Monitoring Wildlife and Human Disturbance at Point Lobos State Natural Reserve




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California State University Monterey Bay
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and
the Point Lobos Foundation

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Table of Contents

Introduction

Often called the "crown jewel of the State Park system," Point Lobos State Natural Reserve (PLSNR) is one of 280 park units managed by the California Department of Parks and Recreation (State Parks). With respect to management, State Parks aim to protect, restore, and maintain PLSNR resources in a natural state. In order to do so, managers need to be able to detect and measure change. According to Dayton et al. 1998, "any measure of change in a natural ecosystem must be grounded upon a well-defined natural standard or benchmark against which potential changes are measured and evaluated in relation to natural variation in the system." That is to say, scientific baseline data is needed.

Scientific baseline data can be obtained through environmental monitoring, or the systematic collection of data in a standardized manner at regular intervals over time. Fundamental to resource management, environmental monitoring provides for the identification of both natural and anthropogenic change in the environment as well as a means for detecting the effects of management actions. The 1979 General Plan, which established California's goals for PLSNR and provides guidelines and suggestions for managers, agrees, stating "scientific monitoring is a prerequisite for developing programs for resource preservation."

This need for baseline data and realization of the importance of environmental monitoring is a result of the dramatic increase in PLSNR visitation over the past several years and growing concern by State Park staff and the PLSNR docent body about the impact it is having on wildlife. Marine mammals, seabirds, and shorebirds were chosen as focal species because they are: (1) reliable indicators of change within marine ecosystems, (2) negatively impacted by human disturbance, and (3) charismatic species that are of great interest to the public.

This report summarizes my internship as a California State University, Monterey Bay graduate student working with State Parks at PLSNR. I've initiated a coastal transect monitoring program and a wildlife disturbance monitoring program, studied the haul out behavior of harbor seals, collaborated with the PLSNR docent body to create an online disturbance reporting form, and developed a harbor seal reproductive success monitoring protocol. Projects were chosen based on their potential to inform management decisions to better protect PLSNR resources.

Goals

The goals of this study were to:

- Gather data on the population size and distribution of marine mammals, seabirds, and shorebirds
- Identify the sources and frequency of human disturbances of marine mammals, seabirds, and shorebirds

Figure 1. Map of Point Lobos State Natural Reserve and Point Lobos State Marine Reserve situated along the central coast of California.

Study Area

PLSNR is situated along the central coast of California just south of Carmel-by-the-Sea and protects 1,324 acres of land (Fig 1). In the waters adjacent to the PLSNR is the Point Lobos State Marine Reserve (SMR), a marine protected area in which no damage or take of living marine, geologic, or cultural resources is allowed. Point Lobos SMR extends from the rocky point on the north side of Monastery Beach in the north to the mouth of Mal Paso Creek in the south and covers about 5.36 mi^2 of offshore waters (Fig 1). These protected areas are home to rare plant communities, unique geological formations, and an incredibly rich flora and fauna of both land and sea that attract nearly one million visitors to the reserve each year.

Coastal Wildlife Monitoring

Introduction

I developed a monitoring protocol structured to collect long term data on the population abundance and distribution of focal pinniped, seabird, and shorebird species. Analysis of the

monitoring data collected through this program will inform management decisions to better protect these species.

Objectives

The specific, long-term monitoring objectives of the Point Lobos State Natural Reserve Coastal Transect Monitoring Program are to:

1. To document the size and distribution of pinniped populations.
2. To estimate seasonal and inter-annual variability in pinniped haul out site utilization.
3. To document the size and distribution of seabird and shorebird populations.
4. To estimate the seasonal and inter-annual variability in roost utilization.

The goal for the end of the first year of data collection is to determine areas of high wildlife diversity.

Methods

I defined a transect along the south shore of PLSNR that could be traveled by foot within 2-4 hours. Along this transect, six observation blocks were defined: Sea Lion Cove, Sand Hill Cove, Weston Beach, the Bird Island Trail head, and Gibson Beach (Fig. 2). Observation blocks were surveyed from predetermined locations accessed via reserve trails.

Surveys began at the northern end of the transect and moved south, each block was surveyed from it's respective observation point along the way. From each observation point, I scanned the offshore rocks, rocky intertidal, and adjacent cliffs using binoculars and a spotting scope. The number of roosting birds and hauled out pinnipeds were recorded. This was done for every seabird, shorebird, and pinniped species observed. Focal pinniped, seabirds, and shorebird species are found in Table 1. Surveys were conducted both before and during reserve hours at low and high tides.

To determine areas of high wildlife diversity, the Shannon-Wiener Diversity Index was calculated for each block for every survey and averaged over the first year of data collection.

Results

On average, Sea Lion Cove had the highest wildlife diversity, followed by Sand Hill Cove and Weston Beach, Gibson Beach, the Bird Island trail head, and lastly, China Cove (Fig. 3). Their Shannon-Wiener Diversity Index was 1.06, 0.56, 0.56, 0.39, 0.36, 0.31, respectively.

The high wildlife diversity seen at Sea Lion Cove could be due in part to the recent closure of the lower Sea Lion Cove trail. This trail had allowed reserve visitors assess to Sea Lion Cove's rocky intertidal and pebbly beach. Visitors are now restricted to the upper Sea Lion Cove trail situated along the adjacent bluff, where they can view the cove from above. In addition, Sea Lion Cove had the highest species richness during surveys with an average of five species and a maximum of nine. Large numbers of harbor seals (*Phoca vitulina*), cormorants (*Phalacrocorax spp.*), and gulls (*Larus spp.*) were frequently recorded at Sea Lion Cove.

Sand Hill Cove and Weston Beach had relatively high wildlife diversity compared to the three southern blocks of the transect. Similar to Sea Lion Cove, harbor seals, cormorants, and gulls were frequently recorded at Sand Hill Cove. However, shorebirds and waders were frequently recorded at Weston Beach. The low wildlife diversity at China Cove can be explained by large number of harbor seals that reliably haul out on the small sandy beach and low species richness during surveys.

Wildlife monitoring is fundamental to resource management. It provides for the identification of both natural and anthropogenic change in the environment as well as a means for detecting the effects of management actions. For example, if wildlife data was obtained prior to the closure of lower Seal Lion Cove trail, managers would have been able to measure any change in wildlife abundance or diversity. As such, wildlife surveys should be continued indefinitely.

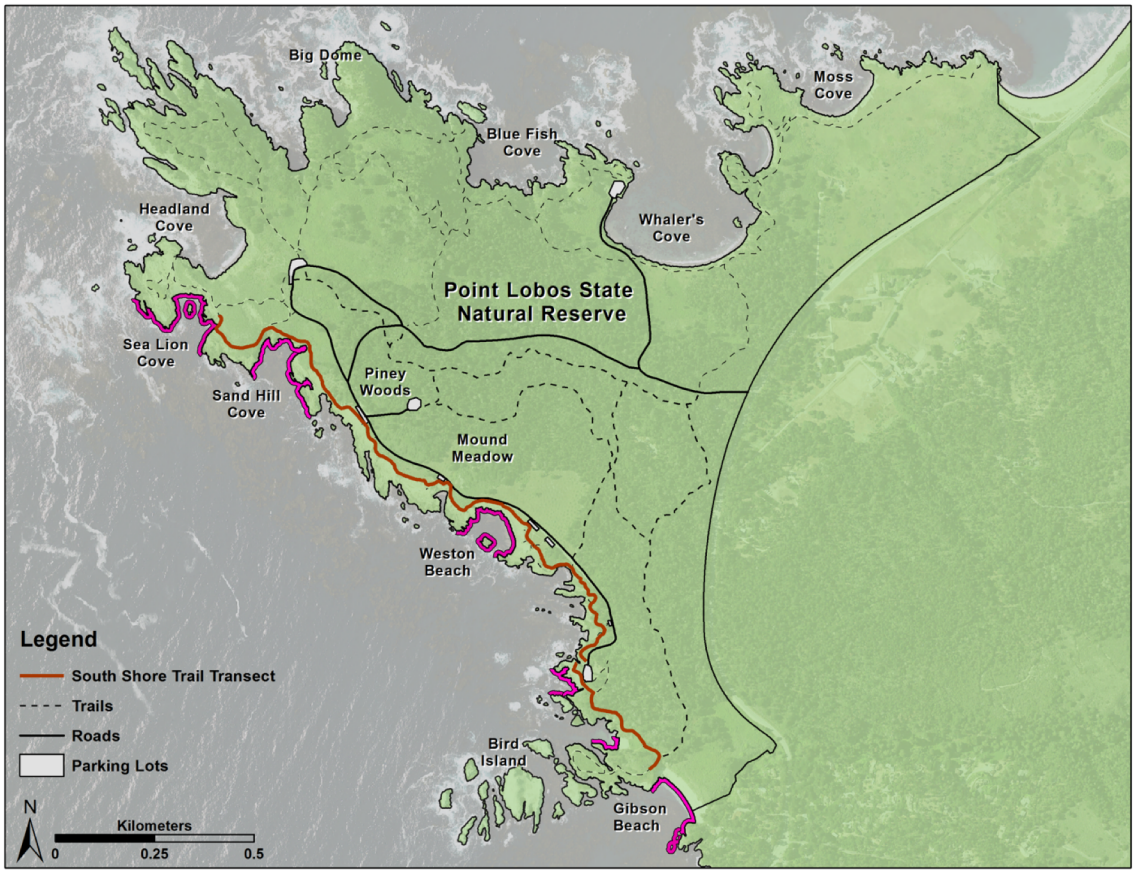

Figure 2. Map of PLSNR showing survey locations (pink) along the South Shore Trail Transect for monitoring the population size and distribution of marine mammals, seabirds, and shorebirds. From north to south, they include: Sea Lion Cove, Sand Hill Cove, Weston beach, the Bird Island trail head, China Cove, and Gibson Beach.

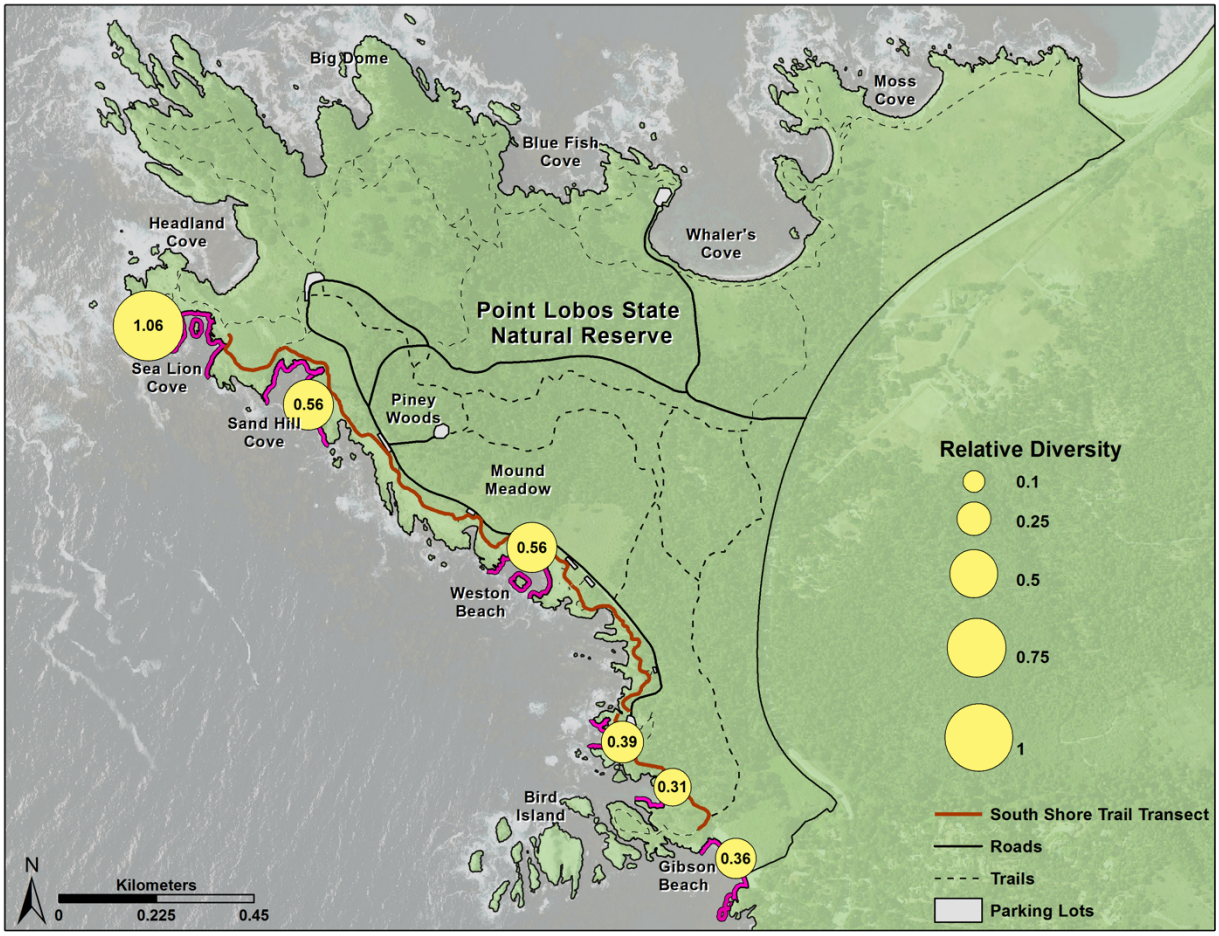

Figure 3. Map of the relative wildlife diversity of monitoring blocks within PLSNR, represented by proportionally size yellow circles. The Shannon-Wiener Diversity Index, averaged over the first year of data collection, is displayed in the center of each circle.

Disturbance Monitoring

Introduction

Areas of conservation interest have become increasingly popular destinations for tourists who wish to view wildlife with certain spatial and temporal predictability (Cassini et al. 2004). This is especially true for coastal areas that provide visitors easy access to an otherwise patchy distribution of flagship species, including marine birds and mammals (Tershy et al. 1997 and Yorio et al. 2001). However, uncontrolled visitor access can have a negative impact on wildlife through human disturbance. This creates a conflict of interest between allowing visitors access to wildlife in an effort to raise conservation awareness, and protecting wildlife from that very same activity.

Human disturbance to birds can be hard to detect, but the most obvious effect is causing birds to flush their roosting locations (Robinette et al. 2013). Other immediate effects on birds include increased vigilance behavior, calling, and changes in daily activities like the amount of

time spent resting or foraging (Borgmann 2001). Chronic disturbance can lead to a decrease in body condition, metabolic rate, habitat use, and reproductive success (Jaques et al. 1966). For example, human caused disturbances can cause birds to take flight, which may increase energy expenditure, or affect their ability to consume needed resources with potential population level consequences (Pfister et al. 1992). During breeding season, disturbances have the potential to reduce reproductive success either through nest abandonment or increased risk of nest predation due to exposure (Carney and Sydeman 1999).

Pinnipeds are very reactive to human activities, they become vigilant and flush into the water when disturbed (Allen et al. 1985). As with birds, studies of pinnipeds have shown that chronic human disturbances can change their behavioral response (Petel et al. 2008). They will alter haul out patterns, shifting to nighttime haul out or abandoning sites completely (Grigg et al. 2002).

PLSNR has seen a dramatic increase in visitation over the past several years. In 1978, 178,000 people visited PLSNR. In 2016, it is projected that over one million people will visit the reserve. State Park staff and the PLSNR docent body are concerned about the impact this increase in visitation is having on wildlife. In regards to this concern, I developed a disturbance monitoring protocol. The goals of which were twofold: to identify human activities that cause disturbance and to estimate the rate of human-caused disturbance. The data collected using this protocol will help State Park staff gain a better understanding of the extent and magnitude of human disturbance and address the issue for better management of reserve resources.

For seabirds and shorebirds, disturbance was defined as any event that results in one or more of the following:

1. Birds displacing (moving from their rest site but remaining within the study area), or
2. Birds flushing (flying out of the study area).

For pinnipeds, disturbance was defined as any event that results in one or more of the following:

1. Head-alert, or
2. Partial flush (movement towards the water but not completely in water), or
3. Complete flush (completely enter the water).

Study Area

This study focused on the intertidal stretch between Piney Woods and Weston Beach where PLSNR visitors have uncontrolled access to the rocky intertidal. This stretch of coastline was divided into three monitoring blocks: Piney Wood, Mound Meadow, and Weston Beach (Fig. 4). While each of three monitoring blocks differ slightly in their geology and accessibility with respect to ease of traversing, they all contain rich tide pools which draw a number of visitors to their shores.

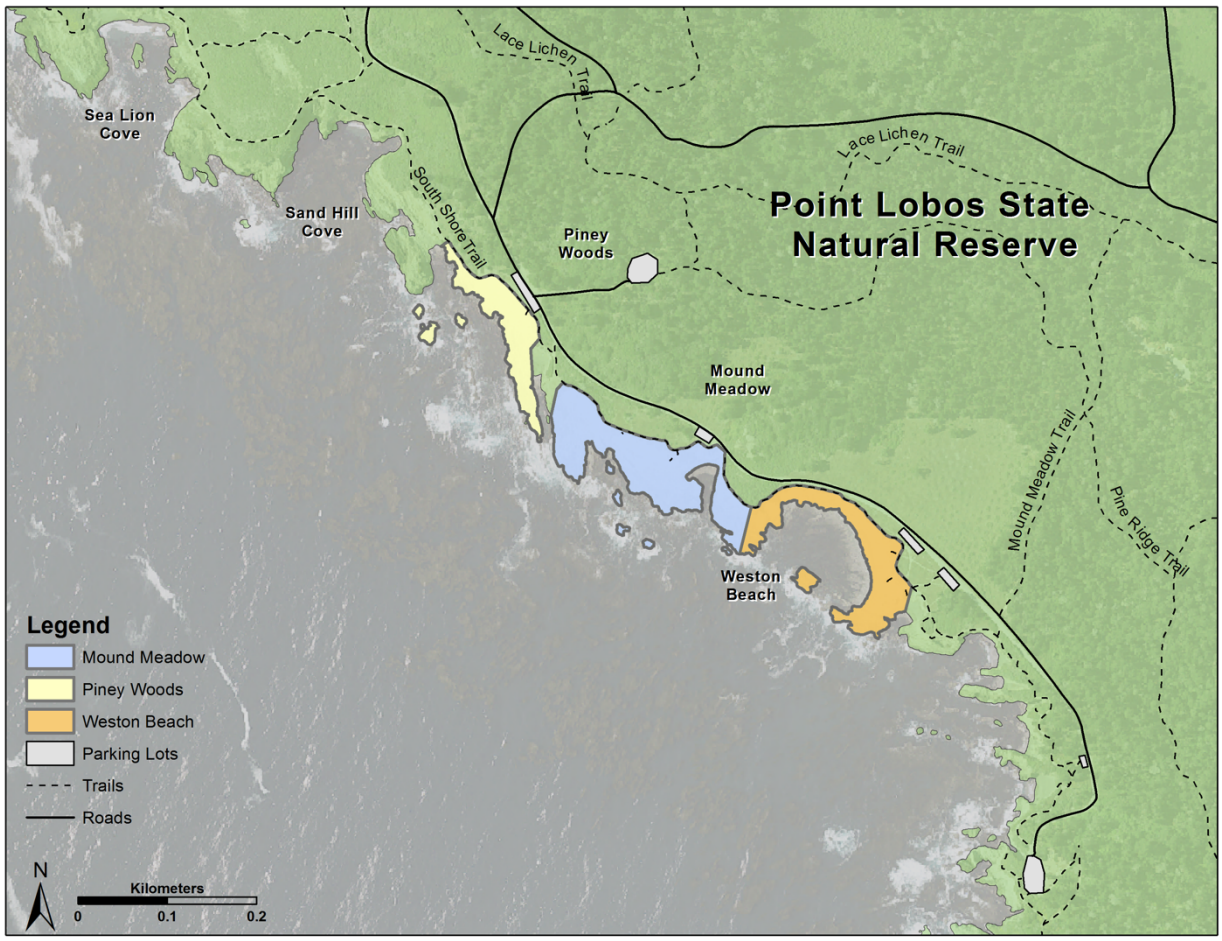

Figure 4. Map of PLSNR showing the three survey locations for monitoring the sources and frequency of human disturbances of marine mammals, seabirds, and shorebirds.

Methods

Shore-based surveys were conducted during weekdays and weekends between 10:00 and 6:00pm. A single monitoring block was surveyed for two to four-hours from a standardized location. When a disturbance was observed, the following information was recorded:

1. Date of the survey
2. Survey location
3. Source of the disturbance
4. Number and species of bird/s disturbed
5. Photographic evidence (when possible)

Table 1 lists possible disturbance sources.

Table 1. Possible sources of human disturbance.

Possible Sources of Disturbances
Humans on foot
Loud noises (whistling, etc.)
Rock throwing or skipping
Boat
Kayak
Aircraft

Results

A total of 59 disturbances were observed in 157.33 observation hours. Of those 59 disturbances, only one involved a pinniped. That incident occurred on a Sunday at Weston Beach, when a harbor seal hauled out on the rocky intertidal for a short period before flushing into the water as visitors became aware of its presence. This was the only instance of pinnipeds utilizing this stretch of the PLSNR coastline.

The remainder of disturbances involved seabird and shorebird species that are either year-round residents of, or migrate through, PLSNR. Of those 58 disturbances, 31 were observed in Weston Beach within 61.25 observation hours, 20 in Mound Meadow within 52.83 observation hours, and ten in Piney Woods within 43.25 observation hours.

Figure 5 summarizes the overall, weekend, and weekday disturbance rate for each monitoring block (not including the single pinniped disturbance). Weston Beach had the highest overall disturbance rate of 0.51 disturbances/hour, followed by Mound Meadow at 0.38 disturbances/hour, and Piney woods at 0.16 disturbances/hour (Fig. 5). Mound Meadow had the highest weekend disturbance rate of 0.56 disturbances/hour, followed by Weston Beach at 0.40 disturbances/hour, and Piney Woods at 0.19 disturbances/hour (Fig. 5). Weston Beach had the highest weekday disturbance rate of 0.58 disturbances/hour, followed by Mound Meadow at 0.29 disturbances/hour, and Piney Woods at 0.16 disturbance/hour (Fig. 5).

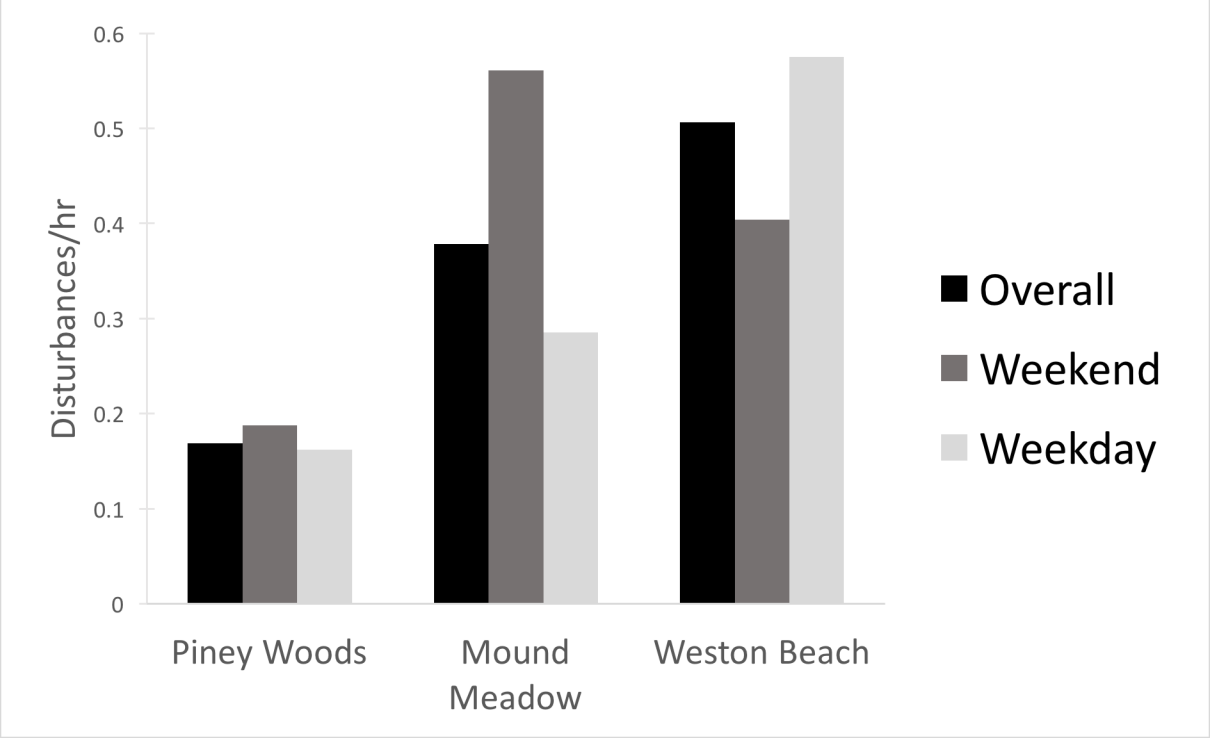

Figure 5. Graph showing the overall, weekend and weekday disturbance rate for Piney Woods, Mound Meadow, and Weston Beach.

Table 2 summarizes the makeup of species disturbed at each monitoring block. Weston Beach had the highest number of species disturbed with a total of nine different species disturbed. Five different species were disturbed at Mound Meadow and only two at Piney Woods. The majority of disturbances at Mound Meadow and Piney Woods involved Western Gulls, *Larus occidentalis*, whereas the majority of disturbances at Weston Beach involved Black Oystercatchers, *Haematopus bachmani*.

Every possible source of human disturbance listed above was observed at least once. However, only humans on foot approaching wildlife resulted in wildlife disturbances.

Discussion

Weston Beach had both the highest overall rate of disturbance and the highest number of species disturbed, making the area a hotspot for disturbance. Seabird and shorebird species used Weston Beach, as well as Piney Woods and Mound Meadow, to carry out a variety of behaviors fundamental to their survival and reproduction including foraging for food and resting. Lost foraging time due to human disturbance can be energetically expensive and potentially decrease fitness. Birds that cannot compensate for lost foraging time are likely to be in poorer physical condition, which could effect their reproductive success. Flying is also energetically expensive, birds that flush in response to disturbance will need to acquire additional resources to compensate not only for the increased energy expenditure due to flight, but lost foraging time (Borgmann 2001).

Knowing humans approaching wildlife on foot is the greatest source of disturbance along this stretch of coastline within PLSNR, the next step would be to establish a flush distance. A flush distance is the distance within which an animal, such a bird, upon being disturbed, will exhibit an escape response, such as flushing. This distance should be used to establish a buffer zone

Table 2. Table summarizing the makeup of species disturbed at Piney Woods, Mound Meadow, and Weston Beach.

	Piney Woods	Mound Meadow	Weston Beach	Total
Western Gull	8	13	5	26
Black Oystercatcher	2	4	14	20
Snowy Egret	-	1	1	2
Brandt's Cormorant	-	1	1	2
Black Turnstone	-	-	3	3
Canada Goose	-	-	4	4
Willet	-	-	1	1
Mallard	-	-	1	1
Multiple Spp.	-	1	1	2
Total	10	20	31	

around important habitat, especially during critical breeding season. Moreover, future research should study the effect human presence has on foraging activities.

Harbor Seal Haul Out Analysis

Introduction

Harbor seals are semi-aquatic mammals that depend upon the marine environment for their food supply, but haul out on land or ice to rest, maintain skin health, molt, play, escape aquatic predation, and give birth to and rear their pups (Pitcher and McAllister 1981). Their choice in haul out site is therefore fundamental to survival and reproduction. However, the mechanisms behind haul out site selection remain largely unknown. Previous studies have suggested harbor seal haul out site selection is dependent upon access to deep water (Sullivan 1980), prey availability (Scheffer and Slipp 1944), wind exposure (Bjorge et al. 2002), substrate type (Montgomery et al. 2007), and level of anthropogenic disturbance (Schneider and Payne 1983). My goal was to investigate the relationships between harbor seal haul out site selection and time of day. More specifically, I wanted to determine if harbor seal haul out site selection differed between "before hours" (i.e. before PLSNR is open and visitors are present) and "during hours" (i.e. while PLSNR is open with visitors present).

Methods

I used linear regression models of haul out selection in terms of environmental covariates, in combination with an AIC model comparison technique to measure the support for various hypothesis about the environmental determinants of harbor seal haul out selection. Each hypothesis was expressed as a linear regression model, with the various hypothesis different only in terms of the specific combination of environmental variables included. The models were fit to a data set of harbor seal abundances at four locations within PLSNR where they tend to haul out with predictability: Sea Lion Cove, Sand Hill Cove, the Bird Island Trial head, and China Cove. This data set was extracted from the more encompassing wildlife monitoring dataset discussed earlier in the report.

I selected a short-list of biologically plausible and comparatively meaningful hypotheses. These hypotheses are expressed as linear regression models and are summarized and explained in Table 3. To evaluate whether habitat selection was in fact random, I also included a null model, M0, with no covariates.

Following Burnham and Anderson (1995), a priori, I decided to use the terms 'substantial', 'considerably less', and 'essentially no' support for a model to correspond approximately to ΔAIC less than two, between four and seven, and greater than seven, respectively, when compared to the best model.

Table 3. Candidate models of harbor seal haul out abundance.

Model	Covariates	Interpretation
M_0	None	Harbor seals have no haul-out site preference.
M_L	Location	Harbor seal haul out site selection is dependent upon the location of haul out site.
M_{TOD}	Time of day	Harbor seal haul out site selection is dependent upon the time of day (i.e. whether or not PLSNR is open).
M_{TOD+L}	Time of Day : Location	Harbor seal haul out site selection is dependent upon the time of day, but its effect is different for each location.

Results

Support for each of the considered models in summarized in Table 4. The best-supported model was model M_{TOD+L}, which included time of day and location covariates. However, the winning model suggests an interaction between the two model parameters, i.e. the number of harbor seals hauled out is dependent upon the time of day, but its effect is different for each location. There was essentially no support for the remaining models.

Table 4. Results of the AIC-based model comparision.

Model	df	AIC	AICc	ΔAIC	AICw
M_{TOD+L}	9	1618.82	1619.44	0.00	0.99
M_L	5	1637.92	1638.12	18.68	0.00
M_0	2	1697.32	1697.36	77.92	0.00
M_{TOD}	3	1697.81	1697.89	78.45	0.00

The number of harbor seals hauled out at China Cove and the Bird Island Trail head is lower during park hours, whereas the abundance of harbor seals at Sea Lion Cove is higher during park hours (Fig. 6). The number of harbor seals hauled out at Sand Hill Cove remains relatively the same before park hours and during park hours (Fig. 6).

Discussion

The winning model suggests an interaction between the two model parameters, meaning the effect of one of the variables differed depending on the level of the other variable. Therefore, the number of hauled out harbor seals is dependent upon the time of day, but its effect is different for each location. This could suggest these sites have different habitat characteristics that harbor seals are preferentially selecting depending on whether it is before hours or during hours.

For example, perhaps China Cove possesses a certain set of habitat characteristics: it is a sandy cove sheltered from wind and waves, but less protected from human disturbance. Sea Lion Cove may possess a different set of habitat characteristics: it is a rocky cove less sheltered from wind and waves, but more protected from human disturbance. Prior to when PLSNR opens, harbor seals may be preferentially selecting sandy haul out sites protected from the wind and waves. When the reserve opens, however, their preferences may change and harbor seals may be selecting haul out sites that are more protected from human disturbance.

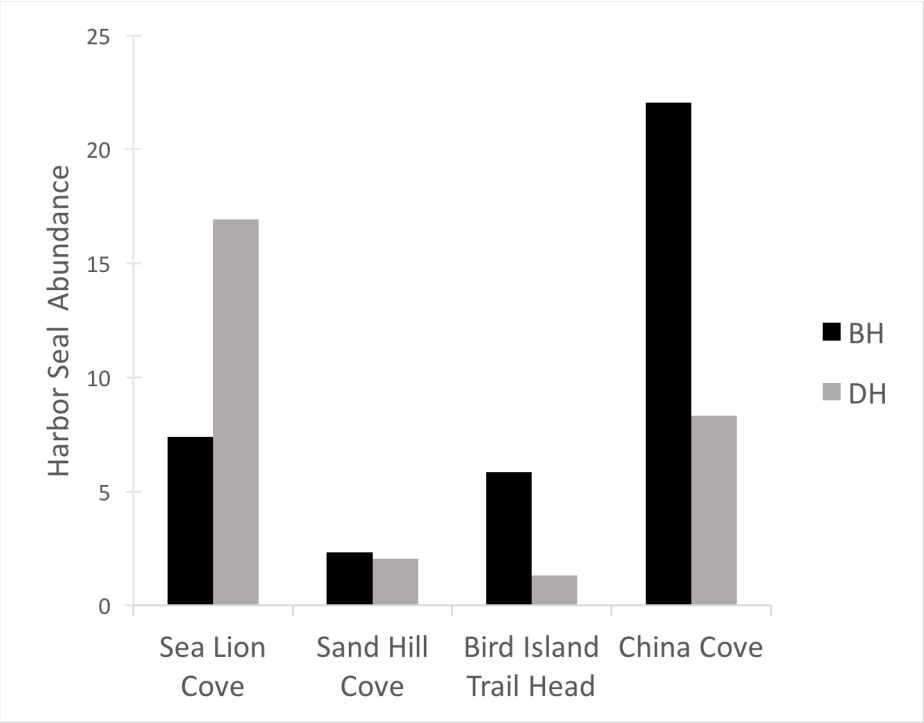

Figure 6. Graph showing the average harbor seal abundance before hours and during hours at Sea Lion Cove, Sand Hill Cove, the Bird Island Trail Head, and China Cove.

Although China Cove has been permanently closed to visitors, protecting harbor seals from human approaches on foot, harbor seals may still be effected by the noise visitors make from the trail located above the haul out site. PLSNR docents have also reported visitors intentionally throwing rocks at harbor seals to gain their attention. A similar situation exists at Sea Lion Cove, the trail leading down to the cove has been permanently closed to visitors, which protects harbor seals from human approaches on foot. When compared to China Cove, however, the trail above Sea Lion Cove is further away both in the horizontal and vertical planes. This could mean, combined with the possibility that Sea Lion Cove has a higher ambient noise level because of the less protected nature of the area from from wind and waves, Sea Lion Cove acts as a buffer to the noise from visitors on the trail above the haul out site.

A more thorough analysis of haul out behavior is needed to fully understand the driving mechanisms. This analysis should include additional predictor variables including those that were just discussed (substrate type, a measure of how protected a haul out site is from wind and wave exposure, and the distance to the nearest trail in both the horizontal and vertical plane) as well as tide height and a measure of localized traffic near haul out sites.

Harbor Seal Monitoring Protocol

I developed a harbor seal monitoring protocol designed to collect long term data on the reproductive success, population size, distribution, phenology, and disturbance of harbor seals during breeding and molting season. This protocol was developed with the intention of creating a citizen science program utilizing the PLSNR docent body. However, due to logistical constraints, the program was not implemented within the duration of my internship. I recommend establishing such a program, if possible, by the 2017 breeding season.

Harbor seals were specifically selected for monitoring because:

1. Harbor seals do not make extensive migrations, are susceptible to disturbance, and regularly use haul out areas throughout the year at PLSNR.
2. Their current population size and distribution of their breeding population within PLSNR are at a level allowing surveyors to complete timely censuses of all breeding sites.
3. Certain areas of PLSNR (China Cove and Lower Sea Lion Point) where visitors previously had uncontrolled access to are now permanently closed. Harbor seals have utilized these areas prior to closure, but undoubtedly at the expense of being disturbed. Permanent closure of these areas could positively effect the harbor seal population.
4. Pinnipeds are sensitive to changes in the marine ecosystem. They respond quickly to changes in prey abundance and distribution, and to human disturbance (Allen et al. 1985, Thompson et al. 1998, Sydeman and Allen 1999). Harbor seals are no exception, making them good indicators of the condition of the marine ecosystem.
5. Harbor seals are charismatic species that are of great interest to the public. Of the nearly one million visitors to the reserve each year, a large portion come to observe marine mammals, including harbor seals.

The specific monitoring objectives of the Point Lobos State Natural Reserve Harbor Seal Monitoring Program are to:

1. Determine the long-term trends in population size and seasonal distribution of harbor seal populations at primary sites during breeding and molting seasons.
2. Determine long-term trends in reproductive success of harbor seals through annual estimates of pup production.
3. Determine the long-term trends in sources, frequency, and level of effects of natural and anthropogenic disturbances on harbor seal haul out use and productivity.

In short, the protocol calls for shore-based surveys a minimum of twice per week during the breeding and molting seasons, which run from March 1 to June 1 and June 1 to July 31, respectively. Surveys are conducted at the four primary harbor seal breeding sites within PLSNR: China Cove, Whaler's Cove, Blue Fish Cove, and Moss Cove. Each survey lasts two hours, if possible, with seal counts occurring every half-hour. Pups may be identified and are counted separately from March 1 to May 31. All harbor seal age classes are combined after May 31 because because pups cannot be easily distinguished from immature seals. To maximize the

number of seals on the haul out site, surveys should be conducted between medium (2.0 ft) to a low (-1.0 ft) tide level during mid-day between 10:00 and 16:00.

Surveys begin prior to the start of the pupping season to capture the date of first pup to track phenology. Tracking the changes in the timing of seasonal activities of certain species can provide information on their responses to seasonal and climatic changes in the environment. In marine mammals, cyclic events such as the first arrival and departure dates during the breeding and molt seasons, the birth of the first pup, and the date of peak pup numbers can be related to seasonal and climatic changes.

Disturbance monitoring is done concurrently with population monitoring. All disturbances that occur during the survey period are recorded. For each disturbance, observers record the source, time, and effect of activity, including the behavioral response of the seals and the number of seals affected. Tracking disturbances allows us to monitor the amount of activity, especially human activity, in an area and by recording the seal's reactions to these events we will also be able to observe trends or changes in their reactions or use of haul-out site.

Analysis of the monitoring data collected through this program will inform management decisions to better protect the species. The full protocol can be found in Appendix A.

Online Disturbance Form

Introduction

PLSNR docents dedicate an extraordinary amount of time at the reserve a have a unique vantage point of the the reserve's daily happenings. As a result, they have the potential to offer a wealth of information to PLSNR staff. One of the biggest challenges PLSNR staff is currently facing is an unprecedented amount of visitor violations. In collaboration with the PLSNR staff and docent body, I aided in the development of an online form that docents fill out to record violations they witness within PLSNR. These observations will help PLSNR staff gain a better understanding of the extent and magnitude of violations within PLSNR and address these issues for better management of park resources.

Violations

Below is a list of violations PLSNR staff, the docent body, and I have compiled to be documented. They are grouped broadly into two categories: wildlife disturbances and other violations

Wildlife disturbances

1. Any instance of a park visitor altering the natural behavior of wildlife.
    a. For pinnipeds (harbor seals and sea lions), this type of behavior includes but is not limited to:
        i. Approaching hauled out pinnipeds, intentionally or unintentially, either on foot, in a vessel, or remotely using a drone, resulting in a head alert or flushing event.

ii. Rock throwing at or near hauled out pinnipeds resulting in a head alert or flushing event.
iii. Whistling or other loud noises (shouting, yelling, etc.) near hauled out pinnipeds that result in a head alert or flushing event.

b. For sea and shore birds, this type of behavior includes but is not limited to:
i. Approaching a bird, intentionally or unintentionally, either on foot, in a vessel, or remotely using a drone, resulting in a flushing event.
ii. Rock throwing at or near the vicinity of a bird that results in a flushing event.
iii. Whistling or other loud noises (shouting, yelling, etc.) near the vicinity of a bird that results in a flushing event.

Other violations

2. Collecting or disturbing tide pool marine life
3. Collecting and removing natural objects (stones, rocks, plants, pinecones, flowers)
4. Traveling off designated trails outside of the wire guides
5. Jumping off rocks into or swimming in the ocean
6. Climbing trees or off trail rocks or cliffs
7. Picnicking in areas other than the designated areas with tables (Whalers Cove, Piney Woods, and Bird Island parking areas)
8. Biking off the paved road
9. Pets within the reserve (other than identified service animals)
10. Vandalizing natural and/or manmade features
11. Airplanes flying below the 1000' AGL as set by the Monterey Bay National Marine Sanctuary regulations
12. Drones (any use regardless of disturbance)
13. Illegal fishing (signs of illegal fishing include deployed fishing lines, nets or poles)

Recording Process

The online form prompts docents to first record basic information regarding the event they are reporting, including the date, time and location of the event. To record the location of the event, I created a gripped map of PLSNR. This map, shown in Figure 7, uses rows 1-18 and columns A-R to reference a location within PLSNR. Because docents must be logged into their docent account to access the form, their name is automatically attached to the event record.

The violations listed above are not exclusive from one another. For example, a docent may witness four visitors walking down the wooden stairs to China Cove disturbing seven harbor seals causing them to flush into the water. In that case, the docent reporting the event would select both “pinniped wildlife disturbance” and “off-trail visitors” and fill out the appropriate information. A comments section is available for docents to write any additional information they feel is pertinent to the event they witnessed. The vessel registration number of a vessel fishing illegally in the Point Lobos State Marine Reserve, for example. Docent also have the opportunity to upload a picture of the event, should they have been able to obtain one.

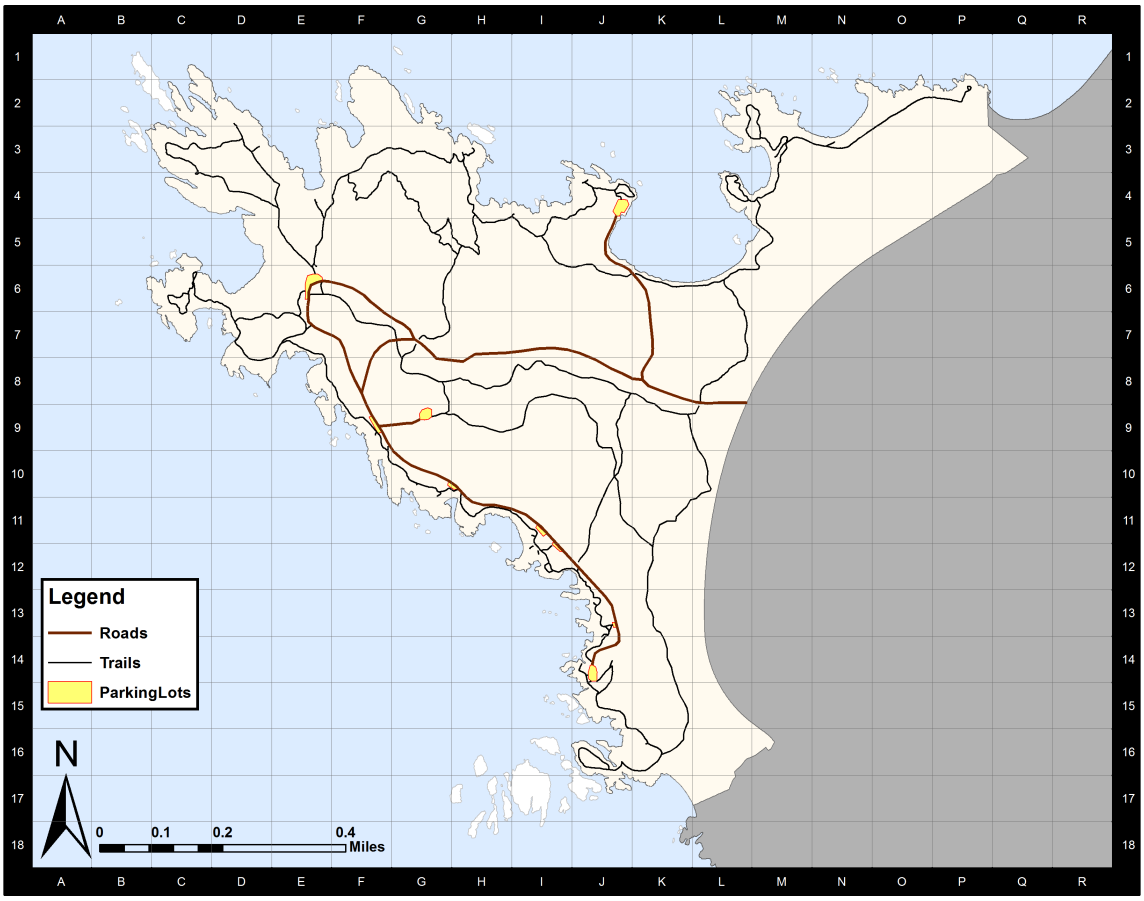

Figure 7. Gridded map of PLSNR used by the docent body to document disturbance location on the online wildlife disturbance form.

Future Studies

For future studies, I recommend:

1. *Continuing wildlife and disturbance surveys and incorporate a larger number of sites.* In collaboration with the new graduate student intern, Erika Senyk, and the help of an undergraduate intern, Derek O'Reilly, we have made progress towards accomplishing this goal with respect to wildlife surveys. We have expanded the South Shore Trail Transect and defined a North Shore Trail Transect, which together cover a much larger portion of PLSNR coastline (Fig. 8). We have also created a list of focal pinniped, seabird, and shorebird species for monitoring, as opposed to recording every species encountered (Table 5).
2. *Monitoring the reproductive success of harbor seals.* Using the protocol found in this document will allow managers to track the reproductive success of harbor seals within PLSNR.
3. *Monitoring the reproductive success of certain focal seabird species, namely the Brandt's and Pelagic Cormorant.* Develop a protocol that will allow managers to track the reproductive success of focal seabird species.

4. *Establishing a flushing distance for focal seabird and shorebird species.* This information can be used to create buffer zones around important habitat, especially during critical breeding season.
5. *Studying the effect humans have on the foraging activity of focal seabirds and shorebirds.* Loss of foraging time due to human disturbance can have negative implications for the health and therefore reproductive success of birds.
6. *Studying how wildlife disturbance is effected by the local foot traffic of an area.* This would provide insight to park managers on how many visitors, if any, should be allowed to access a given area of the reserve.
7. *Conducting a more thorough analysis of harbor seal haul out behavior.* This analysis should include other predictor variables including a measure of how protected a haul out site is from wind and wave exposure, the distance to nearest trail in both the horizontal and vertical plane, and tide height.

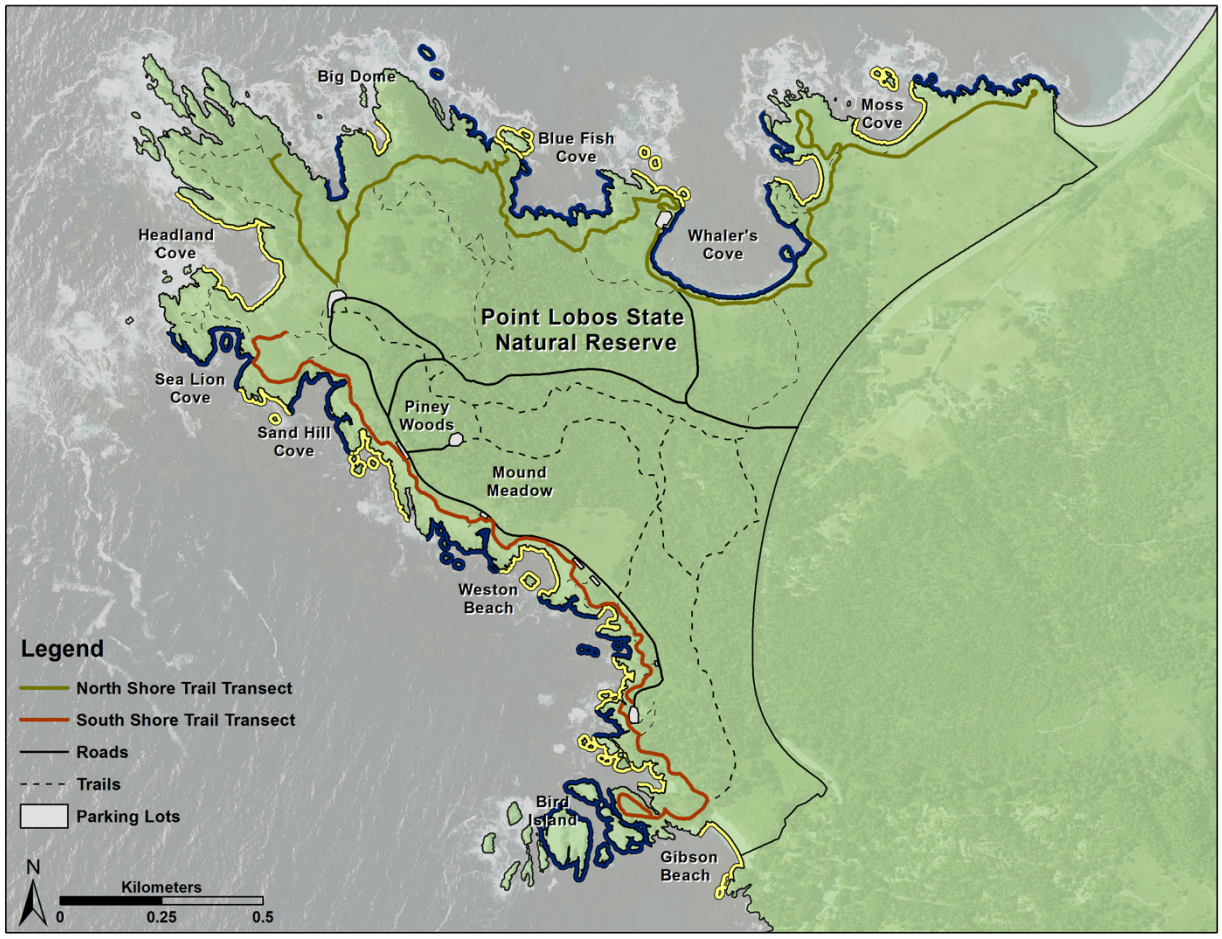

Figure 8. Updated map of PLSNR showing survey locations along the South Shore Trail Transect and newly defined North Shore Trail Transect for monitoring the population size and distribution of marine mammals, seabirds, and shorebirds.

Table 5. Focal pinniped, seabird, and shorebird species for monitoring.

Common Name	Scientific Name
Brandt's Cormorant	*Phalacrocorax penicillatus*
Pelagic Cormorant	*Phalacrocorax pelagicus*
Double-crested Cormorant	*Phalacrocorax auritus*
Western Gull	*Larus occidentalis*
Snowy Egret	*Egretta thula*
Great Egret	*Ardea alba*
Great Blue Heron	*Ardea herodias*
Black-crowned Night Heron	*Nycticorax nycticorax*
Brown Pelican	*Pelecanus occidentalis*
Pigeon Guillemot	*Cepphus columba*
Black Oystercatchers	*Haematopus bachmani*

Recommendations

Based on year one of monitoring, I would recommend the following management recommendations:

1. Establish citizen science based monitoring programs, when possible, to expand the reach of monitoring and ensure the capacity to collect data for years to come. The wildlife and reproductive success monitoring program would thrive as citizen science based programs and allow PLSNR to further inspire the protection of resources through community involvement.
2. List seabirds and shorebirds as an interpretive theme. The data collected through these monitoring programs can be used as an educational tool to inform park visitors of the status of their favorite marine mammal (which is already listed in the 1979 General Plan as a secondary interpretive theme), seabird, or shorebird, how sensitive these species are to disturbance, and what they can do to ensure their visit has a minimal impact on the reserve and species that depend on it.

To mitigate disturbance:

1. *Create an interpretive station at disturbance hot spots, namely Weston beach.* The docent manning that station would be able to inform visitors onsite of the importance of resource protection and help prevent park violations and wildlife disturbances.
2. *Seasonal closures of disturbance hot spots.* Seasonal closures during critical times of the year, such as breeding season, can provide a refuge and additional habitat for breeding activities.
3. *Permanent closure accessible only by guided walks led by docents or park aides.* Guided walks allow greater control of visitors in sensitive areas. The docent or park aide leading the walk would be able to more intimately communicate the importance of resource protection while maintaining control of the groups actions as to not violate park rules or disturb wildlife.
4. *Have a docent or park aide continuously walk trails*. Data collected by the docents through the online disturbance form can be used to identify areas of the reserve that

would benefit most from greater oversight. The docent or park aide can spend more time in those areas of PLSNR that are seeing the greatest number of park violations and wildlife disturbances.

5. *Consider a reservation system*. A reservation system, implemented year-round or for part of the year, would allow managers to control the number of visitors in the reserve.

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