

**BEHAVIOR OF FEMALE SEA OTTERS (*ENHYDRA LUTRIS*) AND
THEIR PUPS IN SIMPSON BAY, ALASKA**

An Undergraduate Research Scholars Thesis

by

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TABLE OF CONTENTS

	Page
ABSTRACT.....	1
NOMENCLATURE	2
CHAPTER	
I INTRODUCTION	3
II METHODOLOGY	5
Study sight	5
Instantaneous sampling.....	5
Activity budget.....	6
Proportional distance between female-pup pairs	7
Foraging dive duration.....	7
III RESULTS	8
Activity budget.....	8
Proportional distance between female-pup pairs	10
Foraging dive duration.....	11
IV CONCLUSION.....	12
REFERENCES	18

ABSTRACT

Behavior of Female Sea Otters (*Enhydra lutris*) and Their Pups in Simpson Bay, Alaska

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Being altricial mammals, sea otter pups need their mother's care in order to survive. As an endangered, keystone species, it is important to understand the relationships between female sea otters and their pups, including how the female cares for herself while also allotting a majority of her energy to her pup. Research on sea otter female-pup relationships in Simpson Bay, Alaska is limited. This research will look at the relationship between female-pup pairs to test the hypothesis that as pups mature they become more independent and less attention and energy input from the female is needed. This research will focus on three questions:

- 1) What are the activity budgets of female and pup sea otters at different pup categories?
- 2) What are the distances between female-pup pairs at different pup categories?
- 3) What is the foraging dive time for the female sea otter at different pup categories?

Sea otters will be observed in female-pup pairs from a boat in Simpson Bay, Alaska using binoculars. At the completion of this research, a better understanding will be gained as to how the female sea otter meets her demands and her pup's demands as the pup grows.

NOMENCLATURE

- B-Gr – Being groomed
- C1 – Category one sea otter pup
- C2 – Category two sea otter pup
- C3 – Category three sea otter pup
- F – Foraging
- GR-P – Grooming pup
- GR-S – Grooming self
- INT – Interacting
- N – Nursing
- RST – Resting
- SW – Swimming

CHAPTER I

INTRODUCTION

Being altricial mammals, sea otter pups rely on their mothers to care for them until they are weaned. The female and pup show different behaviors while the pup grows. The female does not only care for herself, but also for her pup and must spend her time differently depending on how old her pup is. Sea otters lose heat more rapidly than their terrestrial counterparts due to the heat capacity of water ($0.58 \text{ W/m}\cdot\text{k}$) and, therefore, must use more energy to maintain their internal body temperature. Sea otters use fur as their sole source of thermal insulation, so grooming is vital for their survival in water and, consequently, spend about 15% of their day grooming themselves (Wolt et al, 2014).

Their metabolic rate, estimated at 12.69 MJ per day for female sea otters with pups (Wolt et al, 2014), is two to three times higher than terrestrial mammals of similar size. To maintain this metabolic rate, sea otters consume about 25% of their body weight in food daily (Osterrieder & Davis, 2009) even though foraging only accounts for about 18% of their day (Wolt et al, 2014). While caring for a pup, these values can be hard to achieve for the female, so they must prioritize their activities differently when their pup is growing.

This research will look at how these activities change as pups grow. Distance and dive time will also be recorded in this research to help look at how the relationship between the female and pup differ as the pup grows. For the female, it is expected, as the pup category increases, that foraging time will increase, resting time will remain stable, and swimming time will decrease.

For the pup, as the pup category increases, it is expected that foraging time will increase, resting time will decrease, and swimming time will increase. Distance between the female and the pup is expected to increase as the pup category increases. The female's dive time is also expected to increase as the pup category increases with a dive time less than 3 minutes.

Once completed, this research will provide insight to this keystone species and show how the female and pup relationship changes over a period of time when the pup is becoming more independent. This research could be used to better understand altricial behaviors in sea otters and the time and energy a female sea otter puts into raising a pup, while simultaneously taking care of themselves. This research could eventually be used as a comparison when looking at other marine and terrestrial altricial mammals of similar size.

CHAPTER II

METHODOLOGY

Study site

Simpson Bay, located in northeastern Prince William Sound, Alaska, was used as the study site for this research. The bay served as a good study area due to the calm seas and good access by boat to the sea otters in the area. Simpson Bay was split into three sections: North Bay, West Bay, and East Bay. The area of Simpson Bay is 21km² and has about 124 ± 14.7 sea otters, including 31 ± 6.9 female-pup pairs, during the summer months of June thru August (Wolt et al, 2014).

Instantaneous sampling

Female sea otters with pups were randomly selected throughout the three bays. When a female-pup pair was sighted they were approached by boat, staying at least 50 meters away, and were observed using binoculars. The female-pup pairs were classified depending on the category of the pup (C1, C2, & C3). The C1 pups are newborn and smaller than the females, unable to swim or dive, and have a dense fur called lanugo. C2 pups are closer to the size of adult females, have coordinated body movements, attempt to dive but surface very quickly or bob at the surface of the water, and the lanugo begins to molt. The C3 pups are around equal size to the adult females, are able to swim and dive, and have dark fur similar to that of adult sea otters (Osterrieder & Davis, 2009).

Activity of the female and pup and distance between the female and pup were recorded every minute, on the minute, for thirty minutes. If the female was foraging, her dive duration was recorded when the dive was complete. The observations were obtained between 9am and 5pm with 4 to 8 female-pup pairs being observed each day spent in the field. GPS locations were taken at the start of each new female-pup pair being observed. It is possible, with an average of 31 female-pup pairs in Simpson Bay (Wolt et al, 2014), that pairs could have been selected for observation more than once, but care was taken to not observe the same female-pup pairs in a day.

Activity budget

The behaviors recorded for this study were resting, foraging, nursing, interacting, grooming self, grooming pup/being groomed, and swimming. Resting was identified with floating, motionless on back with flippers out of the water. Foraging was acknowledged with repeated dives and carrying, chewing, and consuming food. Nursing (observed with pups only) was recorded when the pup had its mouth at the area of the female's nipples (see Figure 1). Interacting was identified with playing, fighting, and copulating. Grooming was recognized as vigorously cleaning fur, rolling or splashing, and blowing air into fur (see Figure 2) and was separated into grooming self: the female or pup grooming themselves, grooming pup: the female grooming the pup, and being groomed: the pup being groomed by the female. Swimming was identified with moving directly along the water surface from one area to another without stopping (see Figure 3) (Packard & Ribic, 1981). The data was collected and activity budgets were created for both the female and pup for each category.



Figure 1: Pup nursing



Figure 2: Sea otter grooming



Figure 3: Sea otter swimming

Proportional distance between female-pup pairs

The distance between the females and pups were estimated and the differences between each category were analyzed. The distances were taken in conjunction with the behaviors. They were measured in otter length and ranged from 0 (pup on female or touching while in water) to 100+. The distances between the female-pup pairs were converted into proportional distances and graphed for each category.

Foraging dive duration

For each pup category, if the female was seen foraging, her dive duration was recorded in minutes. A foraging dive was indicated by the female when she would periscope before diving. The dive durations for each category were compared between each other, with the maximum recorded dive duration for sea otters (4.5 min.), and with the estimated aerobic dive limit (3 min.). The forage dive duration for each category was calculated into a minimum, maximum, and mean and laid out in a table for easy comparison.

CHAPTER III

RESULTS

Activity budget

22 C1 female-pup sea otter pairs were observed during the research giving 661 total observations. Figure 4 below shows the activity budgets for the females and pups. The two main activities for the female were swimming (60%) and resting (32%), while foraging was at 2%. For the pup, the main activity was resting (87%), while nursing was at 10% and swimming and foraging were at 0%.

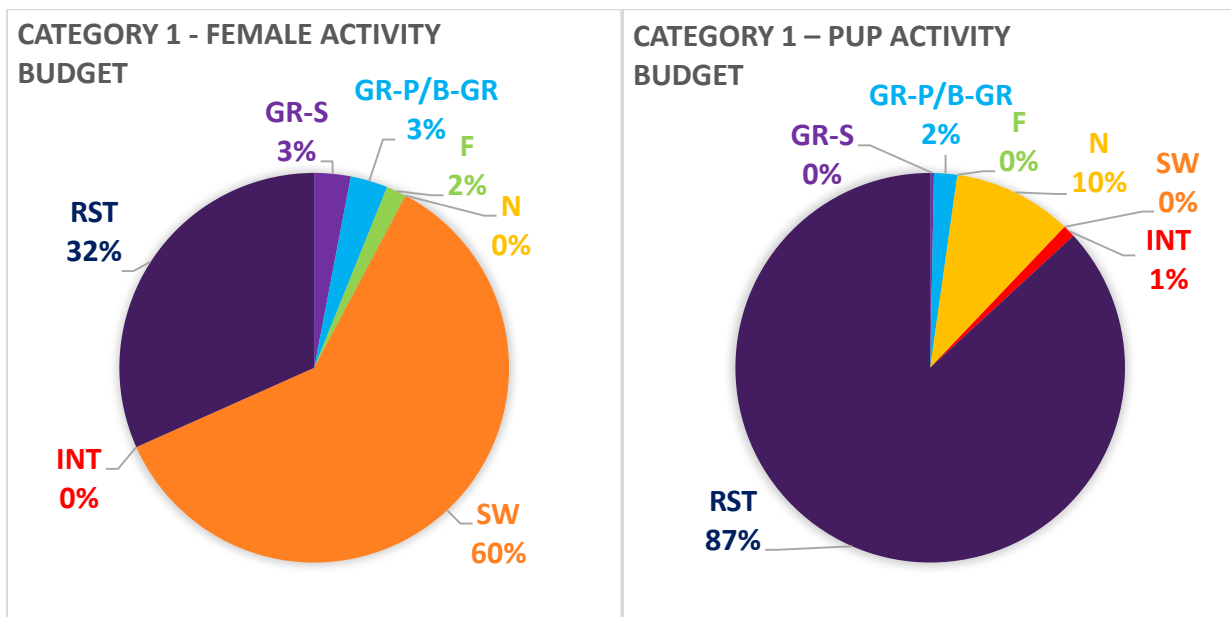


Figure 4: Female and pup activity budgets for category one pups. Seven behaviors were recorded: resting (RST), grooming-self (GR-S), grooming pup/being groomed (GR-P/B-Gr), foraging (F), nursing (N), swimming (SW), and interacting (INT).

28 C2 female-pup pairs were observed giving a total of 837 observations. The activity budgets for the females and pups can be seen below in Figure 5. For the female, swimming (41%) and

resting (37%) were the two main activities, while foraging was at 1%. The pup's main activity was resting (72%), with nursing at 5%, swimming at 6%, and foraging at 9%.

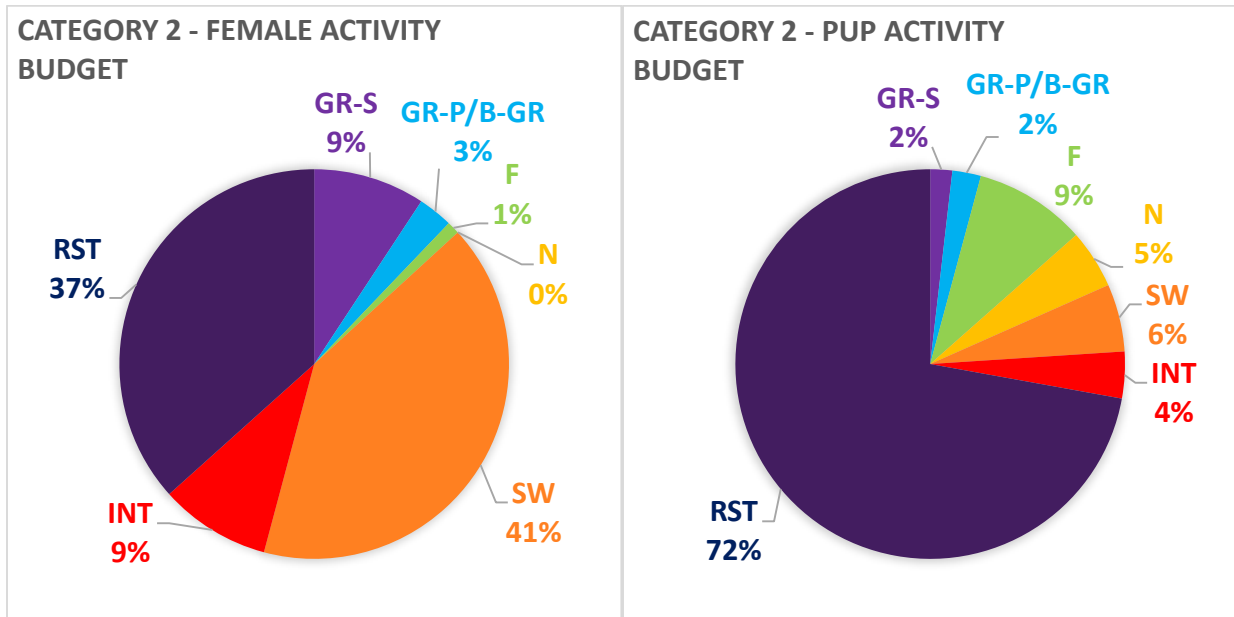


Figure 5: Female and pup activity budgets for category two pups. Seven behaviors were recorded: resting (RST), grooming-self (GR-S), grooming pup/being groomed (GR-P/B-Gr), foraging (F), nursing (N), swimming (SW), and interacting (INT).

20 C3 female-pup pairs were observed giving a total of 600 observations. The activity budgets for the females and pups can be seen below in Figure 6. The main categories for the female were swimming (33%), resting (30%), and foraging (19%). The pup's main categories were also swimming (36%), resting (26%), and foraging (17%).

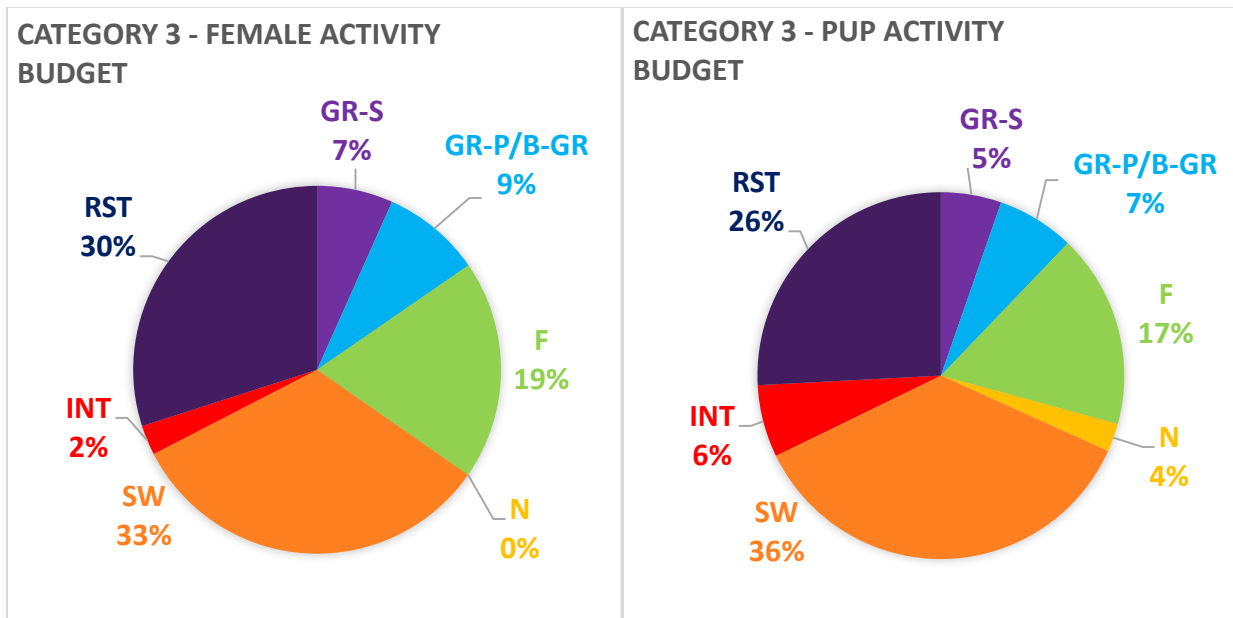


Figure 6: Female and pup activity budgets for category three pups. Seven behaviors were recorded: resting (RST), grooming-self (GR-S), grooming pup/being groomed (GR-P/B-Gr), foraging (F), nursing (N), swimming (SW), and interacting (INT).

Proportional distance between female-pup pairs

16 C1 female-pup pairs (473 total observations), 11 C2 female-pup pairs (449 total observations), and 11 C3 female-pup pairs (248 total observations) were observed during the research. The proportion of pups on the female or touching the female while in the water (distance 0) was 0.95 for C1, 0.83 for C2, and 0.56 for C3. The distance of 0.5 otter lengths had a proportion of 0.03 for C1, 0.04 for C2, and 0.21 for C3. C1 pups have a maximum distance of 5 otter lengths, C2 of 30, and C3 of 100+ (see Figure 7).

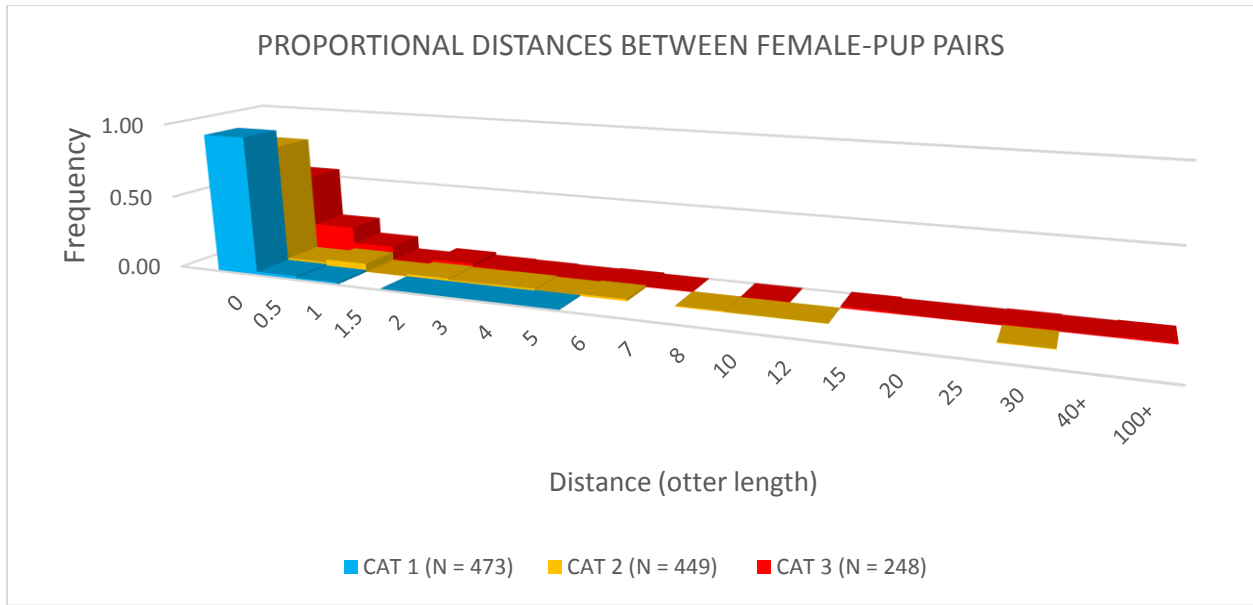


Figure 7: Proportional distances between female-pup pairs per category

Foraging dive duration

0 C1 females, 4 C2 females (32 total observations), and 5 C3 females (30 total observations) were observed foraging during the research. C2 females had a mean dive duration of 1.32 minutes, while for C3 females, the mean dive duration was 2.33 minutes (see Table 1).

Table 1: Experimental foraging dive durations in female sea otters per category

	Experimental Category One	Experimental Category Two	Experimental Category Three
Sea Otter Diving	Female	Female	Female
Mean dive duration	Not Observed	1.32 min.	2.33 min.
Minimum dive duration	Not Observed	0.35 min.	1.63 min.
Maximum dive duration	Not Observed	2.9 min.	2.97 min.
Number of observations	Not Observed	32 (4 sea otters)	30 (5 sea otters)

CHAPTER IV

CONCLUSION

The results found in this research addressed the three questions posed in the abstract. The first question posed: what are the activity budgets of female and pup sea otters at different pup categories, was addressed. For the female, the hypothesis that, as the pup matures, foraging increases, resting remains stable, and swimming decreases was accepted.

For the females, foraging increased from 2% at C1 to 19% at C3. As the pup matures, the female can and must invest more energy into foraging to meet the demands of the growing pup. Resting stayed stable with a low of 30% and a high of 37%. Swimming decreased from 60% at C1 to 33% at C3. As the pup matures, the female sea otter has more time and energy to invest in other activities such as grooming self and pup and interacting. Grooming self and pup and interacting remained below 10% throughout all three categories, but showed subtle increases.

For the pups, the hypothesis that, as the pup matures, foraging increases, resting decreases, and swimming increases was accepted. For the pups, foraging increased from 0% at C1, when nursing was at 10%, to 17% at C3, when nursing was at 4%. Foraging is inversely proportional to nursing and as the pup matures, it is able to begin eating solid food, whether it be stealing it from its female, or by foraging on its own. Resting decreased from 87% at C1 to 26% at C3. As the pup matures, it is able to do more activities on its own, such as: foraging, swimming, and grooming. As a result, a C3 pup is not resting as much as a C1 pup, that cannot do as many activities. Swimming increased from 0% at C1 to 36% at C3, similarly because the pup is

maturing and is able to start swimming on its own. Activities that do not include as much input from the pup, such as being groomed, remained stable, while activities that require more input from the pup: self-grooming and interacting, have a slight increase as the pup matures and is able to participate in more of these activities.

When comparing the female activity budget for the C3 sea otters with the values in the article: “Time and energy allocation of female sea otters (*Enhydra lutris*) with pups in Alaska”, (Wolt et al, 2014), little differences can be seen. Foraging (19%) and interacting (2%) were the only activities that were close in comparison with what Wolt et al. found, (18% and 2% respectively). When grooming self (7%) and grooming pup (9%) were combined (16%) and was close to what Wolt et al. had at 15%. Resting (30%) was lower than what Wolt et al. found (42%) and swimming (33%) was higher than they found (23%) (Wolt et al, 2014).

Wolt et al. made a 24-hour time budget, while the activity budget made for this research was completed with observations made only during the day (9am – 5pm). This could account for the differences seen between the activities resting and swimming, indicating that sea otters participate more in certain activities at specific times during a 24-hour time period.

In the research completed by Wolt et al., it is shown that female sea otters with pups spend more time resting during the dawn (5am – 11am) than they do in the day (11am – 5pm). This is inversely proportional to foraging, which decreases during the dawn and increases during the day. Swimming also increased during the night (11pm – 5am). However, the pup’s activity during these times are not recorded (Wolt et al, 2014).

Further research on the differences of activity during the night and day would be needed to see if the pup's activity is concurrent with the female's. Another further question is if the time spent in each activity, while looking at both the female and pup during the night and day, follows a similar path with each of the three categories. Additional research could also be done to see if there is a significant difference between a female and pup 24-hour activity budget that was completed on sea otters located around Alaska versus sea otters located around California.

The results from the research also addressed the second question posed: what are the distances between female-pup pairs at different pup categories? The hypothesis that, as the pup matures, the distance between the female and pup would increase was accepted. The proportion of C1 pups at a distance of 0 (pup is on female or touching while in the water) was 0.95, C2 was 0.83, and C3 was 0.56. The proportion of C1 pups at a distance of 0.5 otter lengths was 0.21, which was 5.25x more than C2 (0.04) and 7x more than C1 (0.03). The maximum distance for C1 was 5 otter lengths, C2 was 30 otter lengths, and C3 was 100+ otter lengths. The maximum distance for C3 was 6x longer than that of C2 and 20x longer than that of C1. As the pup increases in age, it is able to do more on its own and is able to swim by itself. This allows for greater distances to be reached between a female and pup. As the pup grows in size, the more comfortable the female is with letting the pup get further away.

The largest distance between a female-pup pair was seen with a C3 at 100+ feet. This large distance was correlated with the female diving and the pup either swimming away from the female or the female coming up from her dive far away from the pup. The female and pup would then call for each other until they were able to meet up. This act of the pup continuing to swim

after the female dove, could be correlated to the pup becoming more independent. It could also be that the female feels more comfortable with leaving the pup for longer periods of time and feels that it is safe to not come up right next to her pup.

The third question posed: what is the foraging dive time for the female sea otter at different pup categories, was also addressed. The hypothesis that, as pups mature, the female's dive time would increase while staying under 3 minutes was accepted. The maximum recorded dive duration for sea otters is 4.5 minutes and the estimated aerobic dive limit is 3 minutes. The dive durations recorded in this research were all below both of these values.

No foraging dives were observed for C1. The mean dive duration for C2 was 1.32 minutes, with a maximum dive duration of 2.9 minutes, and a minimum dive duration of 0.35 minutes. The mean dive duration for C3 was 2.33 minutes, with a maximum dive duration of 2.97 minutes, and a minimum dive duration of 1.63 minutes. The mean dive duration for C3 was about 1 minute longer than that for C2. The minimum dive duration for C3 was about 4.66x longer than that for C2. The maximum dive duration for C3 increased from the C2 only by 0.07 minutes.

Even though no C1 females were observed foraging, these observations are congruent with the trend that foraging increases as the pup matures. When the pup is a C1, it cannot dive or swim and the female is wary about leaving the pup for extended periods of time. As the pup matures, grows, and becomes more able to swim and dive on its own, the female seems to become more comfortable with diving longer.

When recording foraging dive duration, depth was not taken into consideration. This may have altered the mean dive duration calculated for the different categories. Simpson Bay has an average depth of 30 meters and a maximum depth of 140 meters (Lee et al, 2010). In shallower depths, sea otters are more likely to have frequent, short foraging dives. While in deeper depths, sea otters are more likely to have less frequent, long foraging dives. One C2 sea otter was being observed while foraging and towards the end of the observation the sea otter began foraging closer to shore. The otter's dive duration went from being about 2 minutes, about every 3 minutes, to under 1.28 minutes, about every minute.

It was shown that female sea otters with a pup tend to make shorter dives in shallower water, thus causing shorter dive durations. However, these short durations could be due to the shallower waters or the unwillingness of the female to leave the pup for an extended amount of time (Lee et al, 2010). Further research focusing on the foraging dive durations for the three categories at different water depths, ranging from shallow to deep, could help provide insight on this question.

This research only looked at the dive durations for the female and not the pups. An additional question to propose further research could be how long a C3 pup dives and if they are successful in obtaining food. C3 pups are able to dive, but may still be learning how to forage successfully. If the female and pup are in shallower water, do they dive for equal amounts of time and are they both successful? If they are in deeper water, how does this affect the dive duration and success rate for the pup? Further research could look at the correlation between these two questions.

This research supported the hypothesis: that as pups mature, they become more independent and less attention and energy input from their female is needed. As the pup gets older it can be seen that it becomes more independent and that the female does not worry as much about leaving or straying short distances from the pup. As the pup grows up it can do more activities and becomes more like its female and an adult sea otter. The pup is able to care for itself, swim, and forage more successfully as it ages from a C1 to a C3.

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