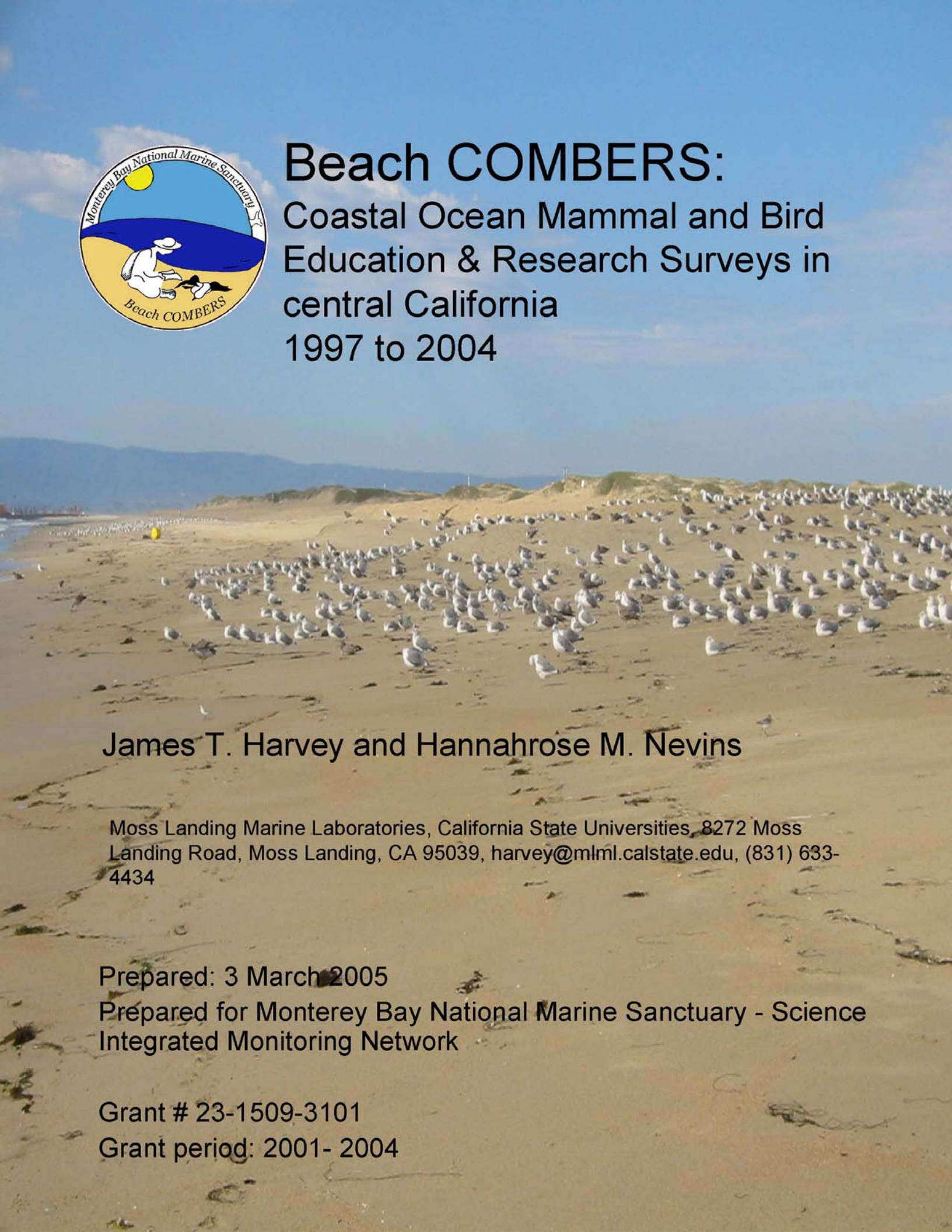

Beach COMBERS:

Coastal Ocean Mammal and Bird Education & Research Surveys in central California 1997 to 2004

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Prepared: 3 March 2005

Prepared for Monterey Bay National Marine Sanctuary - Science Integrated Monitoring Network

Grant # 23-1509-3101

Grant period: 2001- 2004

ABSTRACT

Long-term monitoring programs are needed to establish baseline information and demonstrate effects resulting from catastrophic events (e.g., Exxon Valdez Oil Spill). Long-term monitoring programs also provide consistent data that may resolve subtle changes in environmental quality, which may not be apparent with short-term sampling. The Monterey Bay National Marine Sanctuary (MBNMS) is a large body of water, and monitoring all aspects of the sanctuary is nearly impossible. We proposed, therefore, that surveying beachcast marine birds and mammals can provide an index of ecosystem health. Marine birds and mammals are conspicuous and large predators thus are easily counted, and they are top predators, therefore, their health can be used as an indicator of the quality and quantity of prey resources (e.g. krill, fishes, and squid). Using top predators as indicators also is convenient because the public values these animals and understands the need to study, protect, and conserve them and the habitats they require.

In 1997, we initiated a beach survey program called Beach COMBERS (Coastal Ocean Mammal and Bird Education and Research Surveys) using trained volunteers to survey beachcast marine birds and mammals monthly at selected sections of beaches throughout the Monterey Bay area. The program is a collaborative project between Moss Landing Marine Laboratories (MLML) and MBNMS with the specific goal of using deposition of beachcast carcasses as an index of the health of the MBNMS. We currently have 83 volunteers that survey 70 km of beaches in the MBNMS. This program has been greatly successful providing data for a number of scientific papers, contributing to the conservation of sanctuary resources, identifying and quantifying oiled wildlife, and a great many more accomplishments.

INTRODUCTION

The Coastal Ocean Mammal and Bird Education and Research Surveys (COMBERS) program was established in 1997 to monitor natural and human-related mortality of marine birds, mammals and turtles (Benson et al., 1998; Benson et al., 1999; Benson, 2000). During monthly surveys, trained volunteer teams survey beaches in the Monterey Bay National Marine Sanctuary (MBNMS). Volunteers record dead marine birds and mammals to provide an index of ecosystem health in the sanctuary. Marine birds and mammals are conspicuous top predators of the marine ecosystem, thus are easily counted, and their deposition on beaches can be used as an indicator of availability of prey resources, human impacts, and natural die-offs. Long-term monitoring of deposition of marine birds and mammals enables resource managers to determine trends and identify catastrophic events (e.g., oil spills, harmful algal blooms, disease; Ely, 2002). Eguchi (2002) emphasized the needs for baseline monitoring when he used beached mammal data to model the impacts of a large mortality event on the population of bottlenose dolphin (*Tursiops truncatus*) off Florida. He concluded that the effects of catastrophic events (e.g., oil spills, harmful algal blooms, over-fishing) can only be determined if a proper baseline of beachcast information is available. Long-term monitoring programs also provide consistent data that may resolve subtle changes in environmental quality, such as chronic oiling, which may not be apparent with short-term sampling (Stenzel et al., 1988; Nur et al., 1997).

This program has been greatly successful in providing data for a number of scientific papers (Gulland 2000; Scholin et al., 2000; Forney et al., 2001), contributing to the conservation of sanctuary resources. For example, Beach COMBERS data indicated the gillnet fishery was killing large numbers of nearshore species as bycatch during 1997–1999 (Forney et al., 2001). COMBERS have also contributed to identifying and quantifying oiled wildlife (Nevins and Harvey, 2002) and identifying unusual die-offs of seabirds (Nevins and Harvey, *in press*). Beach COMBERS continue to provide information to link migratory species inhabiting the sanctuary to distant breeding areas using tag returns and genetic markers with collaborators. Beach COMBERS provide important tag return data to the National Bird Banding Lab, USGS-Patuxent Wildlife Research Center, Laurel, MD.

Volunteers contribute reports of dead and live stranded marine mammals to National Marine Fisheries Service - Marine Mammal Stranding Network participants in Monterey County (Moss Landing Marine Laboratories, California State Universities), Santa Cruz County (Long Marine Laboratories, UC Santa Cruz), and The Marine Mammal Center (Sausalito/Moss Landing). Volunteers collect “level A” data for dead marine mammals which include species, location, latitude and longitude, age, sex, standard length. In addition, tags are reported to marine mammal researchers in California.

COMBERS build upon past beach surveys conducted in central California: Stenzel et. al. (1988) surveyed southern, central, and northern

CA beaches 1974 to 1982; Julian and Beeson (1998) surveyed southern CA beaches 1990 to 1995; Mason (1997) surveyed Monterey Bay beaches during 1992 to 1994; and California Department of Fish and Game (Wild 1990) surveyed beaches from 1980 to 1998. In the Pacific northwest, beach survey programs also have been developed for the Gulf of the Farallones (1995 to present; Beach Watch; Roletto and Grella, 1995), Oregon (Bob Lofeffel, unpublished data), and Washington (COASST, University of Washington), and British Columbia (Tasha Smith).

Project Objectives

The objectives of the COMBERS program were: 1) obtain baseline information on rates of beach deposition of marine birds and mammals, 2) assess causes of seabird and marine mammal mortality, 3) assess abundance of tar balls (oil patches) on beaches, 4) assist resource management agencies in early detection of unusual rates of natural and anthropogenic (human-related) mortality, 5) build a network of interacting citizens, scientists and resource managers, and 6) disseminate information to the public and educational institutions.

Methods

To obtain baseline information on rates of deposition of marine birds and mammals, volunteers identified and quantified all beached organisms on selected segments of sandy beaches in the Monterey Bay National Marine Sanctuary (Fig. 1). Each beach segment was surveyed during the first week of the month by a team of two surveyors who were trained to identify marine birds, mammals, and turtles. Surveys were conducted monthly at most locations and two times per month at selected beaches (Table 1). All beaches segments were surveyed each month. The survey design is based upon a strip transect, where it is assumed that all new carcasses in the survey area are observed and recorded. The entire beach was surveyed with the help of binoculars to scan upper beach wrack for distant carcasses, and the survey effort was centered on the wrack line of the previous high tide. Surveys were conducted during an ebbing (out going low) tide; teams began surveys approximately 1 to1.5 hours prior to low tide. Deposition rate was calculated as the number of newly deposited animals per linear km walked. For example, if 10 new birds were found on a 2 km segment, the resulting deposition was 5 birds km^{-1}. This standardized data to amount of effort (number of km walked) enabled comparison with other beaches, among months and years. For monthly comparisons, beach segments were considered replicates.

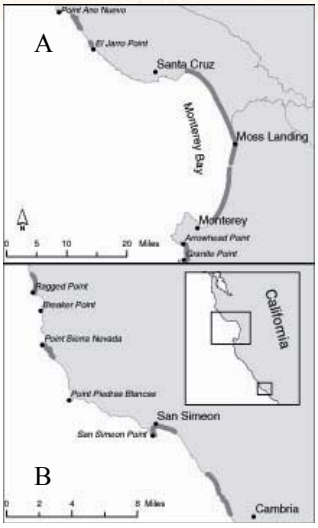


Fig. 1. Study area includes beach segments in Monterey Bay area (A) and Cambria (B) (dark gray line).

To determine the incidence of human caused seabird and marine mammal mortality, volunteers examined carcasses for the presence of oil, entanglement in fishing gear (e.g., monofilament line, hooks). Because other causes of mortality are more difficult to determine in the field, fresh specimens were collected for post-mortem examination by a trained veterinary pathologist (M. Miller, J. Hill). COMBERS were prepared to collect additional specimens for necropsy in the event of an unusual mortality event, by bringing protective gloves, bags, and labeling markers into the field.


Volunteers examining common murre © 2002 H. Nevins

Volunteers recorded the number and diameter of tar balls found during surveys. Volunteers collected fresh or newly deposited tar balls when they were encountered following California Department of Fish and Game (CDFG) recommended procedures for sample collection, storage, and chain of custody. Oil samples were then submitted to CDFG to determine the source of the oil (e.g. natural seeps or vessel traffic) based on chemical constituents. In the case of large deposition of oil, volunteers were instructed to immediately notify CDFG and/or California State Parks dispatch.

Volunteers examined each intact (not heavily scavenged) seabird to determine the presence of oil. If observers found oiled birds, they determined the extent of oiling as the proportion of the body oiled: (1) < 2%; (2) 2–33%; (3) 34–66%; (4) 67–100% of body. Observers also recorded where oil occurred on the body: dorsal only, ventral only, entire body, head only, feet only, wings only, or other. Observers were also instructed in proper oil sampling techniques and would collect or photo-document oiled specimens opportunistically. All oiled feather samples, tar balls, and oiled birds were deposited at CDFG.

Identifying unusual mortality events

We have established an 8-year baseline for comparison with current marine bird and mammal stranding records to determine if mortality event is "unusual" and whether it warrants further investigation. We used the following seven criteria for determining an unusual mortality event adapted from NOAA-Fisheries (2005) definitions of a mass stranding:

- A marked increase in the magnitude of strandings when compared with prior records (threshold level = historic mean plus two times the standard deviation).
- An increase in mortality in a localized area, or it spreads geographically with time, or occurs throughout species' range.
- The species, age, or sex composition of the strandings is different than that normally found during that time of year (compared with baseline).
- Stranded animals exhibit similar or unusual pathologic findings
- Body condition indices (such as fat layer) are different than that usually found for the species.
- Mortality event is accompanied by unusual behavior patterns observed among living individuals, such as abnormal patterns of swimming or feeding.
- Critically endangered species are stranding.

Beach COMBERS assists resource management agencies in early detection of unusual mortality events. The group consists of scientists, resource managers, and citizens, which allows for the quick accumulation of information about the

resources of the MBNMS into a centralized location, and the rapid dissemination of information to the management and enforcement agencies (e.g. MBNMS, CDFG, NMFS).

Volunteers are trained to identify marine mammals (Photo: H. Nevins).

Volunteer Training

Providing proper training and data quality assessments are necessary when incorporating volunteers into collection of scientific information. It is also necessary to maintain volunteer enthusiasm and participation to ensure consistency in the data and to build the expertise and conservation values of the group. To these ends, we developed a training program that consists of in-class lectures and discussions, laboratory-based learning, and field-based experiences. We begin the program with a discussion of the philosophy of the Beach COMBERS, the objectives and the rationale for the sample design we have created. The volunteers must understand there is a rationale behind the sample design so that they value the need for accuracy and consistency in the data they collect.

Volunteers receive 20 hours of instruction in the identification of marine turtles, birds and mammals using slides, handouts, study skins, skeletal preparations, guide books, and in-the-field identification (Appendix A: example of instruction agenda). We stress the use of diagnostic features for beachcast organisms (e.g., feet and bills for birds, skulls and body morphology for mammals), and provide each volunteer with the resources they need, such as an excellent field guide (Ainley et al., 1994). In this way the volunteers are introduced to the local fauna of birds and mammals and instructed on the methods used to identify each specimen. In the laboratory (at MLML and Pacific Grove Natural History Museum) we use study skins, live mounts, and skeletal preps to further instruct in identification skills. The final instruction for identification is conducted on selected beaches, where the volunteers are tested for accuracy of identification and percentage of missed carcasses. Volunteers also are provided information on how to identify gender and age of some birds and mammals, and the methods of measuring specimens. Dr. Jim Harvey and graduate students from MLML with help from MBNMS personnel provide instruction.

Volunteers are trained to recognize oiling of plumage on carcasses, tar balls on beaches, and the proper techniques for sampling so that the sample remains uncontaminated. Personnel from OSPR provide protocols, instruction, and sample containers. Volunteers also are taught how to determine if a carcass has been scavenged and recognize and record the presence of fishing interactions. Volunteers are instructed on the methods used to mark carcasses so we can track individuals that have been counted previously. For instance, the first time a bird carcass is encountered a toe is removed from the bird, and this is recorded on the datasheet (Appendix B). Each subsequent time a marked bird in encountered on following surveys another toe is removed and recorded, thus allowing us to determine the

duration of time carcasses remain on the beach. It also allows us to analyze the data for only first-observed carcasses. We thoroughly describe how the data form is to be completed during each beach survey, and the importance of standardizing effort and accuracy in the process of data collection. At the end of the training session, volunteers are provided a sampling kit, which includes: measuring tape, tide book, ID cards, scissors for removing toes of beached birds, string for marking mammals, reference guides, datasheets, collection materials for oil samples and fresh birds. Volunteers also are provided with the contact numbers for various agencies, such as The Marine Mammal Center for live mammals, UCSC and MLML for dead marine mammals, CDFG for oil events, etc.). We also discuss the need for safety, including the importance of assessing swell and wind patterns, avoidance of toxic substances (use of gloves), and other safety considerations.

Sample Design

The sampling protocol was designed after reviewing past studies of beach surveys (Simons, 1985; Jameson, 1986; Stenzel et al., 1988; Bodkin and Jameson, 1991; Roletto and Grella, 1995). A pilot study was conducted determine the proper number, distribution, frequency of surveys (funded by CUREC in November 1996). The basic method is similar to a strip transect, where all beachcast birds and mammals within the strip (i.e., the width of the beach being surveyed) are counted. Deposition rates of marine birds and mammals are then calculated as the number of new animals encountered per km surveyed. Using these methods we can compare deposition rates among beaches, seasons and years.

This monitoring plan covers the largest sandy beaches within the Monterey Bay National Marine Sanctuary (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 team parks one car at one end of their beach section, drives to the other end of the beach, then surveys as they walk the distance of their beach section back to the first car. The long-term component of the study involves pairs of volunteers surveying pre-defined beach segments 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 beach is surveyed. The two observers generally walk in a zigzag fashion along the beach to make sure all beached birds and mammals are located. Teams of two persons sample each section of beach (typically 1.5-2.5 miles in length) at the beginning of each month throughout the year. Ideally the time period between samples would be exact (for instance a survey conducted every 30 days), however the logistics of organizing numerous volunteers that have jobs and individual lives is too great to expect them all to conduct a survey on the same date. For logistical reason, therefore, we allow a survey team (two persons per section of beach) a window of the first seven days of each month to complete a survey. The resulting confounding factor that may affect the results is that the frequency of surveys, therefore the time between surveys, is not the same for sampling period. For example, if on one month a team were to conduct a survey on the 1st of the month and the following month

conducted the survey on the 7th of the month, then the time between surveys is about 23 days, whereas if the second survey was conducted on the 1st of the month then the time between surveys would be 30 days. The reason this may cause analytical problems is that the greater time between surveys may allow a greater number of beached organisms to accumulate on the beach. The variability in time between surveys probably contributes to some additional variability in number of beachcast organisms; however, we believe this effect is small.

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 3.7 km stretch of sandy beach along the outer coast, north of Santa Cruz, has been monitored since September 1998. Bi-monthly sampling began in October 1998 at beach segments 5 and 8 to provide better temporal resolution of carcass deposition. Each beach segment is approximately 3.7 - 5.2 km in length (Table 1). The average time to complete a survey is two to three hours.

Karin Forney inspects a small beached bird, Marina State Beach (Photo: H. Nevins)

Survey data are documented on standardized data forms (Appendix B). 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 carcass encountered, the following information is recorded: species; stage of decomposition; age and sex (when possible); evidence of scavenging; evidence for the cause of death; presence of oil; whether or not a photograph was obtained, and presence of identification tags or bands. 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 the carcass has been on a beach. Before clipping a toe, the volunteer documents the number of toes previously removed. Marine mammals are marked likewise by attaching a piece of hemp twine to the carcass.

In 2003, we attempted to refine our information for marine mammals stranding in Monterey County (beaches 5 to 9) in an effort to provide better location data to Moss Landing Marine Laboratories stranding network. We provided surveyors with a portable global position system (GPS; Garmin Geko™ 201) to obtain accurate latitude and longitude for each new mammal carcass recorded.

Data limitations

There are some limitations to the using the COMBER data to infer trends in mortality of all species in the MBNMS. Three considerations in interpreting the data are that: 1) pelagic, rare, and small bodied birds are under-represented in beach surveys (e.g., small alcids, phalaropes, and storm-petrels), 2) the depositional environment influences number of birds detected (storms, swell), and 3) scavenging, and depredation at

sea influence deposition rates, these factors likely disproportionately affect small bodied species. Medium and large bodied (600 to 800 g) seabirds are likely represented adequately in surveys, particularly common species, those that occur regularly every year it is possible to make inter-annual comparisons.

Manresa State Beach, Santa Cruz County (Beach #4; Photo: H. Nevins)

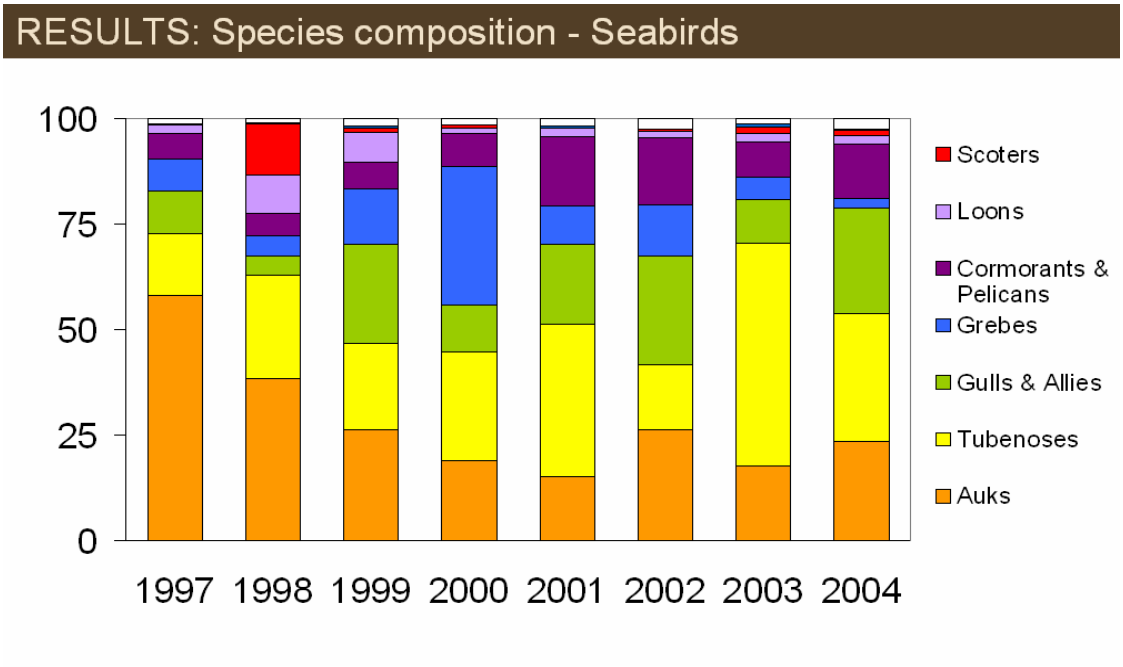
RESULTS AND DISCUSSION

Survey Effort

During 2001–2004, COMBERS had 94 participants, which included 83 beach surveyors, 3 veterinarians, 4 resource agency collaborators, 2 science advisors, one part-time data entry person and a data manager. The COMBERS also have 4 scientific collaborators (Appendix X). Since the project's inception, volunteers have contributed 5,571 hours of survey time (Table 1). In 2004, COMBERS surveyed a total of 67 km of beaches each month in the MBNMS. The survey area has expanded from the original ten beaches (May 1997) to include beach 11 (November 1998), five beaches in the Cambria /San Simeon area (May 2001), one in Big Sur (July 2003), two in Santa Cruz County (July 2003), and one in Morro Bay (November 2003).

Seabirds

Species composition of beached seabirds in all years was dominated by six orders of birds: Anseriformes, Gaviiformes, Podipediformes, Procellariformes, Pelecaniformes, and Charadriiformes (Appendix A). Of these, the first three migrate from inland terrestrial breeding habitats associated with lakes and ponds, and the later three are more truly marine, with few exceptions. In general, seasonal deposition patterns reflected the migratory cycles of these species. For the sake of clarity and space, here we describe the seasonal and inter-annual trends of the ten most abundant bird species found during beach surveys. During the El Niño year of 1997–98, the overall species diversity and deposition of beachcast marine birds was the greatest compared with other years (Fig. 2). Oil spills affected certain mainly diving seabirds (Gaviiformes,



Podipediformes, and Charadriiformes, Alcidae) but also some of the surface-feeding Procellariformes. In past years, fishery-related bycatch significantly affected Commom Murres and porpoises (see below, Marine Mammals); however, this mortality factor appears to have been reduced through changes in fishery regulations enacted in 2000.

Anseriformes - Waterfowl

Adult male Surf Scoter Melanitta *perspiculata* (photo: USGS)

Surf scoters (*Melanitta perspiculata*) were the most often encountered sea ducks found on surveys during January to May, and November to December (Fig. 3a). During the 1997–98 El Niño, Surf Scoters represented a greater proportion (20%) of the recorded species and deposition was slightly later (April to June) than during other years (ave. ~3%; Fig. 4a). White-winged (*M. fusca*) and black scoters (*M. nigra*) were rarely documented. There is evidence that all species of North American sea ducks have undergone population declines. G.V. Morejohn reported that *M. fusca* were once more abundant on beach surveys in the Moss Landing State Beach (Monterey County) during the 1960-70s (MLML, unpublished data; Nevins and Harvey, 2002).

Clark's Grebe *Aechmophorus clarkii* (Photo: L. Henkel)

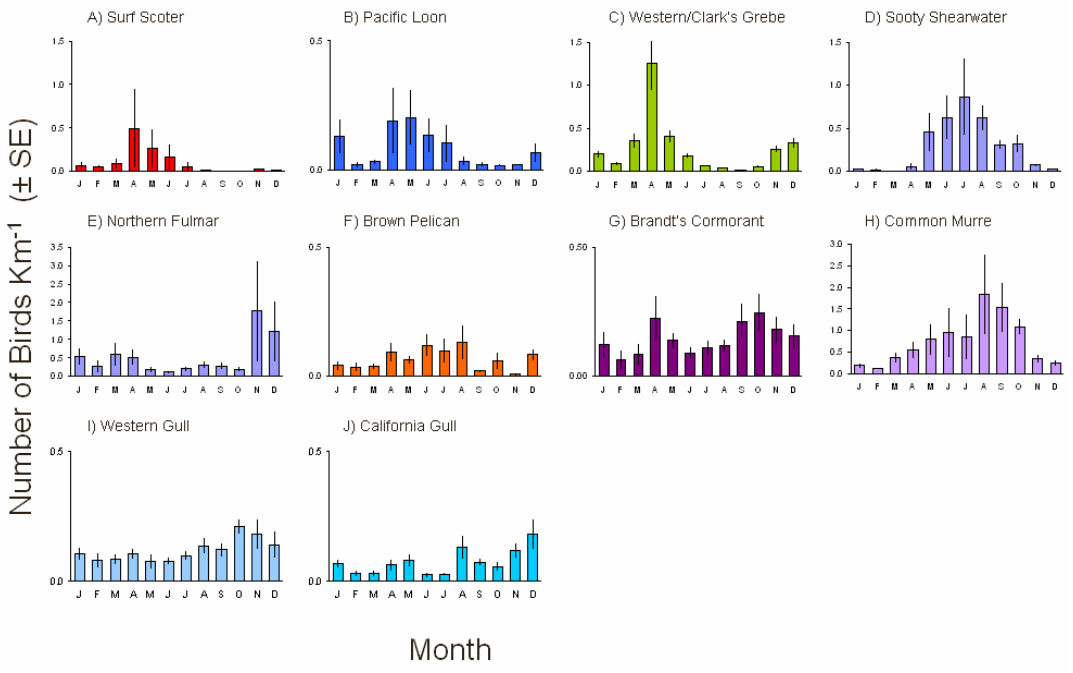
Gaviiformes – Loons

Pacific Loon (*Gavia pacifica*) occurred on beach surveys during spring (April to July) and fall migration (December to January), representing ~3 % of beached birds (Fig. 3b). This seasonal deposition pattern is consistent with relatively low year-round abundance from nearshore surveys (Henkel, 2003). Mortality of this species is thought to be primarily juveniles, but we have no age-specific information due to the difficulty in using plumage of beached birds to age them. There is one band return for this species which was both banded and recovered in California (Mary Gustafson, USGS-BBL, 1929 to 2002). During the past eight years, only the El Niño year of 1998 produced significant mortality for this species (Fig. 4b). Migratory species are expected to have depleted energy stores upon arrival from breeding areas, and are therefore more likely to be affected by reduced prey resources and diminished wind fields during El Niño years.

Podicipediformes – Grebes

Western and Clark's Grebes (*Aechmophorus occidentalis, A. clarkii*) are treated together here as they are recently considered separate species, during beach surveys they are identified to species when possible; otherwise they are recorded as a complex. Grebes are medium-sized birds and represent a consistent proportion (~10%) of beached birds. Their nearshore foraging habits make them particularly well represented in deposition data (Fig. 3c). Because little is known about the colonies of origin for the wintering birds in California, we have no basic information to

Figure 3. Seasonal deposition of seabirds, 1997–2004



put mortality events into context such as the 2000 grebe die-off. The 2000 mortality event began in March, peaked in April to May, and extended into June and July. Birds killed in this event appeared to be entirely young-of-the-year and found in a relatively isolated region, particularly beaches 5 and 6, and lesser extent, beach 7 and 8, in inner Monterey Bay. The pattern of deposition during the die-off, coincides with nearshore survey data collected during 1999 to 2001, which shows a similar increase in the number of birds in central Monterey Bay (Henkel, 2003).

Procellariformes - Tubenoses

Sooty Shearwater (*Puffinus griseus*) represents ca. 9% of birds recorded during beach surveys during May to October (Fig. 3d). Short-tailed Shearwater (*P. tenuirostris*), a similar species, occurred during the winter and in far lower incidence than Sooty Shearwaters.

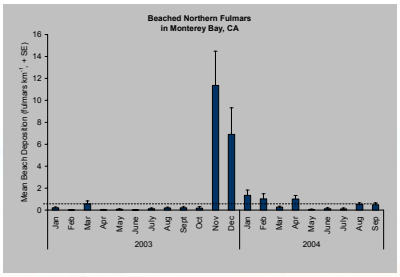
Sooty Shearwaters are affected by entanglement in recreational fishing lines and hooks. During 2001–2004, 15% of 55 entangled seabird recorded were found to be sooty shearwaters.

In inter-annual comparisons, the most significant increase in mortality of this species occurred during the El Niño years of 1998 and 2002 (Fig. 4d). Because these birds travel from southern hemisphere nesting colonies, including New Zealand, Chile, and Australia, effects on reduced wind stress during migration likely influence body condition.

Sooty Shearwater flocks are a common sight in Monterey Bay during summer and fall (Photo: J. Adams).

Northern fulmar (*Fulmarus glacialis*) is a dominant winter species represented on beach surveys, migrating from breeding colonies in Alaska and Canada (Hatch, 1980; Hatch and Nettleship, 1989). Fulmars are offshore species, and are rarely documented on nearshore surveys. Fulmars occurred on beach surveys during November to January, and March to April (Fig. 3e).

Winter mortality of young-of-the-year is a consistent phenomenon which varies in magnitude among years (Twillingate, 1976, Baltz and Morejohn 1977, Stenzel et al., 1988). During November 2003 to April 2004, we documented an unusual mortality event or "die-off" of fulmars. This mortality was significantly greater than had been recorded previously (maximum 12 birds km^{-1} mo^{-1}; Fig. 4e), and was accompanied by other reports from beach surveys from Baja California, Mexico to British Columbia. The mortality event was unusual in magnitude, geographic extent, and the abnormal occurrence of high densities (14 ± 4 bird km^2, Harvey, unpublished data) of fulmars at sea in Monterey Bay; many of which were moribund or found feeding on alternate prey types, such as plastics, *Mola mola* parasites, and jellyfish (*pers. obs.*).



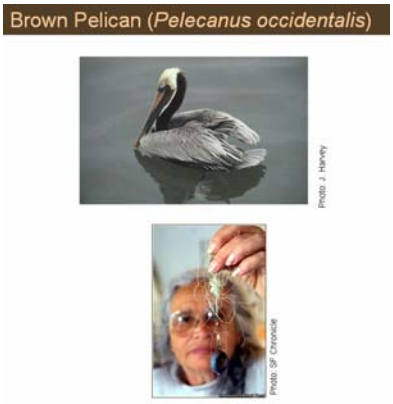
Since no band data are available for this species, we inferred the colony of origin based upon the ratio of color morphs and bill measurements of birds collected during the die-off. In November and December 93% were dark morph, and 7% light (n = 415), indicated an origin of Gulf of Alaska or Western Aleutian Is. (S. Hatch, personal communication). Morphometrics were not different from Semidi Is., and smaller than Chagulak Is. in the Aleutians (Appendix E). We were able to necropsy 186 specimens. These birds were emaciated, had mostly empty stomachs, and were predominantly (96%) young-of-the-year or immature sub-adults (4%). We concluded that a large scale (i.e., ocean basin) environmental perturbation was responsible for the magnitude and extent of this morality. It is likely food limitation occurred in the Gulf of Alaska as fledgling fulmars were making their way south. The fact that many Red Phalaropes (*Phalaropus fulicaria*) were also found freshly dead during this die-off further support of this hypothesis; phalaropes are another surface-feeder and arctic-breeding migrant which would be foraging in the same region post-breeding.

Mass Mortality of Northern Fulmar during October 2003. Eva Bergman, MWVCRC-CDFG, Santa Cruz, CA (Photo: H. Nevins)

Pelecaniformes – Pelicans, Cormorants and Allies

Brown Pelican (*Pelecanus occidentalis*) is a common fall and winter resident in the sanctuary, and historically nested in low numbers at Bird Rock, Point Lobos, Monterey County (Baldrige, 1973). This species is most often encountered on beach surveys during June to October, corresponding to the post-breeding dispersal of adults and young-of-the-year from colonies in southern California (Fig, 3f).

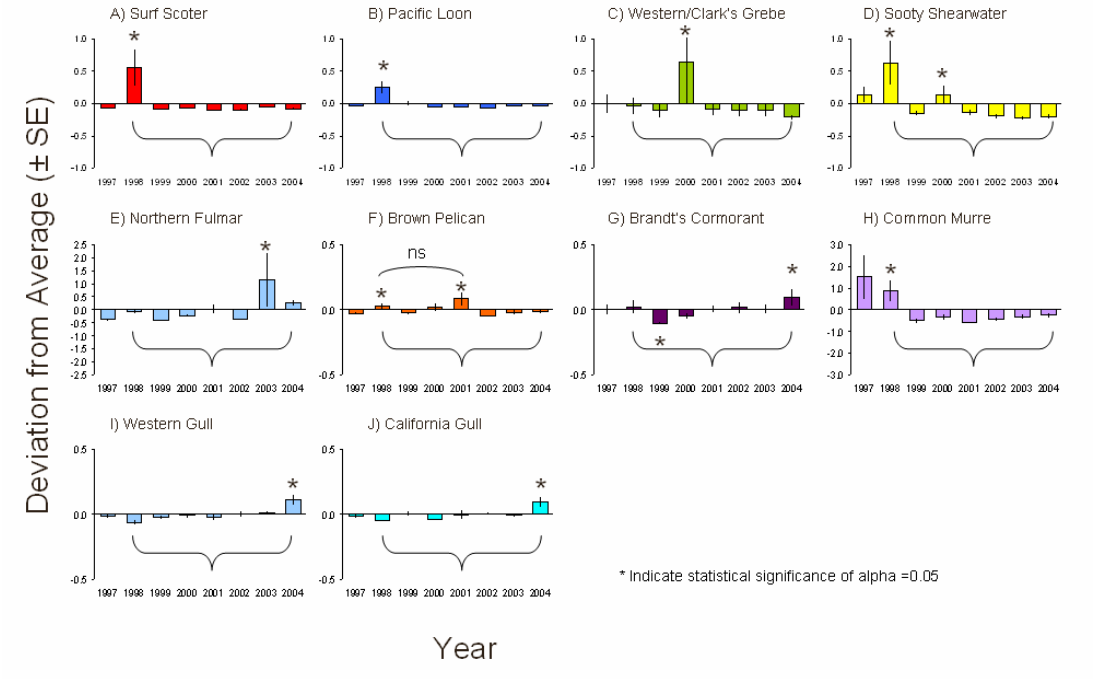
Because the occurrence of pelicans on beach surveys is generally low (i.e., < 0.5 birds km-1) and highly variable from year to year, inference about trends is limited. In 2001, a significant mortality event was detected by beach surveys, when large numbers of pelicans were killed by entanglement in recreational fisheries (Fig. 4f). This mortality was greater than that associated with the 1998 El Niño. Pelicans aggregated near two recreational fishing piers in Santa Cruz County, Seacliff Beach and Santa Cruz Municipal Wharf, where the overlap between forage fish abundance, pelican foraging activity, and fishing activity resulted in an increased level of fishery interactions.



Brown Pelicans are often found entangled in derelict recreational fishing gear.

California Department of Fish and Game wardens responded with increased patrols to help disentangle birds and advised fishers, but ultimately the city responded to wildlife concerns by closing these piers to recreational fishing. Rehabilitation centers recovered more than 170 pelicans during this event (International

Figure 4. Inter-annual trends in deposition of seabirds



Bird Research and Rescue Center, unpublished data).

"the starving young tend to congregate around wharfs, marinas, piers, sports fishing boats, bait barges, fish processors, etc....any place where food might be easy to come by; after while they become pier bums unable to find food from natural sources and often end up becoming a nuisance." – Frank Gress

During 2004, researcher Frank Gress and others reported a phenomenal breeding season for pelicans in southern California and Mexican breeding areas, with great numbers of nests, many of which were initiated early (than in 35 years), for an extended duration, and birds nesting at an island which hadn't been occupied in over 50 years. Our expectation that this would result in significantly increased post fledging juvenile mortality of juveniles, but this was not born out in Monterey Bay. High mortality of young-of-the-year was reported in southern California, outside the COMBER study area. This indicates that sufficient prey were available in the Monterey Bay area to support the influx of juveniles during this banner year.

Western Gull on nesting island in Channel Islands (Photo: J. Adams)

Brandt's Cormorant (*Phalacrocorax penicillatus*) is a resident species with colony areas loosely scattered on suitable habitat throughout the sanctuary (Sowls et al., 1984) and at the large colony at the Farallon islands (Boekelheide et al., 1990a). Brandt's represented ~5% of beached birds each year. They were found on surveys throughout the year, but at relatively low incidence (< 0.5 birds km^{-1}; Fig. 3g). The months with the greatest deposition are April and May, and September to January. During the fall post-breeding season fledgling young are expected to disperse from the largest colony at the Farallones southward into the study area. This seasonal trend tracks the occurrence patterns from nearshore sea surveys (Henkel, 2003), with the exception of the spring mortality. Of the 6 banded birds recorded during 2001-2004, three have been reported as originating from Southeast Farallon Island (BBL data).

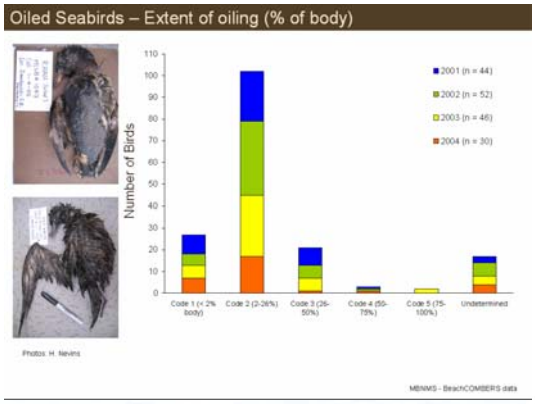
Inter-annual data indicate an increasing trend in morality for this species (Fig. 4g). Surprisingly, Brandt's Cormorants did not show an increase in mortality during the El Niño year, perhaps because reproductive activity is reduced and few young are produced (Boekelheide et al., 1990a).

Charadriiformes – Auks, Gulls and Shorebirds

Common murre (*Uria aalge*) is one of the most abundant species encountered during this study (25% of beached birds) and in previous studies in central California (Stenzel et al., 1988; Mason, 1995; Nur et al., 1997). Murres occurred most often during surveys May to October corresponding to the post-breeding dispersal (1.0 birds km^{-1}; Fig. 3h). Adult males and their dependent chicks comprise a majority of the birds in Monterey Bay during this time (Nevins, 2004). No data are available to

determine the origin of murres, but it is likely some are from the nearest colonies at Big Sur and the Farallones.

The inter-annual trend in the deposition of Common Murres has been significantly affected by human-related activities including oil spills, gill net bycatch, and recreational fishing entanglement. During the first years of this study (1997–1999), fishers using bottom-set gill nets in waters of 30 fm had significant impacts to this species (Forney et al., 1999). In September 2000, fishing regulations were changed to limit fishing to water deeper than 60 fm. Subsequently there has been a reduction in total fishing effort and a decrease in deposition of murres in the study area (Fig. 4h). Increased deposition of murres during 1997-98 is likely a combination of fisheries, oil pollution, and El Niño effects (Boekelheide et al. 1990b). During the winter of 1997-98, the Point Reyes Tarball Incident occurred in central California, oiling ca. 3,000 birds of which 63% were murres (Hampton et al., 2003). During 1997-98 El Niño, ocean conditions reduced the availability of prey to murres and may have also contributed to increased mortality.

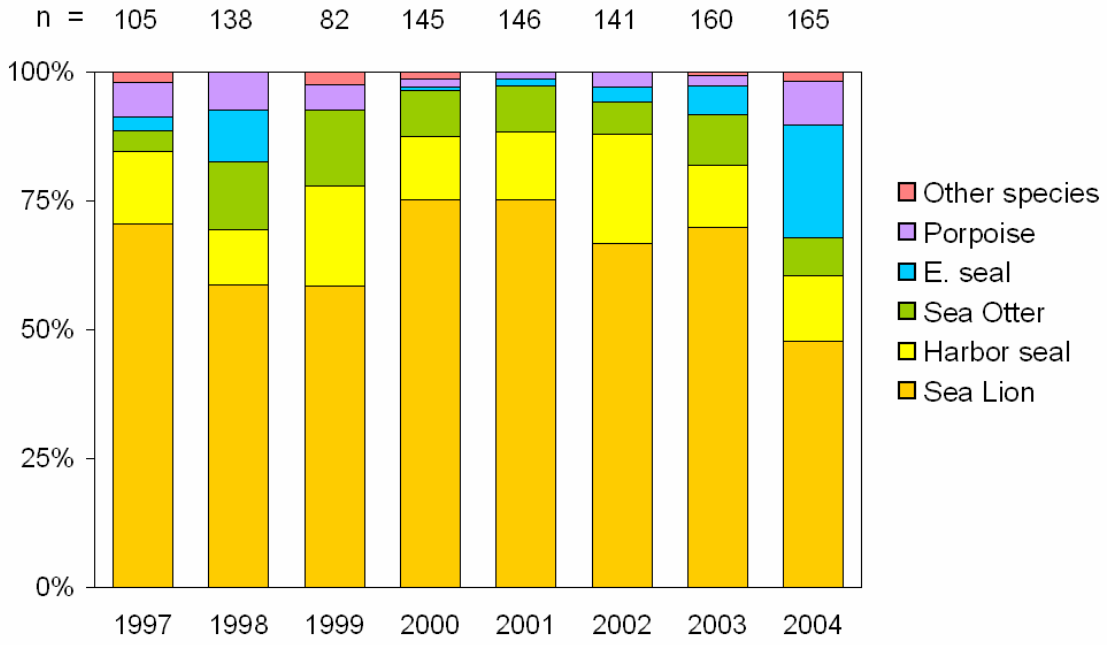


Western Gull (*Larus occidentalis*) is a locally breeding resident species, nesting scattered on rooftops and cliffs throughout the sanctuary (MBBS). The beach deposition data indicates this year-round occupation of the area and matches results from nearshore surveys (Henkel, 2003). Increased mortality occurs during fall and winter, August to December, which likely represents an influx of fledged juveniles into the study area (Fig. 3i). Few band returns (5 of 5) suggest colonies of origin of HY birds at Farallones, however, as with other species, banding is not done systematically at all colony areas. Regional data suggest additional sources from Oregon, Washington, and Mexico (BBL; Penniman et al., 1990). Age data indicated that 48% are AHY, 39% HY, 11% SY, 2% TY (2004; n = 140 birds, additional 36 not aged).

Inter-annual comparisons indicate that like Brandt's Cormorants, an increase in mortality of Western Gull was not observed during El Niño years. Also, there is an overall increasing trend for this species (Fig. 4i). This may reflect lower fledging success of Western Gulls during food poor years (Penniman et al., 1990), such as occurred during 1998. An alternative explanation is that Western Gulls have an opportunistic foraging mode which allows this species to make use of alternative prey resources during food limited years.

California Gull (*Larus californicus*) is a common and abundant winter visitor in Monterey Bay. They represent ~3% of beached birds. Their migratory behavior is evident in their bi-modal seasonal occurrence in beach surveys during August to December, and April to May (Fig. 3j). The seasonal occurrence in beach surveys coincides with occurrence patterns from nearshore sea surveys (Henkel, 2003).

Figure 5. Species composition – Marine Mammals



The inter-annual trend in mortality of California Gulls is similar to that of Western Gulls and Brandt's Cormorants; they all showed an increasing trend throughout the 8-year study and a significant increase in mortality during 2004 (Fig. 4j). This event is unexplained, as few data from known source colonies are available to interpret these results. Many of the band returns from COMBERS indicate Mono Lake (3 of 5 returns) as the primary source for birds found in the study area. However, the long-term BBL reports from California indicate origins from diverse colony regions including Colorado, Idaho, Montana, North Dakota, Nevada, Oregon, Utah, Washington, Wyoming, and Alberta Saskatchewan, Canada (BBL, unpublished data).

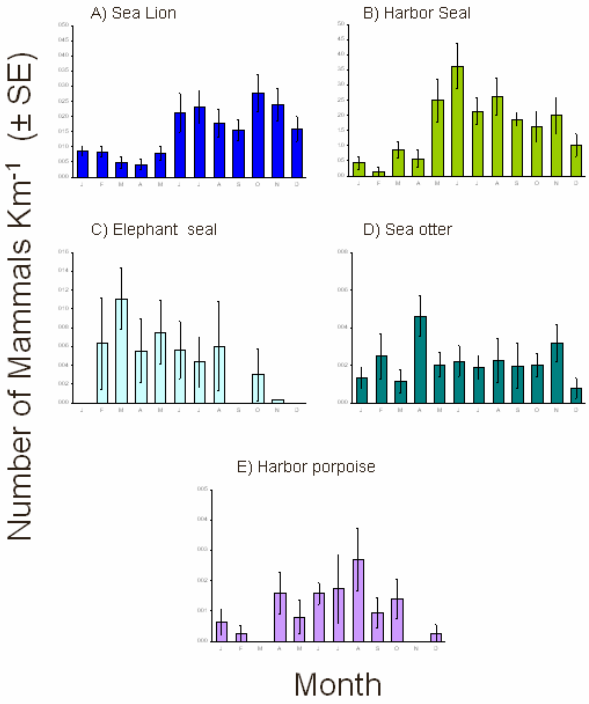
Marine Mammals

Pinnipeds: seals, sea lions and fur seals

California sea lion (*Zalophus californianus*) was the most frequently encountered marine mammal carcass found on surveys in all years (53% of mammals). Sea lions were most often encountered during June to December, corresponding to the non-breeding season (Fig. 6a). Tag returns indicate Channel Islands breeding colonies are the source of animals found in Monterey Bay area. The only significant trend in annual deposition of sea lion was that during the 1999 La Niña year, mortality was less than in other years (Fig. 7a). The majority of animals recovered were immature, and it is likely survivorship of this age class was increased during this productive year.

Harbor seal (*Phoca vitulina*) is one of two breeding phocid species which breed locally. These coastal seals are

Fig. 6. Seasonal deposition of marine mammals, 1997–2004



resident and make little migratory movements with the exception of juvenile dispersal period (S. Oates, unpublished data). Harbor seals were the second most abundant (12%) marine mammal reported each year. The seasonal pattern in deposition reflected the breeding season with the greatest deposition occurring May to November (Fig. 6b). There were no clear inter-annual differences, although a slight increase in mortality was evident during 1999 to 2002 (Fig. 7b).

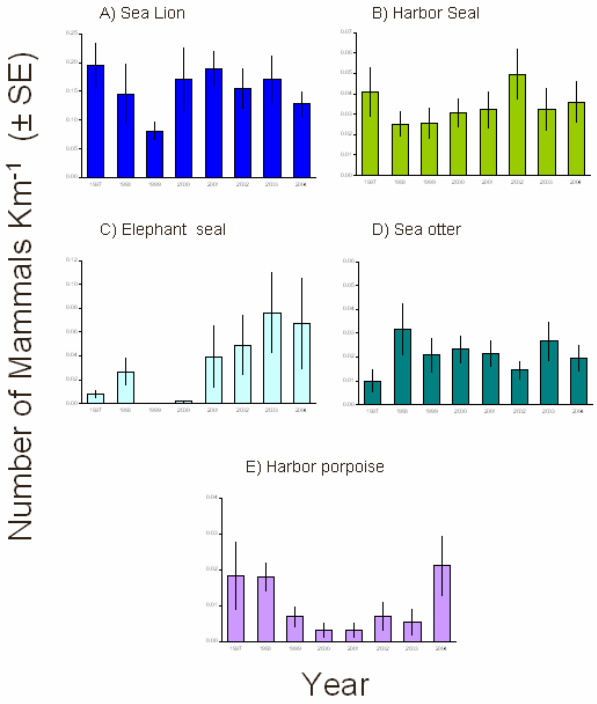
Northern elephant seal (*Mirounga angustirostris*) is an increasing locally breeding phocid. Elephant seals comprised 0 to 14% of new deposited marine mammals each year. We detected most mortality during the spring (March to May), during post-breeding, when the young weanlings leave the colony and experience the greatest mortality (Fig. 6c). Most of elephant seals recorded in surveys were immature. The inter-annual trend indicated an increasing mortality of this species during the study period (Fig. 7c). Increased deposition likely reflects an increasing local breeding population. Since the implementation of the 1972 Marine Mammal Protection Act, elephant seals have been increasing and established new breeding colonies in various sites in central California (Sydeman and Allen, 1999).


Harbor Porpoise (Photo: J. Harvey)

Carnivora - Mustelidae

Southern sea otter (*Enhydra lutris*) carcasses represent on average 7% of reported marine mammals each year. They were encountered frequently during

Fig. 7. Inter-annual deposition of marine mammals, 1997–2004



March to May, and October to November (Fig. 6d). Inter-annual comparisons indicated that 1998 and 2003 were years of increased otter mortality (Fig. 7d). Timely reporting of sea otter carcasses benefited CDFG researchers interested in identifying and quantifying specific mortality factors for this endangered species (Table 2).

Cetacea

Harbor porpoise (*Phocoena phocoena*) are the most abundant cetacean found during surveys (Table 3). Porpoise comprise ~3% of the yearly mammal deposition. Harbor Porpoise were most often reported during April to Oct, with few reported during winter (Fig. 6e). Increased deposition rates occurred in 1997, 1998, and 2004 (Fig. 7e). As was found with the Common Murres, the increase in 1997-1998 was in part due to an increase in gillnet fishing activity and associated bycatch of harbor porpoise during this time (Forney et al., 2001). The increase during 2004, however, remains unexplained. Too few carcasses were of fresh enough condition to conduct thorough necropsies.

On-going investigations

Sample collection


Tar ball (Photo: H. Nevins)

Since 1997, we have collected a number of birds to determine cause of death, for collaborative projects, and for use in the teaching collection at Moss Landing Marine Labs. In 1999, we established a collaborative effort with the California Dept. Fish and Game, Marine Wildlife Veterinary Care and Research Center (MWVCRC), Santa Cruz, to establish baseline cause of death and document disease factors for marine

birds using the veterinary expertise of Dr. David Jessup and Dr. Melissa Miller and Dr, Jim Hill at MWVCRC. We performed necropsies on 39 birds in 2000, and 24 in 2001. Dead beached birds in good condition are salvaged for the teaching and museum collection at Moss Landing Marine Labs. Often specimens are dissected in anatomy lessons or prepared for museum archives.

Bio-geographic project

In 2001, Beach COMBERS began a project to determine bio-geographic affinities of several migratory species in the MBNMS. We used a two methods, band and tag returns, and genetic analyses. In 2001, we began collecting toe clips of Sooty and Short-tailed Shearwaters for genetic analyses by Cheryl Baduini (Keck Science Center, Claremont Colleges, CA) to determine sex ratio and colony affinities of shearwaters. In 2002, we began collecting toe clips of Northern Fulmar for genetic studies by Scott Hatch (USGS-BRD, Alaska Science Center, Anchorage, AK).

Reassessment of Sample Design

We will conduct at least one reassessment or review of our sample methods and design. We conducted a preliminary pilot study to test some factors that might affect the results (e.g. sampling at high vs. low tide, sampling periodicity) and although we have currently been sampling a number of beaches more frequently we have not analyzed these data to determine whether we need to change our sample design. Therefore, we propose to convene a small workshop of the principal participants (i.e., H. Nevins, A. DeVogeleare, S. Lonhart, and J. Harvey) so we can review past methods and data analyses, and to critique our current methods and design. It is possible that we may reduce or increase the number of beaches surveyed, or sample fewer beaches but more frequently, or establish a better method of marking individuals during each survey. We have some of these data that might provide insights into proposed changes in methodology.

Communications with OSPR

One of the persistent problems encountered when interpreting COMBERS data is that during large oiling events oil spill response by Oil Spill Prevention and Response (OSPR) crews remove some or all carcasses from the beaches we survey. This decreases our measured deposition rates. For example, during the 1997-98 Tarball Event, deposition rates documented by Beach COMBERS for Oct. 1997 thru March 1998 were severely underestimated due to OSPR beach response at this time, although the oil event is still evident in the percent of oiled seabirds recorded at this time. This interaction may greatly affect the accuracy of our surveys during some months. In May 2004, we held a meeting with OSPR to resolve these issues. OSPR personnel agreed to provide us with the location, number, species, and condition of carcasses (e.g. toe clippings, amount of oil, etc.) removed from MBNMS beaches during oil spill response. We also proposed a future meeting to be held at CDFG-OSPR headquarters in Sacramento to present Beach COMBER data and discuss the value of these data for Natural Resources Damage Assessment needs.

2004 RESEARCH HIGHLIGHTS

• Long-billed Murrelet (*Brachyramphus perdix*). A very unusual Siberian species (and only recently split from the Marbled Murrelet) was found beached October 2004 on New Brighton State Beach, near Aptos by volunteers Linda Jordan and Dave Evans (beach 1). Very similar to the Marbled Murrelet, the Long-billed should only really be identified by an expert. We submitted this photo and a description to several rare bird experts. This is one of very few (<5) sightings in Santa Cruz County. See a photo and information about this rare sighting on Steve Hampton's website: [http://www.geocities.com/RainForest/Canopy/6181/MAMULBMU.htm]

• Increased stranding rates of Harbor Porpoise (*Phocoena phocoena*). Harbor Porpoise is a small, semi-gregarious, coastal cetacean. They are one of the most inconspicuous marine mammals in the sanctuary, sometimes described as "sneaky". They are chocolate brown in coloration, make fast movements, and are small in size. Adult average length is 130 cm (feet). They are affected by human activities; they are particularly susceptible to entanglement in gill net fisheries.

• Tail-end of the 2003 die-off Northern Fulmar (*Fulmarus glacialis*). Beach COMBERS continued to document increased fulmar mortality associated with a winter "seabird wreck" which began in November 2003. Elevated deposition of this species on beaches was noted into April 2004. Necropsies revealed that most birds were severely emaciated young-of-the-year birds likely died because of food availability on foraging areas between Alaskan colonies and California winter areas.[PDF = COMBERS_Northern Fulmar2]

• BeachCOMBERS participated in beach bird symposium, Pacific Seabird Group Meeting, 19-23 January 2005, Portland, Oregon. The PSG meeting was a great forum for discussions among 12 participants in the day-long session on results of beach surveys from survey programs from Europe and US. Proceedings from this meeting will be prepared and published in Marine Ornithology. [http://www.marineornithology.org/]

• Comparison with Marine Mammal Stranding Network. COMBERS provide information about stranding marine mammals to Monterey and Santa Cruz county chapters of a national network of the National Marine Fisheries Service. In a recent comparison of stranding data between the network and COMBERS, we found that whereas the network is more effective in documenting and responding to rare standings of large cetaceans (such as the October 2004 Blue Whale at Del Monte Beach, and the Baird's Beaked Whale at Waddell Creek Beach), the COMBERS are better at documenting stranding of pinnipeds and small cetaceans (such as harbor porpoise) at remote beaches. The difference between the two programs is that COMBERS data is collected systematically but bi-monthly, whereas the network data is recovered from public calls and is affected by the number of people visiting a beach. See link to MLML stranding network [http://birdmam.mlml.calstate.edu/]

PROGRESS ON GOALS

1. Assessment of sample design:

Completed (20%):

- GPS use on some beaches to rectify location of marine mammals.
- Coordination with MM Stranding network for mm reporting.
- Weekly surveys of Beach 8 (2002)

To complete (80%):

- Permanent marks for marine mammals to resolve identity.
- Analyze data for weekly surveys of beach 8 (efficacy of greater frequency of surveys)
- Workshop top review sample design.

2. Communication with OSPR:

Completed (95%):

- Meeting with OSPR (9 Jan 2004).

To complete (5%):

- Presentation to OSPR in Sacramento.
- Ongoing discussion about oil sampling.

3. Products:

Completed (50%):

- Website information provided to MBNMS.
- Monthly communication to volunteers via email.
- Newsletter (a version completed, but eventually abandoned).

To complete (50%):

- Annual Report.
- Manuscripts

OTHER ACCOMPLISHMENTS

- Presentations: Sanctuary Currents (2003, 2004, 2005), Gulf Farallones Symposium (2004), TWS (2004), PSG (2001–2005), Marine Mammal Stranding Conference (2004, 2005).
- NOAA Environmental Hero award (2004)
- Involvement in Teacher Workshop (Summer 2004)
- Involvement in OSPR Oiled Wildlife Response Plan
- Interview with BBC Canada
- Team Ocean training – MBNMS

- Scientific Collaborations (USGS, Claremont, UC Davis)

FUTURE GOALS

- Continue beach surveys
- Conduct volunteer training and enrichment sessions
- Continue data analysis and presentation (add one student to payroll)
- Conduct sample design evaluation
- Presentation for OSPR in Sacramento
- Manuscript submittal
  - Chronic oiling in MBNMS
  - 2003-04 Northern Fulmar die-off
  - Long-term trend overview
- Increase integration among regional specialists to understand disease & other causes of mortality
  - wildlife & pathology experts
  - rehabilitation centers
  - other beach survey programs

SIMoN- MBNMS INVOLVEMENT

- Continued website and listserve support
- Improve volunteer coordination and public outreach with other MBNMS groups (e.g. Team OCEAN)
- Develop interactive mapping data for teachers, public and volunteers

ACKNOWLEDGEMENTS

Beach COMBERS was supported by Moss Landing Marine Laboratories through a research grant from the Monterey Bay National Marine Sanctuary – Science Integrated Monitoring Program. This work was greatly improved by the collaborative involvement of scientists, resource managers, MLML students and interns, CDFG- Marine Wildlife Veterinary Care and Research Center staff, and MBNMS and SIMoN staff, interns, and research team. This work could not have been accomplished without skilled and dedicated volunteers: Carole Adams, Josh Adams, Phil Adams, Marti Ainsworth, Jack Ames, Joy Bader, Nick Bader, Emily Beggs, Scott Benson, Dede Bent, Eva Berberich, Ken Blood, Tiffini Brookens, Deb Brownstein, Erica Burton, Rob Burton, Robin Carle, Heather Cauldwell, Arthur Chapman, Tish Conway-Cranos, Gwynne Corrigan, Jerry Crews, Lucky Crews, Jim Crowley, Deirdre Darst, Jean DeMarignac, Andrew DeVogelaere, Gail Dinsmore, Dave Dixon, Dave Evans, Karin Forney, Bill Garrison, Judy Garrison, Nancy Gong, Deirdre Hall, Heather Harris, Michael Harris, James Harvey, Brian Hatfield, Chuck Haugen, Jack Hawks, Dawn Hayes, Cynthia Hays, Walter Heady, Laird Henkel, Margo Hober, Jon Hubbard, Jen Jolly, Linda Jordan, Kathryn Karako, Pamela Kearby, Meisha Key, Aaron King, Chad King, Karen Kroslowitz, Dorothy Kukla, Kristen Kusic, Jeff Kwasny, Sue Kwasny, Stewart Lamerdin, Inger Marie Laursen, Carol Maehr, Erica Massengill, Ron Massengill, Sharon McGuire, John McKenney, Jenna McMahon, Chris Miller, Melissa Miller, Natalie Moss, Rich Muller, Kriss Neuman, Colleen Nevins, Kelly Newton, Julia Niland, Stori Oates, Mike Orlando, Regena Orr, Duane O'Sullivan, Frank O'Sullivan, Jennifer Parkin, Jenny Pederson, Josh Pederson, Linda Perkins, Gene Pfeifer, Kathy Pfeifer, Beth Phillips, Kristin Rasmussen, Cassandra Roberts-Lamerdin, Christy Roe, Michele Roest, Nora Rojek, Kristina Schaffran, Barbara Schwefel, Glenn Seiler, Teri Sigler, Alex Sims, Greg Smith, Sarah Smith, Sharese Thompson, Christy Uschynk, Barbara Voss, Bridget Watts, Sophie Webb, Liz Wheeler, Petra Witkowsky, Jeannette Wolff, Peter Wolff, and Mary Yoklavich.

Volunteer Liz Wheeler inspects a common murre during a foggy survey at Marina State Beach (#8), Monterey County (Photo: H. Nevins).

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Appendix A: Beach COMBER training agenda, Summer 2002.

Beach COMBER Training Agenda
Moss Landing Marine Laboratories
9am -2pm

First Meeting –Introduction

I. Purpose of program and its importance (Kelly Newton)
   a. Short term and long term goals
   b. Other beachcomber programs
   c. Role of volunteers
   d. Sign waivers, questionnaire
II. Sampling design and methods (Jim Harvey)
III. Data collection (Hannah Nevins)
   a. Data form description
   b. Toe clipping and marking
   c. Marine mammal response and measurements
IV. Review of local community assemblage

4 May Second Meeting – Seabirds

I. Seabird identification and natural history
   a. Slides of major orders and families
   b. Feet and beaks, measurements
   c. Sex and age determination
   d. Live birds
II. Seabird Collection – study skins
   a. Review of families

11 May Third Meeting – Marine mammals and turtles

I. Marine Mammals: pinnipeds, cetaceans and otters
   a. Slides of local mammal species
   b. Skulls and dentition of marine mammals
   c. Study skins of local species
   d. Sex and age determination
   e. Measurements and Marking carcasses
   f. Marine mammal stranding network
II. Sea Turtles

18 May Fourth Meeting

I. Summary and Wrap- up
   a. Beak and Feet quiz
   b. Seabird identification review
   c. Mammal review
II. Beach safety
   a. Weather – wind and swell
   b. Toxic substances, other hazards
III. Oil documentation and collection
   a. Tarball collection and documentation
   b. Oiled bird collection
IV. Beach Assignments and equipment distribution
V. Field Training – to the beach!!!

Appendix B: Beach COMBER form 1: header datasheet

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_____
_____

Appendix B: Beach COMBER form 2: beached organism datasheet

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	Tag	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/flippersonly), 7 (other).
Photo: Y (yes), N (no).
Tag: 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.

Appendix C: COMBER collaborators

Name, Affiliation	Subject	Description
Cheryl Baduini Claremont Colleges Claremont, CA	Sooty Shearwater genetics	COMBERS provide toe-clips for genetic sexing and population studies.
Dan Anderson, Eduardo Palacios, and Frank Gress University of California Davis, CA	Brown Pelican demographics	COMBERS record the age of pelicans and measure bill and tarsus (leg)
Scott Hatch, Alaska Science Center Anchorage, AK	Northern Fulmar genetics	COMBERS provide toe-clips for genetic population studies and record color morphs.
David Jessup, Melissa Miller, and Jim Hill California Dept. of Fish and Game - Marine Wildlife and Veterinary Care and Research Center Santa Cruz, CA	Seabird necropsy and pathology	COMBERS collect fresh specimens for necropsy to determine cause of death.
Mike Harris and Jack Ames California Department of Fish and Game Sea Otter Program Monterey Bay Aquarium	Sea otter recovery	COMBERS record and call in fresh specimens for recovery.

Appendix D. Status of seabird species encountered during beach surveys in Monterey Bay National Marine Sanctuary. FE=Federal End, SE=State End, FT=Federal Threat, CSC=CA Special Concern species, FSC=Federal Special Concern species, MNBMC=Migr. Nongame Bird of Management Concern. Based on Roberson (2002), NDDB website (1999), and AOU (2004).

ORDER (Family)	COMMON NAME	SPECIES NAME	STATUS
Anseriformes (Anatidae)	Surf scoter	*Melanitta perspicillata*	
	White-winged scoter	*Melanitta fusca*	
	Black scoter	*Melanitta nigra*	
Gaviiformes (Gaviidae)	Common loon	*Gavia immer*	CSC, MNBMC
	Red throated loon	*Gavia stellata*	
	Pacific loon	*Gavia pacifica*	
	Yellow-billed loon	*Gavia adamsii*	
Podicipediformes (Podicipediae)	Western grebe	*Aechomophorus occidentalis*	
	Clark's grebe	*Aechomophorus clarkii*	
	Pied-billed grebe	*Podilymbus podiceps*	
	Red-necked grebe	*Podiceps grisegena*	
	Horned grebe	*Podiceps auritus*	
	Eared grebe	*Podiceps nigricollis*	
Procelliformes (Diomedidae)	Black-footed albatross	*Phoebastria nigripes*	
	Laysan albatross	*Phoebastria immutabilis*	
	Short-tailed albatross	*Phoebastria albatrus*	FE, SE
(Procellaridae)	Northern fulmar	*Fulmarus glacialis*	
	Sooty shearwater	*Puffinus griseus*	
	Buller's shearwater	*Puffinus bulleri*	
	Pink-footed shearwater	*Puffinus creatopus*	
	Short-tailed shearwater	*Puffinus tenuirostris*	
	Black-vented shearwater	*Puffinus opisthomelas*	
(Hydrobatidae)	Ashy storm-petrel	*Oceanodroma homochroa*	CSC, MNBMC
	Black storm-petrel	*Oceanodroma melania*	CSC
	Fork-tailed storm-petrel	*Oceanodroma furcata*	CSC
	Leach's storm-petrel	*Oceanodroma leucorhoa*	
Pelecaniformes (Pelecanidae)	California brown pelican	*Pelecanus occidentalis*	FE, SE, MNBMC
	American white pelican	*Pelecanus erythrorhynchos*	CSC
(Phalacrocoracidae)	Double-crested cormorant	*Phalacrocorax auritus*	CSC
	Brandt's cormorant	*Phalacrocorax penicillatus*	
	Pelagic cormorant	*Phalacrocorax pelagicus*	
Charadriiformes (Scolopacidae)	Red-necked phalarope	*Phalaropus lobatus*	
	Red phalarope	*Phalaropus fulicaria*	
(Laridae)	Parasitic jaeger	*Stercorarius parasiticus*	
	Pomarine jaeger	*Stercorarius pomarinus*	
	Heermann's gull	*Larus heermanni*	
	Bonaparte's gull	*Larus philadelphia*	
	Ring-billed gull	*Larus delawarensis*	
	California gull	*Larus californicus*	CSC
	Western gull	*Larus occidentalis*	
	Glaucous-winged gull	*Larus glaucescens*	
	Mew gull	*Larus canus*	
	Laughing gull	*Larus atricilla*	CSC
	Black-legged kittiwake	*Rissa tridactyla*	
	Black skimmer	*Rynchops niger*	CSC
	Black tern	*Chlidonias niger*	FSC, CSC, MNBMC
	California least tern	*Sterna antillarum*	FE, SE, MNBMC
	Caspian tern	*Sterna caspia*	
	Elegant tern	*Sterna elegans*	FSC, CSC, MNBMC
	Forster's tern	*Sterna forsteri*	
(Alcidae)	Common murre	*Uria aalge*	
	Tufted puffin	*Fratercula cirrhata*	CSC
	Rhinocerous auklet	*Cerorhinca monocerata*	CSC
	Pigeon guillemot	*Cepphus columba*	
	Xantus' murrelet	*Synthliboramphus hypoleucus*	MNBMC
	Marbled murrelet	*Brachyramphus marmoratus*	FT, SE, MNBMC
	Cassin's auklet	*Ptychoramphus aleuticus*	
	Horned puffin	*Fratercula corniculata*	
	Ancient murrelet	*Synthliboramphus antiquus*	

Appendix E: 2003-04 Northern fulmar necropsy results

Parameter (mean, ± SD, n)	Male		Female		All	
Morphometrics						
Culmen (mm)	37.2 ± 1.4	68	35.7 ± 1.8	68	36.5 ± 1.7	179
Tarsus (mm)	51.0 ± 2.0	69	48.4 ± 1.9	67	49.6 ± 2.3	184
Bill Depth (mm)	13.6 ± 0.7	68	13.0 ± 0.7	68	13.2 ± 0.8	181
Bill Width (mm)	11.1 ± 1.4	68	10.7 ± 1.4	68	10.9 ± 1.4	183
Body Condition						
Body Mass (g)[1]	458 ± 56	48	399 ± 63	54	425 ± 66	115
Muscle Mass (g)	14.0 ± 2.5	66	13.1 ± 2.6	56	13.5 ± 2.7	130
Liver Mass (g)	8.9 ± 1.8	67	8.3 ± 1.7	63	8.6 ± 1.8	137
Subcutaneous fat (mm)	0.1 ± 0.2	69	0.1 ± 0.2	68	0.05 ± 0.16	146
Total Sample size *n*		69		68		186

[1] Wet or waterlogged specimens were excluded.

Beach Combers Volunteers

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