River Otter Predation on Brown Pelicans at a Lagoon in the Golden Gate National Recreation Area

Tyler Salman

Abstract In 2006, river otters (*Lutra canadensis*) were seen preying on California brown pelicans (Pelecanus occidentalis) at Rodeo Lagoon in the Golden Gate National Recreation Area, CA. This predator-prey relationship has never before been documented, and calls for further investigation because of the endangered status of the California Brown Pelican. The correlation of timing between this change in the otters' diet and the eutrophication (nutrient overabundance and deoxygenation) of the lagoon, a process associated with the death of larger fish and the main prey of river otters, implicates eutrophication as a possible cause of this predation. Through the collection and analysis of otter spraint from Rodeo Lagoon, both before and after the brown pelican migrated for the season, I determined how the diet of the river otters at Rodeo Lagoon has changed with the migration of the Brown Pelicans. Fecal analysis revealed the brown pelican to have become a substantial part of the diet of river otters at this particular site before pelican migration, though it is unclear if eutrophication has anything to do with it. These findings could, however, have consequences for the reevaluation of the endangered status of brown pelicans by identifying a new predator.

Introduction

River otters (Lutra canadensis) are resourceful predators and while they prefer to feed on slower moving fish, they have been shown to eat numerous kinds of other prey including reptiles, amphibians, crustaceans, and birds (Mason and Macdonald, 1986). Otters have been known to feed upon animals that are substantially larger than them, with reports of them killing geese and even sheep (Harris 1968). An overview of otter predation (Duffy, 1995), has classified some seabirds, namely terns and gulls, as a regular dietary choice for river otters in the northwestern United States. A link between greater bird predation by river otters and seasonal changes has been found as well, where birds comprised as much as 14 percent of the otter diet during summer (Lanszki, 2001). With the recent sightings of otter predation on California brown pelicans (Pelecanus occidentalis) at Rodeo Lagoon in the Marin Headlands, California (Fong, 2006), it has become clear that river otters have expanded their choices of prey and, likewise, a new predator to the brown pelican has emerged.

Historically, the only threats to the survival of the brown pelican in California were oil spills and eggshell thinning from pesticide use, for which reasons they were placed on the endangered species list in 1970 (Hamilton, 2006). Other, smaller ground predators including rats and feral cats have been known to prey upon California brown pelicans, targeting only eggs and juveniles, but showed no real significant threat to pelican populations (Anderson et al., 1989). Recently the US Fish and Wildlife Service has debated removing the California brown pelican from the endangered species list, citing an increased distribution of the species as well as a ban on the use of the pesticides that caused the pelican to be listed initially (Hamilton, 2006). The surfacing of a truly effective predator to the brown pelican should be considered in reevaluating its endangered status.

Though historically otters have fed on some rather large animals including birds, this predator-prey relationship between otters and pelicans has never been observed before now, despite the fact that both species have inhabited the lagoon for years. Either the otters have never been observed attacking pelicans before now, or the more likely: river otters have just recently begun to include pelicans in their diet. Regardless of which is true, this information is distinctly missing from both otter and pelican literature. Perhaps of even greater importance is the fact that the brown pelican is recognized as a federally endangered species and thus threats to its continued conservation and safety should be examined closely (Hamilton, 2006). If the river otters are indeed eating these brown pelicans, the circumstances under which it is happening should be looked at closely in order to prevent similar predation at other sites, and to understand why it is happening here. .

To better understand otter-pelican predation, I determined the extent to which river otters were feeding upon California brown pelicans at Rodeo Lagoon, a lagoon that is becoming increasingly eutrophic. Based on the number of reports of otters attacking pelicans, the increased number of pelican carcasses along the banks of the lagoon, and the condition of the lagoon itself (being heavily eutrophic), I expected that brown pelican would be a large part of the river otters' diet at this particular site, and perhaps replacing or supplementing another declining food source. I also looked at how the otters' diet changed when the brown pelicans migrated in December, and what other species frequently make up the otter diet.

Methods

Study Area

The study site is at Rodeo Lagoon in the Golden Gate National Recreation Area in Marin County, California acting as both a resting site for California brown pelicans and as a hunting ground for river otters (Fong, 2006 and Merkle, 2006). The lagoon is currently undergoing eutrophication as characterized by the numerous algal blooms and foul smell. Eutrophication of most water bodies is commonly attributed to nutrient pollution, and though this characteristic of Rodeo Lagoon is currently being examined, the cause is unknown.

Spraint Collection and Identification

Using several illustrated field guides (Halfpenny, 1986 and Rezendes, 1992) I familiarized myself with the characteristics of otter spraint, the scientific term for otter scat, as well as the probable locations of sprainting activity. This not only allows me to correctly identify otter spraint, but also to keep from misidentifying spraint that does not belong to one of the river otters. The large collection of mammal species present at the lagoon, including bobcats, skunks, and coyotes, make accuracy very important, as there is a large abundance of similarly sized mammal scat that can confound findings (Fong, 2006).

Figure 1: Study site at Rodeo Lagoon in Marin County, California with mapped locations of otter spraint finds.

Identified otter spraint samples were collected into marked sample bags and transported back to a lab on the Berkeley campus for storage. GPS coordinates are taken to note the location of each spraint found, for possible use in mapping of otter activity around the lagoon (see Figure 1). I also recorded the number of brown pelican carcasses observed during sample collection. It was fairly easy to identify what brown pelican remains look like, but due to the separation and relocation of different parts of the remains, it became hard to tell where the remains of one animal begins and another ends. Similarly, pelican remains can be found off in the water of the lagoon as well as on land, so recording pelican remains on the shore alone could lead to an underestimation of pelican kills. Also, without direct observation of otter-pelican predation (of which there has been only a dozen or so reported by bird watchers, rangers, and park visitors, while I found no less than 30 separate pelican remains during collection) there is no way to attribute every single one of the pelican kills to otters, though the placement of remains around sites of high otter activity, i.e. sprainting or near otter holts (dens), and the lack of any other known pelican predators (Anderson et al., 1989) makes it likely that otters are responsible for these kills as well. Because the pelicans, when present, only rest out in the middle of the lagoon, the only possible predators would have to be aquatic, of which the river otter is the only one recorded to be present in the lagoon and large enough to attack a pelican. Pelican remain numbers are recorded which when compared with pelican counts at the lagoon can give both myself and the NPS a rough idea of how big of an impact the otters are having on the pelican community.

By examining the otter spraint, I can determine what the otters are eating, and the extent to which they feed on pelicans and fish at this site. I was able to identify the remains in the otter spraint using identification catalogues (Conroy et al., 1993) and using the help of Professor Reginald Barrett of UC Berkeley as well as Darren Fong, an aquatic ecologist with the National Park Service. I first put the samples through a water sieve to separate out the remains, i.e. bones, feathers, scales, from the fecal material. Then, using an estimation of the percent volume of biomass, I was able to determine, roughly, the amount of pelican in the spraint, that is, I can look at what percentage of a spraint is made up of pelican remains, and thereby determine what part of any given meal in an otter's diet is comprised of pelican (Barrett, 2006, pers. comm.). I also looked more specifically at the amount of pelican remains versus amount of freshwater fish in the spraints to determine the extent to which pelican is used to compensate for a lack of fish, their preferred food source (Kruuk, 1995).

For comparing the data between pre-migration and post migration collection seasons at Rodeo Lagoon I used an arcsine square root transformation and then performed a t-test, allowing me to see how the otters' diet changes with the disappearance of this new food source. In order to keep my data from expressing bias when analyzing between sites, and between seasons, I kept the analysis of the spraints blind by assigning a random number code to each sample, rather than grouping samples by what I expected to find.

Data collection began on September 22, 2006 and continued until April 4, 2007. I did not collect spraint between November 16, 2006 and March 8, 2007 to account for an imprecise date of winter migration of the brown pelicans. This gap in collection would have hopefully allowed any unfound spraint (spraint containing pelican material consumed in the summer/fall) to disintegrate, with any spraint found after March 8, 2007 to theoretically be from a diet lacking brown pelican as a possible food source. The analysis of the samples, i.e. sieving and identification began in early January and continued until late April.

Results

I compared the observed percentage of brown pelican remains comprising the otter spraint between 101 pre-migration and 98 post-migration samples and found there to be a significant difference, with much more pelican found in the spraint before the brown pelican migration (t-test, $p < .0001$).

Looking at the average percentage of pelican remains comprising the otter spraint (see Figure 2) there was a mean of 38 percent by volume of the biomass in the otter spraint being comprised of brown pelican remains in the pre-migration season and 6 percent by volume in the post-migration season. There was a mean of 56 percent by volume of the biomass found in the otter spraint being comprised of fish remains in the pre-migration season and 86 percent by volume in the post-migration season.

I also looked at the frequency of occurrence of the different species found in the otter spraint. Figure 3 is the frequency of occurrence of various species before and after the migration of the brown pelicans. Pre-migration, brown pelican remains appeared in 56 of the possible 101 otter spraint samples collected and in 15 of the 98 samples collected in the post-migration season. In the pre-migration season at least one of the types of fish appeared in 46 of the samples and appeared in 62 of the post-migration samples.

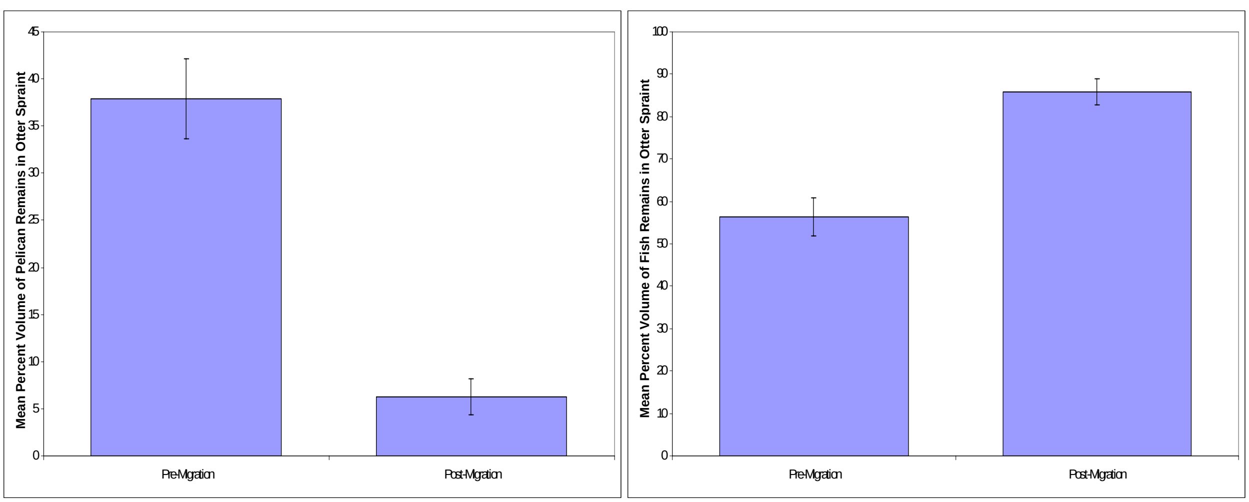

Figure 2: A comparison of the average percent volume of biomass found in river otter spraint comprised of brown pelican and fish remains between the pre and post-migration seasons

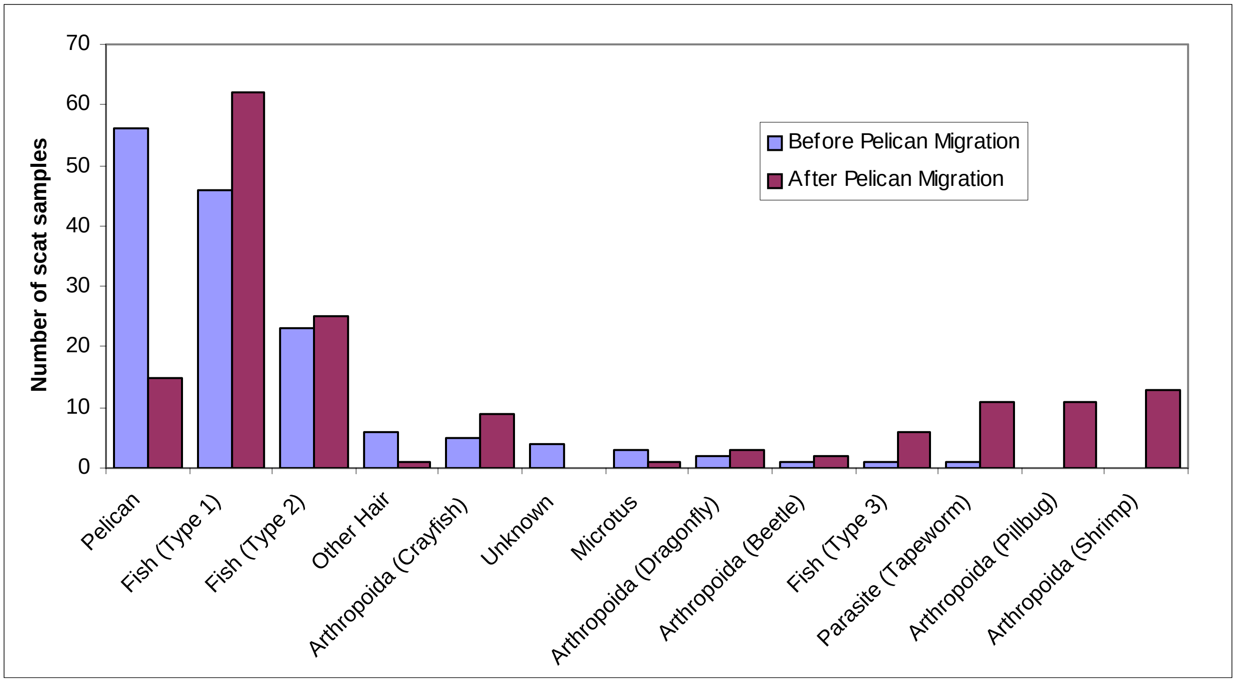

Figure 3: Number of otter spraint samples which contained various food items at Rodeo Lagoon in the Pre-Migration (September-December 2006) and Post-migration season (January-April 2007).

Discussion

As was to be expected from the observed predation of river otters on brown pelicans at Rodeo Lagoon, brown pelicans proved to be a significant part of the river otter diet during their presence in the fall season (pre-migration), appearing in 56 of the 101 pre-migration samples and comprising an average of 38 percent of the volume of biomass in spraint samples. By keeping my samples blind when I ran them, I can confidently say that I was able to correctly identify pelican remains because the data from the spraint is supported by the time frame, that is, a reduction of pelican material found in the otter spraint coincides with the absence of brown pelicans from the lagoon. Unexpectedly, however, brown pelican remains were found in a number of samples collected in the spring season (post-migration). This continued appearance of pelican remains could be explained by several possibilities. The first is that there may have been several “straggler” or “early-bird” brown pelicans, pelicans that did not migrate with the initial main group in December or returned early, ahead of the main group, which may have appeared in samples gathered in the spring season. Though, while I was collecting in the post-migration season I did not observe any pelicans on the lagoon. The other possibility is that spraint left in the early migration season was accidentally gathered in the spring due to some changes in the foliage which allowed me to see spraint that was previously uncollected. It may also be possible that the river otters were scavenging off older kills from before the winter migration.

Regardless, brown pelican remains did make up a significant part of the river otters' diet in the fall season, supporting my hypothesis and the accounts of observed predation. Fish appeared to make up a substantial part of the river otter diet both before and after the pelican migration. Fish remains did appear more frequently and made up a larger percent volume of biomass in the spraint in the post-migration season than in the pre-migration season. It appears that when the pelicans were absent and thus no longer a prey-option the amount of fish in the otter diet increased. I initially expected pelican to act as a replacement food source for what I thought was a declining fish population, but fish and pelican remains appeared together in many samples, and fish always remained the most substantial element of the otters' diet, suggesting somewhat that fish is abundant enough to remain the otters' primary prey. However, without knowing the amount of time and effort the river otters are putting into hunting these fish it is not possible to determine whether the fish populations are declining; the fish species in the lagoon could very well be disappearing but this effect could be masked by an increased amount of fishing effort amongst the river otters. Furthermore, if fish was becoming scarce, I would have expected a much more varied diet in the post-migration season designed to account for this. Rodeo Lagoon has a large population of amphibians (Fong 2007, pers. comm.) and the tendency of otters to prey upon amphibians more when fish populations are depleted (Lanszki et al., 1999) makes it seem that if fish populations were truly depleted in Rodeo Lagoon some amphibian remains would have been observed. However the increased appearance of crayfish in the otters' diet during the post-migration season may reflect an attempt to supplement their fish diet, but the increase is relatively small and so does not reflect the supplementation that might be seen in the conditions caused by a declining fish population.

Another thing changed in the composition of the otter diet between the fall and spring seasons as well. The appearance of a larger amount of arthropoida in the otter spraint in the post-migration season initially appears to show that shrimp and other small aquatic arthropods are acting as a supplemental source of food to the otters. It is more likely that these arthropods were consumed from the gullet of the fish preyed upon by the otters (Barrett 2007, pers. comm.) and merely appear more frequently because more fish has been consumed in the post-migration season. Land arthropods were likely accidentally collected with the otter spraint and were not consumed by the river otters or by any animal the river otters may have eaten.

If the declining fish populations were the cause of emerging otter predation on pelicans, it may be linked with the declining health of the lagoon, through the processes of eutrophication. As a body of water becomes eutrophic, oxygen is consumed resulting in the deaths of biota within the water body including the slower, larger fish, which are a main prey choice of river otters (Botkin and Keller, 2005; Kruuk, 1995). Eutrophication has also been tied to greater predation upon other bird species by river otters in another study by Chanin (1981). As such, it could very well be expected that in an increasingly eutrophic lagoon fish are dying off and being replaced or supplemented with brown pelicans in the diet of river otters (Fong 2006, pers. comm.). Furthermore, eutrophication has been linked with human activity (Botkin and Keller, 2005), as such; this threat to the pelicans may be inadvertently caused by human actions, which may be worth noting in reevaluating the endangered status of the brown pelican.

It is possible that the recent brown pelican predation was really just a bit of opportunistic feeding that evolved out of predation on other types of sea-birds which is a relatively common thing (Duffy, 1995). However, no other bird-remains, that is, outside of brown pelicans, were detected in the otter spraint and no witness observations have been made at the lagoon of predation on any of the other bird fauna. It is a possibility that river otter predation on pelicans occurred merely out of opportunity to acquire a bigger meal for less effort (though without direct observations of the otters hunting it is not possible to say whether hunting pelicans is easier than hunting fish). It would be interesting to be able to examine the relationship between prey-size and frequency of occurrence, to determine whether physical size plays any part in this predator-prey relationship, it was, unfortunately, beyond the scope of this project.

The next important step to understanding what mechanisms may have driven this new predator-prey interaction is to look at how otter diets at several other lagoons (where there have been no reports of predation on pelicans) compare to the otters' at Rodeo Lagoon. If Rodeo's eutrophication is the mechanism driving this interaction then it is likely that one would observe an even greater amount of fish in the diets of river otters outside of Rodeo Lagoon, where they have no need to supplement their diet with birds, arthropods, or anything else. It is very likely that what is actually causing this new predator-prey relationship to emerge is something that has been overlooked in this study, it is thus very important that more research be done on this relationship in order to detect what is the cause.

In addition to collecting and analyzing spraint, I also counted the number of individual pelican carcasses that I found along the shoreline and found there to be about 30 separate pelican kills. With brown pelican populations at Rodeo Lagoon reaching 600 individuals during the middle of summer 2006 and hovering around 50 individuals in late spring and early fall 2006 (eBird, 2007), only about 5 percent of the peak pelican population present was likely killed by river otters. The California brown pelican population continues to grow (Hamilton 2006) and increased predation on these birds is to be expected as they become more abundant. However, the emergence of any new predator to an endangered species should be looked at very carefully, as such, there is a definite need for more research on this new predator-prey interaction.

Acknowledgements

Thank you to Reginald Barrett of UC Berkeley and Darren Fong of the National Park Service for their effort and direction. Thanks as well to John Latto, Ariel Levine, Peter Oboyski, Ashley Holt, and Chad White for acting as my guides through the trials and tribulations of this study.

Bibliography

Anderson, D.W., J.O. Keith, G.R. Trapp, F. Gress, and L.A. Moreno. 1989. Introduced small ground predators in California brown pelican colonies. Colonial Waterbirds 12(1): 98-103

Barrett, Reginald, Professor, Department of Environmental Science, Policy, and Management, UC Berkeley, California. 2006, personal communication

Botkin, D.B., and E.A. Keller. 2005. Environmental Science: Earth as a Living Planet. John Wiley and Sons Publishers, New York. 752 pp

Chanin, P. 1981. The diet of the otter and its relations with the feral mink in two areas of Southwest England. Acta theriologica 26(5): 83-95.

Conroy, J.W.H., J. Watt, J.B. Webb, and A. Jones. 1993. A guide to the identification of prey remains in otter spraint. Mammal Society Publication. 52 pp.

Duffy, D.C. 1995. Apparent river otter predation at an Aleutian tern colony. Colonial Waterbirds 18(1): 91-92

EBird. 2007. Detailed Year Report: High count for Rodeo Lagoon, Marin Headlands, Marin County. Jan 1, 2006-Dec 31, 2006. http://ebird.org/go/eBirdReports

Fong, Darren. Aquatic Ecologist, National Park Service, Fort Cronkite, California. 2006-2007, personal communication.

Halfpenny, J. C. 1986. A Field Guide to Mammal Tracking in North America. Johnson Books, Boulder. 176 pp

Hamilton, C. 2006. Endangered and Threatened Wildlife and Plants: 90-day finding on a petition to delist the California brown pelican and initiation of a 5-year review for the brown pelican. Federal Register, 71(100):29908-29910.

Harris, C.J. 1968. Otters: A Study of the Recent Lutrinae. Weidenfeld and Nicolson Publishers, London. 397 pp.

Kruuk, H. 1995. Wild Otters: Predation and Populations. Oxford University Press, New York. 290 pp.

Lanszki, J., S. Kormendi, C. Hancz, and T.G. Martin. 2001. Examination of some factors affecting selection of fish prey by otters (Lutra lutra) living by eutrophic fish ponds. Journal of the Zoological Society of London, 255:97-103

Lanszki, J., S. Kormendi, C. Hancz, and A. Zalewski. 1999. Feeding habits and trophic niche overlap in a Carnivora community in Hungary. Acta Theriologica, 44(4): 429-442.

Mason, C.F., and S.M. Macdonald. 1986. Otters: Ecology and Conservation. Cambridge University Press, New York. 236 pp.

Merkle, William. Wildlife Ecologist, National Park Service, Fort Cronkite, California. 2006, personal communication.

Rezendes, P. 1992. Tracking and the Art of Seeing. Camden House Publishing, Ontario. 320 pp.