Melding Research and Education in a Zoological Setting

By

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The first zoo was opened in London in 1828 and was intended for scientific study, but was eventually opened to the public in 1847. Since then, public dogma has dictated the development, role, and standards concerning the use of animals across the zoological community. Too often there is disconnect between research programs, captive propagation, and public education. In the fight against human driven extinction of earth's flora and fauna, it is vital that these areas be aligned. Thus in an effort to unite research and education in a zoological setting, East Carolina University (ECU) and Sylvan Heights Bird Park (SHBP) have partnered for a collaborative project involving the study of evolution in the African brood parasitic finches (Viduidae), specifically he Pin-tailed Whydah (Vidua macroura). I attempt to quantify the educational impact of Avian Pirates and SHBP, and assess basic demographic factors that will allow insights into what areas of exhibit design pertain to education. It is important to understand what aspects of zoos facilitate visitor learning in areas of conservation and biodiversity. This is vital as Zoos are under new pressure to substantiate claims of education during visits.

Melding Research and Education in a Zoological Setting

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CHAPTER 1: Evaluating Educational Footprints in a Zoological Setting

INTRODUCTION

Throughout their history as an industry, zoos have shifted their mission as public opinion changed. As recently as the 1950s, zoos were seen as purely a form of entertainment, with few facilities participating in active conservation or sending positive educational messages to their visitors. More recently, "edutainment" gained popularity as zoos began to focus on how they could positively impact conservation while also entertaining their audience (Hyson 2004). Today many facilities take an active role in conservation. To be successfully accredited by the Association of Zoos and Aquariums (AZA), an institution must donate a percentage of their overall budget to conservation projects (AZA, 2016).

Zoos are under pressure to evaluate their educational footprint and have been forced to substantiate claims that learning has taken place during a zoo visit. In two generalized categories, zoos can passively or actively communicate with their visitors. All zoos passively communicate with their visitors while 95% of zoos offer some type of active communication (Roe et al., 2014). Active communication or "live interpretation" has been shown to be more effective in eliciting strong responses from visitors (Falk, 2006). With animal shows, "behind the scene" tours, keeper talks, and interactive exhibits are all active lines of communication. While effective, the quality of these strategies varies immensely across the industry. While skilled presenters with high animal activity combined with programs that contain educational humor have been shown to increase visitor receptivity to learning, unskilled presenters can have a negative effect on visitor learning (Falk, 2006; Perdue et al., 2012). Studies have shown that zoo staff and volunteers that interact with visitors often present inaccurate information. This can be a disadvantage as visitors who recognize the misinformation will further discredit the information and experience (Mony et

al., 2008). Active communication can be a powerful tool to facilitate visitor learning, however zoos are often financially constrained in how much they are able to provide (Roe et al., 2014).

Passive communication has changed considerably in the past several decades, but traditional signage is still an industry wide tool used by zoos to communicate with their visitors. A study across 176 zoos from 50 countries showed that 95% of visitors read at least some exhibit signage (Roe et al., 2014). Well-designed signs, with pointed information are still an easy and relatively inexpensive way to educate the public on conservation. Signage has moved away from individualized taxonomic information, and instead focuses on ecological and conservation based messages and how the species on view fits into that picture (Anderson 2003).

The most common method zoos use to passively communicate with their visitors is through exhibit and educational signs. However, it is difficult to construct signs where the majority of visitors will take away the desired message (Woods 2002). In a previous study, the primary reason visitors gave for not reading all of the signs were they were too busy watching the animals (Roe et al, 2014). Furthermore, 53% of visitors cited familiarity with the information, poor or uninteresting information, and too much information caused them to discontinue reading signs. While expensive and often temperamental, new technology has allowed zoos to change traditional signs (Barshaw et al., 2001, Curbey 2015, Serrell 1988, Birney 1988). Incorporating technology into signs has been shown to be important in reinforcing visitor participation in citizenship activities (Swanagan 2000). Well-designed signs, with pointed messages are critical for successfully enticing visitors to fully read them.

Exhibit design has been shown to play an important role in visitor experience. In a traditional sense, a zoo is a place to view captive animals. The general public, however, does not want to see animals in cages. Visitors look for spacious exhibits, with hidden boundaries and

obvious enrichment activities (Woods 2002). Attributes related to exhibit design have shown strong correlations on how visitors feel about zoos and conservation after their visit (Swanagan 2000). Well-designed exhibits promoted a positive connection between zoos and conservation.

There is little doubt that zoos recognize that conservation is an important part of their purpose and education through positive communication is a critical in achieving this (Patrick et al., 2007). However, it is important that zoos attempt to evaluate their methods as culture and technology evolves. The traditional survey is a popular tool for zoos and aquariums by which zoos can evaluate visitors' experiences. Many zoo surveys target how zoos communicate with their visitors. Facilities use surveys to understand what information their visitors leave with and how it was gained during the visit (Woods 2002, Mony et al., 2008, Perdue et al., 2012).

Surveys-based analyses are faced with a number of challenges. Standardization across surveys with discrete answers has proven difficult when evaluating across multiple demographics, as many surveys included short answers, or picture responses (Dierking et al., 2002). A standardized methodological approach in visitor impact research is important when trying to quantify education (Moss 2010, 2012). In a coupled pre-visit and post-visit survey, it was determined that students between 7-15 years experienced positive learning in relation to conservation biology (Jensen 2014). The AZA has made numerous attempts to quantify educational experiences during zoo visits (Moss 2012). In one study, zoo visitation immediately changed students' attitude and knowledge towards conservation biology, and long-term surveys have shown these behaviors persisted and changed long-term interests (Falk et al., 2007). Education is at the core of any zoo or aquarium, yet many zoos do not know their education footprint (Moss 2012).

A direct measure of evaluating the impact of zoos is examining what behaviors they elicit from a visitors post trip and several studies have attempted to quantify these acts. Two behaviors that have previously been quantified are financial contributions and writing letters to legislators (Swanagan 2000). However post-trip evaluations of a behavior prove problematic due to contamination resulting in bias results. For example, researchers were cautious when discussing the number of individuals who reported writing letters to legislators post trip. It is difficult to tease apart if the post-visit survey resulted in letters being sent or the actual zoo visit itself prompted the behavior. Other studies found participation in post-visit surveys was difficult to encourage (MacDonald 2015, Mony et al., 2008, Moss et al., 2012).

In a study at Wellington Zoo, researchers attempted to evaluate if a pledge card could increase visitor actions after a zoo visit (Macdonald 2015). Visitors were educated about the effect of allowing house cat outdoors and asked to eliminate the behavior. Half were only asked while half were asked to sign a publically visible pledge card committing to keep their cats indoors. The results indicated that only half of those that verbally committed, fulfilled the action, while 100% of those who signed the pledge card no longer allowed their cats outside (Macdonald 2015). However, these results must be viewed with caution. Individuals who signed the public pledge card may have fulfilled their promise, but it is also possible they felt compelled to report false fulfillments of their commitment. Surveys involving incentives, rewards, or some type public display can be prone to contamination with poor quality data (O'Toole et al., 1986). In a study at Zoo Atlanta, during a two-week period, zoo attendance was 21,406 persons, 471 surveys were attempted with only 355 completed (Swanagan, 2000). This 25-question survey provided researchers the ability to analyze only two multiple-choice questions, citing completion rate as a primary reason why some questions could not be evaluated.

For zoological institutions, the literature showed most surveys are evaluated based on percentages and lacked formal statistical analysis. Open-ended questions, which are gaining popularity in research, are difficult to evaluate without assigning scales or values to groupings, thereby negating the point of a open ended question (Falk et al., 2007). Discrete answers are easier to evaluate, however developing questions that provide meaningful data with a yes/no answer is a difficult task. Non-survey approaches can be used to gain some understanding of visitor experience, however these lack the standardized approach needed to assess education (Dierking et al., 2002). Not only is it imperative that zoos validate their educational claims, but review is necessary to promote increased learning efficiency.

Too often there is disconnect between scientific research programs, captive propagation, and public education. In the fight against human driven extinction of earth's flora and fauna, it is vital that these areas be aligned. Thus in an effort to unite research and education in a zoological setting, East Carolina University (ECU) and Sylvan Heights Bird Park (SHBP) partnered for a collaborative project involving the study of evolution in the African brood parasitic finches (Viduidae), specifically the Pin-tailed Whydah (*Vidua macroura*). The exhibit named "*Avian Pirates*" was constructed in summer 2014 at SHBP to fulfill two primary goals. First, to educate people on evolution using brood parasites and second, to study how brood parasitism evolved using birds within the exhibit. Exhibit signage explained brood parasitism in laymen's terms and how brood parasitism drives an evolutionary arms race between host and parasite.

Study objectives and hypotheses

In this study, I attempt to quantify the use and effectiveness of various sources of information by conducting a survey on visitors to Sylvan Heights bird park. Sylvan Heights Bird

Park (SHBP) is a unique facility compared to other zoological institutions with the primary difference being that it focuses exclusively on birds. Located in a rural tier 1 county of Eastern North Carolina, it is important for SHBP to gain a better understanding of the perceptions and expectations of its visitors. Are visitors expecting a formal education experience, a balanced day of "edutainment", or just an entertaining day outside?

At the core of any zoological institution is the basic objective of educating people about the natural world. It is difficult to quantify educational experiences, particularly when diverse demographic audiences are involved. Several organizations have made attempts at gauging the impact of specific exhibits at various zoos and museums, with varying degrees of success (Moss et al., 2007). Specifically, this study tested the following hypotheses:

1) *Individuals will obtain more information from non-traditional methods such as staff interactions, over traditional signage.*
    a) Individuals who engage in staff interactions via "keeper talks" or "ParkTalks" will perform better on detail oriented questions in the survey, or
    b) Effectiveness of traditional signage and staff interactions will vary based on demographic features such as age and gender, or
    c) Traditional signage, staff interactions, or other learning tools will vary by individual with no clear correlation between delivery method and cohorts.

METHODS

Survey

The East Carolina University Medical Center Institutional Review Board Office approved "Melding Research and Education in a Zoological Setting" prior to the start date under the

project code UMCIRB 15-000342 (Appendix). The survey was administered over 19 different days, (9 weekend days, and 10 week days), between the dates of 9/29/15 and 1/15/2016.

Park visitors were presented surveys prior to exiting the facility after their visit. SHBP visitors must re-enter the main building prior to departing through two stairways. Due to the layout of the park, the majority of individuals return via the main stairway. I set up a table to distribute the surveys adjacent to this location and monitored the table to encourage participation. Many visitors would only have one or two family members fill out a survey while they all discussed the questions. Participation was completely voluntary, with small incentive items such as candy and stickers offered for a completed survey.

The Survey Instrument

The focus of the survey was to examine how people viewed SHBP and how they learned during their visit. A double-sided survey containing a total of 26 questions (12 on the front, 14 on the back) was administered to 233 individuals. The survey was constructed to be approximately 50% discrete and 50% open-ended in question format. Discrete questions were designed to avoid forcing a visitor into picking an answer (no response or multiple responses were allowed). For example, the question "Practically speaking, how do you feel you can best support conservation of wildlife?" was followed by; support/visit zoos, donations, volunteering, daily activities (reduce, reuse, recycle), support private breeding centers, or other (refer to appendix X for complete survey). Visitors could then circle yes to the activities they believed were a practical approach to conservation.

The first side of the survey contained 12 check box style questions, while the back side contained primarily open-ended questions along with an area to provide your name, age, sex,

profession, and education level. Prior to administering the survey, it was estimated that it would take approximately five minutes to complete a survey. Many visitors, however, were reluctant to spend more than a few of minutes completing the survey, even when small incentive items were used as a reward for completion. Preliminary analysis showed visitors would complete the first page, but then turn in the half completed survey once they saw the back page. Since demographic information was needed to analyze the results, visitors were asked to complete the first page and at least the personal information at the bottom of the second page.

To evaluate how well staff interactions increased visitor learning at SHBP we tested for differences in responses related to the *Avian Pirates* exhibit from visitors who engaged in active communication related to the exhibit (ParkTalks, Keeper Talks, staff interactions) versus those who did not. The first question gauged if visitors remembered the exhibit by asking them to describe their favorite feature of *Avian Pirates*. The second asked them what obligate brood parasite bird species was being studied. When the survey was turned in, participants were asked if they had joined in a ParkTalk or a Keeper Talk and the two questions were circled if they had. Additionally, for those participants who were recognized as individuals who engaged in interaction at *Avian Pirates* also had the two questions circled.

On completion, surveys were coded with identifying numbers and data entered into excel an excel document based on age group and sex that fed into a summary page. This allowed data to be examined both by cohort, groups of cohorts, and collectively. A cohort was defined as a gender age class, for example: female age class 20-29 (F20-29) a total of 37 surveys were received. Each discrete question was quantified in terms of two metrics, the percent of people who said yes, and the percent of people who completed the question. For example, in cohort F20-29, when asked if zoos were needed to maintain biodiversity (biodiversity being defined

under the question) 97.71% of this age class said yes, with 94.59% completing the question. This data was used to determine what questions to look at in further depth.

UMCIRB approval was received at the end of September 2015, a time during which SHBP first begins to see seasonal a reduction in visitation. The initial proposal called for 1000 surveys administered between July and August 2015 when visitation is highest and an estimated 50 surveys could be collected over 20 administering days with relative ease. However, July/August had an average of 329 visitors a day, while the collection period of 9/29/15 to 1/15/2016 had an average of 68 visitors a day. After review, 233 surveys were deemed to be sufficiently completed based on several published studies using surveys in zoos with similar data sizes (Swanagan et al., 2000, Finlay et al., 1986, Wilson et al., 2001).

Statistical Analysis

I selected four primary questions to focus on based on visual assessment of survey response patterns: 1) Signs were the tools that allowed you to learn the most. 2) The primary purpose of a zoo is conservation. 3) The primary purpose of a zoo is entertainment. 4) Entertainment ranked above education when planning an outing. I used logistic regression in SAS (Statistical Analysis Software version 9.4 for Windows.) to test for variation in visitor response. In each model, I included the additive effects of gender and age, as well as an interaction of these explanatory variables. Visitors were asked to place themselves in age classes (10-19, 20-29, 30-39, etc.), and this data was treated as a continuous variable. The dependent variable was the visitor response (binomial) to each question. Results were considered significant at an alpha value of 0.05. The predicted probabilities and 95% intervals around the modeled relationship are presented (Figures 1-4).

RESULTS

Survey completion

Page 1 of the survey had a completion rate of 98% while page 2 had a 35% completion rate. Out of the 233 responses, 214 provided at least enough information to identify gender and age. The 214 responses with cohort information were used for statistical analysis of the interaction between age and gender with response rate.

Each cohort was defined as follows: F10-19 (11 responses), F20-29 (37 responses), F30-39 (28 responses), F40-49 (14 responses), F50-59 (8 responses), F60-69 (29 responses), F70-79 (16 responses), F80+ (1 response), M10-19 (3 responses), M20-29 (17 responses), M30-39 (5 responses), M40-49 (12 responses), M50-59 (9 responses), M60-69 (17 responses), M70-79 (6 responses), M80+ (1 response), No Demographic (19 responses).

Zoo Communication: Signage

I detected a significant association between age and the responses to the question of whether signs were their primary source of information at SHBP (Figure 1, (β = -0.06, $\pm$ 0.02 SE, χ^2 = 15.03). Older age classes tended to rely less heavily on signage. There was not a significant relationship between responses based on gender.(β = -0.09, $\pm$ 0.13 SE, χ^2 = .46, p = 0.5), nor was there a significant interaction or age and gender (β = 0.03, $\pm$ 0.03 SE, χ^2 = 1.10, p = 0.30). When asked what allowed them to learn the most during their visit 74% of visitors ranked signage as one of their primary sources. However, when visitors were asked to estimate the amount of signage they read at SHBP, on average 58% read 60% or less of a sign.

The sample size for participants who engaged in active communication was very low (37 individuals). Out of the 233 individuals who submitted the survey, 13 remembered a feature of

Avian Pirates and correctly identified the brood parasite (Pin-tailed Whydah). For those who had participated in active forms of communication, 43% correctly answered both questions while 29% who had only participated in passive communication correctly answered both questions. While a two-tailed Fisher's exact test revealed no statistically significant difference between indivduals exposed to active or passive communication (p=0.4875), the response rate was significantly greater among those who participated in active (21 of 37) versus passive (14 of 196) communication (p<0.0001).

Entertainment verse Education

When asked if the primary purpose of a zoo was entertainment, there was a significant relationship between the response patterns and age-class (β = -0.11, $\pm$ 0.02 SE, χ^2 = 34.60, p <0.0001, Figure 3). Younger individuals were more likely to answer yes than older people. When analyzed independently, response patterns between genders were not significant (β = -0.25, $\pm$ 0.16 SE, χ^2 = 2.47, p = 0.12). However for this model, there was a significant interaction between age, gender and response patterns (β = 0.09, $\pm$ 0.04 SE, χ^2 = 7.08, p = 0.0078). Older individuals differed by sex in their responses, with women tending to answer "yes" less frequently.

Only 19% of individuals' ranked entertainment higher than education when planning an outing. For those who did rate entertainment higher, there was no significance difference between response patterns in age, gender, or their additive effect (Figure 4). The results are as follows, gender (β = 0.06, $\pm$ 0.12 SE, χ^2 = .24, p = 0.62), age (β = 0.01, $\pm$ 0.15 SE, χ^2 = .76, p = 0.38), interaction of age and gender (β = -0.01, $\pm$ 0.03 SE, χ^2 = .03, p = 0.87).

Conservation

We did not find statistical difference between the response patterns by age, sex, or their additive effect when respondents were asked whether the primary purpose of a zoo was conservation (Figure 2). The results are as follows, gender (β = 0.19, $\pm$ 0.17 SE, χ^2 = 1.16, p = 0.28), age (β = 0.01, $\pm$ 0.02 SE, χ^2 = .13, p = 0.71), interaction of age and gender (β = -0.06, $\pm$ 0.04 SE, χ^2 = 2.34, p = 0.13)

When asked if zoos were needed to maintain biodiversity (biodiversity being defined in the survey as keeping as many species alive as possible), 96% of visitors answered "yes". However, when asked if the primary purpose of zoos was conservation, only 35% of visitors agreed. Furthermore, only 16% of visitors agreed that captive propagation was an important part of a zoo. The data showed that 27% of individuals listed daily activities such as reduce, reuse, and recycle as a practical way to support conservation, whereas 79% listed visiting a zoo as a practical approach to support conservation.

DISCUSSION

Signs of the Future

The results suggest that signs remain a primary and critical source of information, particularly for younger age groups at SHBP (Figure 1). In 2014, SHBP revised every species sign throughout the park. In addition to higher quality images, the largest change was the massive reduction in text. Older signs had one "low" quality image in addition to three to four sentences. Anecdotal evidence showed that many visitors become overwhelmed and quickly stopped reading exhibit signs thereby missing important messages within the text. With the change in 2014, we focused on higher quality images next to one sentence with a "take home message". This reduction in species text allowed us to stream line conservation signs, but still

keep text in our conservation signs around 5-6 sentences. Many zoos are reducing species-specific text and instead focusing in on big picture messages (Fogelberg 2014).

While traditional signage is a valuable tool used by visitors to SHBP, there are a number of challenges associated with their successful implementation. Signs at zoos are difficult to design; they must provide meaningful information to a huge audience range with a variety of education levels. Additionally, the variability across zoos does not allow for a standardized approach to sign design. The current practice of simplification and reduction of text while increasing "high profile" pictures provides signs that appeal to the largest audience group (Fogelberg 2014). However there is little research into how this affects visitor learning. Which method works best for promoting conservation: targeting a broad audience with a simple message or targeting specific cohorts on a more detailed level?

Industries that revolve around their marketing strategy have examined the cost benefit analysis of targeting specific cohorts verse general populations. In politics, many individuals spend their time targeting specific groups in addition to appealing to the public at large (Holman et al., 2015). In a study examining marketing strategy effectiveness across age and gender, it was found that young males were the most influenced by commercials (Chernin 2008). When educating visitors on conservation, you are fundamentally selling ideas on how they can promote change through their actions.

Signs have rarely been designed to target specific genders or ages in the zoos. However my results suggest that males and females at different ages place varying values on how they utilize signs to gain information during their visit. Young women consistently ranked signs as their primary sources of information more often than young men. Conversely, older male visitors

to SHBP appeared to utilize signs more than their female equivalents (Figure 1). Younger cohorts also used signs more than older generations regardless of gender. At SHBP, this data could provide useful insight on which conservation messages to focus. If the majority of visitors using signs are under 30 years of age, then messages related to conservation should be targeted accordingly (Allen 1982).

With advances in technology, interactive signs are becoming popular. Many facilities recognize that interactive signs increase engagement, which in turn facilitates learning moreso than passive reading (Allen 2004). With the right pathways, information could be layered in interactive signs that allow each user to access information in a personalized manner. Google, Facebook, Amazon, and similar organizations market to the individual (Rust et al 2014). A future platform that allowed interactive signs to deliver personalized messages/information based on the user would allow for an unparalleled delivery method.

Communication

In addition to traditional signage, SHBP offers daily "keeper talks", weekly "ParkTalks", and staff interactions. Due to the number of visitors SHBP receives annually, staff interactions and keeper talks have anecdotally appeared to be useful forms of personalized communication. Often, larger facilities do not find these as feasible methods to routinely communicate with a large percent of their visitors. However, during the peak visitation months of July and August, SHBP sees an average of 329 visitors a day with an average staff of 10 (part time and full time) staff. The visitor to staff ratio allows SHBP to consider these interactions as viable forms of communication.

In an effort to understand how well staff interactions increased visitor learning at SHBP we looked for higher scores on questions related to the *Avian Pirates* exhibit. I compared responses from visitors who engaged in active communication related to the exhibit (ParkTalks, Keeper Talks, staff interactions) to those who did not. The results suggest that visitors who were engaged in active communication on *Avian Pirates* were more prone to remembering details, although the differences were not statistically significant. I do, however, find that visitors who engaged in active communication related to *Avian Pirates* responded to questions related to the exhibit significantly more frequently than those who did not. This could suggest they had a more meaningful experience since they were willing to take the time to respond. The majority of visitors who participated in passive communication did not answer the question, which suggests that they did not know the answer, remember the exhibit, or did not feel obligated to spend the time completing page 2. The overarching theme of the exhibit discussed what a brood parasite was and how different species of parasite impacted the host/environment. (The two main species discussed was the Pin-tailed Whydah located within the exhibit and the Brown-headed Cowbird native to North America). An even simpler message conveyed was that the exhibit was built in collaboration with ECU and the birds on exhibit were being used in current research projects. While the survey hinted that staff interactions could help to increase visitor retention of smaller details, further examination of this issue is needed.

For effective communication, zoos need a better understanding of their personal visitation base. There are over 300 accredited AZA zoos, another 50 collections certified by the Zoological Association of America (ZAA), and numerous facilities that are not accredited by either organization however fulfill similar missions. Achieving industry standards is difficult as the numerous facilities found in North America differ greatly. As a public facility, SHBP was

originally the only approved non-AZA member, however is now currently listed as an AZA Conservation Partner. SHBP is a mono taxon facility that specializes in Anseriforms, further more it is located in a tier 1 county as defined by the North Carolina Department of Commerce. The city of Greenville, NC boosts a population of almost 90 thousand and be located 45 minutes from Scotland Neck, NC represents the closest urban population of size. As an academic city, much of Greenville's population is students of East Carolina University. Furthermore, out of the forty-six thousand visitors in 2015, 22% were k-12 students participating in educational programs offered at the park. SHBP has a very unique visitor population compared to other zoo facilities. Much of the research done on zoo communication focuses on large facilities that see as many visitors in a month that SHBP sees in a year. Designing communication strategies for SHBP is an extremely different undertaking compared to other zoos, just as designing strategies for top tier zoos like San Diego, Disney, SeaWorld, etc. all vary. Each facility must gain a better understanding on their visitors, where they are coming from, why they are coming, and how to provide them with meaningful information during their visit.

Conservation in Zoos

There is little doubt that zoos recognize that conservation is an important part of their purpose (Patrick et al., 2007). However, our results show that visitors to SHBP are not as convinced about the importance of conservation in zoos (Figure 2). When asked if zoos were needed to maintain biodiversity (biodiversity being defined in the survey as keeping as many species alive as possible), 96% of visitors answered yes. However, when asked if the primary purpose of zoos was conservation, only 35% of visitors agreed. Furthermore, only 16% of visitors agreed that captive propagation was an important part of a zoo. Captive propagation was

defined as "breeding animals" in the survey. Fundamentally these are competing statements. It is interesting that visitor's view zoos as important to maintain biodiversity yet do not believe breeding animals is important component of zoos. How do zoo visitors believe zoos maintain biodiversity? At SHBP, 86% of visitors listed education as the primary purpose of a zoo, with were no significant differences between cohorts. Zoos spend millions of dollars on active conservation (AZA 2016), however there appears to be a disconnect between this fact and public perception. It is important that zoos do a better job informing people how they directly impact *in situ/ex situ* conservation, as it is equally important that zoos balance resources between conserving the organisms they work with and educating their visitors.

Research has shown that people can become overwhelmed when faced with large problems that do not have clear answer (Ballantyne et al., 2007). I believe that an important part of zoo is not only to educate individuals on conservation, but also to provide them with tangible solutions that can be incorporated into their daily lives. My survey showed that only 27% of individuals listed daily activities such as reduce, reuse, and recycle as a practical way to support conservation, whereas 79% listed visiting a zoo as a practical approach. As previously suggested, visitors to SHBP believe that zoos are important to conservation via education, however less than one third of visitors believed that daily activities are not a practical solution to conservation. Zoos must understand what messages their visitors are leaving with, and for the sake of conservation, it must be positive. It is my opinion that a zoo has failed if a person leaves highly informed on the dangers of deforestation, carbon emission, overpopulation, etc. but is left overwhelmed and without direction. While it is important that a visitor understands the conservational challenges the world faces, they must leave a zoo with a positive message on how they can personally help.

Entertainment in Zoos

Our data suggests that younger cohorts answer yes more often when asked if the primary purpose of a zoo is entertainment. There was also a substantial difference between the development of zoo perception between males and females (Figure 3). It is essential that zoos educate their visitors, however it is just as important that people have fun at a zoo. Zoos recognize that the majority of their non-student visitors are family groups that have come to teach their children about the natural world in addition to entertaining them (Bruni et al., 2008, Dierking et al 1994). Self-reflection and outdoor activities have shown to be beneficial for families (Therkelsen 2015). As individuals age and develop a family, it makes sense that they would look for educational yet entertaining opportunities. Our data suggests that women place a stronger value on using zoos as an educational experience.

It should be noted that the caveat to voluntary surveys is that they are not a random sample of a population. It could be presumed that a zoo visitor is a unique subset of the general population (Swanagan 2000). For a voluntary survey, it is also likely survey respondents are people that enjoyed their experience at SHBP and were thereby willing to put the time into a survey. These biases should be considered when interpreting the findings here.

CONCLUSION

The key to conservation is education, and the key to education is to make it fun. As zoos evolve to meet societies expectations they must continue to internally evaluate their methods in order to provide an educational setting that allows visitors to connect with nature in an enjoyable environment. Our results show that traditional signs are an important part of visitor learning. As

zoos gain a better understanding of their personal visitation base they will be able to create targeted signs that best facilitate learning.

Active communication via Keeper Talks, ParkTalks, and staff interactions are still an important form of communication for zoos. While inconclusive, our results suggest that active communication for SHBP may enable visitors to better remember exhibit details than passive communication. Future studies should be directed towards gaining a better understanding of how passive and active communication components relate to visitor learning.

For passive communication via traditional signage, zoos must develop methods for evaluating the effectiveness of sign design. Our results show that this method is still a primary source of information for visitors at SHBP. I would predict that while effective, the traditional sign will give way to technologically interactive signs better utilized by future generations. As this new technology develops, it is critical that zoos understand their visitors so that information can be presented in the most effective manor. Active communication will continue to be a viable form of communication used to varying success depending on the size of the facility and the skill of the communicator.

While it is important that zoos continue to evaluate how they communicate with their visitors, self-reflection is needed to address what messages they are sending and how they relate to the current sociologic climate. “At Sylvan Heights Bird Park, we not only seek to entertain and engage visitors, but to inspire and educate them about the importance of waterfowl, wildlife and wetland conservation” (Sylvan Heights Bird Park 2016). In order to fulfill that mission, SHBP needs to evaluate the messages their traditional signs are providing, in addition to how active communication affects their visitors.

FIGURES

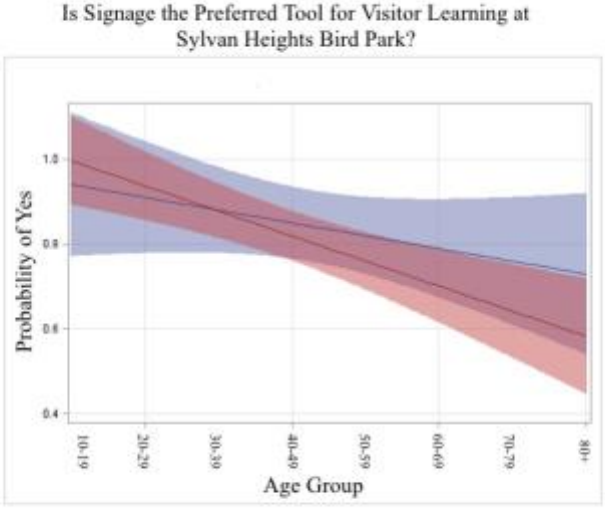


Figure 1 Are signs the preferred tool used by visitors to SHBP to facilitate learning? Male (blue) and female (red) showed significant differences across age cohorts.

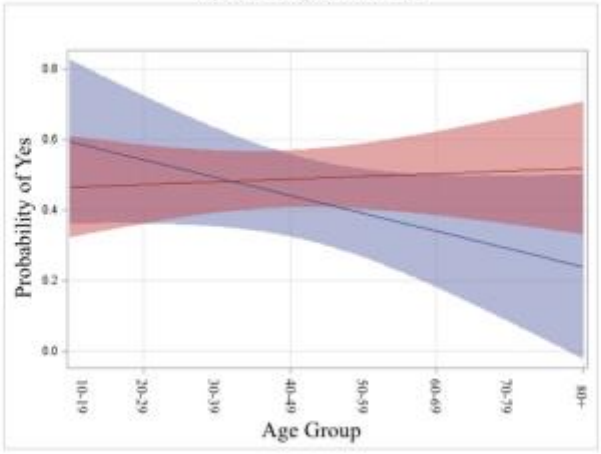


Figure 2 Do visitors to SHBP believe that conservation is a primary purpose of a zoo or aquarium? Male (blue) and female (red).

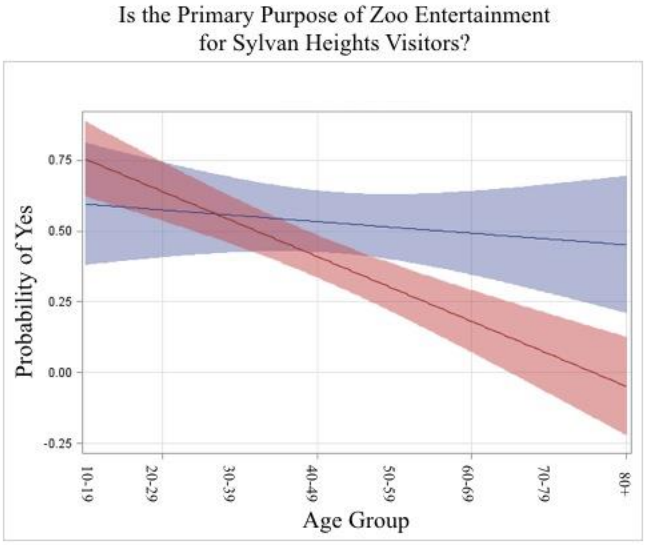


Figure 3 Do visitors to SHBP believe that entertainment is a primary purpose of a zoo or aquarium? Male (blue) and female (red).

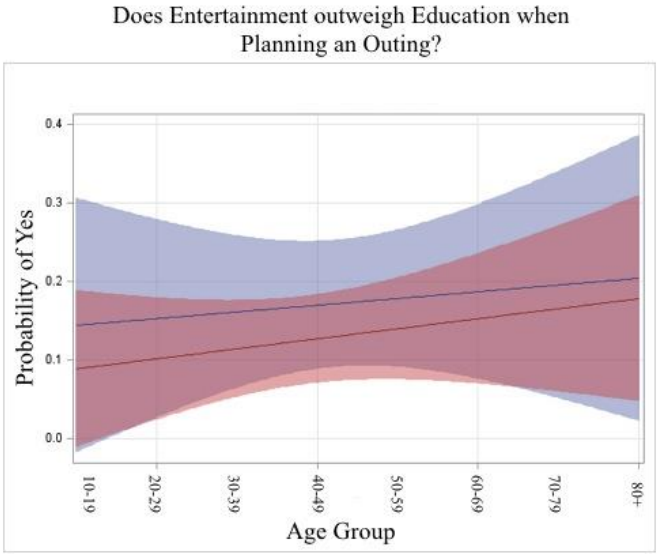


Figure 4 When visitors are planning an outing, do they rank entertainment above education in terms of importance? Male (blue) and female (red).

CHAPTER 2: Defining Pin-tailed Whydah (*Vidua macroura)* Song

INTRODUCTION

In birds, obligate brood parasitism is found in 1% of species (~100 species total). Obligate brood parasitism is a behavior in which female birds lay their eggs in the nest of another species, thus playing no part in the incubation or development of their offspring. Rather, the host species provides care for the parasitic young. Although obligate parasitism is relatively rare, facultative brood parasitism is becoming increasingly documented among species (Yom-Tov et al., 2006). Despite its rarity, obligate brood parasitism has independently evolved seven times in birds (Sorenson et al., 2001). Among these lineages, obligate brood parasitism has evolved twice in Passeriformes, in the *Molothrus* genus of Icteridae in the New World and in the Old World Viduidae (Payne 2010). Passerines comprise almost fifty percent of all extant bird species, and members of the oscine Suborder are commonly known as the "songbirds" (Payne 2010). *Molothrus* are cowbirds common to open fields, similarly Viduidae are a family of finch-like grassland birds. Since songbirds require developmental exposure to conspecifics to learn species-specific song (Hauber et al., 2001), both parasitic songbird groups must have evolved unique mechanisms to support appropriate conspecific recognition and song.

Evidence For Learned Song in Brood Parasitic Birds.

Given the challenge that brood parasitism poses for conspecific song learning, it is worthwhile to review evidence for song learning in brood parasitic birds. Given their unusual developmental situation in which they are isolated from their parents, it is reasonable to hypothesize that brood parasitic songbirds would resort to a strong innate component in their species recognition. In fact, it has been shown in hand-raised cowbirds that despite being visually

and acoustically isolated from other cowbirds that females still presented copulatory postures when presented recordings of male cowbird courtship songs (King et al., 1977).

Some viduids are known to imprint upon their heterospecific host, shaping both adult song structure and mating preferences, and indicating that song is at least partially learned. Indigobirds (Vidua spp.) serve as the best-described example of this as host song learning and mimicry is a driver in speciation (Sorenson et al., 2004). Both the male and female imprint upon host song, and select future mates based upon this (Payne et al., 1998, Balakrishnan et al., 2006). In addition to learning their hosts' songs at the nest, indigobirds have been shown to learn indigobirds-specific song (i.e., not host song) from adult indigobirds (Payne et al., 1995).

Another commonly used line of evidence for song learning is regional song dialects (Marler 1970). If song is completely innate, we do not expect to see dialects as song characteristics should be passed on faithfully from one generation to the next in the absence of genetic mutations that cause song difference. Evidence for local song dialects in *Vidua* is well documented in indigobirds (Payne 2010). Regional dialects have not been documented in any whydah species (Payne 2010).

Study Species

The pin-tailed whydah *Vidua macroura* is a small parasitic songbird that is native to sub-Saharan Africa. Unlike their congeneric indigobirds, *V. macroura* does not seem to incorporate large parts of their host species' songs into their song repertoire, suggesting the possibility that their songs may be innate (Payne et al., 1998). During the breeding season, female *V. macroura* lay three to four eggs on consecutive days up to six times for an average 25 eggs in a single season (several days of rest between each egg group). Rarely are there more than two eggs per

host nest. Their eggs are 14.5-16.6 by 11-12.2 mm, non-mimetic and broader than eggs of waxbills (Payne 2010). Whydahs are polygamous; with a single male soliciting to females from highly guarded breeding territories. Females select males based on morphological characteristics such as tail length in whydahs, and song structure in indigobirds (Barnard 1990). In cuckoos and cowbirds, single parasitic chicks can consume their host's entire breeding season potential (Davies 2011).

The song of the Pin-tail Whydah (*Vidua macroura*) is not well defined in the literature. A compilation of two primary online song databases only produces several dozen recordings (Macaulay Library at the Cornell Lab of Ornithology and xeno-canto). Mimicry has not yet been identified within *V. macroura*, however there has been debate as to whether that is due to lack of research or because they do not mimic their hosts song (Payne 2010). Other whydah species are known to mimic, and their hosts begging, contact, song, and alarm calls have been identified (Payne 2010). Most *Vidua* species have a variety of rapid chatter calls in addition to their song bouts (Payne 2010). The general definition of a song is rather arbitrary, however songs are considered to be complex, long, and produced by males during the breeding season. Calls however tend to be short, simple, and produced by both sexes throughout the year (Catchpole et al., 2008).

In this chapter, I detail the song of the pin-tailed whydah to test whether they have moved towards innate song production as an adaptation to brood parasitism. I visually compare the song composition of captive whydahs housed at Sylvan Heights Bird Park to document song repertoire structure, and individual variation. Additionally, I made comparisons between

recordings on Macaulay Library at the Cornell Lab of Ornithology, the public Xeno-Canto database and new recordings of birds at SHBP.

METHODS

Pin-tailed whydahs were housed in two large flight aviaries (6"x8"12") at SHBP in the exhibit *Avian Pirates*. Two other aviaries were in between the whydah aviaries to minimize aggressive interactions between male whydahs. Eight other species of songbird were also housed in the same aviaries. The Red-cheeked cordonbleu *(Uraeginthus bengalus),* Blue-capped cordonbleu *(Uraeginthus cyanocephalus),* Senegal firefinch *(Lagonosticta senegala),* Orange-cheeked waxbill *(Estrilda melpoda),* Red-rumped waxbill *(Estrilda charmosyna),* Orange-breasted waxbill *(Amandava subflava),* Society finch *(Lonchura striata domestica),* Village indigobird *(Vidua chalybeata).*

I took recordings using a Sennheiser ME 66 Directional Microphone and an Iphone 6S using the program MicPro. First recordings were attempted in October 2015 through December 2015. Males were named after their aviary number. Pin-tail Whydah "male one" dropped first tail feathers on October 26th, with "male four" dropping feathers starting November 6th indicating a transition out of breeding condition. Several weeks prior to tail feather loss both males showed reduced singing. By the end of November both males showed almost no singing. Subsequently record attempts were discontinued until males returned to breeding plumage as they showed reduce breeding behavior and vocalizations. In mid-February 2016 both males had molted into their breeding plumage and could be heard singing throughout the day. Initially recordings were made outside Avian Pirates from a chair located 6ft in front of the aviary. Both males were

apprehensive to vocalizing during first recording attempts however quickly become acclimated and exhibited routine behavior.

I recorded the birds while sitting inside aviary adjacent to the focal birds. Since the overarching goal is to breed the *V. macroura*, it was not appropriate for this study to remove males from the aviary and acclimate them to indoor aviaries for song recording. While important for the educational component of the exhibit in addition to breeding *V. macoura*, the other species made recording the two males within the exhibit difficult. All recordings of whydah vocalizations contained song bouts from other non-target species and individuals. In order to identify male one and two, I verbally identified the individual at the end of their vocalizations. Each recording was kept to approximately 3-minute segments. If neither male vocalized during the recorded the track was deleted onsite.

Audacity (version 2.1.0 for Mac) was used to compare recordings by generating spectrograms (Figure 5, 6). Once generated, spectrograms were layered to visually cross reference for common themes and notes.

RESULTS AND DISCUSSION

A total of 53 recordings (212 minutes and 14 seconds in total) contained usable vocalizations from either whydah male. A total of 112 spectrograms (69 for male 4 and 43 for male 1) were compared. Cornell Macaulay Library contained 15 recordings, spanning Kenya, Zimbabwe, and South Africa and xeno-canto contained 14 songs (Xeno-canto 2016, The Cornell Lab, 2016). In general, there was little to no overlap in song syllables shared between birds. The recordings from online databases contained seven identifiable individuals and three shared,

single note elements could be found in 4 birds. The two males at SHBP contained no similar elements with each other, and a single note that was comparable to the online recordings. Additionally, each male had a series of notes strung together in what appeared to be a random assortment (Figure 6).

Visual analysis of the songs reveled no common song elements that were shared between all males. I did, however, identify single notes that were repeated by individual males. The overall lack of similarity among males would suggest that Pin-tail Whydahs are learning their songs since we would expect that if their song were largely innate, that there would be some regularity found in the vocalizations between males (even males that are from different geographic regions). An alternative explanation of the observed results, however, is that the sampled birds differ in components of their genome that control song structure. At the present time, we know little about the origins of the captive birds. Our observation of high levels of song divergence, however, is consistent with what has been observed in other Vidua (Payne 2010).

The most identifiable shared vocalization was the chatter call of both males. The chatter lasted between 0.5-3 seconds and was given alone, between other vocalizations, or in repetition (Figure 5). Each male gave the majority of chatter vocalizations from the same position (both males defended positions that were high in the aviary on a perch located in the corner). Often the chatter from one male would elicit chatter from the second male.

Since the chatter call seemed to be a common element across male *V.macoura,* I would suggest that it may be used as an innate cue for species recognition as has been suggested for cowbirds (Hauber et al., 2001). The chatter may encode a "password" that allows individuals to recognize and imprint on their own species. The password hypothesis was developed in

conjunction with a captive study on Brown-headed Cowbirds (*Molothrus ater*). Chicks between day 0 and 2 were removed from host nest and raised in isolation and were shown to have stronger begging responses when cowbird chatter calls were played. Between days 60-80, juveniles preferred to associate with cowbird chatter call rather than host songs (Hauber et al., 2001). The password hypothesis has not been empirically tested in *Vidua*, however the data generated in this study suggests that the common element shared between the two captive males at SHBP and the online recordings is a similar chatter call. It could be that *V.macoura* employ a similar system as *M.ater,* where juveniles are drawn to vocalizing adults and imprint on their features (both vocal and visual) thereby allowing them to retain self-identification through delayed learning.

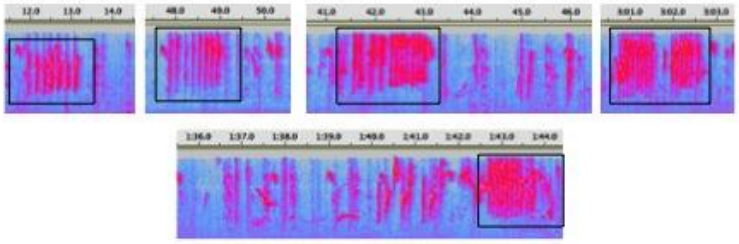
Future Studies

With the addition of two new males in *Avian Pirates*, further analysis of *V.macoura* song should be completed in sound chambers that will allow clean recordings to increase song definition, which would facilitate a more rigorous comparison between males. Obtaining birds from the same known location would allow us to determine if the lack of similarity in this study is due to a small sample size of birds collected/recorded from different locations. This could be addressed in field studies comparing local variation between metapopulations to determine if regional dialects can be identified. Hand-raising *V.macoura* chicks in isolation, would provide empirical evidence of strong structure without outside influence. This would allow us to examine what components of whydah vocalizations are innate

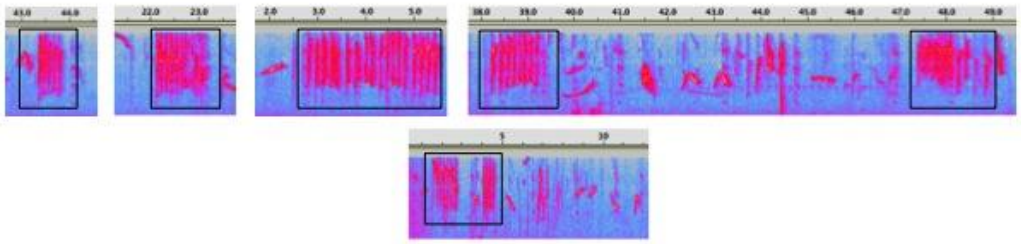
FIGURES

Figure 5 Male 1 and 4 chatter call examples.

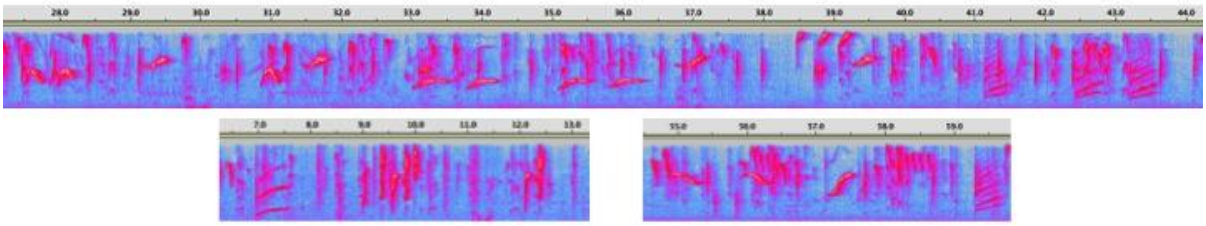
Male 1 Chatter



Male 4 Chatter



Male 1 Random



Male 4 Random

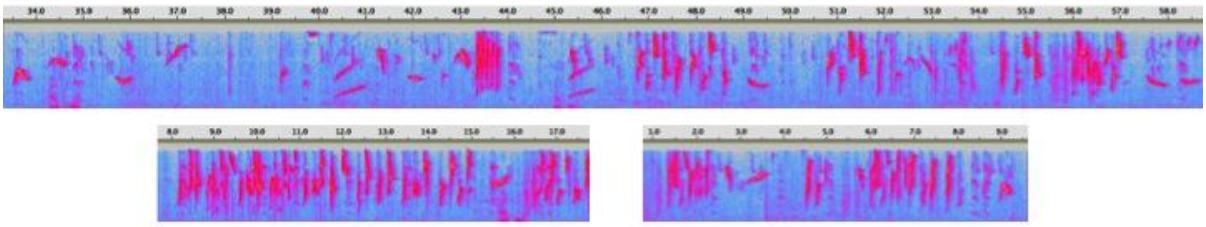


Figure 6 Male 1 and 4 “random” vocalization examples.

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APPENDIX A: Approval Cover Letter from IACUC

Appendix:

IACUC application for Satellite Facility within East Carolina University

Investigator: Dr. Chris Balakrishnan

Date: June 28, 2014

Location of proposed Satellite Facility:

Sylvan Heights Bird Park
500 Sylvan Heights Blvd
Scotland Neck, NC 27874
252.826. 3186

Justification:

Background: ECU and SHBP have collaborated to develop an interactive research exhibit focusing on speciation in indigobirds. The proposed project is led by Dustin Foote, the Assistant Curator at Sylvan Heights who is also a new Master's student at ECU. With one of the largest living ornithological collections in the world, SHBP is building aviaries to house and display several species of *Viduidae* with their appropriate host finches. With a long term captive research colony, the Balakrishnan Lab will have complete access to pursue and answer questions that are not feasible outside captivity. The potential avenues of research using this colony include everything from behavioral ecology to the genomic basis of mimicry. Because of SHBP public image in relation to bird use, all studies will be non-lethal.

Most importantly, the ongoing research projects will serve as a backdrop to education programs on evolution and science inquiry for K-12 and basic undergraduate studies. East Carolina and Sylvan Heights are both committed to connecting youth with their natural environment by getting them engaged outdoors. Students will learn about fundamental science concepts through the interactive research projects centered on the indigobirds. Students, for example, will gain an understanding how host-shifts and subsequent divergence in song, lead to reproductive isolation among indigobird species. The exhibit will also feature high-resolution photos of mimetic mouth patterns in parasites and hosts, and therefore highlight the ways in which natural selection can lead to dramatic adaptation.

The facility: SHBP is located in Scotland Neck, North Carolina approximately forty-five minutes from ECU. Established in 1985, and opened to the public in 2006, SHBP is dedicated to

Appendix B: Approval from IRB for Survey

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834

Office 252-744-2914 · Fax 252-744-2284 · www.ecu.edu/irb

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Christopher Balakrishnan
CC:

Date: 9/25/2015
Re: UMCIRB 15-000342
Melding Research and Education in a Zoological Setting

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 9/25/2015 to 9/24/2016. The research study is eligible for review under expedited category # 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
Foote Thesis Proposal-Draft sent to committee.docx	Study Protocol or Grant Application
SHBP Main Survey.docx	Surveys and Questionnaires
Survey Consent Letter.docx	Consent Forms

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

Appendix C: SHBP Survey

Sylvan Heights Bird Park

Optional Survey

Sylvan Heights Bird Park (SHBP) is committed to educating and connecting the public with the natural world. With your help, we would like to know about your experience today and how it has influenced you so we can better serve that mission. Thank you!

How would you rate your experience today?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Disappointing Exceptional

In the past 12 months, how many times have you visited a zoo or aquarium?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5+

What is your primary reason for visiting a zoo or aquarium? (choose two)

Fun day out ☐ Yes | ☐ No

Quality family time ☐ Yes | ☐ No

Education ☐ Yes | ☐ No

Entertainment ☐ Yes | ☐ No

Animals ☐ Yes | ☐ No

Other _____

What is the primary purpose of a zoo or aquarium in your opinion? (choose two)

Entertainment ☐ Yes | ☐ No

Education ☐ Yes | ☐ No

Conservation ☐ Yes | ☐ No

Propagation (breeding animals) ☐ Yes | ☐ No

Other _____

Do you think zoos or aquariums are needed to maintain biodiversity? (Keeping as many species alive as possible?)

☐ Yes | ☐ No

How much of an exhibits sign would you read on average?

☐ <20% ☐ 40% ☐ 60% ☐ 80% ☐ 100%

How much did you expect to learn today?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Nothing A lot

Sylvan Heights Bird Park

What tools allowed you to learn the most? (choose two)

Exhibit information signs ☐ Yes | ☐ No

Staff interactions ☐ Yes | ☐ No

Personal observations ☐ Yes | ☐ No

Videos/technology ☐ Yes | ☐ No

Programs ☐ Yes | ☐ No

Other _____

What would you like to see changed in zoos or aquariums?

Exhibit signs/information ☐ More | ☐ Less

Staff interactions/talks ☐ More | ☐ Less

Exhibit space/park size ☐ More | ☐ Less

Educational/interactive exhibits ☐ More | ☐ Less

Animal interactions ☐ More | ☐ Less

Other _____

Practically speaking, how do you feel you can best support conservation of wildlife? (choose two)

Support/visit zoos or aquariums ☐ Yes | ☐ No

Donations ☐ Yes | ☐ No

Volunteer ☐ Yes | ☐ No

Daily activates (recycle/reduce/reuse) ☐ Yes | ☐ No

Support private Breeding Centers ☐ Yes | ☐ No

Other _____

When planning a outing, is it more important you educate or entertain everyone?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Education Both Entertainment

How much do you think you learned today?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Nothing A lot

Sylvan Heights Bird Park

Do you plan to return to the Sylvan Heights?

☐ Yes | ☐ No

Did you become a member of Sylvan Heights today?

☐ Yes | ☐ No

Why, or why not?

Are zoos and aquariums your primary source to see wildlife? Where else to you go to see nature?

What exhibit did you spend the most time in or observing?

What about your visit surprised you the most?

What is your definition of a zoo? Are we a zoo?

Sylvan Heights Bird Park

Name _____

Age 10-19 20-29 30-39 40-49 50-59 60-69 70-79 80+

Sex Male Female

Profession _____

Education Level _____

Email _____

How long did you spend at the park today?

Did you enjoy learning about foreign birds you would normally never see, or would you have liked to see more native species?

Where are you from? (county, state)

What other outdoor activities do you regularly do?

What do you remember most about the finch exhibit called *Avian Pirates* (its ok if you don't remember!)?

What was the brood parasite in *Avian Pirates*?

What two areas would you like to learn more about?

Details about individual bird species	☐ Yes | ☐ No
Local environments	☐ Yes | ☐ No
Endangered species	☐ Yes | ☐ No
Conservation	☐ Yes | ☐ No
Animal trivia	☐ Yes | ☐ No
Science	☐ Yes | ☐ No
Other	

Sylvan Heights Bird Park

This information is voluntary; however it is important for us so we may better understand how to reach the diverse needs of SHBP visitors.
With your permission, we would like to contact you via email two months from now for a brief follow-up to see if the experience has changed you. We will not use your email for any other purpose. Do you grant us permission?

☐ Yes | ☐ No