Haul-out Behavior of Harbor Seals (*Phoca vitulina*) in the San Juan Islands: Differences Between Mothers, Pups, and Lone Adults

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Abstract

Harbor seals (*Phoca vitulina*) are a previously endangered pinniped species native to coastal waters across the United States. Seals haul out onto shore year-round to rest, give birth, nurse, and molt. The San Juan Islands in the Salish have one of the highest densities of harbor seals in the world, making it a prime location to study their behavior. We conducted this study at two locations near San Juan Island, Yellow Island and Goose Island. Our research consisted of two key objectives: 1) contrasting vigilance and behavior among three categories of seals (lone adults, lone pups, and mom-pup pairs) at two locations and 2) contrasting the relationship between abundance and tide height at both locations. At both locations, we collected data on behavior and vigilance levels of different categories of seals (lone adults, lone pups, and mom-pup pairs), along with recording abundance and distribution of hauled out seals. Overall, behavior was consistent at both locations, and seals spent most of their time resting. We found that different haul out sites had a large effect on the vigilance levels, with higher levels in lone pups at Yellow Island, and higher levels in lone adults at Goose Island. Tide height at both locations also influenced seal haul out behavior, as fewer seals hauled out at high tides at Yellow Island, while more seals hauled out at higher tides at Goose Island, supporting that abundance is related to availability of haul out space. These findings are consistent with previous work that has shown harbor seals spend the majority of the time alternating between vigilant and non-vigilant resting, but highlights the role of specific haul out locations in behavioral patterns and distribution.

Key Words: Harbor seals, *Phoca vitulina*, behavior, mother-pup pairs, San Juan Islands, Yellow Island, Cattle Point

Introduction

Harbor seals (*Phoca vitulina*) are the most abundant marine mammal in Washington, and have an extensive range along with coasts of the northern hemisphere. While endangered during the early 20th century due to the fur traded and culling programs, following the end of the bounty program in 1960 and the passing of the Marine Mammal Protection Act of 1972, harbor seal numbers steadily increased until reaching equilibrium in the mid-1990s (Jeffries et al., 2003). There are an estimated 50,000 harbor seals currently in the Salish Sea, making it one of the high densities in the world (Zier & Gaydos, 2014).

Harbor seals haul-out on land year-round, and factors like season, time of day, and tide height have been shown to affect haul-out behaviors, though there is variability in patterns throughout the Salish Sea (Zier & Gaydos, 2014). The highest number of hauled out seals occurs during low tides and pupping season, which is when censuses are conducted (Huber et al., 2001). Hauled-out individuals spend most of their time frequently alternating between scanning and resting with their eyes shut. Mother seals remain especially vigilant and will force pups into the water when danger is perceived (Newby, 1973). They also may return less frequently to haul-out sites following a disturbance (Zier & Gaydos, 2014).

Pupping season for harbor seals varies regionally, and peaks during late July to early August in the Salish Sea, one of the latest periods (Ford, 2014). Harbor seals give birth to one pup a year. Pups are typically born on land, but are able to swim almost immediately after birth . Harbor seals are income breeders, and during the 4–5-week nursing period mothers will leave their pups while foraging. Pups are then abandoned after being weaned (Ford, 2014)

The objective of this study is to assess vigilance and behavioral differences between mother-pup pairs, lone adults, and lone pups at two locations. With these locations, we also observed the change in harbor seal abundance with the tide height.

Methods

Locations

We conducted land-based surveys from two locations in San Juan Channel in Washington state (Figure 1a): Yellow Island (48.5920451°N, -123.0326827°W) and Goose Island (48.4578769°N, -122.9565662°W). Yellow Island is located in the San Juan Channel , between San Juan Island and Shaw Island (Figure 1b). We collected data on the west side of the island by a popular harbor seal haul out site. Goose Island is located at the southern part of the San Juan Channel off of the tip of San Juan Island (Figure 1c). We observed seal haul outs on the west side of the island from an overlook at Cattle Point.

Sampling Methods and Materials

Data were collected 10-13 August 2021 in 6-hour periods, for a total of 24 hours. We conducted our observations for 3 hours before and after low tide between the hours of 0900 to 1800. We conducted focal animal sampling, observing each seal for 10 minutes, and recording behavior and vigilance every 20 seconds. We conducted scan sampling hourly to record abundance and distribution of hauled out seals. We had 6 types of behavior categories: resting, locomoting, social, swimming, nursing, and other (Table 1). We classified vigilance as a secondary behavior, and we recorded whether or not an individual was vigilant while performing a behavior.

We alternated between the three categories of seal based on availability. Seals were chosen randomly by moving the scope and selecting the closest one. Lone pups were chosen opportunistically due on limited availability. We observed a total of 136 different harbor seals, with about 25 seal observations per day. Mom-pup pairs were sampled together but recorded separately. Mom-pup pairs were identified based on: size (pup significantly smaller), proximity

(remaining close to each other), and interactions (social behaviors, including nursing and touching). Lone pups were identified by size and lack of presence of a mother (included both abandoned pups and those whose mothers had left to feed).

We used a Celestron Ultima 80 spotting scope and Eagle Optics Ranger 8x42 binoculars for observations. Data analysis was done using RStudio and Microsoft Excel (graphs were also created with Excel). Tide heights were calculated using the NOAA tides & currents website.

Results

At both locations, seals spent the majority of the time resting (88% ± 21%). (Figure 2a). On average, lone adults spent the most time resting (99% ± 3%), followed by lone pups (89% ± 19%) and moms with pups (85% ± 28%), while pups with moms spent the least amount of time resting (77% ± 32%). Mean percent time spent socializing, swimming, and nursing were similar between both locations (Figure 2b), with the exception of lone pup locomotion, which was higher at Yellow Island (12% ± 21%) compared to Goose Island (2% ± 2%).

Vigilance

On average, seals at both locations spent the majority of the time not vigilant (29.5% ± 25% time spent vigilant) (Figure 3a). Lone adults spent the most time resting, and similarly the most time vigilant (38% ± 29%), while pups with moms spent the least time resting along with the least time vigilant (17% ± 19%). While mom-pup pairs displayed similar rates of vigilance at both locations (slightly more at Goose Island) there were two notable differences between locations. At Yellow Island, lone pups were more vigilant (47% ± 30%), compared to Goose Island. (Figure 3b). At Goose Island, lone adults were more vigilant (50% ± 31%), compared to Yellow Island (Figure 3b).

Abundance

We counted an average of 21.53 seals (±10.27) per day, with an average of 19.71 seals (± 9.97) at Yellow Island, and 23.66 seals (±12.48) at Goose Island. We collected data before and after low tide of each day, ranging from -0.29 m to 1.2 m. Overall, there was no significant correlation between tide height and number of seals. However, at Yellow Island there was a negative correlation between tide height and number of seals, $r(12) = -0.84$, $p < 0.01$, meaning there were fewer seals hauled out as tide height increased (Figure 4a). This is contrasted by Goose Island, which had a positive correlation between tide height and number of seals, $r(10) = 0.66$, $p = 0.02$, meaning there were more seals hauled out as tide height increased (Figure 4a). Mom-pup pairs did not have a significant correlation at either location (Figure 4b), while lone adults displayed the same overall trends at each location (Figure 4b). Lone pups were not included in this analysis due to small sample size.

Discussion

Behavior

Consistent with previous findings of studies conducted in the San Juan Islands, we observed that harbor seals spent the majority of the time resting. This is likely due to the fact that one of the primary roles of hauling out by seals is to rest (along with thermoregulation and predator avoidance), which may also explain the similarity in overall patterns of behavior at both locations. One notable difference in behavior was the increase in locomotion of lone pups at Yellow Island. We observed more potential signs of abandonment in lone pups at Yellow Island compared to Goose Island, including signs of malnourishment, along with increased vocalization. Pups will call out when looking for their mothers or wanting to nurse (Newby,

1973), which may result in this increased locomotion as a searching behavior, as they often moved from one haul out site to the next.

Vigilance

Pups with moms spent the most time vigilant, and the least time resting, while lone adults spent the least time vigilant, and the most time resting. This could be because resting both allows and requires vigilance. Compared to other behaviors like locomotion, seals that are stationary are able to be more alert and survey their surroundings. Nursing of pups with moms may account for some of their lower levels of vigilance because of this, along with the safety associated with the presence of their mother. Further, higher levels of vigilance observed while resting may also be due to vulnerability to predation. Though not social creatures, harbor seals will haul out in large groups as a predator avoidance strategy, which allows for increased time sleeping. Individual vigilance is thought to decrease as group size increases due to improved ability to detect predators (Silva & Terhune, 1988). It may be the case that the number of seals we observed at the haul outs did not reach the capacity required to increase levels of non-vigilant rest, resulting in the relationship between higher vigilance with increased resting.

Based on previous findings, we expected to see higher levels of vigilance in mothers with pups compared to lone adults, which was not the case. Instead, we saw higher overall levels of vigilance in lone adults, which was most apparent at Goose Island. One explanation of this may be due to selection of "safer" spots on haul outs by mothers. Mom-pup pairs often haul out separately from main groups on haul outs, especially when pups are young (Newby, 1973). At Goose Island, where we observed increased levels of human disturbance (e.g., boats) on the northwest side of the haul out, while mom-pup pairs were primarily alone on the west side of the haul out.

Abundance

While we found that there was not a relationship between overall numbers of hauled out seals and tide height, we found that fewer seals were hauled out as tide height increased at Yellow Island, while more seals were hauled out as tide height increased at Goose Island. These trends held when examining lone adults, but there was no relationship for mother-pup pairs, whose abundance remained relatively consistent across tide heights at both locations. The haul out sites off Yellow Island are composed of smaller rocks, which become completely submerged at higher tides, meaning seals must compete for limited space and are unable to stay hauled out as the tide rises. In comparison, Goose Island is much larger, and accessible even at the highest tides, meaning seals can remain hauled out. It may be the case that the increase in seals observed at higher tide heights is due to other haul out sites becoming submerged as the tide rises, forcing seals to seek out other available locations. Though one important note is that we sampled a lower range of tide heights at Yellow Island (-0.29 m to 0.95 m) compared to Goose Island (-0.08 m to 1.20 m) due to availability, which may have influenced the relationship between these variables.

Acknowledgments

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Tables and Figures

Table 1: Ethogram describing behavioral categories of harbor seals observed at Yellow Island and Goose Island in the San Juan Islands. .

Behavior	Description
Rest	Laying on haul-out, including comfort movements (e.g., stretching, shifting, scratching)
Locomotion	Moving from one spot to another on land
Nurse	Pup suckling on mother
Swim	Visibly moving through the water
Social	Interactions between mother and pup (e.g., nuzzling, face-to-face contact,petting)
Other	Any behavior not described

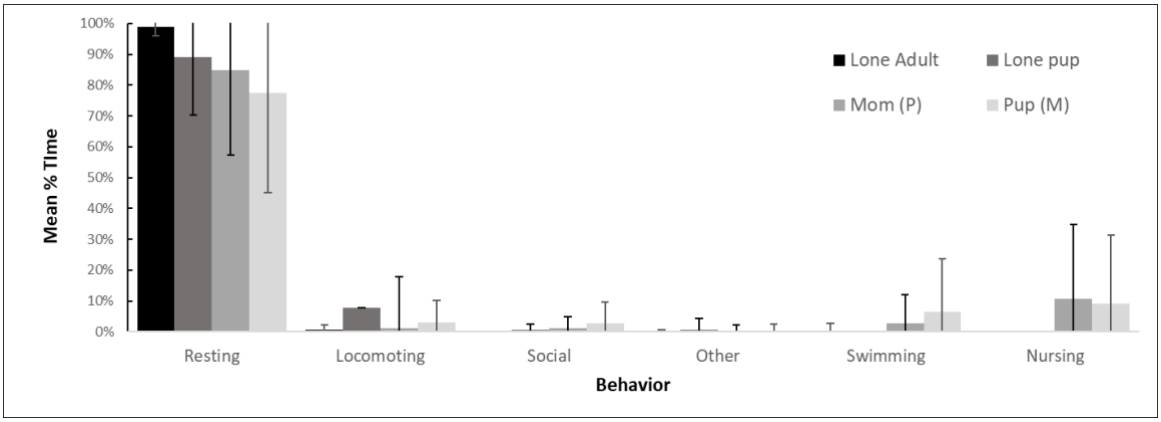
a) 

b) 

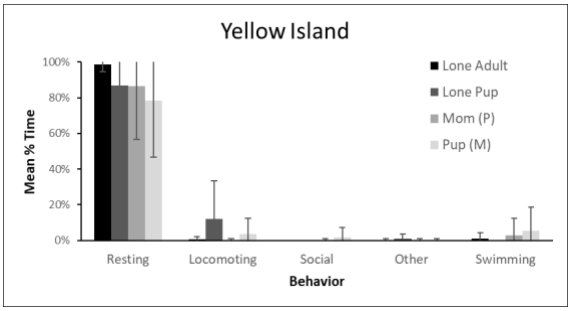
c) 

Figure 1: a) Map of study sites in the San Juan Island; **b)** Map of Yellow Island, located in the San Juan Channel between San Juan Island and Shaw Island. Observations were conducted on the west side of the island; **c)** Map of Goose Island, located at the southern tip of San Juan Island. Observations were conducted off Cattle Point. Images from Google Earth.

a)



b)



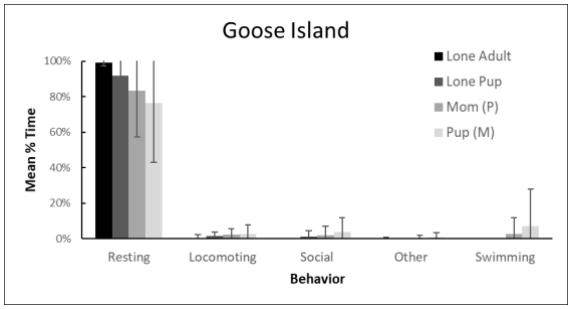
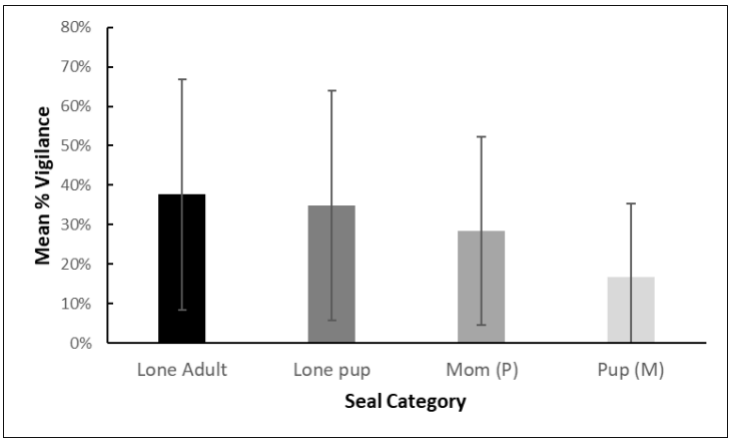


Figure 2: a) Mean (± SD) percent time spent on each behavior by harbor seals in the San Juan Island, broken up by lone adults, lone pups, moms with pups, and pups with moms; **b)** Mean (± SD) percent time spent on each behavior by categories of seal at the two locations, Yellow Island and Goose Island

a)



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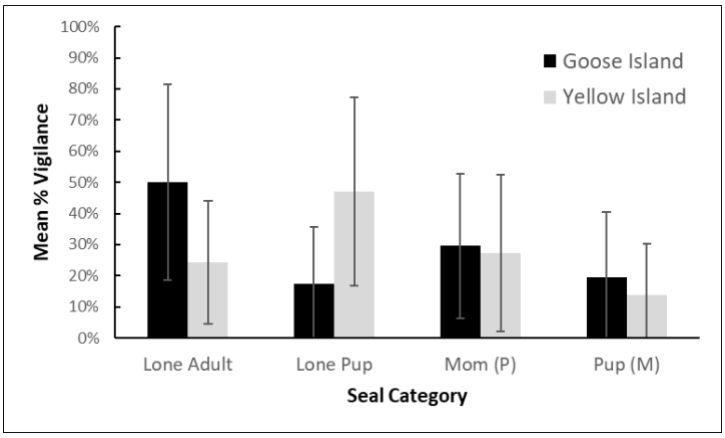
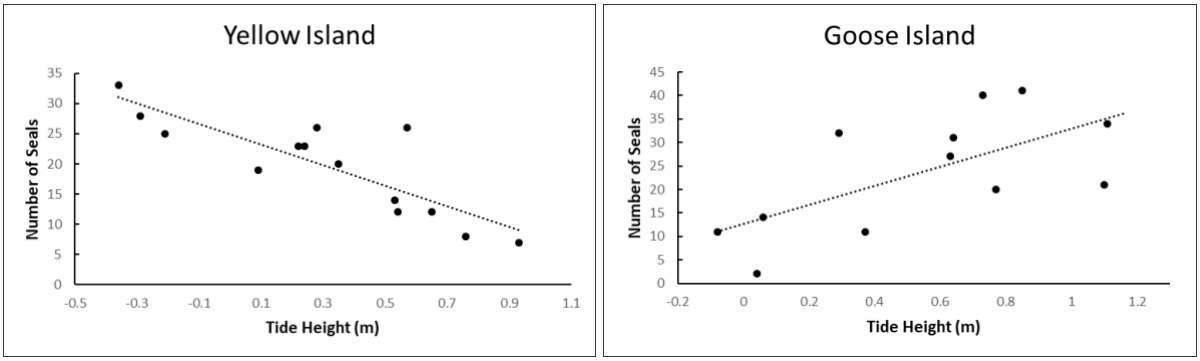


Figure 3: a) Mean (± SD) percent time spent vigilant by category of seal; **b)** Mean (± SD) percent time spent vigilant by category of seal, broken down by location.

a)



b)

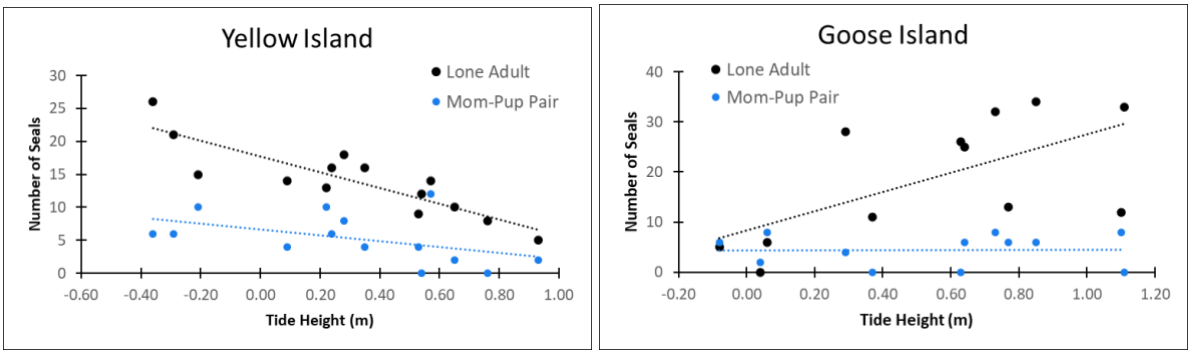


Figure 4: a) Number of seals hauled out by tide height (m) at Yellow Island and Goose Island; **b)** Number of lone adult versus mom-pup pairs hauled out by tide height at both locations.