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Reducing Disturbances to Marine Mammals by Kayakers in the Monterey Bay

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REDUCING DISTURBANCES TO MARINE MAMMALS BY KAYAKERS IN THE
MONTEREY BAY

A Thesis

Presented to

The Faculty of the Department of Environmental Studies

San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Megan M. Gunvalson

May 2011

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The Designated Thesis Committee Approves the Thesis Titled

REDUCING DISTURBANCES TO MARINE MAMMALS BY KAYAKERS IN THE
MONTEREY BAY

by

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ABSTRACT

REDUCING DISTURBANCES TO MARINE MAMMALS BY KAYAKERS IN THE MONTEREY BAY

by Megan M. Gunvalson

Team OCEAN is a kayaker-outreach program located in Monterey Bay National Marine Sanctuary under the direction of the National Oceanic and Atmospheric Administration, whose goal is to reduce disturbances to marine mammals by kayakers. This study documented the interactions between kayakers and resting harbor seals (*Phoca vitulina*) and southern sea otters (*Enhydra lutris nereis*) at Team OCEAN's two outreach sites, Cannery Row and Elkhorn Slough, to determine if outreach was effective in reducing disturbances to harbor seals and sea otters.

No difference was observed in the percentage of kayaks causing disturbances to resting harbor seals when comparing days Team OCEAN was on the water to days they were not present. However, the percentage of kayaks causing disturbances to resting sea otters was significantly lower when Team OCEAN was present. Kayaks that approached animals directly were responsible for significantly more intense disturbances than those that approached animals tangentially.

Recommendations from this study include a continued presence of Team OCEAN at both sites and the extension of the program into the fall months during weekends.

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Introduction

Coastal ecosystems are some of the most ecologically productive systems on earth and are also home to the highest human population densities (Shi & Singh, 2003). Threats to coastal ecosystems include sea level rise, loss of coastal wetlands and biodiversity, coastal erosion, pollution, and urbanization. Marine Protected Areas and other forms of coastal ecosystem protection are essential and very effective in countering some of these human impacts, thereby protecting these regions of high species diversity (Shi & Singh, 2003).

Outdoor recreation has gained in popularity over the years, especially in wetlands and along coasts, and can also be a stressor on coastal ecosystems. The result has been economic gains to communities that attract visitors for recreational and natural experiences as well as opportunities to increase public awareness of important conservation issues. Urban growth adjacent to coastal ecosystems has increased pressure on natural systems and also often results in increased disturbance to wildlife in popular wildlife viewing areas (Monterey Bay National Marine Sanctuary [MBNMS], 2008a). Human disturbances have been a documented problem for multiple wildlife species and can result in negative population level effects through increased energy expenditures, site abandonment, and overall decreased reproductive success (Lafferty, 2001; Naylor, Wisdom, & Anthony, 2009; Verhulst, Oosterbeek, & Ens, 2001; Williams, Lusseau, & Hammond, 2006). In addition to local population pressure, ecotourism, the fastest growing segment of the tourism industry worldwide (The

International Ecotourism Society [TIES], 2006), is increasing human access to sensitive wildlife areas. Ecotourist disturbance of wildlife can result in a range of responses from increased stress levels to interruption of feeding, nursing, and resting activities and sometimes even complete site abandonment (Lafferty, 2001; Naylor et al., Reijnders, 1980; 2009; Verhulst et al., 2001; Williams et al., 2006).

Knight and Temple (1995) cite exclusion and management as two methods resource managers can use to protect wildlife from recreationists. Because national and state parks, open space preserves, and other public areas are often charged with protecting natural resources while promoting public access and enjoyment, management of public access is generally the preferred alternative.

Management of public access to minimize disturbances to wildlife requires knowledge of the types of recreationist behavior that cause disturbances, the species likely to be disturbed, the way that affected animals respond to disturbance, and at the distance away from animals by which recreationists cause disturbances to wildlife (Knight & Temple, 1995). Different populations of the same species may respond differently to recreationists. Therefore, it is important for resource managers to obtain as much information as possible about the effects of recreation on local populations of wildlife (Trulio & Sokale, 2008).

It is also important for resource managers to evaluate the effectiveness of their conservation programs. Some evaluations of public education and outreach

programs focus only on the number of people reached or other metrics related to people. While such metrics are one approach to assessing the effectiveness of the program as it relates to public outreach, evaluating the program's effectiveness in reducing impacts to wildlife is essential. In order to ensure that conservation programs are achieving their end goals, studies should not only focus on the social aspects of the outreach programs, but the ecological aspects as well. Effective wildlife protection programs should both reach their focal audience and decrease the undesired impacts to wildlife.

Literature Review

Effects of Human Disturbance on Wildlife

Human disturbance to wildlife has been a popular area of study and has been documented for many different species, including bats (Speakman, Webb, & Racey, 1991), Western snowy plovers (*Charadrius alexandrinus nivosus*) (Lafferty, 2001), deer (Moen, Whittemore, & Buxton, 1982), elk (Naylor et al. 2009), killer whales (*Orcinus orca*) (Williams et al. 2006), and harbor seals (*Phoca vitulina*) (Allen, Ainley, & Page, 1984). In some animals, disturbance may cause reduced foraging time. For example, human activities have been correlated with decreased feeding activity in wintering Western snowy plovers (Lafferty, 2001). Similarly, Williams et al. (2006) estimate that disturbances to killer whales in Johnstone Strait, British Columbia caused by boating activity may result in a decreased energy intake of up to 18%. If continued disturbances prevent animals from making up lost foraging time, it could affect the ability of animals to perform other necessary life activities and ultimately result in population level consequences. However, for some species and recreational activities, there may be no immediate effect. For example, Trulio and Sokale (2008) found no difference in shorebird abundance, species richness, and proportion of shorebirds foraging when comparing sites near trails to sites away from trails in the San Francisco Bay Area.

Breeding animals are especially sensitive to human disturbance (Trulio, 2005). Reproductive success may be adversely affected by disturbance.

Verhulst et al. (2001) found that oystercatchers (*Haematopus ostralegus*) reduce the amount of parental care to clutches and chicks when disturbed.

Oystercatchers not only reduced the incubation time of clutches when disturbed, but allocated smaller proportions of food to hatched chicks. Moore and Seigel (2006) found that yellow-blotched map turtles (*Graptemys flavimaculata*) would regularly abandon attempts to nest when boats approached.

Assuming that disturbance to a population in itself requires conservation actions be taken has resulted in some controversy. Gill, Sutherland, and Watkinson (1996) note the importance of linking disturbance to population level effects. According to Nisbet (2000), the effects of disturbance to wildlife populations have been overstated, especially in relation to waterbird colonies. Nisbet agrees with Gill et al. (1996) on the importance of linking disturbance issues to reproductive success or population level consequences. Since most resource managers must conserve populations instead of individuals, it is important to understand how impacts to individuals are manifested in the population, if at all.

Effects of Boating on Harbor Seals and Sea Otters

A number of studies on the effects of boating on harbor seals have been conducted (Allen et al., 1984; Fox, 2008; Henry & Hammill, 2001; Reijnders, 1980; Suryan & Harvey, 1999), but very few studies have examined the effects of boating on sea otters (*Enhydra lutris*) (Curland, 1997).

Haul out activities of harbor seals may be adversely affected by continued disturbance. Henry and Hammill (2001) found that seals were more reluctant to haul out again after being disturbed. This is consistent with Suryan and Harvey's (1998) finding that a full recovery at haulout sites after disturbance only occurred 38% of the time for flushed harbor seals on three islands in Washington State. Loss of haul out time can result in an increased need for metabolic heat production, reduced milk consumption by pups, and reduced capability to recover from wounds (Kopec, 1999).

Harbor seal responses to boating are highly variable depending on the type of boat causing the disturbance. In several studies, visitors in kayaks and canoes caused higher levels of disturbance than those in power boats (Allen et al., 1984; Fox, 2008; Henry & Hammill, 2001; Suryan & Harvey, 1999). Presumably the quiet nature of kayaks allows them to approach closer before being noticed by the animal. Kayaks tend to linger near haulout sites as compared to motorized vessels that pass by quickly and kayaks may have a predator-like appearance to seals (Allen et al., 1984; Fox, 2008; Henry & Hammill, 2001; Suryan & Harvey, 1999).

Henry and Hammill (2001) found seasonal variation in the distance at which harbor seals flush when approached by humans in the Saint Lawrence Estuary. During the pupping season, a larger proportion of seals entered the water for disturbances greater than 200 m away than during the molting season. At Bolinas Lagoon, California, Allen et al. (1984) found that most disturbances

that resulted in flushing occurred within 100 m of the haulout site; while Suryan and Harvey (1999) found that 50% occurred at a distance of 100-200 m and an additional 25% occurred within 100 m in the San Juan Islands, Washington. This variability suggests that there may not only be seasonality in the response of harbor seals to disturbance, but it may also vary between populations.

The only relevant study of sea otters was that by Curland (1997), which provides some preliminary information on the potential effects of boater disturbance on sea otters along the nearshore areas of Cannery Row in Monterey, CA. Curland (1997) reported that otters in areas with higher levels of disturbance spent significantly more time traveling than otters in areas without disturbance. Curland (1997) also noted that because of the study design, this difference may be understated. Although Curland (1997) did not find a significant difference in foraging, grooming, interacting, and resting activities between sites with versus those without disturbance, a seasonal correlation in the amount of time spent grooming in disturbed versus undisturbed areas was observed. Because the seasons also correlate to high versus low human recreational activity, he suggests this component be looked at more closely.

Public Education Disturbance Prevention Programs

In response to the problem of human disturbance to wildlife, there are two options that can be utilized to minimize the effects of disturbance. The first is to deny public access to sensitive areas. The second option is to develop

management practices that allow wildlife to be accessible while protecting wildlife from excessive disturbance by visitors. This approach requires tailored plans and specific knowledge of the user groups as well as the affected populations of wildlife (Knight & Temple, 1995).

Many agencies have used education and outreach as a conservation tool. However, education alone will not guarantee that visitors will care about a conservation goal or necessarily do anything to help achieve it (Jacobson, McDuff, & Monroe, 2006). It is therefore important to also implement monitoring and evaluation programs to help identify successes and areas for improvement (Jacobson et al., 2006). Disturbance management programs are no exception to this.

In Portugal, Medeiros et al. (2007) found that human disturbance and predation were the largest factors in the hatching failure of little terns (*Sterna albifrons*). The authors note that although predation in itself is a natural process, increased human disturbance may indirectly increase predation on tern nests. Signs were installed around some tern colonies for part of the study period and colonies were also patrolled by wardens on weekends. An overall increase in nesting success was recorded for areas that had signage and wardens.

A Voluntary Waterfowl Avoidance Area (VWAA) was created in 1986 in response to problems on Lake Onalaska, Wisconsin where boaters were causing disturbances to migrating waterfowl using the lake as a place to rest, preen, feed, and sleep. The VWAA encompassed a part of Lake Onalaska and was marked

with buoys to encourage avoiding the area during the migratory period from October 15 to mid-November. Public awareness activities associated with the VWAA included distribution of leaflets, displays at public boat accesses, mailings to adjacent property owners, news releases, and public service announcements. A study of the area found that there were proportionally fewer disturbances to waterfowl by boaters than occurred before the creation of the VWAA (Kenow, Korschgen, Nissen, Elfessi, & Steinbach, 2003).

In an attempt to reduce disturbances to killer whales and other marine wildlife in the Haro Strait Region between Washington State and Vancouver Island, British Columbia, The Whale Museum initiated the Soundwatch program in 1993. Soundwatch uses a combination of on and off the water boater outreach programs to promote best practices for operating around and viewing whales. Although Soundwatch gathers information about vessel incidents, it does not collect specific data that can be used to determine the overall effectiveness of the program in reducing disturbances to marine mammals. Information from the vessel incidents, however, does seem to indicate a downward trend in behaviors by whale watching boats that result in vessels stopping directly in the trajectory of the whales (Koski, 2004).

Harbor Seal Biology

Harbor seals are members of the suborder Pinnipedia, which also includes sea lions and walruses. This group of specialized animals has four limbs with

webbing between the digits, known as flippers. All pinnipeds require some sort of suitable substrate to haul out onto; haulouts are necessary for resting, molting, mating, giving birth, and nursing (Reeves, Stewart, & Leatherwood, 1992). The peak of haul out activity for harbor seals in Bolinas Lagoon, California occurred in the early afternoon (Allen et al., 1984).

Within the pinnipeds, harbor seals are part of the family known as the Phocidae, or “true seals.” Phocids lack ear flaps and have shorter fore-flippers. They are not able to rotate their rear flippers underneath them and movement on land is done by hunching the body in an undulating manner.

Harbor seals are found in both the Atlantic and the Pacific Oceans in the temperate and sub-arctic areas of the Northern Hemisphere. In the Eastern Pacific, breeding populations range from San Quintín Bay, Baja California to Nome, Alaska. Males reach sexual maturity at three to seven years and females at three to six years. Harbor seals will mate only a few days after weaning and implantation is delayed from 1.5 to 3 months. In the central California region, the pupping period begins in late March and peaks in the first weeks of May. With a lactation period of approximately four weeks, this means that many harbor seals are still nursing during the most popular time for tourism in the region. Molting, another activity heavily dependent on haul out time, also occurs throughout the summer months (Reeves et al., 1992). Hauling out is also important to harbor seals outside of periods of reproduction and molting (Brasseur, Creuwels, v/d Werf, & Reijnders, 1996).

Sea Otter Biology

The sea otter is the largest member of the Mustelid family. The original geographic range encompassed the span of coastal waters of the northern Pacific Ocean from Mexico to Japan. According to Kruuk (2006), sea otters were heavily hunted from about 1780 until they were nearly driven to extinction in 1820. By the beginning of the 20th century, there were only 1000 to 2000 otters remaining across their historical range. They were given legal protection in 1911 and by the 1990s, numbers had recovered to a population level of about 50,000 (Kruuk, 2006). The extensive hunting resulted in three fragmented areas along their historic range where sea otters can still be found. The subspecies *E. lutris* *lutris* is found in the western Pacific, *E. lutris kenyoni* is found in the Aleutian Islands, and *E. lutris nereis* is found along the central California coast (Reeves et al., 1992).

Female sea otters take four to five years to reach sexual maturity and due to delayed implantation, have a gestational period that ranges from four to 12 months. After birth, otter pups in California populations stay with their mothers for four to nine months.

Unlike harbor seals, sea otters lack a layer of thick blubber to insulate against the cold ocean waters. The rate of heat loss in their aquatic environment is large and otters must maintain an average body temperature of approximately 39 degrees Celsius. Otters rely on their dense fur coat to protect them from cold temperatures. An otter's coat is composed of outer guard hairs and an

underlying dense fur. It is essential that otters spend ample time grooming in order to trap air bubbles into this coat for it to maintain its insulative properties (Reeves et al., 1992). Another way otters maintain these elevated heat production levels is through metabolic heat production, which is two to three times that of a land mammal of similar size (Reeves et al., 1992). In order to maintain these elevated production levels, sea otters will eat 20-30% of their body weight each day (Kruuk, 2006).

Sea otters generally rest with their feet out of the water. When otters change positions and put their feet into the water, there is a noted decrease in internal body temperature (T. Nicholson, personal communication, May 21, 2010), which could require increased foraging time to compensate for heat loss. Yeates, Williams, and Fink (2007) found that foraging was the most energetically costly activity for sea otters, followed by swimming and grooming. Resting, conversely, had the lowest energetic demands.

In the Monterey Bay region, sea otters were observed to spend 62% of their time resting (Schimek & Monk, 1977). Estes, Underwood, and Karmann (1986) observed the otter population in the Cannery Row area and found they rested 52% of the time and foraged 26% of the time. No differences were observed in activity time budgets between seasons. Otters at Elkhorn Slough (including those in the adjoining Moss Landing Harbor) comprise approximately 5% of California's population and use the Slough year-round for resting, foraging, and pupping (McCarthy, 2010b).

Problem Statement

Ecotourism is the fastest growing segment of the tourism industry worldwide (TIES, 2006). This increased human presence in important wildlife areas can disturb wildlife, resulting in a range of responses from increased stress levels to interruption of feeding, nursing, and resting activities and sometimes even complete site abandonment. Altering the behavior of wildlife can have acute impacts on the energy budget of an individual, particularly for females, which in turn may manifest as changes at the level of the population.

Marine mammals are an especially popular subject of wildlife viewing activities and harbor seals have been specifically identified as a major reason for visits to Elkhorn Slough in California by recreationists and tourists (McCarthy, 2010a). There have been several studies of harbor seal disturbance by boating, which generally results in the disruption of resting activity. Very little research exists on how boating activities might impact sea otters.

In Monterey Bay National Marine Sanctuary (MBNMS)--designated in 1992 for the purposes of resource protection, research, education, and public use--recreation and tourism are very significant industries. In particular, kayaking in Monterey Bay and local estuaries, such as Elkhorn Slough, is very popular since kayaking allows people to closely approach wildlife. Marine mammals, such as sea otters and harbor seals, are relatively common in the Elkhorn Slough area and serve as a major attraction to kayakers exploring the coast along Cannery Row. Sea otters and harbor seals are protected by the Marine Mammal

Protection Act (1972), which prohibits any disturbance or harassment of marine mammals in United States waters as well as by United States citizens on the high seas (National Oceanic and Atmospheric Administration, n.d.).

In order to protect these animals from disturbance caused by kayakers, the National Oceanic and Atmospheric Administration (NOAA), which is responsible for enforcing the Marine Mammal Protection Act, and MBNMS staff created Team OCEAN (Ocean Conservation Education Action Network) in 2000. Team OCEAN consists of a small staff and large volunteer base whose charge is to kayak Elkhorn Slough and Cannery Row and to provide information about the natural history of the area to visitors as well as information about how to respectfully, and legally, view wildlife. Specifically, Team OCEAN is designed to reduce and prevent disturbances to marine mammals by kayakers. They do this by staying on the water in kayaks on Fridays and weekends from the end of May through August and into the month of September on weekends only. Team OCEAN members approach visitors for an informational interaction, intercept kayakers who are closely approaching marine mammals, and approach kayakers that have caused a disturbance and provide them with information about respectful wildlife viewing and the natural history of the area. Kayakers are educated on the importance of rest to marine mammals, how to identify resting versus disturbed marine mammals, and are generally recommended to remain at least 50 ft (approximately five kayak-lengths) away from marine mammals to avoid causing disturbances. NOAA and MBNMS staff have put much effort into

this education/intervention approach, but no studies have evaluated if Team OCEAN is effective in reducing disturbances to marine mammals (MBNMS, 2008b). In its most recent management plan, MBNMS staff have identified marine mammal disturbances as a serious issue in Monterey Bay. In order to reduce this stressor, MBNMS staff set a goal of reducing observed disturbances to marine mammals by Team OCEAN by 50% from 2008 levels by 2012 (MBNMS, 2008a; L. Emanuelson, personal communication, February 14, 2011).

To make informed management decisions regarding the protection of marine mammals, NOAA requires data on kayaker behavior in Cannery Row and Elkhorn Slough and an assessment on the effectiveness of Team OCEAN in reducing marine mammal disturbances. In this study data were collected and quantified based on the type and number of kayaker disturbances to sea otters and harbor seals at two locations in the Monterey Bay, specifically comparing when Team OCEAN was present and when they were absent. The findings of this study may also prove valuable to managers seeking to reduce kayaker impacts to wildlife at other locations and could be extended to more effective management of motorized boats.

Research Objectives

The purpose of this study was to evaluate the effectiveness of Team OCEAN on kayaker disturbances to resting harbor seals and sea otters at two locations in the Monterey Bay: Cannery Row and Elkhorn Slough, as well as to characterize kayak use of the sites, use of the sites by resting sea otters and harbor seals, and how kayakers approach these resting animals. This information will be used by Team OCEAN to improve the Team OCEAN program and to more effectively manage kayakers at the two sites, thereby increasing the protection of harbor seals and sea otters. To address these objectives, three research questions and four hypotheses were addressed.

Research Questions

- 1: What are the characteristics of kayak approaches to resting harbor seals and sea otters, including the number of kayakers in a group, the duration of kayaker interactions with wildlife, and the approach type (direct versus tangential)?
- 2: What are the characteristics of kayak use of the Cannery Row and Elkhorn Slough sites, including the number of kayakers per hour entering study areas within the sites and how this rate may change on weekdays versus weekends and from summer to fall?
- 3: What is the size of resting groups of harbor seals and sea otters at Cannery Row and Elkhorn Slough during summer and fall?

Hypotheses

H₀1: There is no difference in the number of disturbances to resting harbor seals and sea otters when comparing days that Team OCEAN is present and days Team OCEAN is absent.

H₀2: There is no difference in the number of kayaks entering a five kayak length area around resting harbor seals and sea otters on days when Team OCEAN is present and days Team OCEAN is absent.

H₀3: There is no difference in the number of disturbances to resting harbor seals and sea otters and the percentage of animals disturbed when comparing when kayakers are in the disturbance zone to baseline disturbance levels.

H₀4: There is no change in the number of disturbances to resting harbor seals and sea otters and the percentage of animals disturbed based on the number of kayakers in the study area.

Methods

Study Sites

Monterey Bay National Marine Sanctuary (MBNMS) represents the largest federally protected marine area in the contiguous United States and covers a fifth of the California coastline (Monterey Bay Aquarium, 2006). It is located along central California and stretches from the southern portion of Marin County southward to Cambria. The sanctuary includes extensive kelp forests, the nation's largest submarine canyon, and one of the highest levels of marine biodiversity on the planet (MBNMS, 2008a). The many habitat types provide important feeding, breeding, and resting areas for a large variety of animals (Monterey Bay Aquarium, 2006). Some of these habitat types include the rocky shores, which cover 56% of the Sanctuary's coast line, including the areas of Cannery Row in Monterey, the kelp forests found just offshore from the rocky coasts, and estuaries, such as Elkhorn Slough (MBNMS, 2008a).

Elkhorn Slough is a shallow estuary along the California coast that opens into the Pacific Ocean at the town of Moss Landing, CA in the Monterey Bay (Figure 1). It covers an area of $3.25 \times 10^6 \text{ m}^2$, has an average depth of 1.4 m (Caffrey, Zabin, Silberstein, & Strnad, 2002), and meanders inland approximately 11 km. Tides are exchanged twice daily, exposing extensive mudflats during low tides (Monterey Bay Aquarium, 2006). Approximately 1 mile east of the California Highway 1 overpass is a section of the Slough referred to as Seal Bend. This area commonly has harbor seals hauled out on the mud flats as well

as a raft of sea otters in the nearby eelgrass beds. Team OCEAN shifts at Elkhorn Slough are from 0900 to 1500 hr. Team OCEAN kayaks are launched from the beach in the northern portion of Moss Landing Harbor and staff and volunteers generally linger in the vicinity of Seal Bend.

Cannery Row is characterized by large kelp beds immediately offshore of the City of Monterey, California and generally encompasses the nearshore areas from the Coast Guard Jetty at San Carlos Beach to the Monterey Bay Aquarium (Figure 2). Harbor seals commonly haul out on rocky outcroppings along this stretch and sea otters can be found resting in the many kelp beds. Team OCEAN shifts at Cannery Row are from 1000 to 1600 hr. Team OCEAN kayaks are launched from Del Monte Beach and staff and volunteers must paddle around Fisherman's Wharf and the harbor to reach Cannery Row. Team OCEAN has a larger area to cover at Cannery Row than at Elkhorn Slough and can generally be found throughout the kelp beds of Cannery Row.

At both sites, Team OCEAN operates Friday through Sunday starting the last week of May and continues on this schedule through August. In September, Team OCEAN operates on Saturdays and Sundays only and the program ends operation for the season after the last weekend in September. There must be a minimum of one staff member and one volunteer available at the site in order to deploy for the day. Generally, there are two to four Team OCEAN kayaks on the water during a shift. Although shifts are scheduled for six hours, this time includes preparation, launching, travel time, a lunch break, landing, and clean-up,

which leads to approximately four hours of on the water time for interaction with kayakers and other recreationists.

Study Design

Data for days Team OCEAN was present were collected on weekends (Saturdays and Sundays) from June through August, 2010. Data for days Team OCEAN was absent were collected on weekdays (Monday through Thursday) throughout the study period and on weekends from September through November, when Team OCEAN was no longer present. Data were not collected on Fridays because this day is generally a transitional day between weekdays and weekends. Because of the potential for fireworks to skew disturbance data, no data were collected surrounding the Fourth of July holiday weekend. At Cannery Row, there was a total of nine weekend observation days with Team OCEAN present, seven weekend days with Team OCEAN absent, and eight weekdays with Team OCEAN absent. At Elkhorn Slough, there was a total of nine weekend observation days with Team OCEAN present, four weekend days with Team OCEAN absent, and eight weekdays with Team OCEAN absent.

A minimum of seven observation days each was sought for days Team OCEAN was present and days they were absent at each site and for each species. Due to the absence of resting animals during portions or all of some observation days, the number of observation days and hours for the two species are not equal. At Elkhorn Slough, resting harbor seals were present for at least a portion of the observation period for all but one weekend day Team OCEAN was

present. At Cannery Row, resting harbor seals were present for at least a portion of the observation period on all but five weekend days Team OCEAN was absent and two weekdays Team OCEAN was absent. Sea otters were present for at least a portion of all observation days at both sites (Table 1).

Table 1

Number of Observation Days with Resting Animals Present

Observation Day Type	Cannery Row		Elkhorn Slough	
	Harbor Seals	Sea Otters	Harbor Seals	Sea Otters
Weekend, Present, Summer	9	9	8	9
Weekend, Absent, Fall	2	7	4	4
Weekday, Absent, Summer/Fall	6	8	8	8
Total Days Present	9	9	8	9
Total Days Absent	8	15	12	12
Total Days	17	24	20	21

Note. This table illustrates the number of observation days animals were present for at least a portion of the observation period based on weekends versus weekdays, Team OCEAN presence (present/absent), and season (summer/fall) at Cannery Row and Elkhorn Slough.

Data Collection

At Elkhorn Slough, the observation points for both harbor seals and sea otters were accessed by kayak. Harbor seals were observed from the shore directly across from the Seal Bend haulout site (Figure 3). The sea otter observation point was approximately 250 meters to the northeast just before the slough makes a sharp bend to the southeast (Figure 4).

At Cannery Row, harbor seals were observed from a viewing area above McAbee Beach (Figure 5). There were two observation points for sea otters at Cannery Row. The first was from the lower deck at the Plaza Hotel (Figure 6). On days when there were no resting otters present in the kelp beds near the hotel or on days that events on the deck prevented its use, sea otters were observed from above McAbee Beach, the same location as was used for harbor seal observations (Figure 5).

Observation points were a minimum of 75 m from resting animals, depending on the study area. Harbor seals were observed with binoculars and sea otters were observed with a spotting scope. This allowed for all observation points for both species to be accessed without any observed disturbance to resting animals.

Data were collected from June 2010 to November 2010. Observation periods lasted four hours, unless interrupted by poor weather or some unexpected event. At Cannery Row observations occurred from 1100 to 1500 hr and at Elkhorn Slough observations occurred from 1000 to 1400 hr. These times correspond to Team OCEAN's active hours during days they are present. In total, data were collected over 45 field days for a total of 162 observation hours for each species.

Figure 1. Aerial view of the Elkhorn Slough study site. Image courtesy of the Elkhorn Slough Foundation.

Figure 2. Aerial view of the Cannery Row study site. Image modified from the United States Geological Survey (USGS) Landsat imagery.

Figure 3. Aerial view of the Elkhorn Slough study area for harbor seals (boundaries shown in yellow). An asterisk designates the observation point. Image courtesy of the Elkhorn Slough Foundation.

Figure 4. Aerial view of the Elkhorn Slough study area for sea otters (boundaries shown in yellow). An asterisk designates the observation point. Image courtesy of the Elkhorn Slough Foundation.

Figure 5. Aerial view of the McAbee Beach study area at Cannery Row (boundaries shown in yellow). An asterisk designates the observation point. Image modified from the United States Geological Survey (USGS) Landsat imagery.

Figure 6. Aerial view of the Plaza Hotel study area at Cannery Row (boundaries shown in yellow). An asterisk designates the observation point. Image modified from the United States Geological Survey (USGS) Landsat imagery.

A “study area” was identified within both study sites (see Appendix A for a glossary of terms). At Cannery Row, the boundaries of the study area were determined by rock outcroppings on each side of the beach and the outer edge of the kelp forest (Figures 3 and 4). At Elkhorn Slough, the study area was the full width of the main channel bounded by a bend in the Slough and wooden structures on the opposite bank (Figures 5 and 6). Kayaks were counted continuously as they entered the study area to determine the number of kayaks to pass in the general area around resting animals during the observation period.

The terms “kayak(s)” and “kayaker(s)” are used interchangeably. These refer to both closed deck and sit-on-top kayaks, including inflatables and multiple occupancy models. Multiple occupancy kayaks were counted as single kayaks, therefore kayak counts do not reflect the number of individual visitors to each site, but rather the number of individual kayaks.

In addition to the study area, a smaller perimeter referred to as the “disturbance zone” was established around each group of resting animals. The disturbance zone encompassed an area spanning an estimated radial distance of 50 ft (approximately five kayak lengths, assuming a 10 ft kayak length) around the resting harbor seals or sea otters. This distance was used because it is a common reference given to visitors by Team OCEAN staff and volunteers when discussing how far away from animals kayakers should remain to prevent causing disturbances. At Elkhorn Slough large numbers of harbor seals were observed resting on the mudflat at Seal Bend during the summer months. The

mudflat is divided into two sections by a small tidal creek approximately midway along the flat. The large numbers of harbor seals spread across the entire mudflat made it difficult to collect accurate data for all the seals, so data were collected only for resting harbor seals on half of the mudflat. The western half was used preferentially. If there were no resting harbor seals on the west side of the mudflats, the eastern half was used.

In order to maintain inter-observer reliability, the same researcher completed all sea otter observations. While it was desirable to do this for harbor seal observations as well, research assistant availability required harbor seal observation days to be shared by three field research assistants. One of the three assistants recorded data for a full observation period. Assistants communicated to ensure they maintained the same guidelines for identifying a five kayak length zone around resting harbor seals at each site.

A kayak “event” was defined as any time a kayak, or group of kayakers, entered the disturbance zone. Kayak event data were recorded continuously throughout the observation period. If a kayak left the disturbance zone and either re-entered the same disturbance zone or entered the disturbance zone for another group of resting animals, each entry was recorded as a separate kayak event. It is, therefore, possible that the same kayak may be responsible for multiple kayak events. For each kayak event, the date, start and end times of the event (to the nearest minute), number of kayaks in the group, approach type (direct or tangential), and response of each animal in the group was recorded. A

sample datasheet and detailed description for kayak event data collection is included in Appendix B.

For both species, response was characterized as one of four categories: rest or one of three levels of activity: alert, move, and flee. Alert refers to an otter or seal that raised its head and looked in the direction of the source of disturbance or scanned its surroundings. Move refers to a) a harbor seal that moved away on land or toward the water's edge; or b) a sea otter that swam away on the water's surface. Flee refers to a harbor seal that flushed into the water and dove or a sea otter that dove below the surface. If not enough of an animal could be seen to determine its response category, it was marked as unknown in order to obtain a running count of the total number of hauled out seals or resting sea otters. Differences between the definitions for the levels of activity for harbor seals and sea otters are due the difference in where the different species rest, with harbor seals resting on land and sea otters resting in the water. These levels of activity are consistent with harbor seal disturbance studies done by Suryan and Harvey (1999) and Fox (2008) and are also consistent with those used by Team OCEAN staff and volunteers to log observed disturbances to both species (MBNMS, 2008b).

Animal activity levels were monitored for the entire duration of the kayak event from the time the first kayak in the group entered the disturbance zone until the time the last kayak in the group left the disturbance zone. The highest

activity level during the duration of the kayak event was ultimately recorded for each animal in the resting group.

Kayak events that resulted in at least one animal's response being categorized as a "move" or "flee" activity were classified as "disturbances." The "alert" response category was not included in analyses of disturbances because the energy expended by the animal was not high compared to moving and fleeing.

A kayak was considered to approach directly if the front of the kayak was directly aimed at the group of resting animals at any point during the kayak event. Approaches that were classified as tangential referred to an approach where the kayak passed by the resting group of animals indirectly (Figure 7).

In order to determine baseline disturbance levels, scan sampling (Altmann, 1974) was conducted at 10 minute intervals for harbor seal haulouts and resting sea otter rafts. This interval period is consistent with other disturbance studies involving bald eagles (Stalmaster & Kaiser, 1998), flamingos (Galicia & Baldassarre, 1997), and harbor seals (Suryan & Harvey, 1999). During each scan, the number of seals or sea otters and their behavior was recorded. Because seals and otters exhibit move and flee activity levels in the absence of kayaks and/or disturbance, the same activity levels that were classified as disturbances during kayak events (move and/or flee) were referred to as "disturbance type responses" in the absence of kayaks. The number of

kayaks in the study area was also noted at each scan. If a kayak event was in progress during one of the scheduled scan samples, that scan was skipped.

Institutional Animal Care and Use Committee approval from San Jose State University was obtained prior to the start of this study. A permit was obtained from the Elkhorn Slough National Estuarine Research Reserve to observe from the land as public access is allowed in the main channel of Elkhorn Slough, but not on most adjacent lands.

Figure 7. Illustration depicting the types of kayak approaches. Asterisks represent resting animals. Solid arrows indicate examples of direct approach types while patterned arrows represent examples of tangential approach types.

Data Analysis

The percentage of kayaks causing disturbances for each observation day was obtained by dividing the number of kayaks causing disturbances by the total number of kayaks entering the study area while resting animals were present. The percentage of kayaks entering the disturbance zone was the number of kayaks entering the disturbance zone divided by the total number of kayaks entering the study area while resting animals were present.

Two factor General Linear Models (GLMs) were used to test whether either the percentage of kayaks causing disturbances or the percentage of kayaks entering the disturbance zone differed for the two sites or for days Team OCEAN was present versus absent. The two species were always tested separately. Dependent variables were log transformed and data were pooled for different seasons (summer and fall) and for day of week (weekday and weekend). GLMs were also used to determine if the approach type (direct versus tangential) affected the percentage of kayaks causing disturbances to resting harbor seals and sea otters. Seasonal and day of the week data were tested using GLMs to ensure that pooling data was acceptable in order to achieve the most statistical power.

Scan sample data were analyzed using GLMs to determine if the level of disturbance and/or disturbance type responses for harbor seals or sea otters differed when comparing three conditions: kayaks in the disturbance zone, kayaks in the study area, and no kayaks present (baseline level). Disturbance

level was assessed with two dependent variables: the percentage of scans during which animals exhibited disturbance or disturbance type responses and the percentage of animals showing disturbance or disturbance type responses for each scan sample animals were not at rest. Both dependent variables were log transformed.

Ordinary Least Squares (OLS) regression analysis was used to determine if the percentage of kayaks causing disturbances or the percentage of kayaks entering the disturbance zone changed based on the number of kayaks in the study area when Team OCEAN was absent. The dependent variables were log transformed.

Results

At Cannery Row, observers monitored harbor seals for 94.7 hours and sea otters for 94.4 hours, during which 2,007 and 2,064 kayaks, respectively, entered the study area. At Elkhorn Slough, observers monitored harbor seals for 81.6 hours and sea otters for 80.2 hours, during which 2,861 and 2,504 kayaks, respectively, entered the study area.

Resting harbor seal counts (when resting seals were present) at Cannery Row averaged 4 seals ($SE=0.198$) in the summer and 7 seals ($SE=0.729$) in the fall. In contrast, the Seal Bend haulout site at Elkhorn Slough saw a large drop in the average number of resting seals from summer (54, $SE=2.118$) to fall (8, $SE=0.591$) (Figure 8). Resting harbor seals were more often present during the summer than the fall at both sites. At Cannery Row resting harbor seals were present 82.5% of the total observation time in summer versus 24.6% in fall, while at Elkhorn Slough, resting harbor seals were present 89.3% of the total observation time in summer and 65.3% in fall.

The average number of resting sea otters (when resting otters were present) was similar between seasons and at both study sites, although these figures (as well as those for harbor seals) were not statistically compared because this was not a question of interest for this study. At Cannery Row the average number of resting sea otters was 5 ($SE=0.197$) in the summer and 4 ($SE=0.228$) in the fall, while at Elkhorn Slough the summer average was 9 ($SE=0.344$) and the fall average was 6 ($SE=0.482$) (Figure 9). Resting sea otters

at Cannery Row were observed during 95.5% of the observation periods in the summer and during 70.5% of the observation periods in fall. At Elkhorn Slough, resting sea otters were observed during 86.3% and 63.4% of the observation periods in summer and fall, respectively.

During the summer months at Cannery Row, an average of 35 kayaks per hour (SE=1.855) and 13 kayaks per hour (SE=0.992) entered the study area on weekends and weekdays, respectively. During the fall months, the average number of kayaks per hour was 15 (SE=3.445) on weekends and 8 (SE=2.980) on weekdays (Figure 10). At Elkhorn Slough during the summer months, an average of 47 kayaks per hour (SE=3.573) entered the study area on weekends and 16 kayaks per hour (SE=1.731) on weekdays. In the fall months, the average number of kayaks per hour on weekends was 47 (SE=4.634) and 5 (SE=0.520) on weekdays (Figure 11). These site-level averages were based on pooled data collected from the separate harbor seal and sea otter observations periods.

For harbor seals, a total of 415 kayak events were recorded for both study sites. At Cannery Row, there were 201 events for harbor seals. Forty-six of these events resulted in disturbances to resting seals. At Elkhorn Slough, there were 214 events, 98 of which resulted in disturbances to resting seals.

Figure 8. Average number of harbor seals in resting groups. Summer counts are shown in patterned bars and fall counts are shown in solid bars. Cannery Row counts were 4 (SE=0.198) in the summer and 7 (SE=0.729) in the fall. Elkhorn Slough counts were 54 (SE=2.118) in the summer and 8 (SE=0.591) in the fall.

Figure 9. Average number of sea otters in resting groups. Summer counts are shown in patterned bars and fall counts are shown in solid bars. Cannery Row counts were 5 (SE=0.197) in the summer and 4 (SE=0.228) in the fall. Elkhorn Slough counts were 9 (SE=0.344) in the summer and 6 (SE=0.479) in the fall.

Figure 10. Kayaks entering the study area per hour at Cannery Row. Weekend values are shown in solid bars and weekday values are shown in patterned bars. In the summer there were 35 kayaks per hour (SE=1.855) on weekends and 13 kayaks per hour (SE=0.992) on weekdays. In the fall there were 15 (SE=3.445) kayaks per hour on weekends and 8 (SE=2.980) kayaks per hour on weekdays.

Figure 11. Kayaks entering the study area per hour at Elkhorn Slough. Weekend values are shown in solid bars and weekday values are shown in patterned bars. In the summer there were 47 kayaks per hour (SE=3.573) on weekends and 16 kayaks per hour (1.731) on weekdays. In the fall there were 48 (SE=4.634) kayaks per hour on weekends and 5 (SE=0.520) kayaks per hour on weekdays.

For sea otters there were 298 kayak events recorded at both study sites. Of the 204 events that occurred at Cannery Row, 27 resulted in disturbances to resting sea otters. At Elkhorn Slough 67 of the 94 events resulted in disturbances to resting sea otters.

The average duration of kayak events at Cannery Row was 1 min (SE=0.049) for harbor seals and 2 min (SE=0.138) for sea otters. When analyzing only events that resulted in disturbances, the average event duration for both harbor seals (SE=0.142) and sea otters (SE=0.325) was 2 min. At Elkhorn Slough, the average duration of kayak events was 1 min for both harbor seals (SE=0.062) and sea otters (SE=0.060). For events that resulted in disturbances, the average event duration was also 1 min for both harbor seals (SE=0.098) and sea otters (SE=0.079).

On average, there were 2 kayaks in kayak groups causing kayak events for both harbor seals (SE=0.079) and sea otters (SE=0.075) at both sites. For kayak events resulting in disturbances, the average number of kayaks in a group was also 2 for both harbor seals (SE=0.155) and sea otters (SE=0.123) at both sites.

For all kayak events resulting in disturbances to harbor seals, an average of 34.8% (SE=3.637) of seals showed disturbance responses at Cannery Row, and 14.1% (SE=2.263) showed disturbance responses at Elkhorn Slough. An average of 65.0% (SE=7.029) of resting sea otters showed disturbance responses during disturbance events at Cannery Row, while 86.6% (SE=3.198)

of sea otters showed disturbance responses during disturbance events at Elkhorn Slough.

There was no difference in the percentage of kayaks causing disturbances to harbor seals (Table 2) or to sea otters (Table 3) when considering site and season as factors. The average percentage of kayaks causing disturbances to harbor seals in the summer was 10.0% (SE=3.975) and 13.5% (SE=3.910) in the fall (Figure 12). For sea otters, the average percentage of kayaks causing disturbances in the summer was 7.5% (SE=2.822) compared to 12.7% (SE=4.775) in the fall (Figure 13).

There was no difference in the percentage of kayaks entering the disturbance zone for either harbor seals (Table 2) or sea otters (Table 3) when considering site and season as factors. For harbor seals 26.3% (SE=7.321) of all kayaks entered the disturbance zone in the summer, compared to 19.6% (SE=4.727) in the fall. For sea otters, the percentage of kayaks entering the disturbance zone in the summer and fall were 26.8% (SE=5.451) and 27.8% (SE=5.770), respectively.

When considering day of the week (weekends versus weekdays) and site as factors, there was no difference in the percentage of kayaks causing disturbances to harbor seals (Table 2) or for sea otters (Table 3). The percentage causing disturbances to harbor seals was 13.9% (SE=3.436) on weekdays compared to 5.9% (SE=5.890) on weekends. For sea otters, the

observed percentage causing disturbances on weekdays was 10.2% (SE=4.713) compared to 12.2% (SE=4.632) on weekends.

There was also no difference in the percentage of kayaks entering the disturbance zone surrounding harbor seals (Table 2) or surrounding sea otters (Table 3) on weekdays when compared to weekends. The percentage of kayaks entering the disturbance zone surrounding resting harbor seals was 29.1% (SE=4.734) on weekdays and 14.2% (SE=5.472) on weekends. The percentage of kayaks entering the disturbance zone for sea otters on weekdays and weekends was 25.7% (SE=5.486) and 27.9% (SE=6.840), respectively.

There was no significant difference in the percentage of kayaks causing disturbances to resting harbor seals when site and Team OCEAN presence were considered as factors (Tables 2 and 4, Figures 14 and 15). For sea otters, there were significantly fewer disturbances when Team OCEAN was present than when Team OCEAN was absent ($F_{(1,45)}=5.522$, $p=0.024$). More disturbances occurred at the Cannery Row site than at Elkhorn Slough ($F_{(1,45)}=6.498$, $p=0.015$) (Table 4, Figures 16 and 17).

The percentage of kayaks causing disturbances to resting harbor seals did not change based on the number of kayaks per hour entering the study area at Cannery Row ($r^2=0.231$, $N=9$, $p=0.550$) or at Elkhorn Slough ($r^2=0.217$, $N=12$, $p=0.498$) (Figure 18). There was also no difference in the percentage of kayaks causing disturbances to resting sea otters based on the number of kayaks

entering the study area per hour at Cannery Row ($r^2=0.000$, $N=15$, $p=0.969$) or at Elkhorn Slough ($r^2=0.002$, $N=12$, $p=0.996$) (Figure 19).

The number of scan samples with harbor seals exhibiting a disturbance or disturbance type response was not significantly different when considering site and whether there were kayaks absent from the study area, kayaks in the study area, or kayaks in the disturbance zone as factors (Table 2). An average of 24.6% ($SE=5.386$) of scans while no kayaks were in the area included seals exhibiting disturbance type responses. When kayaks were in the general study area, but not the disturbance zone, 17.0% ($SE=4.908$) of scans included seals exhibiting disturbance type responses and 38.8% ($SE=5.871$) of scans included seals exhibiting disturbance responses while kayaks were in the disturbance zone (Figure 20). During scans with active seals, there was also no difference in the percentage of seals exhibiting disturbance or disturbance type responses in a resting group when comparing the three categories of kayak locations and site as factors. A larger percentage of seals at Cannery Row exhibited disturbance or disturbance type responses than at Elkhorn Slough (Table 2). The percentage seals exhibiting disturbance or disturbance type responses during scans with seals not at rest when there were no kayaks in the study area was 14.0% ($SE=0.325$), when kayaks were in the study area, the percentage was 21.0% ($SE=0.296$), while when kayaks were in the disturbance zone the percentage was 20.4% ($SE=0.354$) (Figure 21).

For sea otters, the number of scan samples with otters displaying disturbance or disturbance type responses when kayaks were in the disturbance zone was significantly higher than when there were kayaks in the study area or when there were no kayaks in the study area ($F_{(2,109)}=9.896$, $p=0.000$). Additionally, more scans at Elkhorn Slough had otters displaying disturbance or disturbance type responses than at Cannery Row ($F_{(1,109)}=42.807$, $p=0.000$). Otters exhibited disturbance or disturbance type responses during an average of 40.4% (SE=2.938) of scans while kayaks were in the disturbance zone but they were only observed for 7.0% (SE=3.009) and 11.6% (SE=4.147), respectively, of scans with no kayaks in the study area or kayaks in the general study area, but not in the disturbance zone (Figure 22). Also, a larger percentage of sea otters in resting groups exhibited disturbance or disturbance type responses during scan samples with active otters when kayaks were in the disturbance zone when comparing the three kayak location categories ($F_{(2,44)}=6.485$, $p=0.004$), while the percentage of disturbed otters or otters displaying disturbance type responses did not change between the two study sites ($F_{(1,44)}=0.011$, $p=0.916$). During scan samples with otters exhibiting disturbance or disturbance type responses, 75.1% (SE=13.315) did so while kayaks were in the disturbance zone, 30.6% (SE=7.293) while kayaks were in the study area but not the disturbance zone, and 20.5% (SE=6.185) while kayaks were absent from the study area (Figure 23).

There was no difference in the percentage of kayaks entering the disturbance zone for resting harbor seals when comparing site and the presence of Team OCEAN as factors (Tables 2 and 5, Figure 24). There was a lower percentage of kayaks entering the disturbance zone around resting sea otters during days Team OCEAN was present compared to days Team OCEAN was absent ($F_{(1,45)}=4.930$, $p=0.032$). A larger percentage of kayaks entered the disturbance zone around resting otters at Elkhorn Slough compared to Cannery Row ($F_{(1,45)}=8.047$, $p=0.007$) (Table 5, Figure 25).

There was no evidence that the percentage of kayaks entering the disturbance zone differed between harbor seals and sea otters ($F_{(1,48)}=0.019$, $p=0.891$) or between the two study sites ($F_{(1,48)}=2.103$, $p=0.154$). An average of 23.5% ($SE=2.889$) of kayaks entered the study area entered the disturbance zone surrounding harbor seals and 20.1% ($SE=2.593$) entered the disturbance zone for sea otters.

Kayaks entering the disturbance zone that approached harbor seals directly caused disturbances to larger percentages of resting harbor seals ($F_{(1,411)}=16.330$, $p=0.000$) and resting sea otters ($F_{(1,298)}=98.423$, $p=0.000$) than kayaks that approached animals tangentially (Figures 26 and 27). Although there was no difference in the percentage of disturbed harbor seals between the two sites ($F_{(1,411)}=0.055$, $p=0.815$) more sea otters were disturbed at Elkhorn Slough than at Cannery Row ($F_{(1,298)}=240.191$, $p=0.000$). An average of 6.0% ($SE=0.819$) of harbor seals exhibited a disturbance response to kayak events

where kayaks approached tangentially while 16.9% (SE=4.09) exhibited a disturbance response for direct approaches. For sea otters, 11.2% (SE=2.087) of otters in resting groups were disturbed during kayak events where kayaks approached tangentially. When kayaks approached resting sea otters directly, 59.2% (SE=4.724) of otters were disturbed.

During the study period, there were three disturbances to note that did not fit the study design and therefore were not analyzed in the results. On two occasions, kayaks equipped with brightly colored sails entered Elkhorn Slough. On the first of these events, the two kayaks entered the study area and then deployed their sails. As soon as the sails were raised, all twelve sea otters resting in the study area dove and fled. The kayaks were well outside of the disturbance zone, approximately 12 kayak lengths, when the otters fled. During the second event involving kayaks with sails, the sails were already deployed when the kayaks entered the study area. As soon as the kayaks came into the line of sight of the resting sea otters, all twelve otters dove and fled. Similar to the first incident, the otters reacted when the kayaks were well outside of the disturbance zone. The third event occurred at Cannery Row when a small group of SCUBA divers came to within approximately 15 ft of rocks being used by resting harbor seals. The divers were at the surface of the water and two of the three harbor seals on the rocks fled; the third harbor seal was clearly agitated, but did not flee.

Table 2

Non- Significant Statistical Results for Harbor Seal GLM Analyses

Factors	n	F	df	p
Dependent Variable 1 by Season and Site				
Season	21	0.346	1	0.564
Site	21	0.522	1	0.480
Season*Site	21	0.635	1	0.436
Dependent Variable 2 by Season and Site				
Season	21	0.504	1	0.487
Site	21	0.267	1	0.612
Season*Site	21	0.009	1	0.926
Dependent Variable 1 by Day of the Week and Site				
WE/WD	21	1.629	1	0.219
Site	21	1.827	1	0.194
WE/ WD*Site	21	0.527	1	0.527
Dependent Variable 2 by Day of the Week and Site				
WE/WD	21	0.664	1	0.426
Site	21	0.003	1	0.961
WE/WD*Site	21	0.054	1	0.820
Dependent Variable 1 by Team OCEAN Presence and Site				
Present/Absent	38	0.054	1	0.817
Site	38	1.801	1	0.188
Present/Absent*Site	38	0.050	1	0.824
Dependent Variable 3 by Kayak Location and Site				
Kayak Location	94	0.735	2	0.483
Site	94	4.237	1	0.042
Location *Site	94	1.149	2	0.702
Dependent Variable 4 by Kayak Location and Site				
Kayak Location	58	0.393	2	0.677
Site	58	33.274	1	0.000
Location*Site	58	0.227	2	0.798
Dependent Variable 2 by Team OCEAN Presence and Site				
Present/Absent	38	0.006	1	0.940
Site	38	0.643	1	0.428
Present/Absent*Site	38	0.042	1	0.838

Note. This table displays results only for analyses that did not yield significant results. Individual tests are listed above each set of results. Dependent Variable 1 refers to the percentage of kayaks causing disturbances. Dependent Variable 2 refers to the percentage of kayaks entering the disturbance zone. Dependent Variable 3 refers to the percentage of scan samples with seals displaying disturbance or disturbance type responses. Dependent

Variable 4 refers to the percentage of seals exhibiting disturbance or disturbance type responses during scans with active animals. Day of the week is split into two categories: weekends (WE) and weekdays (WD).

Table 3

Non-Significant Statistical Results for Sea Otter GLM Analyses

Factors	n	F	df	p
Dependent Variable 1 by Season and Site				
Season	27	0.135	1	0.717
Site	27	3.578	1	0.071
Season*Site	27	0.098	1	0.805
Dependent Variable 2 by Season and Site				
Season	27	0.016	1	0.901
Site	27	3.059	1	0.094
Season*Site	27	0.088	1	0.769
Dependent Variable 1 by Day of the Week and Site				
WE/WD	27	2.670	1	0.116
Site	27	3.984	1	0.058
WE/ WD*Site	27	1.830	1	0.189
Dependent Variable 2 by Day of the Week and Site				
WE/WD	27	0.339	1	0.566
Site	27	3.005	1	0.096
WE/WD*Site	27	0.244	1	0.626

Note. This table displays results only for analyses that did not yield significant results. Individual tests are listed above each set of results. Dependent Variable 1 refers to the percentage of kayaks causing disturbances. Dependent Variable 2 refers to the percentage of kayaks entering the disturbance zone. Day of the week is split into two categories: weekends (WE) and weekdays (WD).

Table 4

Percentage of Kayaks Causing Disturbances to Harbor Seals and Sea Otters

Team OCEAN	Harbor Seals				Sea Otters			
	Avg. (%)	SE	Min. (%)	Max. (%)	Avg. (%)	SE	Min. (%)	Max. (%)
Cannery Row								
Present	5.1	1.327	0.0	12.0	1.7	0.791	0.0	6.7
Absent	9.2	3.748	0.0	32.1	7.6	3.713	0.0	57.1
Elkhorn Slough								
Present	8.1	2.364	1.1	16.4	4.1	1.027	0.0	7.9
Absent	14.0	3.975	0.0	50.0	15.7	5.793	0.0	75.0

Table 5

Percentage of Kayaks Entering the Disturbance Zone Surrounding Harbor Seals and Sea Otters

Team OCEAN	Harbor Seals				Sea Otters			
	Avg. (%)	SE	Min. (%)	Max. (%)	Avg. (%)	SE	Min. (%)	Max. (%)
Cannery Row								
Present	25.2	4.522	2.2	45.6	14.9	3.205	2.4	36.9
Absent	28.0	6.588	0.0	52.5	32.8	5.300	0.0	78.6
Elkhorn Slough								
Present	16.4	3.401	5.9	31.8	5.9	1.642	0.4	14.3
Absent	23.3	5.193	0.0	57.3	18.7	6.241	0.0	75.0

Figure 12. Percentage of kayakers causing disturbances to harbor seals by season. Data were log transformed. Fall (patterned bar): $\bar{x}=1.933$, $SE=0.447$, $n=12$; Summer (solid bar): $\bar{x}=1.542$, $SE=0.490$, $n=9$; $F_{(1,19)}=0.346$, $p=0.564$.

Figure 13. Percentage of kayakers causing disturbances to sea otters by season. Data were log transformed. Fall (patterned bar): $\bar{x}=1.863$, $SE=0.207$, $n=18$; Summer (solid bar): $\bar{x}=1.674$, $SE=0.420$, $n=9$; $F_{(1,27)}=0.135$, $p=0.717$.

Figure 14. Percentage of kayaks causing disturbances to harbor seals by Team OCEAN presence/absence. Data were log transformed and pooled for sites. Absent (patterned bar): $\bar{x}=1.818$, $SE=0.268$, $n=21$; Present (solid bar): $\bar{x}=1.725$, $SE=0.295$, $n=17$; $F_{(1,38)}=0.054$, $p=0.817$.

Figure 15. Percentage of kayaks causing disturbances to harbor seals by Team OCEAN presence/absence and site. Data were log transformed. Values for days Team OCEAN was absent are shown in patterned bars while data for days Team OCEAN was present are shown in solid bars. Cannery Row – Absent: $\bar{x}=1.506$, $SE=0.405$, $n=9$; Present: $\bar{x}=1.502$, $SE=0.405$, $n=9$. Elkhorn Slough – Absent: $\bar{x}=2.162$, $SE=0.351$, $n=12$; Present: $\bar{x}=1.948$, $SE=0.430$, $n=8$. Present versus Absent: $F_{(1,38)}=0.054$, $p=0.817$; Site: $F_{(1,38)}=1.801$, $p=0.188$.

Figure 16. Percentage of kayaks causing disturbances to sea otters by Team OCEAN presence/absence. Data were log transformed and pooled for sites. Absent (patterned bar): $\bar{x}=1.800$, $SE=0.207$, $n=27$; Present (solid bar): $\bar{x}=1.034$, $SE=0.252$, $n=18$; $F_{(1,45)}=5.522$, $p=0.024$.

Figure 17. Percentage of kayaks causing disturbances to sea otters by Team OCEAN presence/absence and site. Data were log transformed. Values for days Team OCEAN was absent are shown in patterned bars while data for days Team OCEAN was present are shown in solid bars. Cannery Row – Absent: $\bar{x}=1.335$, $SE=0.276$, $n=15$; Present: $\bar{x}=0.670$, $SE=0.356$, $n=9$. Elkhorn Slough – Absent: $\bar{x}=2.265$, $SE=0.308$, $n=12$; Present: $\bar{x}=1.399$, $SE=0.356$, $n=9$. Present versus Absent: $F_{(1,45)}=5.522$, $p=0.024$; Site: $F_{(1,45)}=6.498$, $p=0.015$.

Figure 18. Percentage of kayakers causing disturbances compared to number of kayakers per hour for harbor seals. Data were log transformed and pooled for sites. The heavy red line represents the estimate and the thin blue lines represent the upper and lower confidence limits.

Figure 19. Percentage of kayakers causing disturbances compared to number of kayakers per hour for sea otters. Data were log transformed and pooled for sites. The heavy red line represents the estimate and the thin blue lines represent the upper and lower confidence limits.

Figure 20. Percentage of scan samples resulting in disturbance or disturbance type responses based on the location of kayaks in the study area for harbor seals. Data were log transformed and pooled for sites. No kayaks in study area (diagonal bar): $\bar{x}=2.057$, $SE=0.325$, $n=31$; Kayaks in study area (dotted bar): $\bar{x}=1.890$, $SE=0.296$, $n=37$; Kayaks in disturbance zone (solid bar): $\bar{x}=2.244$, $SE=0.354$, $n=26$; $F_{(2,94)}=0.735$, $p=0.483$.

Figure 21. Percentage of harbor seals with disturbance or disturbance type responses based on the location of kayaks in the study area. Data were log transformed and pooled for sites. No kayaks in study area (diagonal bar): $\bar{x}=0.2513$, $SE=0.197$, $n=19$; Kayaks in study area (dotted bar): $\bar{x}=2.657$, $SE=0.177$, $n=23$; Kayaks in disturbance zone (solid bar): $\bar{x}=2.766$, $SE=0.209$, $n=16$; $F_{(2,58)}=0.393$, $p=0.677$.

Figure 22. Percentage of scan samples resulting in disturbance or disturbance type responses based on the location of kayaks in the study area for sea otters. Data were log transformed and pooled for sites. No kayaks in study area (diagonal bar): $\bar{x}=0.989$, $SE=0.216$, $n=44$; Kayaks in study area (dotted bar): $\bar{x}=1.368$, $SE=0.221$, $n=42$; Kayaks in disturbance zone (solid bar): $\bar{x}=2.636$, $SE=0.305$, $n=23$; $F_{(2,109)}=9.896$, $p=0.000$.

Figure 23. Percentage of sea otters to exhibit disturbance or disturbance type responses based on the location of kayaks in the study area. Data were log transformed and pooled for sites. No kayaks in study area (diagonal bar): $\bar{x}=3.088$, $SE=0.368$, $n=13$; Kayaks in study area (dotted bar): $\bar{x}=3.218$, $SE=0.171$, $n=18$; Kayaks in disturbance zone (solid bar): $\bar{x}=4.104$, $SE=0.202$, $n=13$; $F_{(2,44)}=6.485$, $p=0.004$.

Figure 24. Percentage of kayaks entering the harbor seal disturbance zone based on Team OCEAN presence/absence. Data were log transformed and pooled for sites. Absent (patterned bar): $\bar{x}=2.859$, $SE=0.229$, $n=21$; Present (solid bar): $\bar{x}=2.885$, $SE=0.252$, $n=17$; $F_{(1,38)}=0.006$, $p=0.940$.

Figure 25. Percentage of kayaks entering the sea otter disturbance zone based on Team OCEAN presence/absence. Data were log transformed and pooled for sites. Absent (patterned bar): $\bar{x}=2.812$, $SE=0.193$, $n=27$; Present (solid bar): $\bar{x}=2.136$, $SE=0.193$, $n=18$; $F_{(1,45)}=4.930$, $p=0.032$.

Figure 26. Percentage of kayakers causing disturbances to harbor seals based on the kayak approach type. Data were log transformed and pooled for sites. Direct (patterned bar): $\bar{x}=1.610$, $SE=0.194$, $n=47$; Tangential (solid bar): $\bar{x}=0.776$, $SE=0.070$, $n=364$; $F_{(1,411)}=16.330$, $p=0.000$.

Figure 27. Percentage of kayakers causing disturbances to sea otters based on the kayak approach type. Data were log transformed and pooled for sites. Direct (patterned bar): $\bar{x}=3.022$, $SE=0.149$, $n=88$; Tangential (solid bar): $\bar{x}=1.147$, $SE=0.116$, $n=210$; $F_{(1,298)}=98.423$, $p=0.000$.

Discussion

Effectiveness of Team OCEAN

NOAA's Team OCEAN in Monterey Bay National Marine Sanctuary is a kayaker outreach program whose goal is to reduce disturbances to marine mammals by educating the public and visiting kayakers while on the water (MBNMS, 2008b). Results of this study indicate that the presence of Team OCEAN can significantly reduce disturbances to resting sea otters. In fact, the maximum percentage of kayaks causing disturbances to resting sea otters was 9.5 times higher on days Team OCEAN was absent than days Team OCEAN was present. In contrast, there was not a statistically significant reduction in disturbances to harbor seals based on the presence or absence of Team OCEAN (Figure 15), but at both sites the percentage of disturbances was lower when Team OCEAN was present.

Differing resting locations between sea otters and harbor seals may explain some of the difference between the two species. Sea otters rest in the water, sharing a medium with the kayaks (Shimek & Monk, 1977). Harbor seals, on the other hand, rest out of the water on mudflats, beaches, rocks, and other nearshore areas (Monterey Bay Aquarium, 2006) that may be difficult to access on land or by boat. At Elkhorn Slough, the land area of Seal Bend where harbor seals haul out has been off limits to the public since the early 1990s after removal of a public restroom (McCarthy, 2010a). The rocky outcrops utilized at Cannery Row by resting harbor seals are close to shore and do not present an

optimal place for visitors to navigate their kayaks. These locations may prevent and/or deter ultra-close approaches by kayakers and could also provide an element of safety since the seals are land-based and the kayaks are water-based. Additionally, the differing resting locations between the two species result in differing visibility of animals to kayakers. Not only are harbor seals larger than sea otters, but because they rest out of the water their full body is visible to kayakers which improves the ability of the kayakers to observe harbor seals from a distance once they have been noticed. Sea otters, resting on their backs, have a much lower profile and may be difficult to see, especially in the kelp beds along Cannery Row, and may result in accidental disturbances due to kayakers not noticing the sea otters until they are too close.

Another potential explanation for the differing results between the two species is that harbor seals have become habituated to kayaks. Different species demonstrate differing levels of habituation to disturbance. For example, in North Carolina, black ducks (*Anas rubripes*) habituated to aircraft activities, while wood ducks (*Aix sponsa*) did not (Conomy, Dubovsky, Collazo, & Fleming, 1998). The benign nature of kayak approaches to harbor seals may be conducive to habituation, as was demonstrated for Alaskan brown bears (*Ursus arctos*) where habituation by bears to humans was more common in protected areas where the human interactions were more likely to be benign (Smith, Herrero, & DeBruyn, 2005). Fox (2008) found that populations of harbor seals in

Bair Island Reserve in the southern San Francisco Bay habituated to boating activity in the area.

Finally, because there were fewer days with resting harbor seals present at both study sites, the number of observation days for harbor seals was lower than for sea otters. This could indicate a need for more statistical power in order to detect a difference for harbor seal data and could serve as another explanation for the differing results between harbor seals and sea otters.

The percentage of kayaks entering the disturbance zone around resting sea otters also decreased when Team OCEAN was present. Similar to results for the percentage of kayaks causing disturbances, however, there was no difference in the percentage of kayaks entering the disturbance zone surrounding harbor seals based on the presence/absence of Team OCEAN.

Differing resting locations between the two species may also explain the difference in the percentage of kayaks entering the disturbance zone. At Elkhorn Slough, sea otters rest in the middle of the channel, which serves as a main thoroughfare for transiting kayakers. In contrast, the harbor seal haulout at Seal Bend is not easily accessible to kayakers, and the view is somewhat obscured from kayakers approaching from Moss Landing Harbor by a bend in the Slough and a small headland which juts out west of the haulout. Kayakers at Elkhorn Slough often stay closer to the shore where the harbor seal haulout is located as they move into the Slough from the Harbor while they tend to stay near the opposing shore as they return to Moss Landing Harbor, causing a larger

percentage of kayaks to approach the seals from the obscured viewpoint and to inadvertently enter the disturbance zone.

At Cannery Row, sea otters rest in the midst of the kelp canopy, usually well away from shore whereas resting harbor seals haul out on the rocks immediately adjacent to shore. If harbor seals are resting on the shoreward side of the rocks, then kayakers have a somewhat obstructed view and may not see the harbor seals. Additionally, harbor seal coloration causes them to blend in with the rocks at Cannery Row they rest on. These factors may result in kayakers who are not actively looking for harbor seals to inadvertently enter the disturbance zone.

For kayaks entering the disturbance zone and the percentage of kayaks causing disturbances to harbor seals, the mean and maximum percentages for these two variables were always higher on days Team OCEAN was absent when compared to days Team OCEAN was present. Although this difference was not statistically significant, this may indicate an emergent pattern that may be detected with more statistical power.

Previous studies have confirmed that proper management and public outreach programs can be successful in reducing human disturbances to wildlife. Medeiros et al. (2007) found that warning signs and wardens on sandy beaches in Portugal were an important factor in improving the nesting success of Little Terns. Additionally, the creation of a voluntary waterfowl avoidance area in Wisconsin, in conjunction with public education, was successful in reducing

disturbances to migrating waterfowl (Kenow et al., 2003). From a management perspective, the results of this study suggest that efforts to protect sea otters from disturbance have been effective and should be continued. If harbor seals at Cannery Row and Elkhorn Slough are now habituated to approaches by and the presence of kayakers, changes to the strategies used by Team OCEAN may not be necessary.

Animal Response to Kayaks

Resting sea otters were more sensitive to the presence of kayaks than harbor seals. The activity level of otters (swimming away and/or diving) was highest when kayaks approached within 50 ft or less while there was no change in the activity level of harbor seals based on the presence and location of kayaks. This finding indicates that approaches closer than 50 ft (approximately five kayak lengths), the buffer often used by Team OCEAN, resulted in fewer otters becoming active than for approaches outside of 50 ft.

The percentage of kayaks causing disturbances did not change based on the number of kayaks in the study area for either harbor seals or sea otters. Thus, kayak density was likely not a factor in the percentage of kayaks causing disturbances. However, both species were disturbed significantly more often by kayaks that approached directly than by kayaks that passed by tangentially. Many studies have shown that tangential approaches cause much less disturbance to animals than direct approaches (Trulio & Sokale, 2008; Fox,

2008). Because harbor seals often rest along shores, kayaks passing through areas are more likely to pass by tangentially. Sea otters resting mid-channel at Elkhorn Slough and in the middle of the kelp beds at Cannery Row may be more susceptible to a direct approach. Because of the significant difference in the percentage of animals to react between tangential and direct approaches for both species, Team OCEAN staff and volunteers should stress the importance of passing by animals indirectly rather than approaching directly to visitors in order to help minimize disturbances.

When comparing percentage of kayaks causing disturbances, the site factor was often significantly different for sea otters with a significantly higher percentage of kayakers causing disturbances at Elkhorn Slough than at Cannery Row. The surface waters of Elkhorn Slough vary based on the tides. As the tide goes out the main channel narrows, which leaves less space for kayaks to pass around otters resting in the middle of the main channel. This tidal constriction is less likely to affect harbor seals due to their resting location along the shores of the channel. In fact, as the tide drops the distance between harbor seals and kayakers increases, further separating them.

On two occasions, kayak disturbances were observed when kayaks were far outside of the disturbance zone. Both of these instances involved kayaks with fluorescent sails. Kayaks with sails were only observed on three occasions at Elkhorn Slough. All three occasions resulted in disturbances; however, the third disturbance occurred inside the disturbance zone and was therefore included in

the data for this study. NOAA and Team OCEAN staff should closely monitor this recreational trend and determine whether a restriction on kayaks with sails is warranted, both to prevent impacts to animals and to avoid recreationists becoming used to having this form of kayak allowed. A disturbance to harbor seals by approaching SCUBA divers was also observed on one occasion. While divers are fairly common at McAbee Beach at Cannery Row, they rarely approach the nearshore rocks utilized by resting harbor seals.

Harbor seal responses to kayaks were similar inside and beyond the disturbance zone, providing some indication that harbor seals at Cannery Row and Elkhorn Slough may be habituated to the presence of kayaks. Habituation of harbor seals to boats has been documented in other locations (Fox, 2008). Because sea otter flight response rates were highest when kayaks were in the disturbance zone, it is unlikely that sea otters have habituated to kayakers in these areas. There was no difference in the number of kayaks entering the disturbance zone for harbor seals and sea otters, therefore unequal pressure by kayaks would not account for differences between the two species.

The percentage of scan samples with otters exhibiting disturbance or disturbance type responses was higher when kayakers were inside the disturbance zone compared to when kayaks were either outside the disturbance zone or outside the study area. Additionally, fewer otters became active when kayaks were outside the disturbance zone or outside the study area than when kayaks were in the disturbance zone. This further supports that the 50 ft buffer

has been effective at reducing disturbances to sea otters, however future research should examine the optimal distance for preventing sea otter disturbances.

Response distance to disturbances displayed by wildlife is highly variable and subject to many factors. For example, Smith et al. (2005) found the distance at which Alaskan brown bears displayed a response was dependent on the density of the bear population. Rodgers and Schwikert (2002) state that bird size is a major factor in the distance at which waterbirds respond to human disturbance, with large birds responding at greater distances from disturbance than small birds. Many researchers have found the angle of approach affects animal responses, such as the study by Suryan and Harvey (1999) in which the distance at which harbor seals reacted to approaching vessels changed based on the angle of approach. For harbor seals, critical distances to avoid flight responses of 28 - 260 meters (Suryan & Harvey, 1999), 178 meters (Henry & Hammill, 2001), and 100 meters (Allen et al., 1984) have been recorded. A 1985 study in Elkhorn Slough suggested a critical distance of less than 100 meters (Osborn, 1985).

During this study, at Cannery Row and Elkhorn Slough, a minimum of five kayak lengths, or 15 m, from resting animals (assuming an average kayak length of 3 m) was sufficient to reduce disturbances to sea otters to levels comparable to background activity levels. Additionally, visitors should be asked to avoid approaching animals head-on to help prevent disturbance. The results of this

study also suggest that regulating the kayak density or number of kayaks per hour at Cannery Row and Elkhorn Slough would not reduce disturbance levels so long as kayaks stay at least 15 m from animals. However, NOAA should evaluate the need for prohibiting kayaks with sails in Elkhorn Slough.

Use of Sites by Kayaks and Animals

Although both sites are used by recreationists other than kayakers, such as divers and visitors in motorized vessels, kayakers were the dominant user observed at both sites. Kayak traffic at Elkhorn Slough has increased over the last decade (McCarthy, 2010a) and kayaks have been identified as a major source of disturbance to sea otters in the waters along Cannery Row (Curland, 1997). Both these sites are popular places for visitors to rent kayaks and Elkhorn Slough supports two on-site kayak rental companies while Cannery Row supports three. Kayaks generally approached resting animal groups in small groups of about two kayaks and remained near resting animals for relatively short periods of time (an average of one to two minutes).

Kayak use at both sites was higher on weekends than on weekdays, a common recreational pattern (Trulio & Sokale, 2008). At Cannery Row, both weekend and weekday use by kayaks decreased from the summer months into the fall months. At Elkhorn Slough, however, while weekday use dropped off in the fall compared to summer, weekend use in the fall remained at levels comparable to those in the summer months. Team OCEAN ends its patrols at

both sites at the end of summer in anticipation of a drop-off in kayakers due to the end of the tourist season combined with a lack of funding. However, this study suggests that use at Elkhorn Slough, and potentially Cannery Row, may remain high on weekends in fall, justifying the need for Team OCEAN to be present. Continued monitoring of kayak use in these areas is important to identify changes in use patterns that would require changes to the current schedule used by Team OCEAN that would benefit marine mammals.

Although there were times resting animals were not present during observation periods, both resting harbor seals and sea otters were observed at both sites throughout the study period. When resting animals were present, the average resting group size of sea otters changed little between seasons at both Cannery Row (5 in summer and 4 in fall) and Elkhorn Slough (9 in summer and 6 in fall). The resting group size of harbor seals was similar for both summer (4) and fall (7) seasons at Cannery Row, but at Elkhorn Slough, the resting group size was much smaller during the fall months (8) than during the summer (54). These changes in resting group size for harbor seals are likely a result of seasonal changes. Seasonal variation in harbor seal and sea otter populations and daily activities has been recorded in the Monterey Bay (Curland, 1997; Osborn, 1985).

The heavy dependence of important life processes such as resting, molting, mating, birthing, and nursing on hauling out by harbor seals (Reeves et al., 1992) highlights the importance of seals to be able to haul out undisturbed.

Especially when considered with the reluctance of harbor seals to return to their haulout after a disturbance (Henry & Hammill, 2001). Because loss of haul out time corresponds to an increased need for metabolic heat production (Kopec, 1999), disturbance can also lead to increased energetic demands for harbor seals. For sea otters, when compared to other activities, resting has the lowest energetic demands (Yeates et al., 2007). Disruption of rest not only causes otters to move to a higher energy activity state, but may cause otters to put their feet into the water, which causes their body temperature to drop (T. Nicholson, personal communication, May 21, 2010) and creates an increased need for metabolic heat production. These impacts to the energetic demands of individual animals may result in population level impacts. Although the California stock of harbor seals appears to be stabilizing at what may be its carrying capacity (Carreta et al., 2010), sea otter populations have entered a period of decline and pup counts were the lowest in the Spring 2010 survey since 2003 (United States Geological Survey, n.d.). This study has shown the significant benefits Team OCEAN provides in protecting marine mammals from disturbance. With the current decline in sea otter counts, protection of existing populations is increasingly important.

Conclusions

Team OCEAN has been successful at reducing disturbances to sea otters by kayakers at Cannery Row and Elkhorn Slough, with a drop in the percentage of kayaks causing disturbances from 11.0% for days they were not on the water to only 2.9% during days Team OCEAN was present. Also, fewer kayaks entered the disturbance zone surrounding resting sea otters during days Team OCEAN was present, where the percentage of kayaks entering the disturbance zone was cut in more than half during days Team OCEAN was present. Although these same results were not observed for harbor seals, there is some evidence that habituation to kayaks by harbor seals at these sites may prevent a recordable difference.

The hourly rate of kayaks entering the study area does not affect the percentage of kayaks causing disturbances for either species. However, the distance of an estimated five kayak lengths (approximately 15 meters) does appear to be effective in reducing disturbances to sea otters; specifically, disturbances were recorded on 40.1% of scans when kayaks were within this distance and only for 11.6% and 7.0% when kayaks were outside the disturbance zone and outside the study area, respectively. Additionally, more otters in a resting group became active when kayaks were inside the disturbance zone when compared to when kayaks were outside the disturbance zone or outside the study area. Harbor seals did not exhibit these differences based on the locations of kayaks, providing support to the idea that they may be habituated to

the presence of kayaks. Both species were significantly more likely to be disturbed by kayaks that approached resting groups directly rather than tangentially.

Cannery Row and Elkhorn Slough are popular resting locations for harbor seals and sea otters. These are also increasingly popular places for wildlife viewing by kayak for visitors. Both sites experienced heavy kayak usage on weekends throughout the summer months, with average hourly rates of 34 kayaks per hour at Cannery Row and 37 kayaks per hour at Elkhorn Slough. Although there was a decrease from summer, weekend kayak use remained high into the fall months with an average of 27 kayaks per hour at Cannery Row and 28 kayaks per hour at Elkhorn Slough.

Limitations

Previous research has suggested that the response of animals to disturbance varies between populations and species, therefore caution should be exhibited in applying site and species-specific results of this study widely. Additionally, this study only examines one year of activity; multi-year studies are needed to document inter-annual variability in results. This study suggests that public education efforts may be an effective management tool to prevent wildlife disturbances above baseline levels; however, it is important to consider local conditions and the local populations (both wildlife and human) before implementing such a program.

Recommendations

The findings of this study suggest these recommendations:

1. Team OCEAN should continue its current public education and marine mammal protection efforts at Cannery Row and Elkhorn Slough.
2. Because hourly kayak rates at both sites on weekends remain at levels comparable to summer months, Team OCEAN should consider extending weekend efforts into the fall months at Elkhorn Slough.
3. Weekdays at Cannery Row may also be busy enough to justify a Team OCEAN presence during the summer months.
4. Strategic placement of staff and volunteers on the water in areas where it may be difficult for approaching kayakers to see resting animals (for example, before the harbor seal haulout at Elkhorn Slough and near resting sea otters wrapped in kelp at Cannery Row) may improve results.
5. Greater coverage by Team OCEAN is also recommended as there were many occasions where resting animal groups did not have Team OCEAN members in the vicinity.
6. Kayaks with sails were only observed on three occasions; considering the strong response exhibited by sea otters to these boats at large distances, management should consider limiting or prohibiting them in areas with sea otters.
7. Future studies should be conducted to better understand the effects of disturbance on sea otters at Elkhorn Slough and Cannery Row, as well as

outside of these populations, as there is currently very little information available regarding disturbances to sea otters.

8. Continuation of this study for harbor seals in order to achieve more statistical power may be beneficial in better determining Team OCEAN's effectiveness as it relates to harbor seals.
9. Further investigation into habituation of harbor seals at these sites to kayaks may provide management with better information as to where to focus outreach efforts.
10. Specific studies regarding distances at which animals react, how angle of approach affects reactions, if resting group size affects the percentage of kayaks causing disturbances, and how animals that are disturbed multiple times in a day may change their reaction would also be of interest.
11. Information regarding the distribution of resting groups of harbor seals and sea otters at Cannery Row and Elkhorn Slough, as well as monitoring whether preferred resting grounds may change over time, would be beneficial for management to determine where it would be most beneficial to place Team OCEAN kayaks.

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Appendix A

Glossary

Alert – a response where an animal raises its head and looks in the direction of the source of disturbance or scans its surroundings

Disturbance – occurs when an animal exhibits the move or flee activity level during kayak events

Disturbance Type Response – occurs when an animal exhibits the move or flee activity level in the absence of kayaks

Disturbance Zone – a five kayak length area surrounding resting harbor seals or sea otters

Flee – a response where a harbor seal flushes into the water and dives or a sea otter that dives below the surface

Kayak(s)/Kayaker(s) – Interchangeably used terms to refer to both closed deck and sit-on-top kayaks, including inflatables and multiple occupancy models

Kayak Event – occurs any time a kayak enters the disturbance zone

Move – a response where a harbor seal moves away on land or toward the water's edge; or b) a sea otter swims away on the water's surface

Study Area – the designated observation area within the study site

Study Site – one of two general locations (Elkhorn Slough or Cannery Row) where study areas were established

Appendix B

Kayak Event Datasheet

Figure B1 shows an example of the datasheet used to record data during kayak events. Fields are as follows: “#” recorded the sequential number of the event for that day, “date,” “location” recorded both the study site and observation area, “species,” “start time” recorded the time (to the minute) the first kayak in the group entered the disturbance zone, “end time” recorded the time (to the minute) the last kayak in the group left the disturbance zone, “# kayaks” recorded the total number of kayaks in the group, “approach type” recorded whether kayaks approached directly or tangentially, “kayak type” recorded whether the kayak was a rental, private, or unknown, “animal response to event” recorded the total number of animals and the activity level of each animal in the resting group, “post disturbance activity” monitored what disturbed animals did after a disturbance, and “notes” allowed for any notable extra information. Not all fields in the datasheet were used in data analysis for this study.

KAYAK EVENT DATASHEET			
#	DATE:	LOCATION:	SPECIES:
	START TIME:	END TIME:	# KAYAKS:
	APPROACH TYPE:		KAYAK TYPE:
ANIMAL RESPONSE TO EVENT: (note # of animals at each activity state and total # of animals in group)			
POST DISTURBANCE ACTIVITY: (if disturbed, note times)			
NOTES:			

Figure B1. Datasheet used for data collection during kayak events.