

A Behavioral Comparison of Captive Parakeet Auklets (*Aethia psittacula*) and
Horned Puffins (*Fratercula corniculata*)

Alex Parker
Morgan Elfelt
ZO501

Abstract

We completed a short-term observational study of Parakeet Auklets (*Aethia psittacula*) and Horned Puffins (*Fratercula corniculata*) at the North Carolina Zoological Park in Asheboro, NC. Our objective was to determine differences in time allocation between the species. We found that the Parakeet Auklet was less active than the Horned Puffin, and it also spent more time on land than the Horned Puffin. Further research is needed to draw significant conclusions regarding the behavior of these species.

Introduction

Parakeet Auklets (*Aethia psittacula*) and Horned Puffins (*Fratercula corniculata*) are both sea birds of the family *Alcidae*. Birds in this family are commonly referred to as auks. All extant auks are able to fly, and are well adapted to aquatic life. Their body shape, feet position, and wing structure make them especially well adapted for swimming and diving (Denlinger 2006). The majority of their life is spent on the open ocean, feeding mainly on fish, crustaceans, and jellyfish. Horned Puffins nest in large colonies on cliff faces, building nests in burrows and crevices. Parakeet Auklets will commonly nest among colonies of puffins, also in rock crevices and burrows (Denlinger 2006). There have been few studies of behavior or interaction between these species in the wild, most likely due to their infrequent terrestrial use (Hatch 2002). The North Carolina Zoological Park in Asheboro, NC maintains an exhibit containing Parakeet Auklets and Horned Puffins, as well as Thick-billed Murres (*Uria lomvia*). We conducted a scan sampling survey to determine differences in activity level and energy allocation. We hypothesized that the larger Horned Puffin would be less active than the smaller Parakeet Auklet because of enclosure size limitations. One zookeeper mentioned that the Horned Puffins did not have sufficient space to fly in the enclosure, but the Parakeet auklets were able to take off and fly within the enclosure.

Methods

Observation

We conducted our survey on March 17, 2012 at the North Carolina Zoological Park Rocky Cliff Exhibit. The exhibit is comprised of a steep concrete 'rock' cliff that simulates the nesting sites of both birds and a flowing cold water pool in which they can swim and dive. Prior to our recording, we observed the birds to determine different categories of behavior. The behavior categories we defined were: bathing, swimming, standing/walking, preening, sitting, diving and flying. Bathing was defined as when the birds were splashing on the surface of the water. Swimming was when the birds were floating on the surface of the water. Preening was recorded if the bird was preening while on land or on the water and the location recorded. We chose to define flying, diving, preening, standing/walking, bathing, and swimming as active behaviors, and sitting as a non-active behavior. The focal Horned Puffin was chosen because it had a noticeable dark spot on its wing, and the focal Parakeet Auklet was chosen because it was doing the same thing (bathing) as the puffin at the beginning of the observation period. We observed the birds starting at 1:00 pm and recorded their behavior every 30 seconds for 75 minutes.

Analysis

We analyzed the data by counting the number of occurrences for each behavior, and dividing by 150 (the total number of observations) to determine the total percentage of time spent on each activity.

Results

Time allocation differed considerably between the auklet and the puffin during our study period. The most common behavior of the auklet, with 47% of the observations, was standing/walking (Fig.1). The most common behavior of the puffin, with 52% of the observations, was swimming (Fig.2). The Parakeet Auklet was inactive (sitting) 43% of the time while the Horned Puffin spent only 15% of the time sitting. The least common behavior that was actually observed was bathing, which was only recorded in 1% of the observations. The auklet was observed preening in 7% of the observations and all of these occurrences were on land. The puffin was observed preening 16% of the time with 8% being observed on land and 8% being observed while in the water. In total, the auklet spent only 3% of the time in the water while the puffin spent 60% of the time in the water. We observed both species diving and the Parakeet Auklets flying during the initial observation period, but did not observe either of these behaviors during the survey period.

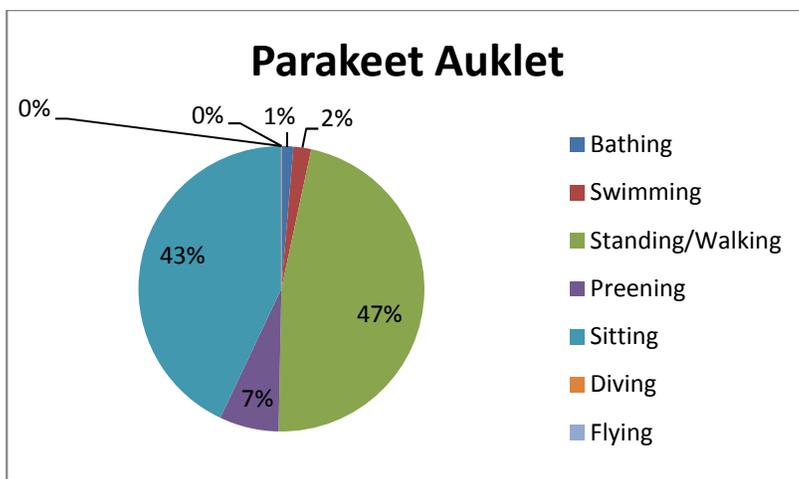


Figure 1. Time allocation of various behaviors of a captive Parakeet Auklet (*Aethia psittacula*) at the North Carolina Zoological Park over a 75 minute time period using 30-second interval scan sampling.

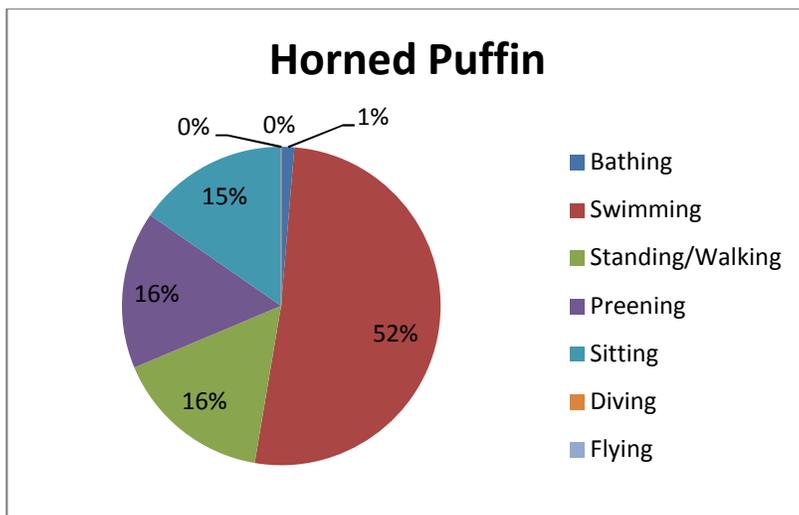


Figure 1. Time allocation of various behaviors of a captive Horned Puffin (*Fratercula corniculata*) at the North Carolina Zoological Park over a 75 minute time period using 30-second interval scan sampling.

Discussion

We hypothesized that the puffin would be less active than the auklet due to its size. This was not supported by our data. This may suggest that the size of the enclosure did not have a significant effect on the activity level of the larger birds. However, during the time the puffin was recorded as “swimming,” which we classified as an active behavior, it was simply floating on top of the water with its head tucked, presumably resting. Furthermore, the zookeeper informed us that we were making our observations between the morning feeding and the afternoon feeding, at a time of day that the birds were less active.

Few studies have reported behaviors of Horned Puffins or Parakeet Auklets in captivity or in the wild. The few studies that have been done have focused on mating behavior (Hunter and Jones 1999) or general monitoring methods (Hatch 2002). Our observed behaviors are probably not directly comparable to behavior of wild individuals of these birds, as both of these species spend the majority of their time in the open ocean. Time spent on land is during the nesting season, when birds are focused on egg-laying, chick-rearing, and nest attendance (Hatch 2002).

In order to make valuable conclusions about auk behavior, captive studies would need to be more intensive, with multiple observation periods of multiple individuals. Behavior of wild auks is difficult to determine using data from captive studies, but comparisons between species in captivity may be useful.

Literature Cited

- Denlinger, L.M. 2006. Alaska Seabird Information Series. Unpubl. Rept., U.S. Fish and Wildl. Serv., Migr. Bird Manage., Nongame Program, Anchorage, AK. Accessed online:
<http://alaska.fws.gov/mbsp/mbm/seabirds/pdf/asis_complete.pdf>
- Hatch, S.A. 2002. Activity patterns and monitoring numbers of Horned Puffins and Parakeet Auklets. *Waterbirds: The International Journal of Waterbird Biology* 25: 348-357.
- Hunter, F.M., and I.L. Jones. 1999. The frequency and function of aquatic courtship and copulation in Least, Crested, Whiskered, and Parakeet Auklets. *The Condor* 101:518-528.

Well done!

A Snapshot of Scarlet Ibis *Eudocimus ruber* Behavior at the R. J. Reynolds Forest Aviary at The North Carolina Zoological Park, Asheboro, NC.

Jerome Brewster

Abstract

The basic behavior of one of a flock of eight Scarlet Ibis *Eudocimus ruber* was studied February 15th 2003, at the R. J. Reynolds Forest Aviary at The North Carolina Zoological Park in Asheboro, North Carolina, over a period of 1.5 hours using instantaneous scan sampling. Behaviors observed in declining order of time spent, included walking on the ground, sleeping, loafing on the ground, perching in a tree, preening, foraging, drinking, and intraspecific interaction. Percentages of time spent terrestrially versus arboreally and active versus non-active were observed to be relatively equal.

Jerome,
Really nice job.
Ted.

Introduction

The Scarlet Ibis *Eudocimus ruber*, is native to northern South America. Attempts at introducing the species into southern Florida failed, but escaped birds can sometimes be seen in the southeast U.S (Kaufman 1996). Hybridization between the Scarlet Ibis and White Ibis (*Eudocimus albus*) of southeastern United States will occur in the wild. This suggests that the two separate species may actually be color morphs of one single species (Sibley 2001). Ibises are known to be highly social, and are most often found in flocks. They detect their food items mainly through touch by probing with the bill in shallow water and mud of various marsh or wetland areas (Sibley 2001). Their variable diet consists of numerous aquatic invertebrates and vertebrates as well as some plant materials (Kaufman 1996). Aside from foraging, Ibises spend most of their time resting and preening (Sibley 2001). A small flock of eight Scarlet Ibis is maintained in captivity at the R. J. Reynolds Forest Aviary at the North Carolina Zoological Park in Asheboro, North Carolina. Captivity provides an excellent opportunity to observe animal behavior in close quarters. A small simple behavioral study was conducted on one ibis of the flock of eight to determine basic behaviors of ibis in captivity including comparisons of time spent in active behavior versus non-active behavior as well as the use of arboreal and terrestrial habitat portions of the aviary.

Materials and Methods

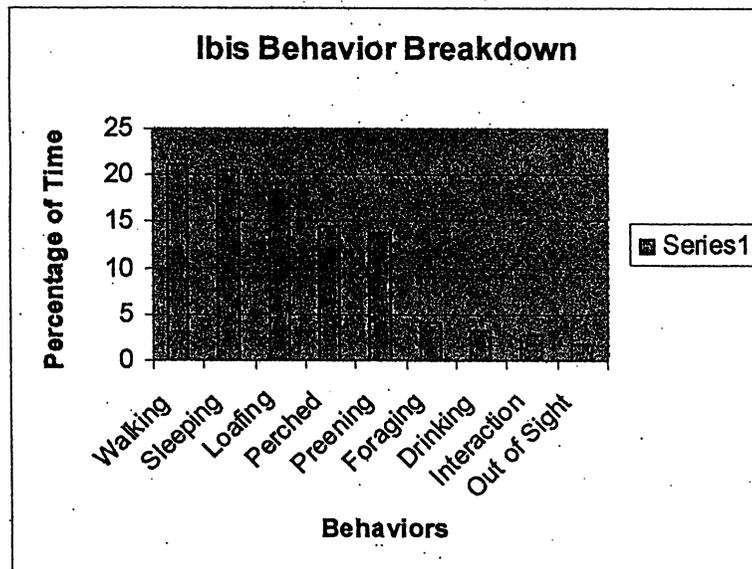
The study was conducted on February 15th, 2003 at the previously mentioned R. J. Reynolds Forest Aviary at the North Carolina Zoological Park in Asheboro, North Carolina. The aviary consists of a glassed in complex with a habitat of lush, leafy tropical plants. Approximately 80 birds of about 35 species inhabit the aviary at any one time. A foot path leads through the entirety of the complex for visitors to travel as they view the exhibit. An artificial stream is included to provide water for waterfowl, bathing, and drinking. Before sampling began, the target species was observed for 10 to 15 minutes to determine categories of behavior. Following this, one individual ibis was identified as the subject for specific sampling. The ibis chosen was identified by its mostly black, slightly malformed bill. Instantaneous scan sampling was then performed on the test subject for 1.5 hours, at an interval of 30 seconds. This made for a total of 180 observations.

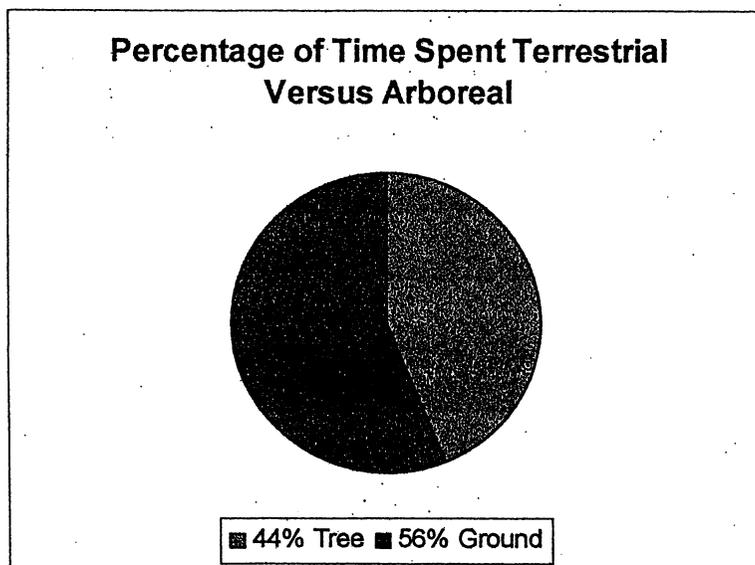
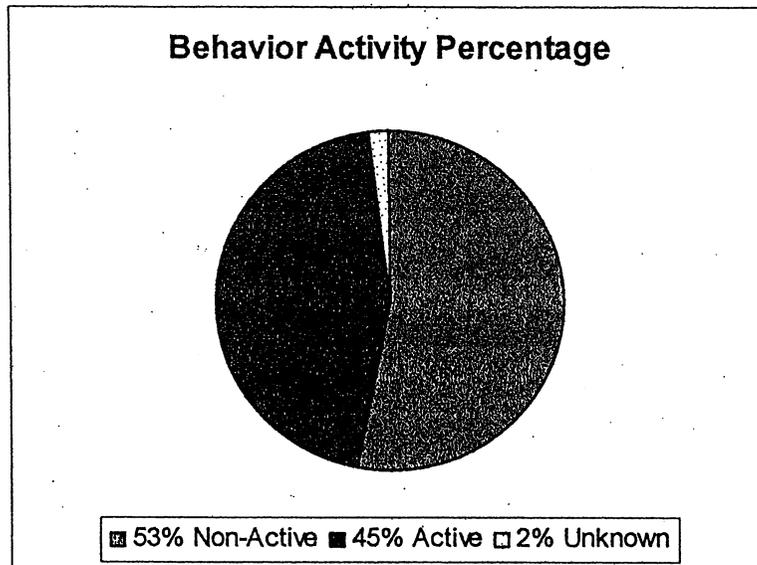
Categories Of Behavior

The categories of behavior were chosen to be all inclusive of every possible behavior that might be seen, and included perching in a tree, loafing on the ground, walking on the ground, bathing, preening, sleeping, foraging, drinking, flying and intraspecific interaction. Perching and loafing were essentially defined as the same absence of movement, but one occurred in a tree, and the other was on the ground. Preening behavior included a posture of holding the wings open to facilitate drying. Sleeping was defined as the posture of the bird with the bill tucked back in wings. Intraspecific interaction was defined as any behavior between 2 or more ibis. Note was also made of whether an activity occurred in the tree branches or on the ground.

Analysis

After the data were collected, behaviors were tabulated and the percentage of time of each behavior was determined. Secondly, the behaviors were divided into categories of active versus non-active, and arboreal versus terrestrial.





Results

The data indicate a wide distribution of time spent in many of the behavior categories. No one or two behaviors monopolized the ibis's time. Also, a relatively equal amount of time was spent in active and non-active behavior, as well as terrestrially and arboreally. Of the original behavior categories, bathing and flying were the only ones not observed at all during the test period. The interactions between ibis included

only 5 instances of a brief one to two second squabble. These squabbles appeared to be associated with a particular foraging area of the aviary. No instances of courtship or breeding behavior were noted. The ibis did maintain a loose flock at all times though, never separating by more than approximately 30 feet. Also of note was the absence of any vocalizations.

Discussion

The general breakdown of the captive ibis behavior appear to be very similar to what has been observed previously in the wild with resting and preening being the most common behaviors when the bird is not foraging (Sibley 2001). Contrastingly, the data indicate approximately 20% of the time spent walking on the ground. In hindsight this walking was often associated with foraging behavior and could likely be placed in that category. Although flying and bathing were not observed at all during the test period, immediately prior to the beginning of the test period, these behaviors were noted. This behavior study provides only the most limited amount of data concerning captive ibis behavior. To make the data more reliable, numerous random sampling periods must be considered as a whole. Time was limited in this case, but this study could be used to help set up a more in depth study of captive ibis behavior. Rather than just the most simple individual data, behavior of the whole flock, and greater inter and intraspecific behavior, including courtship and mating practices would provide a much more detailed look at ibis.

References

- Wilson, C. C. *Methods of Observational Research in the Zoo Setting*, Department of Psychology, University of Washington.
- Kaufman, K. 1996, *Lives of North American Birds*, Houghton Mifflin, Boston, MA
- Sibley, D. A. 2001, *The Sibley Guide To Bird Life & Behavior*, Knopf, NY.

Very Interesting!

Agonistic Behavior of a Captive
Gila Woodpecker (*Melanerpes uropygialis*)

Salina,

Nice job. A copy of your data sheet would
help the reader understand how you did your
analysis.

Salina Kovach
March 3, 2003
ZO 501 Ornithology

Teal

Introduction

Gila woodpeckers (*Melanerpes uropygialis*) are known to be extremely aggressive towards both conspecifics and individuals of other species when defending their nest holes and nest sites (Brenowitz 1978). Agonistic behavior has been exhibited towards Common Fickers (*Colaptes auratus*), European starlings (*Sturnus vulgaris*), bronzed cowbirds (*Tangavius aeneus*), and thrashers (*Toxostoma* spp.) (Bent 1939, Brenowitz 1978, Gilman 1915, Kerpez and Smith 1990). The larger male is the primary nest defender and attacks more frequently than females (Martindale 1982). There are several different gila woodpecker vocalizations associated with agitation and territorial defense including a "gravel call" given when antagonized by other species (Brenowitz 1978). The captive gila woodpecker (GWP) was chosen for a focal animal study (Wilson ????) to observe his aggressive behavior towards several white-winged doves that had been added to the enclosure during the prior day. Preliminary observations revealed the woodpecker attacking the doves that landed on top of the stump bearing his cavity. One zookeeper remarked that the gila woodpecker had pulled tail feathers from two of the doves the day before. The intent of this study was to categorize the woodpecker's activities and locations, and to examine how often the gila woodpecker exhibited aggressive behavior towards the doves.

Study Area and Methods

Observations were conducted from 1:30-3:00 pm on Saturday February 15, 2003 in the Sonoran Desert exhibit at the North Carolina Zoological Park in Asheboro. The enclosure (Figure 1) which houses the woodpecker is also home to house finches (*Carpodacus mexicanus*), inca doves, white-winged doves (*Zenaida asiatica*), phainopepla (*Phainopepla nitens*), and a female Gambel's quail (*Callipepla gambelii*). A black-chinned hummingbird (*Archilochus alexandri*), many Gambel's quail, and several doves roam free within the exhibit but outside of the enclosure. Vegetation present in the enclosure includes a century plant (*Agave parryi*), desert broom (*Baccharis sarothroides*), and desert ironwood (*Olneya tesota*). The glass front of the woodpecker enclosure was covered in strips of brown paper to give the white-winged doves a less exposed environment in which to be introduced to the exhibit. The paper strips made the observation of the woodpecker a little more difficult; however, they also shielded the observer from the subject so behaviors of the subject were not influenced by the actions of the observer or passersby. The size of the enclosure was small enough so that the woodpecker could be continually monitored. The paper strips did not prevent observation at any time. Preliminary observations facilitated the formulation of categories describing the woodpecker's activities and locations (Tables 1, 2). During the observation period, the activities and locations were recorded every twenty seconds using instantaneous sampling (Wilson ????). A countdown stopwatch with an earpiece beeped to mark the end of the time interval. A total of 275 observations were made.

Results

The gila woodpecker spent most of the time (79.64% of observations) in or on his cavity stump with the majority of time spent inside (Table 1). When not in this location, he was frequently observed on his favorite perch on the other side of the enclosure. The most frequent activity was vocalization (Table 2) Most vocalization took place on his favorite perch rather than on the cavity stump (Table 3). Pecking or drumming took place in several locations (Table 4). The GWP did not spend any time near the doves. No attacks were recorded or witnessed during the observation time.

Table 1: Observed locations of the gila woodpecker and the percent of observations in which the woodpecker was present at these locations.

Locations								
Inside Cavity	In Cavity with Head out	On Top of Stump	On Side of Stump	On Base of Stump	Fence	Favorite Branch	Branch 2	Ledge
45.09	9.82	12.73	11.64	0.36	1.09	13.09	1.09	3.27

Table 2: Observed activities of the gila woodpecker and the percent of observations in which the woodpecker exhibited these actions.

Activities			
Vocalizing	Pecking	Flying	Feeding
11.27	4.73	1.09	2.91

Table 3: Percent of recorded vocalizations at each location.

Top of stump	Side of Stump	Inside Cavity	Inside Cavity with Head Out	Favorite Perch	Branch 2	Ledge	Fence
25.81	3.23	6.45	3.23	54.84	6.45	0.00	0.00

Table 4: Percent of pecking observations at each location.

Inside Cavity	Side of Stump	Favorite Perch
30.77	38.46	30.77

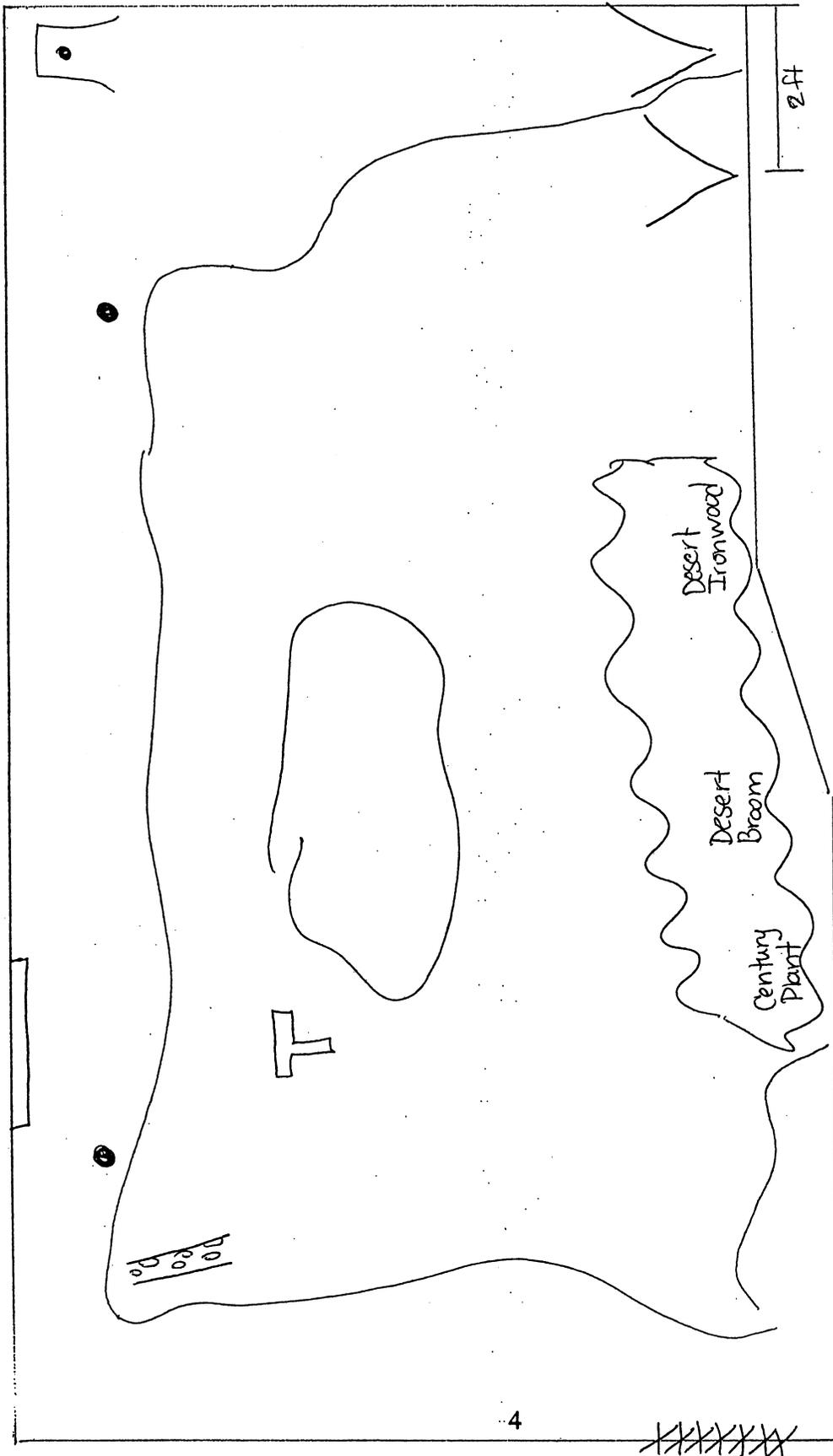
Discussion

The time available to observe the gila woodpecker was a time of the day that the zookeeper referred to as "nap time". It is the time of the day when in the wild, the woodpecker would be the least active. The doves spent most of the time sleeping, or preening in one corner of the cage. Towards the end of the observation period, when they did fly, they mostly flew in small circles returning to the perch they had flown from. They only landed on the woodpecker's stump a few times, and no aggressive behavior resulted. An examination of the woodpecker's aggressive behavior should have been done earlier in the day when both the woodpecker and the doves were most active. What is unknown is whether the activity level was typical of the GWP's afternoon or whether it was greater in response to the presence of the doves. If the GWP had been observed prior to the introduction of the doves, it would be possible to compare the activity levels. Gila woodpeckers are very vocal. Was the GWP more vocal than usual? The types of vocalizations were not distinguished during the study because there was not enough time to observe the GWP and categorize the vocalizations prior to beginning the timed observations. It is possible that some vocalizations were antagonistic. Drumming according to Lawrence (1967), as reported by Brenowitz (1978) is a territorial announcement. It would be interesting to determine if the GWP was more active than usual in this respect. The GWP spent the majority of the time in and around is cavity. Does he usually spend so much time here, or did he remain close to discourage the doves?

Conclusion

The initial intent of this study was to document antagonistic behavior of a captive gila woodpecker towards white winged doves. Because the observations were made during a period of the day characterized by inactivity, what resulted was a catalogue of the woodpecker's activities and locations during the study time with no indication of how it may or may not be related to the presence of the doves. If the focal subject could have been chosen and researched prior to the field observations, a better study would have resulted. Further research might include removing the doves and comparing the activity level to when the doves had been present.

Figure 1: map of gila woodpecker enclosure.



- * Legend:
- Fence XXXX
 - Favorite Perch [vertical line with horizontal bar]
 - Other Perch [T-shape]
 - Cavity Stump [square with dot]
 - Dare Perches [V-shape]
 - Rocks [irregular shape]
 - Ledge [horizontal bar]
 - Food [dot]
 - Plants [irregular shape]

* Dimensions: 1/2 inch = 1 ft

Literature Cited

Bent, A.C. 1939. Life histories of North American Woodpeckers. U.S. National Museum Bulletin 174.

Brenowitz, G. L. 1978. Gila Woodpecker Agonistic Behavior. *Auk* 95:49-58.

Gilman, M. F. 1915. Woodpeckers of the Arizona lowlands. *Condor* 17:151-163.

Kerpez, T. A. and N. S. Smith. 1990. Competition between European starlings and native woodpeckers for nest cavities in Saguaros. *Auk* 107: 367- 375.

Martindale, S. 1982. Nest defense and central place foraging: a model and experiment. *Behavioral Ecology and Sociobiology* 10: 85-89.

Wilson, C.C. Methods of observational research in the zoo setting.

A comparison in the behaviors of three species of Alcidae in the North Carolina Zoo

ABSTRACT: Seabirds of the family Alcidae usually live in large colonies on rocky island cliffs. While there are certainly many evolutionarily conserved behaviors among all species, each species should have developed some unique ethological characteristics. In order to study this, I observed the captive behaviors of the Thick-billed Murre (*Uria lomvia*), the Horned Puffin (*Fratercula corniculata*), and the Parakeet Auklet (*Aethia psittacula*). From this small study, I found a notable difference in each species' affinity for water, their preening habits, and the size of their social groups. Though their behavior at a zoo may differ from wild populations, any difference in behavior might emphasize some evolutionary distinction. In the future, this study would ideally compare both intraspecific and interspecific social interactions.

INTRODUCTION

While birds of the order Charadriiformes are fairly diverse morphologically and ecologically, most have evolved to efficiently make use of the ocean and its shore. Among these, members of the family Alcidae are particularly adept at surviving in colder northern climates and swimming underwater to catch fish. In the wild, they will spend most of their time out at sea while only coming to shore in order to breed. Thus, their wings are short and adapted for both aerial and submarine flight (Robbins, Bruun, and Zim 1966).

Because all members of Alcidae share a common ancestor, it is likely that there are many behaviors shared between them. Also, since they all are pelagic arctic or subarctic birds living in a harsh climate, it would not be surprising for them to have similar life history characteristics. Additionally, most species in the family are colonial in some part (Birkhead 1985), emphasizing the importance of social interaction amongst this taxon. However, because each of these species is genetically distinct, unique behaviors are likely to develop. For example, while many alcids are known to breed on the same islands, Common Guillemots, Razorbills, Black Guillemots, and Puffins prefer to breed in different areas of a coastal cliff, which unsurprisingly leads to distinct associated behaviors (Tschanz 1990).

Many wild behaviors might be altered in captive populations, but any distinctions that can be observed in zoos could still be evidence of interspecific differences. Thus, as long as a study is not specifically focusing on natural behaviors of organisms, captive conditions could still emulate behavioral divergence. Therefore, I attempted to observe and quantify the behavioral differences of three different species of Alcidae, the Thick-billed Murre (*Uria lomvia*), the Horned Puffin (*Fratercula corniculata*), and the Parakeet Auklet (*Aethia psittacula*), at the North Carolina Zoo. Though the sample size of this experiment might not be adequate for strong conclusions, I should at least be able to gain a better understanding of the particular birds in the exhibit.

METHODS

This study was conducted at the North Carolina Zoo in Asheboro, North Carolina. All three species (*U. lomvia*, *F. corniculata*, and *A. psittacula*) were held in the same exhibit, which consisted of a deep pool of water and a ridgy side for the birds to rest when out of the water. The ridges extended upward several meters so that smaller auklets could climb and perch. All together, there were about 50 individuals in the exhibit, consisting of five murrelets, and around twenty of each puffins and auklets.

During the short amount of time that the study could be conducted, a zookeeper was cleaning the cage which might have affected the behavior of the birds.

For each species, I attempted to select three “random” individuals, but the crude “spin and point” method is certainly a rough approximation, at best. Once the individual was selected, I tried to find any identifying features in case the individual became lost from vision. I observed each individual separately for five minutes, and every 15 seconds, recorded a few things about their behavior. These included whether or not the bird was in the water, whether or not the bird was preening, and how many conspecifics were within a two foot radius.

Once data on the nine birds was collected, it was transcribed digitally. Statistical comparisons were made using an ANOVA in JMP. A Tukey-Kramer post-hoc analysis was then used to compare the means between each species.

RESULTS

All three species spent a different amount of time in the water ($P < 0.0001$, $F = 45.1$). The murre spent 92% of the time in the water, which was significantly more than the puffins which spent 67% of the time in water, and both were significantly more often than the auklets' spending 33% of the time in the water. (Tukey-Kramer HSD, $q = 2.36$). Auklets and puffins preened more often than murre ($P < 0.0001$, $F = 12.7$). While there was significant difference between the auklets preening 27% of the time and the puffins preening 18% of the time, they were both different from the murre's 1% (Tukey-Kramer HSD, $q = 2.36$).

Lastly, it is difficult to make any comparisons between the surrounding conspecifics, as I did not record the total population size of any species but the murre. If I were to make a comparison purely on numbers, there would be a significant difference between the conspecifics within the radius ($P < 0.0001$, $F = 28.8$) with puffins having significantly more nearby conspecifics (3.0) than both murre (2.0) and auklets (1.6) (Tukey-Kramer HSD, $q = 2.36$). However, there were far fewer murre than either of the other species making the percentage of nearby conspecifics 50% on average.

DISCUSSION

With the small sample size that I collected, I was able to show that different Alcid species were behaviorally distinct. Since I was not familiar with any species' behavior prior to this study, I was unable to hypothesize specifically how these behaviors would vary. However, the evidence I have provided for their distinct behavior shows that there might have been some behavioral divergence within Alcidae evolutionary history.

The only questionable aspect on this analysis was in the conspecific radius comparisons. While it might be more accurate to compare species weighting on the number of conspecifics in the exhibit, it is far more reasonable to imagine 50% of four individuals around one bird than 50% of twenty birds. Regardless, these differing population sizes should have had some effect on the probabilities of all behaviors, but because the exhibit could not be altered, imperfect experimental design was inevitable. Also, in order to make any strong conclusions about these captive seabirds, it would be necessary to increase the sample size largely. Fortunately, if I were to repeat this, the experimental methods were simple and quick enough to gather a large amount of data in a short amount of time.

It is also important to emphasize that this study was concerning only captive populations of Alcidae species. Even if more data was collected on their behavior from the North Carolina Zoo, wild populations could still exhibit far different behavior than what I witnessed. However, because this study means to emphasize differences in behavior and not specifics, and captive environments are probably more likely to influence similar behavior, it is still likely that differing captive behaviors are the result of divergent traits.

Though this study was successful, it would also be interesting to look at the difference between interspecific and intraspecific social behavior in Alcids. The data clearly shows that Alcids of the same species do like to be around one another, but perhaps the similarity in the family causes these captive Alcids to enjoy the company of other species as well. While this might be hard to record in a similar manner, it could help to understand colonial behavior in Alcids.

LITERATURE CITED

Birkhead TR, 1985. Coloniality and social behavior in the Atlantic Alcidae. Pages 355-383 in *The Atlantic Alcidae*, Academic Press, Orlando, Florida.

Robbins CS, Bruun B, Zim HS, 1966. *A Guide to Field Identification of Birds of North America*. Golden Press, New York, New York.

Tschanz B, 1990. Adaptations for breeding in Atlantic Alcids. *Netherlands Journal of Zoology* 40:688-710.

FIGURES

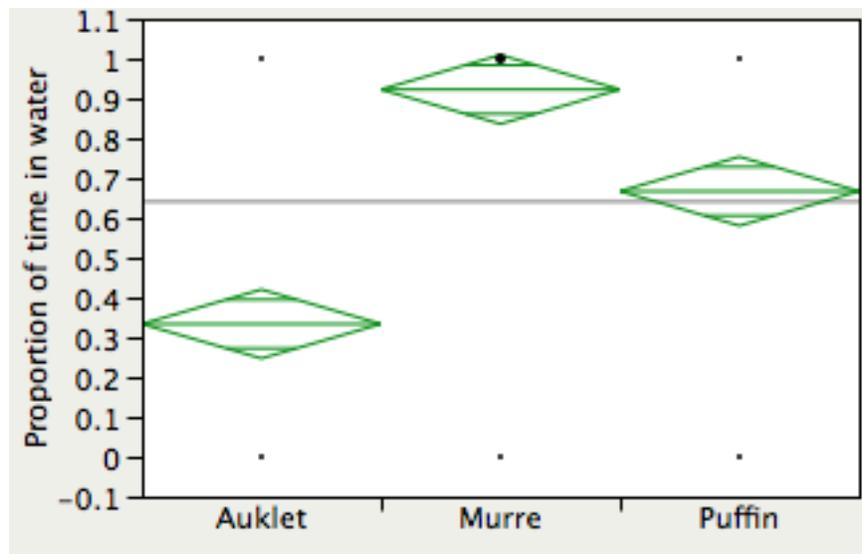


FIGURE 1: Murres spent more time in the water than puffins, and both spent more time in the water than auklets.

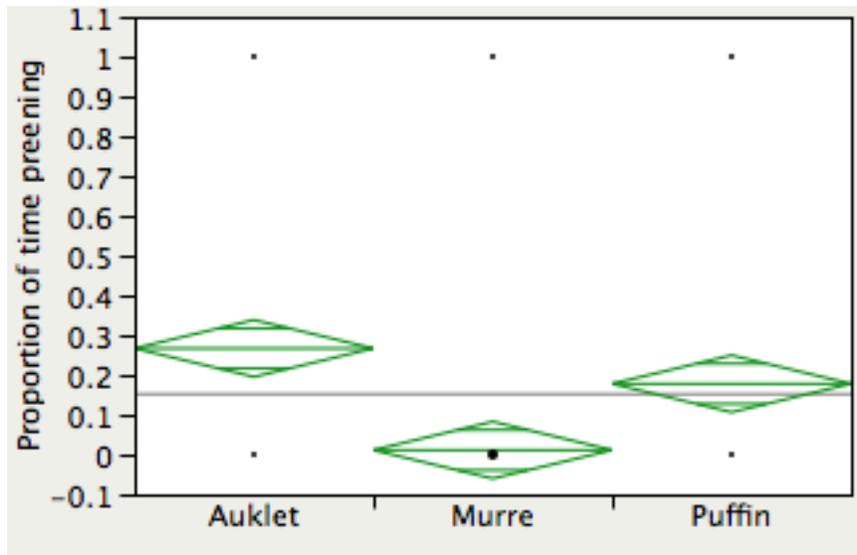


FIGURE 2: Auklets and puffins spent more time preening than murre.

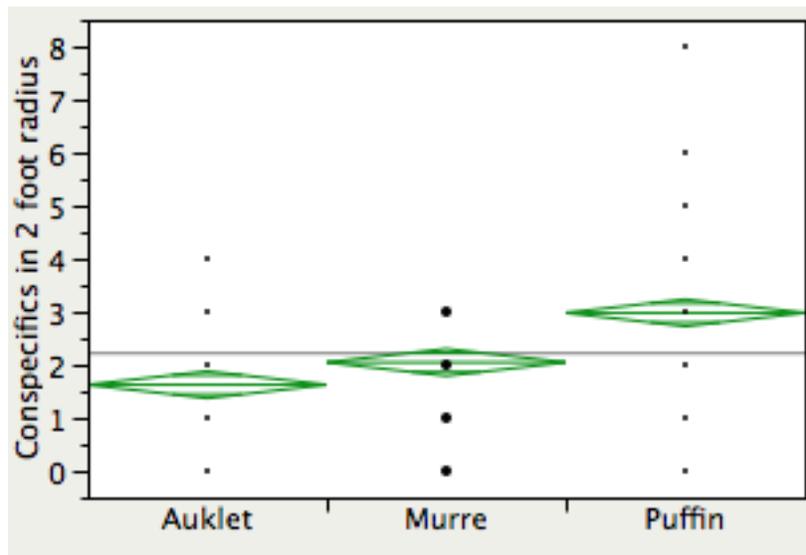


FIGURE 3: Puffins had more conspecifics within their radius than auklets or murre.