AN ABSTRACT OF THE THESIS OF

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Title: Seasonal Abundance and Behavior of Steller Sea Lions in Oregon.

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Selina S. Heppell

Behavioral studies of populations provide clues as to what influences their movements and life history strategies. This is an area of study that has been underutilized in research surrounding the declining western stock of Steller sea lions, *Eumetopias jubatus*, particularly with regards to haulout behaviors. During the time of population declines in western Alaska, the Steller sea lion population in Oregon has been increasing. This study looks at the behaviors at three haulout sites, Three Arch Rocks, Sea Lion Caves, and Cape Arago, in Oregon for one year. Monthly observations were conducted at each site and used to evaluate patterns of abundance and behavior.

Using a generalized linear model, patterns in abundance were found to be associated with site, tidal heights of >4 - 6ft, and hourly wind gust peaks of >6 - 9 knots. The response to different air temperatures was variable in the range of 7^{o} - 17.5^{o}C. Abundance varied between sites and seasons from 0 – 437 animals. A probability of proportions test was used to analyze the behavioral data. This test revealed various levels of differences between the sites and the different age/sex classes. The majority of animals (77-94%) across all sites were engaged in inactive behavior (lying or sitting) throughout the year. At each site, females were the least active group throughout the year and most animals were the least active during summer months.

Associations between animal abundance and environmental conditions are important considerations when evaluating consequences of environmental fluctuations. Information from this study on haulout behaviors provides a baseline for future studies regarding the threatened Oregon population. Appendices include ethograms of behaviors seen each month at the haulout sites and brand resight information from 52 animals. This information can be incorporated into management and monitoring programs along the Oregon coast to further protect the population and aid in its recovery.

Seasonal Abundance and Behavior of Steller Sea Lions in Oregon

by
Jennifer D. Katalinich

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APPROVED:

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Jennifer D. Katalinich, Author

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Seasonal Abundance and Behavior of Steller Sea Lions in Oregon

Chapter 1 Introduction

The Steller sea lion (SSL), *Eumetopias jubatus*, is the largest member of the Otariidae. Its range stretches from southern California, along the eastern Pacific coast, through the Aleutian chain to the Kamchatcka Peninsula of Russia. In 1990, after more than a decade of dramatic decline, the species was listed as threatened under the Endangered Species Act (ESA, 1973). Identification of two genetically distinct stocks, eastern and western (Bickham et al. 1996), prompted a separation of the species for management purposes, with a dividing line near Cape Suckling, AK (144^{o} West longitude) in 1997. At that time, the western stock was reclassified as endangered by the National Marine Fisheries Service while the eastern stock remained listed as threatened (U.S. Federal Register 62:24345-24355). During the mid-1970s, the western stock was estimated to be 282,000 animals (Trites and Larkin 1996). Since then, the stock has declined over 70% (Trites and Larkin 1996, Calkins *et al*. 1999, Winship *et al*. 2002).

While the western stock declined 70%, the eastern stock was on the rise. Southeast Alaska contains 50% of the eastern stock while British Columbia and the western coast of the continental United States support the other 50%. Populations in southeast Alaska rose from 4,500 individuals in 1956 to 17,000 in 1991 (Porter 1997). Following a similar trend, the population in Oregon more than doubled between the years 1976 and 1998 (NMFS 2002). The cause of this dichotomy in population growth rates has been the subject of intensive research and debate (NRC 2003). The premise of my study is that investigation into the behaviors of the growing eastern populations may provide information vital to recovery strategies for the endangered western stock and aid in management of all SSL populations.

Declines of SSL populations have occurred in Russia, California and, most significantly, Alaska (Trites and Larkin 1996). Although reasons for the decline remain unclear, the leading hypothesis has centered on changes in food availability and quality (Hirons *et al*. 2001, Merrick *et al*. 1997, Winship *et al*. 2002, Trites 1998). Fishing activities and environmental changes are likely responsible for altering the sea lion's prey base. Recent declines in SSL populations in western Alaska have led to an increasing interest of SSL life history (Milette and Trites 2003, Winship and Trites 2003, Trites and Porter 2002, Winship *et al*. 2001). One aspect of their life history that is not well documented is the use and function of the haulout area. The availability and functionality of these sites likely serve as essential contributors to sea lion health and survival. Analysis of haulout attendance and behaviors may serve as a proxy in determining foraging frequency and energy budgets. This thesis examines the seasonal abundances and behaviors observed at three haulout sites along the Oregon coast.

A study supporting changes in forage (Pitcher 1981), found that walleye pollock (*Theragra chalcogramma*) was not the predominant prey species in the Gulf of Alaska, as in earlier studies of sea lion foraging habits during the 1950s and 60s. Walleye pollock is the single most abundant fish species in the Bering Sea and is of great commercial importance (Benson and Trites 2002). In 1992, the pollock fishery was the largest single-species fishery in the world (Springer 1992).

Trites and Larkin (1992) found that removals of large quantities of groundfish, particularly pollock, are likely to have an effect on sea lion abundance. Removals not only cause a decrease in available prey and its habitat, but trawl fishing can contribute to direct takes of sea lions through entanglement and shootings (Loughlin and York 2000, Trites and Larkin 1992). Although pollock is not a prey species in Oregon, a trawl fishery for hake (*Merluccius productus*) is present which creates similar threats to prey and prey habitat and direct harm to sea lions.

The increasing threat to the western stock through fishing activity was addressed in 1993, when critical habitat was defined (U.S. Federal Register 58:45269-45285). An extensive designation of land and water protected areas resulted in reduced fishing activities around Steller sea lion haulouts and rookeries in western Alaska. From 1991-2001, however, western stock abundance has maintained an overall decline of 4% per year (NMFS 2001). Since a reduction in fishing has not shown a profound effect on the recovery of the population, other areas of potential influence are under scrutiny.

As part of the hypothesis regarding a decrease in food quality and quantity, regime shifts and other environmental conditions have been studied. In particular, the regime shift of the 1970s is thought to have altered the abundance of key species of North Pacific fishes (Trites 1998, Benson and Trites 2002). Changes in stable carbon and nitrogen isotopes analyzed from wild SSL collagen suggest that an environmental change affecting the seasonal primary production of the region may be responsible for changes throughout the foodweb (Hirons *et al*. 2001). A regime shift with negative effects on primary production along the Alaska current typically results in increased production in the California current as the two currents fluctuate out of phase (Benson and Trites 2002). This means that an increase in the western stock may be foretelling of a decrease in the eastern stock, if regime shifts are playing a major role in the population dynamics of this species.

Other hypotheses regarding the sea lion decline include disease, pollution, subsistence harvests, entanglement in debris, and shootings. Various diseases, parasites and toxins are known to cause neonatal mortality, premature parturition, and amplify effects of malnutrition (Loughlin and York 2000). However, the amount of carcasses and aborted fetuses that have been found are only a small portion of the amount of animals missing from the western stock (Loughlin and York 2000). Antibodies to calicivirus have been detected in sea lion pups; however, there is no evidence of an epidemic having occurred over the period of severe population declines (Barlough *et a*l. 1998). Calicivirus seldom results in death, but is often associated with reproductive failure (Neill *et al*. 1995). Toxic materials and parasites have also been evident in sea lions, but are assumed to contribute little to the decline (NMFS 1995). To account for the other sources of sea lion mortality, Loughlin and York (2000) examined subsistence harvesting, predation by killer whales (*Orcinus orca*) and sharks, entanglement and shootings. Overall, these estimates do not account for the entire rate of decline. The actual rate of mortality is estimated to be 26% more than a stable population would experience.

Our understanding of SSL life history and why the western stock is struggling may be enhanced through observations of the behaviors and demographics of an increasing population. This study of animals in the successful Oregon population compares population abundance and haulout behaviors with other otariid species. One aspect of sea lion life that is not well documented is behavior and habitat use during the non-breeding season, August through May (Mate 1973, Merrick 1987). Most SSL field research has focused on rookeries during pupping season and/or populations in Alaska (Gentry 1970, Chumbley *et al*. 1997, Merrick 1987, Merrick *et al*. 1987, Merrick *et al*. 1997, Merrick and Calkins 1996, Pitcher 1981, Calkins and Pitcher 1982, Milette 1999, Porter 1997). Knowledge about haulout behaviors can provide insight as to the nutritional conditions of a population and the amount of expendable energy that is available.

Table 1 displays a comparison of this study with prior studies of haulout behaviors in other locations and for different pinniped species. This type of comparison is useful in describing differences between species and different populations of the same species. It is also informative when assessing the change in a population over time, as seen when examining this study against Mate (1973), who surveyed some of the same sites in Oregon.

The primary difference found between this study and previous studies is the lack of a pattern in peak abundance. During this study, peak abundance varied by site and by month. Similarities however, were found in the sensitivity of animals to different disturbances and influences from environmental conditions. The change in activity between the seasons and the different age/sex classes were also similar.

Table 1. Table of comparisons between the results and methods of previous studies regarding pinniped species abundance and behaviors and this study.

Reference	Location	Species*	Similarities	Differences
Beentjes, 1989	New Zealand	Ph	More time allocated to rest in summer. Variation in mean monthly abundance at haulout.	Mid-day peak in abundance.
Kastelein and Weltz, 1990	Prince William Sound, AK	Ej	Haulout behavior strongly influenced by tide.	Study conducted during summer only.
Mate, 1973, 1975	Oregon coast	Ej, Zc	Abundance influenced by weather, ocean conditions and human disturbance. Separation of species at Cape Arago.	Mid-day peak in abundance. Small breeding population observed at Cape Arago.
Merrick, 1988	Rogue Reef, OR Ugamak and Marmot Islands, AK	Ej	Females had highest frequency and duration of rest-like behaviors.	Observations from rookeries.
Peterson and Bartholomew, 1967	St. Nicolas Island, CA	Zc	Sensitive to sudden movements and sharp noises. Disturbance caused animals to rush towards water.	
Porter, 1997	Timbered Island, AK	Ej	No diurnal haulout pattern. Haulout patterns influenced by weather and sea conditions.	Study conducted during winter only.
Sandegren, 1970	Montaque Island, AK	Ej	Animals went to sea during storms and strong rain. Startled by low-flying birds and aircraft noise.	Early afternoon abundance peak.
Sullivan, 1980	Humboldt County, CA	Ej, Zc	Minimal effects from tidal height; increase in animals at tidal heights between -0.3 to 0.9m.	Mid-afternoon peak in abundance
Watts, 1992	Pacific Northwest	Pv	Wind speed and air temperature found to have significant effect on haulout abundance. Evaluated three haulout sites.	Measured solar radiation and found it to be a significant factor on haulout abundance.

*Ej-*Eumetopias jubatus* (Steller sea lion); Zc-*Zalophus californianus* (California sea lion); Ph-*Phocarctos hookeri* (Hooker's sea lion), Pv-*Phoca vitulina* (harbor seal).

Chapter 2 Manuscript

2.1 Introduction

The precipitous decline of the western stock of Steller sea lions (SSL) (*Eumetopias jubatus*) during the 1970s and 80s (Trites and Larkin 1996, Calkins *et al*. 1999, Winship *et al*. 2002) has been in sharp contrast to increases of the eastern stock, particularly along the Oregon coast (Porter 1997). From 1976 to 1998, non-pups in Oregon more than doubled from 1,486 to 3,990 (NMFS 2002). This discrepancy in abundance trends may be related to the behavioral responses of the different stocks to environmental conditions and disturbances. To assess this incongruity, it is essential to first identify factors which influence the behaviors of the Oregon population.

Population declines of Steller sea lions have occurred in Russia, California and, most significantly, Alaska (Trites and Larkin 1996). Reasons for the decline remain unclear, but the leading hypothesis has centered on changes in forage availability and quality (Hirons et al. 2001, Merrick *et al*. 1997, Winship *et al*. 2002, Trites 1998). In an effort to slow the declines, and in cooperation with critical habitat designation through the Endangered Species Act, boundary restrictions were placed on fishing activities around specific rookeries and haulouts in western Alaska. Since 1991, however, the western stock as a whole has maintained an average decline of 4% per year (NMFS 2001). Because a reduction in fishing has not shown a profound effect on the recovery of the population (NRC 2003), other areas of potential influence have been under scrutiny.

This study examines the behaviors and demographics of the increasing Oregon population. Studies of SSL behavior on a year-round basis and from haulout sites are scarce and life during the non-breeding season, August through May, is not well documented (Merrick 1987). Much of SSL field research has focused on rookeries during breeding season and/or populations in Alaska (Gentry 1970, Chumbley *et al*. 1997, Merrick 1988, Merrick *et al*. 1997, Merrick and Calkins 1996, Pitcher 1981, Calkins and Pitcher 1982, Milette 1999, Porter 1997).

The goal of this study is to increase our knowledge of SSL life history and population biology though assessment of correlations between environmental conditions and abundance, and of seasonal changes in behavior and abundance. Studies in behavior can offer more than survey numbers in that they can provide insight into movement patterns, effects of disturbances and environmental variables, inter- and intraspecific interactions and, potentially, changes in population abundance or perceived abundance increases. It is important to understand why an animal behaves as it does with relation to its environment to comprehend the consequences of ecosystem changes. If these relationships can be determined for a healthy population, we may better understand what makes a population decline. In their 2003 report on the status of the SSL, the National Research Council (NRC), when discussing the decline of the western stock, stated:

> "Documentation of site-specific trends, especially when evaluated in the context of environmental variation, could greatly enhance understanding of the causes."

Thus, research on behavior and haulout use may help narrow the scope of hypotheses as to what led to the decline of the western stock.

This paper evaluates a year of census and behavioral data collected from three SSL haulout sites in Oregon. Behavior patterns and abundance are examined as they change with time and by site. It was hypothesized that there were no diurnal patterns of abundance and that abundance decreased in the spring and summer months for all sites as animals moved south to the rookeries. Behavior was expected to vary among the different age and sex classes and by site. Additionally, abundance was analyzed with respect to environmental conditions of the surrounding area. These factors were air temperature, peak wind gust, and tidal height. Conditions associated with storm events were hypothesized to have a negative effect on abundance. These results were then compared to studies of other pinniped behaviors and previous evaluation of the Oregon population. To encourage a holistic approach to SSL management, we provide recommendations for further study to enhance our knowledge and understanding of the SSL throughout its range.

2.2 Methods

2.2.1 Study Areas

Study sites were selected based on the premise that they were haulout sites (not normally used for breeding), accessible by foot and safe for a single observer to traverse. Three sites were chosen from the seven SSL haulouts located along the Oregon coast (Figure 1).

Three Arch Rocks (TAR) is located off the coast of Oceanside, Oregon, 9 miles west of Tillamook (45°27’50”N, 123°58’56”W). Three Arch Rocks is the oldest National Wildlife Refuge in the western United States. Three Arch Rocks encompasses 15 acres and is made up of 3 large rock islands, and 6 smaller islands. From the beach at Oceanside, the rocks lie half a mile offshore and were observed by spotting scope from a lookout point atop a 700 foot mountain on the mainland. Animals were typically observed situated on the small rock closest inland. On the back

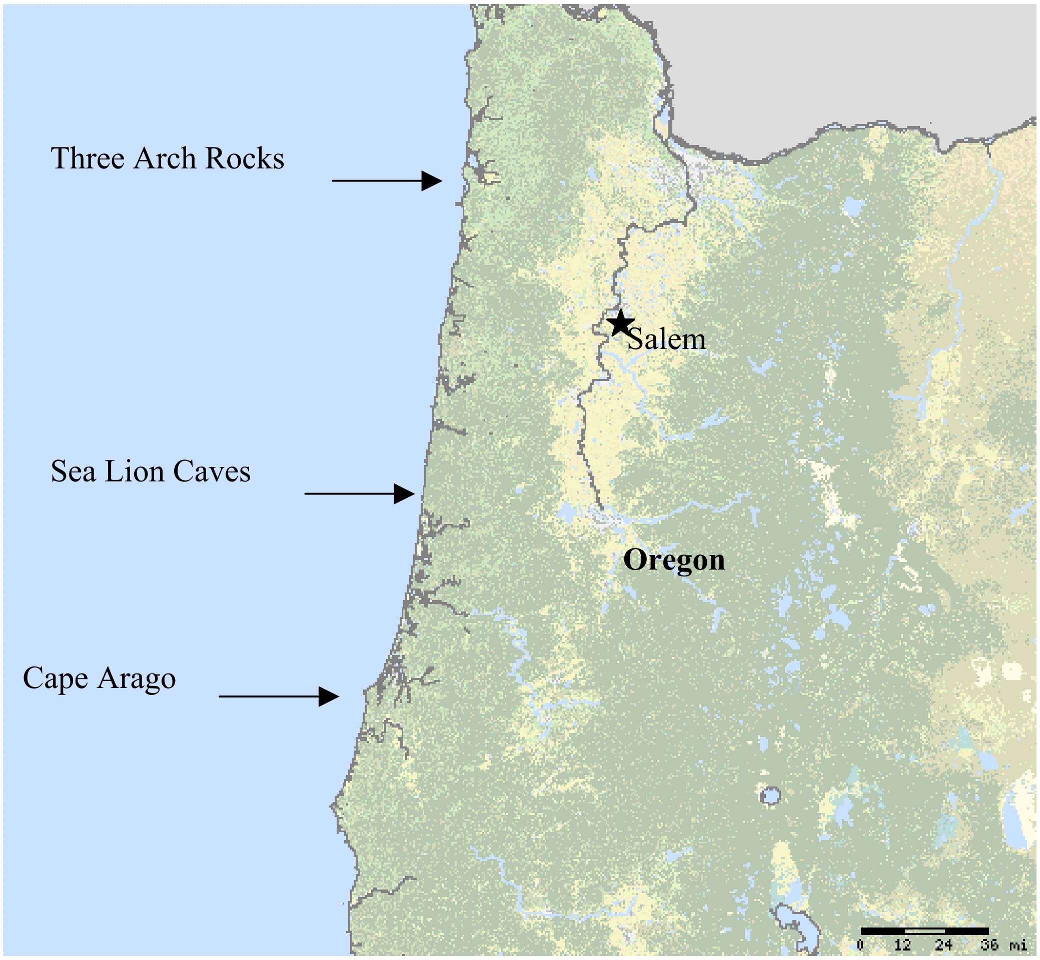

Figure 1. Map of study sites along the Oregon coast.

(south) side of this rock, there is easy access to the water and a flat surface for sea lions to lie on; however this side was not completely visible from the observation point. Animals hauling out on the north side of this rock encounter a steeper slope, but are less likely to encounter spray from the surf. Human disturbance at this site was due to boating activities and aircraft, primarily in summer.

Sea Lion Caves (SLC) is a tourist attraction open year-round and located 11 miles north of Florence, Oregon (44°07'30"N, 124°07'32"W). The terrain in the cave consists of large jagged edged boulders on the perimeter and a single rock island. The island has a flatter surface than the surrounding habitat, but can only accommodate about 25 animals. At low tide, smaller cobbles are exposed and this is typically the area pups use to play in the surf. Animals typically occupy the cave in the winter and spring where they are sheltered from the rain and wind. During the summer months, animals move out to the large shelf area that is the primary viewing area for visitors. Because of its shallow slope, this area is easily inundated by the surf at high tide and during storms. The area surrounding sea lion caves is primarily rocky cliffs with a small beach area to the north. To the south of the caves, animals may be seen occupying a ledge area just around the southern tip of the viewing area. This area can be viewed only by traversing a steep hillside and was thus not used as an observation point. Human disturbances to animals at this site were due to noise and camera flashes inside the cave. Aircraft were relatively common, but were rarely seen to have an effect on behavior of animals outside the cave.

Cape Arago State Park (CAR) is located next to Simpson Reef, about 15 miles southwest of Coos Bay, Oregon (43°18'45"N, 124°24'00"W). This site has a viewing area near the end of Cape Arago Highway. The largest island, Shell Island, is a National Wildlife Refuge whose steep, towering peak provides cover from south winds while the base stretches out to a sandy beach. At low tide, tourists can hike along the southern cove trail and walk out along the shelf that leads to the islands. From 1 March- 30 June, the trail is closed to protect harbor seal (*Phoca vitulina*) pups.

California sea lions (*Zalophus californianus*) and harbor seals are the primary inhabitants of CAR. Elephant seals (*Mirounga angustirostris*) are also known to haulout on the sandy beach area in small numbers. When California sea lions are abundant, Steller sea lions are typically located on the outer edges of Shell Island, on Simpson Reef, and on the smaller island located just west of Shell Island. When

California sea lions were not present, SSLs occupied the beach area and spread out amongst the various smaller islands and the reef. Activities and noise produced by other species were the primary source of disturbance to SSLs at this site, although humans were observed trespassing on the closed area and the potential exists for people to walk near the animals at low tide.

2.2.2 Data collection

Study sites were visited once a month from September 2003 to August 2004. During each visit, observations were made via binoculars, spotting scope and naked eye, for a period of 4-6 hours. Scan samples (Altmann 1974) were conducted every 20 minutes. Each scan described the activity and age/sex class of each individual on the haulout. Animals that were in the water were not counted. Activity was recorded as a categorical action or posture. Descriptions categories for postures and actions follow those previously described for pinnipeds (Stirling 1970, Beentjes 1989, Kastelein and Weltz 1990) and those found relevant to the activities of the local population:

- Agonistic: aggressive physical interaction or threat (head waving, challenging, full neck display, or biting).
- Lying: stationary in prone position, flippers tucked or extended, eyes opened or closed.
- Sitting up: sitting posture, head back in non-threatening position.
- Walking: movement within haulout area.
- Comfort: grooming, scratching, stretching, yawning or shaking off.
- Water: coming in from water or going into water.
- Vocal: in sitting or lying position vocalizing.

- Submissive: head and neck lowered, turning away from threat display.
- Suckling: pup or juvenile attached to female.
- Breeding: intersexual behavior including sniffing and mounting; birth.

The age and sex classifications were: adult male, adult female, juvenile, pup and unknown. Throughout the entire observation period, information on branded and tagged animals was recorded when observed. Other animals with unique markings or fishing gear entanglements were recorded and sketched for future identification.

At sites where animals gather in more than one area, the area where the largest group gathered was the primary population observed. The other groups were counted at the beginning and end of the 4-6 hour observation period. This count data was used in determination of average daily abundance, but was not incorporated into any other analysis. Meteorological conditions were noted at the beginning of each visit and subsequently each hour, or as obvious changes occurred. Noted conditions were air temperature, wind speed, cloud coverage, precipitation, and tidal height. Focal events, such as weather changes or human disturbance, were noted as they occurred along with animal responses. Information available from land based data centers provided air temperature, peak wind gust and tidal height information. Tidal height was recorded as the height at the beginning of each scan.

2.2.3 Data Analysis

Count data were taken from the total abundance of animals present during each scan sample. Animals classified as "unknown" were incorporated into analyses of count data, but were not used in behavioral analyses. Abundance data for each site visit were then pooled together with their respective environmental conditions to provide for a robust assessment of environmental influences. The chosen model for the generalized linear regression was square-root transformed count data versus site, tidal height, peak wind gust and air temperature, without interactions. Count data were also analyzed for correlations of peak abundance with hours from sunrise and from last high tide.

Using the categorical data collected during each scan, behaviors were then reclassified as "inactive" (lying or sitting) or "active" (all other behaviors). This type of classification was chosen because of its widespread application in behavioral studies, including those of other mammals such as primates (Fashing 2001) and bats (Codd *et al*. 2003). Seasonal and site specific haulout behavior patterns were determined by pooling individual scans from sampling days during that three month season (i.e., Summer – June, July, August). Once the data were grouped by seasons, a probability of proportions test with continuity correction (95% CI) was run to determine the likelihood that these behaviors differ by season or by site. Three Arch Rocks did not have animals present during all seasons and thus the behavioral data from Three Arch Rocks were not part of a seasonal analysis. Behavioral differences between age and sex classes were analyzed by pooling all scans within a group and running the same probability test. This method provides a glimpse at general trends among and between sites throughout the year. All statistical analyses were performed using S-PLUS 6.1.

2.3 Results

2.3.1 Haulout Abundance

Until recently, censuses in Oregon have focused on summer months and at southern rookery sites (Mate 1973, Merrick 1987, ODFW unpublished data). Monthly site visits and scan sampling provide information on daily and monthly variability at three primary haulout sites over a one year period (Figure 2). Although sites were surveyed each month, animal presence varied by site throughout the year. Sea Lion Caves had the highest abundance and the most consistent attendance by animals. The southernmost site of Cape Arago, was the only site that had animals hauled out during the fall, but animals left the area for most of the winter and spring, returning again in the summer. Three Arch Rocks was the site of least frequent attendance and lowest abundance between the three sites.

Due to the limited time of observations during site visits, scans for all sites were pooled and these count data were regressed against site, tidal height, peak hourly wind gust, and air temperature variables (Table 2).

There are significant differences in abundance among the three sites (P <0.001) and across environmental variables. There are also significant differences in abundance relative to the different intensity levels of each environmental condition. Tidal heights between >4ft and 6ft, saw a significantly greater number of animals hauled out than the other three height categories (P = 0). Hourly peak wind gust also had a significant effect on haulout numbers, relative to other wind speeds, when gusts were between six and nine knots (P = 0.0004). Air temperature had varying effects. The following temperature ranges, in degrees Celsius, were found to have a statistically significant relationship to abundance relative to the >5 – 7 degree category: >7 - 9, >11 - 14, and >14 – 17.5. The numbers of animals hauled out in relation to environmental variable levels and by site are given in Figure 3.

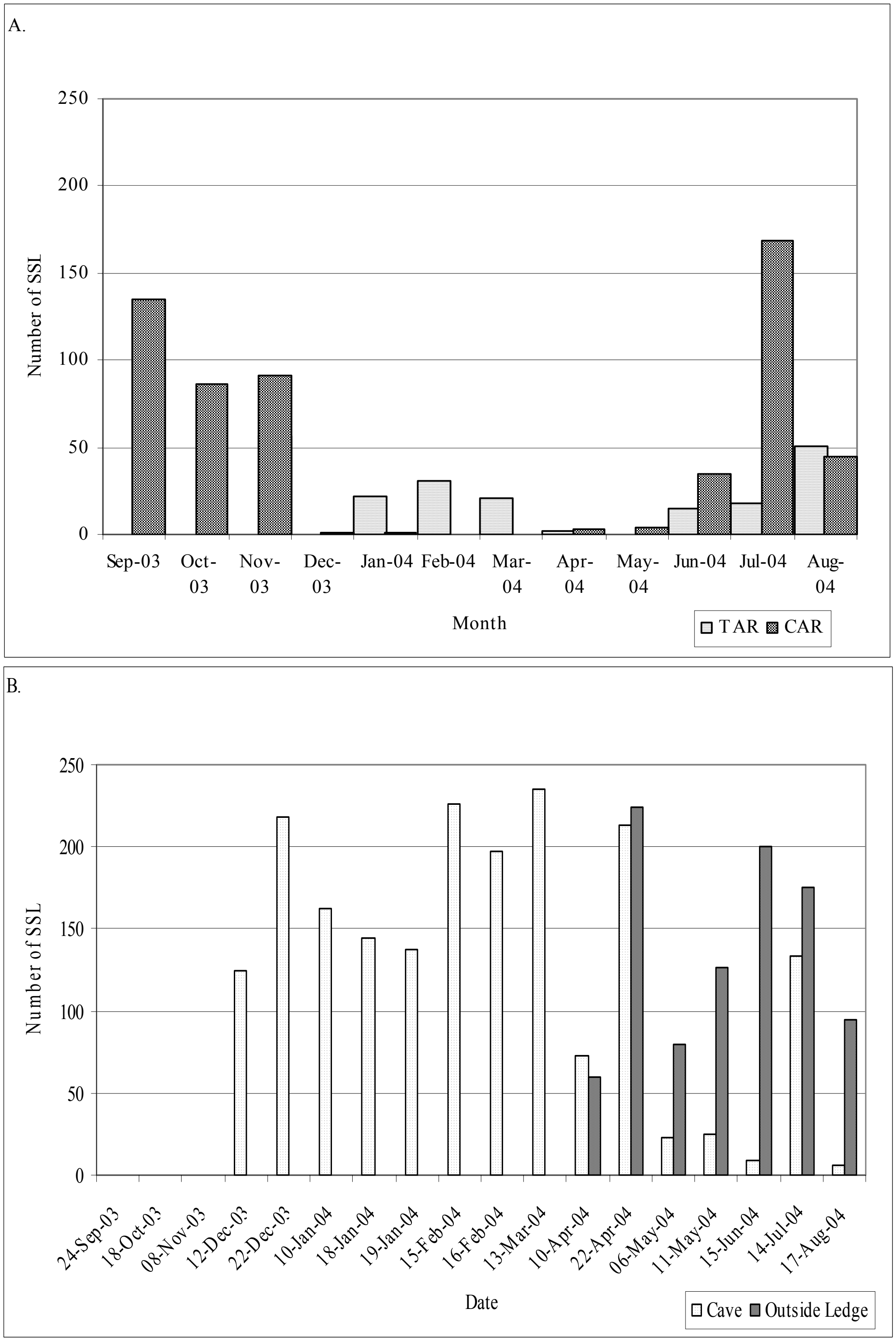

Figure 2. Bar graphs of mean daily abundance of Steller sea lions observed at each site throughout study year. Figure A shows abundance for Cape Arago and Three Arch Rocks, B shows abundance at SLC. Both areas at Sea Lion Caves were surveyed each visit.

Table 2. Table of variables and categories used in the general linear regression to determine their influences on sea lion abundance patterns. N represents number of scans. Right side shows occurrences of each category per site.

Coefficients from full model general linear regression				Occurrences per site		
Variable	Category	N	P-value	Three Arch Rocks	Sea Lion Caves	Cape Arago
Site:	Cape Arago	100				
	Sea Lion Caves	158	<0.0001			
	Three Arch Rocks	86	<0.0001			
Tide Height (ft):	<2	97		3	58	36
	>2 - 4	80	0.8646	30	29	21
	>4 - 6	96	<0.0001	32	43	21
	>6 - 9	71	0.3911	35	28	8
Wind Gust (kts):	0 - 3	141		34	49	58
	>3 - 6	109	0.8785	39	54	16
	>6 - 9	72	0.0250	27	35	10
	>9	22	0.2630	0	20	2
Air Temp. (^{o}C):	>5 - 7	56		8	14	34
	>7 - 9	46	0.0006	6	23	17
	>9 - 11	78	0.2130	16	62	0
	>11 - 14	118	<0.0001	34	49	35
	>14 - 17.5	46	<0.0001	36	10	0
F-statistic: 71.87 on 12 and 331 degrees of freedom						

The time of peak abundance during the observation periods varied by month and by site (Figure 4). During the month of January, when three visits were made to Sea Lion Caves, the peak abundance times varied by day.

2.3.1.1 Three Arch Rocks

This site showed relatively low and variable abundance. Animals were not present at TAR from August 2003 – January 2004. Animals were present during February and March, but were gone during the April and May visits. During the April visit, the lookout point was inundated by hang-gliders and para-gliders. There were no animals present that day, but gliders reported having seen animals the day prior. It is possible that the circling motion of the gliders may have caused animals to flee the site. Monitoring this site during times of increased glider presence may resolve the issue of whether this activity is disruptive to the animals or not.

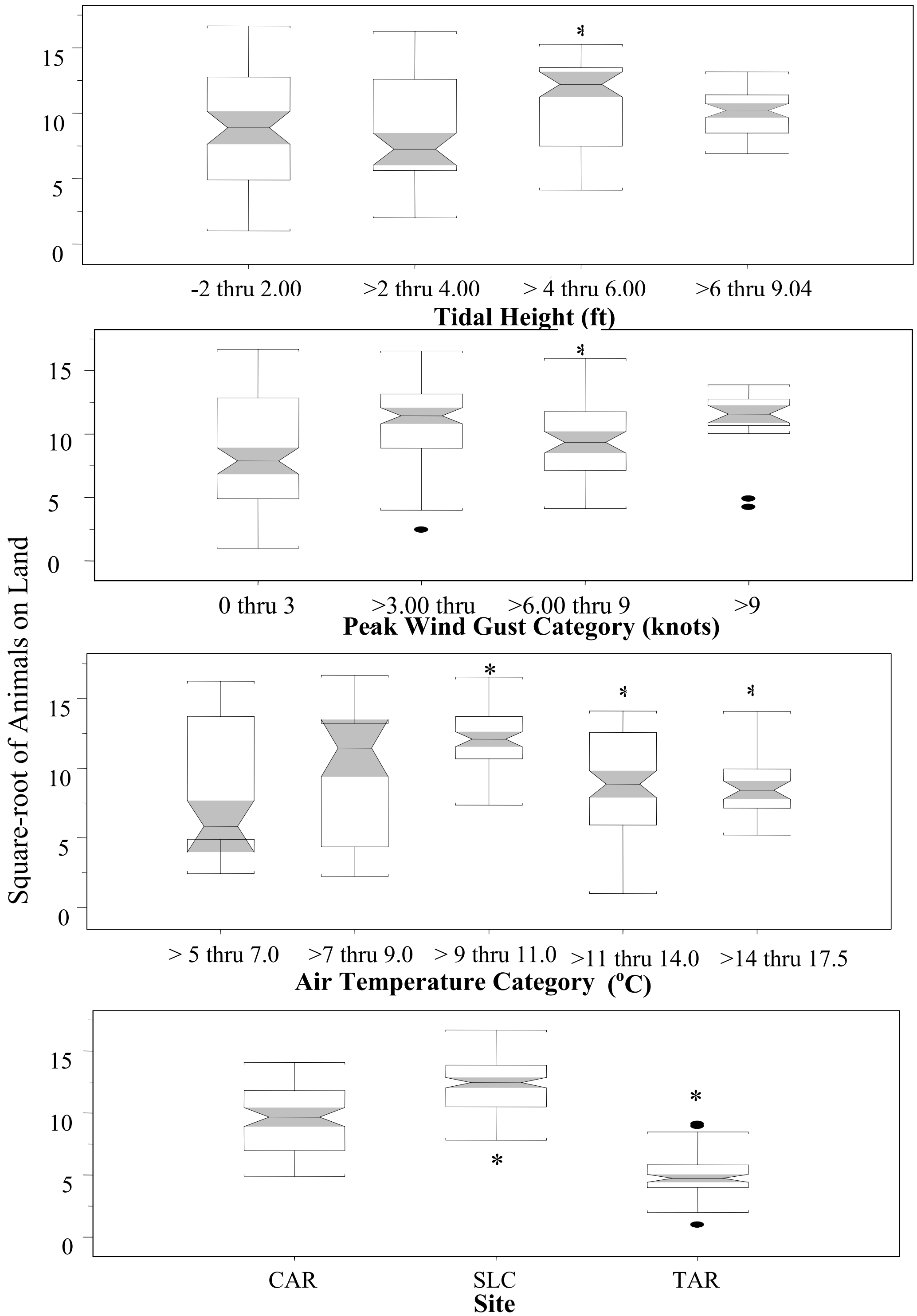

Figure 3. Box plot distributions of haulout number with respect to environmental conditions and site location at time of scan. Shaded areas represent 95% confidence intervals around the median and center line denotes the median. The box represents the inter-quartile range while the bars are 1.5*inter-quartile range. The dots are outliers. *Significantly different category.

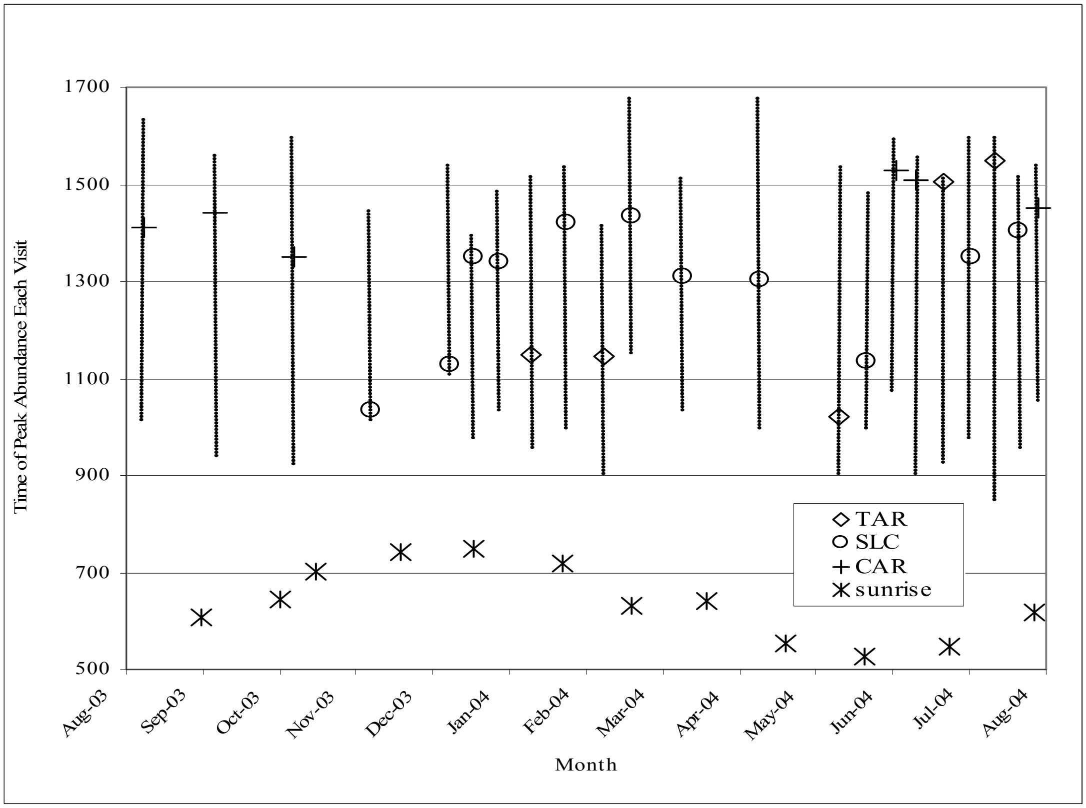

Figure 4. Graph of peak time of abundance at each site during the time surveyed and time of sunrise for first sample day of the month. Time is in Standard Daylight. Vertical lines show duration of visit.

By 11 June, animals had returned and were present for the remainder of visits to this site. Abundance at this site was observed to peak in August when numbers reached 83. Pups were observed at this site during February, March and June, while juveniles and adults of both sexes were seen all five months when animals were observed. The proportion of females was stable during February and March at approximately 26%, and then changed dramatically during the summer months. June saw the highest proportion of females at 32.9%, and then numbers dropped to 1.2% in July and rose again in August to 17.5%.

Daily peak abundance at TAR varied from 0.78-7.92h from the previous high tide and 4 times out of 5, this peak occurred on ebb tides. The time peak abundance occurred also varied from 4.5-9.5h after sunrise (x = 6.7h, SD = 2.52h, n = 5).

2.3.1.2 Sea Lion Caves

During September, October, and November there were no animals hauled out at the caves. All animals seen during that time were rafting in the water nearby. From December through April, most of the animals occupying the site were found in the cave. Site visits after April were spent observing animals from the outside lookout area above the ledge where the majority of animals were then hauled out, outside of the cave. Average monthly abundance at SLC peaked in March with an average of 235 animals during the visit on the 13th.

During the winter months, the primary inhabitants at SLC were females and juveniles, with each comprising an average of 38% of the total winter population. In the spring and summer, females represented 43% and 19% of the haulout populations, respectively. August had the lowest proportion of females present, representing only 9% of the total observed population. The onset of the breeding season that occurs at rookeries off the southern Oregon coast and northern California is assumed to be the primary reason for the decline in female presence at the SLC haulout site. A few males were observed at the site in December, but were then absent until May when large, adult males arrived and were observed through August. Most of these males are believed to be younger than the breeding males at the rookeries and hence, are still spending their summers at haulout locations.

Daily peak abundance at SLC occurred during all tidal stages and from 0.6-12.15h since the last high tide. Peak abundance varied from 2.87-8.07h after sunrise (x = 6.2h, SD = 1.7, n = 11).

2.3.1.3 Cape Arago

Animals were observed at CAR during the fall and summer months. During the fall, juveniles averaged the largest proportion of the population at 60.7%. Five to 22 adult females where observed during visits in September and October. In November, females arrived with pups and a maximum of 55 females were observed. In the summer, with the increased presence of adult males, juveniles averaged 45.5% of the population and females were rarely seen.

The highest observed abundance at this site was on 15 July when there were 198 animals. At this time, adult males were the most prevalent demographic category (82.8%). Daily peak abundance at CAR was observed at low or ebb tide. These peaks ranged from 6.82-9.9h after sunrise (x = 8.22h, SD = 1.2, n = 6).

Cape Arago also had the highest abundance of other pinnipeds species. These species include California sea lions, elephant seals, and harbor seals. Their abundances ranged from 5 – 1420, 0 – 14, and 0 – 520, respectively when SSLs were observed and varied by month. On the last observation day in August, a sea otter (*Enhydra lutris*) also hauled out on the beach.

2.3.2 Haulout Behavior

The most common behavior observed at all haulout sites was lying, indicating that SSL spend the majority of their terrestrial time resting (Figure 5). However, there were some subtle differences in the number of animals observed in

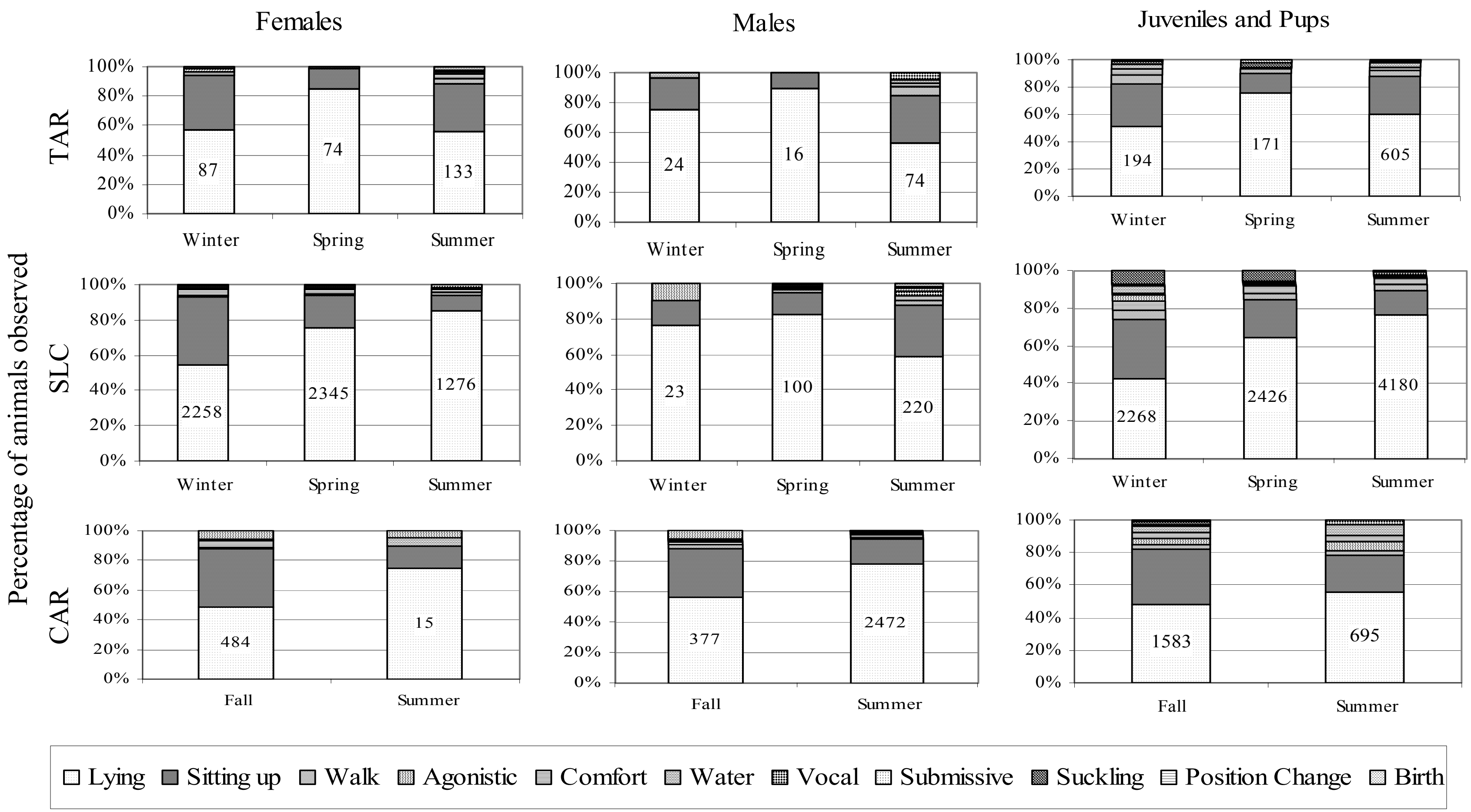

Figure 5. Bar graphs display the percentage of each activity pooled by season, site, and animal type. Number of individuals in lying position is provided.

each activity, with significant site, season, and age/sex differences. Females were commonly the most inactive animals while pups were the most active.

2.3.2.1 Three Arch Rocks

Animals were observed at Three Arch Rocks during February, March, June, July and August 2004. The most common behaviors observed at this site were sitting and lying. Walking was the third most common behavior during February, June, and July. During March, agonistic behavior and suckling were the third most common behavior and in August, comfort was third most common. The highest percentage of agonistic behavior observed at this site (2.7%) was during July.

Pooling all observation days, a significant difference was found between the levels of activity among the different age/sex classes at this site through a probability of proportions analysis ($P < 0.0001$). Females were the least active with an average of 8% in active displays (behaviors other than lying or sitting). An average of 19% males and pups were active, making them the most active groups.

2.3.2.2 Sea Lion Caves

Animals were observed hauled out at SLC from December 2003 to August 2004. Animals were in the area September, October, and November, 2003, but did not haul out. During the winter and spring months, the majority of animals were hauled out inside the cave, and then moved outside during the summer. The percentage of total animal activity changed significantly by season at this site. Differences were found between winter and spring behaviors ($P < 0.0001$) and winter and summer behaviors

($P < 0.0001$) with winter being the most active season. There was no significant difference between spring and summer behaviors ($P = 0.17$). Evaluation of age/sex class information revealed seasonal differences.

Pups were found to be significantly more active in winter than spring (39% and 27%, respectively, $P < 0.0001$). No seasonal behavior analysis was conducted on adult males due to their absence during most winter and spring months. They were present however, during each visit in the summer. Adult females did not show any seasonal changes in proportion of inactivity ($P = 0.30$). This group experienced only a 1% decrease in activity between winter (7%) and spring and summer (6%). Juveniles displayed a significantly different proportion ($P < 0.0001$) of active individuals from winter (19%) to summer (10%). The average proportion of active juveniles was 14%. A significant difference ($P < 0.0001$) was found between the levels of activity displayed between the different age/sex classes with pups being the most active group (35%) while females were least active (7%).

2.3.2.3 Cape Arago

Observations at CAR found a significant seasonal difference between proportions of total animals active for the two seasons, fall and summer, those animals were present during site visits (fall 16%, summer 10%, $P < 0.0001$). Pups were observed at this site during September and November and had an average of 36% of animals active. Adult males were observed during both seasons and were significantly more active during the fall than in the summer (fall 12%, summer 6%, $P < 0.0001$). Adult females were observed during the fall and for the first two months of the summer. Pooling these five months, females had an average proportion of 12% activity. Juveniles were significantly more active during the summer than fall (fall 17%, summer 21%, P = 0.0003). Overall, there was a significant difference between proportions of active animals in the different age/sex classes (P < 0.0001). Pups had the highest average proportion of active individuals (36%) and males had the lowest (7%).

2.4 Discussion

Studies of animal behavior can allow us to further evaluate the status of a population beyond numerical counts. The data collected through behavioral observations may allow for signs of stress or disturbance to be revealed. This study was focused on Steller sea lion haulout behaviors in Oregon as a means for a quantitative base line of data on this missing piece of life history information for animals in this area. Behavior of animals in a healthy, growing population reveal patterns that may vary from those in declining populations, thereby contributing to hypothesis testing of causes for the decline.

SSL at each of the haulout sites peaked in different months. At TAR, SSL peaked in August; this was the latest peak seen at the three sites. Presumably, this was because it is the northern-most site and during much of June and July, animals are gathered at the rookeries in southern Oregon and northern California. As for the majority of daily peak abundances at TAR occurring on ebb tides, this is consistent with the limited amount of space on the small island that was the primary hauling location observed. During the peak month of August, sea lions were observed in the waters near the islands for an hour and forty-five minutes before hauling out. During this time, harbor seals were hauled out and soon after the last seal left the site, the sea lions hauled out. This was the first time harbor seals had been observed at this site during this study and their unusual presence may have been responsible for the sea lions' prolonged time in the water that day. The relatively low numbers of animals seen at this site throughout the year correspond to similar findings by Mate (1973), who described the area as being used by small groups of Steller sea lions. He also described this as a winter haulout area, which is not in exact correspondence with my data; animals were seen at the end of January and during February, then not again until June. There are other haulouts further to the north which animals may now be utilizing which could account for this discrepancy.

A more striking result is in the abundance of SSL pups at TAR, where no pups were seen 30 years ago. During this study year, pups were present at SLC from December through May while Mate (1973) did not observe any pups over-wintering here. Overall peak abundance was observed at the caves in March. This timing is similar to a "wave" of females moving south during March and April described by Mate (1973). These months saw the highest proportion of females observed at this site. The change in pup presence could be associated with the increase in California sea lion presence further south. Mate (1973) hypothesized that the migratory movements of SSLs are likely related to the population pressure from California sea lions, which have been increasing in number as well (Read and Wade 2000). Further support for this hypothesis comes from the drastic reduction of animals from the southernmost SSL rookery at San Miguel Island, CA. At the time of his study, Mate (1973) noted that the rookery was occupied by a single adult SSL and some female California sea lions. In the thirty years since this study was conducted, this rookery has been abandoned by

SSLs. Female SSLs in Oregon may be moving off rookery sites sooner than they had previously to avoid an influx of California sea lions. Further investigation is needed regarding the timing of female movements from rookery sites before this hypothesis can be confirmed.

Males were infrequent visitors to SLC during the winter and began arriving on a regular basis in May, as female abundance was decreasing. This change in sex ratio is synchronized with the timing of animals moving south to the rookeries for birthing and breeding during June and July. The presence of adult males at SLC during breeding season implies that they are still too young to hold territories and breed at the primary rookery sites. Adult males at SLC were observed in numerous aggressive interactions with other males and juveniles. Observations were also made of males sniffing and chasing females, but no copulations were observed. A large adult male presence was also observed at CAR during July with many juveniles present. In contrast to the breeding observed at this site in the late 1960s and early 1970s (Mate 1973), these males were all bachelor bulls as there were no adult females present during this time and no males were conspicuously holding a territory.

Daily peak abundance at SLC was apparently not as dependent on tidal cycle as the other sites as it occurred during every tidal phase. This is likely because of the exclusive use of the cave by SSL and the space available between the hauling areas outside the cave and inside.

There was no discernible pattern to the timing of peak abundance at any site. It was possible however, to find significant associations between abundance and environmental conditions and sites. It is not surprising to find a difference in abundance between sites because of physical differences and presence of other species. The most obvious differences between sites in physical characteristics are the presence of a large sand beach at CAR, a large cave at SLC and the small, solitary island occupied at TAR. The sites differ in their quality and quantity of area suitable for hauling out. In terms of abundance of other pinnipeds, CAR has the highest populations of California sea lions, harbor seals and elephant seals of the three sites, while SLC sees only an occasional California sea lion. Harbor seals were observed briefly one day at TAR. Each site, therefore, presents its own set of physical and biotic dynamics.

Tide height and wind gusts at the time of observation had a significant correlation with abundance with the tidal height category of >4 - 6ft and the peak hourly wind gust category of >6 - 9kt. These categories had a significantly higher abundance relative to the reference category. Two other categories of wind gust had a higher abundance than the >6 – 9kt category, but the medians of overlapped showing no difference between those two categories. The lowest tides saw the largest range in animal abundance while the highest tides had a small range of abundance. The highest tides however, result in higher animals densities because of the limited space available. It is conceivable that space becomes limited once the tide reaches six feet or above. Once the tide is above 9 feet, animals may have reached an elevated area and do not leave. Low tide may result in a similar effect on distribution, mediated by the presence of other pinnipeds. At CAR, for example, the large sand beach and shelf that are exposed at low tide are typically occupied by California sea lions and harbor seals, thus making the increase in space less available for SSLs.

The intermediate wind gust category had a significant association with abundance. This category was associated with abundances greater than the lowest wind speeds, but less than the other categories. It is likely that very strong winds keep animals from hauling out, but because this could not be measured, the underlying effect is not known. Another possible explanation for the intermediate wind level effect is that winds above 6 knots occur primarily during winter. This is also the time when most animals were hauled out at SLC, thus sheltered from the wind. It may be that once winds pick up, animals make a decision whether to haul out or not. By the time with gusts reach over 9 knots, those that are going to haul out have done so, and those are still at sea do not come in. Lower gust speed may simply be less influential because it can not produce the amount of spray and waves caused by stronger gusts.

Temperature has a strong effect on thermoregulation and likely affects the amount of time that individuals haul out. In this study, there were several temperature categories that were associated with abundance changes. With the mild climate of the Oregon coast, temperature may not be as influential as in other locations and other variables in the model may play a stronger role in determining haulout patterns. Further investigation which incorporates the surrounding water temperatures may reveal stronger effects on haulout behavior than air temperatures.

Above all, the most common behaviors observed were lying and sitting, which were grouped as "inactive" behavior. This behavior ranged from 77.4% to 93.6% of all animals surveyed. During their study of territorial bulls in Prince William Sound, AK, Kastelein and Weltz (1990) found that the animals spent 70-79% of their time in a resting position. This level of activity is similar to pups and juveniles observed during my study. Further investigation into the activity budget of territorial males in increasing populations versus those in decreasing populations, such as those previously mentioned, could shed light on energetics related to copulation rates and population growth. The level of activity may also reveal the amount of expendable energy the animals have as a result of nutritional conditions.

The significant difference between fall and winter behaviors versus summer are similar to those found in Hooker's sea lions (*Phocarctos hookeri*) of New Zealand (Beentjes 1989) that also experience less activity in the summer. The insulating properties of the thick blubber and fur which protect sea lions from exposure in cold climates are likely responsible for the decreased activity levels during times on land when they are exposed to warmer temperatures. Resting postures are therefore thought to be used as a form of thermoregulatory behavior during time of increased heat exposure (Beentjes 1989, Stirling 1970). Similar conclusions have been drawn regarding terrestrial species that typically spend approximately 60% of their time resting (Fashing 2001, Codd *et al*. 2003). Since terrestrial animals expend less energy moving about than an aquatic animal does, it is fitting that the time spent resting is less.

Amount of rest may be especially critical for females, particularly those lactating or pregnant. SLC saw the most suckling activity, nearly 3% of activity each month, and the only birth observed at the three sites. This location has been thought of as a rookery, but the susceptibility of the outside hauling area to tidal inundation and the large boulder field of the cave interior, make it unsuitable habitat for young pups. The pup whose birth was observed was not resighted. Female activity levels at SLC and TAR are similar to those seen at rookery sites in the 1980s from increasing (Rogue

Reef, OR) and decreasing, (Marmot and Ugamak Islands, Alaska) populations (Merrick 1987). All of these sites found females to display the most rest-like behaviors. At CAR however, males were the least active. This site also had the least amount of females and in July, when the population peaked, it was primarily males. Also at this time, California sea lions were only present in very low numbers allowing for utilization of large areas of the haulout usually occupied by these other pinnipeds.

Further studies on Oregon's SSL population are needed to determine movement patterns and associations with other pinnipeds distributions. This study has shown several changes in SSL population demographics and haulout use from previous studies. The California sea lion (Mate 1979, 1982) and harbor seal populations are increasing and as space becomes limited, it is likely that the SSL will be the first to leave, as witnessed at San Miguel Island (Mate 1973). Such change may have negative effects on the population if rookery sites are lost.

Although a branding program is in place and surveys are being conducted with more regularity (Brown and Riemer 1992), the use of satellite telemetry technology could provide a more consistent database of movements and habits. Similar method have been incorporated into programs in AK and can be used to determine haulout use and off-shore foraging patterns. With knowledge regarding foraging patterns and areas of high use, managers would be better equipped to handle potential conflicts with resource users and better protect habitat necessary for the survival and success of a healthy population.

Chapter 3 Management Implications

Marine mammal protection received intense scrutiny in the 1970s with the passage of the Endangered Species Act (1973) and the Marine Mammal Protection Act (1972). These acts set in place regulations regarding the treatment and protection of marine mammals and consequences for violations.

Since the 1970s however, marine mammals of various species have seen dramatic declines. The onset of many of these declines was due, in part, to human activity of earlier times, namely whaling, fur trading and subsistence harvesting (Mate 1973). Today, human activity, from pollution to mismanagement of our natural resources, continues to affect the life history and survival of many species. With the dramatic decline of western Alaska's SSL in the 1970s and 80s, particular attention has been drawn to this species and its habitat. Although the ultimate cause of the SSL decline is still unknown, human activity plays a role in each hypothesis. Care must be taken to minimize impacts from human activities that could result in tipping the scales and causing Oregon's population to decline.

Many regulations are already in place in an attempt to make the public aware of this resource and to avoid unnecessary harassment. Aside from their role as a top predator in the coastal ecosystem, SSLs are also important to the tourism industry in Oregon. However, enforcement is low and people may not be aware of indirect effects of disturbance on SSL. At Three Arch Rocks National Wildlife Refuge, the islands are off-limits to public use year-round. During sea bird nesting season (1 May- 30 September), a 500' boundary area is imposed on boaters in the area. This boundary is displayed by several buoys surrounding the 15 acre refuge.

While visiting this site to conduct sea lion scans during nesting season, I observed a recreational fishing boat in this area for over an hour. While en route around the large islands, nesting birds atop the island were startled by the boat and began vocalizing and flying. This resulted in a disturbance to the nearby sea lions that sat up from lying positions and looked about. Later, this same boat encountered sea lions that were swimming in the area which sent the sea lions back to haul out in a hurried manner. Situations such as this present unnecessary energy expenditures and may have detrimental effects on populations that are already experiencing nutritional stress.

From observations of boaters and beach goers, the refuge appears to provide sanctuary for sea lions, when boundaries are respected. There are other potential sources of disturbance however, that are outside of the water. Low flying air craft and hang gliders pose potential threats by their noise and circling nature, respectively. Maxwell Mountain is a popular launch spot for hang gliders and para-gliders. During the May visit, no animals were in the area. The Oceanside fly-in was happening at the same time. Gliders saw animals on the first day of the event, but the SSLs had left the site by the morning of the second day and did not return that day. The presence of these large, soaring objects may have been responsible for the animals' departure.

It is difficult to regulate recreational activities on a public beach, especially non-motorized recreation. The popularity of the TAR area for gliding may be part of the reason why SSLs are observed only infrequently here. To minimize potential impacts, pilots flying out of the nearby airport and gliders launching off

Maxwell Mountain should be made aware of the situation and be advised to keep their distance. Gliders in particular should minimize time spent circling over the waters and beach area off the western tip of the mountain where they are more visible to the sea lions than when flying over the town or further south on the beach.

At Sea Lion Caves, the sea lions are exposed to much more frequent and variable types of disturbance. During the spring, pigeon guillemots (*Cepphus columba*) nest inside the caves. The presence of these birds however, flying, landing and calling, does not seem to affect the sea lions. Numerous occasions of birds landing next to a sea lion were witnessed resulting in the animal looking at its new neighbor, then turning away disinterested. The presence of California sea lions however, can send the SSLs into the water. This movement is usually initiated when one or more animals are startled by a sudden vocalization of the other species.

The tourism aspect of the caves brings the scent, sound, and movement of people directly into the sea lions' environment. Visitors to the caves, old and young, often try to imitate the barking of a California sea lion. This noise is often directed at the sea lions with the intent of getting a reaction and thus, is typically a loud noise. On other occasions, visitors "whoop and holler" as large waves crash over the rocks. These scenarios present obvious unnatural disturbance to the animals. Suckling pups, which are often distracted by other animals or incoming waves, were observed to be the most curious as they would stop suckling to look about when these noises were heard. There are several ways in which the caves could provide a better sanctuary for the sea lions.

When entering the caves, visitors must first purchase a ticket at the front desk of the souvenir shop. Some may ask questions here, such as directions to the caves, or how many animals are present. During the ride down the elevator into the caves, there is a brief announcement regarding the cave depth, prohibited use of flash photography, the use of quiet voices while in the caves, and some general information about the animals. During this announcement, visitors are told that this area is a rookery site and is where they "breed and bear their young." This area in fact, is not a rookery, but a haulout site. Births rarely occur, but have been witnessed in late spring on the outside lookout area. The pups do not typically survive due to the strong surf that inundates the area during high tides and storms thus making the area unsuitable as a rookery. To educate the public, proper information must be communicated.

Although there is a kiosk full of information and sea lion videos playing at the media area of the caves, information in many cases is not being relayed to the visitor in time for disturbance to be minimized. Many children believe this is a zoo and ask when the animals will be fed and who is taking care of them. Flash photography is frequently used and conversations rarely take place at the level of a whisper. Although there is a cave attendant present at all times, this person is not always at the lookout or playing an active role in educating the public.

A simple strategy to minimize disturbance to the sea lions, especially during days of high tourist volume when the caves can get crowded and chaotic, would be to keep another attendant in the elevator or at the lookout. This person would take an active role in informing visitors about the life history and sensitivity of the animals. They may even mention the ESA and MMPA to demonstrate the national concern and laws that were put in place to protect these creatures. The caves offer a unique shelter to the animals from wind and rain. In order to keep animals coming back to this site, cave management should take a proactive step to further inform visitors about the fragility of wild populations, especially threatened and endangered species.

At Cape Arago State Park, visitors can view the site from the Simpson Reef pull-off area or the southern Cape Arago Highway turnaround. The islands are far enough away that the animals are not disturbed by usual human noise on land. The southern turnaround area has a trail that leads down to the water where visitors can go tidepooling or walk along the beach.

Cape Arago is a rookery site for harbor seals during spring and early summer months. During this time when pups are born, the north cove trail, which leads out towards the islands, is closed to the public. While observing at this site however, I observed people walking out along the shelf at low tide when the area was supposedly closed. Shell Island, the largest of the islands, is a designated wildlife refuge and is closed year-round to visitors. This does not mean however, that visitors to the area will not try to go out near animals closer in during low tide. Enforcement beyond the chain and sign at the trailhead during breeding season may be necessary as visitor frequency increases.

In general, the Oregon population of SSLs is well protected, but efforts to minimize human disturbances could easily be improved. During my observations, small planes and helicopters flew over 13 times. The level of reaction was variable, from no reaction to vocalizations and increased movement on the haulout. Reactions all types of disturbances varied, but were most acute when movements or noises where in close proximity. The most important site to the sea lions, according to frequency of presence and overall abundance, is Sea Lion Caves. The caves are also the most visited by tourists and the closest exposure sea lions have to humans on a regular basis. Regulations here must be continually evaluated and improved in an effort to keep this population wild and successful.

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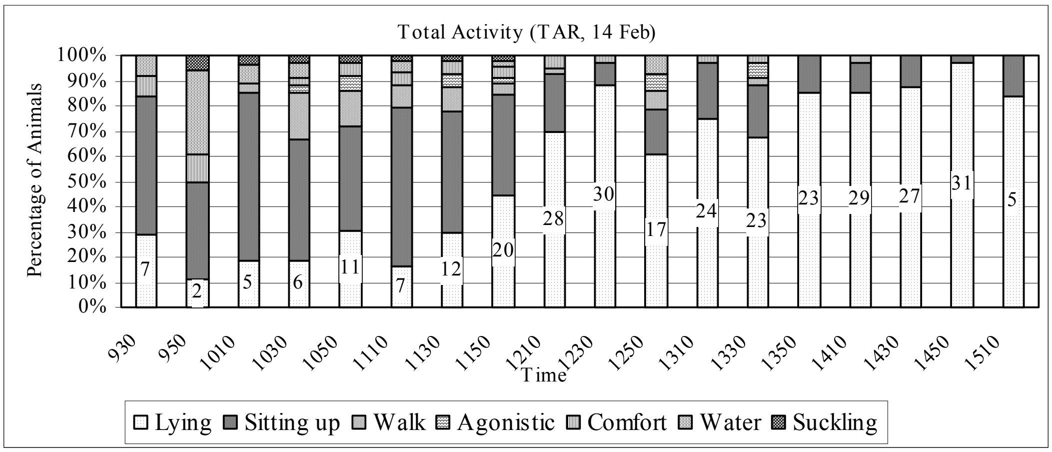
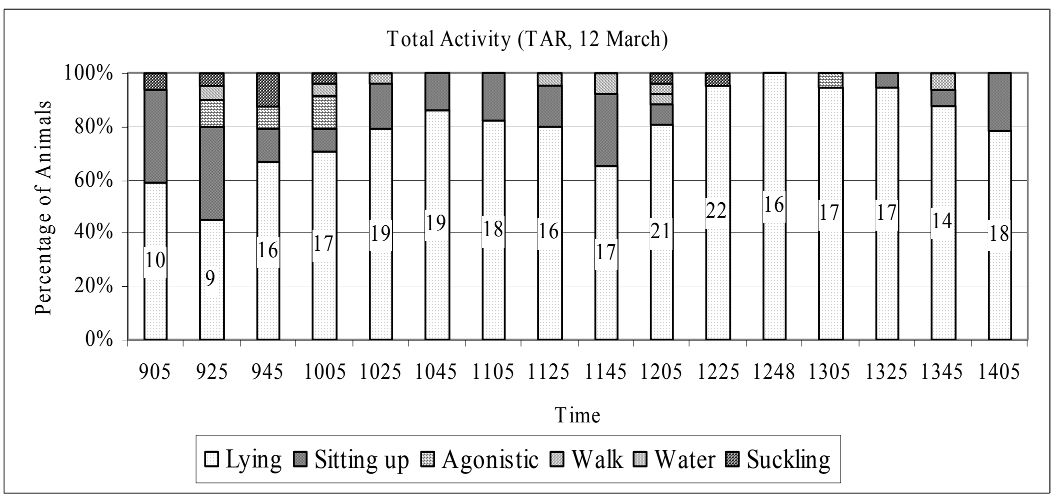
Appendices

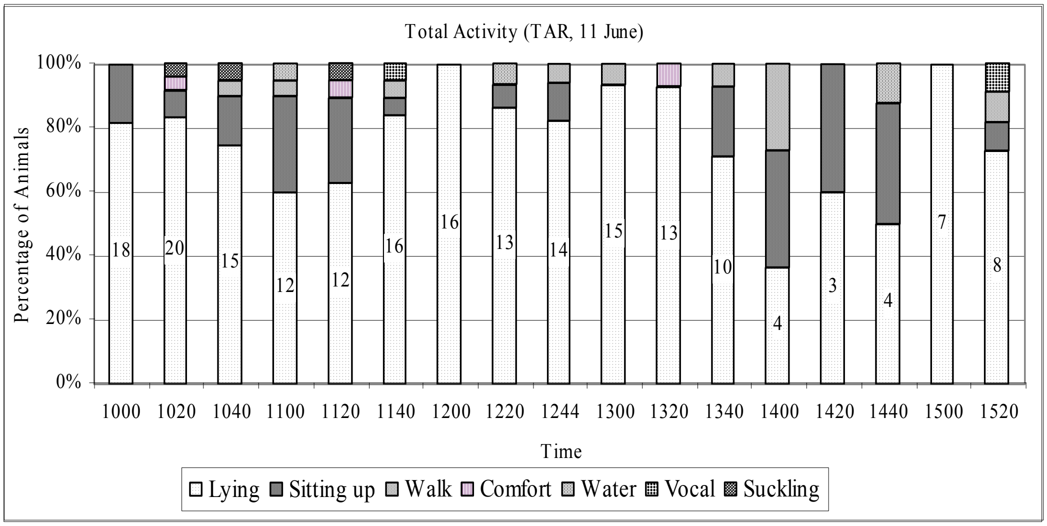
Appendix A Ethograms

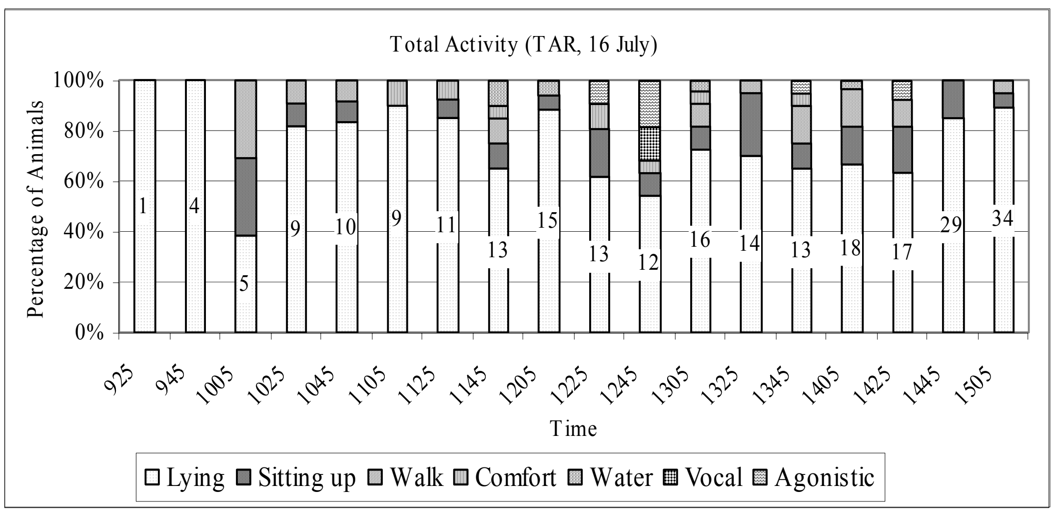
The following graphs show the behavior of all animals at the different sites for each observation day. The animal types are pooled to show total animal activities for each scan. The number of animals lying during each scan is given as a reference for sample size.

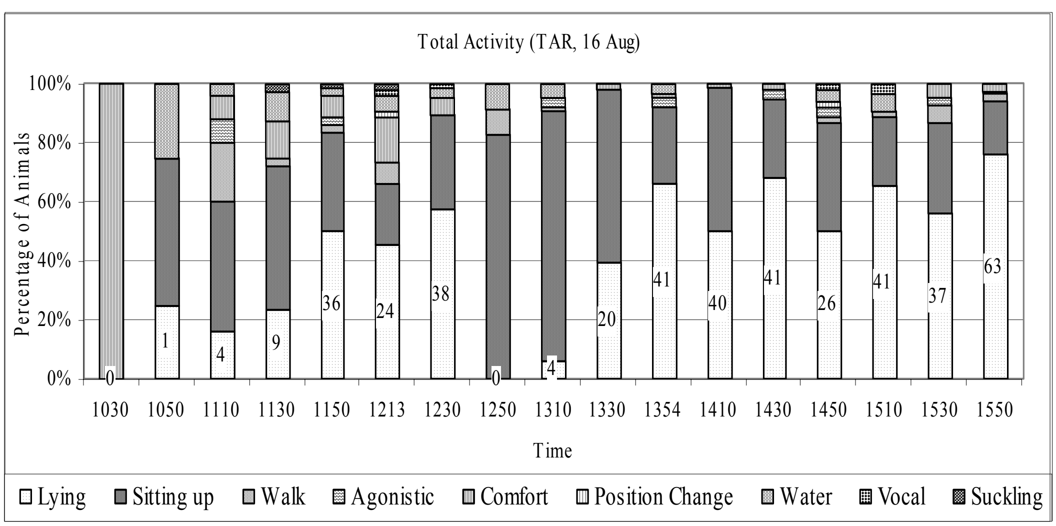
Three Arch Rocks



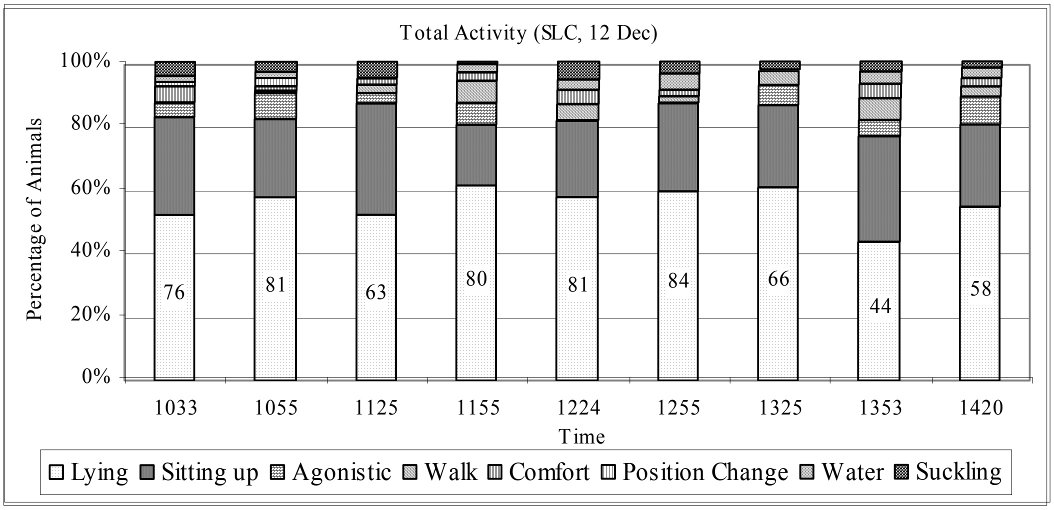


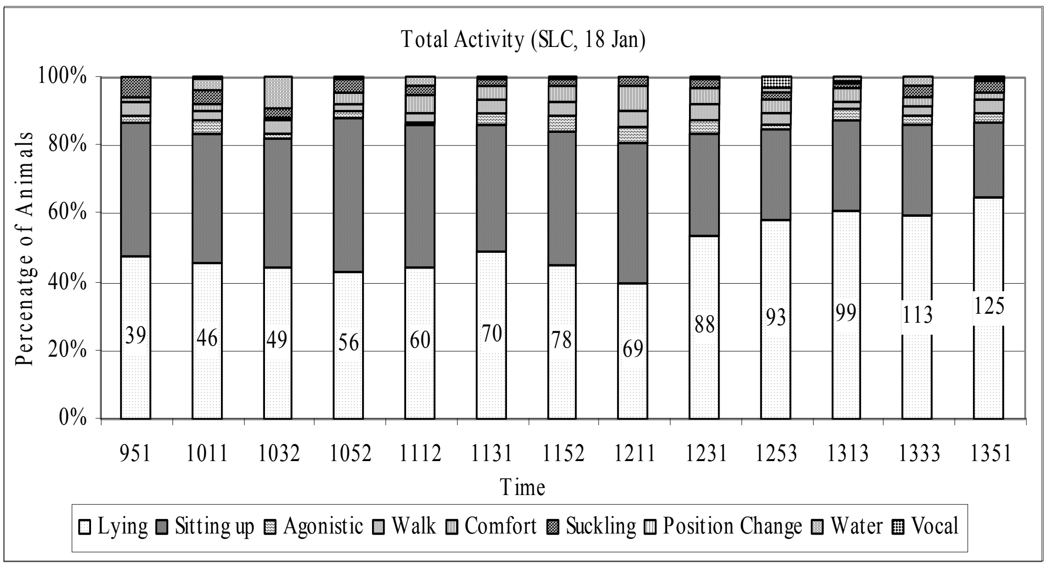

Total Activity (TAR, 11 June)
Percentage of Animals
100%
80%
60%
40%
20%
0%
18 20 15 12 12 16 16 13 14 15 13 10 4 3 4 7 8
1000 1020 1040 1100 1120 1140 1200 1220 1244 1300 1320 1340 1400 1420 1440 1500 1520
Time
Lying Sitting up Walk Comfort Water Vocal Suckling

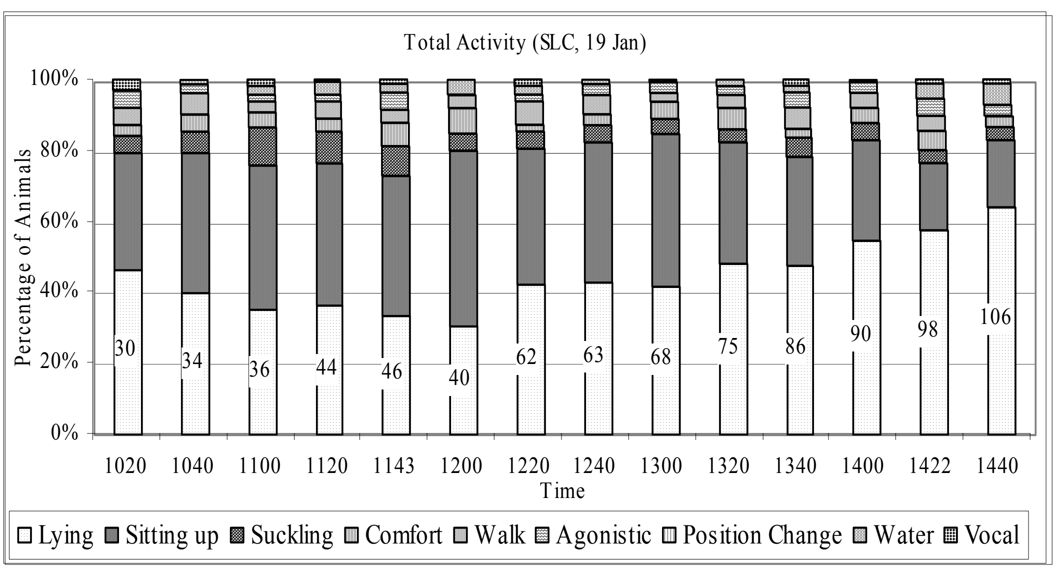

Total Activity (TAR, 16 July)
Percentage of Animals
100%
80%
60%
40%
20%
0%
1 4 5 9 10 9 11 13 15 13 12 16 14 13 18 17 29 34
925 945 1005 1025 1045 1105 1125 1145 1205 1225 1245 1305 1325 1345 1405 1425 1445 1505
Time
Lying Sitting up Walk Comfort Water Vocal Agonistic

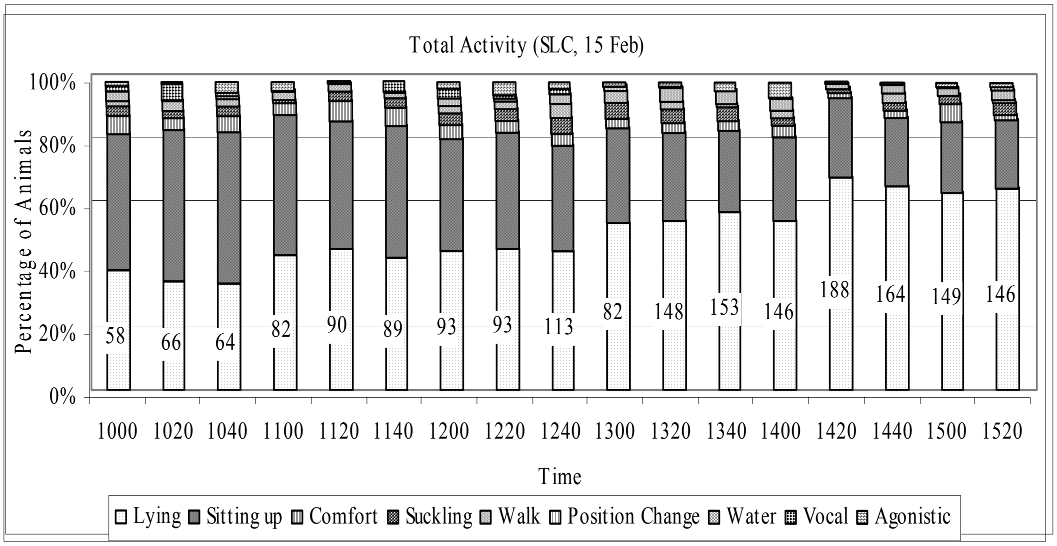

Total Activity (TAR, 16 Aug)
Percentage of Animals
100%
80%
60%
40%
20%
0%
0 1 4 9 36 24 38 0 4 20 41 40 41 26 41 37 63
1030 1050 1110 1130 1150 1213 1230 1250 1310 1330 1354 1410 1430 1450 1510 1530 1550
Time
Lying Sitting up Walk Agonistic Comfort Position Change Water Vocal Suckling

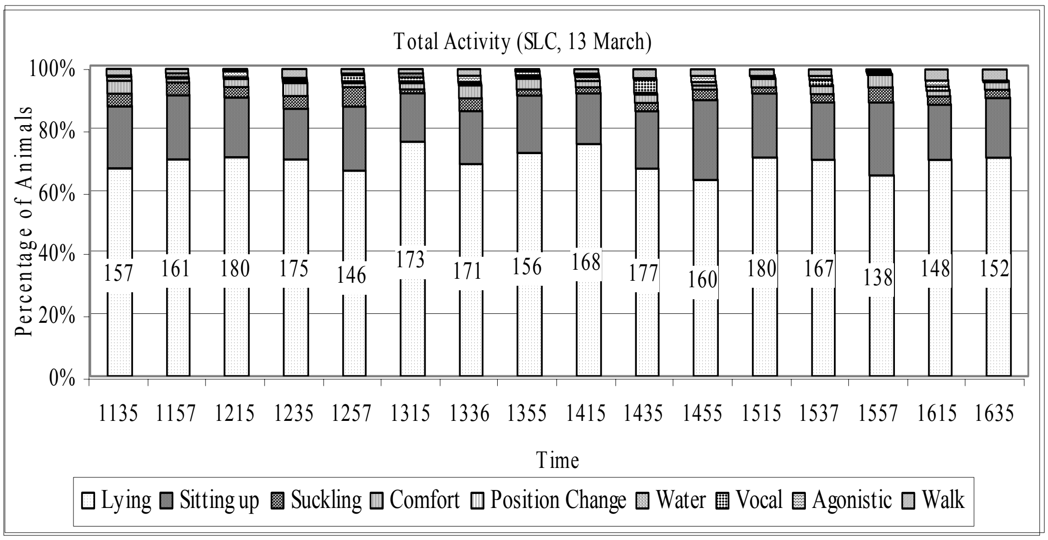
Sea Lion Caves

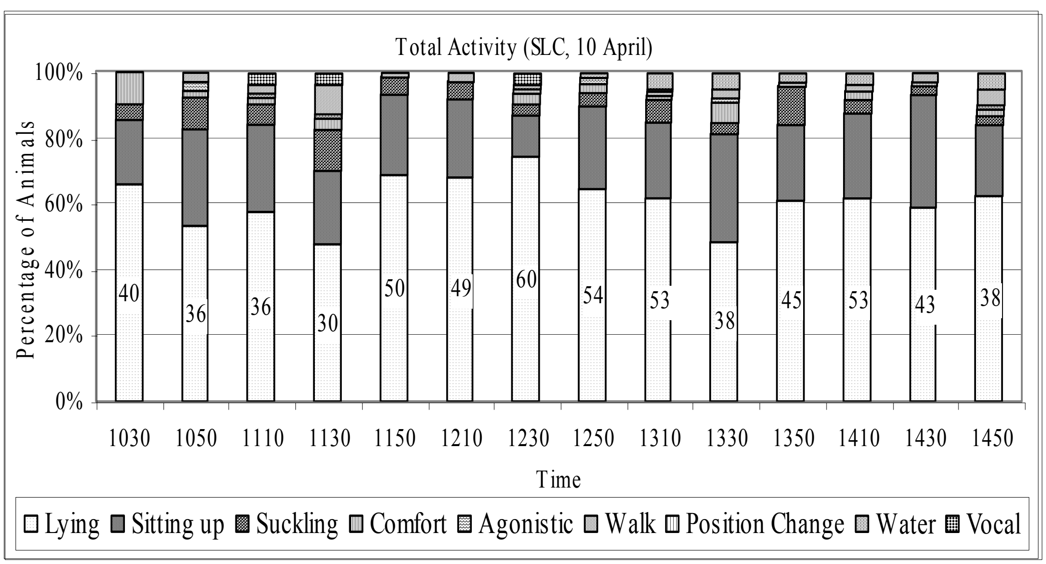


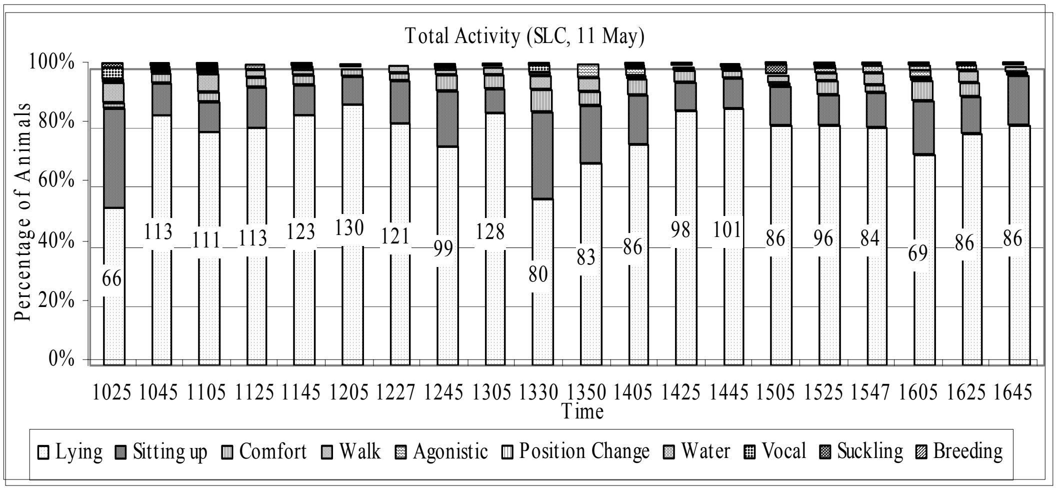


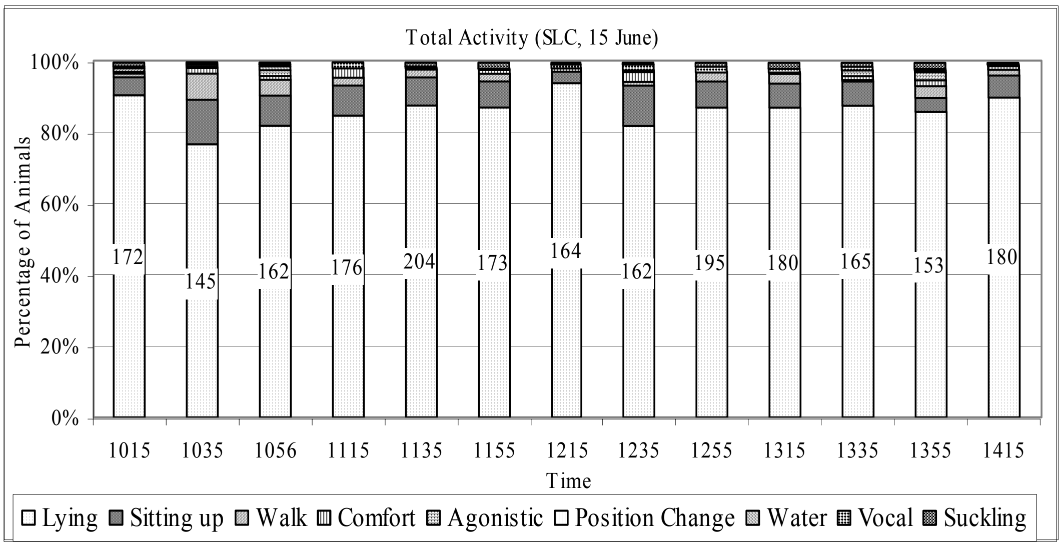


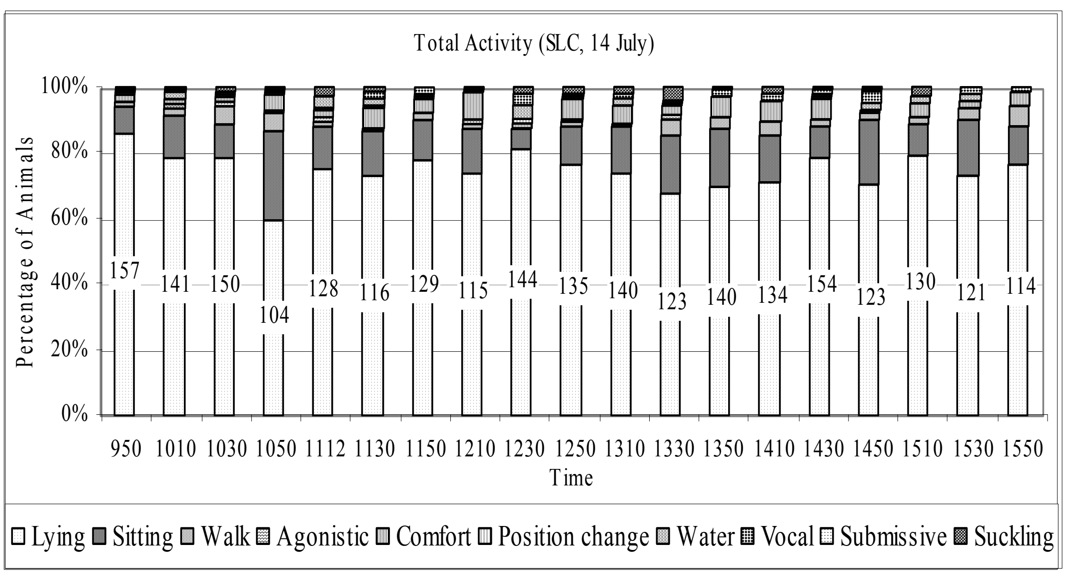

Total Activity (SLC, 15 Feb)
Percentage of Animals
100%
80%
60%
40%
20%
0%
58 66 64 82 90 89 93 93 113 82 148 153 146 188 164 149 146
1000 1020 1040 1100 1120 1140 1200 1220 1240 1300 1320 1340 1400 1420 1440 1500 1520
Time
Lying Sitting up Comfort Suckling Walk Position Change Water Vocal Agonistic

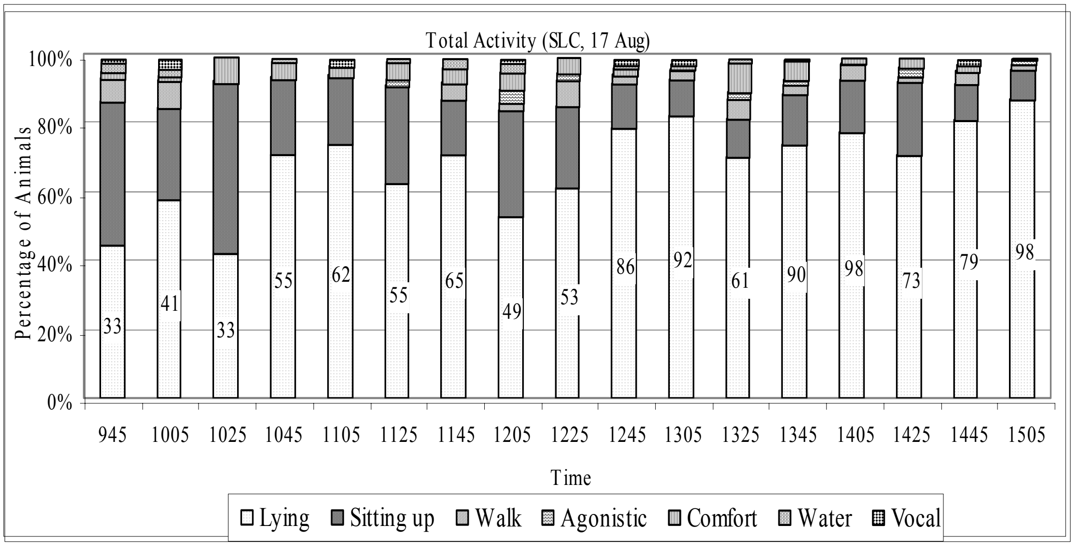

Total Activity (SLC, 13 March)
Percentage of Animals
100%
80%
60%
40%
20%
0%
157 161 180 175 146 173 171 156 168 177 160 180 167 138 148 152
1135 1157 1215 1235 1257 1315 1336 1355 1415 1435 1455 1515 1537 1557 1615 1635
Time
Lying Sitting up Suckling Comfort Position Change Water Vocal Agonistic Walk


Total Activity (SLC, 10 April)
Percentage of Animals
100%
80%
60%
40%
20%
0%
40 36 36 30 50 49 60 54 53 38 45 53 43 38
1030 1050 1110 1130 1150 1210 1230 1250 1310 1330 1350 1410 1430 1450
Time
Lying Sitting up Suckling Comfort Agonistic Walk Position Change Water Vocal


Total Activity (SLC, 11 May)
Percentage of Animals
100%
80%
60%
40%
20%
0%
66 113 111 113 123 130 121 99 128 80 83 86 98 101 86 96 84 69 86 86
1025 1045 1105 1125 1145 1205 1227 1245 1305 1330 1350 1405 1425 1445 1505 1525 1547 1605 1625 1645
Time
Lying Sitting up Comfort Walk Agonistic Position Change Water Vocal Suckling Breeding

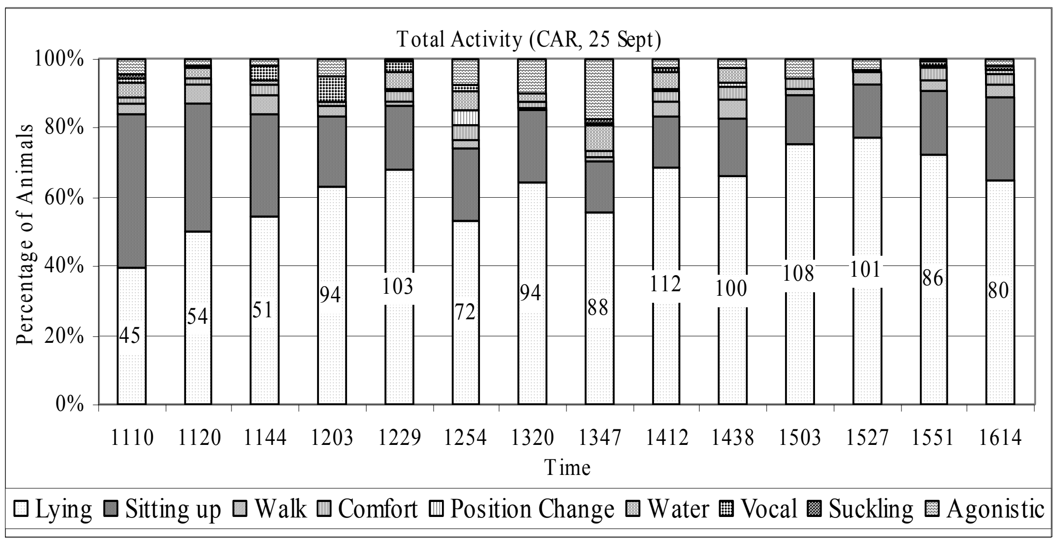

Total Activity (SLC, 15 June)
Percentage of Animals
100%
80%
60%
40%
20%
0%
172 145 162 176 204 173 164 162 195 180 165 153 180
1015 1035 1056 1115 1135 1155 1215 1235 1255 1315 1335 1355 1415
Time
Lying Sitting up Walk Comfort Agonistic Position Change Water Vocal Suckling


Total Activity (SLC, 14 July)
Percentage of Animals
100%
80%
60%
40%
20%
0%
157 141 150 104 128 116 129 115 144 135 140 123 140 134 154 123 130 121 114
950 1010 1030 1050 1112 1130 1150 1210 1230 1250 1310 1330 1350 1410 1430 1450 1510 1530 1550
Time
Lying Sitting Walk Agonistic Comfort Position change Water Vocal Submissive Suckling

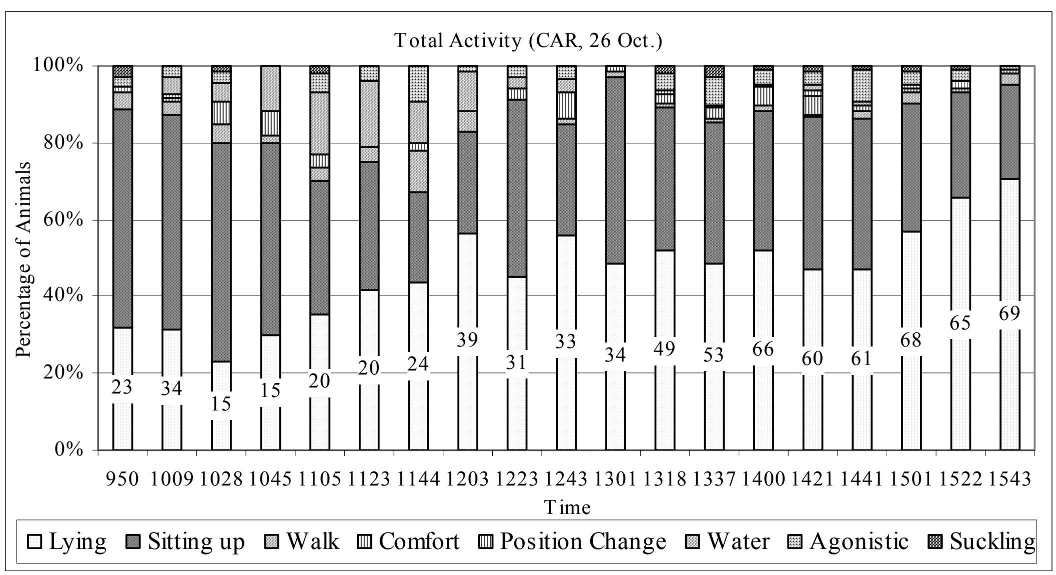


Total Activity (SLC, 17 Aug)
100%
80%
60%
40%
20%
0%
Percentage of Animals
33
41
33
55
62
55
65
49
53
86
92
61
90
98
73
79
98
945 1005 1025 1045 1105 1125 1145 1205 1225 1245 1305 1325 1345 1405 1425 1445 1505
Time
Lying
Sitting up
Walk
Agonistic
Comfort
Water
Vocal

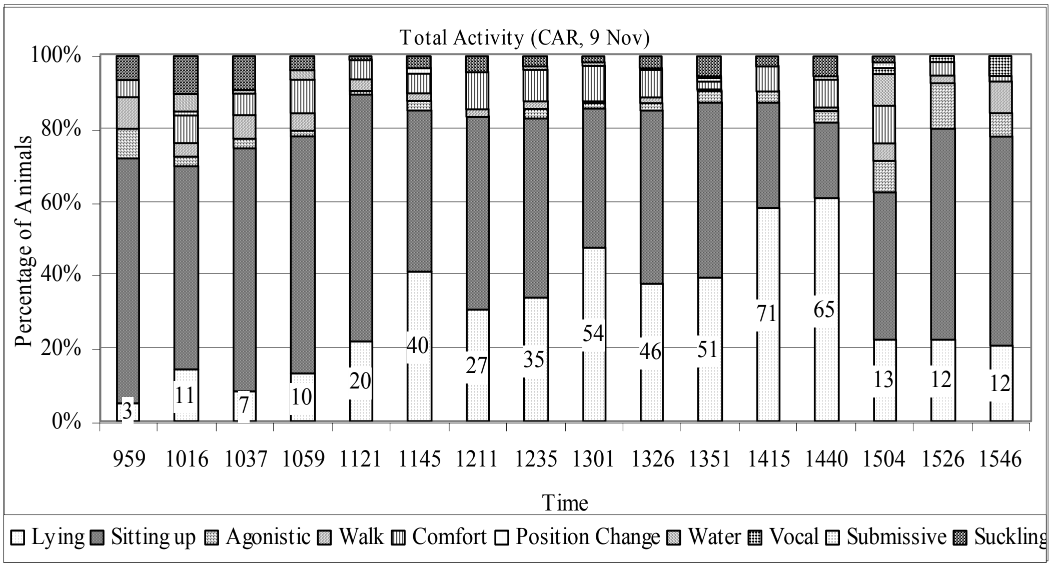
Cape Arago

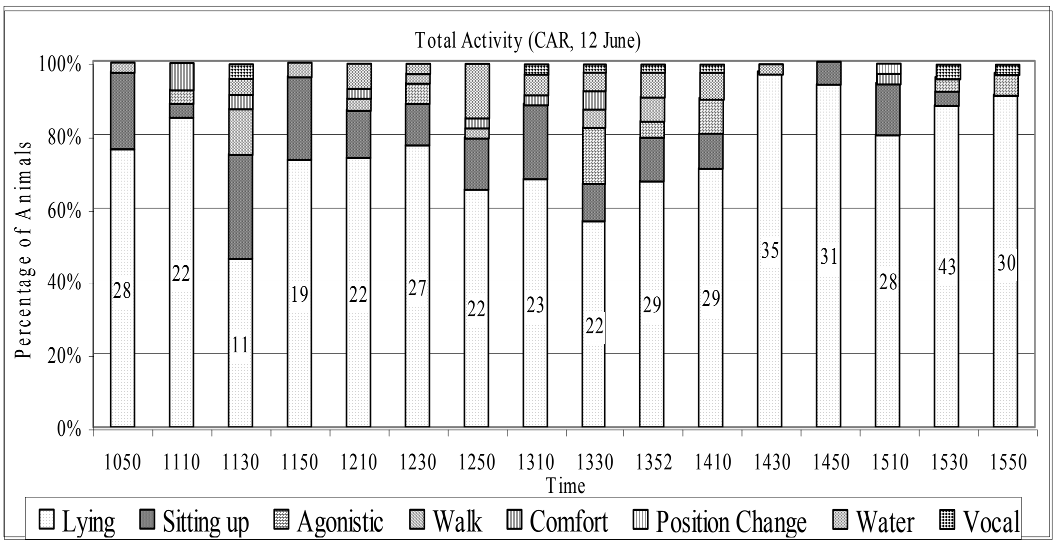


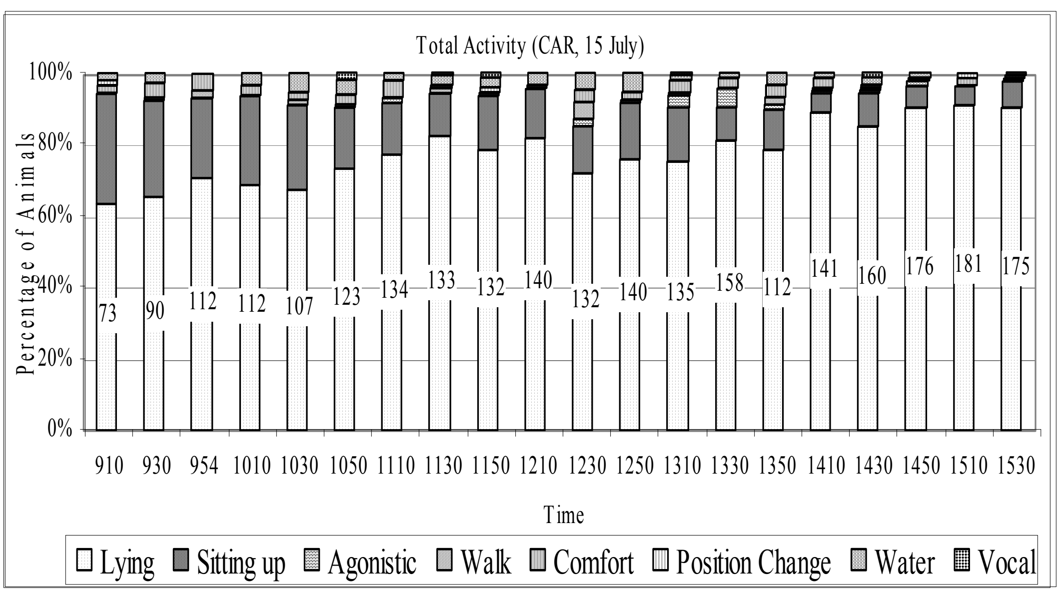
Total Activity (CAR, 25 Sept)
100%
80%
60%
40%
20%
0%
Percentage of Animals
45
54
51
94
103
72
94
88
112
100
108
101
86
80
1110 1120 1144 1203 1229 1254 1320 1347 1412 1438 1503 1527 1551 1614
Time
Lying
Sitting up
Walk
Comfort
Position Change
Water
Vocal
Suckling
Agonistic

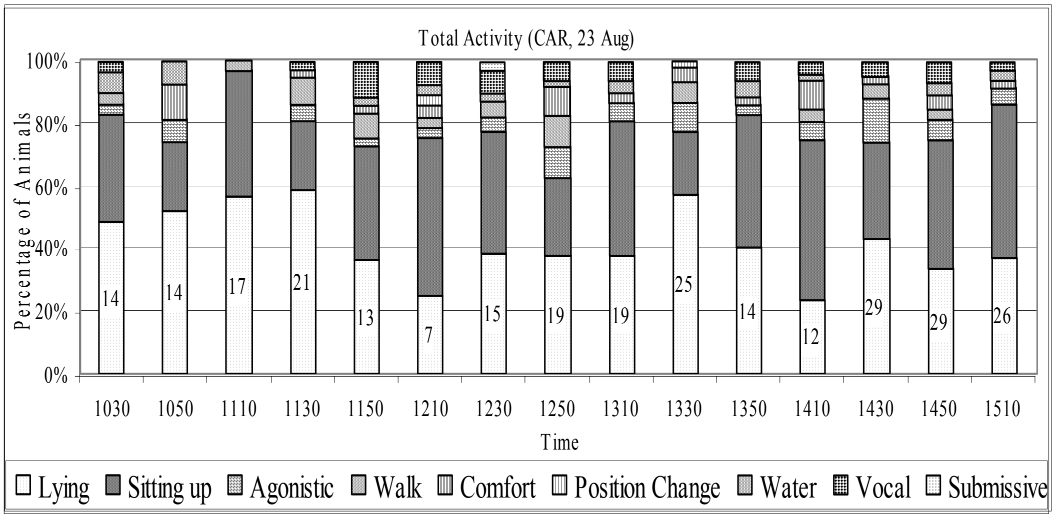


Total Activity (CAR, 26 Oct.)
100%
80%
60%
40%
20%
0%
Percentage of Animals
23
34
15
15
20
20
24
39
31
33
34
49
53
66
60
61
68
65
69
950 1009 1028 1045 1105 1123 1144 1203 1223 1243 1301 1318 1337 1400 1421 1441 1501 1522 1543
Time
Lying
Sitting up
Walk
Comfort
Position Change
Water
Agonistic
Suckling


Total Activity (CAR, 9 Nov)
100%
80%
60%
40%
20%
0%
Percentage of Animals
3
11
7
10
20
40
27
35
54
46
51
71
65
13
12
12
959 1016 1037 1059 1121 1145 1211 1235 1301 1326 1351 1415 1440 1504 1526 1546
Time
Lying Sitting up Agonistic Walk Comfort Position Change Water Vocal Submissive Suckling


Total Activity (CAR, 12 June)
100%
80%
60%
40%
20%
0%
Percentage of Animals
28
22
11
19
22
27
22
23
22
29
29
35
31
28
43
30
1050 1110 1130 1150 1210 1230 1250 1310 1330 1352 1410 1430 1450 1510 1530 1550
Time
Lying Sitting up Agonistic Walk Comfort Position Change Water Vocal


Total Activity (CAR, 15 July)
100%
80%
60%
40%
20%
0%
Percentage of Animals
73
90
112
112
107
123
134
133
132
140
132
140
135
158
112
141
160
176
181
175
910 930 954 1010 1030 1050 1110 1130 1150 1210 1230 1250 1310 1330 1350 1410 1430 1450 1510 1530
Time
Lying Sitting up Agonistic Walk Comfort Position Change Water Vocal


Total Activity (CAR, 23 Aug)
Percentage of Animals
100%
80%
60%
40%
20%
0%
14
14
17
21
13
7
15
19
19
25
14
12
29
29
26
1030
1050
1110
1130
1150
1210
1230
1250
1310
1330
1350
1410
1430
1450
1510
Time
Lying
Sitting up
Agonistic
Walk
Comfort
Position Change
Water
Vocal
Submissive

Appendix B Branded Animal Observations

Animals 1R- 90R, 92R - 180R, 901R branded in 2001 at Rogue Reef, OR, 1Y-140Y in 2002, at St. George Reef, CA and 181R-370R in 2003 at Rogue Reef, OR by Oregon Department of Fish and Wildlife.

Brand	Location	1st Sighting	2nd Sighting	3rd Sighting	4th Sighting	5th Sighting	6th Sighting	7th Sighting
105Y	SLC	2/16/2004	7/14/2004					
109R	SLC	7/14/2004						
111Y	SLC	5/11/2004						
118R	SLC	4/22/2004						
11Y	CAR	11/9/2003						
11Y	SLC		2/15/2004	5/6/2004				
12Y	SLC	3/13/2004						
140R	SLC	1/19/2004						
154R	SLC	4/22/2004						
16Y	SLC	7/14/2004						
17R	SLC	2/15/2004						
190Y	SLC	1/19/2004						
197R	SLC	2/16/2004	4/22/2004					
1Y	SLC	1/18/2004						
20Y	SLC	2/15/2004						
212R	SLC	1/18/2004	1/19/2004	2/15/2004				
214R	SLC	1/19/2004	2/15/2004					
215R	SLC	2/16/2004						
216R	SLC	4/22/2004						
240R	SLC	2/16/2004						
242R	CAR	11/9/2003						
249R	SLC	5/11/2004	6/15/2004					

Brand	Location	1st Sighting	2nd Sighting	3rd Sighting	4th Sighting	5th Sighting	6th Sighting	7th Sighting
252R	SLC	1/18/2004	1/19/2004					
255R	SLC	2/16/2004	4/22/2004					
260R	SLC	1/10/2004	2/15/2004	3/13/2004	4/22/2004	5/6/2004	7/14/2004	
262R	SLC	4/10/2004	6/15/2004					
263R	CAR	11/9/2003						
269R	SLC	6/15/2004	8/17/2004	12/22/2004				
270R	CAR	11/9/2003						
275R	SLC	8/17/2004						
279R	SLC	1/19/2004						
281R	SLC	1/19/2004	2/15/2004					
282R	SLC	2/15/2004						
283R	SLC	2/15/2004	7/14/2004					
294R	SLC	2/16/2004	3/13/2004	4/10/2004	12/22/2004			
309R	SLC	2/16/2004						
321R	SLC	1/19/2004						
326R	SLC	2/15/2004	2/16/2004	5/11/2004	6/15/2004	7/14/2004	8/17/2004	
336R	SLC	1/19/2004	4/10/2004	5/6/2004	7/14/2004	8/17/2004		
348R	SLC	12/22/2003	1/10/2004	1/18/2004	1/19/2004	2/15/2004	4/10/2004	4/22/2004
350R	SLC	1/19/2004	2/15/2004					
352R	SLC	1/19/2004	2/15/2004	3/13/2004	7/14/2004			
364R	SLC	5/6/2004	6/15/2004	7/14/2004				
383R	SLC	8/17/2004						
62Y	SLC	2/15/2004						
6R	CAR	9/25/2003						
6Y	SLC	4/22/2004	6/15/2004					
71R	SLC	3/13/2004	5/6/2004					
78Y	SLC	2/15/2004	6/15/2004					

Brand	Location	1st Sighting	2nd Sighting	3rd Sighting	4th Sighting	5th Sighting	6th Sighting	7th Sighting
8Y	SLC	8/17/2004						
91Y	SLC	1/19/2004	5/6/2004					
94Y	SLC	3/13/2004	4/10/2004					
9Y	CAR	11/9/2003						
9Y	SLC		2/15/2004	5/11/2004				