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Mating Behaviors Exhibited by a Captive Male Pacific Walrus (*Odobenus rosmarus divergens*)

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by

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Abstract

Understanding mating behaviors of a species can be utilized to help protect the species. Results of population surveys have shown the walrus population to be on the decline, and over the history of walruses being held in captivity, few pups have been born or survived. Not much is known about Pacific walruses (*Odobenus rosmarus divergens*) due to the isolated Arctic habitats in which walruses live making wild population studies difficult. Few studies have examined wild observations of walrus mating behaviors and virtually none for captivity. The purpose of this study was to observe a captive male Pacific walrus for mating behaviors, examine frequency of behaviors, and describe observations. The subjects, one male and two females, were video recorded in the pool area of the walrus exhibit at Six Flags Discovery Kingdom from November 2013 through January 2014. Only behaviors exhibited directly by the male were noted. Behaviors directly associated with mating were considered grabs, rolls, and holds, which could also be coupled with tusk strikes or nuzzles. Grabs were the most frequently observed behavior, and holds were not significantly observed which could elude to an issue with successful walrus mating in captivity. The male walrus used other sexual outlets such as self-gratification and toy use; however, these behaviors were not as significant as sexual encounters with females. There appeared to be mate preference for the female with tusk as interactions with this female occurred significantly more. Pharyngeal sac inflation (PSI) was described as a vocal and visual behavior that has frequently been noted in previous research. PSI and other mating behaviors are likely learned from other males, which could explain possible behavioral differences exhibited by the male of this study.

Keywords: Pacific walrus, mating behavior, *Odobenus rosmarus divergens*, captivity

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Chapter I – Introduction

Animal behaviors have been studied for many years in a wide variety of species and for various types of behaviors. Studying mating behaviors in particular enables researchers to better understand the species as a whole and can be used to develop strategies to help conserve the species (Fay, Ray, & Kibal'chich, n.d.). Some species are difficult to study in the wild, so researchers may rely upon captive populations to have an idea of what mating behaviors are like in the wild (Berger-Wolf, Moore, & Saia, 2006).

The walrus (*Odobenus rosmarus*) is relatively rare in captivity and has been infrequently studied in the wild (Muraco, Coombs, Procter, Turek, & Muraco, 2012). Walruses are thought to be polygynous, aquatic mating pinnipeds that thrive in Arctic seas (Riedman, 1990; Sjare & Stirling, 1996; Kastelein, 2009). Within the past thirty-five years, wild Pacific walrus (*Odobenus rosmarus divergens*) populations have been declining (Speckman et al., 2011) possibly due to environmental factors (Hannah, 2012) and may become extinct in both natural and captive settings given the lack of breeding success in captivity and lack of information on walrus mating behavior (Muraco et al., 2012). The present study examines mating behavior of a captive male walrus to help fill the gap in knowledge about walrus mating behavior. The results may help identify issues with mating in captivity for this species and should provide a basis for future studies.

The primary focus of this research project is observing and defining mating behaviors exhibited by a male Pacific walrus in captivity. The one male and two female Pacific walruses observed in the study have been housed in captivity at Six Flags Discovery Kingdom (located in Vallejo, California) since stranded as pups in 1994 (Figure 3). Video footage was collected outside of the walrus enclosure focusing on the

pool area by Six Flags Discovery Kingdom staff from mid-November 2013 through January 2014. Only the behaviors displayed by the male Pacific walrus are noted except for when the male is interacting with the female(s). An ethogram was used to catalog behaviors from video coding and then the data analyzed. The methods for this project may be broken down into four portions: (1) closely observing the walrus video footage previously collected by SFDK and shared in collaboration with the Marine Mammal Behavior and Cognition Lab, (2) noting and/or numerating and describing behaviors that might be associated with mating behavior, (3) calculating frequencies of behaviors over the duration of the study, noting any trends or patterns in behavioral occurrences, and (4) defining, elaborating on, and comparing relevant behaviors with any previous research.

Chapter II – Literature Review

Five possible motives for studying animal behavior include forming universal principles of behavior, uncovering how animals interact with their surroundings, protecting the environment, defending and sustaining threatened species, and curiosity (Lehner, 1996). The animal subjects may consist of a wide variety of species and can focus on a particular type of behavior. Some example behavioral studies include play behavior in cetaceans (Paulos, Trone, & Kuczaj, 2010), feeding behavior in sheep (Meier et al., 2013), social behavior in African lions (Matoba, Kutsukake, & Hasegawa, 2013), and hostile behavior in rats (van den Berg et al., 1983).

Mating behaviors in particular have been studied in multiple species ranging from flies (*Drosophilia paulistorum*) (Ehrman, 1960) to rhesus monkeys (*Macaca mulatta*) (Kaufmann, 1965). It is often difficult to study animal behavior in the wild, so observing captive species in some cases may give researchers and idea of behaviors for the species as a whole (Berger-Wolf et al., 2006). Successful breeding, or the production of viable offspring, is essential for a population to continue; for without new members being added, the population will decline and eventually die out (Berger-Wolf et al., 2006). This is of particular concern for captive populations which generally are smaller with less genetic diversity and at a greater risk of discontinuing (Earnhardt, Thompson, & Marhevsky, 2001). Examining factors that contribute to breeding, such as genetics and behavioral aspects, may assist with sustaining populations (Lacy, 2013). Miyaki et al. (1998) discusses one breeding program put into effect for some tropical bird species that were endangered or approaching endangerment; the researchers determined one issue with redeeming the bird populations was recognizing the sex of individuals needed in

order to understand the sex ratio in populations. For the experiment, the researchers used captive bird populations to run DNA test for sex recognition (Miyaki et al., 1998).

The tropical bird species from the Miyaki et al. (1998) study were under threat due to habitat loss. Changes in the environment have impacted populations of animal species throughout the world (Hannah, 2012). For example, over 150 primate species are at risk of extinction from changes to tropical ecosystems (Strier, 1997); several amphibians have suffered severe decline or complete extinction due to increase in global temperatures (Hannah, 2012); the loss of sea ice has had a negative impact on polar bears which often rely upon ice for resting and traveling (Hannah, 2012). Animals unable to adjust to deviations from their normal habitat may be at risk of declining and possibly extinction (Plesnar-Bielak, Skryznecka, Prokop, & Radwan, 2012). Similar to polar bears, walruses (*Odobenus rosmarus*) appear to also be affected by the recession of sea ice, and of the three subspecies, the Pacific walrus (*Odobenus rosmarus divergens*) appears to be suffering in population decline the most (Hannah, 2012). A survey taken in 2006 estimated the Pacific walrus population to be around 130,000 walruses (Speckman et al., 2011). This number continues the declining trend seen in the Pacific walrus population since the mid to late 1970s where the population was believed to reach carrying capacity before starting the decline (Figure 1; Speckman et al., 2011).

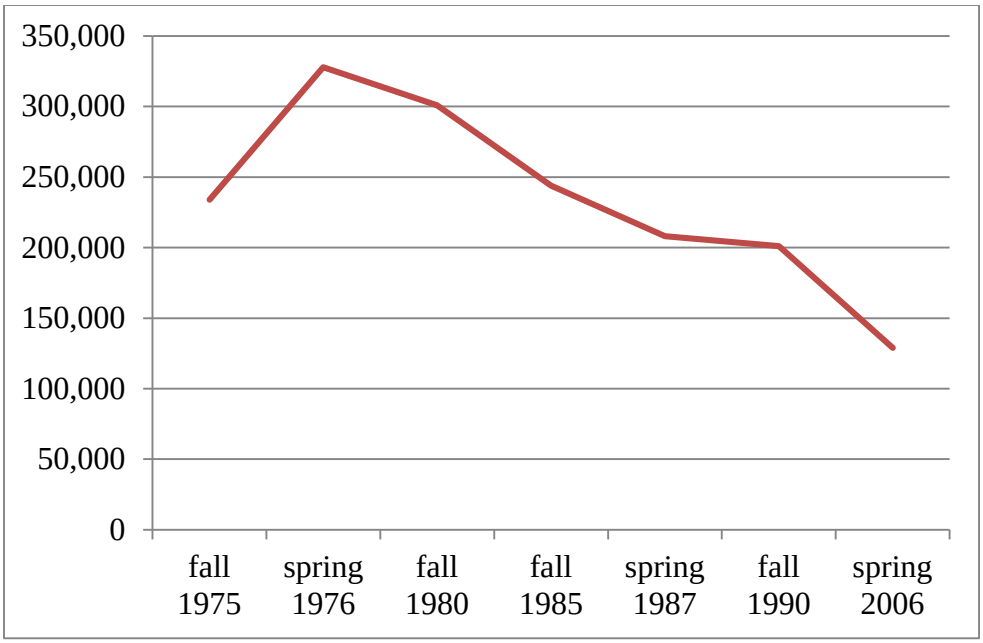

Figure 1 – Compilation of survey results of estimated Pacific walrus population sizes from various years taken either in the fall or spring (information gathered from Speckman et al., 2011).

Walruses are classified as pinnipeds, which is a group of marine mammals that also consist of sea lions and seals (Reidman, 1990). Pinniped species may have unique mating behavior characteristics with shared similarities and variances across species. One study reveals that male Antarctic fur seals (*Arctocephalus gazella*) appear to show mating preference for mothering Antarctic fur seals as opposed to females without calves (Hoffman, Boyd, & Amos, 2003). A single male southern elephant seal (*Mirounga leonina*) may defend hundreds of females to lower the chances of other males mating with the females (de Bruyn et al., 2011). Southern elephant seals like most pinnipeds, including walruses, are polygynous, meaning the individuals of the species do not typically mate with just one but multiple individuals over a typical lifespan (Riedman, 1990). Observations of polygyny in pinnipeds are also seen in the formation of leks by

some species, such as some observations of Pacific walruses (Fay et al., n.d.). Sjare and Stirling (1996) suggest four qualifications for a lek: females have a choice of mate selection, mating areas provide no value to females besides the males, mating only takes place in a small segment of a female's possible range, and males only provide gametes to contribute to offspring. Some early investigations speculated walruses could be monogamous due to sightings of family groups (Fay, 1982; Fay, Ray, & Kibal'chich, n.d.). About half of all pinnipeds copulate in the water as opposed to on land or ice floes (Sjare & Stirling, 1996), and little is known about the mating behaviors for these species, which includes the walrus.

There are three subspecies of walruses primarily distinguished by geographic location, and the two most abundant and more commonly studied subspecies are the Atlantic walrus (*Odobenus rosmarus rosmarus*) and the Pacific walrus (*Odobenus rosmarus divergens*) (Hannah, 2012). Walruses are among the larger species of pinnipeds and are distinguishable by enlarged canines, or tusks (Muraco et al., 2011; Riedman, 1990). Tusks are present in both male and female walruses; however, males typically have shorter, bulkier tusks whereas females have slenderer tusks (Riedman, 1990). Pacific male walruses can be twice the body size of female Pacific walruses; males typically weigh around 1,200 kg and females weigh around 830 kg (Fay, 1982; Riedman, 1990). The Pacific walrus habitat range lies primarily within the Bering and Chuckchi Sea and sometimes in the Eastern Siberian and Beaufort Sea during summer months (Figure 2; Kastelein, 2009).

Walruses are typically sexually mature around ten years old for females and 15 years old for males in wild populations; in captivity, walruses have been noted to

possibly reach sexual maturity sooner with females being capable to reproduce around five or six years old and males around eight to ten years old (Fay, 1982). Mating season for the Pacific walrus is directly associated with the maximum testes size reached by the male Pacific walrus (Fay, 1982). Mating typically occurs within the first few months of the year (January through March) in wild populations yet can occur year round for captive populations with a greater occurrence of copulation occurring in the earlier months of the year (Fay, 1982).

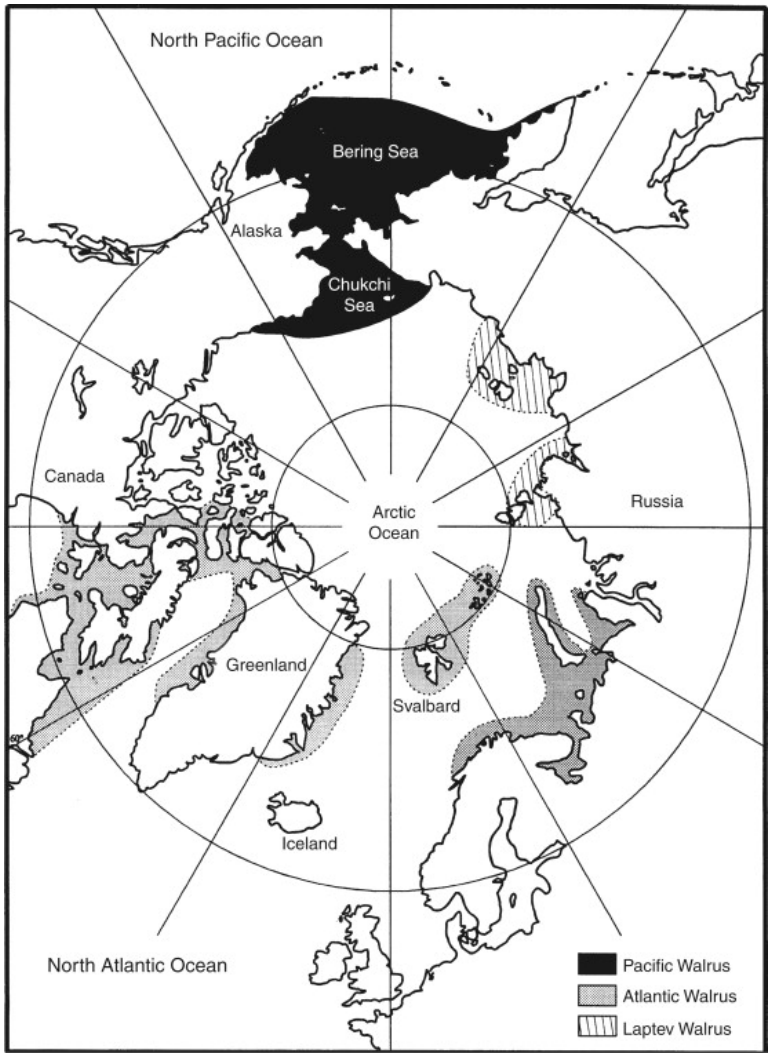

Figure 2 – Distribution map of Pacific, Atlantic, and Laptev walrus subspecies. Photo credit: (Kastelein, 2009).

To initiate mating, male walruses surround female walruses resting upon ice floes and perform mating displays (Fay, 1982; Fay et al., n.d.). The male walruses produce varying vocalizations above and below the water which is thought to be an attempt to lure the females into the water (Fay, 1982; Fay, et al., n.d.; Riedman, 1990). Fay (1982) described these vocalizations as successions of differing thumps, whistles, and vocals resembling bells. Once a female elects a male to mate with, the female walrus moves into the water where mating occurs under the water (Fay, 1982; Riedman, 1990). Sjare and Stirling (1996) suggest that copulation may be occurring for Atlantic walruses if the male appears to have a bent back partially visible above the water and the male's foreflippers are holding the sides of the female. Signs of the male trying to flip the female while still grasping the female may also allude to an attempt at copulation as seen in Atlantic walrus subspecies (Sjare & Stirling, 1996). Aside from preference over mating calls, female walruses may also select to mate with male walruses that have larger tusks, which can be a sign of supremacy in walrus rank (Riedman, 1990). Often male walruses may be seen with scratches and wounds from skirmishes with other male walruses using tusks to ward off competition for females (Collins, 1940).

Differences exist between mating behaviors of Atlantic and Pacific walrus subspecies; for example, female Atlantic walruses appear to have less of a choice when selecting a male to mate with than the female Pacific walruses, and scuffles among competing males seems to occur more often in the Pacific walrus population (Sjare & Stirling, 1996). The majority of mating behaviors recorded in Pacific walrus have been associated with acoustics more so than describing and defining visual behaviors. More detailed observations of walrus mating behaviors in the wild have been difficult to record

due to the remoteness of the walrus habitat (Fay, 1982; Muraco et al., 2012). This project aims to record and define possible visual mating behaviors exhibited by walruses through analyzing the mating behaviors of a captive male Pacific walrus.

Captive walruses have been housed in captivity within North America for almost 85 years (Muraco et al., 2012). During that time, there have been less than 15 births, the majority of which have not survived (Muraco et al., 2012). Only one account of captive walrus breeding has been published, which attempted to match up a captive female Pacific walrus ovulation time with a hormone induced captive male Pacific walrus (Muraco et al., 2012). The study resulted in the female walrus becoming pregnant from successful breeding with the male (Muraco et al., 2012); however, the walrus pup was dead at birth, adding to the unsuccessful breeding list of walruses in captivity.

Chapter III – Methods

Study Subjects

The three captive Pacific walruses (*Odobenus rosmarus divergens*) observed for this study are the same walruses from the Muraco et al. (2012) study and consists of one male and two females (Figure 3). The walruses were rescued after being stranded as pups in 1994 and housed at Six Flags Discovery Kingdom located in Vallejo, California, a city just outside of San Francisco. The walruses are unrelated and all approximately 19 year of age during the time of video recordings for this study. The three walruses may be considered fairly distinguishable from one another: the male, Sivuqaq (or "Jocko"), has shorter tusks than the one female with tusks, is noticeably larger than both females, and may be identified by a mark that looks like a light circle anterior to the right hindflipper. The two females, Uquq and Siku, are discernable by one female (Uquq) having tusks and a slightly larger body size and the other female (Siku) being smaller in size and lacking tusks, which were removed due to an infection while young. In 2011, Uquq gave birth to a stillborn pup, which was the only pregnancy from either of the two female walruses.

Figure 3 – From left to right, male (Sivuqaq) and two female (Siku and Uquq) captive Pacific walruses housed at Six Flags Discovery Kingdom in Vallejo, California. Photo credit: https://pbs.twimg.com/media/Bm-t7CFCQAEfEAF.jpg:large.

Video Collection

The video footage for this project was collected by staff members of Six Flags Discovery Kingdom prior to the study. The videos were collected on a regular, daily basis from November 15, 2013 through January 31, 2014. Typically, one hour of video footage was recorded per day, usually broken down into three videos lasting about 20 minutes apiece. Majority of the videos incorporated a hydrophone, a device that records sound underwater. The video camera was stationed outside the public walrus viewing tank area at Six Flags Discovery Kingdom and angled towards the water portion of the tank only, which holds approximately 644,731 L of water (Muraco et al., 2012). The view from the tank window allows one to see what is occurring at the glass underwater and at the

surface. Video recording often overlapped with park operational hours, so park guests may also be seen around the viewing area at times (Figure 4).

Figure 4 – A typical view of the walrus tank window at Six Flags Discovery Kingdom when park guests are present. Photo credit: http://media-cdn.tripadvisor.com/media/photo-s/04/68/9a/1d/we-could-watch-this-walrus.jpg.

Procedure

This study focuses on mating behaviors exhibited by the male Pacific walrus, so all possible mating behaviors exhibited by the females are disregarded except for those that are in partnership with the male, such as behaviors the male walrus exhibits with or towards a female walrus (i.e. copulation or the male striking a female with his tusks). Possible mating behaviors of the male walrus was described by researchers in the Marine Mammal Behavior and Cognition Lab located in Hattiesburg, Mississippi. Throughout the video coding process, the researchers attempt to transition from descriptive identification of observed behaviors to properly defining behaviors. Peer-reviewed sources such as Sjare and Stirling (1996) that discusses some wild Atlantic walrus behaviors may be put into use for attempting to define behaviors of the observed captive

male Pacific walrus for this study; however, there are no sources that define Pacific walrus mating behavior.

Observations of possible mating behaviors were recorded in an ethogram generated with Microsoft Excel and either be marked “Y (yes)” for occurrence if a behavioral state or quantified if considered a behavioral event. Once all videos were coded and recoded to ensure validity, the data was examined for trends and computed for frequency of occurrence through Statistical Package for the Social Sciences (SPSS) and/or Microsoft Excel. Frequencies of behaviors in relation to copulation or attempts at copulation could reveal possible mating behaviors of the captive male Pacific walrus. Permission for the study was be submitted to and approved by the Institutional Animal Care and Use Committee including appendix K: animal owner/client consent form (see appendix A).

Chapter IV – Description of Behavior Observations

Sexual encounters consisted of the male walrus initiating a grab, roll, and/or hold with a female. Sexual encounters were numerated by observation of at least one of the three behaviors, but one encounter could include two or all three of the behaviors (i.e., a grab could be directly followed by a roll then a hold or the male walrus could be attempting to grab a female or drift into the camera viewing area already in a hold). Occurrences were further categorized by interaction with either Uquq, the female distinguishable by presence of tusks (F), or Siku, the female lacking tusks (FNT, “female no tusks”).

A grab occurred when the male walrus was actively attempting to place both foreflippers on the sides of a female. This could be initiated from (1) above, posterior to the female, (2) below with female in neutral dorsal position and male ventral side up, or (3) from either side of the female. Unsuccessful grab attempts were viewed as male attempting to establish contact with female but unable to do so (i.e., male swims toward female, brings both foreflippers inward toward female at an attempt to grab, and female avoids by swimming away). A successful grab could be followed by a roll or hold depending upon the location of initiating the grab. A roll occurred when the male grabs a female walrus from underneath and slides along the side of the female until the male is positioned upright posterior to the dorsal female (Figure 5). A hold was observed as the male maintaining position posterior to female with both foreflippers secured around the sides of the female (Figure 6). This state was noted as where copulation could commence.

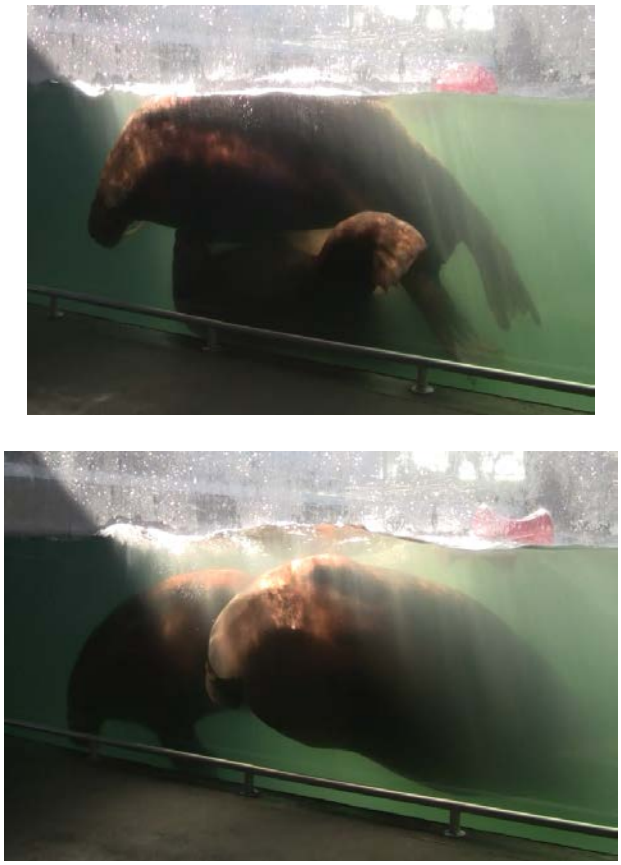

Figure 5 - Male Pacific walrus initiating a roll behavior starting from underneath and sliding around the side of the female Pacific walrus (from video 13-11-28 Walrus (1)).

Figure 6 – Male Pacific walrus maintaining a hold behavior with both foreflippers around sides of female Pacific walrus (from video 13-12-31 Walrus (3)).

Sexual encounters could be followed by tusk strikes or nuzzles. The male walrus exhibited tusk strikes by swiftly jabbing the tusks downward upon or towards a female. This was considered sexual if occurring during a sexual encounter; however, other tusk strikes could be observed with no apparent relation to a sexual encounter. A nuzzle occurred when the male snout was pressed against the back of the female, moving around during a hold.

The male would sometimes engage in behaviors sexually by other means; sexual outlet refers to the means utilized by the male to express sexual behavior, which could be a sexual encounter with a female, a toy, or with self. Sexual toy use was noted as the male placing an enrichment item floating in the pool over or directly in front of the genitals (Figure 7). The male was observed to self-gratify by placing both foreflippers around the genital area or holding erected penis (Figure 8); the behavior could be observed with the posterior of the male walrus notably shaking while floating at water level. Penis exposure, or when the male walrus noticeably had an erect penis, could be observed during sexual encounters, while engaging with other sexual outlets, paired with pharyngeal sac inflation or with no other notable behaviors (i.e., the male could be simply floating in the water not engaging in other activity) (Figure 9).

Figure 7 – Male Pacific walrus with blue ring enrichment item over genitals engaging in sexual toy use (from video 13-11-18 Walrus (2)).

Figure 8 – Male Pacific walrus exhibiting self-gratification by grabbing erect penis (from video 14-1-21 Walrus (1)).

Figure 9 – Male Pacific walrus floating in pool with exposed penis (from video 14-1-30 Walrus (1)).

Pharyngeal sac inflation (PSI) consisted of a visual and audible behavior. The neck area of the male could be viewed as expanding or swelling concurrent with a vocal resembling the scraping of a washboard followed by hitting a gong. The sound mostly occurred in sequence of twos before a break and repeated PSI if repeated; however, the sound could consist of multiple cycles before a break of no vocal or just one cycle.

Video footage was sometimes collected during periods of Six Flags Discovery Kingdom operation hours and thus open to the public. Presence of park guests could potentially alter frequency of some behaviors. “People present” refers to SFDK park guests and not workers of whom the walruses would potentially see on a routine basis. Presence of park visitors was noted by day and not specific instances with behavior.

Chapter V - Results

There were 203 videos collected for this project totaling 66 hours, 48 minutes, and 20 seconds. Sixty-eight sexual encounters were observed between the male and the two females, 60 encounters for the female with tusks (F) and eight for the female without tusks (FNT) (Figure 10). Most of the sexual encounters noted occurred in November (32) and the least occurred in January (11). No sexual encounters were recorded between the male and FNT during January. Using chi-square test with an effect size cutoff of +/- 2 as suggested by Sharpe (2015), the male was found to be significantly more likely to interact with F (Std Residual = 4.459) and less likely to interact with FNT (Std Residual = -4.459) (X^2 (1, N = 68) = 39.77, p<.000). Examining specific behaviors (X^2 (4, N = 171) = 26.98, p<.000), the male was more likely to grab (Std Residual = 4.07) and less likely to roll or nuzzle the female (Std Residuals = -2.26, -2.26, respectively) (Figure 11). Hold and tusk strikes were not found to be significant (Std Residuals = -0.03, 0.48, respectively).

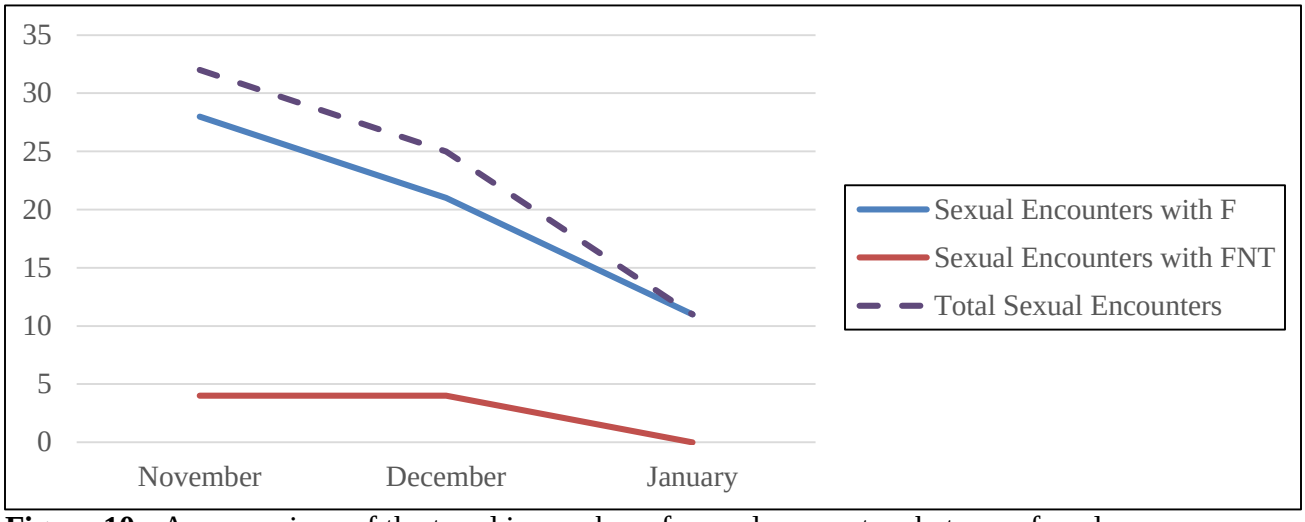

Figure 10 - A comparison of the trend in number of sexual encounters between female (F) to female no tusk (FNT) over the duration of the study and scale to contribution of the total sexual encounters observed.

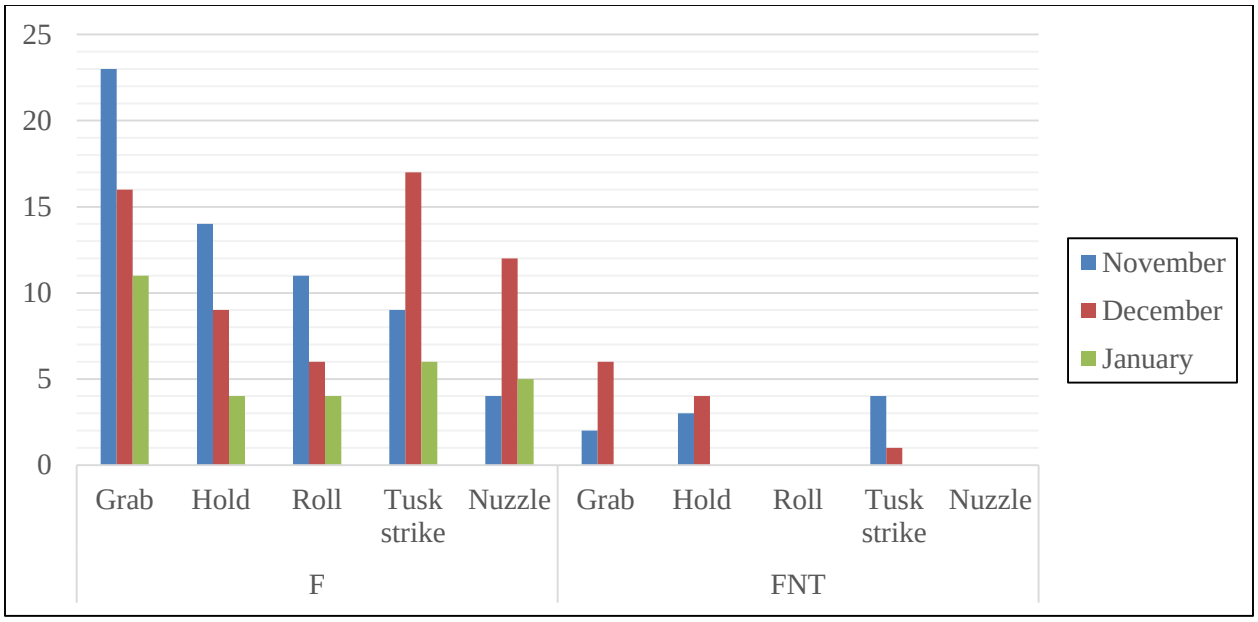

Figure 11 - Month and frequency comparison for the occurrence of each behavior associated with mating split between female (F) and female no tusk (FNT).

Male initiated sexual encounters were combined for both females and compared with male self-gratification and sexual toy use to test for preference of sexual outlet (Figure 12). Results from the chi-square (X^2 (2, N = 107) = 48.02, p<.000) found males more likely to engage with females (Std Residual = 5.41) than exhibit self-gratification (Std Residual = -4.13); toy use was not found to be significant (Std Residual = -1.28). Four enrichment items were observed during the study: a blue ring, a red hourglass, a flat red board with holes, and a green cylinder, which were used 18, five, two, and three times, respectively. No toys were recorded for December.

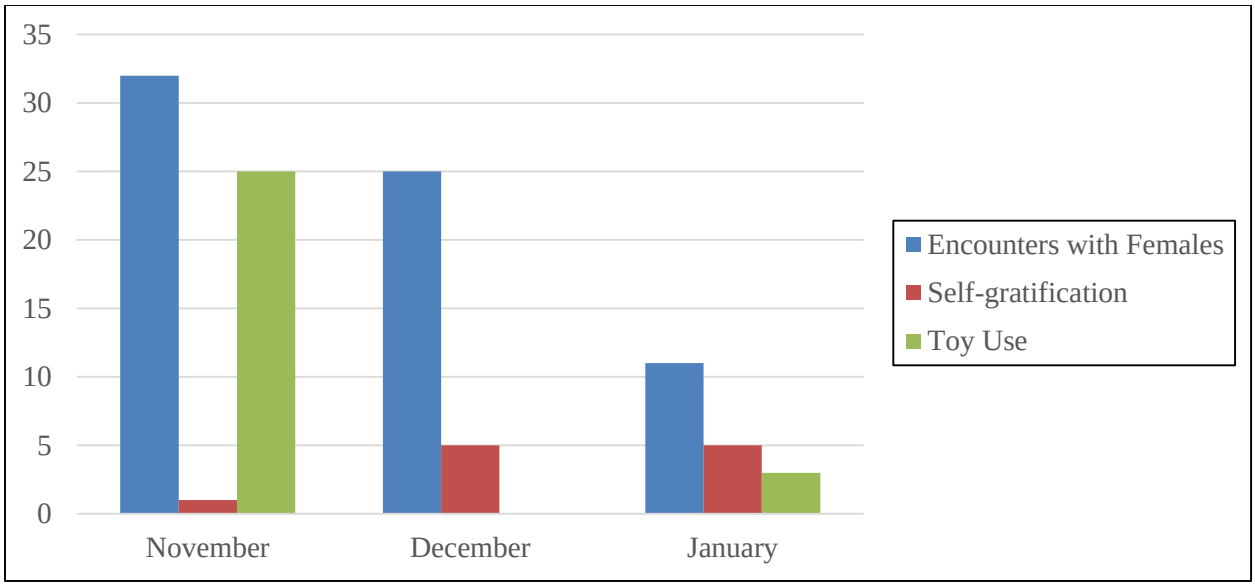

Figure 12 - Number of sexual events per sexual outlet utilized by the male walrus over the duration of the study.

There were 1,908 recorded instances of the male walrus performing a vocal and visual behavior referred to as a pharyngeal sac inflation (PSI) for this study. The behavior was observed during sexual and nonsexual instances. The male exhibited PSI in nonsexual settings (77.72%) more abundantly than sexual (22.27%). PSI appeared during sexual encounters with the female walruses, toy use, male self-gratification, and with exposed penis (Figure 13). Running a chi-square test (cutoff of +/-3) found that PSI was observed more frequently when the penis was exposed (Std Residual = 16.71) and during toy use (Std Residual = 8.84) than encounters with either female (Std Residual = -7.76 (F), -9.27 (FNT)) or self-gratification (Std Residual = -8.52) (X^2 (4, N = 430) = 576.40, p<.000). No instances were reported of the male performing a PSI during sexual encounters with FNT. PSI was also monitored in relation to presence of park guests (Figure 14). The male was significantly more likely to display PSI when park guests were present (Std Residual = 3.17) (X^2 (1, N = 1908) = 20.13, p<.000).

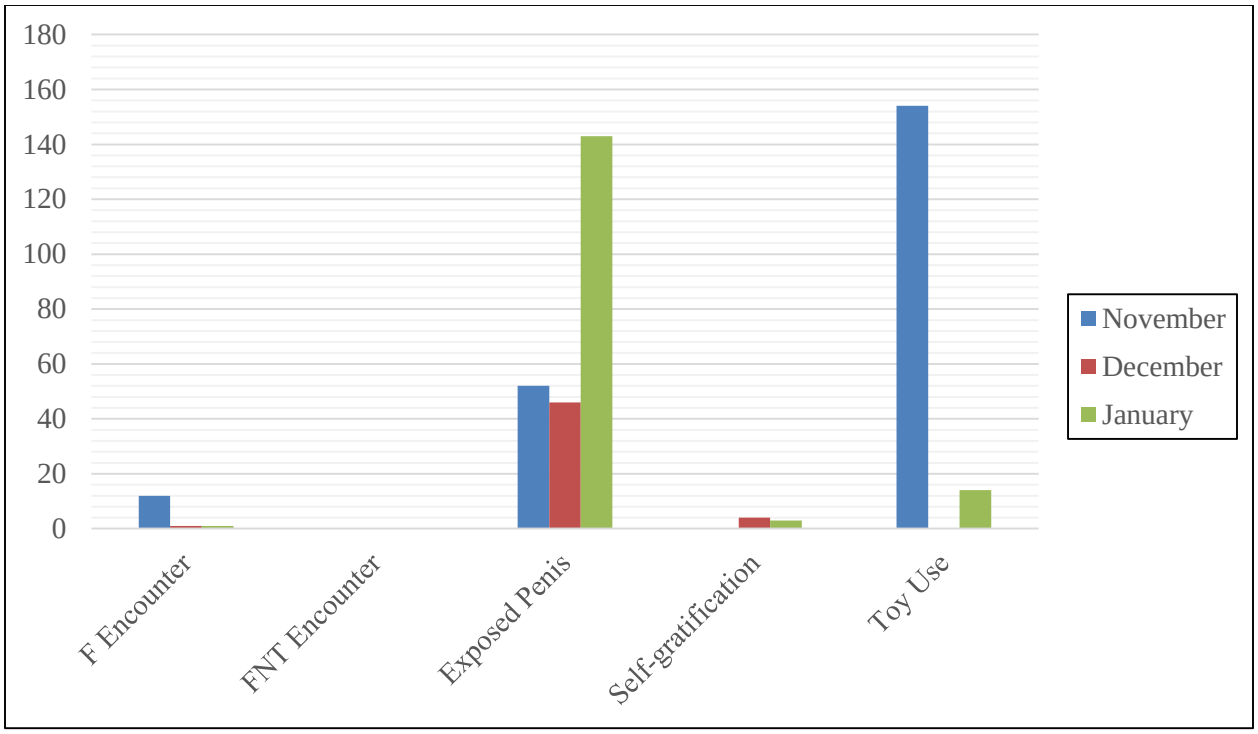

Figure 13 - Comparison of frequency for state of pharyngeal sac inflation (PSI) occurrence over the duration of the study.

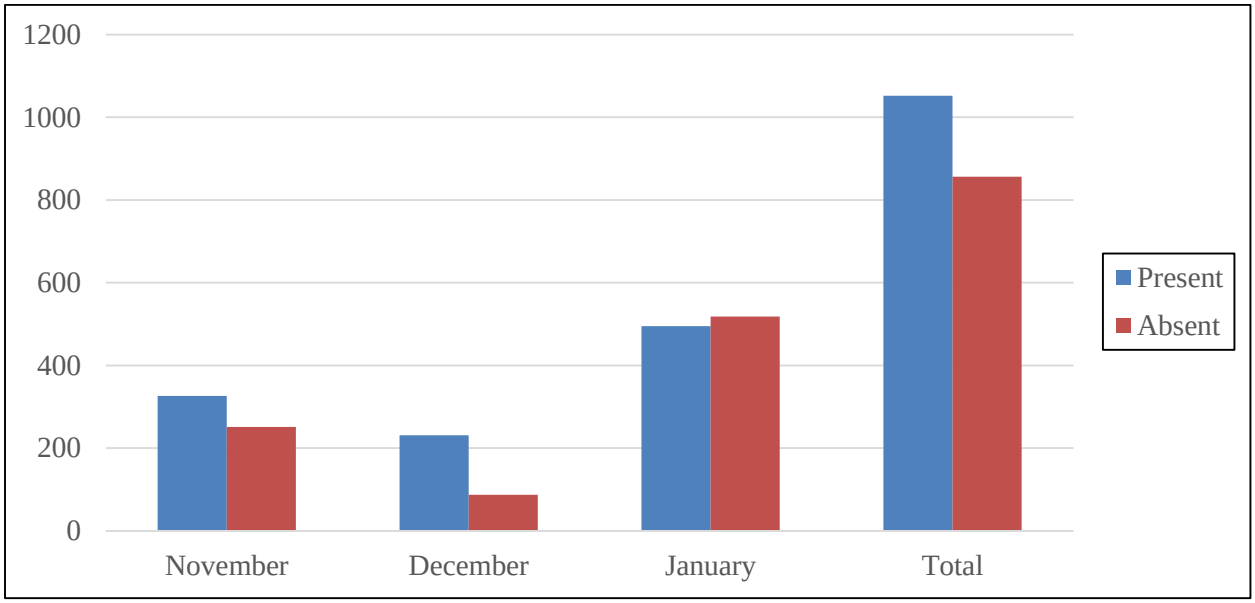

Figure 14 - Comparison of number of pharyngeal sac inflation (PSI) when park guests were present or absent observed for each month and the total observed PSI when park guests were present or absent.

Chapter VI – Discussion

Timing

Sexual encounters in general occurred less frequently over the duration of this study. Recording were made throughout all of December and January; however, video recording did not start in November until halfway through the month. Fay (1982) stated that captive walrus mating occurs year round with greater frequency in the earlier months of the year similar to wild populations. The sample population for this study exhibited mating behaviors more in late fall to early winter; however, more observations spanning throughout the year are needed to determine most sexually active months.

Mate Preference

Observational studies of wild walruses have shown walruses to be primarily polygynous creatures (Fay, 1982; Riedman, 1990; Sjare & Stirling, 1996). It is suggested female Pacific walruses have more of a choice when it comes to mating than female Atlantic walruses (Sjare & Stirling, 1996); however, male preference for females has not been recorded. The captive male Pacific walrus from this study engaged in mating behaviors significantly less with the female walrus without tusks (FNT). No sexual interactions were noted in January for FNT, and there were no recorded instances of the male to perform a pharyngeal sac inflation or associated vocalization during encounters with FNT. Moreover, FNT was in estrus during the time of the study. Despite this, the male walrus appeared to prefer engaging in mating attempts with the female with tusks (F). Although F had previously been successfully impregnated (Muraco et al., 2012), the calf was a stillborn. The main apparent difference between the females is absence of tusks for FNT. Riedman (1990) notes female walruses view tusks as characteristic to

identify quality males to mate with; presence of tusks in F could suggest tusks may be a contributing factor for the preference of mate for the male walrus of this study.

Mating Behaviors

Few studies have examined mating behaviors of Pacific walruses. Fay (1982) observed male walruses performing mating displays near female walruses on ice floes and females sliding into the water approaching the male. Fay (1982) and other researchers observing wild walrus populations mating have been limited to surface viewing; this project was able to examine behaviors beneath the surface. Behaviors of the male directly interacting with the females were described as grabs, rolls, holds, tusk strikes and nuzzles. Other noted behaviors included pharyngeal sac inflation, penis exposure, self-gratification and toy use.

Sjare and Stirling (1996) study on a population of wild Atlantic walruses described similar mating behaviors to the grab (referred to as flipper touch), roll, and hold of this study. Holding behavior was not found to be significant for this study, suggesting actual occurrences of copulation were few. Sjare and Stirling (1996) also speculated few occurrences of copulations despite frequency of other mating behaviors exhibited. Grabs were the most frequently means of sexual interactions with females. The attempts (grabs) at copulation were abundant but actual succession to copulation (completed during a hold) were not significantly frequent. Rolls were observed but significantly less likely to occur; this was similar to the report made by Sjare and Stirling (1996). Tusk strikes and nuzzles were not frequently observed. Tusk strikes exhibited in this study could potentially be signs of aggression rather than mating specific. Nuzzles could have been modified tusk strikes with the snout of the male already making contact with the female.

The Sjare and Stirling (1996) study also mentions vocalizations of the male during mating periods are songs consisting on knocking sounds. The vocalizations paired with pharyngeal sac inflation from this study are likely the same vocalizations noted by previous studies and was noted as a bell or knock sound (Fay, 1982; Fay et al, n.d.; Sjare & Stirling, 1996). Kibal'chich claims the sounds are concurrent with pharyngeal sac inflation, but Fay and Ray say there is no association between the two behaviors (Fay et al., n.d.). PSI was much more likely to occur during nonsexual related states; however, these instances could be the result of the male calling to the female and the female not responding. For sexual events, PSI occurred more frequently with toy use and when exposed penis was present suggesting PSI is a mating display rather than a behavior to occur once interacting with the females.

The male was more likely to perform an auditory PSI when park guests were present. Mating vocalizations are probably not solely for attracting females but also for alerting other competition (Kastelein, 2009). In absence of other competing male walruses, the increase in PSI vocalizations could be due to the male warning other possible threats for mating competition, i.e., the figures outside the glass. Charrier, Burlet, and Aubin (2011) reported captive Pacific walruses only emitted whistles rather than knocks; however, the male Pacific walrus of this study seldom produced whistles over the duration of video recordings. Like the male of this study, the two males from the Charrier et al. (2011) study were born and/or raised in captivity suggesting vocalizations during mating are learned from other male walruses.

Sexual Outlet Preference

The male was less likely to engage in self-gratification and toy use and more likely to engage in sexual interactions with the females which is conducive to mating. Being sexual toy use was not significantly less likely could possibility suggest the male walrus could search for other external factors for sexual interaction than a female walrus. Evidence of self-gratification has been noted in other animal species such as rodents and primates, and Waterman (2010) suggest this could have evolutionary significance (Waterman, 2010). Frequency of self-gratification could be inversely linked to success of mating for the male (Waterman, 2010).

Limitations

Although walruses have been known to mate in water, captive populations of walruses have been observed mating on land (Kastelein, 2009). The view of video footage was limited to only the pool area so presence of sexual interactions on land were not observed if present. Female access to pool and availability of enrichment items was not recorded. FNT electing to stay on land rather than enter the water while in estrus could account for lack of sexual interactions accounted for during January. Start time of video recording was not exact for each day but mostly occurred mid-morning. Activeness could vary given the time of day which could account for the behaviors noted. Visibility was often limited by presence of park guests crowding the walrus tank viewing area. Furthermore, not all instances of pharyngeal sac inflation were directly visually observable but could only be noted from the hydrophone; only PSI behaviors that were observable by the male walrus being oriented at the viewing window were considered for statistical analysis. The nature of behaviors was difficult to determine by the orientation of the male walrus in relation to view of the camera. For instance, it is likely not all

instances of exposed penis were recorded due to the limited visibility of the male floating in the water. If the male was not observed form the side, the nature of the behavior would be determined upon directly previous or latter observations so states of behaviors between when visibility was limited were often impossible to determine exact nature.

Being the subjects of the study were raised under human care since orphaned as pups, the male of the study was never around any other male walruses, which could have implications for behavior differences from other captive males or wild populations. The male walrus of this study passed June 28, 2015, limiting further investigations to prerecorded video. The male was one of three potential breeding males to pass in 2015, increasing the importance of revealing more about walrus mating, particularly in captive setting, to assist with the fading population. This study provides a basis for examination of captive male Pacific walrus mating behaviors. Although mating behaviors of the Atlantic subspecies has been more thoroughly studied and were comparable (Sjare & Stirling, 1996) to those presented by the male Pacific walrus of this study, there are possible behavioral differences between captive and wild Atlantic and Pacific walrus populations. Despite present differences, studying mating behavior in captive settings can be revealing of capabilities of the species as a whole (Fay, 1982). Understanding more about how walruses interact in their environment can be used for future management strategies (Kastelein, Mosterd, van Ligtenberg, & Verboom, 1996).

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Appendix A:
IACUC Approval Letter

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE

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NOTICE OF COMMITTEE ACTION

The proposal noted below was reviewed and approved by The University of Southern Mississippi Institutional Animal Care and Use Committee (IACUC) in accordance with regulations by the United States Department of Agriculture and the Public Health Service Office of Laboratory Animal Welfare. The project expiration date is noted below. If for some reason the project is not completed by the end of the approval period, your protocol must be reactivated (a new protocol must be submitted and approved) before further work involving the use of animals can be done.

Any significant changes should be brought to the attention of the committee at the earliest possible time. If you should have any questions, please contact me.

PROTOCOL NUMBER:	**15101511**
PROJECT TITLE:	**Mating Behavior Exhibited By a Captive Male Pacific Walrus (Odobenus rosmarus divergens)**
PROPOSED PROJECT DATES:	**10/2015 - 09/2018**
PROJECT TYPE:	**New**
PRINCIPAL INVESTIGATOR(S):	**Stan Kuczaj**
DEPARTMENT:	**Psychology**
FUNDING AGENCY/SPONSOR:	**N/A**
IACUC COMMITTEE ACTION:	**Full Committee Approval**
PROTOCOL EXPIRATON DATE:	**September 30, 2018**

Frank Moore, PhD
IACUC Chair

10/01/2015
Date