Pinniped Abundance and Distribution in the San Juan Channel, and Haulout Patterns of Steller Sea Lions at Cattle Point

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Abstract

Two species of pinnipeds were focused on in this study, the Harbor seal (*Phoca vitulina*), and the Steller sea lion (*Eumatopias jubatus*). In this study the abundance and distribution of Harbor seals and Steller sea lions in the San Juan Channel was studied in fall 2014 using the strip transect method. Results were compared with data collected by previous Pelagic Ecosystem Function Research Apprenticeship students from fall 2007-2013. Harbor seal numbers were found to be stable, but steller sea lion's numbers have been declining for the past three years. Over the course of fall 2014 harbor seal numbers declined, possibly due to the fall transition, while steller sea lion numbers stayed low throughout the season. Steller sea lion haulout patterns were also examined at Cattle Pass, Washington, and found to have a correlation with current speed.

Introduction

The harbor seal and steller sea lion are the two species of pinnipeds most common in the San Juan Channel. Harbor seals are smaller (150-170 lbs, 1.2-2m), dark to light grey in color with spots, lack external ear flaps, and have small forelimbs. Steller sea lions are much larger (580-1200 lbs, 2-3 m), light brown in color, possess external ear flaps, and have large hind and forelimbs and a long neck allowing them to be more agile on land (Nordstrom 2012).

Harbor seals are the most common pinniped in the San Juan Island archipelago (Lance et al. 2007), are present in the area year round, and are local breeders. The harbor seal is found throughout temperate and artic waters of the northern hemisphere, and has the widest distribution of any pinniped. It is considered a non-migratory species, breeding and feeding in the same area throughout the year (Jeffries et al. 2003). Harbor seal numbers were severely reduced in the early 1900s by bounty hunters under a state financed program that considered harbor seals to be predators in direct competition with commercial and sport fishermen. After the bounty program ceased in 1960 and the Marine Mammal Protection Act was passed in 1972, Washington harbor seals began to recover (Jeffries et al 2003). The Salish Sea now has an approximate population of 4,000 seals and has been at or near carrying capacity for over a decade despite worldwide declines of many other marine species (Jefferies et al 2003). Harbor seals are at or near the apex of marine food webs, and given their abundance and trophic position, harbor seals undoubtedly make up an influential component of their marine ecosystems (Bromaghin et al 2012).

Steller sea lions are non-breeding winter and fall visitors in the Salish Sea. World populations of Steller sea lions have decreased by two-thirds since 1980 (Nordstrom 2012). On April 5 1990, the steller sea lion was classified as a "threatened species" under the U.S. Endangered Species Act (Reeves et al 1992). Steller sea lions are now considered stable from the coast of Southeast Alaska to Oregon (Trites et al 1996). Local status of steller sea lions in the Salish Sea has not been well studied other than through the Pelagic Ecosystem Function Research Apprenticeship at Friday Harbor Laboratories.

Steller Sea Lions spend extended periods of time hauling out in the San Juan Channel near Cattle Pass after their breeding season comes to a close at the end of July (Pitcher and Calkins 1981). A haulout site is a place to rest or breed out of the water that is safe from predators. Harbor seals have many different haulout sites located throughout the San Juan Channel, they mostly use low rocks and beaches to haul out, and their hauling out pattern is dependent on tides. Steller sea lions on the other hand, only have one haulout site located at Cattle Pass. Harbor Seals' haulout sites become completely submerged under water during high tides, but steller sea lions always have a place to haulout because Whale Rocks near Cattle Pass never becomes completely submerged under water. Steller sea lions have a choice when to haulout since their haulout site is never under water. This gave me a chance to study Steller sea lions' diel haulout patterns. In recent years Friday Harbor Laboratories students' have examined pinniped haulout patterns in the summer but no one has looked at haulout patterns in the fall.

Steller sea lions' only haulout site, Cattle Pass, experiences some of the strongest current tides in the San Juan Channel, because it is narrow, bathymetrically complex, and has steep sides that drop rapidly to about 100 meters (Vermeire 2010). These features constrict water flowing in and out of the pass and create strong tidal currents and turbulent mixing (Vermeire 2010). This turbulent mixing is known to be a key factor in providing nutrients for high productivity throughout the food chain (Petersen et al 1998). Mixing provides an 'auxiliary' source of energy that subsidizes direct solar input, and is in part responsible for the relatively high productivity of coastal ecosystems (Mann 1992). Mixing can also lead to increased prey availability through physical forcing (Zamon 2002).

The overall goal of this study was to continue the work previous Pelagic Ecosystem Function Research Apprenticeship students started, monitoring the status of harbor seals and steller sea lions. To do this, my specific objectives were to determine the abundance and distribution of harbor seals and steller sea lions in fall 2014, and to compare 2014 abundance to previous years. In addition, the diel haulout pattern of steller sea lions at Whale Rocks near Cattle Point was examined to determine possible causes, such as, availability, thermoregulation, and feeding.

Methods

Study Sites

Two sites were used throughout this study, both located in the San Juan Channel, in the Salish Sea. The larger study site began in the northern area of the channel with coordinates 48°35'N, 123°02,54'W and ends just outside Cattle Pass in the southern part of the San Juan Channel with coordinates 48°25'N, 122°56,59'W (fig.1). The transect measured 21.11 kilometers in length and was separated into six zones based on geography and bathymetry. Zone one has coordinates 48°35'N, 123°02,54'W with a surface area of 1.26 km^2. Zone two has coordinates 48°33', 122°59'67'W with a surface area of 0.96 km^2. Zone three has coordinates 48°32'N, 122°58'W with a surface area of 0.93 km^2. Zone four has coordinates 48°31'N, 122°56,89'W with a surface area of 1.68 km^2. Zone five has coordinates 48°28'N, 122°57,17'W with a surface area of 1.17 km^2. Zone six has coordinates 48°26'N, 122°56,72'W with a surface area of 0.45 km^2.

The haulout study site was Cattle Pass, Washington (approximately 48.45° N, 122.96° W). The study was conducted from the lighthouse located at Cattle Point, where Whale Rocks is visible from shore. Tidal flow through the narrow pass (at Cattle Point) is quite strong and creates strong surface currents and eddies near islands and rocky points. Large numbers of seabirds and pinnipeds commonly forage in these tidal currents (Zamon JE. 2001).

Centennial Data Collection

The strip transect method was utilized for this study to count harbor seals and steller sea lions in the water. Two transects were taken each day on September 30th, October 7th, 14th, 21st, 29th, November 5th, and 10th on the research vessel, R/V Centennial. The first transect began in the northern part of the channel and went to the southern part of the channel just outside Cattle Pass (Zone 1 to 6). The second transect started in the southern part of the channel and went to the northern part of the channel (Zone 6 to 1). A minimum of one recorder and two observers were on both the port and starboard side of the bow of the boat. As the Centennial moved throughout the channel all pinnipeds within 200 meters of the boat were counted and recorded; binoculars were used by observers to identify pinnipeds. A total distance of 118.22 kilometers was covered by all transects this fall.

Cattle Pass Data Collection

Steller sea lions were observed at Cattle Point lighthouse, utilizing a 48x Nikon scope. The steller sea lions hauled out on Whale Rocks were observed for a minimum of two hours and were counted and recorded every twenty minutes on the days of October 8th, 18th, 19th, November 1st, 2nd, and 4th. Mr. Tides (station, Cattle Point, 1.2 miles southeast of the San Juan Channel) was used to determine current speed.

Results

Abundance

During fall 2014 the total number of harbor seals observed on Centennial transects was 234 and the total number of steller sea lions was 46. The mean harbor seal density was 2.0 /km^2 and the mean steller sea lion density was 0.4 /km^2 (fig. 3). Harbor seal density was consistent with previous years, from 2007-2013 numbers ranged from about two to four seals/km^2 (fig. 4). Harbor seal numbers were higher in the first three cruises ranging from about 3.8 to 5.5/ km^2, the numbers of last four cruises range from 1.7 to 0.8/ km^2 (fig.5). Steller sea lion numbers stayed low throughout all cruises. Steller sea lion numbers seem to be declining over the past three years, their average density ranged from two to 0.5 individuals/ km^2 from 2007 to 2014 (see fig. 4).

Distribution

During fall 2014 harbor seals were seen in all six zones, while steller sea lions were only seen in three zones (fig. 6). Harbor seals were most abundant in zones three and four, zone three density was about eight seals/ km^2 and zone four was about four seals/ km^2 all other zones were under 2.0 seals/ km^2. Steller sea lions were most abundant in zone 5 with a density of about 4.5 steller sea lions/ km^2 all other zones were under 1.0 steller sea lion/ km^2.

Cattle Pass

The steller sea lions that haulout on Whale Rocks at Cattle Pass were found to have a haulout pattern that has a negative correlation with current speed. As current speed decreased, the number of steller sea lions hauled out increased (fig. 7). This pattern was found to be independent of time of day (fig. 9 and 10), and was consistent both in the morning and late afternoon. When current speed went from decreasing to increasing very suddenly, steller sea lions did not react quickly (fig. 11 and 12).

Discussion

Harbor seal numbers do not appear to have drastically changed in fall 2014; there was no net change in their abundance (fig. 4). There were two peaks in 2010 and 2011 that are most likely due to high prey abundance. Harbor seal numbers in fall 2014 started decreasing after cruise three (fig. 5), which also happens to be the same time that the fall transition occurred. After the fall transition, downwelling occurs and causes the waters to become nutrient poor and therefore less prey is available for animals like harbor seals, this could be one explanation for the decrease in harbor seals after cruise three. Steller sea lion numbers stayed low throughout the seven cruises in fall 2014. Steller sea lion numbers also appear to be declining over the past three years (fig. 4), it is too early to make much of this but it is something that should definitely be monitored in the future, and needs further research.

Steller sea lions and harbor seals had different distributions in the San Juan Channel. Harbor seals were most abundant in zones three and four and steller sea lions were most abundant in zone five (fig.6). Steller sea lion distribution is congregated around their haulout site in zone five, since their haulout site is close to a location (Cattle

Pass) that has high prey availability, they do not have to go far when looking for food. These results were similar to those found by previous Pelagic Ecosystem Function Research Apprenticeship students in 2011 and 2012. Harbor seals have haulout sites located all throughout the San Juan Channel (Jefferies et al 2000), and they are known to forage within 10 km of their haulout site (Lance et al 2007), this explains why harbor seals were more widely distributed throughout the zones. The increased abundance of harbor seals in zones three and four suggests that prey availability is greatest here.

Steller sea lions' haulout patterns at Cattle Pass were found to be dependent upon current speed (figs. 7-10), as current speed decreased the number of steller sea lions hauled out increased. Faster current speeds offer more feeding opportunities; therefore, more steller sea lions would be in the water when the current speed was faster. Large numbers of seabirds and pinnipeds commonly forage in the currents around Cattle Pass (Zamon JE. 2001). Cattle pass has some of the strongest currents and because of its bathymetrically complex morphology; these currents cause aggregations of prey through physical forcing. Cattle Pass' narrow and steep sides that drop rapidly to about 100 meters constrict water flowing in and out of the pass and create strong tidal currents and turbulent mixing (Vermeire 2010). This turbulent mixing is known to be a key factor in providing nutrients for high productivity throughout the food chain (Petersen et al 1998). Although it was proven that the number of steller sea lions hauled out has a negative correlation with current speed, figs. 11 and 12 show that when there was a sudden change in current speed the steller sea lions did not react quickly. This was in the afternoon and the Steller sea lions might have fed earlier and at that time not felt the need to feed, or they might not have been feeding due to low light and poor visibility. This study was a good starting point for understanding steller sea lions' haulout patterns in the fall at Cattle Pass, further research is needed to fully understand other potential factors that may affect haulout patterns. In the future, perhaps more extended periods of time need to be spent counting the steller sea lions on Whale Rocks, and other factors like the amount of sunlight and temperature need to be examined. Also, counting the steller sea lions from the shore proved to be difficult because Whale Rocks could not be seen from all sides which may have caused some bias during the counts, in the future a small boat could be utilized to get closer to Whale Rocks and have more accurate counts.

In conclusion, harbor seals had no net change in abundance, their numbers seem stable, and they are most abundant in zones three and four. The decline in harbor seal numbers after cruise three could be attributed to the fall transition. Steller sea lion numbers have been declining over the past three years, and it is something that should be watched closely and needs further research. Steller sea lions are most abundant in zone five, near their haulout site, and their haulout pattern is dependent on current speed.

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Tables and Figures:

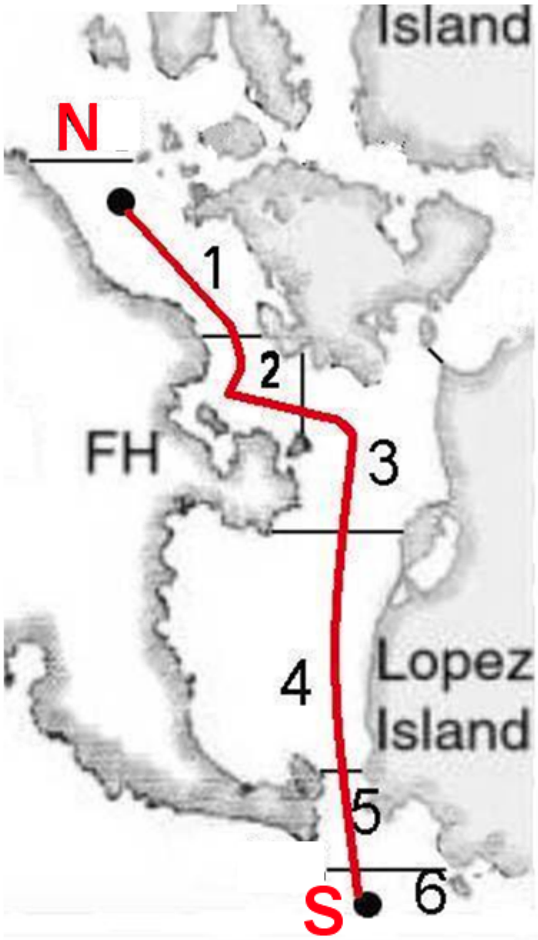

Figure 1. Study Site. This is the area of the San Juan Channel that was surveyed aboard the Centennial (Nordstrom 2012).

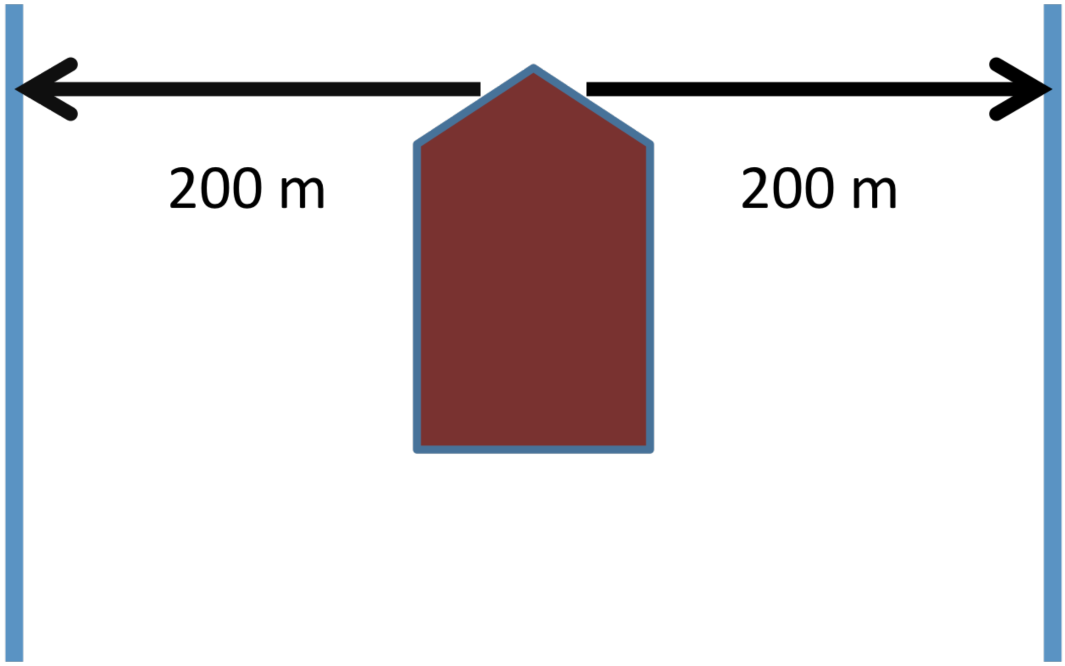

Figure 2. Survey Method. This is a diagram of the strip transect method used to survey pinnipeds. The pentagon represents the boat, and the arrows represent the survey area, we counted all pinnipeds within 200 m of the boat on each side (Nordstrom 2012).

Dates	9/30-11/10
Total Transects	14
Total # km^2	118.22
Total Harbor Seal Count	234
Total Steller Sea Lion Count	46
Mean Harbor Seal Density	2.0 /km2
Mean Steller Sea Lion Density	0.4 /km2

Figure 3. Table of results

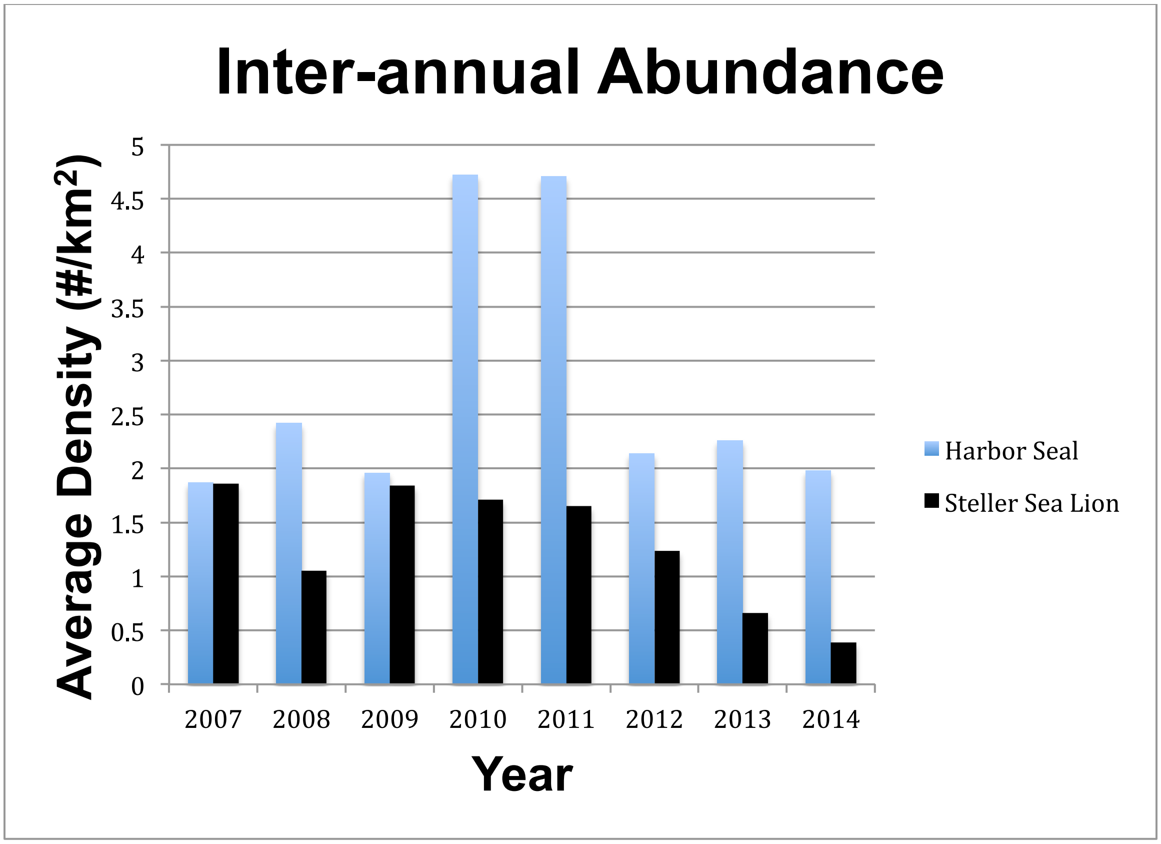

Figure 4. This graph shows the inter-annual abundance from 2007-2014.

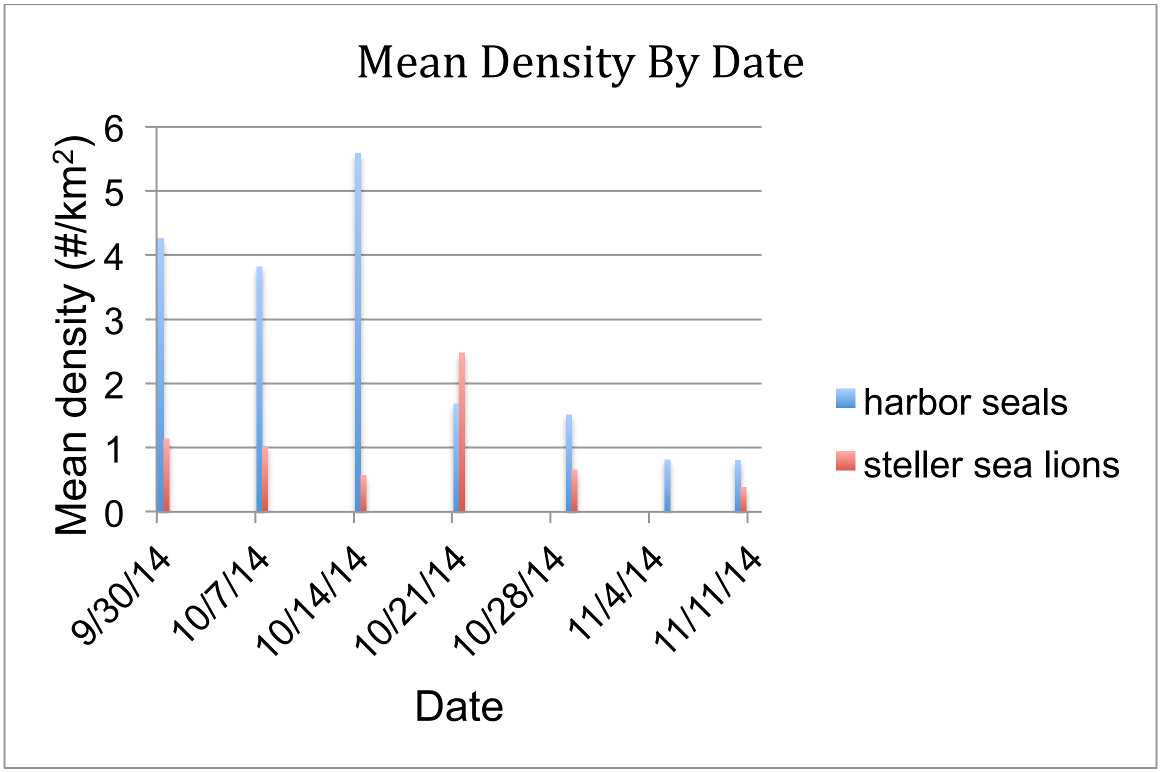

Figure 5. This graph shows mean density of harbor seals and steller sea lions by cruise date.

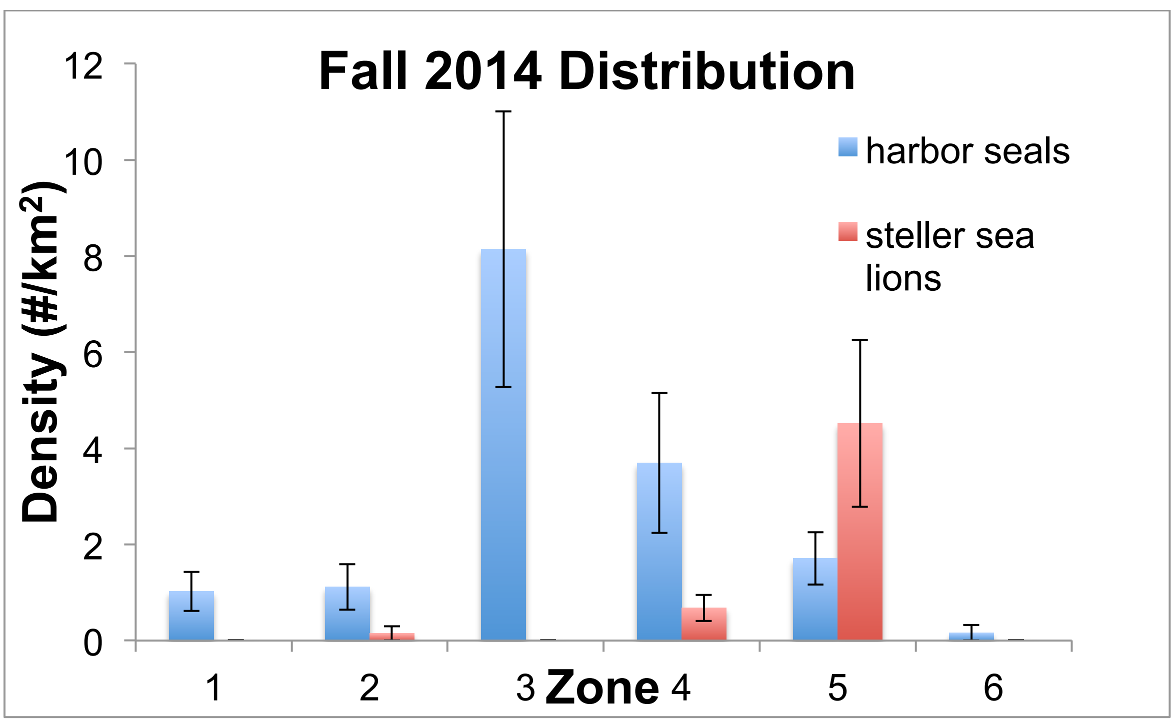

Figure 6. This graph shows fall 2014 distribution by zone

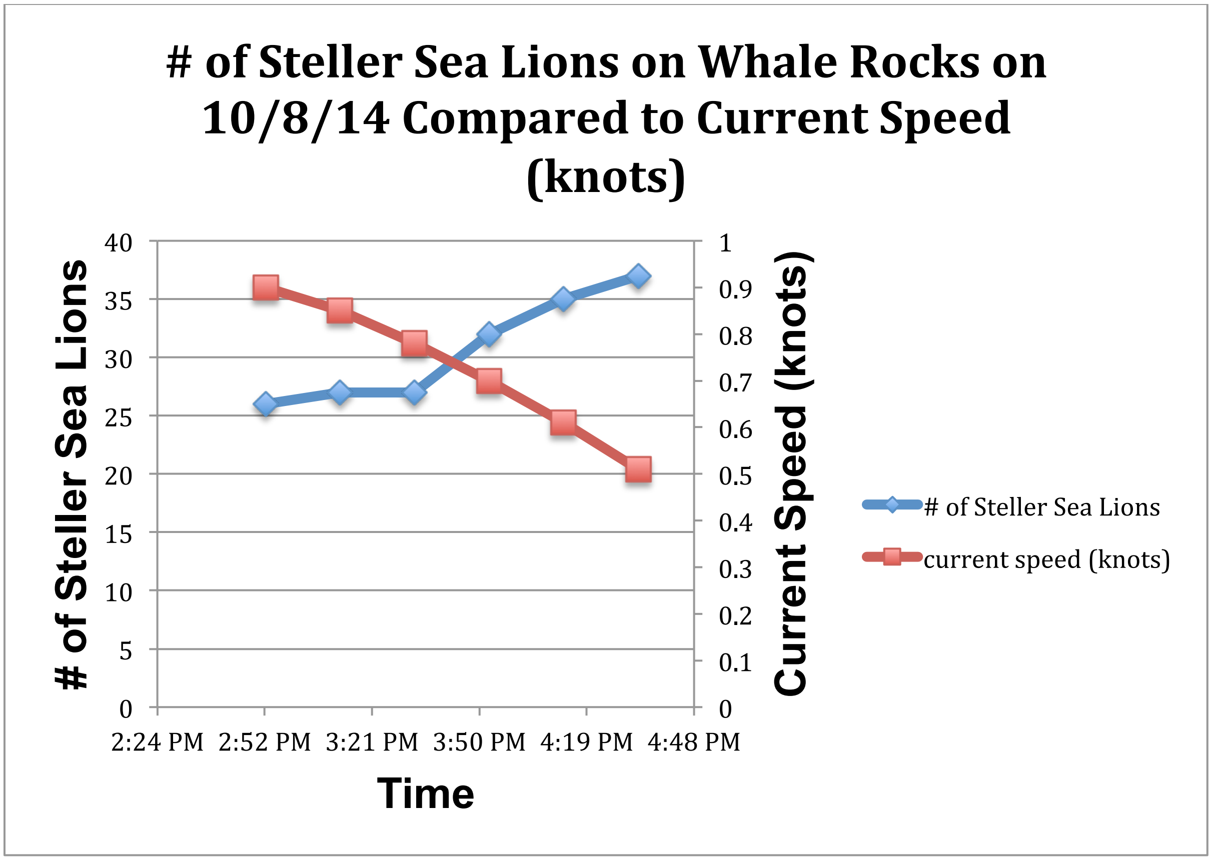

Figure 7. This graph shows current speed vs. the number of steller sea lions hauled out on Whale Rocks. As current speed decreases the number of steller sea lions hauled out increases.

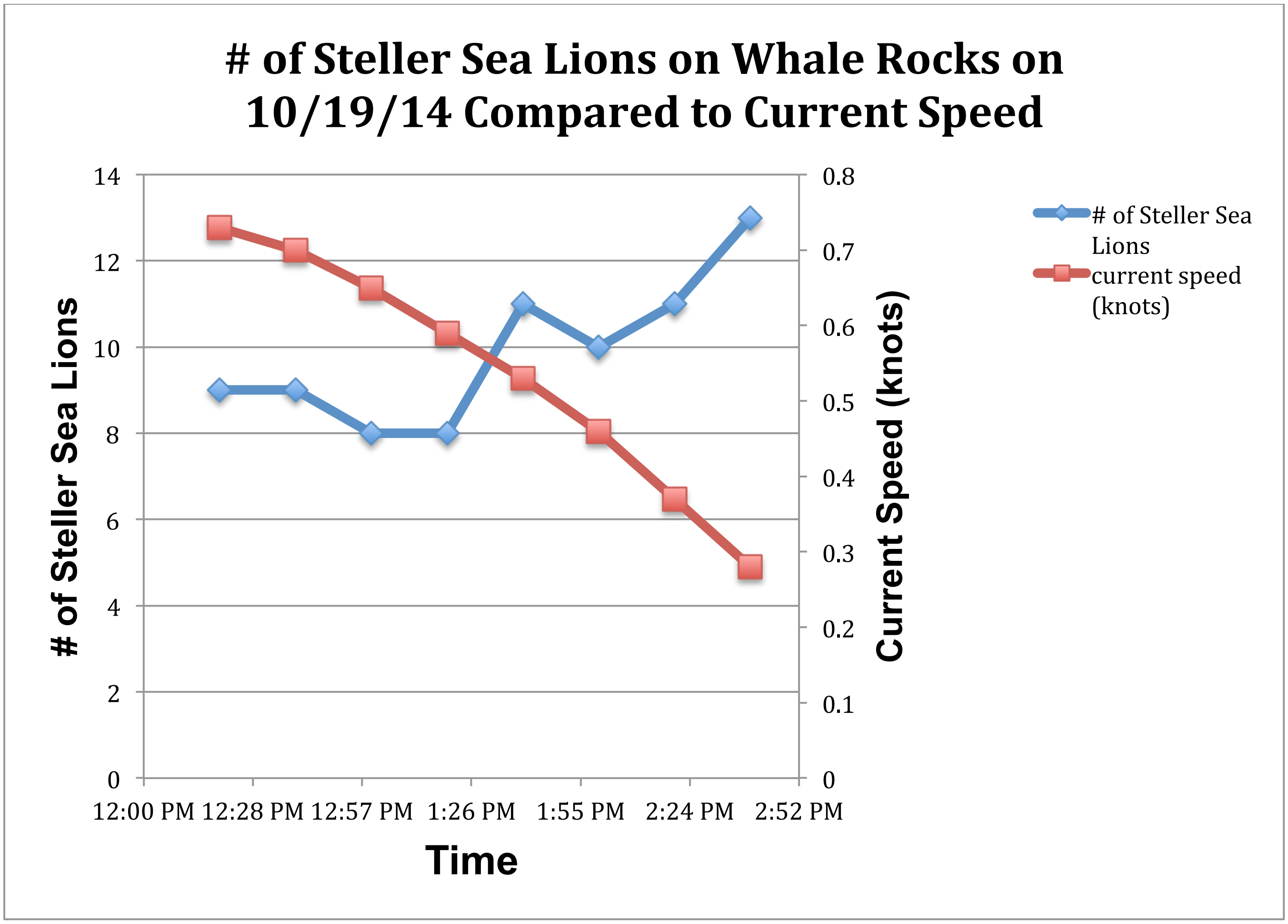

Figure 8. This graph is also showing as current speed decreases, the number of steller sea lions hauled out increases.

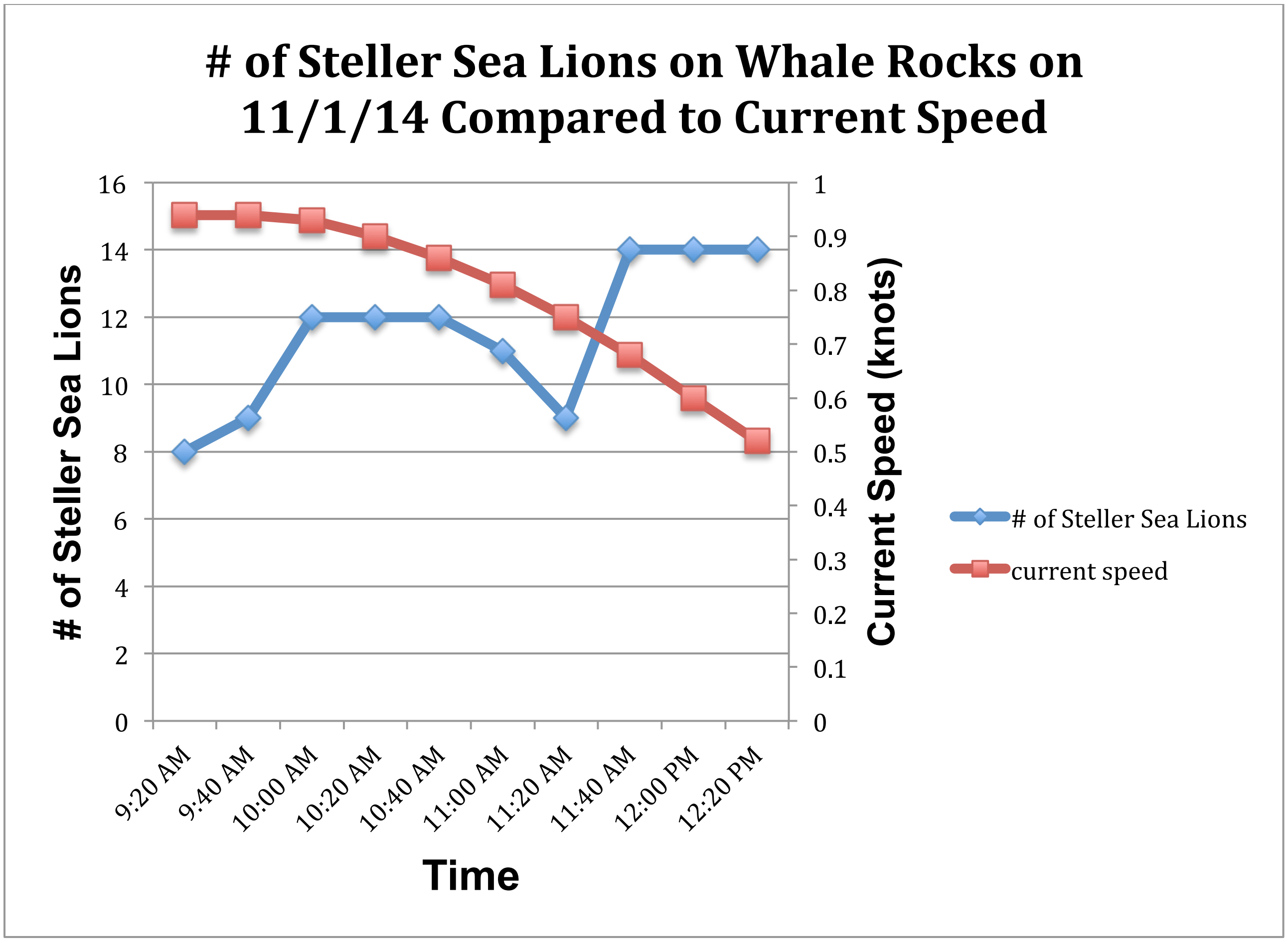

Figure 9. This graph again shows current speed decreasing while steller sea lions hauled out increases, but this was in the morning, showing the pattern is not dependent on time of day.

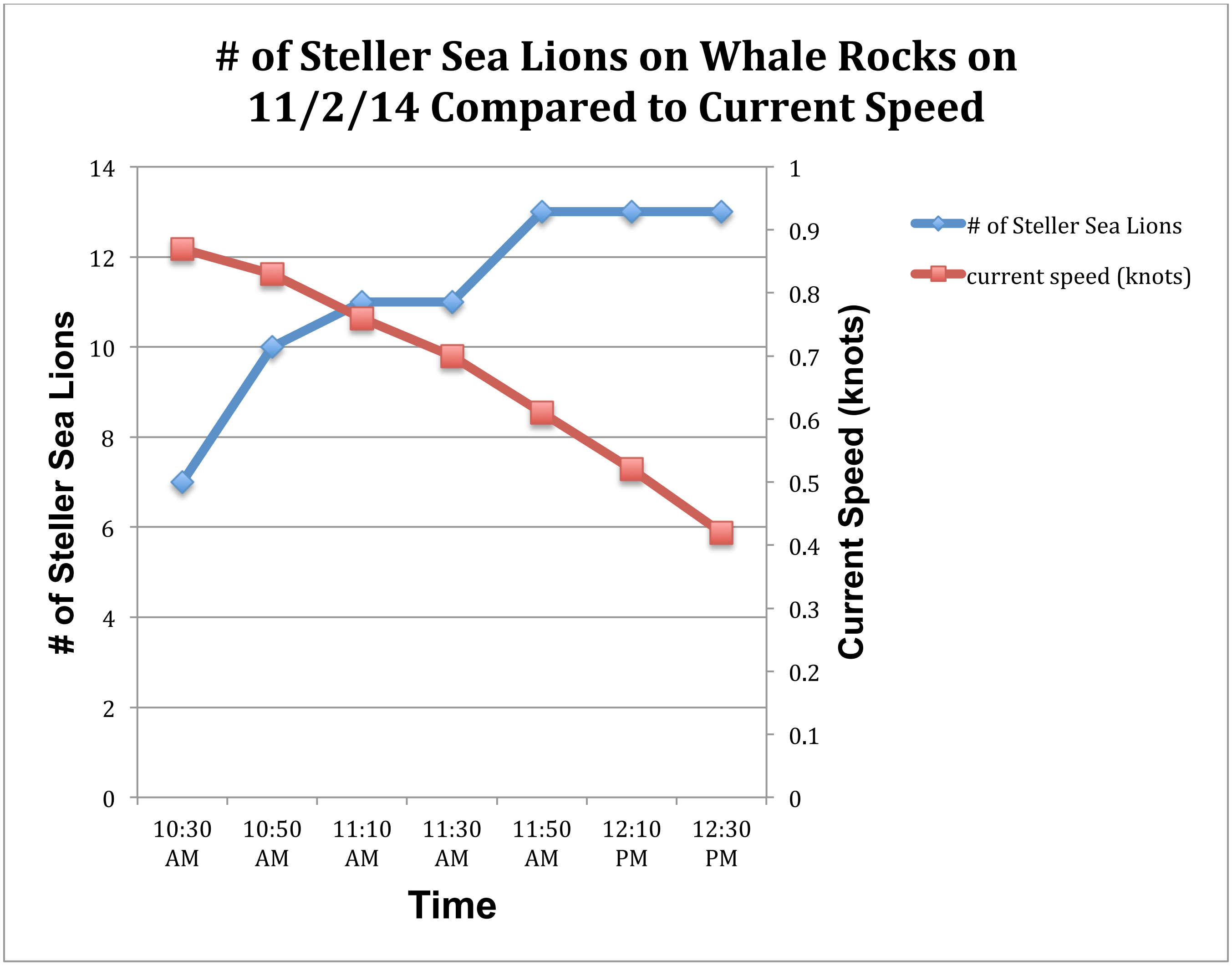

Figure 10. This graph again shows current speed decreasing while steller sea lions hauled out increases, but this was in the morning, showing the pattern is not dependent on time of day.

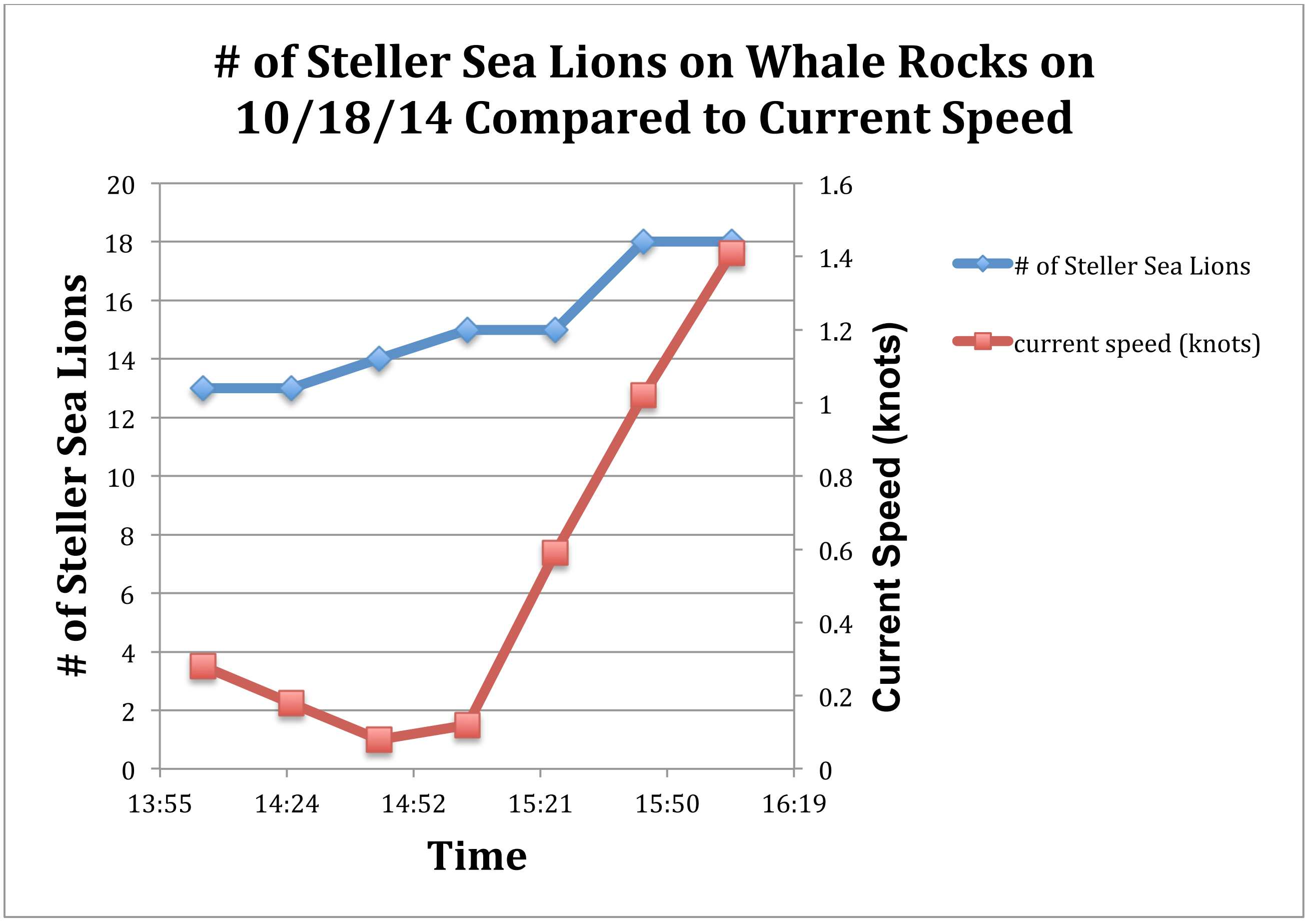

Figure 11. This graph shows the number of steller sea lions hauled out compared to current speed, this pattern starts out like the other graphs with current speed decreasing and the number of steller sea lions hauled out increasing, but when there is a sudden change in current speed the steller sea lions do not react quickly.

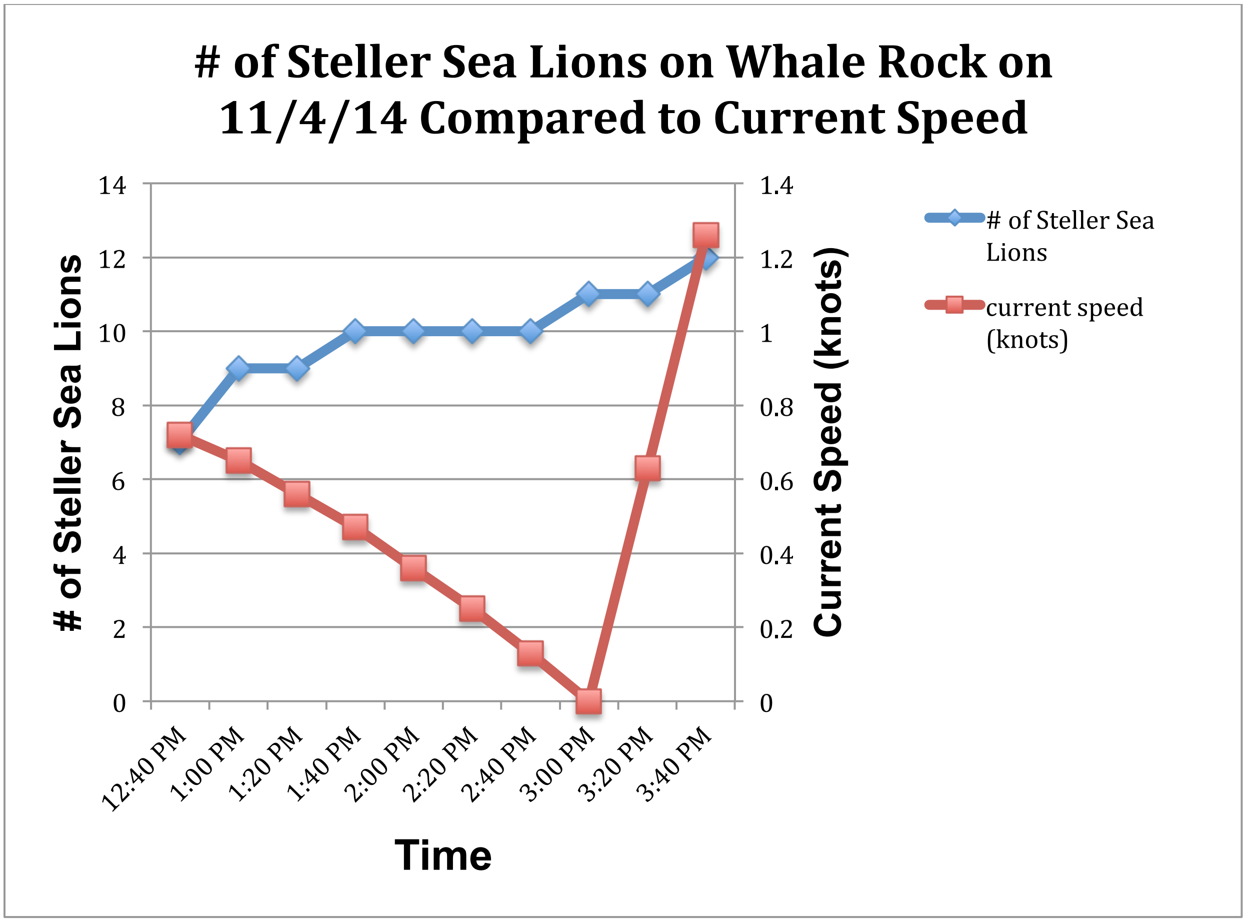

Figure 12. This graph shows the number of steller sea lions hauled out compared to current speed, this pattern starts out like the other graphs with current speed decreasing and the number of steller sea lions hauled out increasing, but when there is a sudden change in current speed the steller sea lions do not react quickly.