Sexual Selection in the Wild Inferred using 3-D Printed Decoys and PIT Tags: Male Mate Choice in Yellow-Bellied Slider Turtles (Trachemys scripta)

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Abstract
Mate choice is central to sexual selection, and there is a lack of knowledge regarding male mate choice specifically, despite it being a driver of adaptive evolution and speciation. Mate choice studies have scarcely been conducted in turtles because of the difficulty of observing mating behaviors occurring in water. With developments in technology, observing potential patterns in male mate choice in freshwater turtles has become increasingly feasible. We hypothesize that male mate choice occurs due to female body size being associated with reproductive success. To reflect this, we are testing whether male yellow-bellied slider turtles (Trachemys scripta) prefer to interact with females of larger sizes when presented with two 3-D-printed female decoys of differing sizes.

Each decoy is fixed with a passive integrated transponder (PIT) tag reader that records when previously PIT-tagged males approach either decoy within close range (<40cm). We predict that males will approach the larger decoy more frequently than the smaller decoy. By choosing a female of larger size, males should increase their reproductive success due to increased fitness being associated with body size. This novel approach to mate choice study offers a realistic context in which observing mating behaviors in the wild is feasible with conditions that are not traditionally ideal.

Sexual selection is crucial to the reproductive success of an individual, favoring traits that increase an individual’s fertilization success when there is reproductive competition[1]. Mate choice is the preferences exhibited by one sex that result in mating biases toward the opposite sex[1]. Compared to other taxa, sexual selection is rarely studied in turtles.

Many turtle species with female-biased sexual size dimorphism potentially exhibit male mate choice. Therefore, male mate choice is hypothesized to occur in aquatic turtles because female size is variable, and it is associated with increased reproductive success. Females of larger size can carry more eggs[2] and therefore are able to produce more offspring. In traditional aquatic mating systems, male turtles are likely to encounter multiple females at once and therefore must decide who to mate with to maximize reproductive success.

Introduction
Classic mate choice experiments [3] remove individuals from the population to observe an individual choosing between candidate mates. Conversely, observing mate choice in the wild affords a realistic context though potentially sacrificing details that can be observed in artificial experiments. Mate choice studies of either type have scarcely been conducted in turtles because of the difficulty of observing mating behaviors occurring in water. Previous studies[4] have demonstrated the feasibility of mate choice experimentation in the wild using 3-D printed turtle decoys. However, previous studies [4] were done in relatively clear lakes where video recording enabled the observation of mating behavior with decoys. Many turtle habitats throughout the world have turbid water that makes visual observations impossible, requiring the development of a modified method.

Methods
Study Site:
This study is being conducted at a pond on the Auburn University campus, off Woodfield Dr. in Auburn, Alabama (GPS coordinates: 32.588887, -85.494796). This location has been part of an ongoing ecological study of aquatic turtles where over 200 turtles have been recorded and individually marked to date (ME Wolak, unpublished data).

**PIT-Tagging:**
To determine mate choice behavior in male yellow-bellied slider turtles (*Trachemys scripta*), passive integrated transponder (PIT) tags were inserted into the thigh muscle of male turtles. The PIT tags provide a unique identification associated with each turtle that corresponds with body measurements that have been previously recorded for each tagged individual in the study system (Figure 1).

![Figure 1. PIT-tag (A) Insertion of a PIT-tag that is pre-loaded into the syringe and (B) a previously PIT-tagged turtle that was recaptured one-week post-injection.](image)

**3-D Printing:**
Using a preserved female *T. scripta* specimen from the Auburn University Museum of Natural History, a digital scan was developed to create a realistic female decoy. The specimen was scanned and printed in the Auburn University MakerSpace in the Innovation and Research Commons. Two decoys will be 3-D printed and painted to emulate the females that males may encounter in this mating system. The decoys will be identically shaped and painted but scaled to lengths of 81.5 mm or 211.3 mm, corresponding with the 10th and 90th percentiles of female length from previous research at the study site. The decoys will be fully submerged and fitted with PIT tag readers. The readers attached to each decoy will record close interactions (<40 cm) of males that have PIT tags inserted into their thigh muscles (Figure 2).

![Figure 2. The PIT-tagged male is given a choice between two female decoys of differing sizes. If the hypothesis is supported, we can expect the reader on the larger female decoy to record more interactions with PIT-tagged males than the reader on the smaller decoy.](image)

**Expected Results:**
It is anticipated that the male turtles will interact more frequently with the larger female decoy than the smaller female decoy.

**Acknowledgements**
I would like to thank the Undergraduate Research Fellowship and the Department of Biological Sciences at Auburn University for providing funding for this project.

I would also like to thank Gary Hawkins and Yinbo Chen at the MakerSpace in the Innovation and Research Commons at Auburn University for 3-D printing services.

**Statement of Research Advisor**
McKae has introduced a new direction to my research group, by extending our work into sexual selection in turtles. McKae has begun PIT tagging turtles and has overseen the creation of our 3D turtle decoys. Mate choice in turtles is almost completely unstudied and male mate choice is rarely studied in any animal. This work will also test a major evolutionary cause of widespread turtle sexual size dimorphism.

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References


Authors Biography

McKae Sarkowski is a junior-year undergraduate student pursuing a degree in Organismal Biology- Ecology, Evolution, and Behavior in the College of Sciences and Mathematics at Auburn University. She is particularly interested in evolutionary and behavioral ecology and conservation.

Iwo Gross is a Ph.D. candidate in the Auburn University Department of Biological Sciences. He is broadly interested in the integration of evolutionary ecological theory and conservation practice. Presently, he is studying the potential conservation implications of mating system dynamics in turtles.

Matthew E. Wolak is an Assistant Professor in the Department of Biological Sciences at Auburn University. Matthew earned a B.Sc. from The College of William & Mary, his Ph.D. from the University of California at Riverside, and completed a postdoctoral research fellowship at the University of Aberdeen in Scotland before moving to Auburn. His research investigates the causes of among individual variation in populations and how they affect evolution by natural selection.