Distributions of harbor seals (*Phoca vitulina*) relative to tidal currents during summer at Yellow Island, Washington

Ryan Gray

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Friday Harbor Laboratories, University of Washington, Friday Harbor, WA 98250
Department of Biology, University of Washington, Seattle, WA 98195

Contact Information:
Ryan Gray
4110 12th Ave NE, Apt. 301
Seattle, WA 98105
ryangray84@gmail.com

Abstract - Harbor seals (*Phoca vitulina*) are fish predators that are commonly found in coastal waters of the Pacific Northwest. They are frequently seen swimming or hauled out during lower tides on rocks in the San Juan Islands during the summer months. I studied associations of swimming seals with tidal currents of different speeds. To do this, I observed a group of seals off the west coast of Yellow Island in the northern San Juan Channel at various intervals during a two-week period in August 2011. Near one particular haul out site, seals appeared to prefer slower currents during low tide when differences in adjacent current speeds were greater than during higher tides. Seals swam near this site more than near any other overall. Seals swam more during late afternoon hours, and mother seals and their pups were associated mainly with slower currents near shoreline.

Key words: current speed, habitat use, harbor seal, *Phoca vitulina*, San Juan Islands, tidal current.

Introduction

The harbor seal (*Phoca vitulina*) is a phocid, or true seal, that ranges from 30°N to 80°N, making it the most widespread pinniped in existence (Reder 2003). They play a predatory role in a wide variety of aquatic ecosystems, including foraging for fish in temperate coastal areas (Zamon 2001).

Harbor seals are abundant in the San Juan Archipelago of Washington during late spring through late autumn (Zamon 2001). Most often they are seen hauled out on exposed shorelines or swimming in the adjacent waters. In general, seals haul out during low tide and in the middle of the day (Simpkins 2003). There is a gradual increase in the number of seals hauling out during an ebbing tide followed by a rapid decline during the flooding tide (Cunningham 2010). The extent of haul out time depends on the tidal cycle as well as the time of day (Simpkins 2003).

Although harbor seals often haul out during the day, they spend more than 80% of their time in water (Krafft 2001). About two-thirds of their time in water is spent diving, and they tend to dive mainly at night (Krafft 2001). In the southern San Juan Channel, harbor seals tended to aggregate near the most constricted part of the channel where their hunting success was highest (Zamon 2001). While that study did not measure current speed, the fastest currents were likely at most constricted part of the channel where seals were observed catching the most salmon.

In this study, I assessed how seal use of different current speeds varied with tidal height. I present reasons in this paper why their use of fast and slow current changed during the tidal cycle near Yellow Island. I also provide insight into how the nature and availability of their haul out sites interacted with tidal height to influence their use of relatively fast or slow currents. Finally, I discuss other research avenues that may contribute to our knowledge about harbor seal aquatic behavior.

Methods

I conducted this study on 0.045 km^2 Yellow Island in northern San Juan Channel, WA during summer 2011 (Fig. 1). I visited the site by boat a total of nine times at various tidal heights during daylight hours from August 5 to 17. I observed all harbor seals that were present on one or more of six designated haul out sites (Fig. 2) on or near the island well as all seals that were swimming within view. I made observations using 8 × 42 binoculars from locations that were about 15 m inland, 10 m above sea level, and 30 to 80 m away from haul out sites.

I recorded the number of harbor seals swimming at the surface in categories of relatively fast and slow currents off the coast every ten minutes and noted which haul out site each seal was in closest proximity to. I classified slow currents as those <0.5 m/s and fast currents as those >0.5 m/s. I estimated all current speeds during counts. I visually scanned the waters for two minutes before recording each count to increase the probability of observing all seals. I counted and recorded the total number of seals on land and in water in the area upon arrival to the site and then a minimum of two times each hour during observations. I recorded whether haul out sites were above or below the water level and noted seal movements from one site to another during flood tides. I used the program "Mr. Tides 3" to obtain tidal data for Friday Harbor (~5.6 km southeast of Yellow Island) for each ten-minute interval that corresponded to my seal observations and current speed data from Spring Passage (~3.0 km north of Yellow Island).

Results

I conducted 95 seal counts, with a mean observational period of 119 min (range 70 to 190 min) per day. All observations were made between 0850 and 1720 hrs. Tidal height ranged from –0.83 to 7.20 ft during observations. The average number of seals I observed swimming per count was 6.98 (range 0 to 20 seals). More seals were swimming during the afternoon hours than during the morning hours (Fig. 3). The mean number of seals present on land and in the water was 40.50 per count (range 7 to 80 seals).

I observed a larger percentage of the seal population swimming at Yellow Island when the tide was relatively high, with the highest percentage swimming at tidal heights above 5.16 ft (Fig. 4). Seals swam mostly in slow currents during both low and high tides but not during intermediate tidal heights (Fig. 5). Specifically, slow current swimmer count numbers were higher when the tide was <1.20 ft or >5.50 ft and lower when the tide was between those tidal height values. The preference of seals for slow currents was most pronounced at tidal heights with negative values (Fig. 6).

Harbor seal count numbers in water varied among sites in response to different tides and throughout the day. I observed more seals swimming near site A than near any other site at most tidal heights and especially during low tide (Fig. 7). Haul out site C is located on an elevated peninsula, near which I did not observe any swimming seals. Haul out sites A and F became completely submerged when flood tides reached about 4.59 ft and 4.27, respectively, while none of the other four sites were ever completely submerged. I observed relatively few seals swimming in the morning and the greatest number of seals swimming between 1520 and 1720 hrs.

Discussion

The harbor seal pattern of swimming in slow currents during low but not during intermediate tidal heights is at least partly a function of the geography of the area. The two islands present at Site A at low tidal heights were nearly always surrounded by fast current but shielded the flow of water from the middle of the channel creating an area of slow current between them. Submerged seals near the site spent most of their time in this region of slow current when both fast and slow currents were present. As the tide rose and Site A became submerged, the difference between the fast and slow currents became less pronounced, and seals spread out into surrounding, fast current waters. This trend could be because seals chose to spend less energy swimming by spending more time in the slower currents when they were available near the haul out site. As tidal height increased and the speed of the slow current began to approach that of the surrounding fast current, seals had to expend more energy swimming in the slower current. It appears as though the option to enter the surrounding faster current and possibly forage in the deeper water became increasingly attractive to seals as the tide rises and the slow current speeds up. Seals tended to do this when the tidal height was above 1.20 ft.

There are two possible reasons why a higher percentage of seals swam at high tidal levels than at intermediate tidal levels. First, the two most popular haul-out Sites, A and F, were submerged at relatively high tidal levels. Many of the seals forced off of these sites by incoming flood tides appeared to be swimming and frequently diving near recently submerged Site A where there was no longer land nearby. Secondly, the seals swimming at the very highest tidal levels appeared to be mostly mothers and their pups, neither of which were frequently observed in fast current during any tidal height. They rarely if ever ventured out of the slowest current near the shoreline of Site E. While it is clear that mothers and their pups tend to swim in slow currents at high tide, it is impossible to infer the current use of non-maternal adult sea lions at high tide because so few were observed.

The locations and physical characteristics of each haul out site likely influenced the number of seals swimming nearby. Seals hauled out in the largest numbers on Sites A and F, possibly because the two sites are located farthest from the shore, but I rarely observed seals swimming near Site F. This could be because Site F being located furthest out in the channel where there were no adjacent slow current regions or because it was mostly surrounded by rock formations jutting out above the surface of the water and thus may have provided less aquatic space for seals to maneuver to catch prey. Conversely, the water around Site A appeared from the surface to be free of surrounding obstacles. I frequently observed seals migrating from Site F to Site A after being forced to move by increasing tidal height. Site A may also have provided the richest waters of hunting fish considering seals appeared to dive in that region more than in any other, and I observed surface feeding near Site A only.

My results indicating that the number of harbor seals swimming correlates with time of day are consistent with Simpkins et al (2003). The high number of seals I observed swimming during the late afternoon is likely because that period of the day was preceded by high air temperatures. Seals that hauled out during the warmest hours of the day in the early afternoon may have subsequently submerged themselves to reduce their body temperature.

This study would have been improved by more precise measurements of two variables. More precise measurements of current speed would have allowed for more specific and possibly more accurate results. While I could visually distinguish relative fast and slow currents from one another, I did not have the tools to quantify short-distance current speed changes within the immediate area. Also, precise measurements of tidal height closer to Yellow Island would have improved the study.

Several variables could be taken into account in future studies. First, behavioral differences underwater in fast and slow currents could be studied, especially with regards to where seals catch prey more efficiently. I observed seals diving more often in fast currents than slow currents but could not observe underwater behavior. Research analyzing the influence of boat traffic on seal aquatic behavior may also be useful. There was one instance in which the inter-island ferry caused a wake that forced all of the seal hauled out at Site A into the water. Finally, a study could be done to better describe the difference in current use between adult seals and pups. It frequently appeared as though pups were unwilling to venture into fast currents, which possibly caused their mothers to likewise spend most of their time in slower currents. I observed this discrepancy but did not quantify it.

Yellow Island was an excellent site to observe seal behavior because of the consistency in which seals were present near the west coast. Future research on harbor seal aquatic behavior will determine if the trends described in this paper are applicable to seals in other coastal regions of the world.

Acknowledgements

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Figures and Tables

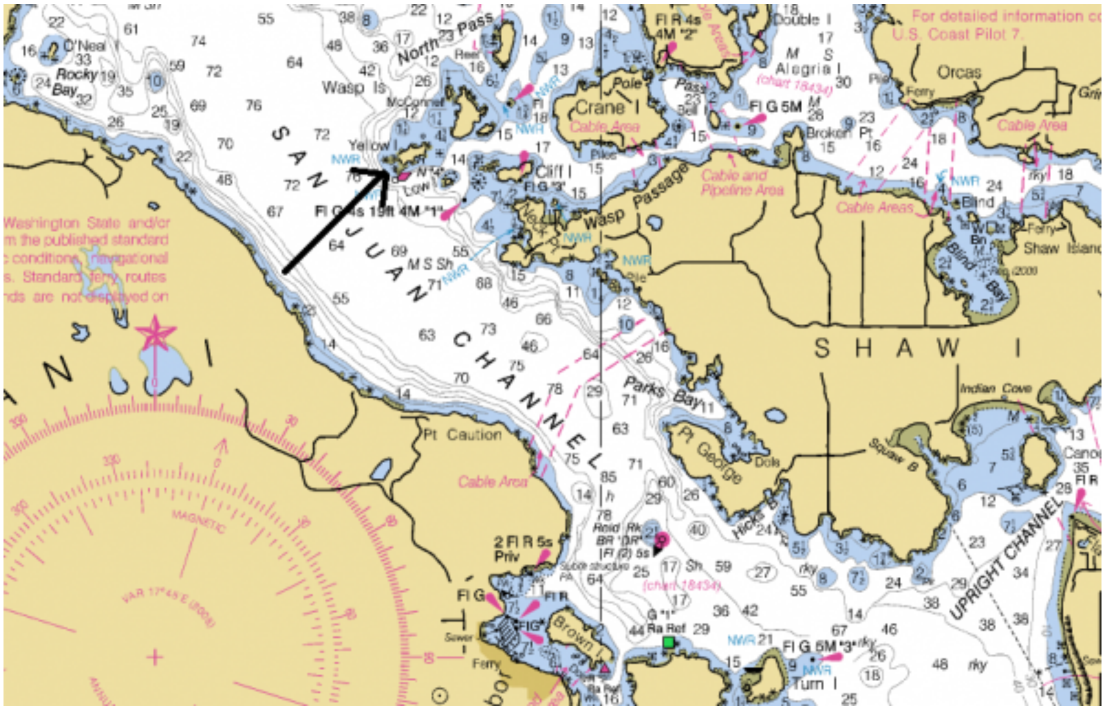

Figure 1: Study site on Yellow Island in San Juan Channel, WA.

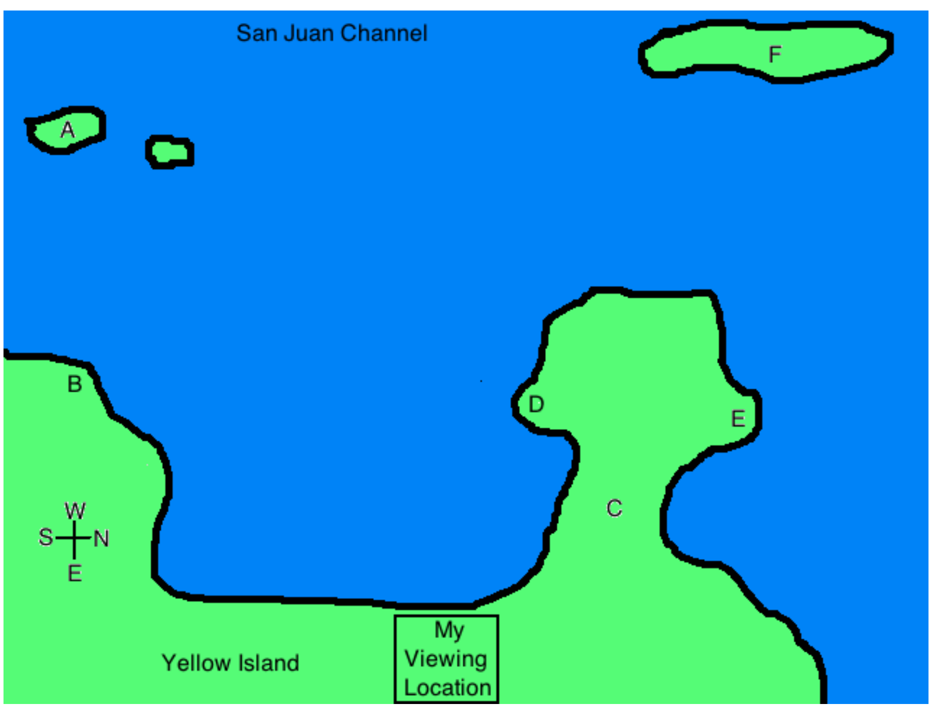

Figure 2: Schematic diagram of seal haul-out sites at Yellow Island, WA.

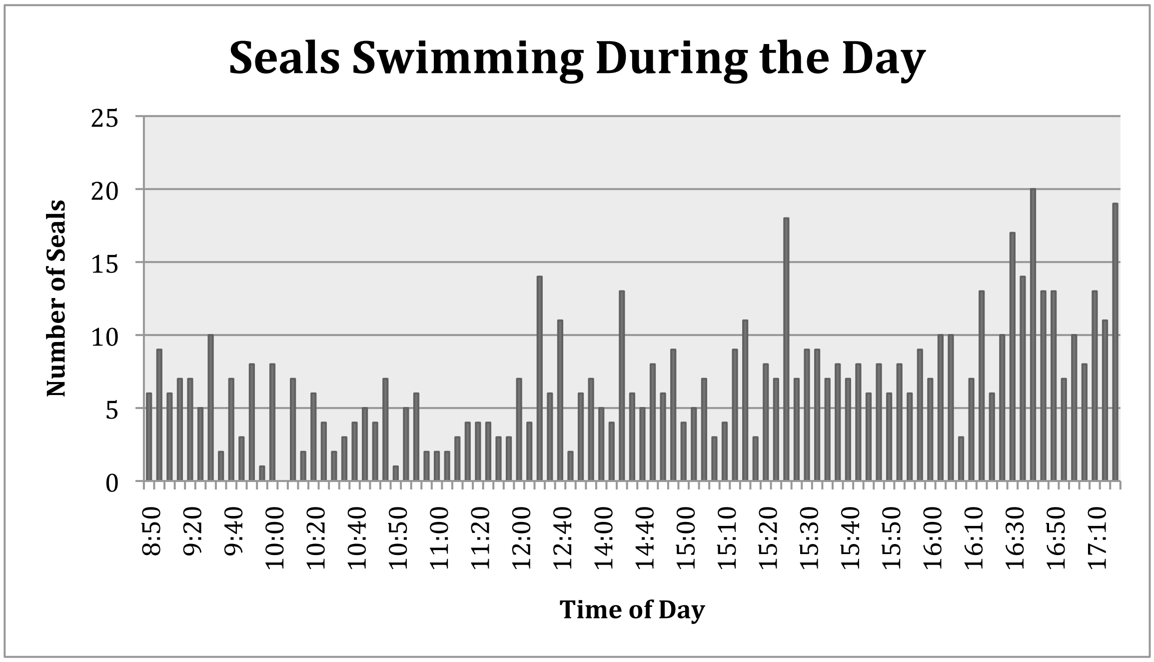

Figure 3: The number of seals observed swimming at various times throughout the day.

(Note: Some times have multiples observational counts.)

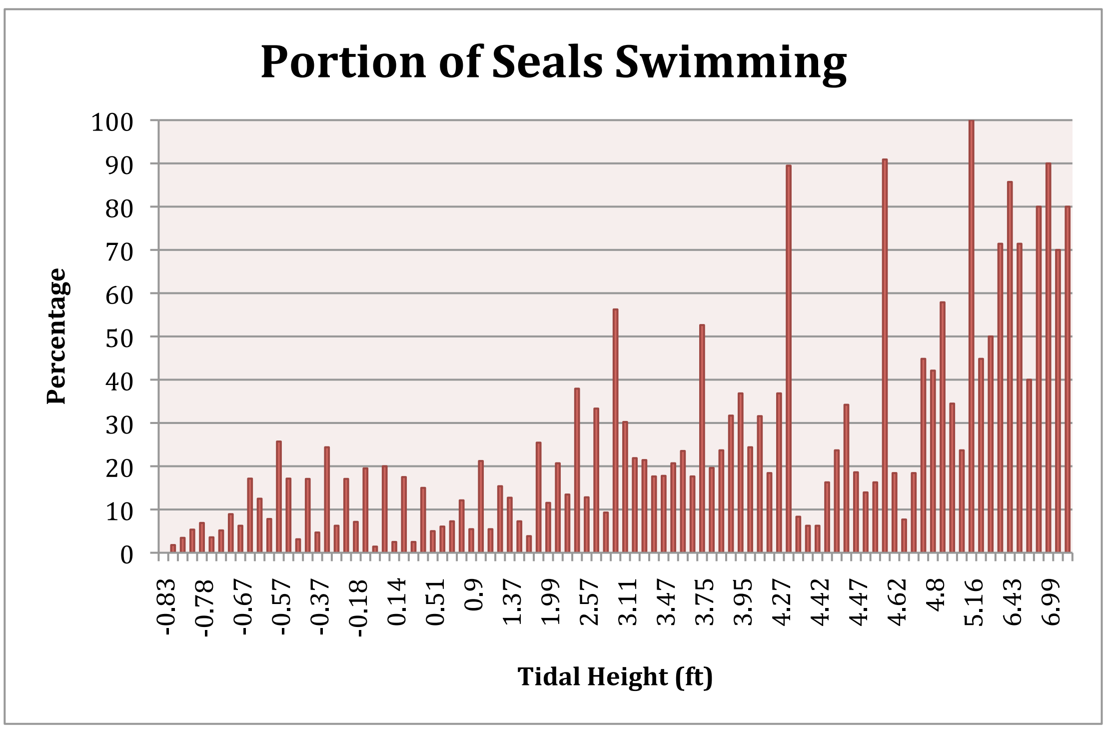

Figure 4: Percentage of all seals in the area observed swimming at various tidal heights.

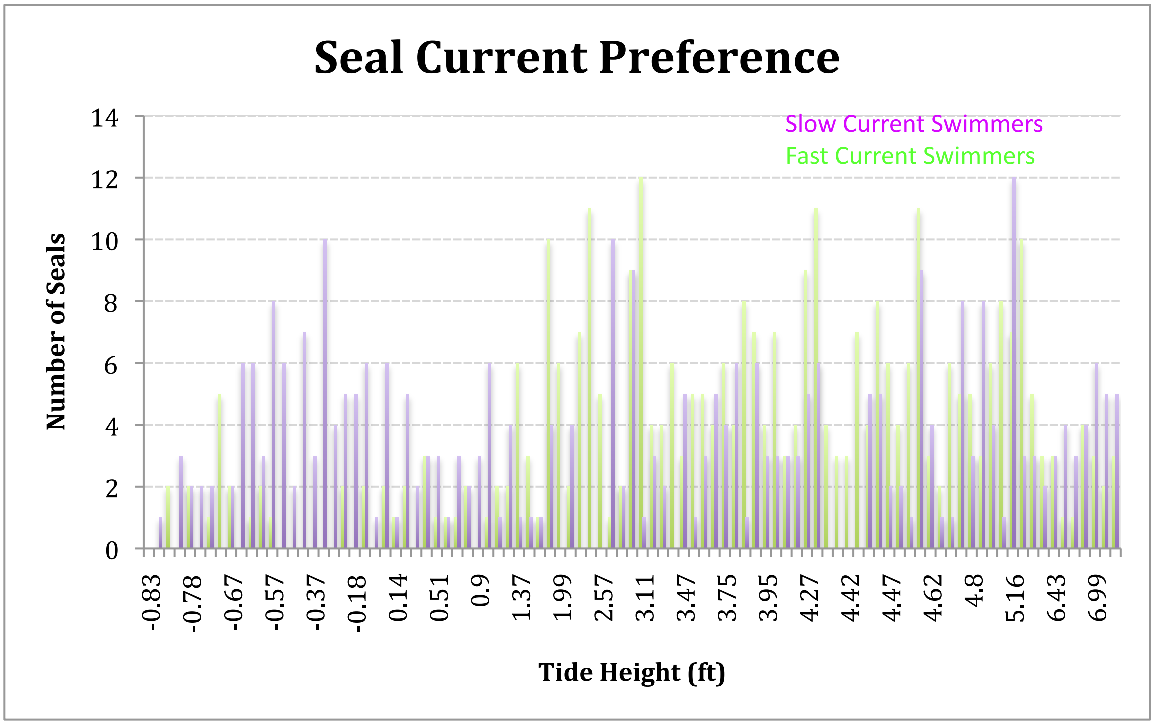

Figure 5: Number of harbor seals swimming in fast and slow currents off the coast of Yellow Island, WA at various tidal heights during August 2011.

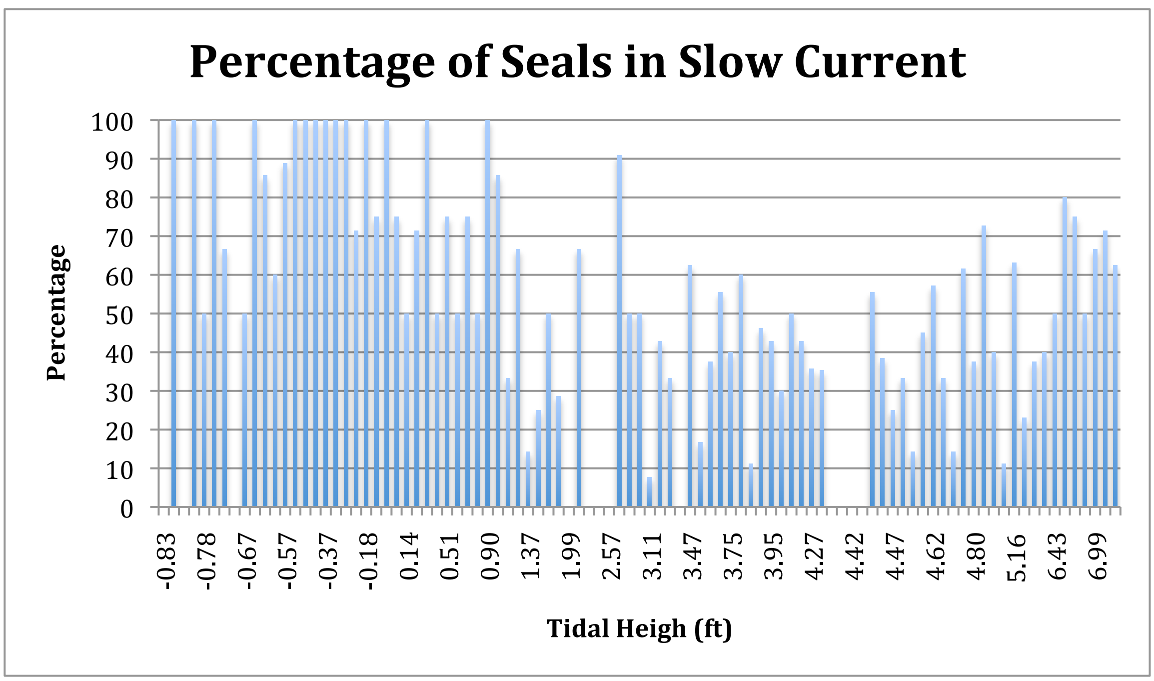

Figure 6: The percentage of swimming seals observed in slow current waters at various tidal heights.

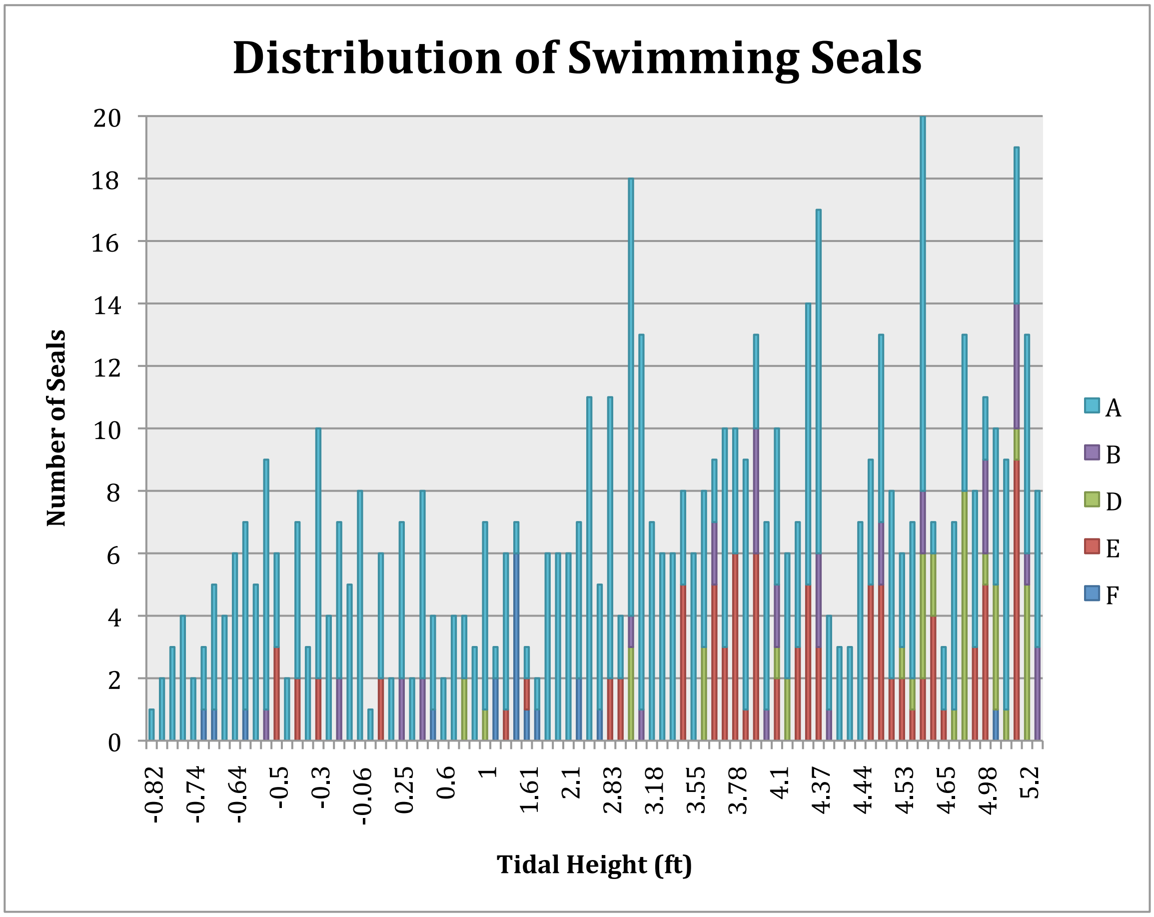

Figure 7: Number of seals counted in water proximate to each haul out site at various tidal heights.