# *Do pinnipeds in a mixed species enclosure exhibit individual and species-specific social preferences?*

Presented by

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**Abstract**

This study aims to determine whether California sea lions and harbor seals, when housed in a mixed species exhibit, display individual and/or species-specific social preferences. Data was previously obtained from the Seal Cove, Six Flags Discovery Kingdom, California zoological enclosure using focal follows and recording when individuals come within one metre of each other. Individual preferences for both the California sea lion and the harbor seal were observed, in addition to particular species-specific social preferences. Further studies would be beneficial to support the findings due to a small sample size and data set.

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## 1.0 Introduction

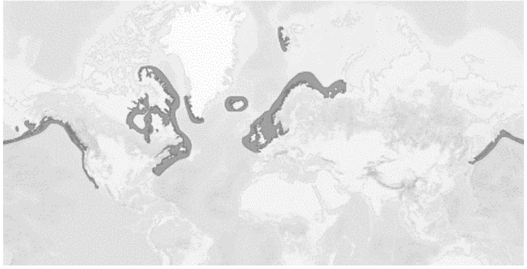

Figure 1 – Distribution of the harbor seal (*Phoca vitulina*). Darker areas show range of populations (NPI, 2016).

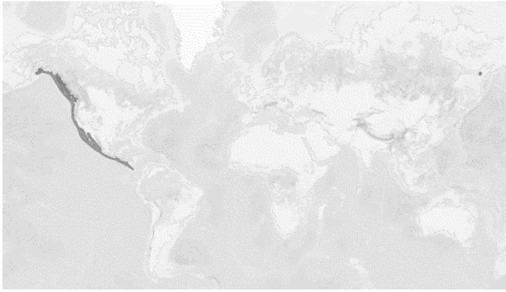

Figure 2 – Distribution of the California sea lion (*Zalophus californianus*). Darker areas show range of populations (Aurioles, 2015).

Pinnipeds are aquatic carnivores listed within the Carnivora order (Le Boeuf, 1978). The harbor seal *(Phoca vitulina)* is also known as the common seal due to having the broadest distribution amongst pinnipeds with a large latitudinal range over many coastal habitats around the North Atlantic and North Pacific, and with an estimation of 315,000 mature wild individuals (Burns, 2009; Lowry, 2016). California sea lions *(Zalophus californianus)* are long lived and also hold extensive ranges but are only seen along the Pacific coast of North America with an estimated 180,000 mature wild individuals (DeLong, et al., 2017; Aurioles-Gamboa and Hernández-Camacho, 2015). As seen in Figures 1 and 2, territories of both species' wild populations are recorded to overlap naturally.

Both species hold a similar social structure and are seen to primarily interact with other individuals of the same species when hauled out on land (Edgell and Dermarchi, 2012; Honeywell and Maher, 2017). However, even while hauled out in groups, harbor seals are seen to maintain a distance of approximately one meter between one another (Honeywell and Maher, 2017) and social factors, despite mother-pup relationships, did not affect the formation of haul out space use (Godsell, 1988). These large social gatherings promote the ideal conditions for male-male competition during breeding season. This is shown with both species being widely polygynous, where individual males will father multiple pups from multiple females (Le Boeuf, 1978). Females of both species benefit from group breeding as pups are more likely to survive with less risk of infanticide by subordinate males, as well as increasing the chance of reuniting with their pup post feeding (Campagna, et al., 1992). Harbor seals also use group haul outs as an anti-predator strategy (da Silva and Terhune, 1988). While individual vigilance decreases in large groups, the overall vigilance of the group increases. It has been observed that these large groups are capable of detecting more potential predator attacks from greater distances compared to solitary seals who often fail to recognise them.

Males of both species will fight for territory and social status in a dominance hierarchy, however aggression is primarily directed towards individuals of the most equal size (Schusterman and Dawson, 1968). Agonistic behaviours will start with fore-flipper waving and/or scratching before leading to head-thrusts (Neumann, 1999). California sea lions use vocalisations frequently during the establishment and maintenance of social groupings (Peterson and Bartholomew, 1969). Disputes are often brief and rarely escalate to fights due to there being limited fitness benefits for each individual (Neumann, 1999). However, an unsettled social ranking may be reflected during prolonged encounters (Sullivan, 1982). Hierarchies within adults and juveniles are often based on size, sex and age, while there is no clear dominance between sexes of pups (Wolf, et al., 2007). While influencing interactions, size also has an impact on the outcome of interactions with smaller individuals often being displaced by larger ones (Neumann, 1999).

Social preferences are seen within many, if not all, species. For example, both sexes of prairie voles favour larger individuals, although females show the stronger preference (Solomon, 1993). Recognition is often important in all social interactions between individuals of any species (Insely, et al., 2003) and is noted in calves which spend significantly more time with familiar calves, as well as being less stressed during separation from the mother, when compared to unfamiliar calves (Færevik, et al., 2006). Giraffes are seen to hold social preferences based on two factors: the amount of spatial overlap which shows an increase in preferred relationships, and the degree of relatedness between the individuals with higher relatedness resulting in increased preference (Carter, et al., 2013)

These social interactions are likely non-random with influencing external and internal factors (Wolf, et al., 2007). Age groupings are common in pinnipeds and males often have fewer social partners than females, with single sex groups appearing to create a better environment for development of social behaviours. During rehabilitation programmes it was seen that single sex groups maintained activity levels throughout the day, expressed more interactions and coordinated swimming when compared to mixed sex groups where activity decreased throughout the day (Meyer, et al., 2017). Pups and/or juveniles score significantly higher than adults on impulsivity tests but other age factors do not influence dominance or reactivity expression rates (Ciardelli, et al., 2017). Recipients of behaviours, as seen in a captive setting, vary between the two species with harbor seals directing more behaviours towards the environment rather than other individuals, whereas California sea lions exhibit the opposite pattern with more interactive behaviours exhibited towards other individuals as opposed to the environment (de Vere, et al., 2017). In addition, Hanggi and Schusterman

(1990) recorded that California sea lions interacted more with related individuals than unrelated individuals.

Mixed species exhibits aim to offer behavioural enrichment, increase in social complexity and stimulation (Leonardi, et al., 2009). However adequate space and experience is needed to ensure success for each species within the enclosure, ensuring one is not at a disadvantage for the benefit of another (Kaandorp, 2012). There are risks involved when maintaining a mixed-species enclosure including the possibility of decreased health and welfare (Dorman and Bourne, 2010). Choice of species must be carefully considered, a purpose-designed enclosure is vital to reduce risk of social tension and continued monitoring on a long-term basis should be implemented (Rendle, et al., 2018; Buchanan-Smith, 2011). The potential transmission of disease between species should be identified and, where possible, removed (Dorman and Bourne, 2010). Trauma is often identified as the most common cause of health issues within mixed enclosures with competition for resources, seasonal aggression, exceptional rough play or accidental injury (Kaandorp, 2012). Even without physical harm occurring, dominant species can cause unnecessary stress through bullying (Dorman and Bourne, 2010).

California sea lions and harbor seals are housed together in mixed species enclosures within sixteen zoological institutions, with more institutions housing them both and additional species together (Zoorope, 2019). Despite this there is no research into the social interactions between the two different species, with little research into the interactions between members of the same species. Pinniped personalities have been briefly researched and the study by de Vere, et al., (2017) showed that both species, and the individuals within, interact differently with age often being a factor. Evaluating the social preferences of each individual and the quality of interactions gives an insight into the social structure of a mixed species exhibit.

Based on previous research (de Vere, et al., 2017) it is hypothesised that California sea lions will exhibit more interactions compared to harbor seals. In addition, interactions between the two species will be limited with little to no individual preferences exhibited. However, within each species individual social preferences will be exhibited with most occurring due to the age and/or relatedness of the individuals (Hanggi and Schusterman, 1990; Ciardelli, et al., 2017).

## 2.0 Methods

### 2.1 Ethics Statement

Original data collection was approved by the ethics committee at the University of Southern Mississippi, and re-analysis of the data for the present study was approved by the Plumpton College Ethics Committee.

### 2.2 Subjects

Six harbor seals and four California sea lions at Seal Cove, Six Flags Discovery Kingdom, California were observed for a previous study (de Vere, et al., 2017). However, only four harbor seals and two California sea lions will be

**Table 1.** Subjects involved in focal follows including age, sex and species.

| Animal | Age (years) | Sex | Species |
|---|---|---|---|
| 1 | 11 | F | Seal |
| 2 | 10 | F | Seal |
| 3 | 2 | F | Seal |
| 4 | 1 | F | Seal |
| 5 | 0.1 | M | Sea lion |
| 6 | 9 | F | Sea lion |

observed for data collection. Of the four harbor seals all were females with two of breeding age, 11 and 10 years, with both having been bred at another zoo. The remaining two seals were second year pups, 1 and 2 years, both from one of the breeding females. One California sea lion was of breeding age having been bred at another zoo and the second sea lion was a first-year pup, one month of age, from this female. See table 1 for further clarification.

### 2.3 Data Collection

Data was collected using focal follows with each animal recorded for 7.5 minutes twice a day (de Vere, et al., 2017). The first session of focal follows was carried out between 7:30am and 12:30pm with the second session carried out between 11:00am and 4:00pm with a minimum of 30 minutes between each session. The order of each animal used for focal follows were randomised. The total amount of data collected was forty morning and forty afternoon recordings for each animal equating to 80 focal follows and 10 hours of data. An ethogram was used to record the data including, but not limited to, focal follow individual, animal interacted, animal initiated, the outcome of the interaction and the duration of the interaction.

### 2.4 Data Analysis

Five days of the available data of used, equating to 10 focal follow sessions for each individual and at least 70 minutes of data. Any individual that comes within one body length of the focal follow individual will count as an interaction and logged within the ethogram (Coleing, 2009). The initiator of the interaction will be determined based on which individual went towards the other and the recipient of the interaction will also be recorded.

Genstat will be used to analyse the data with a Chi-square test of association to identify a) which individual interacted the most and b) which individual initiated the most interactions. This test was chosen due to the amount of information that can be obtained from the test output (McHugh, 2013). No modifications to the data occurred.

## 3.0 Results

There was a significant association with the number of interactions between the focal animal and the animal interacted with ($\chi^2_{(25)}$ = 2125.41, $p<0.001$), with Seal 4 interacting the most during focal follows and seal 1 interacting the least. Seal 2 was interacted with the most during other focal follows and seal 1 interacted with the least.

Cramer's coefficient (*V)* was calculated at 0.6274, indicating that there is a high association between the number of interactions between the focal animal and the animal interacted with.

**Table 2.** Summary of interactions between the focal animal and the animal that was interacted with. Expected frequencies are shown in brackets.

| | | Focal Animal | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 6 | 5 | 1 | 3 | 2 | 4 | **Total** |
| **Animal Interacted** | 6 | - (32.52) | 208 (42.81) | 1 (22.02) | 0 (39.10) | 0 (32.72) | 4 (43.83) | **213** |
| | 5 | 151 (23.51) | - (30.95) | 0 (15.92) | 0 (28.27) | 0 (23.66) | 3 (31.69) | **154** |
| | 1 | 0 (17.25) | 0 (22.71) | - (11.68) | 40 (20.74) | 30 (17.36) | 43 (23.26) | **113** |
| | 3 | 0 (31.75) | 0 (41.80) | 45 (21.50) | - (38.18) | 89 (31.95) | 74 (42.81) | **208** |
| | 2 | 4 (33.28) | 0 (43.81) | 29 (22.54) | 96 (40.02) | - (33.49) | 89 (44.86) | **218** |
| | 4 | 3 (19.69) | 0 (25.92) | 32 (13.34) | 54 (23.68) | 40 (19.82) | - (26.55) | **129** |
| | **Total** | **158** | **208** | **107** | **190** | **159** | **213** | **1035** |

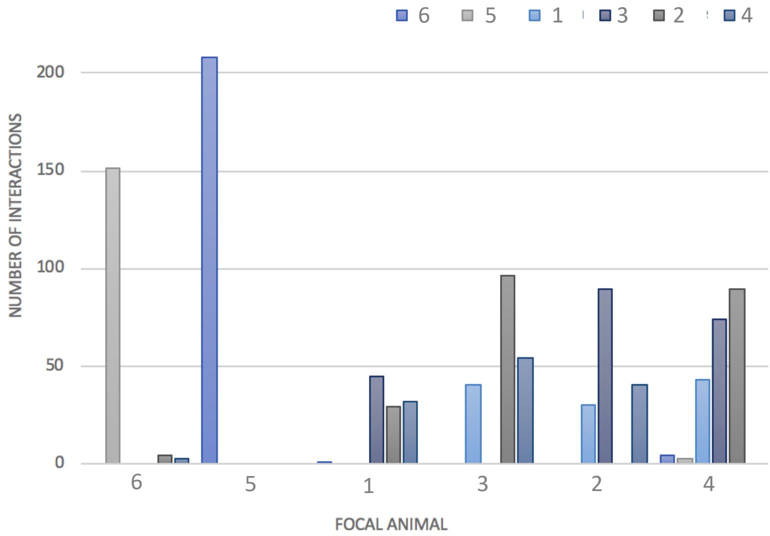


**Figure 3** – Number of interactions that each focal animal participated in and the animal interacted with.

There was a significant association with the number of interactions between the focal animal and the animal interacted with ($\chi^2_{(25)}$ = 2075.25, p<0.001), with seal 3 initiating the most interactions and seal 1 initiating the least. Sea lion 6 received the most interactions and Seal 4 received the least.

Cramer's coefficient (*V)* was calculated at 0.6277, indicating that there is a high association between the number of interactions between the focal animal and the animal interacted with.

**Table 3.** Summary of interactions between the individual that initiated interaction and the receiving animal. Expected frequencies are shown in brackets.

| | | Receiving Animal | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 6 | 5 | 1 | 3 | 2 | 4 | **Total** |
| **Animal Initiated** | 6 | - (30.58) | 131 (17.09) | 1 (17.99) | 0 (18.38) | 1 (32.77) | 0 (16.19) | **133** |
| | 5 | 228 (52.67) | - (29.44) | 0 (30.98) | 0 (31.65) | 0 (56.44) | 1 (27.89) | **229** |
| | 1 | 0 (18.40) | 0 (10.28) | - (10.82) | 25 (11.05) | 30 (19.71) | 25 (9.74) | **80** |
| | 3 | 0 (58.64) | 0 (32.77) | 60 (34.49) | - (35.23) | 127 (62.83) | 68 (31.04) | **255** |
| | 2 | 3 (28.05) | 0 (15.68) | 29 (16.50) | 58 (16.86) | - (30.06) | 32 (14.85) | **122** |
| | 4 | 7 (49.67) | 2 (27.76) | 50 (29.22) | 60 (29.84) | 97 (53.22) | - (26.30) | **216** |
| | **Total** | **238** | **133** | **140** | **143** | **225** | **126** | **1035** |

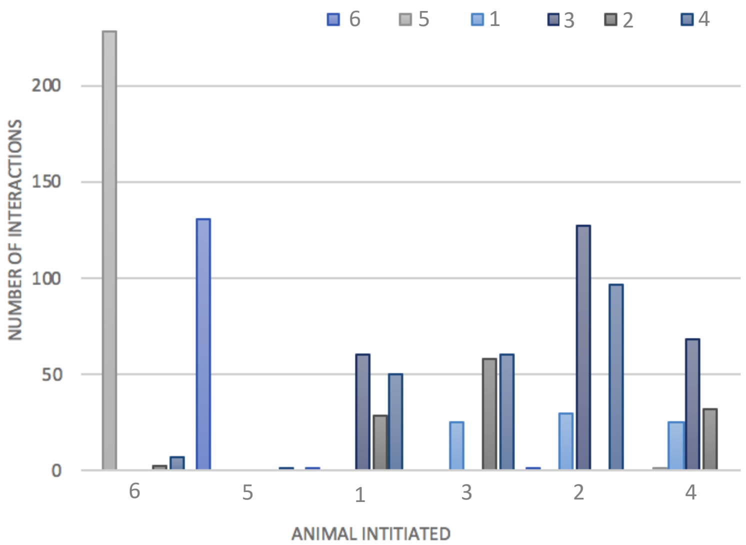

**Figure 4** – Number of interactions each animal initiated and which animal received the interaction.

## 4.0 Discussion

The aims of this study were to determine if California sea lions and harbour seals, when housed together, display individual and/or species-specific social preferences. Individual differences were expected to be identified due to previous California sea lion and harbor seal research, within a captive environment, showing individual personality factors (de Vere, et al., 2017). The results from this study also highlighted obvious individual social preferences, however species-specific social preferences were not seen with both California sea lions interacting with at least one harbor seal. Species-specific preferences could be identified for the harbor seals with one only interacting within the species and another only interacting with the California sea lions if they initiated the interaction.

## California Sea Lions

Sea lion 6 interacted the most with Sea lion 5 which was expected due to the mother-pup relation (Hanggi and Schusterman, 1990). Other interactions with both adult harbour seals, Seal 1 and Maile, took place suggesting an age influence on interaction preference (Meyer, et al., 2017). While Sea lion 5 also interacted the most with Sea lion 6, he also initiated and received interactions with Seal 4, the youngest harbor seal, also supporting the idea that age affects social preferences. Males also commonly have fewer social partners than females (Wolf, et al., 2007), however, at the time of recordings Sea lion 5 was only one month old which will influence interaction rate and which individuals he may prefer to interact with.

The total number of interactions, collectively, for the California sea lions was on average higher (336) than that of the harbor seals (334) which is consistent with the social nature of this species (Bigg, 1981). However, a small sample size (n=2) was used for the California sea lion data subsequently increasing the margin of error on the results (Hackshaw, 2008). In addition, the results show interactions of two related individuals, one being a young and dependent pup, whereas unrelated individuals may not have the same rate of interaction (Hanggi and Schusterman, 1990).

## Harbor Seals

Seal 1 interacted with all harbor seals and Sea lion 6, but not Sea lion 5. Despite this, initiated interactions only occurred with harbor seals suggesting her social preference is species-specific. Seal 3 also only interacted and initiated interactions with other harbor seals and was seen to have no interaction with the

California sea lions. Seal 2 interacted, initiated and received interactions from all harbor seals as well as Sea lion 6, but no interaction took place with Sea lion 5. Seal 4 was the only individual, of both species, to interact with all other individuals in the enclosure, including initiating interactions with all harbor seals and both California sea lions. These interactions were reciprocated from all individuals apart from Sea lion 6. The extent of interactions from Seal 4 may be due to the inquisitiveness of her age, as a first-year pup and the youngest seal (Wolf, et al., 2007).

Similarly, to the California sea lions, results were from a small sample size (n=4) and 75% of the individuals were related to one another which is likely to influence interactions (Hackshaw, 2008; Hanggi and Schusterman, 1990). Half of the harbor seal group chose to only interact within its species showing species-specific social preferences despite the opportunity to interact with the California sea lions.

The method of using focal follows is more time efficient as opposed to continuous data collection which can be demanding (Rose, 2000). Using continuous data collection can reduce the rate of sample loss, however focal following removes sampling bias for the location of the observer due to the need to follow the animal where it is visible resulting in reduced yet accurate data (Stevenson, et al., 2004).

During busy periods at the zoo, focal follows were disturbed and interrupted creating the possibility of missed interactions that would have added to the results, however, the frequency of disruption was minute. In addition, a feature of the enclosure was a large island within the middle of the pool. As the harbor seals and California sea lions swam around the back of the island they would no longer be able to be seen from the viewing area resulting in potential missed interactions. Feeding shows also occurred during some focal follows. Typically, only Seal 2, Seal 3 and Seal 4 took part in the feeding shows, resulting in these seals interacting at a higher frequency and for longer periods of time which might not have occurred in other circumstances.

In addition, studies of wild seals showed increased alertness and reduced resting time during human presence (Kovacs and Inness, 1990). Taylor, et al., (1988) also saw increased vigilance of captive seals when unfamiliar observers were present, but habitation to consistent human individuals occurred relatively quickly. With more visitors present, Stevens et al., (2013) saw seals spend more time completely submerged, which was observed with Seal 2, less time swimming at the surface and performing fewer social behaviours. The latter was not observed within this study, however, often with the increase in visitors came a feeding show thus increasing human presence would be linked to food supply; alternatively, motivation for food was higher than the desire to avoid human presence.

A social group structure is built from behavioural interactions of the group (Rose and Croft, 2017). Lifetime productivity is dependent on these social interactions (Silk, et al., 2009), and for some species provides a buffer from environmental stress (Wiitig, et al., 2008). Within the wild the social structure is built on relationships surrounding food sourcing, predation and cooperative care (Whitehead, 1997). However, these factors are often relaxed or eliminated within a captive environment (Schulte, 2000). While these captive environmental pressures vary from wild individuals, mates are still sought after and the limited space within the enclosure restricts the opportunity to decrease social tension (Price and Stoinski, 2007). Group size can have an impact on behaviour and it has been suggested that suboptimal group sizes may be associated with change in social behaviours and increased abnormal behaviours (Price and Stoinski, 2007).

Pinnipeds have complex social lives and extensive behavioural repertoires (Marino, 2002). Interaction rates and displays of behaviour will vary between wild and captive populations as recorded by Renouf (1993) where play behaviours were seen to last longer within wild populations than within captive settings, however, rate of play within the wild was seen to be arguably influenced by lack of time as opposed to energy constraints. Enrichment will also have an effect on behaviour where Hunter et al., (2002) saw random swimming and exploration behaviours were increased while pattern swimming was seen to decrease. Increasing random swimming and exploration behaviours is likely to increase the number of interactions between individuals, even if more so by chance.

## 5.0 Conclusion

Individual preferences were seen for each individual with preferences appearing to be primarily influenced by age groups. Species-specific preferences were also noted but more commonly seen for harbor seals as opposed to California sea lions. Animal welfare is affected by a range of factors such as genetics, temperament, previous experience, but also the interactions with environmental stimuli to include social groupings and the interactions within (Sherwen and Hemsworth, 2019). These factors and the results from this study should be put into consideration when housing captive pinnipeds in the future. This is to ensure individuals that commonly interact at a higher frequency are not socially limited or isolated which may have a detrimental impact on welfare if ignored. Future studies should aim to include a larger data set and sample size. Of the sample a lower percentage of individuals that are related to one another would be beneficial in order to compare and observe how interaction rate varies with unrelated individuals.

## 6.0 Acknowledgements

I would like to thank Amber de Vere for suggesting the title of this study, for supplying the data and for support throughout.

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