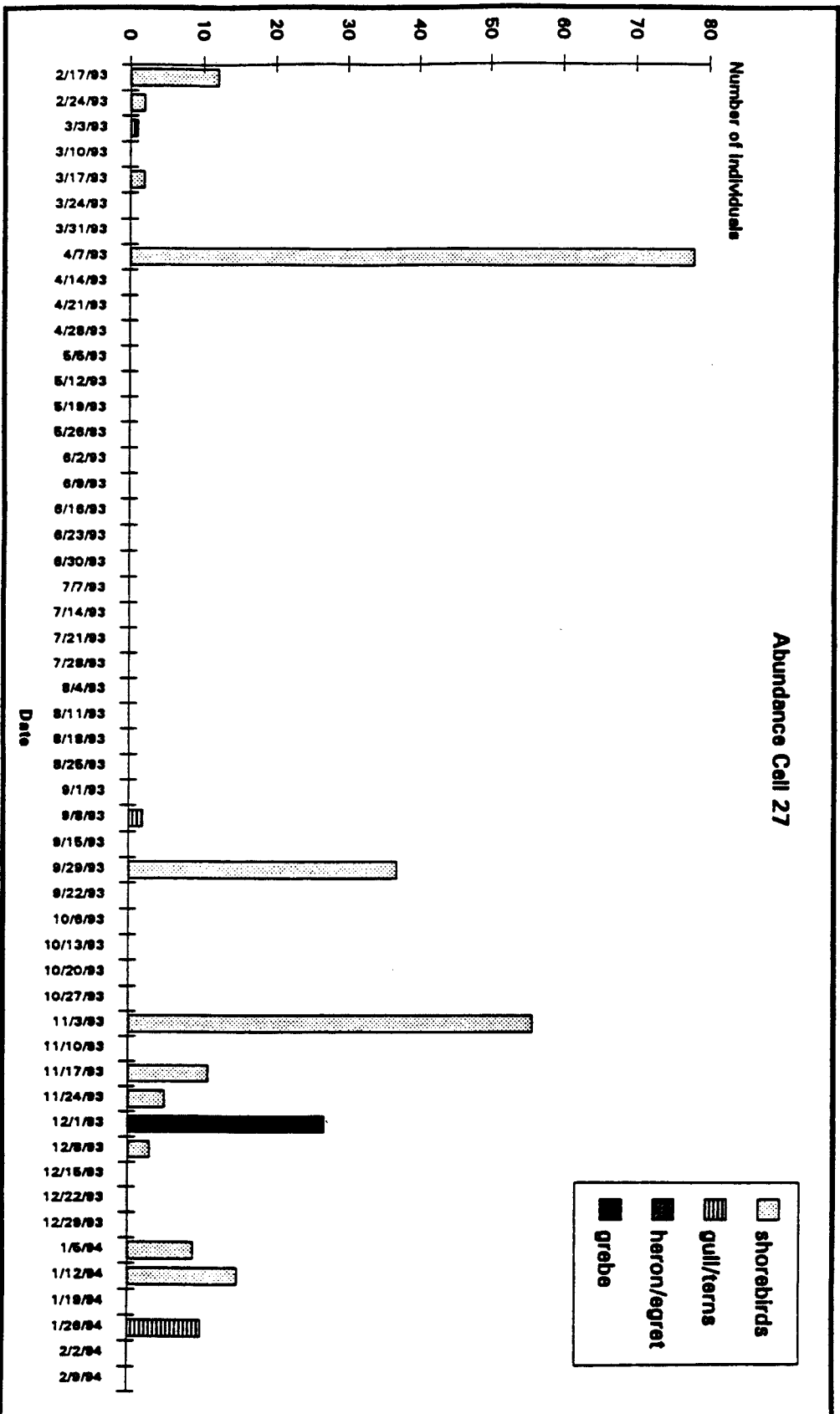
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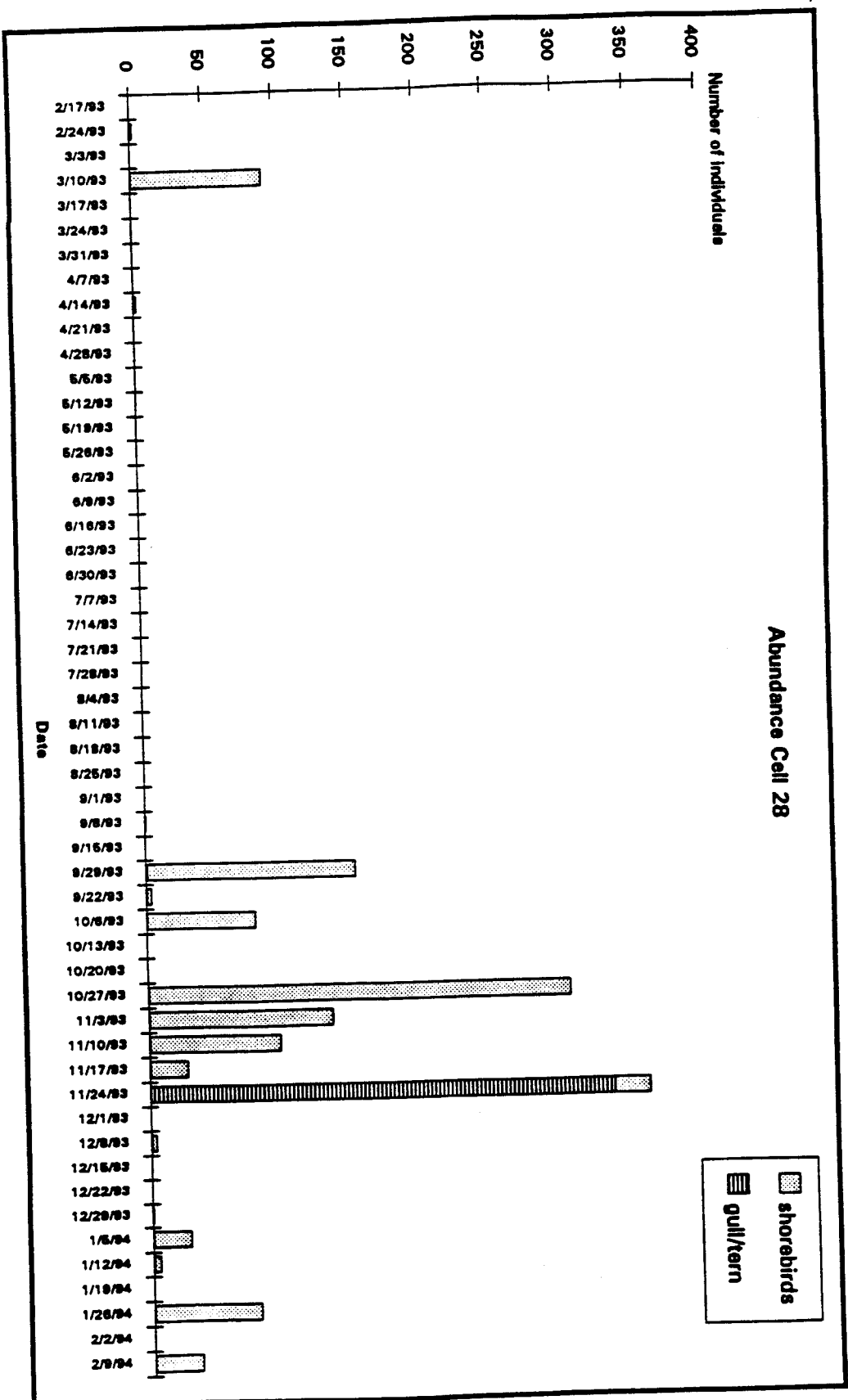


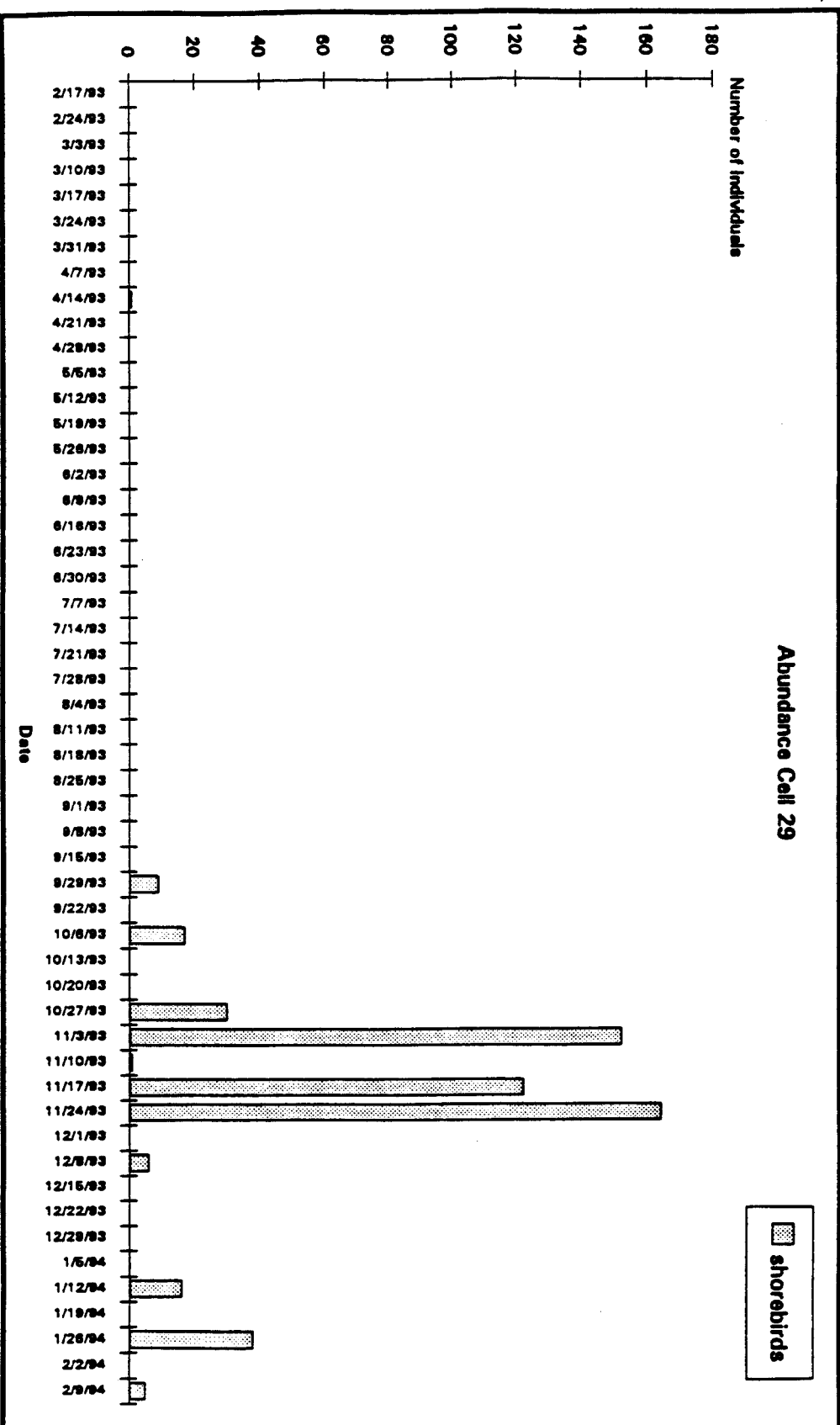


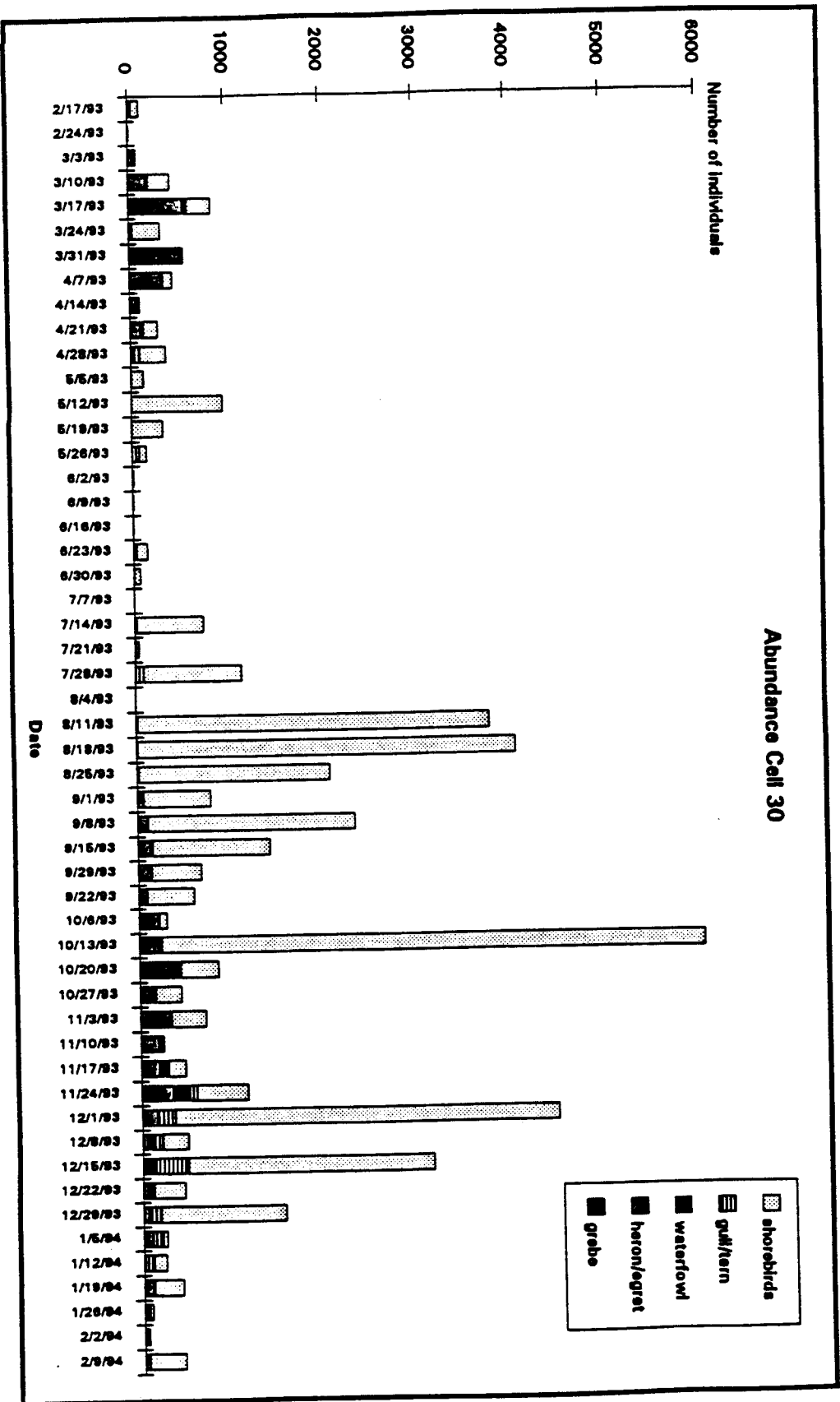


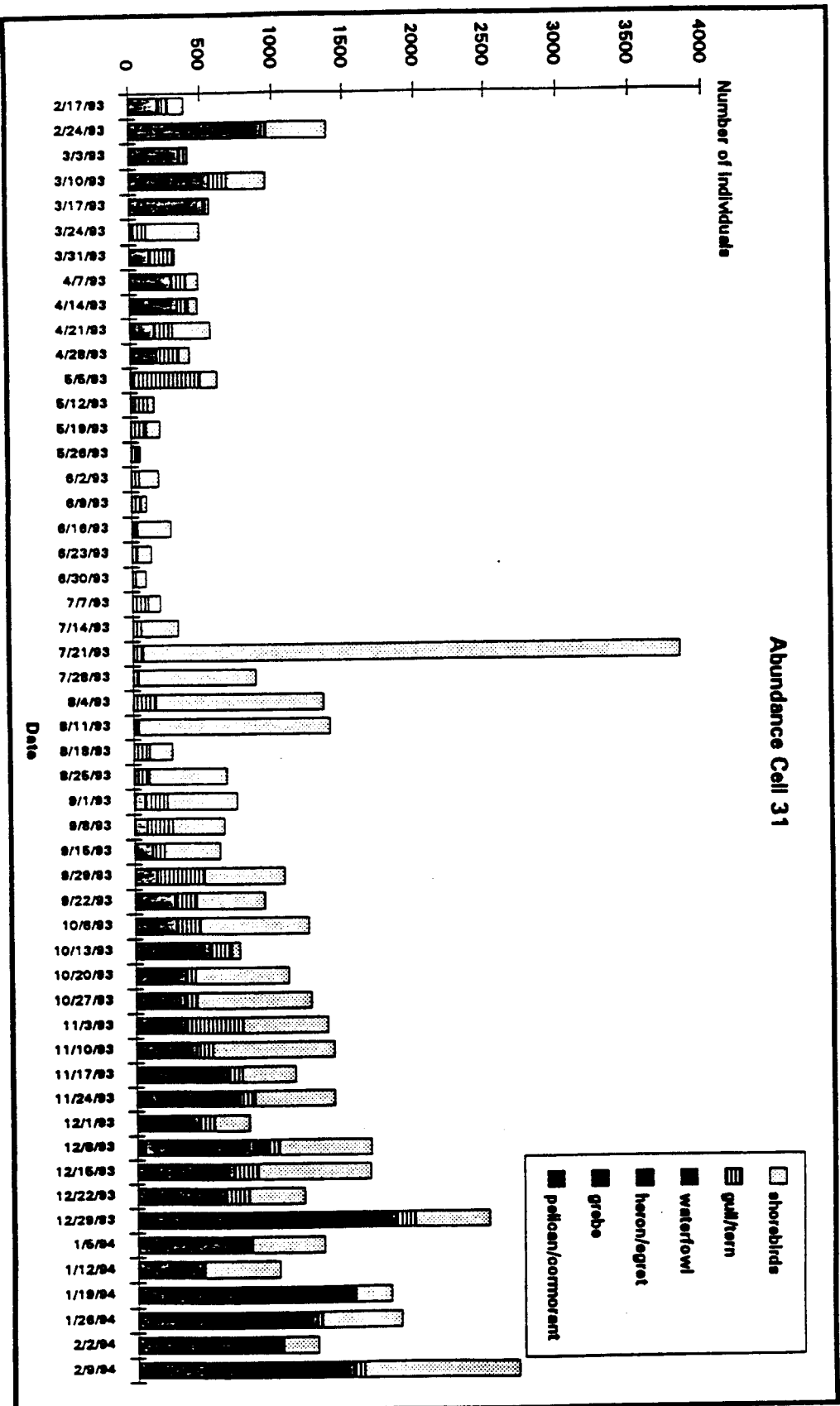


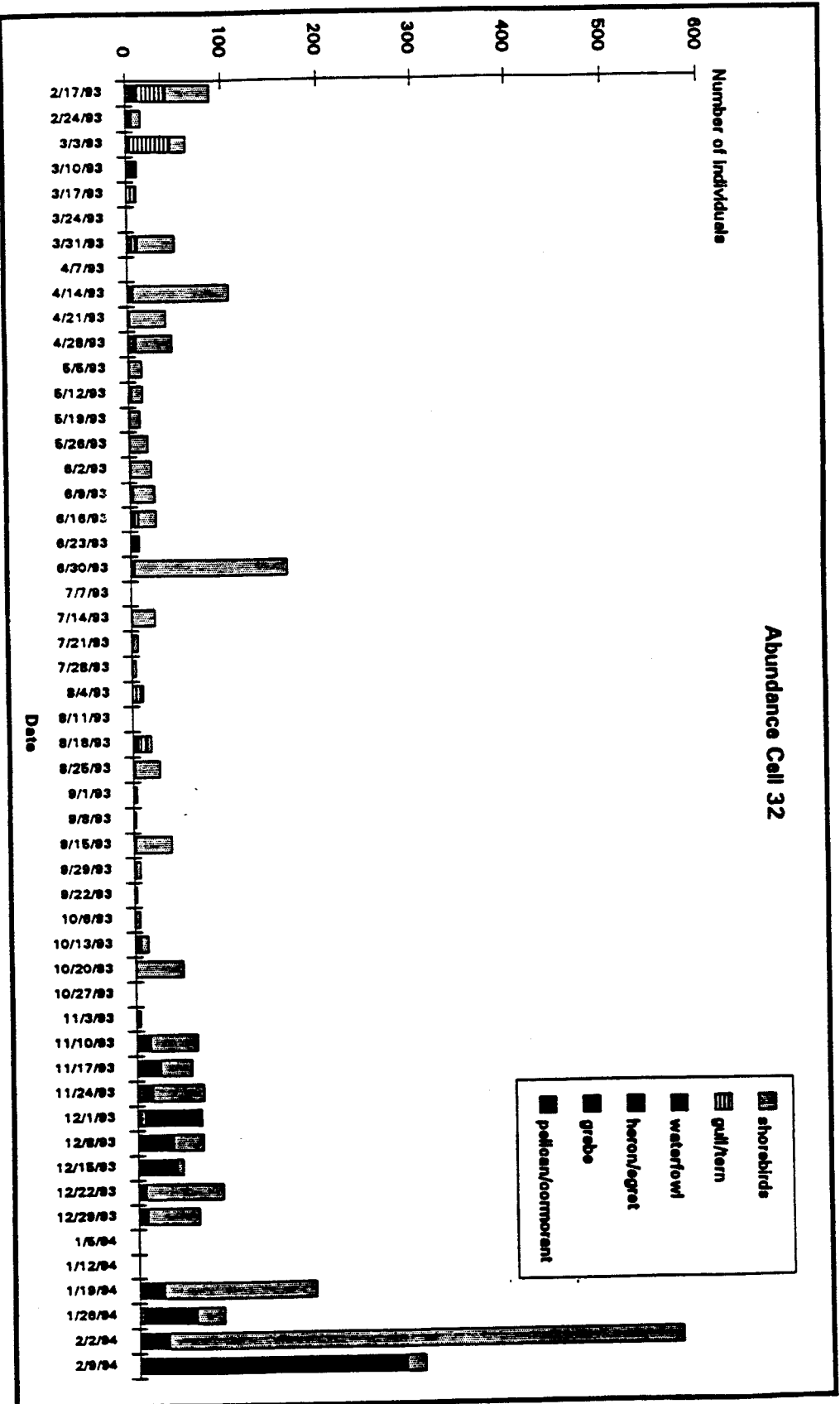


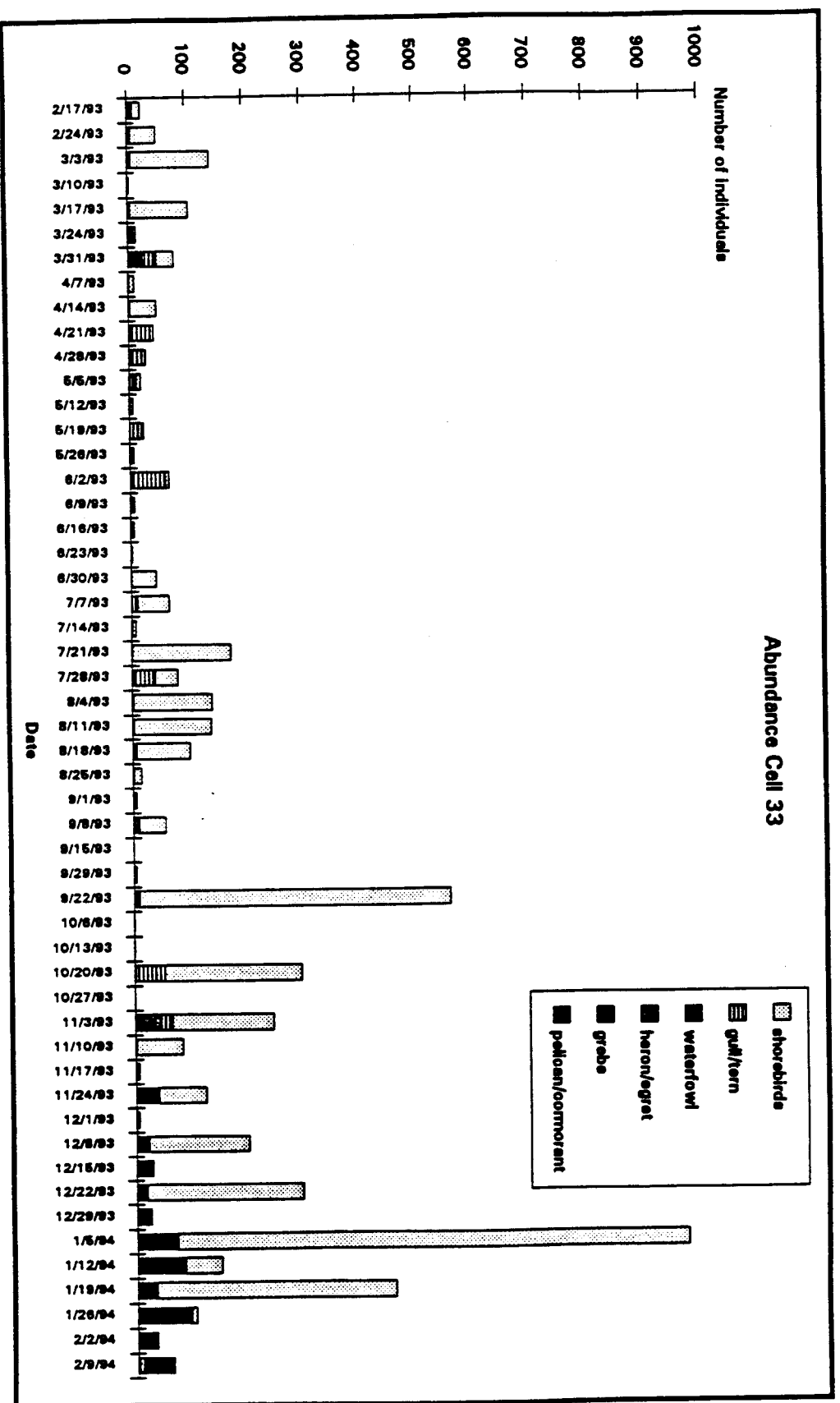


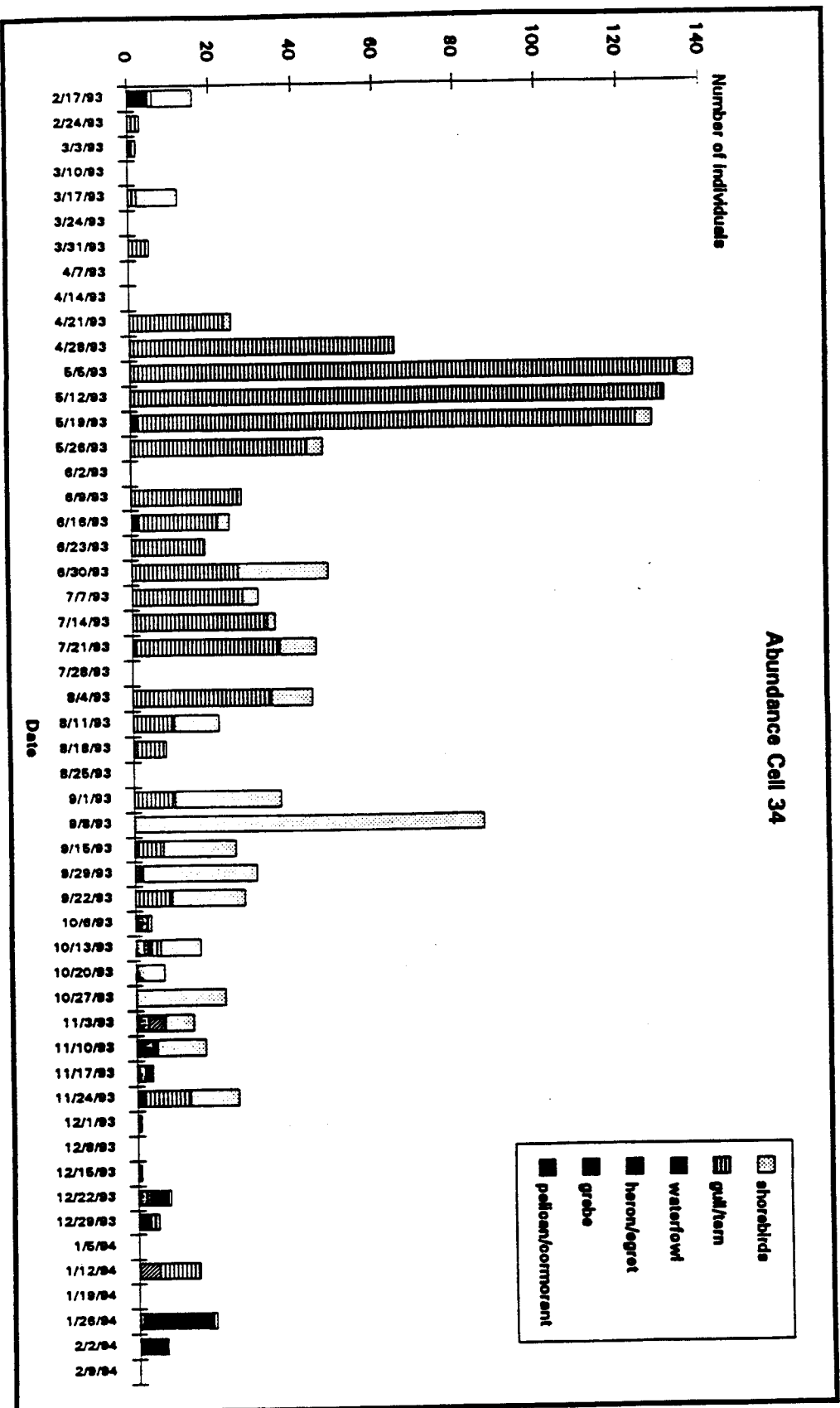


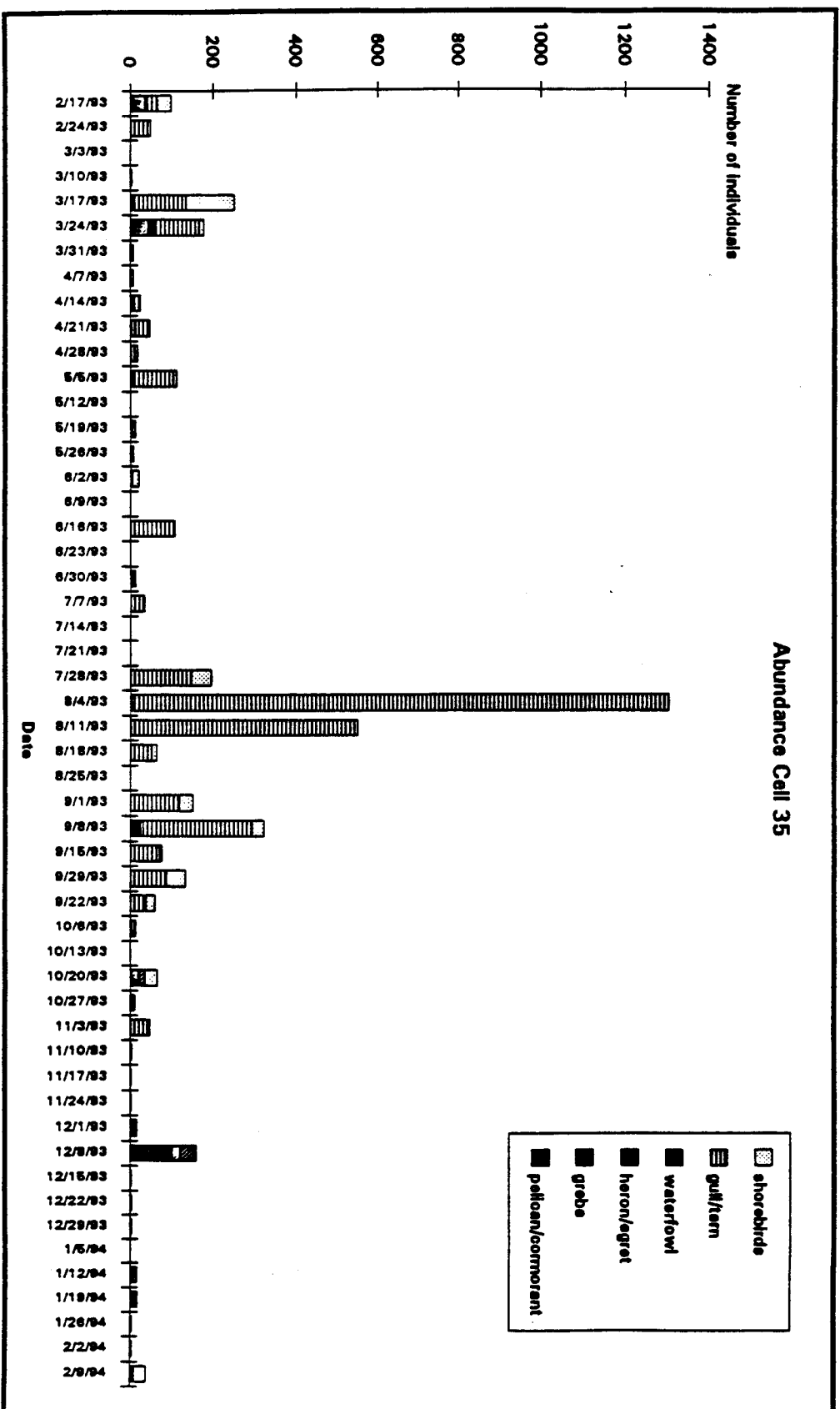


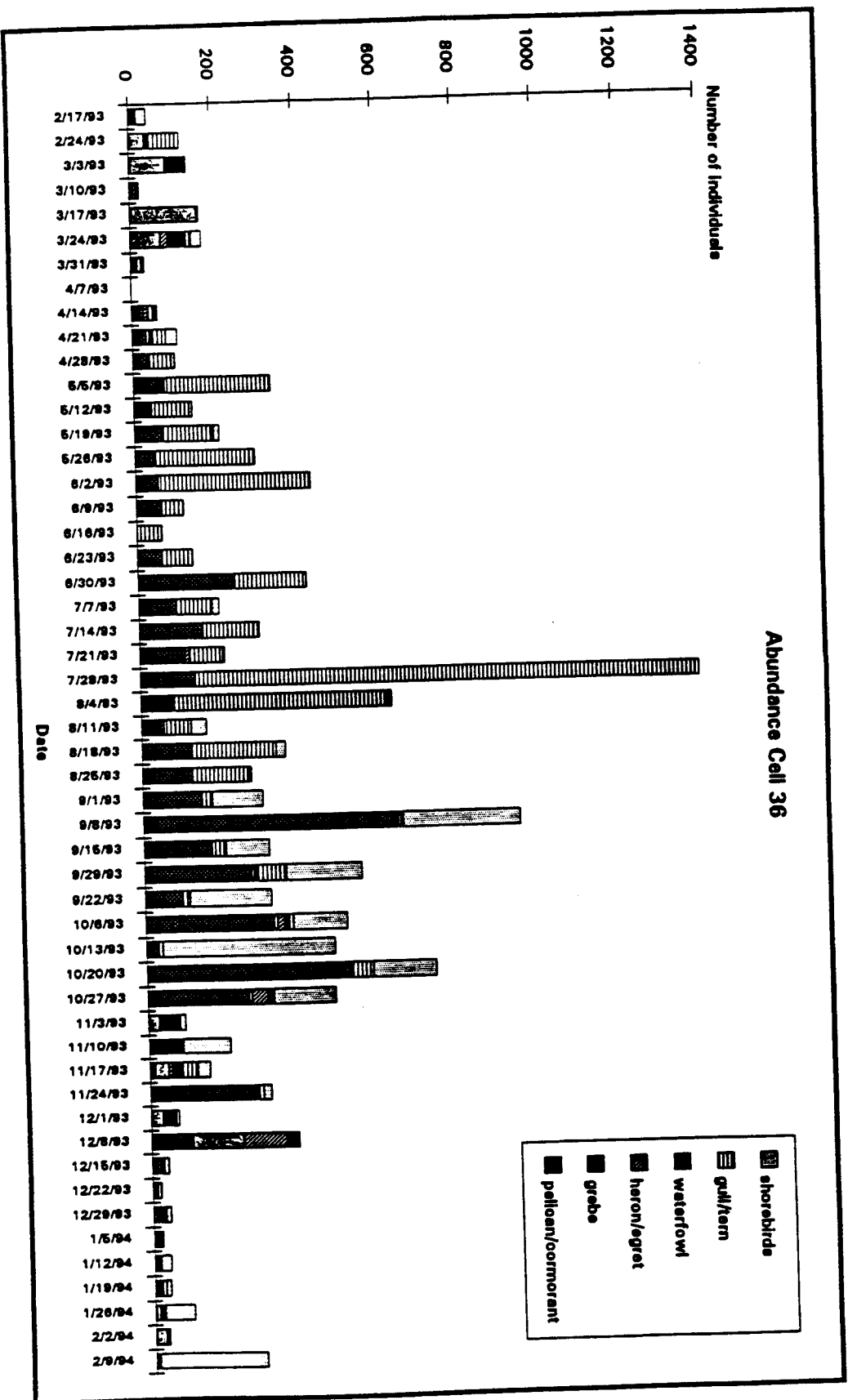


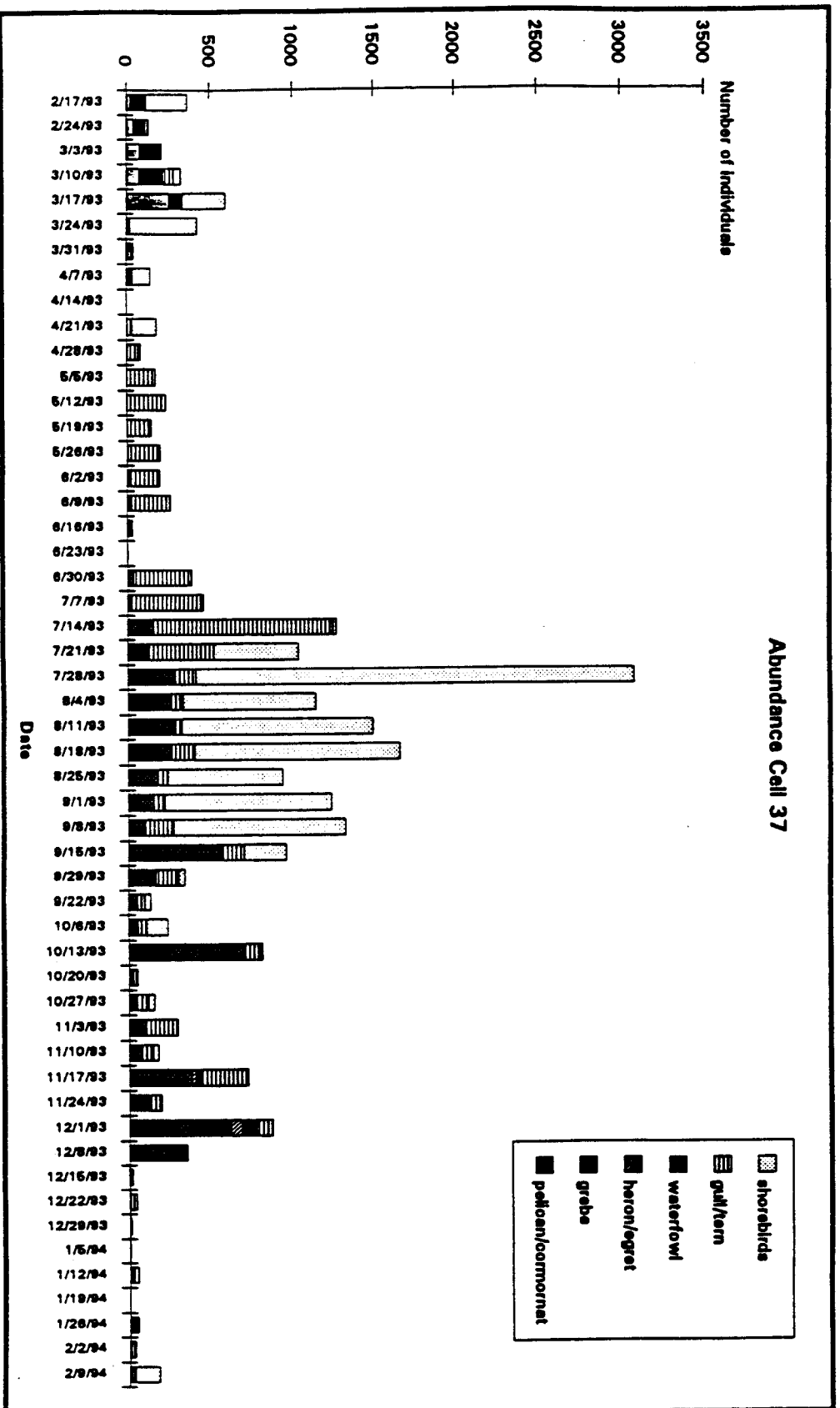


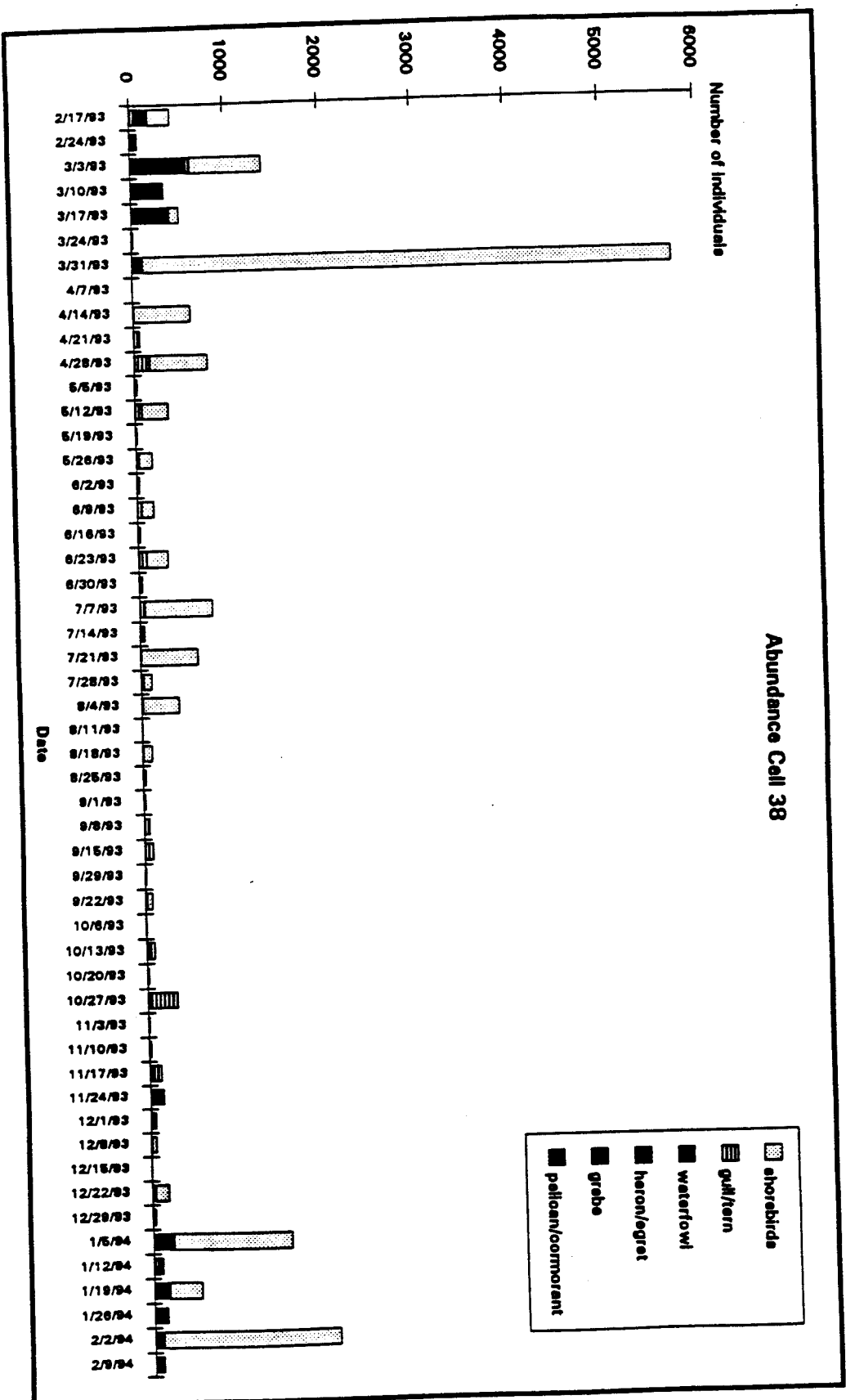




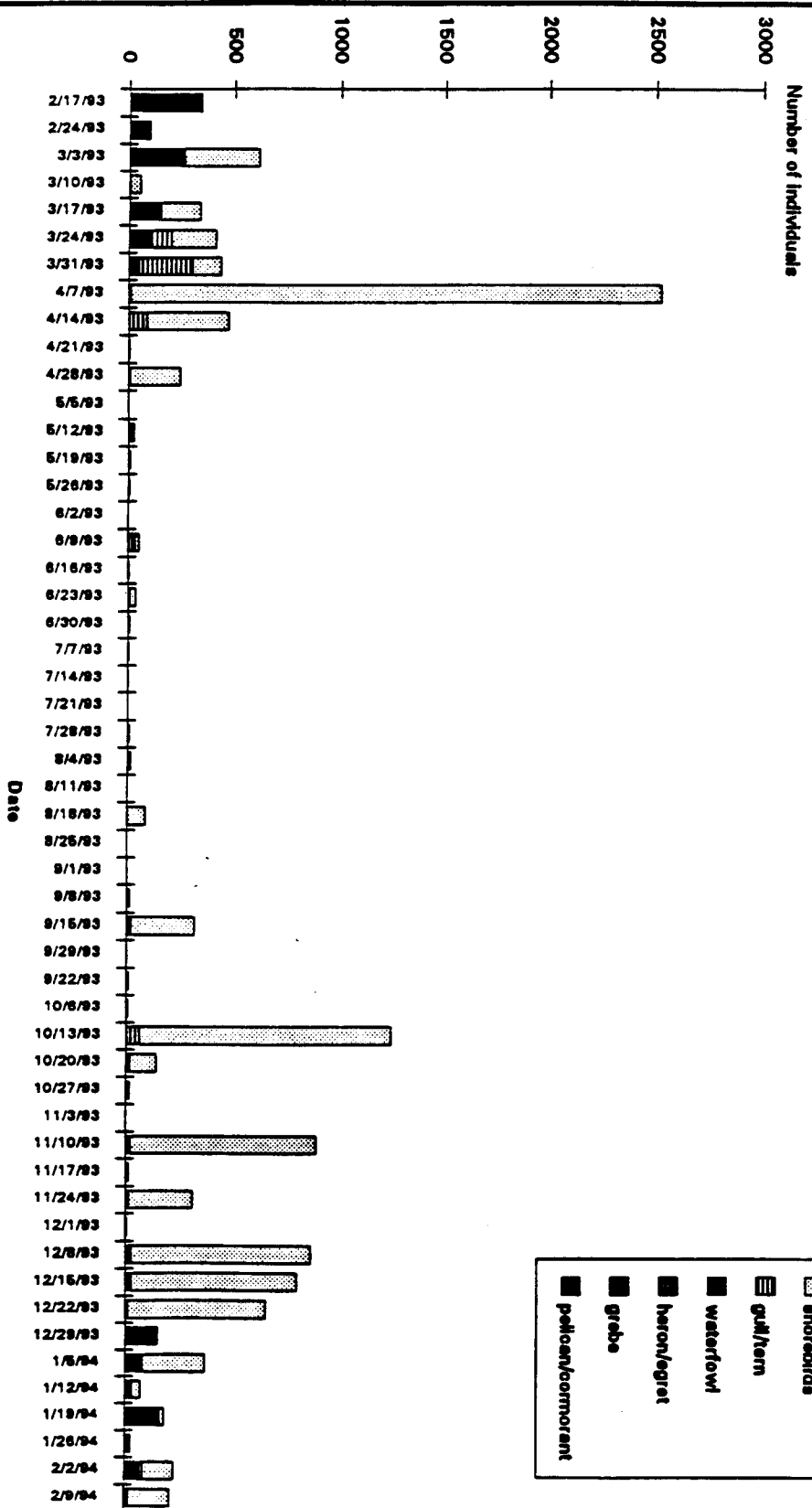


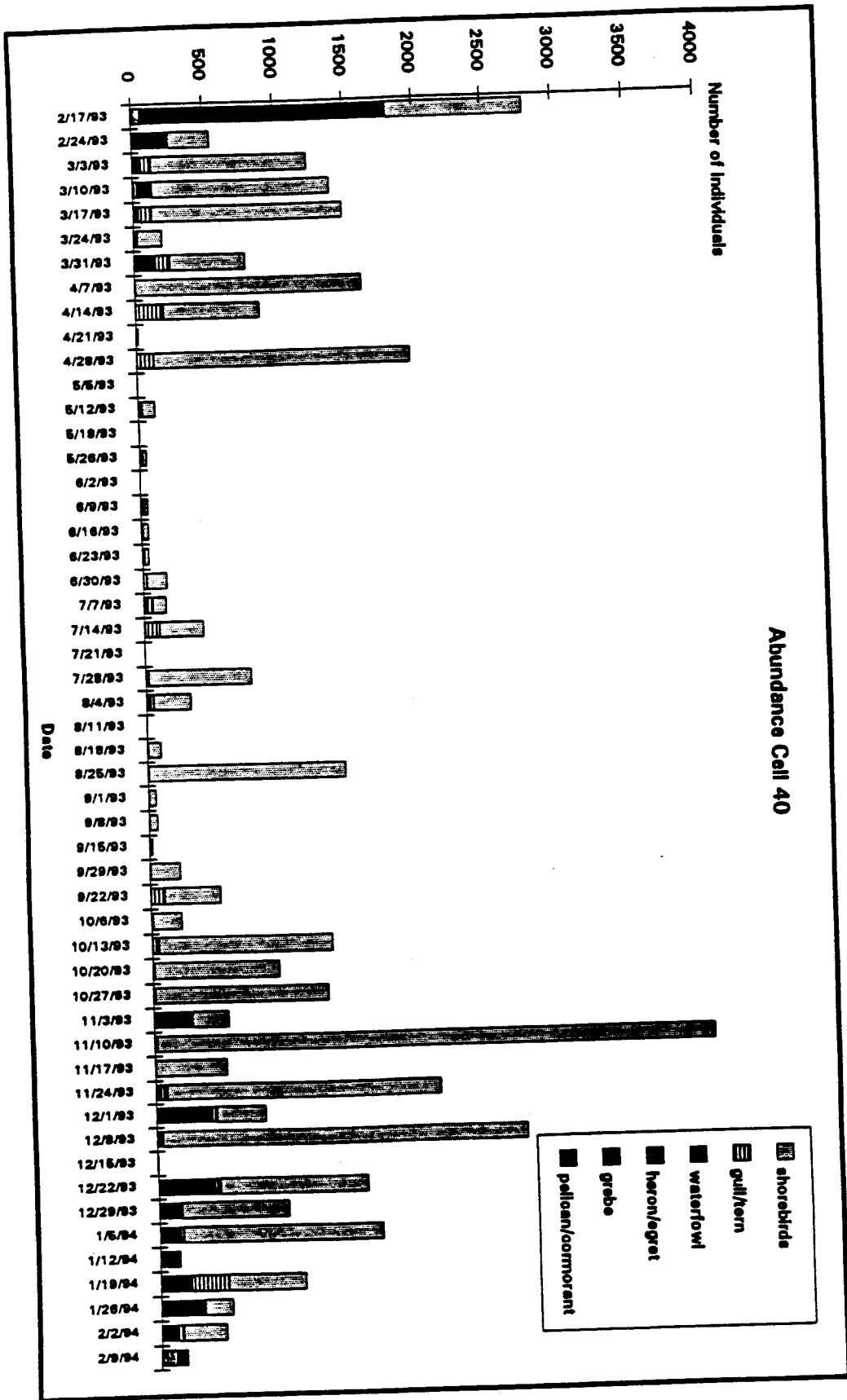


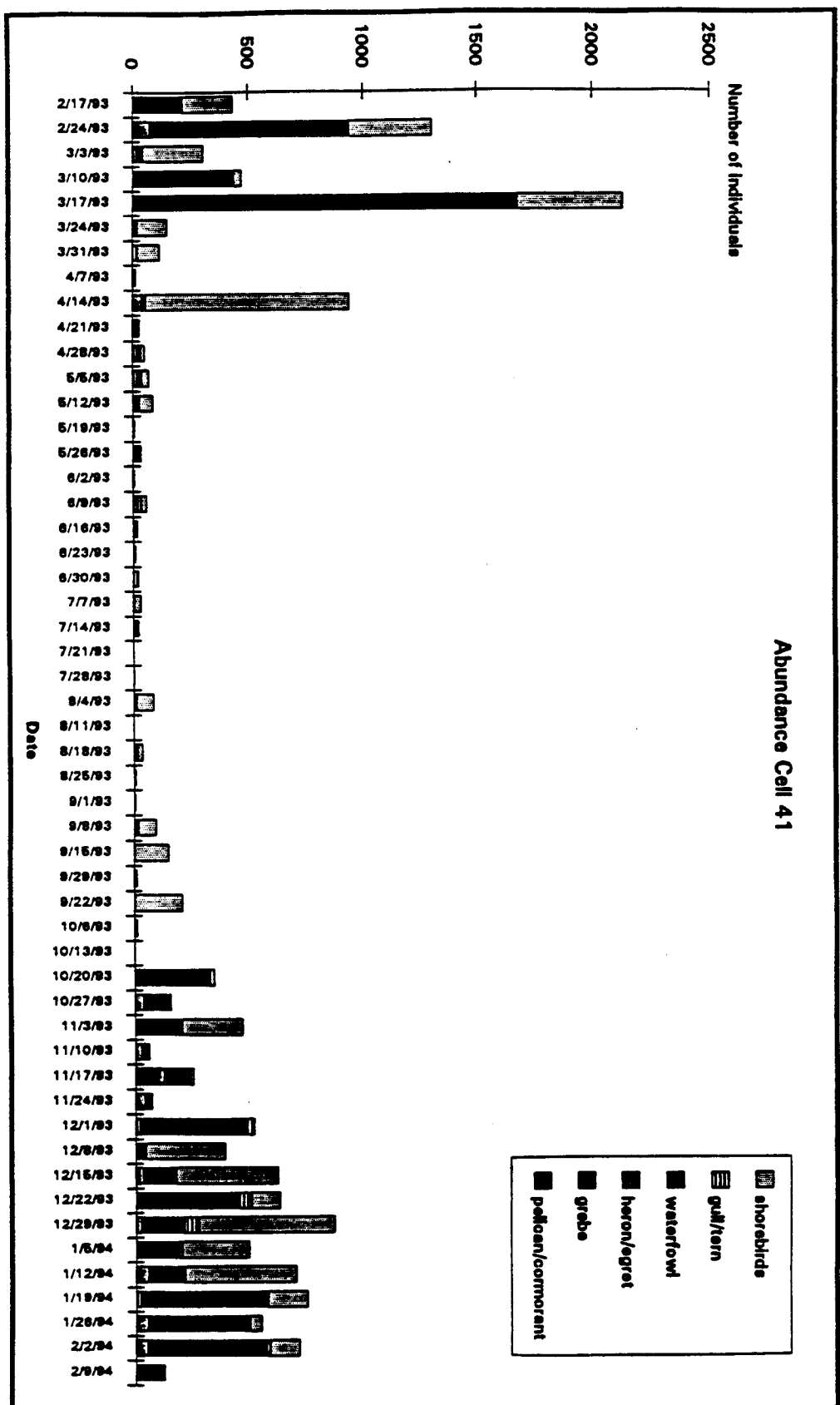


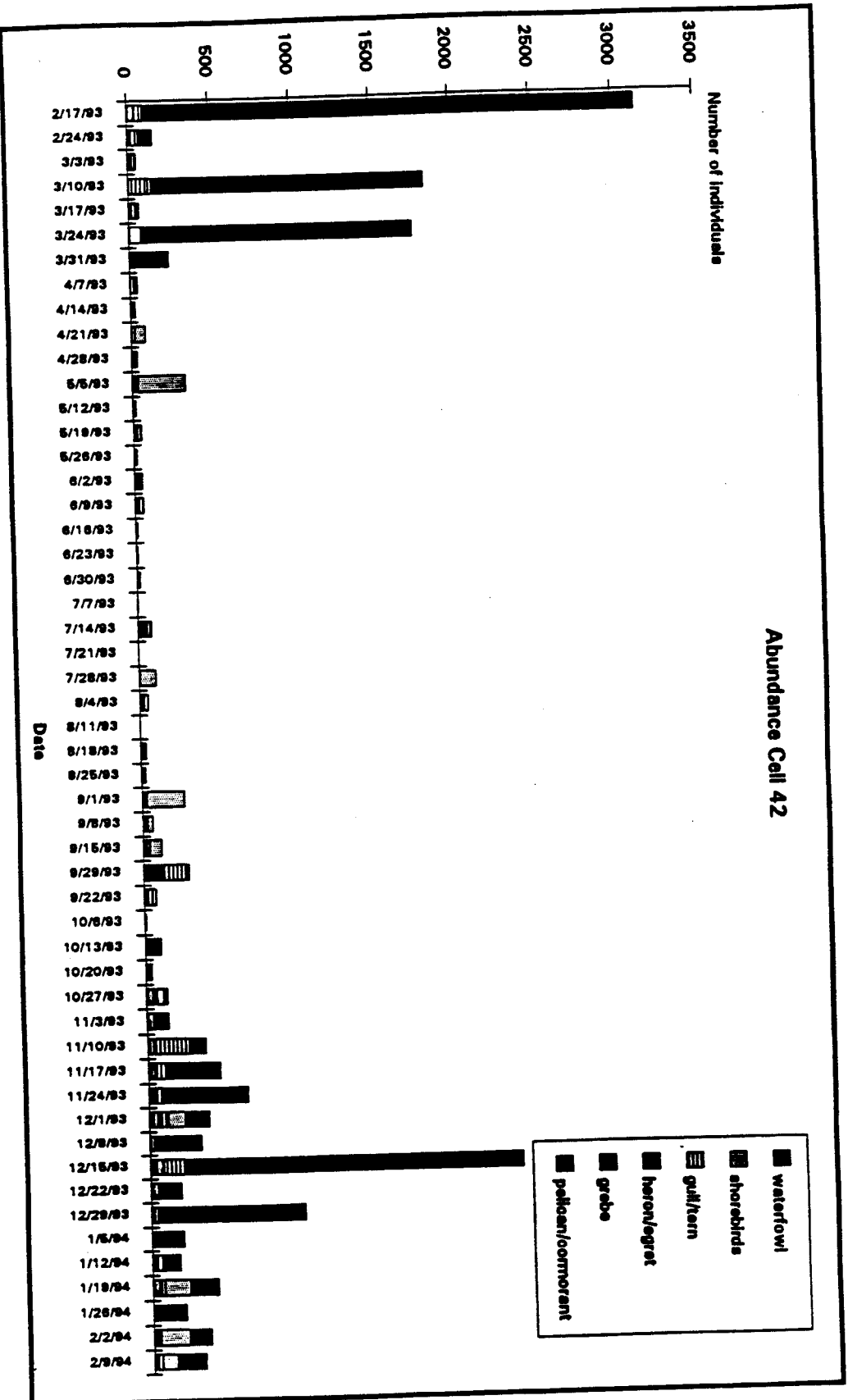


Abundance Cell 39









Abundance Cell 43

