SOUTHERN SEA OTTER RESEARCH UPDATE MEETING
December 11, 2007
La Feliz Room, Seymour Marine Discovery Center
Long Marine Laboratory

Presentation Abstracts

East vs. West: The Emerging Picture of Sea Otter Ecology at the Commander Islands
Gena Bentall, Monterey Bay Aquarium, gbentall@mbayaq.org

As research continues into the ecology of the Russian sea otter (*Enhydra lutris lutris*), a clearer picture of this near carrying capacity population begins to emerge. In 2006 at Bering Island, the largest of the Commander Islands, 27 sea otters were instrumented with VHF radios and TDRs. A crew returned in summer 2007 to collect survival, foraging, and activity budget data. The results of the analysis of these data and a projection of future plans for this project will be presented.

Update on Valvular Endocarditis and Septicemia Due To *Streptococcus infantarius* ssp. *coli* in Sea Otters
Barbara A. Byrne, University of California, Davis, bbyrne@ucdavis.edu

Valvular endocarditis/septicemia due to *Streptococcus infantarius* ssp. *coli* has been identified as an important cause of mortality in northern sea otters and occurs sporadically in southern sea otters. Our laboratory has examined the genotypes and pathogenicity of *S. infantarius* ssp. *coli* isolates from both sea otter populations. We have determined that the streptococci found in northern sea otters are highly related to one another but distinct from those found in southern otters. Furthermore, our work has demonstrated that most isolates from otters are capable of survival within macrophages. Preliminary work has shown that some sea otter isolates are capable of adhering epithelial and endothelial cells. These findings support our hypothesis that bacteria enter through the gastrointestinal tract to colonize the heart or cause septicemia. Our group has tested prey species from California and Alaska for *Streptococcus infantarius* ssp. *coli* to determine potential sources of this opportunistic pathogen. The preliminary findings from these studies will be presented.

Southern Sea Otter Management Update
Lilian P. Carswell, U.S. Fish and Wildlife Service, lilian_carswell@fws.gov

This presentation will provide brief summaries of management issues and activities relating to southern sea otters.

Sea Otters: Defenders of Wildlife's Efforts in Conservation, Advocacy, and Education
Jim Curland, Defenders of Wildlife, jcurland@defenders.org

Defenders of Wildlife's marine program focuses on specific issues that will have the greatest overall impact to our coastal and marine environment. Working in collaboration with a number of other conservation organizations and scientists, Defenders is working on protecting key marine areas, reducing the impacts of over-fishing and certain fishing practices (bycatch), recovering declining marine species—particularly the threatened southern sea otter, and reducing environmental pollutants to our coastal waters. We recognize that a thriving marine and coastal environment will engender economically viable and healthy coastal communities. Defenders' premises for our sea otter program are based on: 1) sea otters are keystone and indicator species; 2) if sea otters are unable to thrive or are declining, part of their plight may signal that there are significant problems with the overall health of the coastal ecosystem—health problems that may affect humans as well as sea otters and other marine species; and that, 2) unfortunately, the sea otter, particularly the southern sea otter, continues to face a number of threats, some of which may include food limitation, habitat degradation, entanglement in fishing gear, and impacts from environmental contaminants. Defenders' primary focus is on the southern and Alaskan (emphasis on the SW stock of northern sea otters in Alaska) sea otter populations, while we are involved with issues related to the Washington state and Canadian sea otter populations. The southern sea otter program includes, among various efforts, educational outreach (which

includes the annual Sea Otter Awareness Week), stakeholder meeting participation, advocating strong recovery planning, and implementation and policy issues, promoting fishery-gear restriction strategies, and securing federal and state research money. As of late, some of our sea otter work has involved a campaign for the sea otter tax check-off, a funding workshop in early March of this year, presiding as a member of the Southern Sea Otter Recovery Implementation Team and the SW Alaska Sea Otter Recovery Team, issues related to native take and sea otters and water quality issues as they relate to sea otters and nearshore ecosystem health.

Understanding Sea Otter Mortality at the Population Level

Jim Estes, U.S. Geological Survey, jestes@cats.ucsc.edu

Trends in sea otter populations are driven largely by variation in mortality. Four specific sources of mortality have been variously implicated as being important—disease, predation, food limitation, and incidental losses to fishing gear. We will discuss the nature of evidence for each and some of the difficulties inherent in interpreting this information. Overall, predation and incidental loss is difficult to document through field observation, but positive records are relatively easy to interpret. Disease and food limitation are relatively easy to document through field observations, but the information is often difficult to interpret. To illustrate these latter difficulties, we discuss observed relationships between disease exposure and population growth in Alaska, and between food limitation, dietary patterns, and disease exposure in California. These issues map onto the larger problem in ecology of understanding the importance of rarely seen events. We advocate the comparative approach in attempts to understand ultimate versus proximate causes of sea otter mortality and their effects on lambda, the population growth rate.

Determination of the Contribution of β-Carotene to the Dietary Vitamin A Supply of Sea Otters: An Introduction to the Methods and Study Design

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Recent research on the nutrient composition of sea otter diets from mainland CA shows that they provide marginal levels of vitamin A compared to the requirements of other carnivores and only about 50% of the vitamin A concentration found in the diets of the more successful otter population in Glacier Bay, Alaska. Vitamin A is an essential nutrient important for many physiological functions, including immune function, reproduction, growth, development, epithelial maintenance, and vision. Thus, a deficiency in vitamin A could play a role in the high incidence of infectious disease and low population growth in the CA sea otter population. However, sea otter prey species do contain significant amounts of beta-carotene, a potential precursor to vitamin A. While omnivores and herbivores can convert beta-carotene to vitamin A, most carnivores do so only very inefficiently. This study will measure sea otters' ability to utilize beta-carotene for vitamin A, allowing for an estimate the total vitamin A value of their food. The study design will involve dosing captive sea otters with stable isotope-labeled beta-carotene and tracing labeled metabolites, including vitamin A compounds, using mass spectroscopy. The results of this study will help to determine the likelihood of a vitamin A deficiency in sea otter populations.

Virulence Shift in a Wild Clade of *Toxoplasma gondii* Infecting Marine Mammals

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Toxoplasma gondii–associated meningoencephalitis is a significant disease of California sea otters (*Enhydra lutris nereis*) and other marine mammals. *Toxoplasma* isolates have been obtained from a harbor seal, a California sea lion, and 52 California sea otters since 1998. Based on multi-locus PCR-RFLP and DNA sequencing at polymorphic genes (B1, BAG1, BSR4, ROP1, SAG1, SRS9, GRA6, and GRA7), two distinct lineages have so far been identified: Type II and a new clade, called Type X, that possesses distinct alleles from archetypal strains at all eight polymorphic loci sequenced. The majority (72%) of marine mammal *Toxoplasma* infections were of Type X, with the remainder being infected with Type II strains. No Type I or Type III genotypes were identified. Type X strains have also been identified infecting a variety of terrestrial animals in the US, including humans. Phylogenetic analyses separated the Type X *Toxoplasma* isolates from Types I, II, and III. When assayed through mice, a number of Type X strains possessed differing degrees of virulence. The genetic basis for the altered virulence patterns among Type X strains is currently being assessed and will be presented.

Recent Southern Sea Otter Range-wide Survey Results and Stranding Numbers
Brian Hatfield, U.S. Geological Survey, brian_hatfield@usgs.gov

Results of the 2007 spring and fall (even if not yet completed!) range-wide sea otter surveys will be presented, as well as the results of recent counts at San Nicolas Island. A brief summary of 2007 sea otter stranding numbers will also be given.

Rub a Dub Dub: Update on Thermoregulatory Physiology of Washing Sea Otters
David A. Jessup, Marine Wildlife Veterinary Care and Research Center, djessup@ospr.dfg.ca.gov

The primary means of removing oil from sea otters is washing them in dilute detergent with prolonged rinsing in warm water, forced-air drying, and recovery with variable access to seawater (Williams and Davis, 1995). In our initial efforts, we attempted to optimize the existing washing methods and procedures. We then used these standardized procedures to determine the effects of one variable, the type of water into which otters were released for recovery and self grooming—in order, ambient-temperature sea water; warm, soft fresh water; or ambient temperature soft fresh water. Both temperatures of soft fresh water appeared to promote much more rapid return of waterproofing, normal behaviors, physiology, and thermal profiles than did seawater, but we were concerned that some learned behaviors (e.g.,)may have confounded our serial experiments. We repeated the first washing and release into ambient temperature seawater and got the same results as the first trial despite a yearlong learning opportunity for each animal, showing that the results of the trial are real and repeatable. We believe we have identified a number of improvements in sea otter washing and care that could reduce time to recovery and time in care by about 50%. This could improve outcomes for free-ranging sea otters should a major oil spill in the southern sea otters' range occur.

Progress on Sea Otter Health-related Research
David A. Jessup, Marine Wildlife Veterinary Care and Research Center, djessup@ospr.dfg.ca.gov

Over the last 10 years, as we have investigated causes of southern sea otter morbidity and mortality, it has become clear that there are significant and complex interactions between disease agents, prey selection, contaminant exposure, algal intoxications, and possibly genetics. Great progress has been made in understanding the role and complexity of interaction of several types of sea otter mortality and in understanding the linkages to human activities along the California coast. During the last year we have seen new findings and ideas surface, several publications of note emerge in the areas of sea otter contaminants/toxicology and immunology, and connections between prey selection and ecology of the live animals identified. Increasing evidence point to various forms of pollution—some previously recognized, some new—as basic causes of many types disease in sea otters. This presentation will review some of these findings and concepts and attempt to summarize some of the progress made in the last few years.

Moss Landing Mystery Spill and the Red Tides of 2007
David A. Jessup, Marine Wildlife Veterinary Care and Research Center, djessup@ospr.dfg.ca.gov

In early November of 2007 conditions in Monterey Bay lead to a "red tide" event in which *Akashiwo sanguinea* was the dominant dinoflagellate. Formation off foam, scum, and slicks adjacent to red tide blooms was observable and prominently reported throughout the event. On November 11, a beaching of over 150 marine birds occurred, first off Sunset and Manressa beaches, west of Watsonville, then moving north toward Capitola and Santa Cruz. These beachings, primarily involving two species of scoter, several species of grebe, loons, and other coastal marine birds, appeared to follow the emergence of the red tide and lag behind it by a day or two. Because the birds were sticky/greasy, not waterproof, and smelled fishy and oily, CDFG-OSPR declared a "mystery spill" estimated to be greater than 44 gallons in marine waters. An investigation to identify the nature ands sources(s) of the material were undertaken by CDFG with cooperation from many other cooperating organizations and Monterey Bay institutions. A second beaching event involving over 180 northern fulmar occurred on beaches near Marina on November 20 and 21. These birds were also not waterproof, but presence of the fouling product was less distinct. A third beaching event involving over 150 sea birds, very similar to the first event, occurred around the weekend of November 24–25 on beaches in the Soquel–Capitola areas and Moss Landing. Surface seawater foam collected from areas near Santa Cruz during the event showed significant surfactant properties in simple bench top tests on normal bird feathers and carcasses. We believe a product or byproduct of the red tide, possibly a surfactant protein, was the cause of most of the

bird beachings during November 2007. Our work on washing sea otters has shown a number of similarities between sea bird and sea otter waterproofing problems, but sea otters did not appear to be involved in the fouling phenomenon. However, since November 20, eight dead sea otters in Monterey Bay have been discovered and investigation into their cause of death and potential relationship to the red tides is under investigation.

A New Permit for Research with Captive-held Southern Sea Otters

Andrew Johnson, Monterey Bay Aquarium, ajohnson@mbayaq.org

The program plan for the Sea Otter Research and Conservation (SORAC) program at the Monterey Bay Aquarium includes an emphasis on captive research. In 2008, the Division of Management Authority of the U.S. Fish and Wildlife Service will issue the SORAC program a new permit that, among other things, will authorize us to embark on directed studies using captive-held southern sea otters (i.e., live-stranded otters slated for eventual release to the wild and non-releasable or conditionally releasable animals). This presentation will outline the salient features of the permit.

Putative Blue-Green Algal Toxicosis in Southern Sea Otters

Melissa Miller, Marine Wildlife Veterinary Care and Research Center, mmiller@ospr.dfg.ca.gov

Between January and November 2007, four southern sea otters presented for necropsy at MWVCRC with gross lesions consistent with acute, severe liver failure. The affected otters were mildly to markedly icteric (jaundiced) and their livers were swollen and friable (easily fragmented) with multifocal hemorrhage. All affected animals to date have stranded in central and southern Monterey Bay. Histopathology revealed severe hepatic necrosis and massive acute hemorrhage. The few surviving hepatocytes were enlarged and swollen with severe vacuolation of the cytoplasm and distinctive, patchy clumping of the cytoskeleton. Rare cells resembling free-floating liver cells were observed within hepatic venules. Serology and immunohistochemistry for *Leptospira* antigens were universally negative and bacterial culture did not reveal a consistent bacterial pathogen. Frozen livers were submitted for evaluation for the presence of algal hepatotoxins to the CDFG-Water Pollution Control Laboratory: All 3 animals tested positive for microcystin, a potent algal hepatotoxin that most commonly affects domestic animals and humans. This toxin is usually associated with blooms of blue-green algae in warm, stagnant, nutrient-rich freshwater lakes or ponds. This is the first report of mortality of marine mammals due to hepatotoxins produced by blue-green algae. An investigation of potential environmental sources of the algae and toxins has been initiated; preliminary findings will be discussed.

Findings from a Study of *Toxoplasma* in Marine Invertebrates and Terrestrial Carnivores in Central California and Results from an Investigation of a Mortality Event Impacting Sea Otters in April 2004

Melissa Miller, Marine Wildlife Veterinary Care and Research Center, mmiller@ospr.dfg.ca.gov

The purpose of this presentation is to summarize results from two long-term studies for review and discussion by the sea otter community.

Between 2000 and 2005, 45 terrestrial carnivores (lions, bobcats, domestic cats and foxes) and 1,396 invertebrates (mussels, clams and worms) were collected and screened for *Toxoplasma gondii* using PCR and DNA sequencing to 1) determine the phylogeographic distribution of *T. gondii* genotypes present and 2) determine whether the Type X strain that dominates in otters is also common in local terrestrial animals and downstream invertebrates. Marine bivalves have previously been shown to concentrate *T. gondii* oocysts in the laboratory, but a comprehensive survey of wild invertebrates has not yet been reported. Of 1,396 invertebrates tested, a wild mussel collected within an estuary draining into Monterey Bay was confirmed positive for Type X *T. gondii*. This *T. gondii*–positive mussel and a sand crab that initially tested positive for *T. gondii*, but was unconfirmed, were both collected within three weeks of the first major flush of rainfall in fall 2002. Of 45 carnivores tested, 15 had PCR-confirmed *T. gondii* infections; 11 were infected with archetypal Type I, II, or III strains; and 4 were infected with Type X *T. gondii*. The 4 Type X strains infecting 2 mountain lions, a bobcat, and a fox were identified in coastal watersheds adjacent to sea otter habitat in the Monterey Bay and Estero Bay regions. Confirmation of Type X *T. gondii* in coastal-dwelling felids, canids, a marine bivalve, and nearshore-dwelling sea otters supports the hypotheses that feline fecal contamination is flowing from land to sea through surface runoff, and that otters are infected with *T. gondii* via consumption of filter-feeding invertebrates.

The second study was an in-depth investigation of an unusual mortality event affecting southern sea otters. During April 2004, 40 southern sea otters were recovered dead or dying near Morro Bay, California. Live-stranded otters exhibited seizures, tremors, paresis, somnolence, coma, melena, hyperthermia and emaciation; most died or were euthanized within 48 hours due to the severity of their symptoms. Because of the localized nature of this event and signs consistent with acute neurological disease, exposure to a marine biotoxin, such as domoic acid (DA) was considered likely. However, postmortem examinations revealed findings consistent with an infectious etiology, including lymphadenopathy, nodular hyperplasia of splenic white pulp, and myocarditis. This epizootic was extensively investigated using histopathology, immunohistochemistry, bacterial culture, and biotoxin testing of otter urine, stomach contents, and invertebrate prey. Serological and PCR screening for viruses (morbillivirus, parvovirus, encephalomyocarditis virus, phocine herpesviruses, and West Nile virus) and apicomplexan protozoa (*Toxoplasma gondii*, *Neospora caninum*, and *Sarcocystis neurona*) were also performed. Our investigation identified a terrestrial pathogen, *S. neurona*, as the cause of this epizootic. Of 16 otters examined in detail, 13 had *S. neurona*–associated meningoencephalitis. The focally severe character of this event and detection of high concentrations of anti-*S. neurona* IgM in the majority of stranded animals is supportive of point-source exposure to *S. neurona*, most likely as infective sporocysts from a terrestrial source.

Pathogen Pollution Project: Sea Otter Habitat Quality Update

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Water quality affects both human and animal health, and yet much remains unknown about how best to monitor and mitigate water and habitat quality in coastal ecosystems. Our ongoing Pathogen Pollution Project (P3) aims to evaluate water quality monitoring methods, fecal source tracking technology, terrestrial animal/otter pathogens, and wetlands as a potential Best Management Practice (BMP) to improve the quality of water reaching sea otter habitat. The first aim, to evaluate water quality monitoring methods, started in the spring of 2007 and involves monthly sampling of the 10 main tributaries to the Monterey Bay region, as well as quarterly sampling of ocean/mussels from 6 sites (3 Monterey Bay, 3 Morro Bay) and of sewage influent/effluent from 4 treatment plants. Preliminary results will be presented to evaluate whether standard water quality indicators (high total coliform, fecal coliform, and *Enterococcus* counts) are associated with direct detection of selected protozoal and bacterial pathogens, whether indicator and pathogen detection is higher in sentinel mussels or the surrounding waters, and whether the sewage treatment plants are significantly reducing the load of indicator bacteria and pathogens entering nearshore waters. Distribution of study sites and indicator/pathogen detection will also be discussed to provide insights on sea otter habitat quality along the central coast.

Patterns of Body Size, Growth, and Condition Among Sea Otter Populations: What Can It Tell Us About Population Status? or, A Tale about Tail Length

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An international fur harvest decimated sea otter populations during the 18th and early 19th centuries. Since then sea otter populations have existed at every stage in the recovery process, allowing examination of populations at various stages of resource limitation—from newly founded populations with abundant food resources to long-established populations existing at the limit of resource availability. Morphometric data provides direct measures that can be used to evaluate body size and condition relative to population status at various temporal scales. Sea otter length and mass data was compiled and examined from several thousand individual otters over their entire modern-day range, spanning five decades. Resource availability over two long-term time scales (i.e., the past 2–4 years and the past 10–20 years) may be reflected in the characteristics of standard growth curves, and current population status is reflected by body condition at the time of sampling. Results suggest asymptotic length reflects resource availability over the average lifetime of an otter (10–20 yrs) while growth rate reflects conditions over the average developmental period (2–4 yrs). From this analysis, a body condition index has been developed that appears very sensitive to current resource availability/quality—so sensitive, in fact, that differences in average proportional tail length between populations have become apparent. Individual variability in proportional tail length is high, but patterns relative to overall length, sex, and population can be identified. These results strongly suggest that tail length should be measured and accounted for when assessing body condition, especially when comparing genetically isolated populations.

Using Stable Isotopes to Investigate Individual Diet Specialization in California Sea Otters (*Enhydra lutris nereis*)
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Differences in diet composition among con-specifics (dietary specialization) have been documented across a broad range of taxonomic groups and habitats, and such variation at the individual level is increasingly recognized as an important component of diversity in trophic interactions. Accurate identification of individual dietary specialization, however, requires longitudinal dietary records that are labor-intensive and cost-prohibitive to obtain for many species. Here we explore the use of stable isotopes (δ13C and δ15N) as a promising technique for detecting and quantifying patterns of individual dietary specialization. Southern sea otters (*Enhydra lutris nereis*) offer a unique opportunity for testing this approach because 1) they consume a wide variety of prey that span multiple trophic levels, habitats, and ecologically defined functional groups; 2) individual diet specialization can be validated with existing observational data. We analyzed the isotopic composition of sea otter vibrissae (n=31) in order to characterize inter- and intra-individual variation in sea otter diets at Monterey Bay, CA. At the population-level, sea otters showed substantial variation in both δ13C and δ15N values, occupying nearly all of the "isotopic space" created by the diversity of isotopic signatures of potential prey taxa. Most of the variation in sea otter vibrissae was accounted for by differences between individuals, with much less contributed by within-individual variation. A majority of sea otters (~80%) showed relatively little temporal variability in isotopic composition, suggesting that the proportional composition of most individuals' diets is relatively constant over time; a few individuals (~20%) exhibited a high degree of intra-vibrissae isotopic variability, suggesting seasonal shifts in diet composition. These results and our interpretation of them were supported by long-term observational data on the diets of radio-tagged sea otters from the same population (n=23). Our results demonstrate that stable isotopes can provide an efficient tool for measuring individual- and population-level dietary breadth, and may be useful for studying populations where longitudinal data on individuals would otherwise be impossible to acquire. This will be critical for examining the causes and consequences of dietary variation within and among consumer populations, thereby improving our understanding of these important ecological and evolutionary processes at the community level.

Famine Then Feast: Effects of Ephemeral Resources on Females Rearing Pups along Monterey Peninsula
Teri Nicholson, Monterey Bay Aquarium. tnicholson@mbayaq.org

Females demonstrate an array of strategies, such as resting ashore or increasing foraging effort, to compensate for greater energetic demands of rearing a pup along Monterey Peninsula. The extent to which females compensate may then have profound effects on their health, reproductive success, and long-term survival. The environment, however, is dynamic; resources are ephemeral, and by necessity, female behavior may vary seasonally and annually. By reviewing the outcomes of known wild females along the Monterey Peninsula from 2004 to 2007, we present a preliminary survey of how females responded to their changing environment, and explore the longer-term consequences of their behavior on reproduction and survival.

Southern Sea Otters and Sound: Auditory Adaptations in a Transitional Marine Carnivore
Colleen Reichmuth, University of California, Santa Cruz, coll@ucsc.edu

Surprisingly little is known about the sensory biology of sea otters, the most recent mammal to transition from a terrestrial to a marine lifestyle. In particular, there is virtually no data concerning the auditory capabilities of sea otters. Such information would be relevant to an improved understanding of the evolutionary pressures shaping underwater perception in marine mammals, the interaction between perceptual, behavioral, and ecological aspects of sea otter life history, and the vulnerability of these animals to human disturbance in nearshore marine environments. We plan to apply three approaches to examine the auditory adaptation of sea otters: comparative investigation and description of auditory anatomy, measurement of relevant aspects of auditory function using neuro-physiological methods, and cooperative behavioral assessment of amphibious hearing capabilities. This effort, planned to begin in 2008, will capitalize on expertise and resources from ongoing programs at Long Marine Laboratory, Monterey Bay Aquarium's Sea Otter Research and Conservation (SORAC) program, and California Department of Fish and Game's Marine Wildlife Veterinary Care and Research Center.

Transport of *Toxoplasma gondii* from Land to Sea: How, When, Where, and Why?
Karen Shapiro, University of California, Davis, kshapiro@ucdavis.edu

Toxoplasma gondii infects a large proportion of Southern sea otters along the central California coast. Felids are the only known definitive host of this protozoan parasite, and sea otters are thought to become infected after accidental ingestion of oocysts that are carried to near coast waters through contaminated freshwater runoff. We recently evaluated the surface charge (zeta potential) and hydrophobicity of *T. gondii* oocysts to determine how the surface properties of this pathogen enable its transmission from cats to sea otters through aquatic environments. Results show that *T. gondi*i oocysts are negatively charged when suspended in fresh waters, but their charge is neutralized in water with increased salinity such as estuarine and marine waters. Hydrophobicity experiments revealed that oocysts are very hydrophilic; that is, they are "water loving." Hydrophilic and negatively charged oocysts could be easily mobilized from cat feces and become entrained in freshwater runoff to coastal waters. However, the loss of negative charge and associated potential to repel other negatively charged particles results in an increased likelihood of oocyst flocculation in marine waters. At locations where fresh and salt water mix, a high proportion of oocysts is likely to stay suspended in the water with marine aggregates or fall to the ocean floor and accumulate in sediment. In sea otter habitats such as Elkhorn Slough, such mixing only occurs during high-flow winter storms when contaminated runoff reaches near-shore waters, forming distinct high-risk zones where otters are likely to become exposed to *Toxoplasma*.

Sea Otter Distribution, the No-otter Zone, and "Recovery" Under the MMPA and ESA
Steve Shimek, The Otter Project, steve1096@sbcglobal.net

This talk will very briefly review the genesis of the no-otter zone and the criteria defining "failure." The talk will review what is known about pre-hunt sea otter distribution and what that distribution means in terms of "recovery" under the Marine Mammal Protection Act and the Endangered Species Act.

One Year Later: An Update on the Causes and Consequences of Diet Specialization in a Top Predator—Individual Variation in Maternal Care, Provisioning and Pup Development in the Southern Sea Otter (*Enhydra lutris nereis*)
Michelle Staedler, Monterey Bay Aquarium and University of California, Santa Cruz, mstaedler@mbayaq.org

Over the past year, fifteen VHF and TDR instrumented female sea otters inhabiting coastal waters around the Monterey Peninsula have been monitored at least three days a week to compile individual forage, reproductive and maternal investment strategies. Twelve females have pupped with varying degrees of success. To date only three pups (two males and one female) have weaned successfully. This update will focus primarily on these three mother-pup pairs: the mothers' diet specialization, the pups' development, and the successful weaning. Fifteen new females were instrumented in 2007, and data collection on thirty females including three new mother-pup pairs continues. Comprehensive data entry and analyses are in progress.

Walking the Science Talk in a Web-centric World
Jane Stevens, Tagging of Pacific Predators, jstevens@mmjourno.com

With most traditional news organizations laying off their science reporters, and schools teaching less and less science, scientists and their institutions have an opportunity to step into the vacuum and use the Web to tell their own stories, build communities, and engage people in those communities to participate in and advance science. The presentation will provide an overview of some current projects (e.g., Seaotterresearch.org, GreatTurtleRace.com, TOPP.org) and a proposal (Oceans Now!).

Exploring the Terrestrial Side of Potential Land-sea Transmission of *Toxoplasma gondii* in Coastal California
Elizabeth VanWormer, University of California, Davis, evanwormer@ucdavis.edu

Toxoplasma gondii, a globally distributed protozoan parasite, infects a wide range of birds and mammals, including humans. Identified as a significant cause of mortality in the threatened California Southern sea otter population, *T. gondii* also presents an important public health concern. The terrestrial shedding of *T. gondii* by wild and domestic felids and studies linking otter infection to freshwater run-off suggest potential land to sea pathogen transmission along California's central coast. High-risk

sites for marine exposure to *T. gondii* have been identified, but parasite burden in the terrestrial environment is not well characterized. Current limitations of molecular tests prevent direct measurement of parasite load in the environment. Our collaborative, interdisciplinary research approach, using current epidemiologic and molecular techniques, is addressing the hypothesis that terrestrial environmental contamination with oocysts and risk of exposure to *T. gondii* can be predicted based on the prevalence of infection in domestic felid, wild carnivore and wild rodent populations. Identifying areas of increased terrestrial *T. gondii* exposure and risk factors for environmental parasite accumulation will facilitate the identification and implementation of future management strategies to reduce the environmental exposure of humans and sensitive wildlife species to this pathogen.

The Mind of a Diver: Specialized Neural Protection in Sea Otters

Terrie M. Williams, University of California, Santa Cruz, williams@biology.ucsc.edu

The vulnerability of the human brain to injury following just a few minutes of oxygen deprivation with submergence contrasts markedly with diving mammals, which can remain underwater during prolonged foraging periods while exhibiting no neurological or behavioral impairment. This response often occurs despite exposure to blood oxygen levels concomitant with human unconsciousness. To determine if such aquatic lifestyles result in unique adaptations for avoiding ischemic-hypoxic neural damage, we measured the presence of circulating (hemoglobin) and resident (neuroglobin, cytoglobin) oxygen-carrying globins in the cerebral cortex of 16 mammalian species considered terrestrial, swimming, or diving specialists. Here we report a striking difference in globin levels depending on activity lifestyle. A nearly 9.5-fold range in hemoglobin concentration (0.17–1.62 g Hb.100 g brain wet wt-1) occurred between terrestrial and deep-diving mammals; a three-fold range in resident globins was evident between terrestrial and swimming specialists including otters. In addition, sea otters demonstrated a remarkable capacity to increase both types of globins when challenged by hypoxia, far exceeding the response observed for sea lions and mice. Together these two globin groups provide complementary mechanisms for facilitating oxygen transfer into neural tissues and the potential for protection against reactive oxygen and nitrogen groups. This enables marine mammals to maintain sensory and locomotor neural functions during prolonged submergence, and suggests new avenues for averting oxygen-mediated neural injury in the mammalian brain. Thus, despite being considered a "transitional" species in terms of aquatic adaptation, sea otters appear uniquely protected for the neural challenges associated with underwater foraging.