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Establishing a Beach Monitoring Program to Assess Natural and Anthropogenic Changes in Populations of Birds, Mammals, and Turtles in the Monterey Bay National Marine Sanctuary

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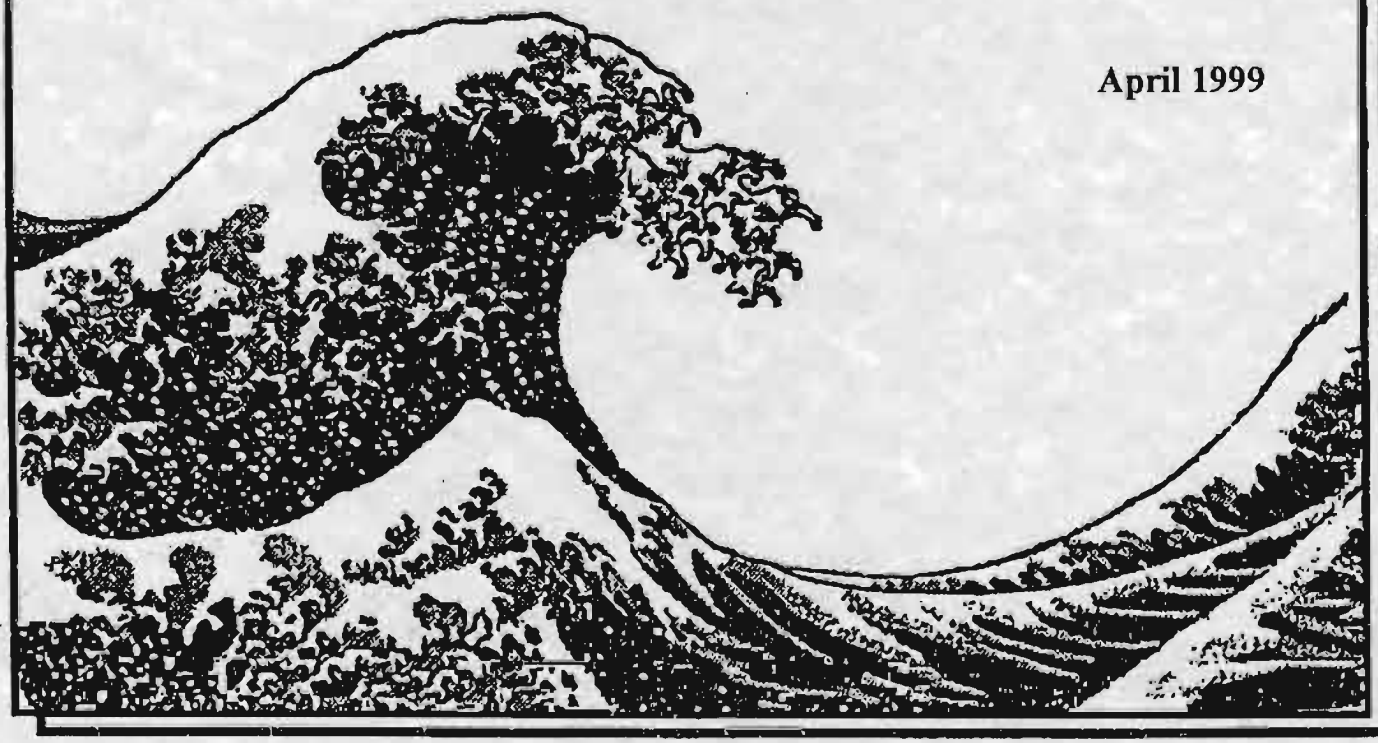

Establishing a Beach Monitoring Program to Assess Natural and Anthropogenic Changes in Populations of Birds, Mammals, and Turtles in the Monterey Bay National Marine Sanctuary

Logo created by Beach COMBERS volunteer, Lydia Neilsen

Final Report to the

California Urban Environmental Research and Education Center

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April 1999

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ABSTRACT

A beach monitoring pilot study, utilizing volunteers to sample selected sections of beach for dead marine birds and mammals, was established within the Monterey Bay National Marine Sanctuary (MBNMS) in February 1997. The primary goal of the program, designated Beach COMBERS (Coastal Ocean Mammal / Bird Education and Research Surveys), is to obtain information on rates of stranding for all species of marine birds and mammals in Monterey Bay. Pairs of volunteers survey pre-defined beach segments within the study area during the first week of each month at low tide. A total of nine beaches within Monterey Bay and one in Carmel Bay (47.4 km total length) have been monitored monthly since May 1997. A separate weekly survey series was conducted to investigate the effects time of day and tidal cycle on deposition rates and to provide weekly information on persistence times of carcasses. Beachcast seabirds were the most abundant organisms encountered during any beach survey. Temporal variability of seabird deposition was high. During the eight months that were sampled in 1997, high seabird deposition was recorded in August and September. Common Murre (*Uria aalge*) and Sooty Shearwater (*Puffinus griseus*) were encountered with the greatest frequency, comprising 68 percent of all seabirds encountered. Counts of beachcast marine birds were greater during 1998. High seabird deposition was recorded from April through July. The diversity of seabird species encountered beachcast was greater during 1998. Common Murre and Sooty Shearwater comprised 46 percent of all beachcast seabirds. Residence time of beachcast seabirds varied by beach. Approximately 30 to 50 percent of new birds disappeared within the first week of being recorded. There was no detectable difference in deposition rates due to the effects of time of day or tidal cycle.

Table of Contents

List of Tables.....i

List of Figures.....ii

Introduction.....1

Study Area and Design.....1

Results.....2

Discussion.....3

Literature Cited.....7

Tables.....8

Figures.....15

List of Tables

Table		Page
1.	Volunteer training and topics presented.	8
2.	Active Beach COMBERS volunteers.	9
3.	Seabirds, marine mammals, and other organisms encountered during monthly surveys of 47.4 km of sandy beaches within Monterey and Carmel Bays during 1997 (May-December).	10
4.	Seabirds, marine mammals, and other organisms encountered during monthly surveys of 47.4 km of sandy beaches within Monterey and Carmel Bays during 1998.	12
5.	Results of test for effect of day (AM/PM) and tidal cycle (High/Low) on deposition rates of marine birds at beaches 5 and 8.	14

List of Figures

Figure		Page
1.	Beach segments sampled within Monterey Bay and Carmel Bay, California.	15
2.	Beach survey data header.	16
3.	Beach survey data form.	17
4.	Number of seabird and marine mammal carcasses encountered in study area during 1997 and 1998.	18
5.	Mean density of seabird carcasses encountered at beach segments 1-10 during 1997 and 1998.	19
6.	Residency time of beachcast bird carcasses at beaches 5 & 8 determined from weekly toe clippings (May - October 1997).	20
7.	Beach COMBERS study area and proposed beaches for future monitoring.	21

INTRODUCTION

It is necessary to monitor the marine environment, especially if an overriding goal of conservation is to protect natural resources for future generations to enjoy and use sustainably. By monitoring health indicators (e.g., mortality and condition of organisms, presence of pollutants, or biodiversity), we are able to understand natural variability and assess human impacts to biological systems. In coastal waters, potential human threats include oil spills, overfishing, and degraded water quality. Moreover, we are finding that less obvious threats only become apparent if data are collected for long periods of time, such as in monitoring programs. While it is expensive and scientifically difficult to monitor all aspects of an ecosystem, using birds and mammals as indicators of ecosystem health is a viable resource management tool. Birds and mammals are excellent indicators because they are large, easily counted, and at or near the sea surface; in addition, they require and use many of the other trophic levels of importance in the ocean (e.g., krill, fish, and squid). Another increasingly clear aspect of effective conservation is that there has to be interaction and understanding between citizens, scientists, resource managers and policy makers.

A beach monitoring pilot study, utilizing volunteers to sample selected sections of beach for dead marine birds and mammals, was established within the Monterey Bay National Marine Sanctuary (MBNMS) in February 1997. The primary goal of the program, designated Beach COMBERS (Coastal Ocean Mammal / Bird Education and Research Surveys), is to obtain information on rates of stranding for all species of marine birds and mammals in Monterey Bay. Secondary objectives of the study are to: 1) determine the appropriate number of beaches to sample; 2) determine the appropriate number of days in each month to sample; 3) determine the appropriate time of each day to sample; and 4) provide volunteer training and education to the public about the coastal environment. The long-term objectives of the program are to provide a baseline of information on the average presence of beachcast marine organisms and assist the Sanctuary in the early detection of mortality events triggered by natural and anthropogenic environmental perturbations such as red tides and oil spills.

STUDY AREA AND DESIGN

This monitoring plan covers the sandy beaches within Monterey and Carmel Bays (Fig. 1). Most of the shoreline covered in the project is accessible by road or a trail less than 2 km from vehicular access. The long-term component of the study involves pairs of volunteers surveying pre-defined beach segments within the study area on a monthly basis. Surveys are conducted during the first week of each month at low tide. Because birds are often dragged to the dune line by scavengers, the entire width of the beaches are surveyed, generally in a zigzag fashion. A total of nine beaches within Monterey Bay and one in Carmel Bay (47.4 km total length) have been monitored monthly since May 1997. Each beach segment is approximately 4.7 km in length and the average time to complete a survey is three hours.

A separate weekly survey series was conducted from May through October 1997 to investigate the effects time of day and tidal cycle on deposition rates and to provide weekly information on persistence times of carcasses. Two of the ten beaches were selected for this

effort and each was sampled at a seven-day interval for 20 weeks. Analysis of variance (ANOVA) was used to test for differences in mean number of birds and mammals for the two factors (tide and time of day) and for any interaction effects.

Collected data are documented on standardized data forms (Figs. 2 and 3). Minimum data collected include: date; name of the person(s) making the observations; beach name and segment number; northern and southern boundary; time survey began and ended; wind and sky conditions; and number of tar balls found or collected. For each encountered carcass, the following information is recorded: species; stage of decomposition; age; sex (when possible); evidence of scavenging; evidence for the cause of death; the presence of oil; and whether or not a photograph was obtained. The intended use of the "comments" section is for documentation of any tags present on the carcass, length measurements, photograph roll and frame numbers, or any notes that would aid in post-identification of the encountered carcass. A toe is clipped from seabird carcasses to assess the length of time they may remain on a beach. Prior to clipping a toe, the volunteer documents the number of toes previously removed. On the two beaches that were surveyed weekly, toes were not clipped during the monthly surveys to avoid confounding the two types of sampling.

Volunteer training

Proper training is necessary when incorporating volunteers into collection of scientific data. Volunteers must possess skill in identifying live and dead marine birds and mammals. Many dead birds and mammals are decomposed or scavenged, making identification difficult. Twenty hours of training were provided to instruct volunteers on how to survey a beach and identify and document live and dead marine birds and mammals (Table 1). Procedures for proper sampling of oil or oiled organisms were included in the training. Upon completion of the training period, volunteers were issued a guide to the census and identification of beached marine birds and mammals (Ainley et al. 1993). An effort to recruit volunteers was begun in January 1997. Initially, 44 volunteers were recruited into the training program. As trainees became aware of the commitment required to participate in the program, several resigned. A second group of 19 volunteers was recruited and trained in August 1998. Currently, 35 volunteers are active in the program (Table 2). Additional training sessions are anticipated in the future.

RESULTS

Monthly surveys through December 1998

Beachcast seabirds were the most abundant organisms encountered during any beach survey. During the eight months that were sampled in 1997, high seabird deposition was recorded in August and September (Fig. 4). Seventy-six percent of the deposition recorded during August and September occurred at three of the southern beach segments within Monterey Bay and led to higher variances of mean numbers of seabirds encountered during 1997 at those beaches (Fig. 5). Few beachcast seabirds were encountered at beach segments one and ten (Fig. 5). Common Murre (*Uria aalge*) and Sooty Shearwater (*Puffinus griseus*) were encountered with

the greatest frequency, comprising 68 percent of all seabirds encountered during 1997 (Table 3). The presence of beachcast marine mammals was low and constant during 1997 (Fig 4). California sea lion (*Zalophus californianus*) comprised 58 percent of encountered beachcast marine mammals (Table 3).

Counts of beachcast marine birds and mammals were greater during 1998. High seabird deposition was recorded from April through July (Fig. 4). A greater mean number of beachcast seabirds were encountered at seven of ten beach segments during 1998 compared to 1997, although mean number of carcasses encountered and variances were highest again at southern beach segments within Monterey Bay (Fig. 5). The diversity of seabird species encountered beachcast was greater during 1998. Common Murre and Sooty Shearwater comprised 46 percent of all beachcast seabirds (Table 4). Presence of beachcast marine mammals remained low from January through May but exhibited a dramatic increase in June (Fig. 4). California sea lion comprised 45 percent of all beachcast marine mammals (Table 4).

Weekly surveys: May 1997 - October 1997

Two beach segments were sampled weekly for 20 weeks to provide information on persistence time of seabird carcasses. Residence time of beachcast seabirds, determined from weekly toe clippings, varied by beach. Approximately 30 to 50 percent of new birds disappeared within the first week of being recorded (Fig. 6). A two-factor orthogonal design, with tide (high and low) and time of day (AM and PM) as factors, was employed to investigate the effects time of day and tidal cycle have on deposition rates. An ANOVA was utilized to test for differences in mean number of new birds/km for the two factors and for any interaction events. Neither time of day or tidal cycle exhibited a significant effect, but statistical power was low due to the large amount of temporal variability in deposition rates (Table 5).

DISCUSSION

Cause of death of beachcast marine birds and mammals was rarely determined. Composition of species encountered and examination of the temporal and spatial patterns of deposition may provide insight to the cause of death. The high level of deposition that occurred at southern beach segments in Monterey Bay during August and September 1997 was comprised mostly of Common Murres (83%). Review of set-gillnet fishing effort and shipboard survey data of seabirds indicated that the sharp peak in deposition might have been a result of increased set-gillnet activity in southern Monterey Bay (Forney et al., in review). The seabird deposition peak during 1998 was broader in time and space, and more diverse than the 1997 pattern, indicating that resource limitations or other natural mortality factors (perhaps caused by El Niño conditions) may have been a factor. The increase in marine mammal deposition during May and early June 1998 was likely caused by the combination of the unusual presence of female California sea lions (influenced by El Niño conditions) and a toxic diatom bloom (*Pseudo-nitzchia australis*) during late May off the central California coast (Gulland et al., in press).

Rates of seabird deposition varied by beach segment location. Typically, few carcasses are ever encountered at beach segments one and ten. The cause of this pattern is uncertain; however, both beach segments experience a high level of beach attendance from nearby urban areas. Individuals and groups attending these beach segments may bury or discard beachcast seabirds as refuse, rendering carcasses unavailable for counting during beachcast surveys. Typically, fewer carcasses are encountered at beach segments in northern Monterey Bay. Beach orientation is a likely factor for the observed pattern because southwest facing beaches in the north bay are not exposed to predominant northwest winds, and therefore receive less carcasses. Beach segments in southern Monterey Bay are characterized by high variability in the mean number of carcasses encountered during the year relative to segments in the northern half of the bay. Beach orientation (greater exposure to northwest swells during winter months) and morphology of southern beach segments likely plays a role in this variability and needs further investigation.

Weekly sampling revealed that residence time of beachcast carcasses is often shorter than one month. Although major deposition events were detected at monthly sampling intervals, a shorter interval would provide a more precise determination of the timing and duration of deposition events and reduce the probability of losing birds between samples, particularly during winter months when high swells and narrow beaches prohibit carcasses from remaining on a beach for prolonged periods of time. As a result, beach segments five and eight are now sampled every two weeks to reduce the probability of missing deposition events that occur between monthly sampling intervals. Weekly surveys are presently not feasible because of the time and number of volunteers this would require.

There was no detectable difference in deposition rates due to the effects of time of day or tidal cycle. The power of the test was low however, therefore the effects of these factors on carcass deposition is unknown. If present, any variability in deposition rates attributable to time of day and tidal cycle would be considerably lower than the observed temporal variability. Samples continue to be collected during low tides because beaches are often inaccessible or unsafe during winter high tides.

In conclusion, monthly surveys have been successful for describing trends in distribution and abundance of beachcast marine birds and mammals, assisting resource managers in evaluating the health of the Monterey Bay National Marine Sanctuary. Temporal variability of seabird deposition has been high. Major deposition events are being detected at monthly sampling intervals although shorter sampling intervals would reduce the probability of missing birds between samples. Although spatial variability of seabird deposition has also been high, it is important to monitor several spatially separate beaches to obtain an accurate overall picture of Monterey Bay deposition rates. Effect of time of day and tidal cycle on deposition rates was small relative to large-scale temporal and spatial variability.

Volunteer participation

Volunteers have logged 3220 hours to date, including training, monthly surveys, weekly surveys, and special projects. Volunteers bring a diverse array of experiences to the program and

come from all walks of life (e.g., retired people, students, and professionals). Interns have logged 980 hours assisting with outreach, data entry, and beach surveys.

Maintaining program participation and enthusiasm builds an individual's capacity for addressing conservation issues. Enrichments for volunteers have included: periodic meetings to discuss data trends and share experiences; field trip opportunities in Monterey Bay with scientists and resource managers aboard the research vessel Point Sur; personal recognition on scientific posters presented at the annual Sanctuary Currents event; and access to an e-mail list serve for monthly updates and local seminar announcements.

Cooperative Arrangements

If a live-stranded marine mammal or seabird is encountered, the volunteers notify the proper authorities and rehabilitation facility for the animal. When hazardous materials or oil spills are witnessed, the volunteers record their observations and notify the beach caretaker and hazardous materials specialists.

Collection of oil samples, tar balls and oil from dead marine organisms is an important responsibility of the volunteers. Properly collected and stored samples can be later used to determine the origin and type(s) of oil, as well as evidence during litigation against an alleged spiller. In most circumstances, the oil encountered is weathered tar balls or patties, or is on marine organisms. The Beach COMBERS program works in cooperation with the California Department of Fish and Game (CDFG) office of Oil Spill Prevention and Response (OSPR) in the collection of oil samples. OSPR has provided the program with training to ensure that oil samples are suitable for "fingerprinting".

Program volunteers have provided local agencies with information on the date and location of beachcast marine mammals. Dead pinnipeds and cetaceans are reported to county stranding networks administered by Moss Landing and Long Marine Laboratories and to the California Marine Mammal Stranding Network administered by the National Marine Fisheries Service (NMFS) Southwest Region. Beachcast sea otters are reported to the Monterey Bay Aquarium and CDFG. Information on live-stranded marine mammals is forwarded to the Marine Mammal Center for potential animal rehabilitation. Sightings of live dying seabirds are relayed to the SPCA or native animal rescue centers. Encountered beachcast marine birds and mammals with identification tags or bands are reported to the U.S. Fish and Wildlife Service, NMFS, Point Reyes Bird Observatory, CDFG, and local researchers.

The Director of the Pacific Grove Natural History Museum, Dr., Stephen Bailey, has offered his expertise to volunteers unable to identify encountered seabirds. Seabird identification training was also enhanced by access to the museum's collection of seabird specimens.

The Beach COMBERS program has made arrangements with the Pajaro Dunes Colony and the Monterey Dunes Colony homeowners associations to allow volunteers beach access and parking privileges at designated beaches that front those properties. Permission has also been obtained from the Fort Ord Base Realignment and Closure (BRAC) commission for access to

beaches within the former military base. Permits have been granted by the California Department of Parks and Recreation for data collection and access privileges at state beaches within the study area. State park staff at Marina State Beach have provided shuttle service to program volunteers sampling a stretch of beach that is difficult to access.

Contributions to resource management, science, and the community

- Data collected in May and June 1997 were used for comparison with similar data collected at beaches within the Cordell Bank and Gulf of the Farallones National Marine Sanctuaries when an unusually high number of dead adult harbor seals were found on San Francisco Bay area beaches. The comparison revealed that the unusually high mortality was a localized event within those sanctuaries.

- Several volunteers participated in beach assessment and wildlife capture after a vegetable oil spill in the northern portion of Monterey Bay during October 1997. The knowledge of beach access and seabird identification by Beach COMBERS volunteers was invaluable to the Coast Guard and CDFG-OSPR.

- Beachcast survey data was an essential source of information for better understanding the impact of a red tide event during May 1998 (Gulland et al., in press). Contributed data included the temporal aspect of the deposition of hundreds of marine bird and mammal carcasses; species affected, and provision of carcasses to a NMFS toxicology laboratory.

- The deposition of hundreds of Common Murre carcasses at beaches in southern Monterey Bay during August and September 1997 was closely correlated with set gillnet fishing effort and halibut landings (Forney et al., in review), prompting the National Marine Fisheries Service to re-institute a set gillnet fishery observer program on 1 April 1999.

- Volunteers assisted local graduate students by collecting carcasses for subsequent studies of food habits and parasite loading.

- Information on the Beach COMBERS program and results have been presented at the Moss Landing Marine Laboratories Community Seminar Series, Monterey Bay Aquarium Research Institute Seminar Program, Point Lobos Volunteer Program, Sanctuary Currents Symposiums, and the Pacific Seabird Group 25th Annual Meeting. A presentation to a special symposium on seabird by-catch, by invitation from the Pacific Seabird Group, was made at the 26th Annual Meeting.

- A program description and data summary were presented in "Ecosystem Observations", the annual report for the Monterey Bay National Marine Sanctuary, 1998.

Program Recognition

The Beach COMBERS program was presented with a "Volunteer Recognition Award" at the National Ocean Conference in Monterey, California; June 12, 1998.

Future Plans

All beaches within the study area will continue to be monitored. A new beach segment, north of Monterey Bay, was added in September 1998 and plans are to expand coverage to beaches south of Monterey Bay (Fig. 7). In collaboration with CDFG Oiled Wildlife Veterinary Care and Research Center, postmortem analysis will be performed on fresh beachcast seabirds in conjunction with those collected by NMFS observers aboard set gillnet vessels operating in Monterey Bay. Results will be made available to resource managers and organizations interested in funding the program, thus ensuring its longevity and usefulness.

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Table 1. Training schedule and topics presented.

	Topics Addressed
Session I.	* General meeting and recruitment * Purpose of program and its importance * Short-term and long-term goals * Review of similar programs * Role of volunteers * Completion of questionnaires (name, address, pertinent experience, interests)
Session II.	* Sampling design and methods * Data form descriptions * Proper completion of data forms * Toe clipping methods * Natural history of local marine birds * Description of designated beaches

Session III.	* Seabird identification
	  * Slides of major orders and families
	  * Study skins of local species

Session IV.	* Seabird identification * Study specimens at the Pacific Grove Natural History Museum

Session V.	* Marine mammal and sea turtle identification
	  * Slides of local marine mammals
	  * Skulls and dentition of marine mammals
	  * Study skins of local Pinnipeds

Session VI.	* Beach assignments and pairings * Distribution of sampling equipment * Seabird identification review
Session VII.	* Oil documentation and collection * Discussion and evaluation of first sample * Seabird identification review
Session VIII.	* Field training with experienced volunteers

Table 2. Active Beach COMBERS volunteers.

Beach	First Name	Last Name
1	Dave	Evans
1	Linda	Perkins
2	Jim	Crowley
2	Christy	Roe
3	Pamela	Kearby
3	Glenn	Seiler
4	Michele	Jacobi
4	Cassandra	Roberts
4	Kate	Stanbury
5	Alex	Sims
5	Duane	Matterson
5	Inger Marie	Laursen
5	Jill	Baltan
5	Kimberly	Puglise
6	Jack	Ames
6	Andrew	De Vogelaere
6	Barbara	Schwefel
7	Aaron	King
7	Jim	Patterson
7	Jon	Hubbard
8	Scott	Benson
8	Lydia	Neilson
8	Stori	Oates
8	Mandy	Toperoff
9	Dede	Bent
9	Chuck	Haugen
9	Deirdre	Darst
10	Ken	Blood
10	Carol	Maehr
11	Jill	Pettinger
11	Michelle	Wainstein
Alternate	Patrick	Cotter
Alternate	Terry	Darcey
Alternate	Tom	Kieckhefer
Alternate	Nancy	Gong

Table 3. Seabirds, marine mammals, and other organisms encountered during monthly surveys of 47.4 km of sandy beaches within Monterey and Carmel Bays during 1997 (May-December). Number of seabirds found indicates only newly deposited birds. Marine mammals and other organisms found represents presence of beachcast animals regardless of residence time.

Seabirds 1997

Common name	Species name	Number found	Percent of total
Common Murre	*Uria aalge*	902	55.2%
Sooty Shearwater	*Puffinus griseus*	169	10.3%
Western Grebe	*Aechmophorus occidentalis*	91	5.6%
Unidentified Gull	*Larus sp.*	76	4.7%
Brandt's Cormorant	*Phalacrocorax penicillatus*	59	3.6%
Northern Fulmar	*Fulmarus glacialis*	51	3.1%
Western Gull	*Larus occidentalis*	41	2.5%
Pigeon Guillemot	*Cepphus columba*	27	1.7%
California Gull	*Larus californicus*	23	1.4%
Pacific Loon	*Gavia pacifica*	17	1.0%
Unidentified Alcid	*Alcidae*	14	0.9%
Unidentified Cormorant	*Phalacrocorax sp.*	14	0.9%
Brown Pelican	*Pelecanus occidentalis*	14	0.9%
Pelagic Cormorant	*Phalacrocorax pelagicus*	13	0.8%
Heermann's Gull	*Larus heermanni*	12	0.7%
Unidentified Shearwater	*Puffinus sp.*	11	0.7%
Unidentified Grebe	*Podicipedidae*	10	0.6%
Common Loon	*Gavia immer*	9	0.6%
Surf Scoter	*Melanitta perspicillata*	8	0.5%
Clark's / Western Grebe	*Aechmophorus clarki / occidentalis*	7	0.4%
Clark's Grebe	*Aechmophorus clarki*	6	0.4%
Eared Grebe	*Podiceps nigricollis*	5	0.3%
Unidentified Shorebird	*Scolopacidae*	5	0.3%
Herring Gull	*Larus argentatus*	4	0.2%
California / Herring Gull	*Larus californicus / argentatus*	4	0.2%
Unidentified Seabird	N/A	4	0.2%
Mew Gull	*Larus canus*	3	0.2%
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	3	0.2%
Rhinoceros Auklet	*Cerorhina monocerata*	2	0.1%
Cassin's Auklet	*Ptychoramphus aleuticus*	2	0.1%
Ancient Murrelet	*Synthliboramphus antiquus*	2	0.1%
Black-footed Albatross	*Diomedea nigripes*	2	0.1%
Unidentified Loon	*Gavia sp.*	2	0.1%
Double-crested Cormorant	*Phalacrocorax auritus*	2	0.1%
Glaucous-winged Gull	*Larus glaucescens*	2	0.1%
Elegant Tern	*Sterna elegans*	2	0.1%
Unidentified bird (non-marine & non-passerine)	N/A	2	0.1%
Horned Puffin	*Fratercula corniculata*	1	0.1%
Pink-footed Shearwater	*Puffinus creatopus*	1	0.1%
Flesh-footed Shearwater	*Puffinus carneipes*	1	0.1%
Horned Grebe	*Podiceps auritus*	1	0.1%
Red-throated Loon	*Gavia stellata*	1	0.1%
Arctic Loon	*Gavia arctica*	1	0.1%
Brandt's / Double-crested Cormorant	*Phalacrocorax penicillatus / auritus*	1	0.1%

Table 3. cont.,

Seabirds 1997			
Common name	**Species name**	**Number found**	**Percent of total**
Ring-billed Gull	*Larus delawarensis*	1	0.1%
Caspian Tern	*Sterna caspia*	1	0.1%
Common Tern	*Sterna hirundo*	1	0.1%
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	1	0.1%
Unidentified Storm-Petrel	*Hydrobatidae*	1	0.1%
Red-breasted Merganser	*Mergus serrator*	1	0.1%
Total		**1633**	**100.0%**

Marine Mammals 1997			
Common name	**Species name**	**Number found**	**Percent of total**
California Sea Lion	*Zalophus californianus*	243	58.3%
Harbor Seal	*Phoca vitulina*	50	12.0%
Unidentified seal	*Pinnipedia*	45	10.8%
Unidentified Sea Lion	*Otariidae*	35	8.4%
Harbor porpoise	*Phocoena phocoena*	10	2.4%
Unidentified earless seal	*Phocidae*	8	1.9%
Unidentified porpoise	*Delphinidae*	7	1.7%
Sea Otter	*Enhydra lutris*	7	1.7%
Northern Elephant Seal	*Mirounga angustirostris*	5	1.2%
Northern Fur Seal	*Callorhinus ursinus*	2	0.5%
Unidentified dolphin	*Delphinidae*	2	0.5%
Unidentified toothed whale	*Odontoceti*	2	0.5%
Humpback whale	*Megaptera novaeangliae*	1	0.2%
Total		**417**	**100.0%**

Other organisms 1997			
Common name	**Species name**	**Number found**	**Percent of total**
Other mammal	N/A	2	66.7%
Unidentified shark	*Chondrichthyes*	1	33.3%
Total		**3**	**100.0%**

Table 4. Seabirds, marine mammals, and other organisms encountered during monthly surveys of 47.4 km of sandy beaches within Monterey and Carmel Bays during 1998. Number of seabirds found indicates only newly deposited birds. Marine mammals and other organisms found represents presence of beachcast animals regardless of residence time.

Seabirds 1998

Common name	Species name	Number found	Percent of total
Common Murre	*Uria aalge*	983	29.3%
Sooty Shearwater	*Puffinus griseus*	544	16.2%
Surf Scoter	*Melanitta perspicillata*	366	10.9%
Northern Fulmar	*Fulmarus glacialis*	253	7.5%
Pacific Loon	*Gavia pacifica*	187	5.6%
Cassin's Auklet	*Ptychoramphus aleuticus*	163	4.9%
Common Loon	*Gavia immer*	110	3.3%
Brandt's Cormorant	*Phalacrocorax penicillatus*	97	2.9%
Western Grebe	*Aechmophorus occidentalis*	92	2.7%
Rhinoceros Auklet	*Cerorhina monocerata*	66	2.0%
Unidentified Gull	*Larus sp.*	62	1.9%
Brown Pelican	*Pelecanus occidentalis*	54	1.6%
Pigeon Guillemot	*Cepphus columba*	51	1.5%
Unidentified Scoter	*Melanitta sp.*	42	1.3%
Western Gull	*Larus occidentalis*	34	1.0%
Clark's / Western Grebe	*Aechmophorus clarki / occidentalis*	32	1.0%
Heermann's Gull	*Larus heermanni*	19	0.6%
Unidentified Alcid	*Alcidae*	18	0.5%
California Gull	*Larus californicus*	16	0.5%
Unidentified Seabird	N/A	16	0.5%
Unidentified Shearwater	*Puffinus sp.*	14	0.4%
Unidentified Grebe	*Podicipedidae*	12	0.4%
Pelagic Cormorant	*Phalacrocorax pelagicus*	12	0.4%
Unidentified Cormorant	*Phalacrocorax sp.*	10	0.3%
Herring Gull	*Larus argentatus*	10	0.3%
Unidentified Loon	*Gavia sp.*	8	0.2%
Clark's Grebe	*Aechmophorus clarki*	7	0.2%
Eared Grebe	*Podiceps nigricollis*	7	0.2%
Unidentified Shorebird	*Scolopacidae*	6	0.2%
Buller's Shearwater	*Puffinus bulleri*	5	0.1%
Red-throated Loon	*Gavia stellata*	5	0.1%
Double-crested Cormorant	*Phalacrocorax auritus*	5	0.1%
Pink-footed Shearwater	*Puffinus creatopus*	4	0.1%
Black-legged Kittiwake	*Rissa tridactyla*	4	0.1%
Red Phalarope	*Phalaropus fulicaria*	4	0.1%
Horned Grebe	*Podiceps auritus*	3	0.1%
Ancient Murrelet	*Synthliboramphus antiquus*	2	0.1%
Black-vented Shearwater	*Puffinus opisthomelas*	2	0.1%
Short-tailed Shearwater	*Puffinus tenuirostris*	2	0.1%
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	2	0.1%
Unidentified Storm-Petrel	*Hydrobatidae*	2	0.1%
Unidentified bird (non-marine & non-passerine)	N/A	2	0.1%
Unidentified Passerine	N/A	2	0.1%
Craveri's Murrelet	*Synthliboramphus craveri*	1	0.0%

Table 4. cont.,

Seabirds 1998			
Common name	**Species name**	**Number found**	**Percent of total**
Xantus' Murrelet	*Synthliboramphus hypoleucus*	1	0.0%
Laysan Albatross	*Diomedea immutabilis*	1	0.0%
Red-necked Grebe	*Podiceps grisegena*	1	0.0%
White-winged Scoter	*Melanitta fusca*	1	0.0%
Black Scoter	*Melanitta nigra*	1	0.0%
Glaucous-winged Gull	*Larus glaucescens*	1	0.0%
Mew Gull	*Larus canus*	1	0.0%
Ring-billed Gull	*Larus delawarensis*	1	0.0%
Bonaparte's Gull	*Larus philadelphia*	1	0.0%
Pomarine Jaeger	*Stercorarius pomarinus*	1	0.0%
Arctic Tern	*Sterna paradisaea*	1	0.0%
Ashy Storm-Petrel	*Oceanodroma homochroa*	1	0.0%
Unidentified Dove / Pigeon	*Columbidae*	1	0.0%
Unidentified Duck	*Anatidae*	1	0.0%
American Coot	*Fulica americana*	1	0.0%
Total		**3351**	**100.0%**

Marine Mammals 1998			
Common name	**Species name**	**Number found**	**Percent of total**
California Sea Lion	*Zalophus californianus*	411	44.2%
Unidentified Sea Lion	*Otariidae*	170	18.3%
Unidentified seal	*Pinnipedia*	146	15.7%
Harbor Seal	*Phoca vitulina*	67	7.2%
Northern Elephant Seal	*Mirounga angustirostris*	38	4.1%
Sea Otter	*Enhydra lutris*	29	3.1%
Harbor porpoise	*Phocoena phocoena*	25	2.7%
Unidentified earless seal	*Phocidae*	16	1.7%
Unidentified toothed whale	*Odontoceti*	12	1.3%
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	4	0.4%
Unidentified porpoise	*Delphinidae*	3	0.3%
Unidentified dolphin	*Delphinidae*	3	0.3%
Steller's Sea Lion	*Eumetopias jubatus*	2	0.2%
Goose-beaked whale	*Ziphius cavirostris*	2	0.2%
Northern Fur Seal	*Callorhinus ursinus*	1	0.1%
Total		**929**	**100.0%**

Other organisms 1998			
Common name	**Species name**	**Number found**	**Percent of total**
Other mammal	N/A	7	46.7%
Unidentified fish	N/A	6	40.0%
Unidentified shark	*Chondrichthyes*	1	6.7%
Unidentified crab	N/A	1	6.7%
Total		**15**	**100.0%**

Table 5. Results of test for effect of day (AM/PM) and tidal cycle (High/Low) on deposition rates of marine birds at beaches 5 and 8.

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of variation	SS	DF	MS	F	P
Total	416.693	39			
Time	8.742	1	8.742	0.783	0.382
Tide	5.256	1	5.256	0.471	0.497
Time X Tide	0.756	1	0.756	0.068	0.796
Error	401.939	36	11.165		

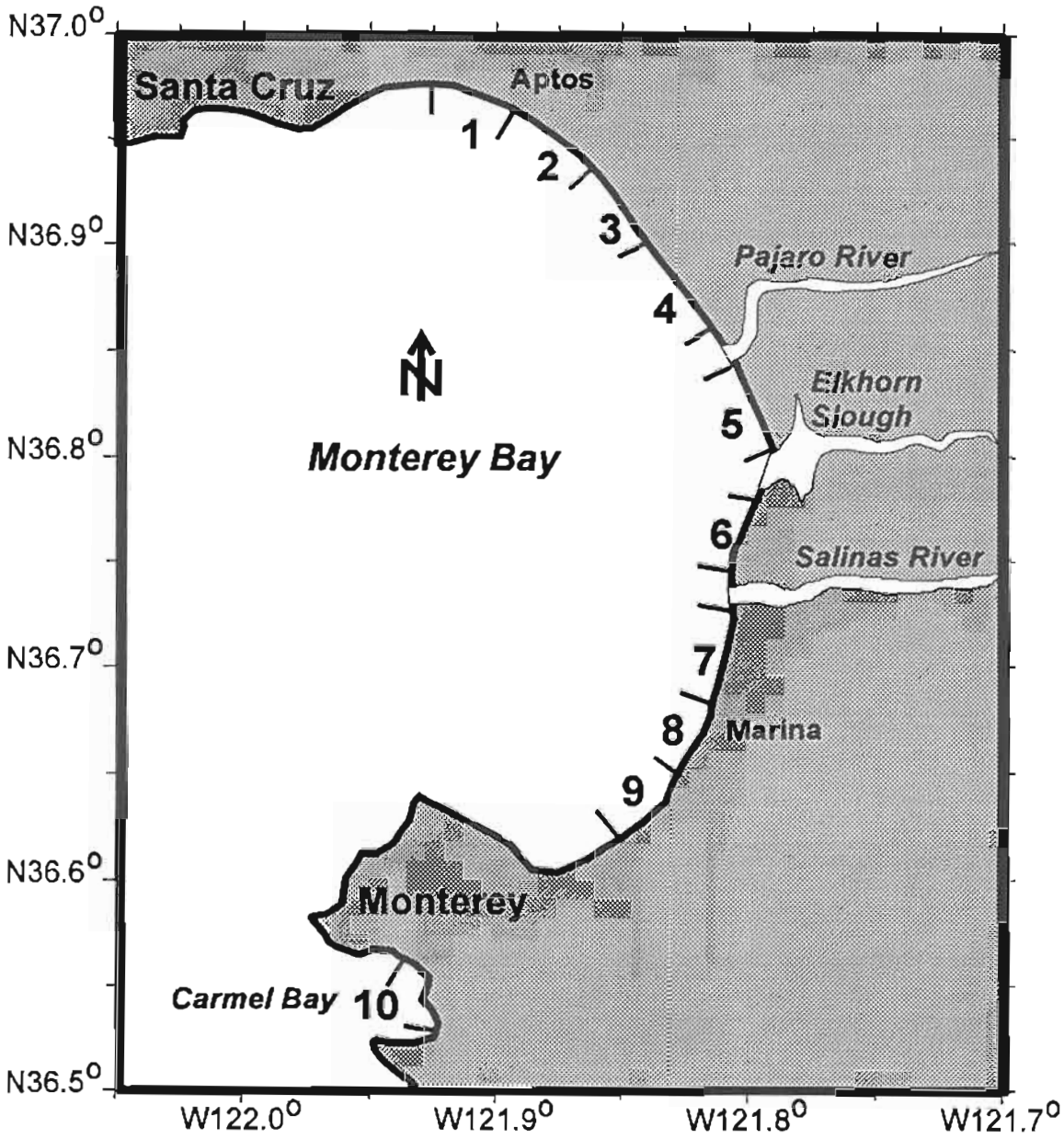


Figure 1. Beach segments sampled within Monterey Bay and Carmel Bay, California.

Beach Monitoring Survey Form Page___of____

Date_____ Name_____

Beach segment number_____

Beach segment name_____

Northern boundary_____

Southern boundary_____

Time begin_____ Time end_____

Other Surveyors_____

_____

Weather:

sunny___, overcast___, drizzle___, or rain____

calm___, light wind___, moderate wind___, or strong wind___

Comments:_____

Number of Tar Balls Found _____

Number of Balls Collected for Lab_____

Range of Size Found (Diameter inches)_____

General Comments_____

_____

_____

_____

_____

_____

_____

Figure 2. Beach survey data header.

NAME_____ DATE_____

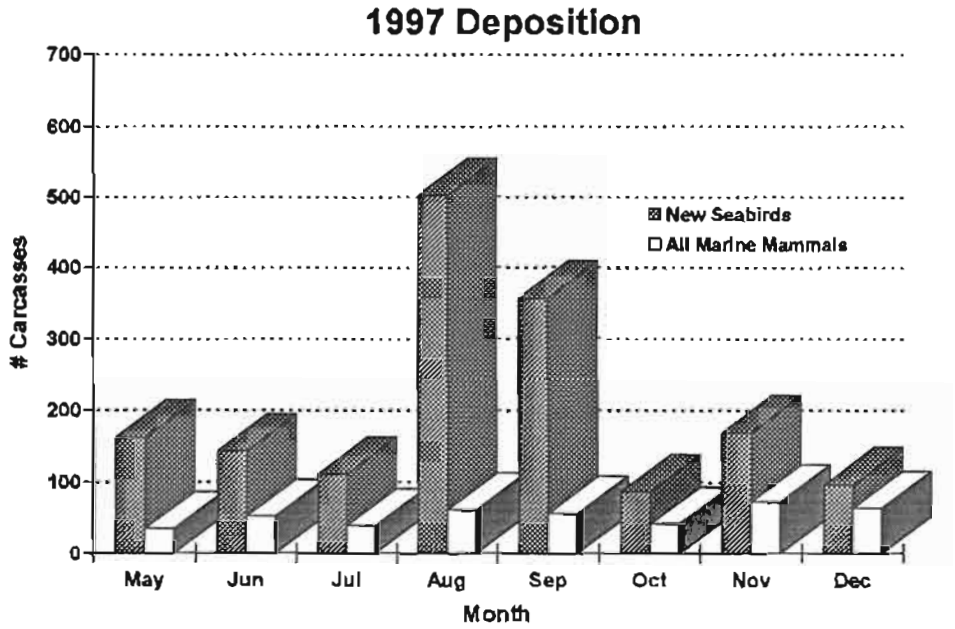
Beached Organisms (please use pencil) page_____of_____

				Toe Clipping								
Species	Condition	Sex	Age	previous	post	Scavenged	Cause of Death	Oiled	Oil Extent	Where Oiled	Photo	Comments

Codes for Beached Organisms Categories

Condition: 1 (live dying), 2 (fresh dead), 3 (decomposing), 4 (dried, mumified), U (unknown).
Sex: F(female), M (male), U (unknown).
Age: HY (hatch year), AHY (after hatch year), FY (first year), SY (second year), TY (third year), IM (immature), AD (adult), PC (pup, newly hatched chick/egg, or calf), U (unknown).
Toe Clipping: Indicate number of toes clipped when you encountered animal (previous), and number clipped when you left it (post). Leave blank if no toes to clip. Indicate "6" if all toes have been clipped on bird with two feet. Indicate "8" if all toes have been clipped on bird with one foot. Indicate "9" if animal is removed from beach. Use comments if necessary.
Scavenged: Y (yes), N (no), U (unknown).
Probable Causes of Death: 1 (shot), 2 (tangled in fishing net/line), 3 (tangled in plastic), 4 (unknown), if other write in.
Oiled: Y (yes), N (no), U (unknown).
Oil Extent: 1 (small globules, <2% of body), 2 (2-33% of body), 3 (34-66% of body), 4 (67-100% of body).
Where Oiled: 1 (dorsal only), 2 (ventral only), 3 (entire body), 4 (head only), 5 (feet only), 6 (wings/flippers only), 7 (other).
Photo: Y (yes), N (no).
Comments: Indicate number, color, and location of any tags present. Disposition and label of removed animal. Length measurements. Photo roll and frame numbers.

Figure 3. Beach survey data form.



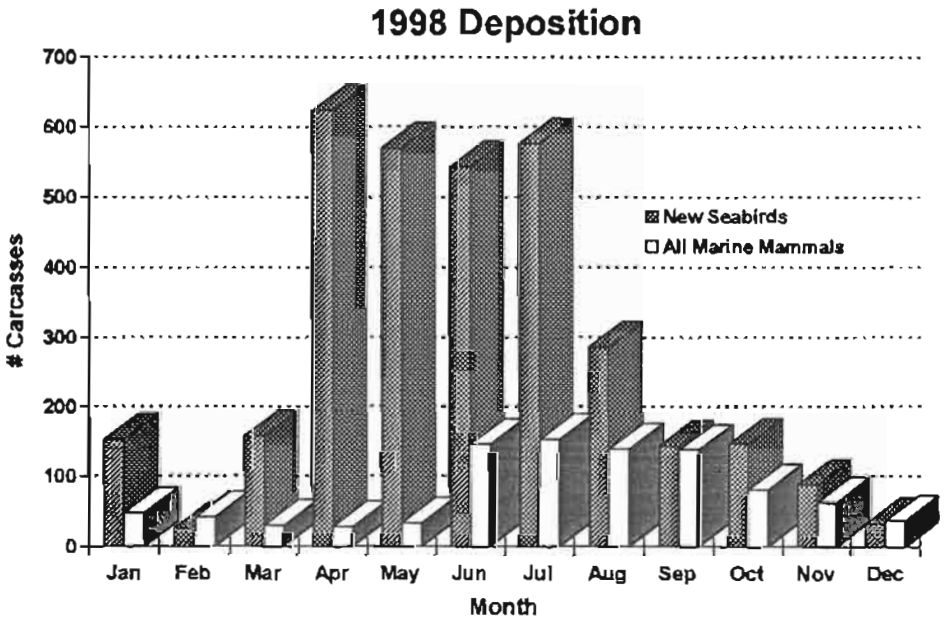
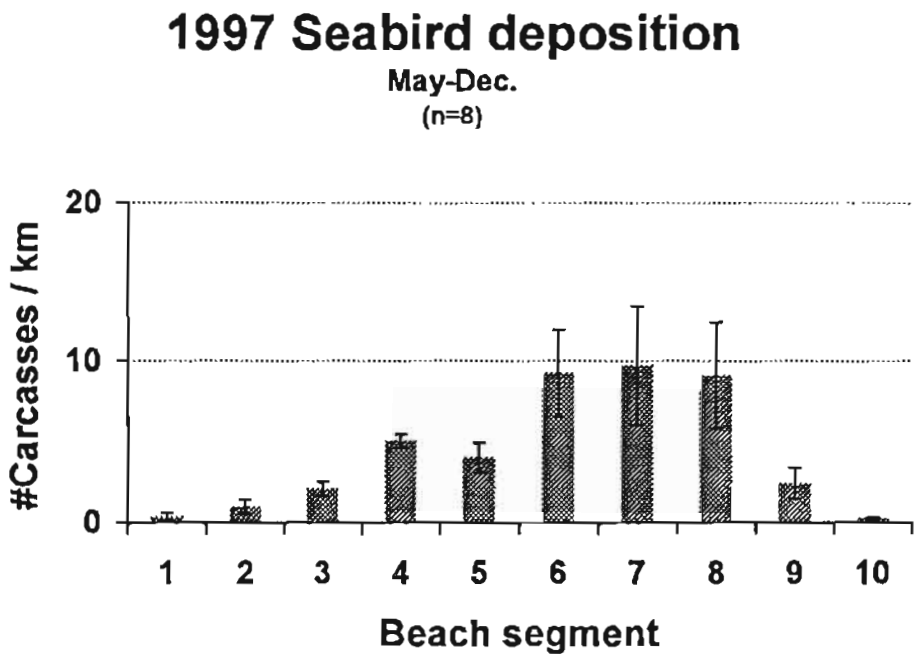


Figure 4. Number of seabird and marine mammal carcasses encountered in study area during 1997 and 1998.



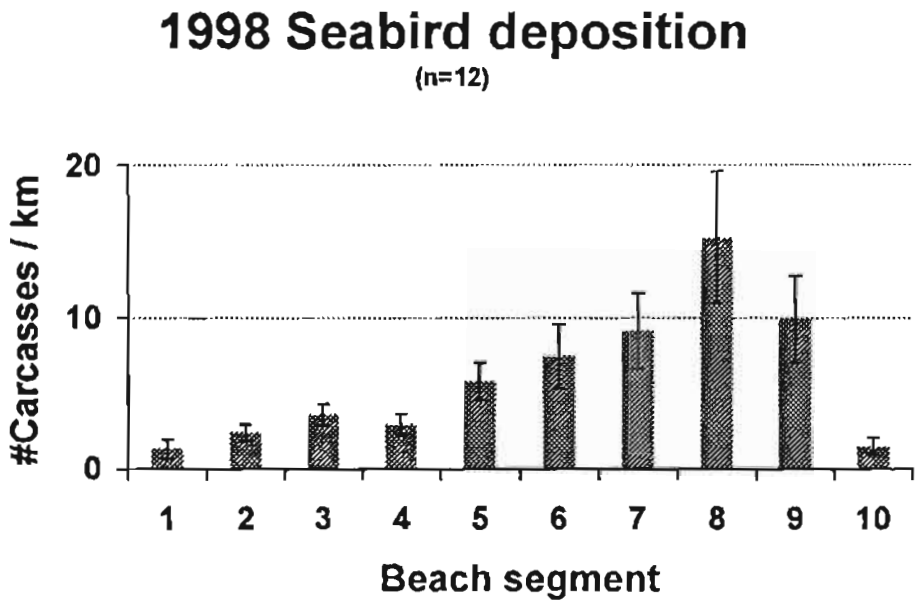


Figure 5. Mean density of seabird carcasses (± SE) encountered at beach segments 1-10 during 1997 and 1998.

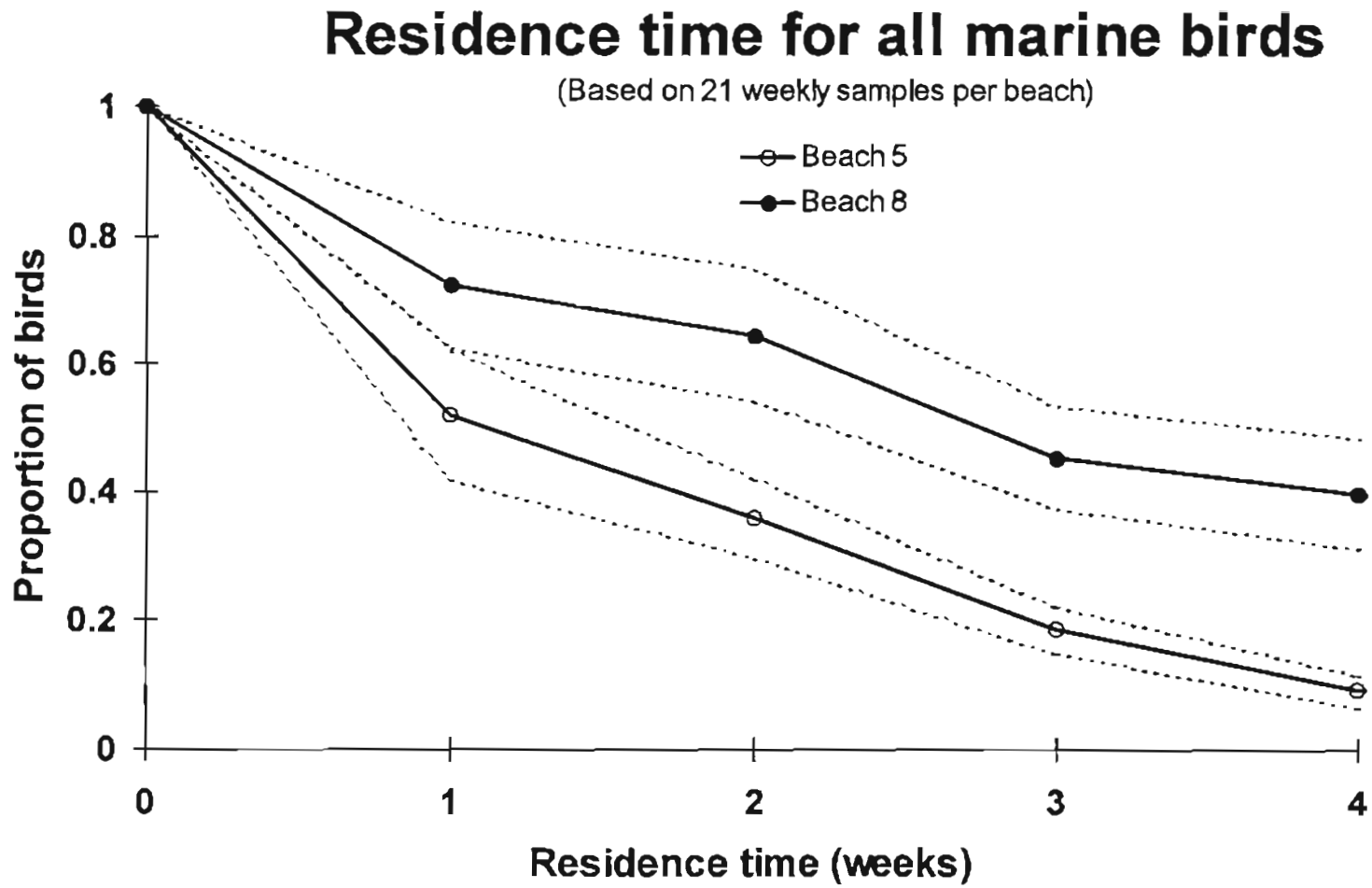


Figure 6. Residency time of beachcast bird carcasses at beaches 5 & 8 determined from weekly toe clippings (May - October 1997). Dotted line represents ± one standard error.

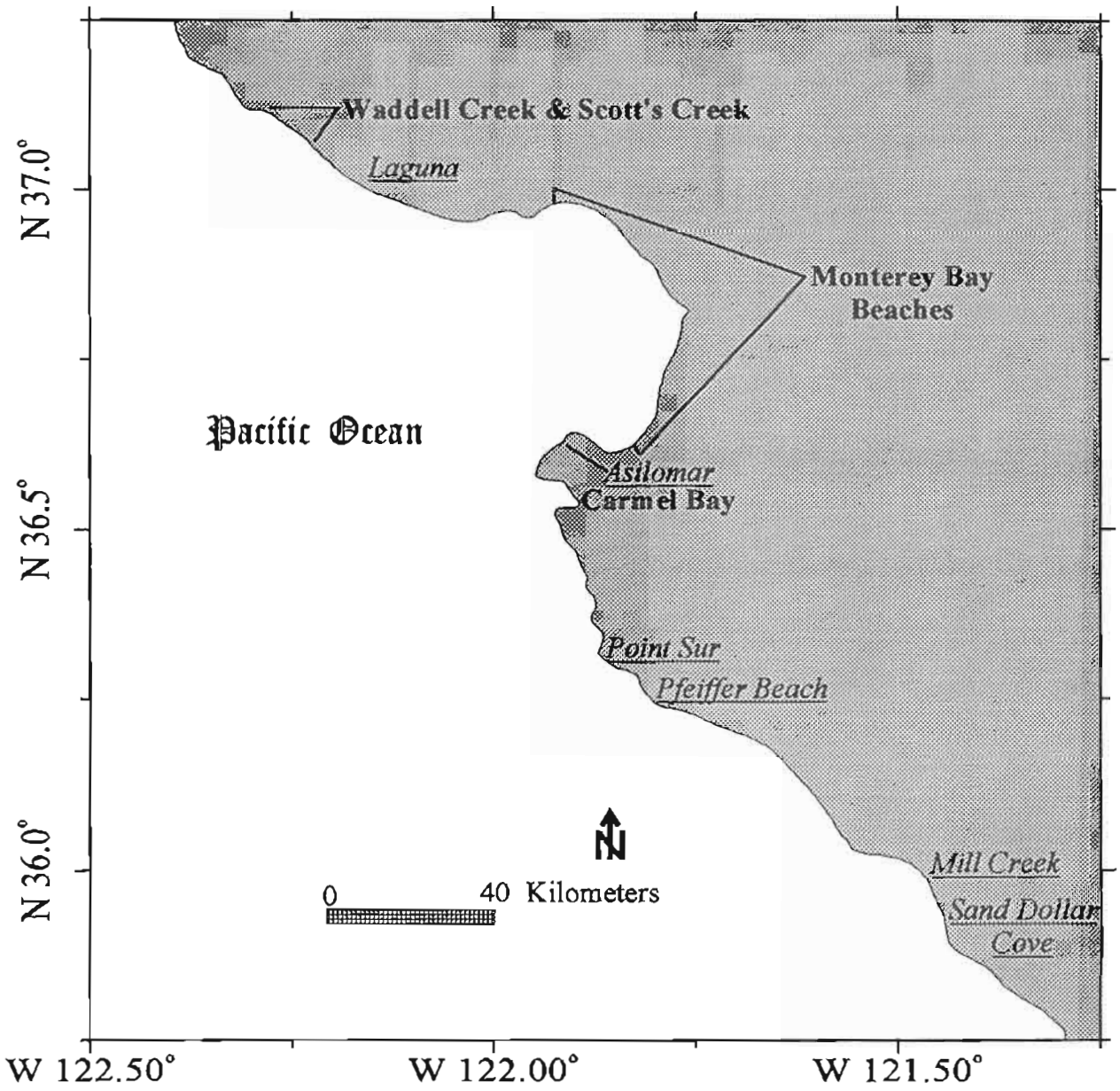


Figure 7. Beach COMBERS study area.
Current beaches monitored in bold.
Proposed beaches for future monitoring italicized and underlined.