Harbor Seals Unveiled: Exploring Human Interaction Dynamics in Beaverton Cove

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Abstract:

Understanding both the impact of human presence on marine wildlife and their cognitive abilities is essential for developing effective conservation strategies. Harbor seals *(Phoca vitulina)*, commonly found in coastal waters, often encounter human activities, which can influence their behavior and well-being. This study aims to explore the exploratory behavior of harbor seals in response to human presence, specifically focusing on their interactions with rowboats during night time vs daylight hours in Beaverton Cove, Friday Harbor, Washington. We hypothesize that harbor seals will exhibit higher levels of exploratory behaviors towards rowboats at night compared to daytime. This could be due to factors such as reduced visual stimuli, increased foraging behavior, perceived lower predation risk, and decreased vessel traffic. To test this hypothesis, we conducted systematic observations of seal behaviors during 30-minute sessions, following standardized protocols to minimize disturbance. During these sessions, we recorded the presence and proximity of seal interactions with rowboats, both at night and during the day. Statistical analyses were performed to compare the frequency and nature of these interactions between the two periods. The results of this study will provide insights into how light conditions influence seal exploratory behavior and contribute to our understanding of the impact of human activity on marine wildlife. This knowledge is essential for informing conservation strategies and offers a window into the cognitive abilities of harbor seals.

Introduction:

Harbor seals (*Phoca vitulina*) are found across a wide geographical range, inhabiting coastal waters of the North Atlantic and North Pacific oceans, from the Arctic to temperate regions. As opportunistic feeders and curious explorers, their interactions with human activities, such as boating, can provide insights into their behavioral ecology. Understanding how these interactions vary between day and night is crucial, as it reflects the seals' sensory adaptations, perceived predation risks, foraging behavior and overall exploratory behavior (Wilson 2014)

The sensory component of an animal's environment can significantly influence its behavior. In harbor seals, the transition from daylight to nighttime reduces the usefulness of visual cues, compelling them to rely more on their auditory and tactile senses (Hanke & Dehnhardt, 2018). This shift may enhance their exploratory behaviors as they seek to understand their surroundings and potential threats or resources. We define these exploratory behaviors as: approach, investigation rate , and passive observation (further explained in the methods section). These are important because they provide insights into the seal's adaptive strategies, cognitive abilities, and habituation to human presence. Additionally, nighttime may present a perceived reduction in predation risk, further encouraging seals to engage in exploratory activities (McInnes et al. 2024).

Cognitive Abilities and Foraging Behavior

Harbor seals are recognized for their high cognitive abilities, which are evident in their problem-solving skills, memory, and learning capacity (Niesterok et al., 2022). These cognitive traits are closely linked to their exploratory behaviors, as seals use these cognitive abilities to navigate and understand their complex marine environment. Curiosity drives them to investigate novel objects and unfamiliar stimuli, such as rowboats, which serves as a mechanism for learning

and adaptation (Fox. 2008). Through exploration, seals gather critical information about their surroundings, potential food sources, and possible threats. This level of cognition not only demonstrates their intelligence but also plays a crucial role in their survival and ecological success (Niesterok et al. 2022). By studying their exploratory behaviors, we gain insights into their cognitive processes and how they interact with their environment, highlighting the sophisticated mental capabilities of these marine mammals.

With this, a possible confounding factor as to why harbor seals exhibit a higher level of exploratory behavior towards rowboats at night is due to their foraging habits. Harbor seals are known to be nocturnal foragers, meaning they are more active hunters during nighttime hours (Simmonds et al. 2024). Alongside that, their main predators in the area of this study –the mammal-eating killer whale (*Orcinus orca*)– often show higher rates of foraging, locating and hunting for prey during daylight hours (McInnes et al. 2024). Thus, allowing harbor seals to increase their activities such as foraging and exploration during the night.

Human Activity and Habituation

One notable factor influencing harbor seal behavior is the level of human activity, particularly vessel traffic, in their habitat (Blundell & Pendleton, 2015). During daylight hours, coastal regions often experience a higher volume of boat traffic, which can lead to increased noise and disturbances that might inhibit seal exploration. Conversely, nighttime typically has a significant reduction in vessel activity, creating a quieter and less chaotic environment (Jansen et al,, 2015). This reduction in noise and movement may encourage harbor seals to engage more freely in exploratory behaviors, as their innate curiosity and cognitive abilities lead them to investigate unfamiliar stimuli like rowboats

This ties into the history of the early 20th century, where Washington state implemented a state-funded program that drastically diminished the harbor seal population. The decline was largely attributed to a bounty program that targeted seals perceived as threats to commercial fishing. The seal population began to improve notably after the practice was outlawed in the 1960s, removing the incentive for seal hunting (Jeffries et al., 2003). Additionally, the implementation of the Marine Mammal Protection Act provided further safeguards for harbor seals and other marine mammals. These conservation measures have been crucial in aiding the rebound of harbor seal numbers, leading to a resurgence in their population. Consequently, these seals are now more inclined to explore and interact with humans, as reduced human persecution has allowed them to gradually become more tolerant and curious towards human presence along coastal areas (Carpenter et al., 2021). This increased interaction signifies not only a rebound in their numbers but also a shift in their behavior towards greater adaptability to coexist with human activities.

This study explores how the varying levels of human presence such as the fluctuations in the frequency and intensity of vessel activities and interactions within Beaverton Cove across different times of the day and sensory stimuli between daylight and nighttime hours influence harbor seal exploratory behaviors, shedding light on the relationship between their environmental interactions and possible cognitive traits. We aim to quantify their interactions with rowboats under varying light conditions in a common vessel-filled area in Washington. Our findings will contribute to the broader understanding of how environmental factors influence marine mammal behavior, cognitive abilities, and inform strategies for mitigating human-wildlife conflicts,

Methods:

The present study was conducted in Beaverton Cove, Friday Harbor, Washington (Figure 1) , a coastal region known to be inhabited by local harbor seals (Angell & Anderson, 2023). Surveys were conducted both during daylight and nighttime hours, as we assume the specific time of day will have an insignificant effect on the relationship being studied; therefore, data was collected during both hours of sunlight and darkness. Surveys were conducted between April 4 and May 25. The observation platform for each survey was a 3.6-meter rowboat, staffed by 2-4 observers to ensure efficient data collection and personnel safety. For each survey, the observer team rowed to the center of Beaverton Cove (48.544, -123.0168).

Each survey session lasted 30 minutes, beginning when the rowboat entered the study location until it exited. The survey began with a 7.5-minute search for seals as the observer team rowed into Beaverton Cove, followed by a 15-minute waiting period to ensure quiet observation conditions, and concluded with another 7.5-minute row out of the cove. This method ensured that both the commotion of rowing and the quietness of waiting were accounted for when observing seal presence and behavior. Surveys were conducted with the rowboat positioned at a consistent distance of approximately 40 feet from the seals to minimize disturbance (estimated using nearby objects or landmarks of known sizes). A flashlight to locate seals was used sparingly, limited to brief 5-second intervals to avoid disturbing the seals. During the 15-minute waiting period, noise from observers was minimized, with researchers refraining from unnecessary talking or disruptive activities to ensure a quiet environment.

Observations were conducted twice a week, with nighttime sessions beginning at 9:00 PM for peak darkness or later and daytime sessions conducted before 3:00 PM. A standardized observation sheet was used to record seal behaviors, including date, time, weather, and water

conditions. Seal exploratory behaviors were categorized into three types: approach, investigation rate, and passive observation. An approach was defined as a seal coming within 20 feet of the rowboat. Investigation rate was measured by counting the number of times a seal surfaced to investigate the boat. To ensure accurate identification of individual seals during each surfacing, we noted specific features such as size, coloration patterns, and unique markings, along with following their water movements and surfacing patterns. Passive observation referred to seals observing the boat from a distance of 20 to 40 feet away. Each behavior was recorded separately.

The primary variables were day versus night (independent variable) and the presence and type of seal interactions (dependent variables).Statistical tests were used to separately depict the relationship between the frequency of seal exploratory behaviors during daylight versus nighttime sessions, with bar charts included to illustrate this relationship. Additionally, a table will be included to show the specific types of exploratory behaviors observed in seals at night versus during the daytime (Table 1). Control measures will include a consistent observation location in the middle of Beaverton Cove, uniform duration of observation sessions (30 minutes), and minimized sound levels during the waiting portion of observations. A total of seven nighttime and seven daytime observation sessions were conducted in the present study.

Figure 1: Map of Beaverton Cover, Friday Harbor, Washington

Results:

During the 14 observation sessions, evenly divided between daylight (n=7) and nighttime (n=7), harbor seals exhibited distinct interaction patterns with the rowboat. Overall, seals were recorded to have a higher frequency of interactions occurring during nighttime sessions. Seals exhibited exploratory behavior in 6 out of 7 nighttime observations, whereas they displayed this behavior in only 1 out of 7 daytime sessions (Figure 2). Statistical analysis using a t-test on the program R-Studios revealed the difference in interaction frequency between day and night.

Behavioral observations were categorized into three types: approach, investigation rate, and passive observation. The distribution of these behaviors varied between day and night sessions. At night, seals were more likely to exhibit exploratory behaviors such as approaches,

and a variety of investigation rates. In contrast, during daylight sessions, seals were more likely to exhibit passive observation behaviors from a greater distance. The distribution of behaviors is summarized in Table 1, showing that if seal sightings were observed, investigative behaviors predominated during nighttime sessions, while passive observation was more common during daylight sessions.

In addition to categorized observations, the proximity of harbor seal interactions was measured by estimating the distance between the seals and the rowboat during each session. On average, seals approached the rowboat significantly closer during nighttime sessions between 0 (swimming under boat) and 20 feet away compared to daylight sessions being 30-40 feet away. The estimation was based on objects or landmarks of known size such as boats, the shore, etc.

Environmental conditions, including weather and water state, were recorded during each session to control for external variables. Analysis indicated no significant differences in weather conditions or water state between day and night sessions, suggesting that these factors did not significantly influence the observed patterns of behavior.

Through the statistical analysis, our data proved to be statistically insignificant with a p value of 0.4097. To improve the study's statistical power, we could have aimed for a higher sample size. By increasing the number of observation sessions, particularly during both daytime and nighttime periods, we could have potentially captured a more representative sample of harbor seal interactions with the rowboat. Additionally, expanding the study to include different locations or seasons might have provided further insights into the variability of seal behavior.

However, despite not reaching statistical significance, our data still holds importance. The observed trend of higher exploratory behavior during nighttime sessions suggests potential shifts in seal activity patterns in response to environmental factors such as reduced visual stimuli

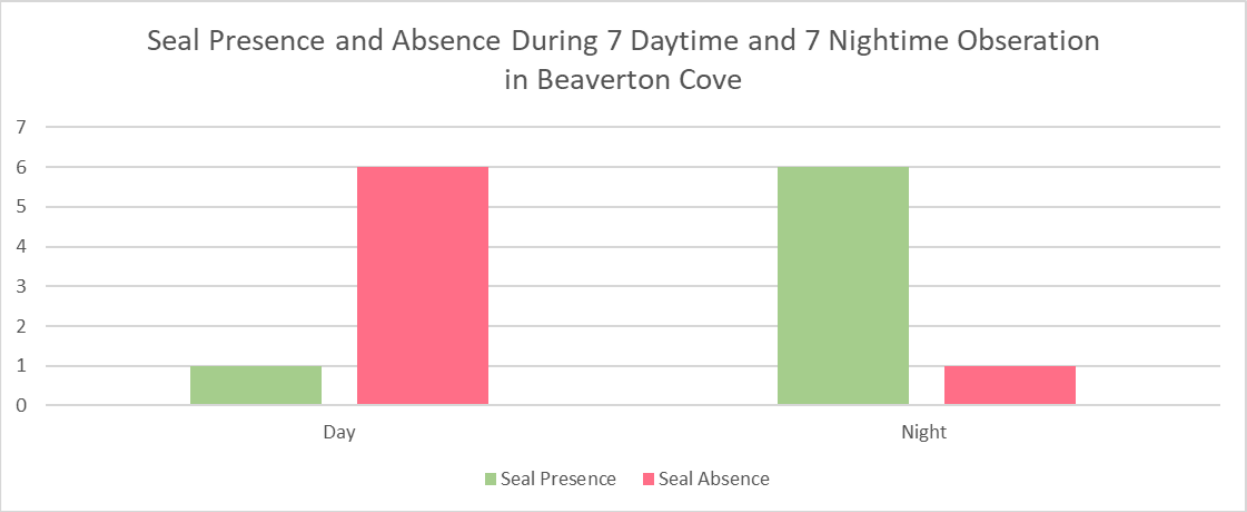
and predatory threats and vessel traffic. This insight can guide further research and conservation efforts aimed at understanding and protecting marine mammal populations.

Furthermore, our study highlights the complexity of marine mammal behavior and the multitude of factors that influence it. By controlling specifc variables such as survey length and rowing/waiting time, we've demonstrated an approach to understanding the nuances of seal interactions with human activities. This attention to detail contributes to a more comprehensive understanding of the factors shaping marine mammal behavior.

In summary, while our study may not have achieved statistical significance, it still provides valuable insights into harbor seal behavior and the factors influencing it. By considering potential improvements in study design and recognizing the importance of non-significant findings, we can continue to advance our understanding of marine mammal ecology and inform conservation strategies effectively.

The findings may suggest that reduced visual stimuli, reduced predatory threat, foraging behavior and lower levels of vessel traffic at night may encourage seals to engage more freely in investigative behaviors. These insights contribute to our understanding of how environmental and anthropogenic factors influence marine mammal behavior and can inform conservation strategies to mitigate human-wildlife conflicts.

Figure 2:



Bar chart of seal presence and absence of seals within 14 total surveys (7 day & 7 night). Seal presence (green) was seen in 6 out of 7 nighttime surveys and once in the daytime surveys.

Table 1:

Date of Seal Presence	Day or Night	Exploratory Behavior
28-Mar	**Night**	**Investigated rate: 3 times within 15 feet of boat**
30-Mar	**Night**	**Approached boat, followed moving boat by swimming under**
1-Apr	**Night**	**Approached boat once around 15-18 feet away**
4-Apr	**Night**	**Investigated twice within 20 feet (second investigation closer to boat ~ 15 ft)**
14-Apr	**Night**	**Approached boat once: very close around 10 feet away**
5-May	**Night**	**Swam around/circled boat once within 20 feet**
23-May	**Day**	**Passive Observation around 40 feet away.**

Exploratory behaviors of seals that were present 6 times in night time surveys and once in a daytime survey out of 14 surveys total (7 day, 7 night). Passive observation was seen only in the daytime survey, while high investigation rates and closer approaches were seen in night time surveys

Discussion:

The data collected for this study indicate that harbor seals in Beaverton Cove exhibit significantly higher levels of exploratory behavior towards rowboats during nighttime compared to daylight hours. Although statistically insignificant, the data collected supports our hypothesis that harbor seals will exhibit higher levels of exploratory behaviors towards rowboats at night compared to daytime. The reasons for this conclusion may be due to reduced visual stimuli, perceived lower predation risk, foraging behavior, and reduced vessel traffic at night encouraging more investigative interactions. The increased frequency and proximity of nighttime interactions highlight the seals' adaptability to different environmental conditions, suggesting that they adjust their behavior based on perceived safety from predators (Deecke et al., 2002), and reduced anthropogenic disturbances (Jansen et al., 2010) as well as optimal foraging opportunities (Blundell et al., 2011) . This provides insights into their cognitive flexibility and ability to exploit varying ecological niches (Fox. 2008).

Our data revealed that harbor seals approached and interacted with the rowboat significantly more often and at closer distances during nighttime sessions. This can be interpreted as a response to the quieter and less chaotic environment at night, which reduces stress and disturbances caused by daytime vessel traffic (Jansen et al., 2010) . The reduced noise and movement at night likely create a more calm and encouraging environment for the seals to explore novel objects such as rowboats (Hoover-Miller et al., 2013). The categorization of behaviors into approach, investigation, and passive observation showed a clear pattern: investigative behaviors predominated at night, while passive observation was more common during the day. This suggests that seals are not only more active at night but also more curious and willing to engage with unfamiliar stimuli. The reduced visual stimuli at night likely compel

seals to rely more on their other senses, such as hearing and touch (Scholtyssek et al., 2008), enhancing their exploratory behavior. These adaptations show a correlation between evolutionary adaptations and cognitive abilities.

The significant difference in seal behavior between day and night underscores the impact of human activity on wildlife. During the day, higher levels of vessel traffic and associated noise likely deter seals from approaching rowboats (Karpovich et al,. 2015). This avoidance behavior during daylight hours can be attributed to the increased disturbances and potential threats posed by numerous and larger vessels. At night, the quieter environment with fewer vessels allows seals to engage more freely in exploration, highlighting the importance of managing vessel traffic to minimize disturbances to marine life (Johnson et al., 2007).

The high levels of curiosity exhibited by harbor seals, particularly at night, reflect their advanced cognitive abilities in several ways. Their nighttime exploratory behavior indicates they have a sophisticated understanding of their environment, demonstrating strong problem-solving skills and spatial awareness (Scholtyssek et al., 2013). This curiosity also suggests learning and memory capabilities, as they continually seek out new information and experiences, even in challenging conditions like low light. Harbor seals are known for their problem-solving skills, memory, and learning capacity (Niesterok et al., 2022). Their investigative behaviors towards rowboats suggest a sophisticated level of cognition, as they gather critical information about their surroundings. These behaviors are a crucial survival trait, enabling them to adapt to changing environments and identify potential threats or resources (Fox et al., 2008).

Understanding the behavioral patterns of harbor seals in response to human presence is essential for developing effective conservation strategies. The findings of this study indicate that managing human activity, particularly vessel traffic, is vital to reduce disturbances and support

the natural behaviors of harbor seals. Conservation efforts should include establishing designated quiet zones or time restrictions for boating activities in key habitats, especially during critical periods such as nighttime when seals are more active and exploratory (Jansen et al., 2015)

The high intelligence and curiosity of harbor seals also suggest that they are capable of adapting to conservation measures if these measures are designed to consider their behavioral and sensory needs (Solvason, 2015). Educating the public about the impact of human activities on marine life and promoting responsible boating practices can further aid in minimizing negative interactions.

The results of this study highlight the significant influence of anthropogenic and environmental factors on the exploratory behavior of harbor seals. By demonstrating the higher levels of interaction at night, we gain a deeper understanding of how reduced visual stimuli, lower predation risk, foraging behavior and decreased vessel traffic encourage natural behaviors in marine mammals. These insights emphasize the need for targeted conservation strategies that address the impact of human activity and support the cognitive and sensory adaptations of harbor seals (Brooker et al., 2016). Protecting their habitats from excessive disturbances will not only preserve their natural behaviors but also contribute to the overall health and sustainability of marine ecosystems.

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