AVIAN ECOLOGY IN SOUTH TEXAS AND ITS USE IN CONSERVATION EDUCATION

A Dissertation

by

JANEL LYNNETTE ORTIZ

Submitted to the College of Graduate Studies
Texas A&M University-Kingsville
in partial fulfillment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

May 2018

Major Subject: Wildlife Science

AVIAN ECOLOGY IN SOUTH TEXAS AND ITS USE IN

CONSERVATION EDUCATION

A Dissertation

by

JANEL LYNNETTE ORTIZ

Approved as to style and content by:

April A. Conkey, Ph.D.
(Dissertation Chair)

Leonard A. Brennan, Ph.D.
(Dissertation Co-Chair)

LaVonne C. Fedynich, Ed.D.
(Member of Committee)

Mary E. Green, Ph.D.
(Member of Committee)

Hua Li, Ph.D.
(Graduate Council Representative)

Scott E. Henke, Ph.D.
(Chair of Department of Animal, Rangeland, Wildlife Sciences)

George Allen Rasmussen, Ph.D.
(Vice President for Research & Dean of Graduate Studies)

May 2018

ABSTRACT

Avian Ecology in South Texas and Its Use in Conservation Education

(May 2018)

Janel Lynnette Ortiz, B.S., University of California, Davis;

M.S., California State University, Los Angeles

Co-Chairs of Advisory Committee: Dr. April A. Conkey and Dr. Leonard A. Brennan

The goal of interdisciplinary research is to integrate disciplines using their techniques, data, tools, perspectives, and concepts to improve our knowledge, understanding, or to solve problems existing in a single discipline. As wildlife scientists, we have the wildlife knowledge to execute ecological studies to learn more about our model systems. Conservation education acts as a link between the factual knowledge gathered by scientists and the distribution of that knowledge for the community to understand. I set out to create this link by forming a Student-Teacher-Scientist-Partnership (STSP) to enhance the knowledge and attitudes of students and educators towards birdlife in South Texas through the Wild Bird Conservation Curriculum I developed. I assessed 6th (n=39) and 7th grade (n=52) students' and formal educators' (Pre: n= 25, Post: n = 15) affinity, perceptions, and attitudes towards wildlife, birds, science, and nature prior to and after the program. Students had a positive affinity towards wildlife and attitude towards working with a scientist. Their attitude towards habitat fragmentation and its effect on wildlife improved as well as their perceived knowledge of birds. Seventh grader perceived ability to identify birds improved, yet 6th grader perceptions remained similar. Perceived knowledge of educators towards bird biology and identification remained negative; however, positive attitudes were observed on all other topics. I also incorporated a course-based undergraduate research experience (CURE) into a junior level Wildlife Management Techniques course to assess student (n=38) skills and confidence in bird identification and research, study design, and scientific writing. I observed improved perceived confidence in data management, but no improvement in their confidence in writing or setting up their own bird research project, improved their ability to identify bird species by an average of 18%, however no change in their interest in birdlife prior to and after the study. The students and educators I worked with on this project were introduced to bird survey methodology that I utilize in studying bird populations. I investigated the influence of the Normalized Difference Vegetation Index (NDVI) on breeding landbird abundance using long-term bird monitoring data collected on the East Foundation’s El Sauz Ranch. Positive relationships between avian abundance and NDVI were not always observed, these relationships depended upon the year (i.e., wet or normal rainfall year) and NDVI levels in the month prior to the peak of the breeding season. My results do not completely support previously supported research and theories, suggesting the climatic fluctuations that occur in South Texas landscapes do not always follow earlier findings in the literature. Integrating the tools, techniques, and concepts used in wildlife science into conservation education aids our ability to disseminate our knowledge as scientists to the community, further gaining their support in our efforts and creating conservation-minded citizens.

ACKNOWLEDGMENTS

I would like to thank my co-advisors, Dr. April Conkey and Dr. Leonard Brennan, for their support on this project and allowing me to be creative and expand it to my strengths and interests. I appreciate all of the opportunities afforded to me throughout my career as a doctoral student. Your support in attending conferences, getting additional experience, and assistance in writing has helped me grow as a scientist and educator. Thank you to Dr. La Vonne Fedynich and Dr. Marybeth Green for serving on my committee, Dr. Hua Li for serving as my graduate council representative, for all of their advice and support during this process. A special thank you to Angelica Arredondo for being my partner in education and fieldwork, I appreciate your commitment to educating our future generation of wildlife biologists and for your support of me in every aspect of this project from fieldwork to educator workshops. Dr. David Wester has been instrumental to statistical analyses for this project and I thank him for his kindness and support over the last 4 years. Dr. Humberto Perotto, an honorary committee member, has been a great support and I thank him for his persistence and support of my career. Lastly, thank you to Andrea Bruno, Kelsey Bedford, Dr. Katherine Miller, Dr. Alan Fedynich, William Colson, Zach Pearson, and Josh Pearson for their contributions to the lesson plans for this research. Funding for this research provided by Elizabeth Huth Coates Foundation of 1992, Rachael and Ben Vaughan Foundation, East Foundation, Ms. Leatrice Koch, and the Coastal Bend Audubon Society. Tuition assistance provided by the Texas Alliance for Graduate Education and the Professoriate (TAMUS AGEP), Mr. Rene Barrientos, Mr. Phil Plant, Amanda Whitaker Memorial Scholarship, South Texas Chapter of the Quail Coalition, and Hill Country Chapter of the Quail Coalition.

DEDICATION

For my little zoologist, Gianna Noelle.

I hope Nina’s drive and passion has paved a path for your future.

For my grandparents, without them, I would not be who I am today nor would I have had the opportunities to get to where I am.

For Christian, Jackie, Mom, and Dad, thank you for your love and support on this journey.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER I

DEVELOPMENT, IMPLEMENTATION, AND EVALUATION OF THE WILD BIRD CONSERVATION CURRICULUM FOR GRADES K-12

ABSTRACT

Few positive outdoor experiences may lead a child to grow up perceiving that the natural world has little importance in our modern technology-based society, thus, they might not appreciate local wildlife or be interested in natural resource careers. To address this issue, I initiated a Student-Teacher-Scientist-Partnership (STSP) to enhance the knowledge and attitudes of students and educators towards birdlife in South Texas. I developed a wild bird conservation curriculum aligned with state standards for use in K-12 classrooms. I assessed 6th (n=39) and 7th grade (n=52) students' and formal educators (Pre: n= 25, Post: n = 15) affinity, perceptions, and attitudes towards wildlife, birds, science, and nature prior to and after the program using a mixed methods design of open-ended questions and Likert-type statements. Student Likert-type statement responses were analyzed using an upper-tailed Sign test and educators statements with an upper-tailed Mann-Whitney test. Students had a positive attitude towards wildlife ($P > 0.05$) and working with a scientist ($P > 0.05$). Their attitude towards habitat fragmentation and its effect on wildlife improved (6th: $P = 0.004$, 7th: $P = 0.003$) as well as their attitudes towards their knowledge of birds (6th: $P = 0.004$, 7th: $P = 0.009$). Seventh grader attitudes improved towards their ability to identify birds ($P = 0.003$), yet 6th grader attitudes remained similar ($P > 0.05$).

This chapter is formatted following the journal guidelines of the International Journal of Environmental and Science Education.

Educator perceived knowledge towards bird biology ($T = 0.88$, $P > 0.05$) and identification ($T = 0.36$, $P > 0.05$) remained negative with some neutral responses, however positive attitudes were observed on all other topics. Lessons provided local educators with a professional development opportunity and additional tools to incorporate wildlife techniques and research into their instruction. Students had the opportunity to be outdoors while being introduced to the STEM (Science, Technology, Engineering, & Math) career of wildlife biology.

INTRODUCTION

Outdoor play and time spent in nature has become an activity of the past. Louv's (2005) book *Last Child in the Woods* documents this change as the children of today are often restricted to the indoors leaving less freedom to explore nature. The time once spent outside is now spent inside as our world grows in the use of video games and other electronics which has been termed "videophilia" (Zaradic and Pergams 2007). Early childhood exposure to the outdoors has been a primary motivator for showing care towards nature later in life (Chawla 2009*a*). Not only are outdoor experiences an influence in how children perceive the environment but culture and adults are part of the influence as well (Hoffman 2000, Atran and Medin 2008, Chawla 2009*b*). A child's emotional affinity towards nature is usually influenced by what is experienced with parents or family (Kals et al. 1999) and the valuable time that is spent in nature (Muller et al. 2009). Through experiences and activities with these models, children can begin to define important components to their lives and assign intrinsic value to the activities shared with those role models. Kals et al. (1999) also mentioned that environmental identity development is a lifelong process and begins growing at an early age. It is at this beginning stage of growth that environmental awareness should be a key component to not only a child's at-home life but in their formal education to encourage positive choices and feelings towards nature. This can lead the younger generation to becoming environmentally aware citizens who can make sound decisions based on their experience and knowledge of science.

Environmental Education (EE) is absent in many primary and secondary school systems, especially within urban cities (Paige et al. 2010). The push for EE has been brought forth with proposed amendments to the Elementary and Secondary Education Act of 1965 to include the No Child Left Inside Act which was reintroduced in 2013 (Everett and Raven 2012). The Act was proposed to encourage the training of teachers in EE, promoting hands-on field experiences, and to decrease the gap in environmental knowledge in grades K-12. Yet still, very few schools offer opportunities in environmental science that allow students to go outside, explore, and create their own project of interest. Much of this hesitation can be due to overloaded school curriculum, lack of funds, necessary facilities and resources, large classroom size, lack of appropriate lessons, and potentially the location of the school (Barthwal and Mathur 2012). Integration of hands-on activities or having a biologist in the classroom can improve the impact of EE (Huxham et al. 2006, Awasthy et al. 2012). This would also be the first step in connecting students with nature as they become stewards of the environment and conservation.

Educational standards have undergone some changes in recent years. In 2009, there was an effort to create the Common Core State Standards by state leaders to develop standardization across all states (Common Core State Standards Initiative 2015). Common Core was divided into two categories: (1) college and career readiness standards and (2) K-12 standards that focus on the improvement of English language arts and math content and skills. Unfortunately, this leaves out the science component in education and in turn, provides greater attention to math standards and less science instruction in the classroom (Banilower et al. 2009). In 2013, the National Science Standards were replaced by the Next Generation Science Standards (NGSS), which are informed of the advances in science and are more understanding of how students learn science effectively. NGSS focus on three dimensions in which the students are to be proficient in science: 1) practices in which a scientist engages in as they investigate, not only skills but knowledge to each specific practice, 2) understanding concepts that cross all components of science, linking the knowledge of all science fields, and 3) the disciplinary core ideas that focus instruction, curriculum, and assessment on the most important aspects of science (Next Generation Science Standards 2015). With the addition of both standards programs, teachers often find it difficult and time consuming to integrate both programs into their teaching. This leaves educators without the flexibility of offering what they would like to teach and pushes their creativity and ideas aside.

Because of the limited availability of environmental courses within primary and secondary schools, alternative options for outdoor studies within life sciences and biology classes are crucial. Many educators have now turned to citizen science as an opportunity to involve their students with nature and conduct scientific observations as part of coursework or as an independent project (Paige et al. 2010). Citizen science is a growing field primarily within the areas of ecology and astronomy (Dickinson et al. 2010). It allows everyday people and students to get involved in scientific research at the local, regional, national, or even international level. Participants get the opportunity to learn and become engaged in science while contributing data for their own use or for a much broader audience.

Teaching and Learning

Traditional Methods.−Finding the best way to teach is often a difficult task to accomplish. Traditional ways of conveying information have been to present the topic and information to the students verbally and/or through reading of textbooks and completing worksheets. However, this method of teaching is slowly becoming more obscure. The urge for hands-on, experiential activities and increased involvement from students (i.e., student-centered) is now the preference of most teachers and educators and has been a large focus of educational research (McCombs and Whisler 1997, Chall 2000, Cornelius-White 2007).

Three categories most commonly used to identify learning styles of individuals include visual, auditory, and kinesthetic learners. However, Morgan (1992) states that education that includes multi-sensory stimuli result in much more positive responses from students, and teachers “feel” that education is taking place. LeCount and Baldwin (1986) categorized three educational program types (telling, showing, and doing) within a hierarchical format showing the effectiveness on information retention. “Telling” program types included articles, radio talks, and lectures with the least effectiveness on retention and “showing” included live demonstrations, field trips, movies, and slide programs with intermediate retention of information. “Doing” program types had the most retention and included field experiences, role-playing, simulation activities, inquiry activities, and gaming. “Doing” types of programs allow the learning to involve the whole person, making them effective and able to retain the concepts or ideas learned while incorporating multi-sensory stimuli that Morgan (1992) found important.

Traditionally, teaching by textbook was the method many educators used in the classroom, more recently the push for active-learning through hands-on activities has been preferred. Bestelmeyer et al. (2015) strongly supports these ideas but believes that alternative skills should be included in K-12 ecology education. An alternative skill that they suggest includes having K-12 students thinking as those at the graduate level by preparing them early on for future careers but also making them aware and literate of the surrounding environment. The skills of collaboration, interdisciplinary thinking, and strong communication are crucial of a scientist and should be skills practiced at the primary and secondary school level and beyond through the use of citizen science, lessons integrating multiple subjects, and project presentation or peer-teaching opportunities.

Experiential Opportunities.−Much of education reform has suggested science education must go beyond the hands-on approach and provide an experience that resembles the practice of science. When one considers the scientific method, it begins with the scientist asking a question to which they seek the answer. Keeping this in mind it is clear that the backbone of the science field is inquiry, which is defined as the act of seeking an answer or knowledge, and should be the main focus of science education. Allowing students to inquire about various topics allows them to have the experience of the scientific process and learn by practicing.

A scientist often encounters limitations when it comes to research. These limitations include funding, time, and lack of staffing. It almost appears as though an untapped resource sits right in front of us, Student-Teacher-Scientist-Partnerships (STSPs). Scientists need the assistance of volunteers, or in this case students and teachers, to help collect and possibly expand their research endeavors. STSPs allow for experiential and authentic science inquiry to occur (Houseal et al. 2014). Educators are often limited in what they can provide to their students, STSPs bring in an alternative and effective method to meet the standards.

The benefits of these partnerships are tri-fold. Scientists get the help they need to complete their research with the assistance of teachers and their students, thus growing their research team or participants and hours of effort towards their research (Lawless and Rock 1998, Evans et al. 2001) and opportunities for service hours. Scientist options for STSPs should not be limited to professionals in industry, but should include graduate students, professors, and agency personnel who may need assistance in completing their research as well. They too can benefit from these partnerships in developing communication skills with lay audiences and spreading the knowledge of their research to the community (Dolan and Tanner 2005, Tomanek 2005). Teachers can learn from scientists and develop their background in the field through hours of professional development and training workshops put on by planning organizations of the STSPs. Students can gain experiences that they may have never received with traditional classroom curriculum and be exposed to potential science fair projects or relevant community-based projects (Ledley et al. 2003).

Although STSPs appear to be beneficial for all, there are challenges in the development of such partnerships. Additional time and effort is required by all parties to plan and organize the structure of the project. All projects must follow strict guidelines to develop successful partnerships as suggested by Ledley et al. (2003). Partnerships must identify research questions and suggest them to the teachers and students taking part, but allow them flexibility in developing their own questions in consultation with the leading scientists. This allows students to find a tie to what they are studying and find some relevance in the project as a whole. Scientists should make the collection of data as easy as possible for the students and their teachers by providing the measurement variables, spreadsheets, and tools that they need to complete the task. To maintain data quality, scientists need to train students, request a trial run, and assist them in the field. Conducting professional development training for participating teachers can also increase their comfort throughout the project and can provide feedback to the partnership as to what will and will not work with their age group based on their knowledge and experience.

By providing an authentic, inquiry-driven science experience, students and teachers can provide feedback on their attitudes towards the science field and scientists. This is important to gauge whether or not these participants are relating to the scientists they are working with and finding an interest in the field. Particularly for students, it is important to see whether they are engaged and have improved attitudes towards the many aspects of science, which may result in them pursuing an interest in the field in the future. These experiences open the doors for partnerships among grades K-12 and universities and expand opportunities for students to develop a deeper connection with the multi-faceted field of science.

Need for Wildlife Education

Wildlife education is defined as “those teaching and learning processes that introduce information about specific wildlife resources, habitats, ecological relationships, conservation, and management strategies into public school and community educational programs” (Adams and Thomas 1986). In the 1940’s, Aldo Leopold (1940, 1942), the father of wildlife management, had expressed concerns for the lack of training in land ecology for students and teachers. Land ecology integrates all of the sciences, including wildlife, and shows the public that we may learn the sciences separately in the classroom but in life, they are one. Leopold (1942) continued to express that a large amount of money had been thrown away to fund professional education and has left out the community, and he proposed to begin funding wildlife education for all citizens.

Much of the research on wildlife education has taken place during a camp or at on-site outdoor education programs that exclude the students who cannot afford or attend for one reason or another (Dettmann-Easler and Pease 1999). The inclusion of wildlife into GK-12 curriculum has the potential to expand awareness and appreciation of nature to the majority of students in primary and secondary schools who may not have the chance to participate in extra-curricular wildlife programs or camps. Wildlife science can easily fit into many of the topics covered in the life science or biology classrooms but can also blend into topics covered in the social sciences, health, math, and other subjects (Wilke et al. 1980, LeCount and Baldwin 1986, Waller 2011). Waller (2011) also suggests for topics to be tied to the local area of the school and, as quoted from a teacher, it will allow students to "develop a good appreciation when there is a focus on species with which they are familiar." Waller (2011) goes on to provide ideas on ways to include the topic of endangered species conservation to enrich biology curricula through activities such as class speakers, field trips, class labs, and participating in the Endangered Species Day art contest. The topic of endangered species is also integrated with society and how we have an influence on those species through habitat destruction and introduced species.

Adams and Thomas (1986) provided three recommendations to improve wildlife education: 1) a national survey of work being done on wildlife education for future policy changes, 2) direct involvement of wildlife professionals in pre-service training for teachers, and 3) the implementation of a "conservation educator" position within wildlife department faculty of universities. Thirty-two years later, it appears that these goals have not been met. There has been a push with the "No Child Left Inside" Act, however, change has not been witnessed across schools, and teachers believe they have very little experience and knowledge to teach about the topic (Jacobson et al. 2006). Wildlife agencies have formed educational programs as part of their outreach component; however, the focus has been on providing these programs to in-service teachers and their classrooms. A few universities have created wildlife educator positions within their staff, for example Texas A&M University-College Station (AgriLife Extension) and Texas A&M University-Kingsville, yet still falling short of Adams and Thomas' (1986) recommendation.

Wildlife lesson plans and activities have been developed through a slew of state and government agencies such as Texas Parks and Wildlife and the U.S. Fish and Wildlife Service and non-governmental organizations (NGOs) like the Texas Wildlife Association. Agencies such as these have also sponsored wildlife education programs such as the nationally known "Project WILD." Since 1970, the goal of Project WILD has been to provide curriculum materials for wildlife-based conservation and environmental education to help students of all ages become aware, knowledgeable, skilled, and committed to the environment resulting in responsible citizens who can make informed decisions and act constructively towards the environment (CEE 2018). Project WILD has other programs focusing on specific taxa or biomes such as Flying WILD, aimed at providing migratory bird education in urban areas. Project WILD and related programs provide curriculum and resources free of charge as long as the interested teacher or educators attend a workshop (Jacobson et al. 2006, CEE 2018). Even with free resources available, teachers are not taking advantage of the opportunity.

Cross- and Inter-Disciplinary Curriculum

Wildlife topics can be extended past the typical biology and life science classrooms into other subjects that help fulfill a thorough understanding of the topic. It can link subjects together and provide additional material to help students understand and apply the knowledge to something else that may interest them. Waller (2011) pushes to think about wildlife topics beyond just the ecology setting. Teachers are known to use the example of endangered species not only in ecology but also in evolution and genetics. The topic of endangered species can cover blended fields by including genetics and biotechnology together, even societal concerns of decreased recreation and aesthetic values to areas that contain this endangered species.

The authors believe that if teachers from multiple subjects can work together, they can provide a great learning experience for their students while allowing them to see how working together in a collaborative setting can be successful. Bestelmeyer et al. (2015) understand that a challenge exists in tying in multiple disciplines at the primary and secondary level. An example of this can be seen with the growing idea of place-based education by creating and using a school garden. Classroom gardening is an interdisciplinary and problem-based environment for students to meet the objectives of the standard classroom (Canaris 1995, Brunotts 1998, Skelly and Zajicek 1998, DeMarco et al. 1999, Culin 2002). Quantitative and qualitative studies have shown positive outcomes in science achievement, food and consumption behavior, and social and environmental behavior (Ratcliffe et al. 2009, Blair 2009). Educational activities such as this provide the opportunity to enhance critical thinking skills and provide a platform for integrating several disciplines, creating a well-rounded student.

Wildlife can be used across a variety of subjects including social studies, mathematics, English/literature, and art and can be modified for the level of the students. In literature, wildlife is a common topic in children's books, although stories are not always biologically accurate. Wildlife literature generally pertains to particular species of interest or learning about the land ethic as in the writings by Aldo Leopold (1949). Using wildlife literature can help students develop a larger vocabulary and find writing more interesting if it is about a topic they enjoy. Lessons can also be tied to mathematics by calculating wildlife home ranges or the number of prey required by a predator per year (Hernbrode 1978). Hernbrode (1978) set goals in wildlife teaching to include: learning to appreciate all living things, understanding a person's importance in conservation and environmental problems, developing an interest in living things that carry over to their free time, and understanding that living things depend on one another including our impact on nature. With these goals in mind and knowing that wildlife education can be used across many disciplines, we should find it easier to apply wildlife to our educational system.

Future Protection of Nature

Knowing how important wildlife is for our environment is the first step in protecting nature. Bestelmeyer et al. (2015) believes that ecological literacy should begin early and given a head start rather than waiting until the children attend college. This would already exclude a large portion of the population since more than 41% of people 25 years and older have not attended college (US Census Bureau 2013). Not incorporating ecological education at an earlier age would exclude those of low income and/or who are not college ready.

Integrating wildlife into the grade school classroom has the potential to have positive influences on student attitudes towards wildlife (Adams et al. 1987). LeCount and Baldwin (1986) have a goal of providing the best bear information as possible to the public, and one way they see fit is through a child's education. Although their focus is on bears, this idea can be applied to a variety of wildlife species. The information relayed to these students can aid in future wildlife management by allowing the public an opportunity to understand species, their role in their environment, and their role in our lives.

Today's children will be tomorrow's decision makers in environmental policy and laws (Hayward 2012). They are the future wildlife conservationists and with the wildlife field being small, the only way to continue the protection of wildlife species is to educate and encourage students in the classroom to be aware of nature. Children are losing touch with nature, missing outdoor experiences and with wildlife education in place it can provide the link between children and the outside. Preparation of our future conservationists has been merely a suggestion in the many presentations and articles from agency and organization leaders (Leopold 1942, Adams and Thomas 1986), yet there is still minimal effort to incorporate conservation education into our schools.

A New Curriculum

I developed, implemented, and evaluated a curriculum packaged as a kit (Jones and Eick 2007) focused on wild bird conservation for 6^{th} and 7^{th} grade classrooms to increase student and educator interest in birds and the outdoors. Classrooms were self-selected by the teachers showing interest during the professional development workshops offered on this curriculum. Given the issues in implementation of wildlife education in the classroom, I placed myself in the classroom as a visiting scientist as a form of a Student-Scientist-Teacher Partnership (STSP) alongside teachers who had been trained in the curriculum and had an interest in conducting these lessons in the classroom.

The objectives of this study were to 1) develop K-12 curriculum integrating wildlife techniques specific to bird studies and research project components of ongoing or completed projects from the Caesar Kleberg Wildlife Research Institute (CKWRI), 2) train educators on the curriculum by offering professional development workshops, 3) assess workshop teachers' affinity, perceptions, and attitudes towards birds, wildlife, and citizen science via pre- and post-survey and gather participant information via a background questionnaire and workshop feedback form, and 4) evaluate the curriculum via student pre- and post-surveys prior to and after curriculum implementation in the classroom to determine changes in students' affinity, perceptions, and attitudes towards birds, wildlife, science, and nature. I hypothesized that the curriculum would improve or influence positive responses in students' affinity, perceptions, and attitudes towards birds, wildlife, science, and nature. In addition, teachers' affinity, perceptions, and attitudes towards birds and wildlife will improve as well as their awareness of citizen science.

METHODS

Curriculum Development

Five hands-on, kit-based, experiential lesson plans were developed to cover aspects of wild bird conservation research and techniques, making up the Wild Bird Conservation Curriculum. The curriculum was developed for evaluation in the 6th grade science classroom but was later modified for the inclusion of 7th grade assessment. The lessons are aligned with science TEKS (Texas Essential Knowledge and Skills) for ease of implementation in the classroom. Lesson plans include introductions and topic background, procedure for conducting the lesson plan, lesson assessment, and potential ways to expand the lesson to include more topics or increase the complexity for varying age groups. In addition, the lesson plan includes the standards being covered, learning objectives, related vocabulary and definitions, and materials required to conduct the lesson successfully. Basic information related to the lesson is also included such as group size required for activity, total cost, and time required to complete the lesson. All lesson plans can be modified to fit the needs of the teacher (i.e. splitting lesson into multiple time periods, reducing costs to the minimum, simplifying or increasing the complexity of the lesson depending upon the ability of the students).

Lesson plans covered the following topics: bird identification and surveying, mist-netting and banding, citizen science and data entry, aging quail and their internal parasites, and mapping quail home ranges and the effect of habitat fragmentation. An example of the lesson plan “Basics of Birding” can be seen in Appendix A which covered bird identification by field marks and surveying. All lesson plans and supplemental material can be found on the CKWRI website under the Education and Outreach Program, Wild Bird Lesson Plans (https://www.ckwri.tamuk.edu/research-programs/wildlife-education-outreach/events/lesson-plans/wild-bird-conservation-curriculum). Table 1.1 shows the units and lessons that make up the Wild Bird Conservation Curriculum and the aligned TEKS for 6th and 7th grade science.

Table 1.1. Lesson topics and names for the Wild Bird Conservation Curriculum for GK-12 with corresponding TEKS for 6th and 7th Grade Science. Source: Texas Education Agency

Unit	Lesson	Science TEKS (6th Grade)	Science TEKS (7th Grade)
Wildlife Research	Buildings, Rivers, and Roads	Scientific Investigation & Reasoning: use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum; Organisms and Environments: describe biotic and abiotic parts of an	Scientific Investigation & Reasoning and Organisms and Environments: understand the relationship between living organisms and their environment. Organisms are living systems that maintain a steady state with that environment and whose balance may be disrupted by internal and external stimuli. External stimuli include human activity or the environment; identify advantages and

Table 1.1 Continued

Unit	Lesson	Science TEKS (6th Grade)	Science TEKS (7th Grade)
		ecosystem in which organisms interact.	limitations of models such as size, scale, properties, and materials; model the effects of human activity on groundwater and surface water in a watershed; investigate how organisms respond to external stimuli found in the environment such as phototropism and fight or flight
	Early bird catches the WORM??*	Scientific Investigation & Reasoning: use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment	Scientific Investigation & Reasoning and Organisms and Environments: use appropriate tools to collect, record, and analyze information, including life science models, hand lens, stereoscopes, microscopes, beakers, Petri dishes, microscope slides, graduated cylinders, test tubes, meter

Table 1.1 Continued

Unit	Lesson	Science TEKS (6th Grade)	Science TEKS (7th Grade)
		as needed to teach the curriculum; use preventative safety equipment, including chemical splash goggles, aprons, and gloves, and be prepared to use emergency safety equipment, including an eye/face wash, a fire blanket, and a fire extinguisher. *can also be applied to Health courses	sticks, metric rulers, metric tape measures, timing devices, hot plates, balances, thermometers, calculators, water test kits, computers, temperature and pH probes, collecting nets, insect traps, globes, digital cameras, journals/notebooks, and other equipment as needed to teach the curriculum; observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms; explain variation within a population or species by comparing external features, behaviors, or physiology of organisms that enhance their survival

Table 1.1 Continued

Unit	Lesson	Science TEKS (6th Grade)	Science TEKS (7th Grade)
			such as migration, hibernation, or storage of food in a bulb; recognize levels of organization in plants and animals, including cells, tissues, organs, organ systems, and organisms.
Wildlife Techniques	Be a Bird Biologist!	Scientific Investigation & Reasoning: collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers; use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers,	Scientific Investigation & Reasoning: use appropriate tools to collect, record, and analyze information, including life science models, hand lens, stereoscopes, microscopes, beakers, Petri dishes, microscope slides, graduated cylinders, test tubes, meter sticks, metric rulers, metric tape measures, timing devices, hot plates, balances, thermometers, calculators, water test kits, computers,

Table 1.1 Continued

Unit	Lesson	Science TEKS (6th Grade)	Science TEKS (7th Grade)
		calculators, computers, timing devices, and other equipment as needed to teach the curriculum.	temperature and pH probes, collecting nets, insect traps, globes, digital cameras, journals/notebooks, and other equipment as needed to teach the curriculum
	Basics of Birding	Scientific Investigation & Reasoning: use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum.	Scientific Investigation & Reasoning and Organisms and Environments: use appropriate tools to collect, record, and analyze information, including life science models, hand lens, stereoscopes, microscopes, beakers, Petri dishes, microscope slides, graduated cylinders, test tubes, meter sticks, metric rulers, metric tape measures, timing devices, hot plates, balances, thermometers, calculators, water test kits, computers,

Table 1.1 Continued

Unit	Lesson	Science TEKS (6th Grade)	Science TEKS (7th Grade)
			temperature and pH probes, collecting nets, insect traps, globes, digital cameras, journals/notebooks, and other equipment as needed to teach the curriculum; describe how biodiversity contributes to the sustainability of an ecosystem; explain variation within a population or species by comparing external features, behaviors, or physiology of organisms that enhance their survival such as migration, hibernation, or storage of food in a bulb; investigate how organisms respond to external stimuli found in the environment such as phototropism and fight or

Table 1.1 Continued

Unit	Lesson	Science TEKS (6^{th} Grade)	Science TEKS (7^{th} Grade)
			flight
	Citizen Science for South Texas Birds	Scientific Investigation & Reasoning: construct tables and graphs, using repeated trials and means, to organize data and identify patterns; use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum.	Scientific Investigation & Reasoning: use appropriate tools to collect, record, and analyze information, including life science models, hand lens, stereoscopes, microscopes, beakers, Petri dishes, microscope slides, graduated cylinders, test tubes, meter sticks, metric rulers, metric tape measures, timing devices, hot plates, balances, thermometers, calculators, water test kits, computers, temperature and pH probes, collecting nets, insect traps, globes, digital cameras, journals/notebooks, and other equipment as needed to teach the curriculum

Curriculum Evaluation

Teacher Assessment.− Teachers were assessed using a mixed methods design of qualitative (i.e., open-ended questions) and quantitative data (i.e., Likert-type statements (strongly disagree (1) to strongly agree (5)). At the workshop, teachers completed a pre-program survey (Appendix B) regardless if they were to volunteer to participate in the curriculum evaluation. Pre-surveys allowed teachers to describe their previous knowledge regarding the subject matter. A post-program survey was distributed at the end of curriculum implementation in the classroom in a hard copy format (Appendix C) or via an anonymous online Google Forms© email (Appendix D) to receive feedback and suggestions from teachers for further improvements to the program. Post-surveys asked teachers to rank their knowledge about the subject after the lesson was completed; in addition, they were asked how well they think the students understood the material and how helpful it was in achieving the TEKS goal.

Teacher pre-surveys included statements regarding their interest in wildlife, knowledge of birds, ability to identify bird species, and awareness of nature, which they responded by using the ranking system (Likert-type) from strongly disagree (1) to strongly agree (5). Teachers also included the approximate amount of time they spend outdoors during the school year and whether they have included wildlife and citizen science into their curriculum previously (yes (1), somewhat, or no (0)). Somewhat responses were later lumped into yes responses for the purpose of statistical analysis. The teacher post-survey, only completed by those teachers that participated in the curriculum evaluation and responded to online requests to complete the survey, included the same Likert-type statements as well as whether students met learning objectives and understood and retained lesson topics. The remainder of the survey asked teachers whether they would continue to incorporate wildlife and citizen science in the classroom and approximately the amount of time they spent outside during class time. Lastly, teachers were asked to mark the lessons conducted in class (yes/no), and if they did not conduct a particular lesson, they were asked to provide a reason why. Each Likert-type statement was analyzed separately (Clason and Dormody 1994) using an upper-tailed Mann-Whitney test which is appropriate for two independent samples and ordinal based data (Conover 1999), and yes or no questions were analyzed using a 2-sample upper-tailed binomial proportions test using normal approximation conducted in SAS 9.4 (SAS Institute, Inc., Cary, NC, USA). Open-ended questions were summarized using frequency effect size by dividing the number of individuals that contributed to that response category by the total number of responses (Onwuegbuzie 2000).

Student Assessment.− Students were assessed using a mixed methods design of qualitative (i.e., open-ended questions) and quantitative data (i.e., Likert-type statements (strongly disagree (1) to strongly agree (5)). Students completed a pre-survey prior to their teacher conducting any bird-related lesson plan (Appendix E). A post-survey was completed following the end of all bird-related lesson plans in the program (Appendix F). Student pre- and post-program surveys included statements regarding their interest in wildlife, birds, their ability to identify birds, awareness of nature, and their interest in science and working with a scientist, which they responded using a ranking system (Likert-type) from strongly disagree (1) to strongly agree (5). Students also included the approximate amount of time they spend outdoors during the school year and answered an open-ended question as to their favorite Texas animal on the pre-survey and their favorite wildlife-related activity of the year on the post-survey.

Each Likert-type statement was analyzed separately (Clason and Dormody 1994) using an upper-tailed sign test to determine improvement (Conover 1999) and analyzed in SAS 9.4 (SAS Institute, Inc., Cary, NC, USA). Open-ended questions were summarized using content cloud analysis (Cidell 2010) for favorite bird-related activities. Word clouds were created on Wordle (wordle.net) in which word size is related to frequency of response. Emergent themes from reasons why it was their favorite activity were identified by using open coding then axial and selective coding, when appropriate, of data into common categories of meaning (Corbin and Strauss 1990, Glaser 2016). Frequency effect sizes are reported by dividing the number of individuals that contributed to that response category by the total number of responses (Onwuegbuzie 2000). Sixth and 7th grade surveys were analyzed separately, but results are shown side by side for comparison.

Students hand wrote their names at the top of both surveys for identification purposes. Following the program, I ensured that pre- and post-surveys are matched up by student name and removed, shredded, and disposed of the strip of paper that includes each student's name for privacy purposes. Each student received an identification number based on their teacher's initials followed by four digits (e.g., AB1234) for my record keeping. All surveys, prior to disposal, were stored in a locked filing cabinet in Dr. April Conkey's office. All pre- and post-surveys for both students and teachers were approved by the Institutional Review Board for the Protection of Human Subjects at Texas A&M University–Kingsville under protocol number 2015-040.

Professional Development Workshops for Educators

Formal and informal educators, with a focus on those who specialize in the sciences, were recruited from schools and organizations in the South Texas region to attend a free, two-day training workshop in which they were trained in the information to be conveyed in each lesson to the students. These trainings provided sufficient background knowledge on the bird lesson(s) to be covered during each topic session. Advertisement for the "Wild Bird Conservation Curriculum Professional Development Workshop" occurred through a variety of platforms including: receiving contacts from Welder Wildlife and East Foundations, posting on social media, attendance at Texas teacher conferences, and mail-outs/emails to local schools, faculty, and environmental groups.

At the start of the workshop, all educators were asked to complete a consent to participate in research form, a consent to photography/video recording form, and a background questionnaire specified for teachers (or formal educators, e.g. active classroom teachers or full-time substitutes) and non-teachers (or informal educators, e.g. environmental educators, pre-service teachers). Both consent forms informed educators that their information and responses (not including their names) could be used for the research study and put into a publication. Photographs and video were taken during the workshop for future presentations at conferences and other events. The questionnaire included open-ended questions relating to the educator's background such as highest level of education, number of science courses taken, number of years teaching or in current position, estimated number of students per year, and whether there was any technology or specific tools available for student use at their schools/facilities (Appendix G). Additional open-ended questions relating to their attitudes towards science and teaching were asked. In addition, educators were asked to describe their teaching method or which method they thought was most effective (e.g., textbook, hands-on, etc).

During the workshop, I went through each of the 5 lesson plans of the curriculum. The two-day workshop provided sufficient time to cover all material and concepts related to the lesson, while allowing educators the opportunity to practice and ask questions to ensure their comfort in the material. It also gave them time to share any tips and tricks to engage students in the classroom or while outdoors. Teachers learned about the types of traps used in bird studies, handling methods, and required permits during the workshop. Educators received hands-on experience with live birds (House Sparrows, *Passer domesticus* or White-winged Doves, *Zenaida asiatica*) and the techniques of trapping, handling, and banding birds (if permitted). All animals and demonstrations used for teaching purposes were approved by the Institutional Animal Care and Use Committee at Texas A&M University–Kingsville under protocol number 2015-02-14. Trapping, handling, and banding of White-winged doves was permitted under the Texas Parks and Wildlife Department's Master-Station Federal Bird Marking and Salvage Permit Number 06827 issued to Shaun Oldenburger.

At the completion of the workshop, all educators were given a workshop survey to provide feedback on the training, its delivery, and suggestions for improvements (Appendix H). Educators were asked whether the material was presented clearly, if the material would be useful in their teaching and if they would use it in class, if they would recommend the workshop to a colleague, if the workshop met their expectations, and if it was well organized. Their responses were on a ranking scale (Likert-Type) of strongly disagree (1) to strongly agree (5) with the option of not applicable for non-teachers. The survey also asked which topics were of most interest to the educator, if the time allotted on specific material was enough, as a non-teacher how they intend to use the curriculum, and lastly how they heard about the workshop.

To ensure interest and attendance at the workshop, educators were provided a certificate of participation for 16 hours of professional development once the workshop was completed. Certification is an important incentive for educators to include for current and future job evaluations. If educators were not able to attend both days, a certificate for 8 hours was provided, unless they chose to make up the missing date at a future workshop. In addition, those teachers who continued in the evaluation of the curriculum in the classroom were given a certificate of program completion. All surveys and questionnaires for educators attending the workshop were approved by the Institutional Review Board for the Protection of Human Subjects at Texas A&M University–Kingsville under protocol number 2015-040.

Curriculum Implementation

School Locations.–Evaluation of the curriculum was open to any school within the South Texas region, but was restricted to 6th grade science classrooms of teachers that attended the workshop and volunteered to participate in the research program, thus they were considered self-selected. Later, interest from a 7th grade teacher was presented and lessons were modified for evaluation in those classrooms. Sixth grade classrooms were the original target audience for this curriculum because of the lack of state testing at this grade level, general interest from this age group, and previous experience of working with students in this age group. Two 6th grade science teachers participated from 2 different schools. These schools included Sarita Elementary (Kenedy County-Wide CSD, Sarita, TX) and Nanny Elementary (Riviera ISD, Riviera, TX). One 7th grade science teacher participated from Kaffie Middle School (Corpus Christi ISD, Corpus Christi, TX).

Sarita Elementary serves grades pre-kindergarten through 6th grade, Nanny Elementary serves grades pre-kindergarten through 6th grade, and Kaffie Middle School serves grades 6th through 8th. Sarita, Texas is located in northern Kenedy County along Highway 77, approximately 70 miles south of Corpus Christi, TX. Sarita is a rural town with a population of 238 with approximately 79% of the population reporting as Hispanic or Latino (US Census Bureau 2010). Riviera, Texas is located in the southern portion of Kleberg County along Highway 77, approximately 56 miles south of Corpus Christi, TX. The total population of Riviera was reported as 689 with approximately 73% reporting as Hispanic or Latino (US Census Bureau 2010). Corpus Christi is located along the Gulf of Mexico, approximately 130 miles southeast of San Antonio, TX. It is an urban center with an estimated population of 305, 215 with a majority population reporting as White (81%) with 62% of population being Hispanic or Latino (US Census Bureau 2010).

Teacher and Student Demographics.−All state public education data provided here was sourced from the Texas Public Schools Explorer by the Texas Tribune and represents the 2016-2017 school year (2017). Sarita Elementary had 11 full time teachers of White (55%), Hispanic or Latino (36%), and American Indian (9%) ethnicities. Average teacher experience at Sarita Elementary is 21 years with an average of 6.8 students per teacher. Nanny Elementary had 17 full-time teachers of Hispanic or Latino (55%) or White (45%) ethnicities. Nineteen years was the average teacher experience with an average of 11 students per teacher. Kaffie Middle School employed 52 full-time teachers with an average of 16 years of experience. Average number of students per teacher was much higher at 19 per teacher. Teachers represent 4 ethnicities: Hispanic or Latino (24%), White (24%), African American (6%), and Asian (2%).

The student population of rural to urban participating schools varied greatly. Sarita Elementary had a total population of 75 students representing 5 ethnicities (Hispanic 84%, White 9%, African American 4%, Asian 1%, and two or more races 1%). Forty-one percent of students were considered at risk of dropping out of school, 68% being economically disadvantaged, and 7% with limited English proficiency. Nanny Elementary had a total population of 179 students with 70% being Hispanic or Latino, 27% White, and 3% two or more races. At-risk students made up 35% of students, 70% were considered economically disadvantaged, and 6% had limited English proficiency. Kaffie Middle School had a total student population of 989 and was the most diverse of the schools participating in the study. Seven ethnicities were represented: Hispanic or Latino (64%), White (25%), Asian (6%), African American (4%), two or more races

(1%), Pacific Islander (<1%), and American Indian (<1%). Thirty-seven and 35% of students were considered at-risk and economically disadvantaged, respectively. Less than 1% of students had limited English proficiency.

RESULTS

Educators

Participation.─Four 2-day training workshops took place during summer 2015, summer and winter 2016, and summer 2017. A total of 49 educators attended the workshop (Figure 1.1). Active, in-the-classroom, pre-service or formal educators were categorized as teachers, while informal or environmental educators were categorized as non-teachers for the purpose of survey administration. From here on, I will refer to them as formal and informal educators. Of the educators, 36 were female and 13 were male. Participating formal educators (n = 28) came from the following private, public schools or districts, and colleges: Epiphany School, Corpus Christi, Flour Bluff, Kenedy County-Wide, Kingsville, Riviera, Santa Gertrudis, Tuloso-Midway, Aransas County, Harlingen Consolidated, United, San Antonio, Banquete, Brightwood College, Texas A&M University─Corpus Christi, and Texas A&M University─Kingsville. Participating informal educators (n = 21) came from the following organizations: Coastal Bend Audubon Society, East Foundation, King Ranch, Laguna Atascosa National Wildlife Refuge, Oso Bay Wetlands Preserve and Learning Center, King Ranch Institute for Ranch Management, Texas General Land Office, South Texas Master Naturalists and Gardeners, Texas Outdoor Education Association, Texas Parks and Wildlife Department, and Texas Wildlife Association.

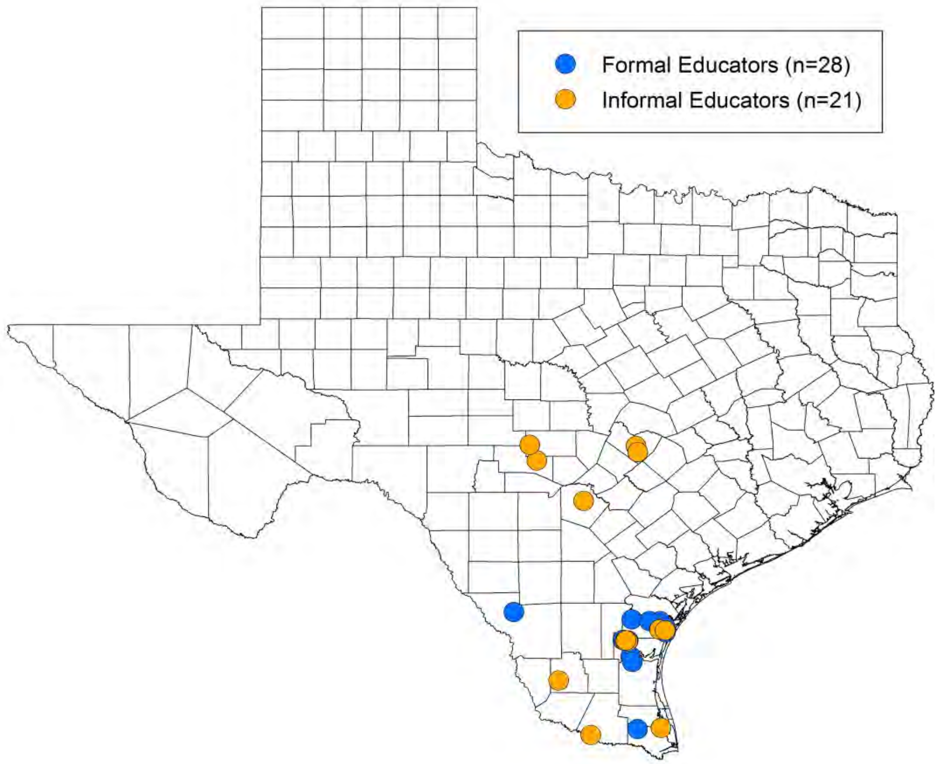


Figure 1.1. Distribution of formal (n=28, blue) and informal (n=21, yellow) educators who attended the Wild Bird Conservation Curriculum Professional Development 2-Day Workshop in Kingsville, Texas, USA.

Background.−The majority of educators came from a STEM background (51%) followed by education (24%). Remaining educational backgrounds included: business (10%), communications (2%), social sciences (4%), other (6%), and no response (2%). Formal educators reported teaching the following grade levels: elementary (PK-6) (64%), middle school (7-8) (7%), high school (9-12) (18%), combination of primary and secondary school (PK-12) (4%), and college (undergraduates) (7%) reaching between 20 and 500+ students per year and ranging from 1 to 30 years of teaching experience. Informal educators covered a variety of grade levels including: PreK-12 (14%), K-12 (24%), K-8 (19%), college (5%), high school (5%), all (19%), not applicable (10%), and no response (5%). Informal educators reported interacting with at least 30 to 1000+ students per year and having between less than a year to 8 years of experience in their current position.

The most effective teaching method reported as open-ended responses by formal educators (43%) was a combination of all teaching methods (e.g. hands-on, lecture, textbook, etc.). Twenty-one percent of formal educators responded with hands-on only, same with the response of both hands-on and lecture. The remaining effective teaching methods were guided inquiry and self-directed, hands-on and inquiry, use of visual aids, and no response, each at 4%. Informal educators responded with hands-on as the most effective teaching method (67%), followed by a combination of all (14%), hands-on and lecture (10%), and experiential learning (10%).

Workshop Evaluation & Follow-Up.− The topics of most interest covered at the workshop are shown in Figure 1.2. Ninety-eight percent (n = 45 of 46) of educators agreed the workshop material was presented clearly, was well organized, met their expectations, and would recommend it to a colleague. Ninety-five percent (n = 39 of 41) of educators agreed the material would be useful in their teaching and 89% (n = 33 of 37) reported agreement in using the material in their class.

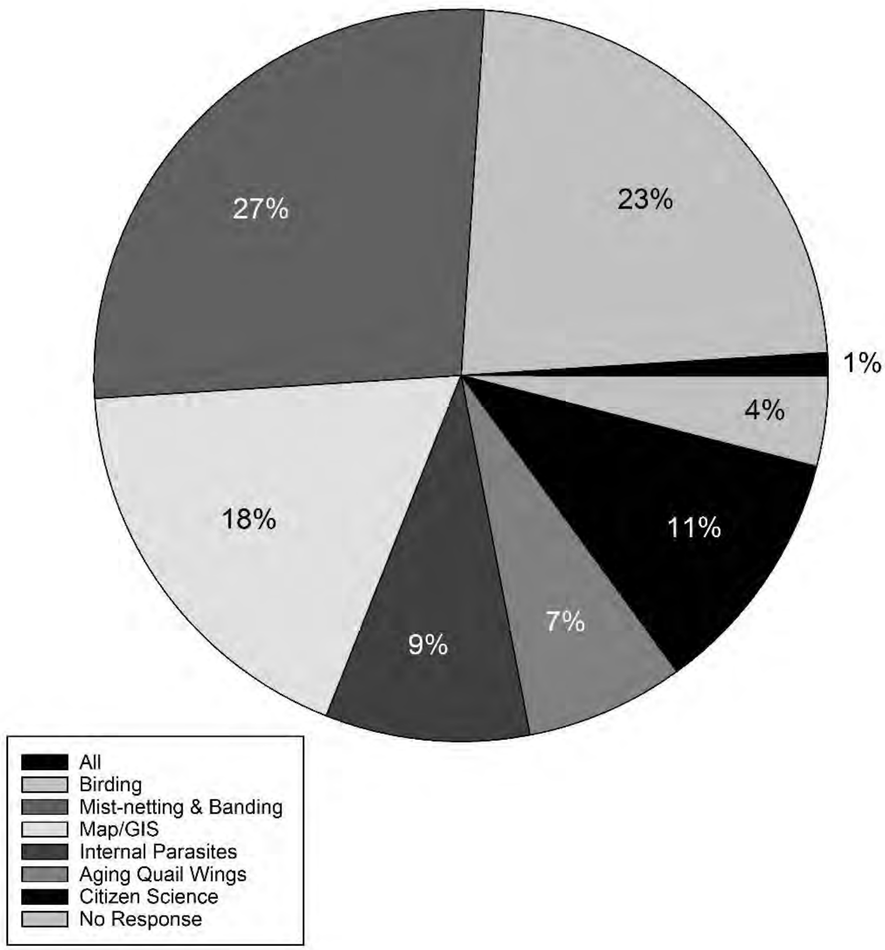


Figure 1.2. Topics of most interest covered during the professional development workshop in order of most reported: mist-netting and banding (27%), birding (23%), map/GIS (18%), citizen science (11%), internal parasites (9%), aging quail wings (7%), no response (4%), and all (1%).

Fifteen formal educators (not including those who implemented curriculum) responded to the online post-program survey via Google Forms© and responses were used to statistically analyze pre- (n = 25) and post-program (n = 15) surveys. Over 90% of formal educators reported a positive affinity towards wildlife (T = -0.3, P > 0.05; Fig. 1.3) and taking time to stop and look at wildlife ($T = 0.18$, $P > 0.05$; Fig. 1.3) comparing pre- and post-surveys. Their attitudes towards habitat fragmentation and its effect on wildlife populations remained similar with most in agreement ($T = 0.42$, $P > 0.05$; Fig. 1.3). The majority of participating formal educators were in disagreement and in the neutral category in their perceived knowledge of bird biology ($T = 0.88$, $P > 0.05$; Fig. 1.4) and ability to identify many birds ($T = 0.36$, $P > 0.05$; Fig. 1.4).

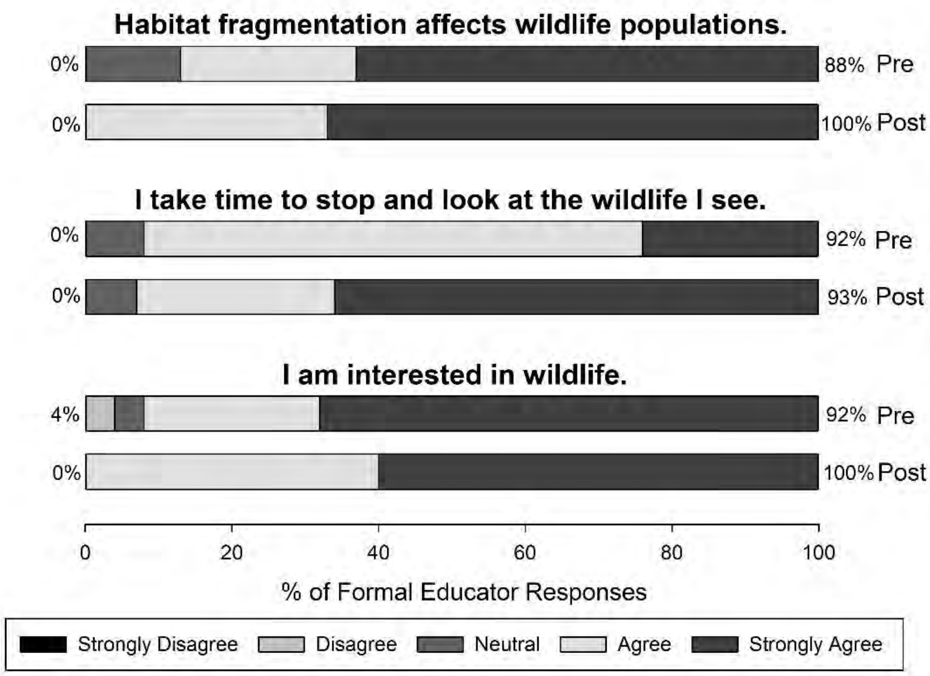


Figure 1.3. Pre- (n=25, top bar) and post-survey (n=15, bottom bar) formal educator responses to Likert-type (1- strongly disagree to 5-strongly agree) statements regarding their attitudes towards habitat fragmentation, taking time to look at wildlife, and their wildlife affinity. Percentage on left represents cumulative percentage of negative responses (in disagreement) and on the right indicates cumulative percentage of positive responses (in agreement).

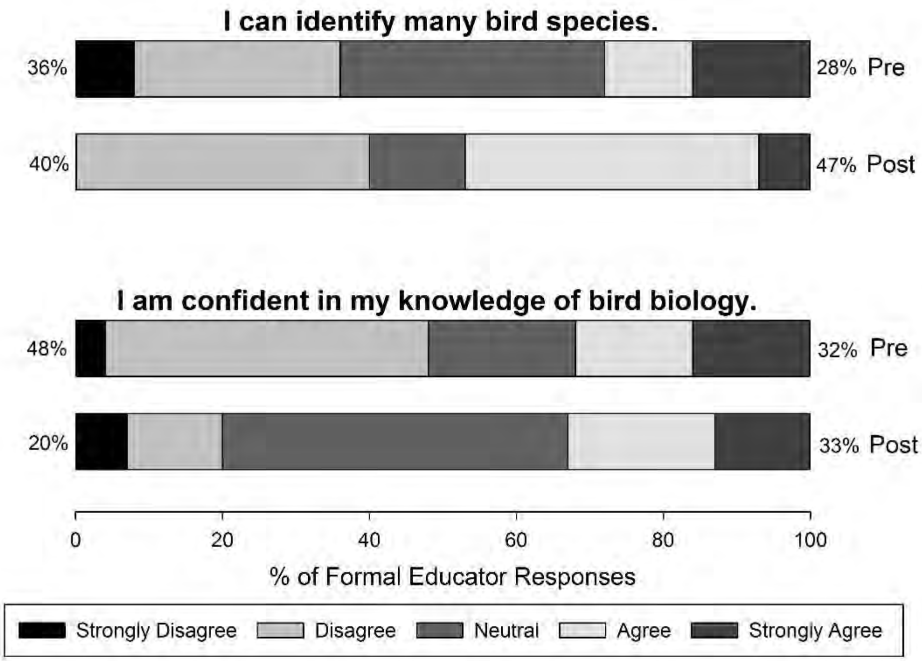


Figure 1.4. Pre- (n=25, top bar) and post-survey (n=15, bottom bar) student responses to Likert-type (1- strongly disagree to 5-strongly agree) statements regarding their perceived ability to identify many bird species and knowledge of bird biology. Percentage on left represents cumulative percentage of negative responses (in disagreement) and on the right indicates cumulative percentage of positive responses (in agreement).

Most educators responded yes to incorporating wildlife into their curriculum, a significant improvement from pre- to post-program survey (Pre: n = 25, Post: n =15; $Z = 1.85$, $P = 0.03$). Forty-four percent of formal educators were aware of citizen science, but a majority (56%) had not heard of the field during the pre-program survey. All post-program respondents (100%) reported yes to enjoying citizen science. There was a significant improvement in participant responses to possibly incorporating citizen science into their classroom curriculum

(Pre: n = 11, Post: n =15; Z = 2.5, P = 0.006). Twenty-seven percent of respondents reported to using one or more of the lessons in the classroom or outdoors, while majority (67%) have not had the opportunity to do so.

Classroom Implementation.–Due to the small number of teachers who implemented the curriculum in the classroom, data from these 3 teachers (all female) will be reported separately and in this section. No statistical comparisons could be made between the pre- and post-program surveys due to the low sample size. The 3 teachers implemented all 5 lessons in the classroom with my assistance as a visiting scientist. All 3 teachers reported agreement across both surveys for the perceived confidence in bird biology, affinity towards wildlife, and taking the time to stop and look at the wildlife they see. Two teachers reported their agreement in their ability to identify many birds and 1 responded with neutral on the pre-program survey, while on the post-program survey, all 3 were in agreement. The same outcomes are reported in their responses regarding habitat fragmentation and its effect on wildlife populations. Two of the 3 teachers were not aware of citizen science, yet following implementation all 3 responded yes to enjoying the field of citizen science and would incorporate it into their classroom curriculum.

Students

The curriculum was implemented in 6th grade classrooms at Sarita Elementary (Sarita, TX) with 17 students and Nanny Elementary (Rivera, TX) with 22 students and with 52 7th graders at Kaffie Middle School (Corpus Christi, TX). Seventh grader attitudes improved towards their ability to identify birds (n = 29, T = 8, P = 0.0025; Fig. 1.5), yet 6th grader attitudes remained similar (n = 30, T = 2.5, P > 0.05; Fig 1.5). Sixth graders appeared to enjoy collecting bird data more than 7th graders, however, both grade levels did not significantly improve (6th: n = 29, T = 2, P > 0.05; 7th: n = 36, T = 3.5, P > 0.05; Fig. 1.5). Both grade levels improved in their perceived knowledge of birds but with a majority of students falling within the neutral category (6^{th}: n = 27, T = 7, P = 0.0043; 7^{th}: n = 29, T = 7, P = 0.0094; Fig. 1.5).

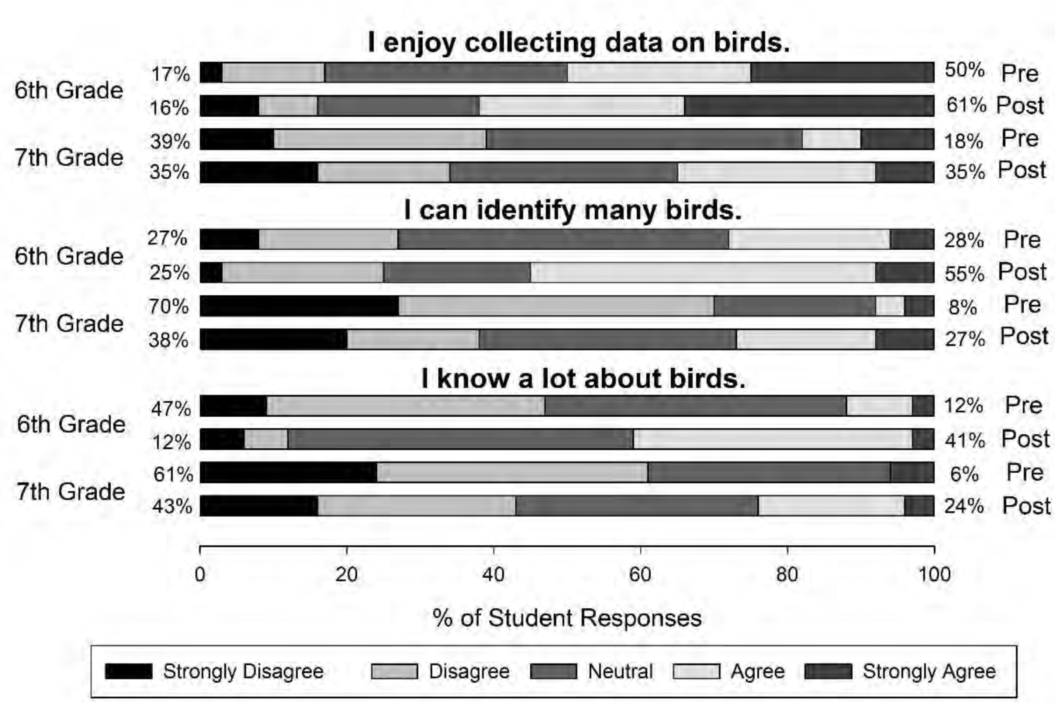


Figure 1.5. Pre- (top bar) and post-survey (bottom bar) 6^{th} and 7^{th} grade student responses to Likert-type (1- strongly disagree to 5-strongly agree) statements regarding their perceptions and perceived knowledge towards collecting bird data, identifying birds, and bird knowledge. Percentage on left represents cumulative percentage of negative responses (in disagreement) and on the right indicates cumulative percentage of positive responses (in agreement).

Students had a positive affinity towards wildlife (6^{th}: n = 22, T = -3.5, P > 0.05; 7^{th}: n = 23, T = -3.5, P > 0.05; Fig. 1.6) and improved attitude towards habitat fragmentation and its potential effect on wildlife populations (6^{th}: n = 22, T = 6.5, P = 0.0044; 7^{th}: n = 39, T = 12, P <

0.0001; Fig. 1.6). There was no change in either grade level on taking the time to stop and look at the wildlife they see (6th: n = 25, *T* = -4, *P* > 0.05; 7th: n = 33, *T* = -2.5, *P* > 0.05; Fig. 1.6). Attitudes towards working with a scientist (6th: n = 16, *T* = -0.5, *P* > 0.05; 7th: n = 25, *T* = 0.5, *P* > 0.05; Fig. 1.7) and science affinity (6th: n = 23, *T* = -4, *P* > 0.05; 7th: n = 21, *T* = 0, *P* > 0.05; Fig. 1.7) remained positive across both grade levels. The majority of students (between 70 and 80%) reported agreement that they do not disturb or harm the animals and plants they see outside across both surveys and grade levels (6th: n = 21, *T* = -2, *P* > 0.05; 7th: n = 27, *T* = 2.5, *P* > 0.05; Fig. 1.8). Each grade level responded similarly on both surveys regarding their free time spent outside (6th: n = 23, *T* = 3.5, *P* > 0.05; 7th: n = 27, *T* = 4, *P* > 0.05; Fig. 1.8), yet a higher percentage of 6th graders agreed with this statement (Pre: 69%, Post: 80%) as compared to the 7th graders (Pre: 43%, Post: 53%).

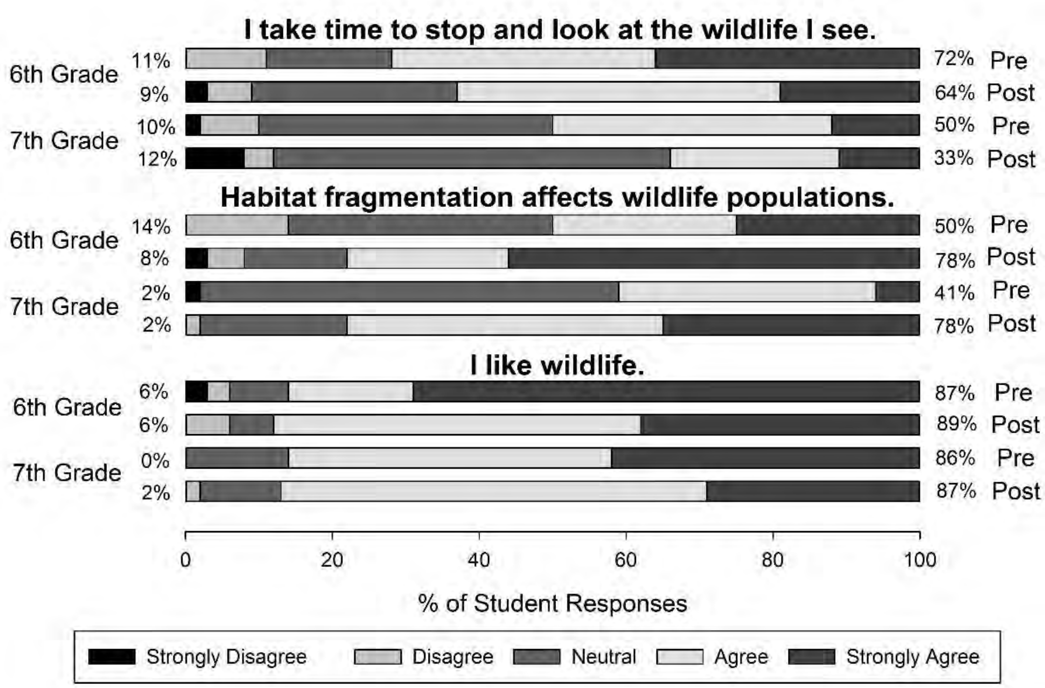


Figure 1.6. Pre- (top bar) and post-survey (bottom bar) 6th and 7th grade student responses to Likert-type (1- strongly disagree to 5-strongly agree) statements regarding their perceptions and affinity towards taking time to look at wildlife, habitat fragmentation, and wildlife. Percentage on left represents cumulative percentage of negative responses (in disagreement) and on the right indicates cumulative percentage of positive responses (in agreement).

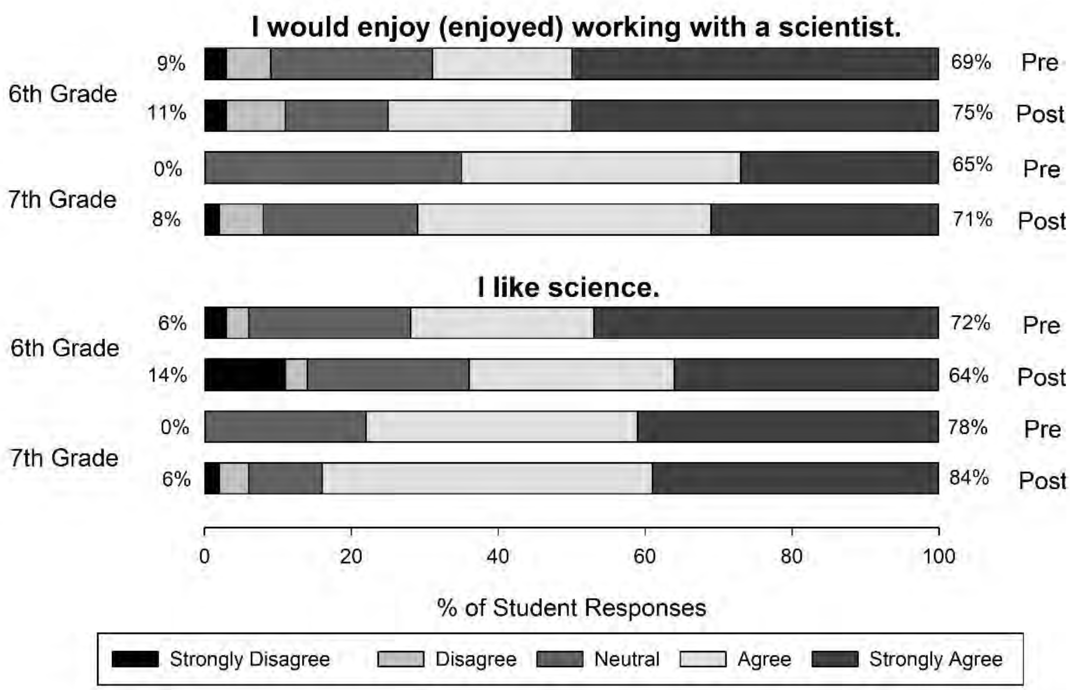


Figure 1.7. Pre- (top bar) and post-survey (bottom bar) 6th and 7th grade student responses to Likert-type (1- strongly disagree to 5-strongly agree) statements regarding their perceptions and affinity towards a scientist and science. Percentage on left represents cumulative percentage of negative responses (in disagreement) and on the right indicates cumulative percentage of positive responses (in agreement).

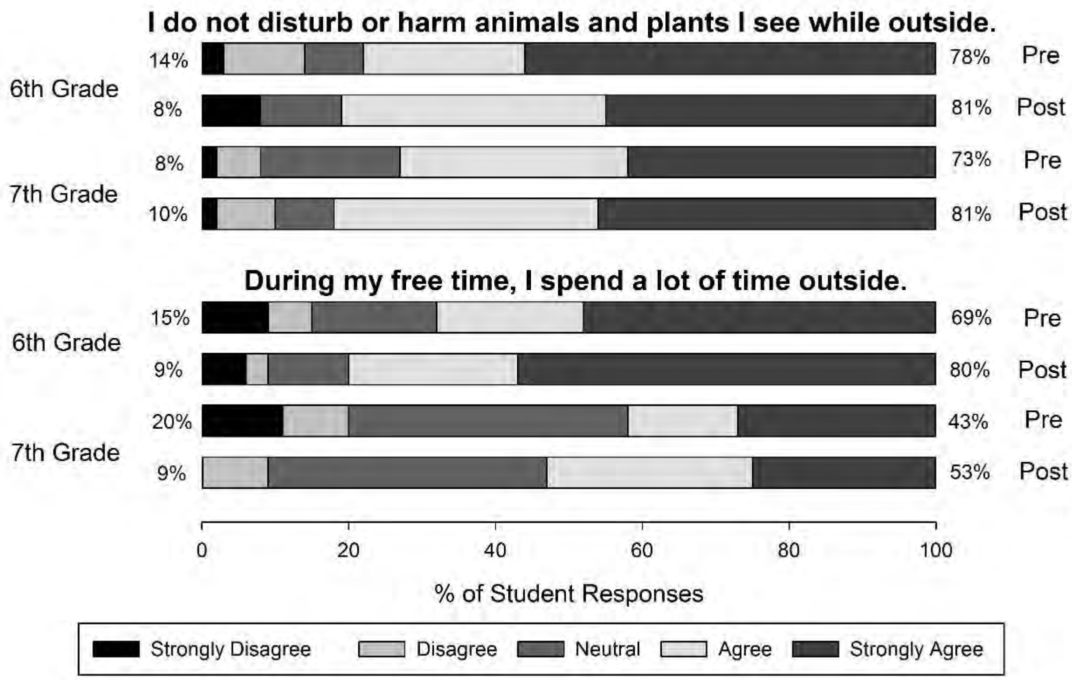


Figure 1.8. Pre- (top bar) and post-survey (bottom bar) 6th and 7th grade student responses to Likert-type (1- strongly disagree to 5-strongly agree) statements regarding their attitudes towards disturbing or harming nature and spending time outside. Percentage on left represents cumulative percentage of negative responses (in disagreement) and on the right indicates cumulative percentage of positive responses (in agreement).

Pre-program survey responses to favorite Texas animal resulted in a variety of domestic and wild animal answers (Figure 1.9 & 1.10). Sixth graders' most frequently reported animal was deer (n = 4) followed by hog (n = 3), cat (n = 3), and dove (n = 3). They included a variety of wild Texas species including quail, nilgai, mountain lion, and cardinal as well as domestic animals such as chicken, bunny, and pig. Fifty-nine percent of 6th graders included at least 1 native wild animal. There was a 13% no response rate in 6th graders. Seventh graders responded most with armadillo (n = 5) followed by all (n = 3) and dog (n = 3). Only 25% of the 7th graders included at least 1 native wild animal which include javelina, roadrunner, and horned lizard. One 7th grader included a response of a non-animal, the bluebonnet, the state flower of Texas. Seventh graders had a very high no response rate of 57%.

Figure 1.9. Content cloud analysis of 6th grade student responses to their favorite Texas animal on the pre-program survey. Most frequent response was deer (n = 4, 10%) followed by hog, cat, and dove. Thirteen percent of students had no response. Larger words indicate responses that are more frequent. Word cloud created on Wordle.net.

Figure 1.10. Content cloud analysis of 7th grade student responses to their favorite Texas animal on the pre-program survey. Most frequent response was armadillo (n = 5, 10%) followed by all and dog. Fifty-seven percent of students had no response. Larger words indicate responses that are more frequent. Word cloud created on Wordle.net.

Post-program survey responses to students' favorite bird-related activity varied across both grade levels. Sixth graders (n = 36) favorite activity was internal parasites of quail (31%), followed by mist-netting and banding (22%) and identifying birds (17%) (Fig. 1.11). Almost half (48%) of 7th graders (n = 49) reported bird surveys as their favorite activity. Followed by mist-netting and banding (23%) and aging quail wings (18%) (Fig. 1.11). Students were asked to elaborate on why their provided response was their favorite activity. Emergent themes in student responses are summarized in Table 1.2. A total of 5 themes were identified among both grade levels based upon common words used in student responses to the question.

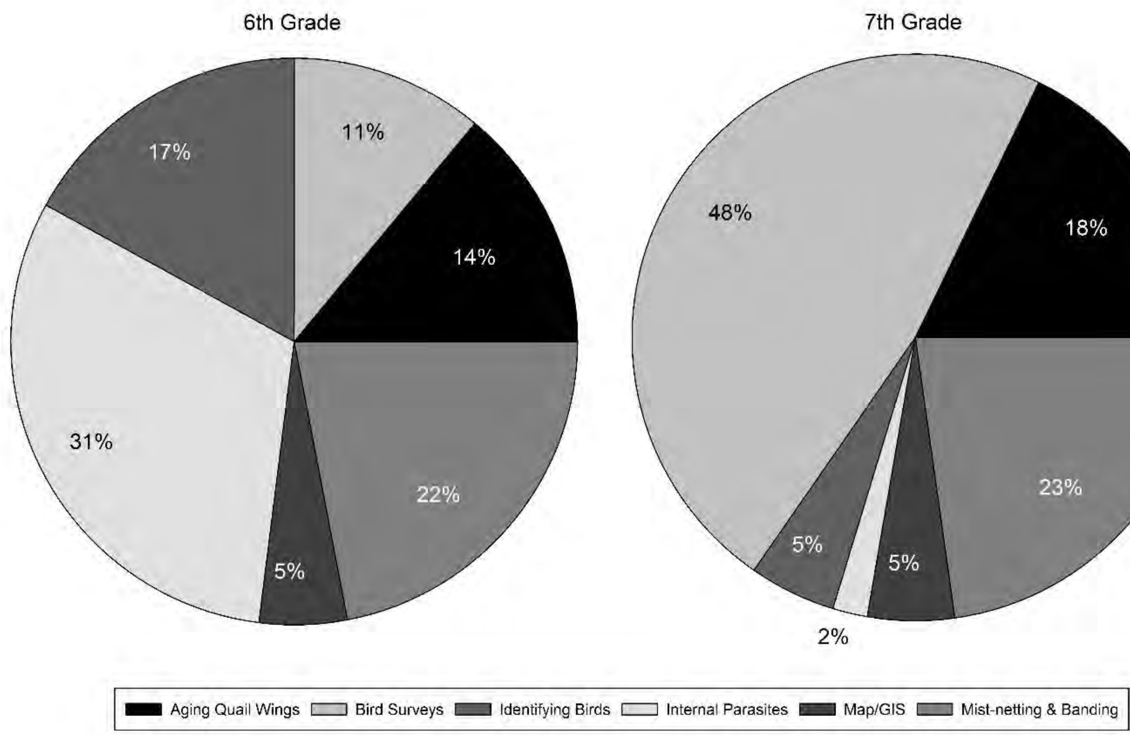


Figure 1.11. Sixth (n = 36) and 7th grade (n = 49) student responses for favorite bird-related activity administered on the post-program survey.

Table 1.2. A summary of emergent themes identified in 6th and 7th grade student responses explaining why their selected bird-related activity was their favorite. Frequency effect size was calculated by dividing the number of students that mentioned each theme by the total number of participants for each grade.

Theme	6th Grade Frequency Effect Size	7th Grade Frequency Effect Size	Exemplar Quote
No Activity	3%	0%	"Weighing them because we didn't do much."
Experiential and/or Hands-on	18%	33%	"When we worked on how to band birds, it gave us the ideal way people band birds."
Enjoyment	28%	19%	"Looked cool and was fun."
Visual	13%	10%	"The one where we looked at the birds with binoculars because we got to see them closely."
Outdoors	0%	25%	"Catching birds because we got to go outside."
No Response	51%	29%	N/A

DISCUSSION

My hypotheses regarding positive influence or improvement in student and educator affinity, perceptions, and attitudes in response to the curriculum were minimally supported given the results of this study. Students had a positive affinity towards wildlife and attitude towards working with a scientist prior to and after curriculum implementation. Their perceived knowledge of habitat fragmentation and its effect on wildlife and birds improved. Seventh graders' perceived ability to identify birds improved, yet 6^{th} graders' perceptions remained similar. Educators' perceived knowledge towards bird biology and identification remained negative with some neutral responses, however, positive attitudes were observed on all other topics.

The results presented here show the presence of an intrinsic affinity to wildlife and nature with not only children but adults as well prior to curriculum participation. This is shown in the literature previously as a precursor for individuals to be conservation minded, environmentally aware and sensitive to issues regarding these animals (Chawla 1999, Schultz et al. 2004). Our attitude towards a particular animal or species can be a good indicator of our concern regarding animal welfare, and it is this value we place on animals which expresses our compassion and our shift away from previous thinking that humans dominate wildlife (Manfredo et al. 2009, Owen et al. 2009, George et al. 2016). Particularly within urbanizing areas, the idea of mutualism among humans and wildlife is the domineering attitude (George et al. 2016), which shows a potential for the future conservation of our wildlife populations with a growing human population and land use expansion.

Our ability to become environmentally conscientious has been tested by our growing disconnect with nature. Author Richard Louv (2005) coined the term "nature-deficit disorder" to define our lack of time spent outdoors as one of the causes of the increase in behavioral problems we are seeing in young children. But when time is spent in nature, there are added health benefits such as improved social ability, self-discipline, concentration, motor skills, agility, wonder, and curiosity (Fjortoft 2001, Taylor et al. 2001, Kellert 2002). Time spent outdoors appeared to be an important characteristic of the Wild Bird Conservation Curriculum as shown by the 7th graders in an urban setting. Some of the primary barriers of using natural outdoor settings as learning environments are the lack of walking access to the outdoors, lack of time, weather conditions, and safety concerns (Ernst 2014). However, in this study, the use of the school yard and surrounding area (e.g., residential area with 7th graders) fulfilled this need of outdoor time. This shows that a nearby park or natural area is not necessary for students, instead access to an environment that is out of their everyday classroom sufficed, unlike what was described in Awasthy et al. (2012).

Students and formal educators had a pre-existing affinity towards wildlife and improved perceptions towards issues such as habitat fragmentation and its potential effects on wildlife. My hope was that this affinity for wildlife would carry over to the student and formal educator perceptions of birds. Although there was improvement on behalf of the students, a majority of students fell within the neutral category, which according to Raaijmakers et al. (2000) may be a reaction of "don't know" or "undecided" in response to bird-related statements. This suggests that more work is needed in gauging the true knowledge and ability of students rather than just their perceptions. Educators had much more realistic responses to their perceived knowledge of birds and ability to identify them, which is expected since young children are more likely to report extremes on Likert-type statements in comparison to older children and adults (Chambers and Johnston 2002). Administering a test or quiz on the lesson material and bird identification may be a route to pursue if I wish to measure learning gains as opposed to participant feelings and attitudes. The use of local species or taxa in this study brings relevancy and easily accessible study material to the classroom that has not been fully utilized in education (Huxham et al. 2006). However, additional barriers exist to the implementation of curriculum such as the one developed and used in this study.

Teachers often are not interested in the topics at hand, increased preparation required, and lack of financial support (Nelson 2010). With the Wild Bird Conservation Curriculum, I attempted to eliminate the financial barrier by providing the materials needed within kits, in-class support by ways of a visiting scientist, and the training of teachers. Yet, the disinterest in wildlife by teachers may still be a barrier we need to overcome (Crim et al. 2017). Barthwal and Mathur (2012) found favorable attitudes towards wildlife in general, particularly in female teachers, which may be one reason why only female teachers opted to implement this curriculum in the classroom and why females outnumbered males in workshop attendance. This can further skew the exposure students have to conservation education curriculum if male teachers are not interested in the topics or are not willing to pursue the use of such curricula.

Unfortunately, there is nothing I can do to create additional time in the classroom for this curriculum. With the lessons meeting state standards for science it was up to the teacher to select a time frame in which the lessons would best fit their existing curriculum and timeline. It seems that the best time to incorporate these additional activities in the classroom would be in classes and subjects that are not state tested for that year or in classrooms where teachers are with students the entire day (i.e., primary schools) or in team-teaching environments providing flexibility of time and curriculum (Jacobson et al. 2006). For example, 6th and 7th grade students in Texas are not assessed in science during these years; hence, there is opportunity to incorporate supplemental lessons in conservation education. Furthermore, aiming at students aging from 6 to 14 (Grades 1-9) can aid in the positive social influence on their individuality and identity development (Eccles 1999) in regards to pro-environmental behavior.

Science attitudes in students have been covered in depth at many grade levels and across educational settings (Foley and McPhee 2008, Houseal et al. 2014). Overall, students had positive attitudes towards science and working with a scientist in the classroom (e.g., STSP), which has been documented in other studies (Houseal et al. 2014). Students who strongly believe that they can succeed in a science activity are more likely to choose those activities, work hard at them, and in the end increase their confidence in completing them successfully (Britner and Pajares 2006). Observation, data collection, and microscope use were key science practices used in the lessons of this study, with a majority of 6^{th} grade students enjoying the data collection process. The ability of middle school students to use science process skills has been found to be a strong predictor of a student's persistence in the sciences (Gallagher 1994). This is particularly important when considering the science pipeline and how minority and female students, specifically, "leak out" of the pipeline between their time in high school and into college (Hilton and Lee 1988). This is where the presence of a visiting scientist (e.g., STSP) that is reflective of the student population demographic can be important in influencing the public's science literacy and diversity of the future workforce (Laursen et al. 2007). Students see these visiting scientists as role models and are influenced by how personable they are and may change their misconceptions about the science field (i.e., stereotypical scientist image and women scientists) (Laursen et al. 2007, Van Raden 2011, Conner and Danielson 2016). Scientists in the classroom put a human face to the field and allow the scientist to develop valuable communication skills applicable to a broad audience and increase their public service as a professional (Wellnitz et al. 2002).

Having experiential learning in the classroom along with a visiting scientist is important for the development of a STSP. With an STSP, students and teachers are able to contribute to a research project and develop science skills and content knowledge (Ledley et al. 2003). It is important to implement this type of STSP or experiential learning opportunity in a classroom setting that is inclusive of all students (Cuevas et al. 2005) and not limited to students who have access to outdoor programming or camps. The training of formal educators is critical for the implementation of kit-based and experiential learning programs (Arias et al. 2016). Often times, educators are limited in their background knowledge, preparation, and are unable to execute the array of programs and curriculum available for the classroom (Walberg 1991, Spickler and McCreary 1999, Crim et al. 2017). Professional development benefits teachers in a variety of ways in that it is necessary for their continued certification and their gain in content knowledge on topics they may not be familiar with. Much of the focus in educational settings has been the decrease in teacher-centered instruction through the use of kit-based curricula and their development as educators (Von Secker and Lissitz 1999, Lawrenz et al. 2001). Kit-based activities and professional development are essential for supporting teachers in order to keep up with the science curricular reform (Young and Lee 2005).

Considering survey responses from both students and formal educators, their responses towards wildlife, science, and nature began and ended positively or improved. Because many of their responses were already positive to begin with, it is difficult to say whether this curriculum changed any of their behaviors or feelings toward the topic at hand. Further research into conservation-related behaviors, outdoor recreation involvement, and conservation efforts with this study population are needed to gather more details on whether this curriculum has made changes beyond the classroom. Follow-up interviews or focus groups would be ideal to gather information as to what the students and educators have become involved in after their participation with the Wild Bird Conservation Curriculum. In addition, there was difficulty in recruiting teachers to participate in curriculum implementation with only motivated teachers actively involved in the implementation, a common downfall in conservation education (Barrett 2007). Additional incentives (i.e., resources or funding, supplies, continuing credits (Jacobson et al. 2006)) may need to be offered to get others involved. Furthermore, incorporating a control group to measure the true attitudes and perceptions of students in that age group and teachers of the studied grade levels will further solidify the study design.

Childhood experiences have been described by many as the foundation for their later relationship, appreciation, and commitment to the environment (Chawla 1999). I have shown that 6^{th} and 7^{th} graders have positive attitudes towards wildlife, science, birds and the establishment of a scientist partnership. In addition, student interest in these hands-on, outdoor activities and scientist visits highlight the need to incorporate such lessons into schools. These lessons provided local educators with additional tools to incorporate wildlife topics and for students to be outdoors during their allocated class time. More importantly, students were introduced to the STEM (Science, Technology, Engineering, & Math) career of wildlife biology. STSPs can be an avenue to address the lack of conservation education in K-12 education by providing a strong community connection and resource opportunities between institutions and local schools to foster more environmentally aware citizens who can make sound decisions based on their experience and knowledge of science.

LITERATURE CITED

Adams, C.E. & Thomas, J.K. (1986). Wildlife education: present status and future needs. *Wildlife Society Bulletin, 14*(4), 79-486.

Adams, C. E., Thomas J. K., Newgard, L., & Cooper, C. (1987). How a biology curriculum affects students' wildlife orientations. *The American Biology Teacher, 49*(4), 208-211.

Arias, A. M., Davis, E. A., Marino, J., Kademian, S. M., & Palincsar, A. S. (2016). Teachers' use of educative curriculum materials to engage students in science practices. *International Journal of Science Education, 38*(9), 1504-1526.

Atran, S., & Medin, D. (2008). *The native mind and the cultural construction of nature*. Massachusetts: MIT Press.

Awasthy, M., Popovic, A. Z., & Linklater, W. L. (2012). Experience in local urban wildlife research enhances a conservation education programme with school children. *Pacific Conservation Biology,* 18, 41-46.

Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn, K. A., Campbell, K. M., & Weis, A. M. (2013). *Report of the 2012 National Survey of Science and Mathematics Education*. North Carolina: Horizon Research, Inc.

Barrett, M. J. (2007). Homework and fieldwork: investigations into the rhetoric–reality gap in environmental education research and pedagogy. *Environmental Education Research*, 13(2), 209-223.

Barthwal, S. C. & Mathur, V. B. (2012). Teacher's knowledge of and attitude toward wildlife and conservation. *Mountain Research and Development, 32*, 169-175.

Bestelmeyer, S. V., Elser, M. M., Spellman, K. V., Sparrow, E. B., Haan-Amato, S. S., & Keener, A. (2015). Collaboration, interdisciplinary thinking, and communication: new approaches to K-12 ecology education. *Frontiers in Ecology and the Environment, 13*(1), 37-43.

Blair, D. (2009). The child in the garden: an evaluative review of the benefits of school gardening. *Journal of Environmental Education, 40*(2), 15-38.

Britner, S. L. & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43*(5), 485-499.

Brunotts, C. M. (1998). *School gardening: A multifaceted learning tool. An evaluation of the Pittsburgh civic garden center's Neighbors and Schools Gardening Together*. Unpublished Master's Thesis, Duquesne University, Pittsburgh, PA.

Canaris, I. (1995). Growing foods for growing minds: Integrating gardening into the total curriculum. *Children's Environments, 12*(2), 134-142.

Chall, J. S. (2000). *The academic achievement challenge: what really works in the classroom?* New York: Guilford Publications.

Chambers C. T. & Johnston C. (2002). Developmental differences in children's use of rating scales. *Journal of Pediatric Psychology, 27*(1), 27-36.

Chawla, L. (1999). Life paths into effective environmental action. *Journal of Environmental Education, 31*(1), 15-26.

Chawla, L. (2009*a*). Growing up green: becoming an agent of care for the natural world. The *Journal of Developmental Processes, 4*(1), 6-23.

Chawla, L. (2009*b*). *Participation as capacity-building for active citizenship*. Les Ateliers de l' Ethique Spring issue.

Cidell, J. (2010). Content clouds as exploratory qualitative data analysis. *Royal Geographic Society, 42*(4), 514-523.

Clason, D. L. & Dormody, T. J. (1994). Analyzing data measured by individual Likert-type items. *Journal of Agricultural Education*, *35*(4), 31-35.

Common Core State Standards Initiative. (2015). Development Process. Available online at http://www.corestandards.org/about-the-standards/development-process/.

Conner, L. D. C. & Danielson, J. (2016). Scientist role models in the classroom: how important is gender matching? *International Journal of Science Education*, *38*(15), 2414-2430.

Conover, W. J. (1999). *Practical nonparametric statistics*. Third Edition. New York: John Wiley & Sons, Inc.

Corbin, J. & Strauss, A. (1990). Grounded theory research: procedures, canons, and evaluative criteria. *Qualitative Sociology, 13*(1), 3-21.

Cornelius-White, J. (2007). Learner-centered teacher-student relationships are effective: a meta-analysis. *Review of Educational Research*, *77*(1), 113-143.

Council for Environmental Education (CEE). (2018). Project WILD. Available online at http://projectwild.org/.

Crim, C., Desjean-Perrotta, B., & Moseley, C. (2017). Strategies toward the inclusion of environmental education in educator preparation programs: results from a national survey. *School Science and Mathematics*, *117*(3-4), 104-114.

Cuevas, P., Okhee, L., Hart, J., & Deaktor R. (2005). Improving science inquiry with elementary students of diverse backgrounds. *Journal of Research in Science Teaching*, *42*(3), 337-357.

Culin, J. D. (2002). Butterflies are great teachers: the South Carolina butterfly project. *American Entomologist, 48*(1), 14-18.

DeMarco, L. W., Relf, D., & McDaniel, A. (1999). Integrating gardening into the elementary school curriculum. *HortTechnology, 9*, 276-281.

Dettmann-Easler D. & Pease, J. L. (1999). Evaluating the effectiveness of residential environmental education programs in fostering positive attitudes toward wildlife. *Journal of Environmental Education, 31*(1), 33-39.

Dickinson, J.L, Zuckerberg, B., & Bonter, D.N. (2010). Citizen science as an ecological research tool: challenges and benefits. *Annual Review of Ecology, Evolution, and Systematics, 41*, 149-172.

Dolan, E. & Tanner, K. (2005). Moving from outreach to partnership: striving for articulation and reform across the K-20+ science education continuum. *Cell Biology Education, 4*, 35-37.

Eccles, J. S. (1999). The development of children ages 6 to 14. *The Future of Children, 9*(2), 30-44.

Ernst, J. (2014). Early childhood educators' use of natural outdoor settings as learning environments: an exploratory study of beliefs, practices, and barriers. *Environmental Education Research, 20*(6), 735-752.

Evans, C. A., Abrams, E. D., Rock, B. N., & Spencer, S. L. (2001). Student/scientist partnerships: a teachers' guide to evaluating the critical components. *The American Biology Teacher, 63*(5), 318-323.

Everett, M.W. & Raven, M.R. (2012). *Incorporating conservation education in agricultural education*. The Agricultural Education Magazine, January-February:9-10,14.

Fjortoft, I. (2001). The Natural Environment as a Playground for Children: The Impact of Outdoor Play Activities in Pre-Primary School Children. *Early Childhood Education Journal, 29*(2), 111-117.

Foley, B. J. & McPhee, C. (2008). Students' attitudes towards science in classes using hands-on or textbook based curriculum. *American Educational Research Association*, 1-12.

Gallagher, S. A. (1994). Middle school classroom predictors of science persistence. *Journal of Research in Science Teaching, 31*(7), 721-734.

George, K. A., Slagle, K. M., Wilson, R. S., Moeller, S. J., & Bruskotter, J. T. (2016). Changes in attitudes towards animals in the United States from 1978 to 2014. *Biological Conservation, 201*(2016), 237-242.

Glaser B. G. (2016). Open coding descriptions. *Grounded Theory Review: An International Journal, 15*(2), 1556-1542.

Hayward, B. (2012). *Children, citizenship and environment: nurturing a democratic imagination in a changing world*. New York: Routledge.

Hernbrode, W. (1978). *Multidisciplinary wildlife teaching activities*. ERIC/SMEAC, Ohio State University, Columbus. 86pp.

Hilton, T. L. & Lee, V. E. (1988). Student interest and persistence in science: changes in the educational pipeline in the last decade. *Journal of Higher Education*, *59*(5), 510-526.

Houseal, A. K., Abd-El-Khalick, F., & Destefano, L. (2013). Impact of a student-teacher-scientist partnership on students' and teachers' content knowledge, attitudes towards science, and pedagogical practices. *Journal of Research in Science Teaching, 51*(1), 84-115.

Huxham, M., Welsh, A., Berry, A., & Templeton, S. (2006). Factors influencing primary school children's knowledge of wildlife. *Journal of Biological Education, 41*, 9-12.

Jacobson, S. K., McDuff, M. D., & Monroe, M. C. (2006). *Conservation Education and Outreach Techniques*. New York: Oxford University Press Inc.

Jones, M. T.& Eick, C. J. (2007). Implementing inquiry kit curriculum: obstacles, adaptations, and practical knowledge development in two middle school science teachers. *Science Education, 91*(3), 492-513.

Kals, E., Schumacher, D. & Montada, L. (1999). Emotional affinity toward nature as a motivational basis to protect nature. *Environment and Behavior, 31*(2), 178-202.

Kellert, S. R. (2002). *Experiencing Nature: Affective, Cognitive, and Evaluative Development, in Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*. Massachusetts: MIT Press.

Laursen, S., Liston, C., Thiry, H., & Graf, J. (2007). What good is a scientist in the classroom? Participant outcomes and program design features for a short-duration science outreach intervention in K-12 classrooms. *CBE-Life Sciences Education, 6,* 49-64.

Lawless, J. G. & Rock, B. N. (1998). Student scientist partnerships and data quality. *Journal of Science Education and Technology, 7*(1), 5-13.

Lawrenz, F., Huffman, D., & Welch, W. 2001. The science achievement of various subgroups on alternative assessment. *Science Education, 85*, 279-290.

LeCount, A. L. & Baldwin, K. L. (1986). *The bear in the classroom*. International Conference on Bear Research and Management, 6, 209-217.

Ledley, T. S., Haddad, N., Lockwood, J., & Brooks, D. (2003). Developing meaningful student-teacher-scientist partnerships. *Journal of Geoscience Education, 51*(1), 91-95.

Lehnhardt, K. (2010). Are we evaluating children's nature experiences? *International Zoo Educators Journal, 46,* 4-5.

Leopold, A. (1940). The state of the profession. *Journal of Wildlife Management, 4*(3), 343-346.

Leopold, A. (1942). *The role of wildlife in a liberal education*. Trans 7th NAWC, 485-489.

Leopold, A. (1949). *A Sand County Almanac*. New York: Oxford University Press.

Louv, R. (2005). *Last Child in the Woods*. North Carolina: Algonquin Books.

Manfredo, M. J., Teel, T. L. & Henry, K. L. (2009). Linking society and environment: a multilevel model of shifting wildlife value orientations in the western United States. *Social Science Quarterly, 90*(2), 407-427.

McCombs, B. L. & Whisler, J. S. (1997). *The learner-centered classroom and school: strategies for increasing student motivation and achievement*. The Jossey-Bass Education Series. California: Jossey-Bass Inc.

Morgan, J. M. (1992). A theoretical basis for evaluating wildlife-related education programs. *The American Biology Teacher, 54*(3), 153-157.

Muller, M. M., Kals, E., & Pansa, R. (2009). Adolesents' emotional affinity toward nature: a cross-societal study. *The Journal of Developmental Processes, 4*(1), 59-69.

Nelson, A. (2010). Environmental education and ecology in a life science course for preservice K-8 teachers using Project Wildlife in learning design. *The American Biology Teacher, 72*(3), 156-160.

Next Generation Science Standards. (2015). Three Dimensions. Available online at http://www.nextgenscience.org/three-dimensions.

Onwuegbuzie, A. J. (2000). *Effect sizes in qualitative research*. Annual Meeting of the Association of the Advancement of Educational Research, Ponte Verde, FL November. 34pp.

Owen, K., Murphy, D., & Parsons, C. (2009). ZATPAC: a model consortium evaluates teen programs. *Zoo Biology, 28*(2009), 429-446.

Paige, K., Lawes, H., Matejcic, P., Taylor, C., Stewart, V., Lloyd, D., Zeegers, Y., Roetman, P., & Daniels, C. (2010). "It felt like real science!" How operation Magpie enriched my classroom. *Teaching Science - the Journal of the Australian Science Teachers Association, 56*(4), 25-33.

Raaijmakers, Q. A. W., Van Hoof, A., Hart, H., Verbogt, T. F. M. A. & Vollebergh, W. A. M. (2000). Adolescents' midpoint responses on Likert-type scale items: neutral or missing values? *International Journal of Public Opinion Research, 12*(2), 208-216.

Ratcliffe, M. M., Merrigan, K. A., Rogers, B. L., & Goldberg, J. P. (2009). The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice, 12*(1), 36-43.

Schultz, P. W., Shriver, C., Tabanico, J. J., & Khazian, A. M. (2004). Implicit connections with nature. *Journal of Environmental Psychology, 24*(2004), 31-42.

Skelly, S. M. & Zajicek, J. M. (1998). The effect of an interdisciplinary garden program on the environmental attitudes of elementary students. *HortTechnology, 8,* 579–583.

Spickler, T. & McCreary, C. (1999). *Making the case for teaching science using a hands-on inquiry-based approach*. Pennsylvania: Bayer Corporation.

Texas Public Schools Explorer. (2017). The Texas Tribune Texas Public Schools Explorer. Available online at https://schools.texastribune.org/.

Tomanek, D. (2005). Building successful partnerships between K-12 and universities. *Cell Biology Education*, *4*, 28-29.

US Census Bureau. (2010). 2010 Census. Available online at https://www.census.gov/2010census/.

US Census Bureau. (2013). *2013 annual social and economic supplement*. Washington, DC: US Census Bureau.

Van Raden, S. J. (2011). *The effect of role models on the attitudes and career choices of female students enrolled in high school science*. Unpublished Master's Thesis. Portland State University.

Von Secker, C. E. & Lissitz, R. W. (1999). Estimating the impact of instructional practices on student achievement in science. *Journal of Research in Science Teaching, 36*, 1110-1126.

Walberg, H. J. (1991). Improving school science in advanced and developing countries. *Review of Educational Research, 61*, 25-69.

Waller, P. (2011). Bringing endangered species to the classroom. *The American Biology Teacher*, *73*(5), 277-279.

Wellnitz, T., MacRury, N., Child, A., & Benson, D. (2002). Spreading the wealth: graduate students and educational outreach. *Conservation Biology, 16*(2), 560-563.

Wilke, R. J., Peyton, R. B., & Hungerford, H. R. (1980). *Strategies for the training of teachers in environmental education: a discussion guide for UNESCO training workshops on environmental education*. Strategies for the training of teachers in environmental education, UNESCO.

Young, B. J. & Lee, S. K. (2005). The effects of a kit-based science curriculum and intensive science professional development on elementary student science achievement. *Journal of Science Education and Technology, 14*(5-6), 471-481.

Zaradic, P.A. & Pergams, O.R.W. (2007). Videophilia: implications for childhood development and conservation. *The Journal of Developmental Processes, 2*(1), 130-144.

CHAPTER II

INCORPORATING AVIAN RESEARCH INTO THE UNDERGRADUATE WILDLIFE MANAGEMENT CLASSROOM

ABSTRACT

I incorporated a course-based undergraduate research experience (CURE) into a junior level Wildlife Management Techniques course to improve student skills and confidence in bird identification and research, study design, and scientific writing. The objective of this course was to provide hands-on experiences for students and give them exposure to a variety of field methods used in wildlife science. I added a bird observation study to the existing course curriculum where students formulated a research question, designed a 4-week study to address the research question, and then wrote a report in scientific journal format. Students (n=38) were given a written pre-survey and a post-survey with Likert-type statements and a quiz on bird identification. I hypothesized that students would improve in their perceived confidence of science practices, knowledge of bird species, and attitudes towards birdlife. I observed improved perceived confidence in the science practice of data management, but saw no improvement in their confidence in writing or setting up their own bird research project. Students improved their ability to identify bird species by an average of 18%. However, students had no change in their interest in birdlife prior to and after the study. Eighty-nine and 97% of students agreed at project completion that the course helped them improve their bird identification and research/survey

---

This chapter is formatted following the guidelines of the Wildlife Society Bulletin.

skills, respectively. Adding this research experience to the Wildlife Management Techniques course allowed students to expand their skills, exposed them to research concepts, and provided a collaborative working environment. Participating in research projects could potentially make undergraduate students more marketable for future employment or graduate school opportunities.

INTRODUCTION

Experiential learning theory places experience as the key element in learning and acquiring knowledge (Kolb and Kolb 2012). Knowledge is created by grasping and transforming these experiences through a student's immersion in the experience and actively or passively processing these experiences (Kolb et al. 2001). Educators have placed much emphasis on promoting higher-order thinking strategies in the classroom to achieve an active-learning experience (Bonwell and Eison 1991). Active-learning requires student involvement and engagement in experiences that go beyond traditional lecture-style teaching techniques to include cooperative projects, fieldwork, discussions and other pedagogical approaches that promote action by students and only guidance from instructors (Bonwell and Eison 1991, Beard and Wilson 2002).

Student-centered approaches to learning have been shown to produce creative, productive, professional and responsible students ready for life beyond the university (Matter and Steidl 2000, Moen et al. 2000). The active-learning style allows students to learn by doing and has shown high levels of retention and enthusiasm from students who have participated in such an approach to teaching (Millenbah and Millspaugh 2003). Although it has been a positive step in building well-rounded students who are experienced with the skills and background needed to succeed beyond the university, there are often barriers that prevent educators from implementing this approach.

Implementing experiential learning in many undergraduate classes can pose considerable problems. Barriers surrounding decisions to implement these strategies within undergraduate course include added time for planning and in-the-classroom activities, budget concerns, and the instructor's comfort level with the material (Bonwell and Sutherland 1996, Brownell and Tanner 2012). Previous literature has provided models and recommendations such as the backward design and the CURE logic model to cope with these barriers and highlights the potential benefits to students and faculty of this type of approach (Auchincloss et al. 2014, Corwin et al. 2015, Bakshi et al. 2016, Cooper et al. 2017). Calls for reform in undergraduate biology education have pushed for what is known as course-based undergraduate research experiences (CUREs) (Auchincloss et al. 2014, Bangera and Brownell 2014, Corwin et al. 2015, Cooper et al. 2017, Flaherty et al. 2017). Experiences like CUREs have been utilized to emphasize the value of research in undergraduate courses while applying an experiential and active-learning approach. A CURE employs research practices in the classroom such as conducting broadly relevant research, addressing novel questions and generating hypotheses, collecting, analyzing, and interpreting data, and forming collaborative relationships (Auchincloss et al. 2014). Students benefit from CUREs by developing an understanding of the research process, developing their communication skills, identifying potential research careers, and improving their retention of science content, all of which are important especially for underrepresented students (Lopatto 2003, Millspaugh and Millenbah 2004, Kinkel and Henke 2006, Lopatto 2007, Bangera and Brownell 2014). Research experiences like CUREs and other project-based learning experiences can be accomplished by providing a controlled active-learning environment where time dedicated to the activity is carefully planned and structured to keep both the educator and students on task (Bonwell and Sutherland 1996, Cooper et al. 2017).

Pedagogy to promote experiential and active-learning has appeared in the wildlife education literature (Moen et al. 2000, Ryan and Campa III 2000, McCleery et al. 2005, Hiller and Tyre 2009). CUREs can be a system by which students can achieve course objectives while experiencing real-world applicability of their field of study. Undergraduate students often have mixed levels of experience and knowledge within a discipline (Evans 1987, Day 1997). In wildlife sciences, undergraduate students can vary in their exposure to study design, survey methodology, and species identification. Given that undergraduate wildlife courses (lecture only or laboratory) are often small (approximately 25-50 students) (Hiller 2009), there is an opportunity to integrate a CURE to ensure all students have research experience without the instructor being overwhelmed by a large class size.

A research experience within a particular location falls into the category of "place-based education." This location serves as the foundation for which the curriculum is based on (Jacobson et al. 2012). Undergraduate students can further their professional development by practicing local wildlife identification and observation in a place-based project on or near their university campus. A wild bird observation study is an easy fit for a place-based CURE. Because wild birds are conspicuous in most environments, additional travel time and budgeting is not necessary, making a university campus or local park an easily accessible study site. In addition, a wild bird observation project would not require preparation of additional IACUC paperwork for the CURE, as observation studies are typically exempt from review. Place-based CURE experiences can increase the relevancy and authenticity of the course content and emphasize the real-world learning that is found in an experiential environment (Woodhouse and Knapp 2000, Jacobson et al. 2015).

I integrated a CURE into an existing "Wildlife Management Techniques" course in the fall of 2016. The upper division course "Wildlife Management Techniques" (RWSC 3310) in the Department of Animal, Rangeland, and Wildlife Sciences at Texas A&M University—Kingsville is a lecture-laboratory course aimed at providing students hands-on opportunities with techniques used in wildlife management such as capture, marking, and monitoring. The course is within the Range and Wildlife Management undergraduate program that serves approximately 200 undergraduates with class sizes that range from 20 to 70 students with an average class size of 35 students. For the research experience, students worked collaboratively to develop and execute their own bird research project using the tools and skills learned in the course with instructor guidance.

Following the integration of this research experience, our main objective was to assess how this project influenced undergraduate students' cognitive (e.g. knowledge, study design ability, conceptions about science process; Cooper et al. 2017), affective (attitudes, feelings, values; Martin and Reigeluth 1999, Jacobson et al. 2015, Cooper et al. 2017), and psychomotor (e.g. practical skills; Cooper et al. 2017) outcomes related to science practices and birds. This research was guided by the following questions: Will this research experience affect student 1) perceived confidence in study design, data management, and scientific writing skills, 2) knowledge of bird species, and 3) attitudes towards birdlife? I hypothesized that this project would:

1) Improve the students' perceived confidence toward study design, data management, and scientific writing
2) Improve students' ability to identify resident and seasonal birds

3) Enhance students' attitudes towards birdlife via an increased interest in birdwatching and attracting birds to their place of residence

METHODS

Following general instructor and syllabus introductions on the first day of class, students were given a consent form and written pre-survey to complete. Of the 44 enrolled students, those that consented (n=38) signed the consent form and completed the pre-survey. Survey responses did not affect student grades. All students in the course were required to conduct a research project as part of their participation grade as suggested by Flaherty et al. (2017) in order to increase participation and motivation. Over the next 2 weeks, lectures and in-field or lab exercises were given on the topics of bird identification and survey methods, research and experimental design, and general project requirements. Students worked in collaborative teams of 2-3 students per group and were allowed to pick their research partner(s). One week later, student teams turned in a 1-page proposal that they co-authored with a partner with the following information: research question, hypothesis, study site name and description, and bird survey method or protocol. Example research questions included "Is bird activity affected by human traffic at the park?," "Does bird activity depend upon temperature?," and "What is the impact of human disturbance on the relative abundance of avian species?"

Supplemental reading materials, such as journal articles on methodology and bird survey research, were provided for guidance as suggested by Ryan and Campa III (2000). After proposal approval by the instructor, student teams independently conducted bird observations for 4 weeks with a minimum requirement of 15 observation minutes per week at their approved study site in the South Texas region. All bird observations were approved by the Institutional Animal Care and Use Committee at Texas A&M University−Kingsville under protocol numbers 2013-11-12-

A3 and 2016-10-28. Students entered their data into a Microsoft Excel© workbook for contribution to a citizen science platform and descriptive statistical analysis. Following the completion of their bird observations, they had an additional 2 weeks to write a final report written in the *Journal of Wildlife Management* format. Reports were graded based upon the rubric in Appendix K. Post-surveys (n=38) were completed during the next class meeting after all reports were collected. The entire project took place in 2 months from pre- to post-survey administration.

The pre-survey (Appendix I) included questions regarding student demographic information, ornithology courses taken, outdoor activities of choice, and listing their top 3 career options. Summary statistics for demographics and ornithology course enrollment reported as total students in the category divided by the total number of participating students. Outdoor activities and career options are reported as frequency effect sizes by dividing the number of responses within a category by the total number of responses for the given question (Onwuegbuzie 2001).

Pre- and post-surveys were identical with the exception of additional statements on the post-survey related to attitudes towards the course and the removal of student demographic questions. Each survey had a total of 16 Likert-type statements (post-survey had an additional 2 statements; Appendix J) and yes or no questions related to their perceptions and attitudes towards birds and science practices with 20 color bird photos to identify. Students were asked to respond to Likert-type statements that were meant to produce stand-alone responses with no attempt to combine responses into a composite score for each student (Clason and Dormody 1994, Boone and Boone 2012). Responses to Likert-type statements were similar to those originally developed by Likert (1932), ranging from completely disagree (1) to completely agree (5) on both surveys.

All Likert-type items and yes (1) or no (0) questions were analyzed using an upper-tailed sign test to test for improvements in student responses from pre- to post-survey with the use of ordinal measurements (Conover 1999).

At the end of each pre- and post-survey, students were required to identify 20 seasonal and resident bird species (Table 2.1) occurring in South Texas by standardized common name based on the American Ornithologists' Union (AOU 1998) using the color photos included in the surveys with assistance from the projector display. Each survey was scored using a rubric for the 20 species identified. Each species response received a score of 0, 3, or 5 depending upon the completion and/or accuracy of the name. A zero was given if the name was left blank, student wrote "I don't know" or "N/A," or if the species was misidentified completely. Three points were given if the student gave a partial name or taxonomic grouping (e.g., White-winged dove identified as "dove"). Five points were given if the student wrote the correct AOU full common name (e.g., Northern Bobwhite and not "quail" or "bobwhite"). Spelling and capitalization errors were not considered in the score. Pre- and post-survey bird identification scores were analyzed using a paired t-test and are represented as a percentage with a maximum possible score of 100%. Student identity was kept anonymous by assigning each student a numerical code to match their pre- and post-surveys following their initial submission using their university identification number which was unknown to the instructor. Consent forms and surveys were approved by the Texas A&M University−Kingsville Institutional Review Board protocol number 2016-070. All statistical analyses were conducted in SAS 9.4 (SAS Institute, Inc., Cary, NC, USA).

Table 2.1. Twenty avian species occurring as residents or seasonally in South Texas that undergraduate Wildlife Management Techniques students (n=38) were asked to identify by full common name as declared by the American Ornithologists' Union on written pre- and post-surveys during fall 2016 at Texas A&M University–Kingsville, Kingsville, TX, USA. Species occurrence determined by range maps from the Cornell Lab of Ornithology and National Audubon Society.

Avian Species	Occurrence
Black-bellied Whistling Duck	Resident
Black-crested Titmouse	Resident
Eastern Phoebe	Seasonal
Golden-fronted Woodpecker	Resident
Great Kiskadee	Resident
Greater Roadrunner	Resident
Green Jay	Resident
House Sparrow	Resident
Inca Dove	Resident
Laughing Gull	Resident
Loggerhead Shrike	Resident
Northern Bobwhite	Resident
Northern Cardinal (Female)	Resident
Northern Mockingbird	Resident
Orange-crowned Warbler	Seasonal
Pyrrhuloxia	Resident

Table 2.1 Continued

Avian Species	Occurrence
Turkey Vulture	Resident
Vermilion Flycatcher	Seasonal
White-crowned Sparrow	Seasonal
White-winged Dove	Resident

RESULTS

Demographics and Interests

Forty-four students were enrolled in the course and 38 consented to participate in the study (i.e., completing pre- and post-surveys). Of those participants, 32% were female and 68% were male. Seventy-one percent of the students identified as White/Caucasian and the remaining 29% as Hispanic/Latino/Spanish. Most participants (60%) reported being from cities or towns with populations of 10,000 or below. Remaining students came from cities or towns with a population between 10,000-20,000 (24%), 20,000-50,000 (8%), and 50,000+ (8%). Eighty-seven percent of students indicated that they were born in a county within the state of Texas, 10% indicated they were born out-of-state (California, Colorado, New Mexico), and 3% did not report a location.

The top three career choices on the pre-survey were: 1) game warden (24%), 2) wildlife biologist (14%) and ranch manager (14%), and 3) consultant (11%). Post-survey responses were similar, yet with no mention of consultant as a career choice: 1) game warden (19%), 2) wildlife biologist (18%), and 3) ranch manager (16%). Other career choices included: deer breeder, park ranger, teacher or professor, hunting guide, zookeeper, and wildlife rehabilitator. Many students also mentioned state and federal agencies that they would consider for potential career opportunities such as Texas Parks and Wildlife and the United States Department of Agriculture.

The top outdoor activities included fishing (71%), hunting (63%), birdwatching (32%), hiking (29%), and kayaking/canoeing (24%). Remaining outdoor activities included camping, biking, nature photography, and archery.

Science Practices

Student perceived confidence in writing a scientific article showed no improvement (Pre: 47% unsure, Post: 47% unsure) ($T = 2$, $P = 0.48$, Statement 2 Fig. 2.1). However, when asked if they had written in scientific journal format, there was a significant change ($T = 8.5$, $P < 0.001$, Question 2 Fig. 2.2) with the majority of students (75%) responding “yes” in the post-survey. Perceived confidence in using Microsoft Excel© significantly improved and was assessed as a measure of data management ability ($T = 6$, $P = 0.004$, Statement 1 Fig. 2.1). The majority of student responses (68%) changed to “yes” following the project when asked if they have conducted their own research ($T = 10$, $P < 0.001$, Question 1 Fig. 2.2). Statements and questions given on surveys related to science practices are provided in Figures 2.1 and 2.2.

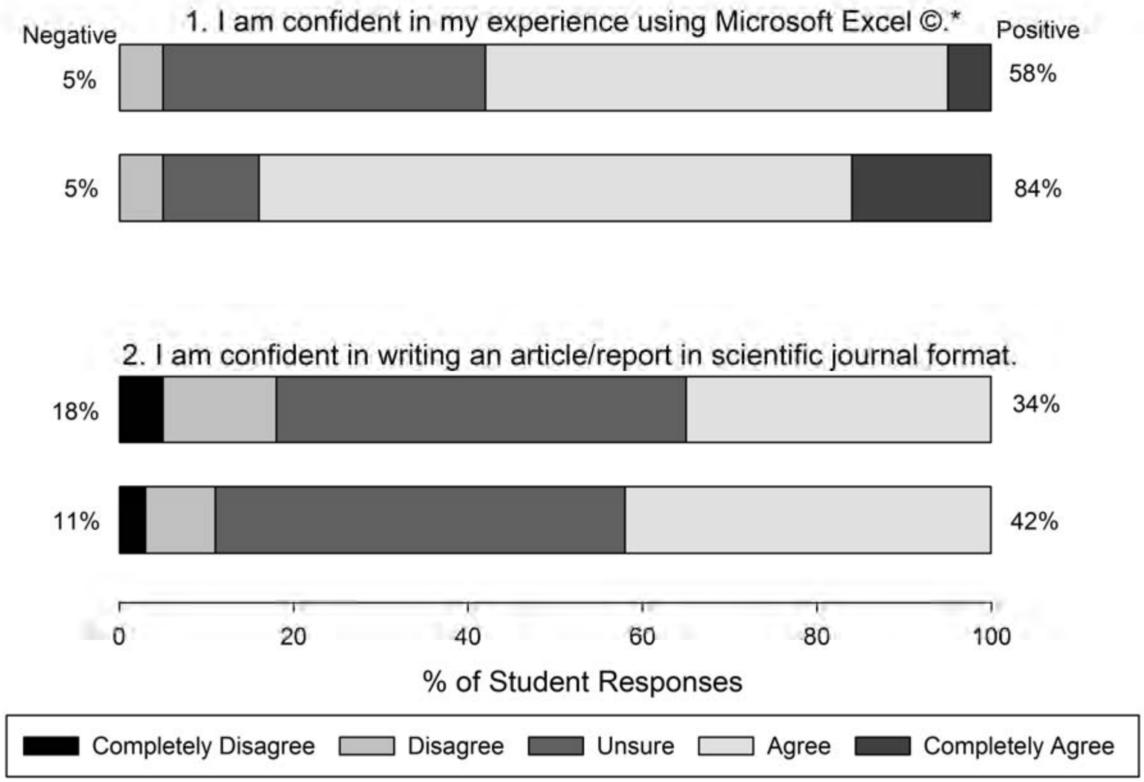


Figure 2.1. Percent of undergraduate student responses (n=38) to Likert-type statements regarding science practices including perceived confidence in using Microsoft Excel© and writing in a scientific journal format on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville, Kingsville, TX, USA in fall 2016. Responses were based on a 5-point Likert-type scale ranging from completely disagree (1) to completely agree (5). Percentage values on the left indicate the cumulative negative response (i.e., in disagreement) while percentage values on right represent cumulative positive response (i.e., in agreement). *Asterisk indicates significant improvement or positive change.

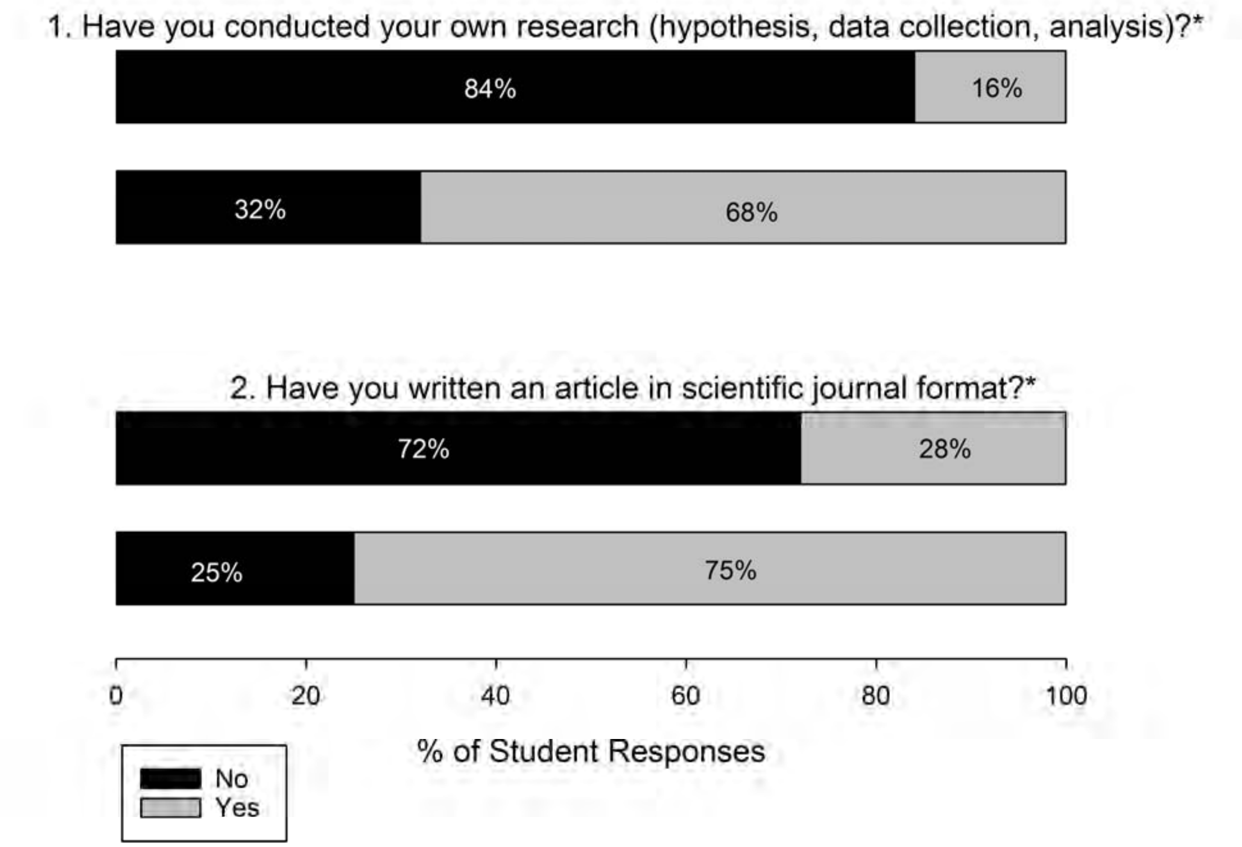


Figure 2.2. Undergraduate student responses to yes or no questions regarding science practices including conducting your own research (n=38) and previous writing experience in a scientific journal format (n=36) on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville, Kingsville, TX, USA in fall 2016. *Asterisk indicates significant improvement or positive change.

Birdlife and Bird Research

The pre-survey bird identification scores ranged from a low of 0% to 79% with a mean score of 31%. The mean score on the post-survey was 49% with a low of 23% and high of 87%. On average, bird identification scores increased by 18%, a significant improvement in the students' ability to identify resident and seasonal birds (t = 10.28, P < 0.001, Fig. 2.3). Breakdown of students who scored within the 3 credit categories (no credit, partial credit, or complete credit) is shown in Figure 2.4 for each of the 20 species they were asked to identify. Students had no significant improvement in comfort level for setting up their own bird survey research project (T = 3, P = 0.26, Statement 3 Fig. 2.5). There was also no significant change in attitudes towards collecting data on birds (T = -0.5, P = 1.00, Statement 4 Fig. 2.5). At the completion of the project, there was a 19% student increase in perceived confidence in their ability to identify many birds (>20) by full common name (T = 6.5, P = 0.01, Statement 2 Fig. 2.5). Statements and questions given on surveys related to bird research are provided in Figure 2.5.

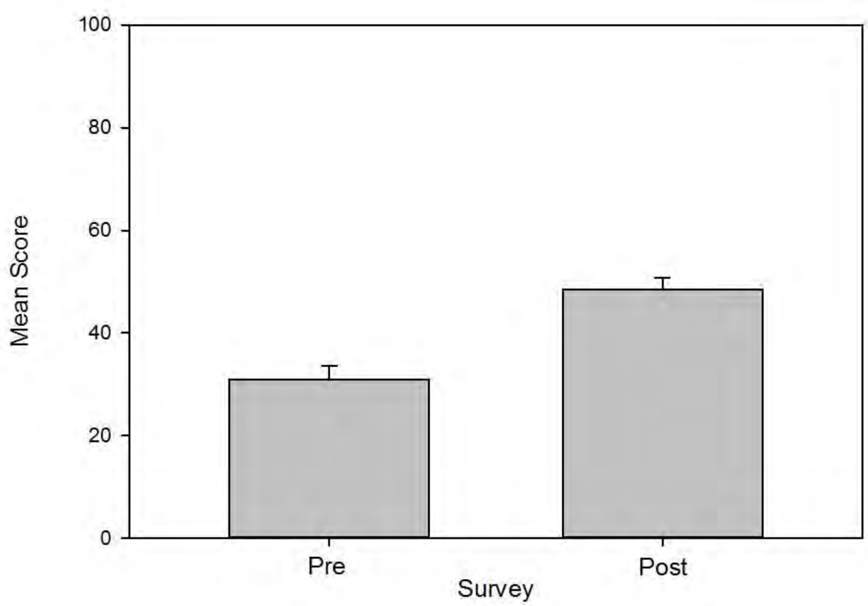


Figure 2.3. Mean scores (± standard error) for pre- and post-survey bird identification quiz for the undergraduate students (n=38) in the fall 2016 Wildlife Management Techniques course at Texas A&M University‒Kingsville, Kingsville, TX, USA. Pre- and post-survey bird identification mean scores were 31±3% and 49±2%, respectively, a significant improvement in the students' ability to identify resident and seasonal birds.

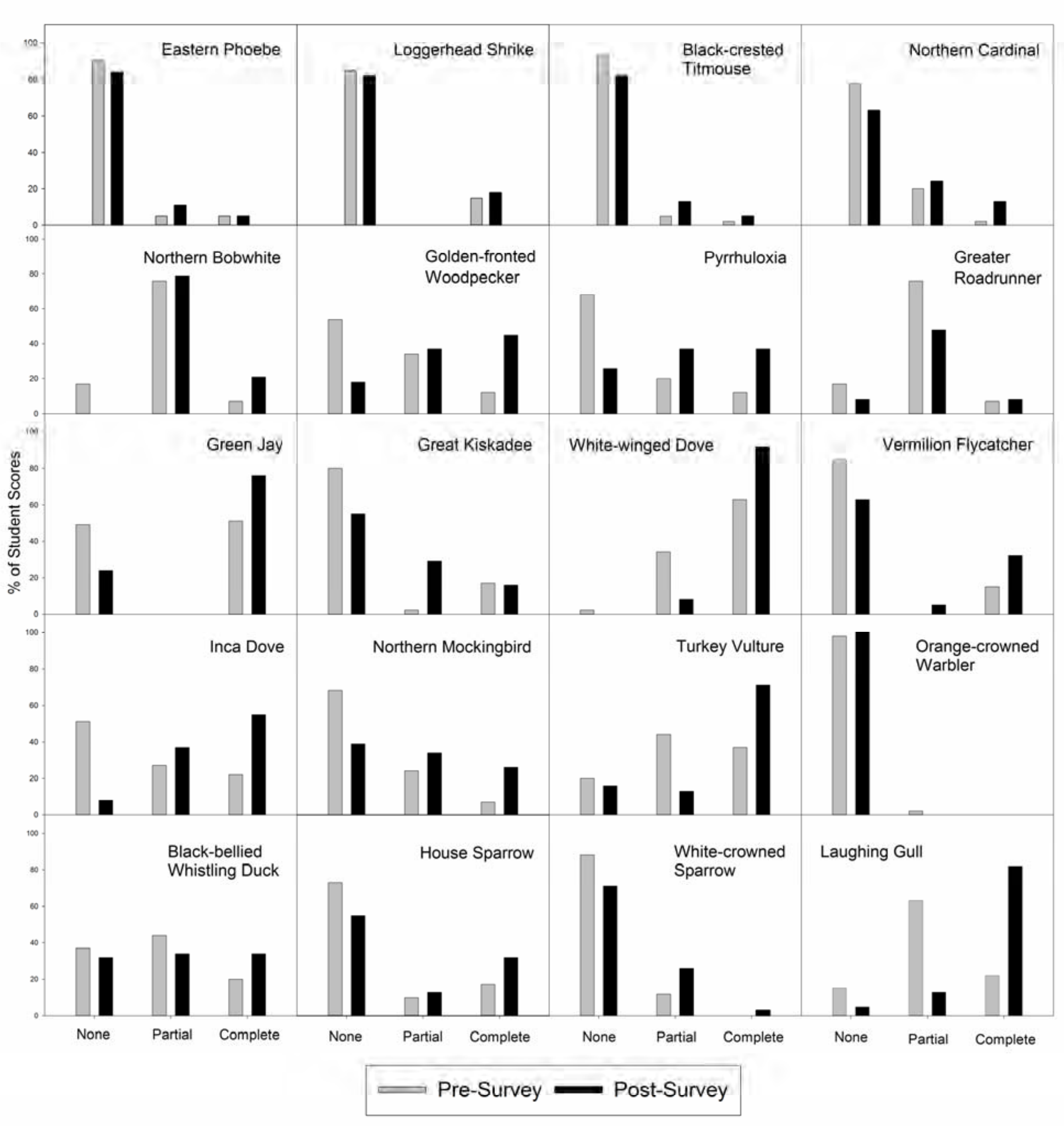


Figure 2.4. Percentage of undergraduate students in the fall 2016 Wildlife Management Techniques course at Texas A&M University–Kingsville, Kingsville, TX, USA who received no credit or none (0 points), partial (3 points), or complete credit (5 points) for each of the 20 avian species included on the pre- (n=41, gray bar) and post-survey (n=38, black bar) bird identification quizzes.

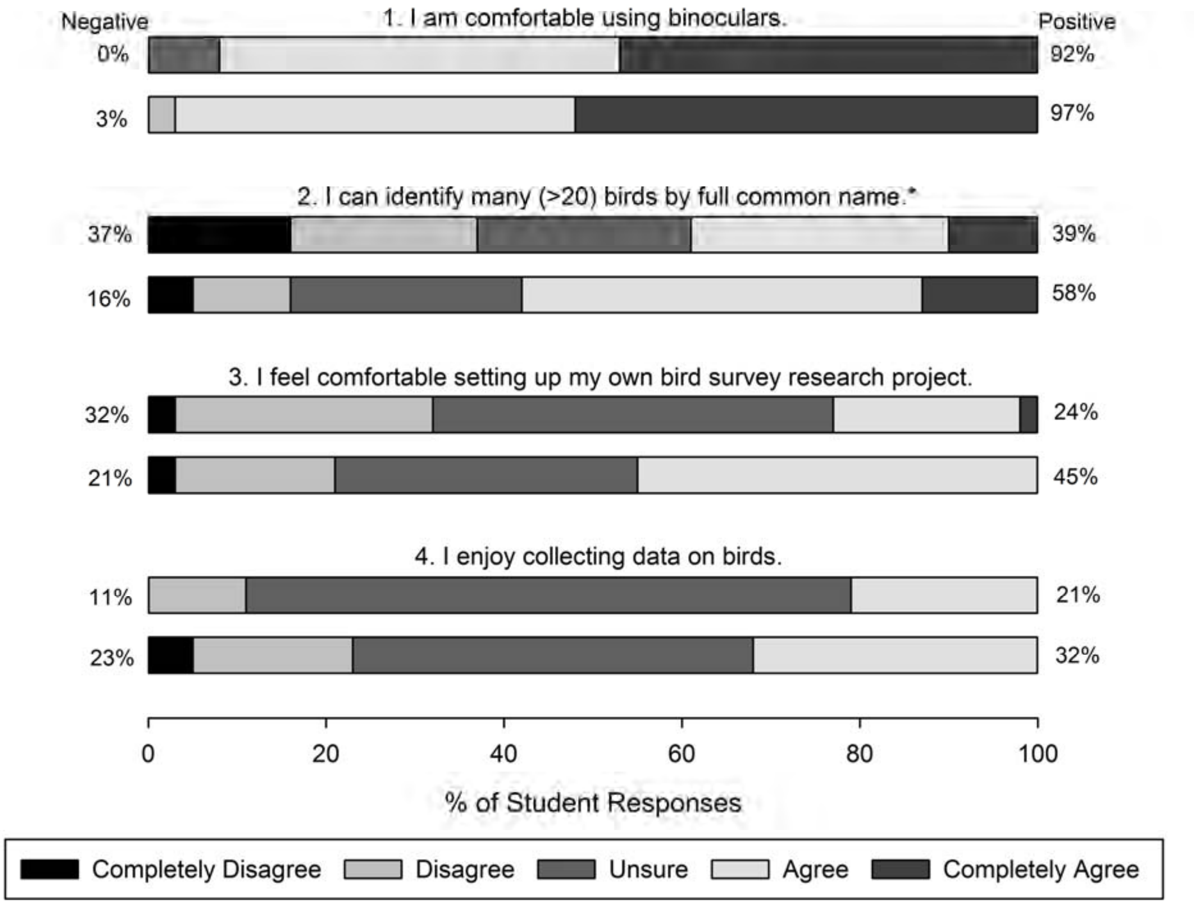


Figure 2.5. Undergraduate student responses (n=38) to Likert-type statements regarding bird research including their perceived confidence of using binoculars, identifying many birds by full common name, setting up their own bird survey research project, and enjoyment of collecting bird data on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville, Kingsville, TX, USA in fall 2016. Responses were based on a 5-point Likert-type scale ranging from completely disagree (1) to completely agree (5). Percentage values on the left indicate the cumulative negative response (i.e., in disagreement) while percentage values on right represent cumulative

positive response (i.e., in agreement). *Asterisk indicates significant improvement or positive change.

Students were asked if they birdwatch outside of class activities, and there was no significant change in those that agreed to birdwatching (T = -3, P = 0.23, Question 2 Fig. 2.6). Of those that responded “no” to birdwatching initially (32%), 100% still showed a positive attitude towards birds by being interested in learning about them (Question 2b Fig. 2.6). Sixty-three percent of students responded “yes” to attracting birds to their place of residence on the pre-survey but following the project responses dropped to 42% (T = -4, P = 0.03, Question 1 Fig. 2.6). There was no difference in their comfort level of using binoculars (T = 1, P = 0.75, Statement 1 Fig. 2.6). Statements and questions given on surveys related to birdlife are provided in Figure 2.6.

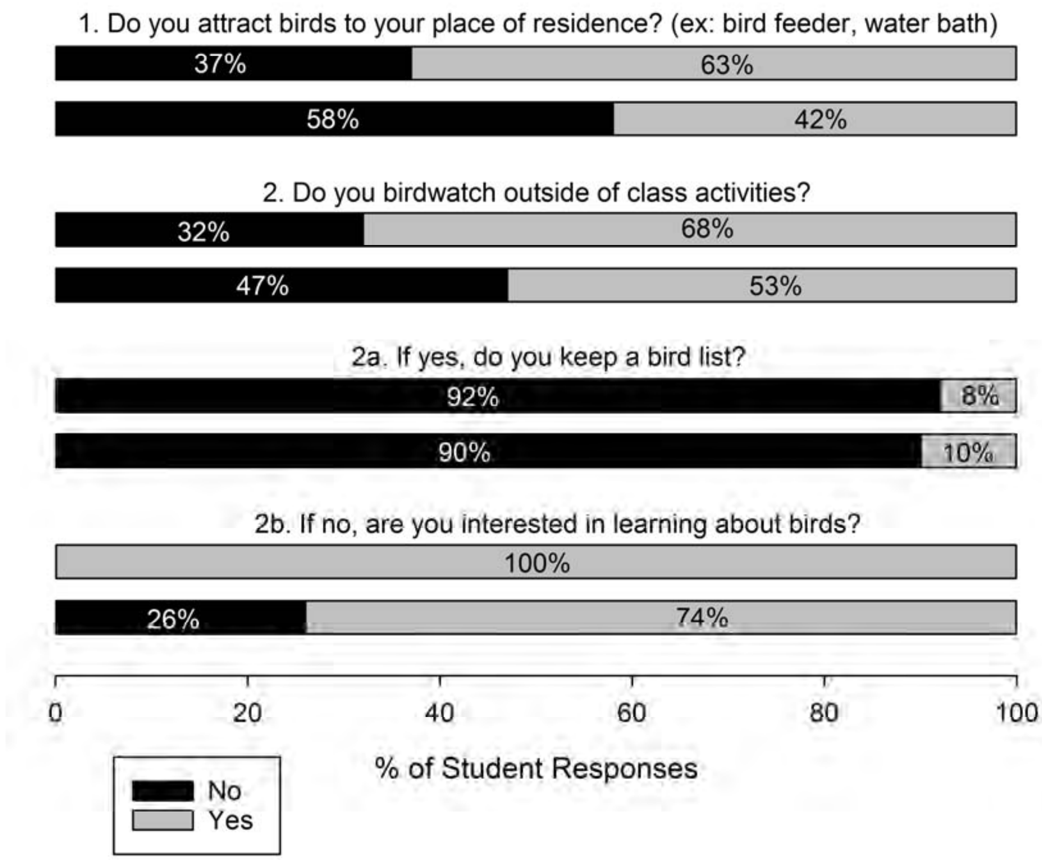


Figure 2.6. Undergraduate student responses (n=38) to yes or no questions regarding birdlife including their interest in attracting birds to their residence and birdwatching on written pre- (top bar) and post-surveys (bottom bar) during the undergraduate Wildlife Management Techniques course at Texas A&M University–Kingsville, Kingsville, TX, USA in fall 2016. No statistical analysis conducted on questions 2a-b regarding bird lists and interest in learning about birds.

Of all participants, only 8% students reported taking an ornithology course prior to the Wildlife Management Techniques course. Following the research experience and only on the post-survey, eighty-nine percent of participating students agreed that this course helped them improve their bird identification skills. Ninety-seven percent of the students agreed the course improved their understanding of bird surveys and experimental design.

DISCUSSION

Our results of this research experience fall in line with some of the benefits observed in other CURE projects (Hanauer and Dolan 2014, Elgin et al. 2016, Kerr and Yan 2016, Sarmah et al. 2016, Flaherty et al. 2017). In addition to successfully integrating a bird observation study into an existing course as a research experience, students improved in their perceived confidence in general study design and data management, partially supporting our first hypothesis and in their bird identification skills which supports our second hypothesis. Although, students' perceived confidence in writing an article and setting up their own bird research project did not improve, they were given the opportunity to cultivate these skills. Our results also indicate that students' perceived confidence in identifying resident and seasonal birds improved, yet their attitude towards birdlife by ways of birdwatching, attracting birds to their residence, and learning about birds remained similar and fails to support our third hypothesis.

Over 500 species have been documented in the South Texas region alone (Langschied 2011). With so many species to learn, this research experience established a starting point for the bird identification learning process through real-world experience. Students showed an increase in their perceived confidence in identifying many (>20) birds, however none of the students were able to fully identify all 20 species provided on the survey quiz. This may be a result of misgauging their confidence or being overly confident, known as the Dunning-Kruger effect and is common in self-reporting studies (Boud and Falchikov 1989, Falchikov and Boud 1989). It is also possible that students can identify other avian species that were not included in the 20 provided in this study. As a direct measurement of knowledge gains, students did increase their bird identification scores over the course of the research experience. Many students showed improvements in not only being able to label species by full common name but by taxonomic grouping if they could not recall the entire name as dictated by AOU.

Other possible benefits in science practices and observation skills can result from this study. It allowed students to build in their ability to pay attention to detail which they can now apply to other focal species or animal groups of interest. Students may or may have not had a primary interest in birds, but up to 42% of students reported being interested in birdwatching outside of class activities and attracting birds to their place of residence on both surveys. Students that were not interested in this particular taxa may have carried this disinterest into their motivations of the project. Projects based on instructor research interests may only benefit those concerned with the model species or taxa and may limit the impact the project has on others in the classroom (Cooper et al. 2017). Going beyond the study taxa proved to be more difficult than expected for the students as many had not conducted their own research or designed a study, yet using the tools to complete a research project seemed easier to achieve.

Data management is crucial to the organization and progress of a project, without it our outcomes can become erroneous and lack credibility. Students did improve in their confidence in using the tools necessary to manage their data (i.e., Microsoft Excel©). To our knowledge, no study has looked at an undergraduate students' perceived confidence in using data management software; much of the focus has been on data literacy programs and data management practices of faculty and graduate students (Carlson et al. 2013, Buys and Shaw 2015, Carlson et al. 2015). Richards et al. 2012 did incorporate the use of Microsoft© products in a student-driven, field-based, active-learning laboratory module but strictly for the use of analyzing data in which the students presented. Although Microsoft Excel© may seem elementary compared to Microsoft

Access© for example, students must begin developing those skills early to have an understanding of the full suite of tools that are available for research. Having the opportunity to use such a tool can be a great addition to resume skills for future employment, however preparing the study and gathering the data is the first task that needs to be completed in order to reach this step.

The ability to set up your own research project takes time, experience, and a thorough knowledge of the scientific method. Although students' confidence in their ability to set up their own bird research project did not significantly improve, there was a shift in positive responses (21%; Statement 3 Fig. 2.5) of students. This demonstrates that some students may have improved in their confidence but the overall student population in the course requires additional support in creating a project. Kardash (2000) reported that undergraduates participating in a research experience rated their lowest skills as having to identify a question and formulate hypotheses. Furthermore, the process of testing hypotheses had the least gain from the beginning to the end of a research experience (Kardash 2000). Flaherty et al. (2017) argued that intimidation of designing and conducting your own project may impact student perceptions.

Additional challenges exist in implementing student research in the classroom. The presence of student resistance is also possible as some students may not like working with others or do not like being challenged and having to think on their own (Shortlidge et al. 2016). More practice by ways of longer-term research projects or in-class brainstorming activities may be needed to further student confidence in the designing of their studies. An alternative option would be to offer elective courses in research if institutional support is available and provide additional guidance in finding volunteer and internship opportunities that promote these topics. Programs should also strive to incorporate research in required courses in addition to electives as students may opt to not enroll and, therefore, miss the opportunities provided (Bangera and Brownell 2014, Cooper et al. 2017). Research has also suggested independent research projects but those also are problematic. Independent research projects rely on students recruiting their own faculty advisor, which may dissuade students who feel uncomfortable approaching faculty with these requests (Bangera and Brownell 2014). In addition, faculty may tend to approach their best students to participate in their research programs giving only a selected few those experiences (McCleery et al. 2005, Wood 2009, Jones et al. 2010, Wei and Woodin 2011, President's Council of Advisors on Science and Technology 2012, Bangera and Brownell 2014).

Study design is a component of research that must be considered beforehand, yet may need to be modified once a project has begun. Considering only 16% of students reported that they had conducted their own research at the start of the course, a high percentage of students (97%) were in agreement on the post-survey that the course improved their understanding of general study design and research methods. Personal-professional gains in doing research often have additional benefits of students being able to think and work independently (Hunter et al. 2006). The project allowed students to develop their own question and structure their own study providing them a sense of ownership and more responsibility, which has been shown to improve motivation, self-efficacy in scientific investigation, and potential persistence in the sciences (Auchincloss et al. 2014, Jeffery et al. 2016). Giving students the opportunity to run a "pilot" study in order to test their design may give them the chance to determine what will "not work," allowing them to think critically about the components of their research and how they can make it "work" further iterating the process of science and one of the important steps of a CURE. The exploratory nature of research gives these student scientists the ability to try alternative techniques to examine their question, providing them real-world practice as stressed by the experiential learning theory.

Real-world practice is necessary to prepare students for their future professions in which writing is deemed a pertinent skill and may be one of the most valuable experiences that is relevant to their career (Moen et al. 2000). Experiential learning theory calls for authentic experiences and writing can be considered a skill that is critical for the professional development of a student (Day 2007). Although many students reported that they had never written an article at the start of the project, this research experience gave them scientific writing and a form of communication practice. Their perceived confidence did not improve in this study nor was this skill highly rated in previous research experiences (Kardash 2000, Hunter et al. 2006). It is important to note that students recognized their writing as being formatted for a scientific journal, which can aid in their project ownership, participation in the scientific community, and persistence in science (Lave 1991, Corwin et al. 2015). By including this writing component into an existing course, I avoided the addition of specialized courses to the curriculum, such as technical writing, that may extend a student's stay at the university or deviate from the program or institution's original goal (Elsen et al. 2009). To expand this experience, future studies should include a peer review step, which will mimic the professional process many scientists encounter when publishing their research. Ryan and Campa III (2000) suggest students take full advantage of the revision process and urge instructors to require multiple versions of graded writing to keep students motivated and with encouragement and constructive criticism, students can become better writers (Day 1997).

I recognize self-reported gains in student learning, experience, and confidence is not an accurate way to measure student outcomes. Disadvantages exist with self-reporting such as dishonesty, carelessness, and other misleading effects (Borg and Gall 1983). Further empirical research is needed to measure true knowledge gained in these areas. I touched on this through our work with testing the technical skill of students on bird identification, but additional effort will be necessary to gauge improvement in writing, study design, and other science practices. It will be important to incorporate more than one measure to identify changes in perceptions and provide direct evidence of student outcomes (Corwin et al. 2015). In addition, the lack of control in this study did not provide the support I needed to reflect the true perceptions and interests that may exist with wildlife-minded undergraduates (Flaherty et al. 2017). It is difficult to accomplish this at our institution due to the small student cohort in the program, only one course section available, and the risk of double responses from the same individuals since many of the same students take other wildlife courses in the same semester. There is much room for additional study in the support of CUREs among the science disciplines in an effort to determine factors that may influence students in the sciences and their success.

Experiential and active-learning has been previously underutilized in the undergraduate wildlife curriculum due to time constraints, funding, and class size (McCleery et al. 2005). A hands-on research experience, such as the one described here, can be instrumental to the growth of undergraduate students as these experiences are needed in order to prepare them for real-world situations. Learning opportunities that engage students are important to develop undergraduates that are responsible, goal-driven, and scientifically literate members of society (Matter and Steidl 2000, Moen et al. 2000, Ryan and Campa III 2000). A primary motivator to become involved in such opportunities as the CURE presented here or an independent project is one’s interest in animals and it is this perception of nature that is important to develop individuals who take conservation actions, are environmentally aware, and sensitive to issues that may affect nature

(Tanner 1980, Chawla 1998, Owen et al. 2009). Integration of research into existing curricula may better prepare students for their future in wildlife by making research accessible, teaching critical thinking, forming collaborative relationships, and promoting awareness to the potential issues they may encounter as practicing scientists.

Course Recommendations

A goal of The Wildlife Society's working group on College and University Wildlife Education is to improve communication regarding issues in education but also to improve the quality of education for our future professionals (Ryan and Campa III 2000). Many courses provide the tools students need to pursue research questions but may never give the opportunity to execute the use of those tools. By re-structuring an existing course into a CURE, students may be given that opportunity. The type of research experience presented here can be an easy fit particularly in courses that have learning outcomes related to study and research design. To re-structure an existing course, begin by evaluating the topics covered in the syllabus to see how they can be re-organized in a way to provide all of the necessary information to the students early on in the semester or quarter. This will require much more initial planning and preparation time on behalf of the instructor prior to the start of the course (Cooper et al. 2017). Providing the required information to the students early on in the course allows the remaining time for students to put together and conduct a short-term research project. Consider providing students the flexibility in choosing their focal species or taxa, yet reminding them that they should be easily accessible or at no cost to the student or instructor. This approach can motivate students to perform well in the course, increase their knowledge and retention of information on their species or taxa of interest, and improve classroom project diversity. Research projects are an avenue for active-learning to naturally occur and can provide students with authentic experiences to make them more marketable for future employment or graduate school opportunities (Weaver et al. 2008, Miller et al. 2013).

LITERATURE CITED

American Ornithologists' Union (AOU). 1998. Check-list of North American Birds. Seventh edition. American Ornithologists' Union, Washington, D.C., USA.

Auchincloss L. C., S. L. Laursen, J. L. Branchaw, K. Eagan, M. Graham, D. I. Hanauer, G. Lawrie, C. M. McLinn, N. Pelaez, S. Rowland, M. Towns, N. M. Trautmann, P. Varma-Nelson, T. J. Weston, and E. L. Dolan. 2014. Assessment of course-based undergraduate research experiences: a meeting report CBE-Life Science Education 13:29-40.

Bakshi, A., L. E. Patrick, and E. W. Wischusen. 2016. A framework for implementing course-based undergraduate research experiences (CUREs) in freshman biology labs. American Biology Teacher 78(6):448-455.

Bangera, G. and S. E. Brownell. 2014. Course-based undergraduate research experiences can make scientific research more inclusive. CBE-Life Sciences Education 13(2014):602-606.

Boone, H. N. and D. A. Boone. 2012. Analyzing Likert data. Journal of Extension 50(2):2TOT2.

Bonwell, C. C. and J. A Eison. 1991. Active Learning: creating excitement in the classroom. ASHE-ERIC Higher Education Reports.

Bonwell, C. C. and T. E. Sutherland. 1996. The active learning continuum: choosing activities to engage students in the classroom. New Directions for Teaching and Learning 67:3-16.

Borg, W. R. and M. D. Gall. 1983. Educational research: an introduction. Fourth Edition. Longman Inc., New York, New York, USA.

Boud, D. and N. Falchikov. 1989. Quantitative studies of student self-assessment in higher education: a critical analysis of findings. Higher Education 18:529-549.

Brownell, S. E. and K. D. Tanner. 2012. Barriers to faculty pedagogical change: Lack of training, time, incentives, and… tensions with professional identity?. CBE-Life Sciences Education 11(4):339-346.

Buys, C. M. and P. L. Shaw. 2015. Data management practices across an institution: survey and report. Journal of Librarianship and Scholarly Communication 3(2):eP1225.

Carlson, J., L. Johnston, B. Westra, and M. Nichols. 2013. Developing an approach for data management education: a report from the data information literacy project. The International Journal of Digital Curation 8(1):204-217

Carlson, J., M. S. Nelson, L. R. Johnston, and A. Koshoffer. 2015. Developing data literacy programs: working with faculty, graduate students, and undergraduates. Bulletin of the Association for Information Science and Technology 41(6):14-17.

Chawla, L. 1998. Significant life experiences revisited: a review of research on sources of environmental sensitivity. Journal of Environmental Education 29(3):11-21.

Clason, D. L. and T. J. Dormody. 1994. Analyzing data measured by individual Likert-type items. Journal of Agricultural Education 35(4):31-35.

Conover, W. J. 1999. Practical nonparametric statistics. Third Edition. John Wiley & Sons, Inc., New York, New York, USA.

Cooper, K. M., P. A. G. Soneral, and S. E. Brownell. 2017. Define your goals before you design a CURE: a call to use backward design in planning course-based undergraduate research experiences. Journal of Microbiology and Biology Education 18(2):1-7.

Corwin, L. A., M. J. Graham, and E. L. Dolan. 2015. Modeling course-based undergraduate research experiences: an agenda for future research and evaluation. CBE-Life Sciences Education 14:1-13.

Day, J. W. 1997. On improving wildlife education. Wildlife Society Bulletin 25(4):912-914.

Elgin, S. C. R., G. Bangera, S. M. Decatur, E. L. Dolan, L. Guertin, W. C. Newstetter, E. F. San Juan, M. A. Smith, G. C. Weaver, S. R. Wessler, K. A. Brenner, and J. B. Labov. 2016. Insights from a Convocation: Integrating Discovery-Based Research into the Undergraduate Curriculum. CBE Life Sciences Education 15(2):1-7.

Elsen, M., G. J. Visser, and J. H. van Driel. 2009. How to strengthen the connection between research and teaching in undergraduate university education. Higher Education Quarterly 63(1):64-85.

Evans, R. 1987. Beyond the classroom. Biological Journal of the Linnean Society 32:67-76.

Falchikov, N. and D. Boud. 1989. Student self-assessment in higher education: a meta-analysis. Review of Educational Research 59:395-430.

Flaherty, E. A., S. M. Walker, J. H. Forrester, and M. Ben-David. 2017. Effects of course-based undergraduate research experiences (CURE) on wildlife students. Wildlife Society Bulletin 41(4):701-711.

Hanauer, D. I. and E. L. Dolan. 2014. The project ownership survey: measuring differences in scientific inquiry experiences. CBE-Life Sciences Education 13:149-158.

Hiller, T. L. and A. J. Tyre. 2009. Investigating active-learning strategies in wildlife ecology college courses. North American Colleges and Teachers of Agriculture Journal. December 2009:36-41.

Hunter, A., S. L. Laursen, and E. Seymour. 2006. Becoming a scientist: the role of undergraduate research in students’ cognitive, personal, and professional development. Science Education 91:36-74.

Jacobson, S. K., M. D. McDuff, and M. C. Monroe. 2015. Conservation education and outreach techniques. Second edition. Oxford University Press, Oxford, England, United Kingdom.

Jeffery, E., K. Nomme, T. Deane, C. Pollock, and G. Birol. 2016. Investigating the role of an inquiry-based biology lab course on student attitudes and views toward science. CBE-Life Sciences Education 15(4):1-12.

Jones, M. T., A. E. L. Barlow, and M. Villarejo. 2010. Importance of undergraduate research for minority persistence and achievement in biology. Journal of Higher Education 81(1):82-115.

Kardash, C. M. 2000. Evaluation of an undergraduate research experience: perceptions of undergraduate interns and their faculty mentors. Journal of Educational Psychology 92(1):191.201.

Kerr, M. A. and F. Yan. 2016. Incorporating Course-Based Undergraduate Research Experiences into Analytical Chemistry Laboratory Curricula. Journal of Chemical Education 93(4):658-662.

Kinkel, D. H. and S. E. Henke. 2006. Impact of undergraduate research on academic performance, educational planning, and career development. Journal of Natural Resources and Life Sciences Education 35:194-201.

Kolb, D. A., R. E. Boyatzis, and C. Mainemelis. 2001. Experiential learning theory: previous research and new directions. Perspectives on thinking, learning, and cognitive styles 1(8):227-247.

Kolb A. Y. and D. A. Kolb. 2012. Experiential Learning Theory. Pages 1215-1219 *in* N. M. Seel, editor. Encyclopedia of the Sciences of Learning, Springer, Boston, MA, USA.

Langschied, T. M. 2011. A guide to bird-watching and South Texas Wintering Birds. Caesar Kleberg Wildlife Research Institute, Texas A&M University−Kingsville, Kingsville, TX, USA.

Lave, W. E. 1991. Situated learning: legitimate peripheral participation. Cambridge University Press, New York, NY, USA.

Likert, R. 1932. A technique for the measure of attitudes. Pages 5-55 *in* R. S. Woodworth, editor. Archives of Psychology, New York, USA.

Lopatto, D. 2003. The essential features of undergraduate research. Council on Undergraduate Research Quarterly March 2003:139-142.

Lopatto, D. 2007. Undergraduate research experiences support science career decisions and active learning. CBE−Life Sciences Education 6:297-306.

Martin, B. L. and C. M. Reigeluth. 1999. Affective education and the affective domain: Implications for instructional-design theories and models. Pages 485-510 *in* C. M. Reigeluth, editor. Instructional-design theories and models: A new paradigm of instructional theory, Lawrence Erlbaum Associates, Inc., Mahwah, New Jersey, USA.

Matter, W. J. and R. J. Steidl. 2000. University undergraduate curricula in wildlife: beyond 2000. Wildlife Society Bulletin 28(3):503-507.

McCleery, R. A., R. R. Lopez, L. A. Harveson, N. J. Silvy, and R. D. Slack. 2005. Integrating on-campus wildlife research projects into the wildlife curriculum. Wildlife Society Bulletin 33(3):802-809.

Millenbah, K. F. and J. J. Millspaugh. 2003. Using experiential learning in wildlife courses to improve retention, problem solving, and decision-making. Wildlife Society Bulletin 31(1):127-137.

Miller, C. W., J. Hamel, K. D. Holmes, W. L. Helmey-Hartman, and D. Lopatto. 2013. Extending you research team: learning benefits when a laboratory partners with a classroom. BioScience 63(9):754-762.

Millspaugh, J. J. and K. F. Millenbah. 2004. Value and structure of research experiences for undergraduate wildlife students. Wildlife Society Bulletin 32(4):1185-1194.

Moen, A. N., G. S. Boomer, and M. C. Runge. 2000. Professional development of undergraduates in wildlife ecology and management. Wildlife Society Bulletin 28(1):180-190.

Onwuegbuzie, A. J. 2001. Effect sizes in qualitative research: a prolegomenon. Quality and Quantity 37(4):393-409.

Owen, K., D. Murphy, C. Parsons. 2009. ZATPAC: A model consortium evaluates teen programs. Zoological Biology 28: 429-446.

President's Council of Advisors on Science and Technology. 2012. Engage to excel: producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Executive Office of the President, Washington, DC, USA.

Richards, S. M., K .I. Adsit, and D. M. Ford. 2012. Integrating inquiry-based field investigations into an environmental science curriculum. Journal of the Tennessee Academy of Science 87(2):105-115.

Ryan, M. R. and H. Campa III. 2000. Application of learner-based teaching innovations to enhance education in wildlife conservation. Wildlife Society Bulletin 28(1):168-179.

Sarmah, S., G. W. Chism III, M. A. Vaughan, P. Muralidharan, J. A. Marrs, and K. A. Marrs. 2016. Using Zebrafish to Implement a Course-Based Undergraduate Research Experience to Study Teratogenesis in Two Biology Laboratory Courses. Zebrafish 13(4): 293-304.

Shortlidge, E. E., G. Bangera, and S. E. Brownell. 2016. Faculty perspectives on developing and teaching course-based undergraduate research experiences. BioScience 66(1):54-62.

Tanner, T. 1980. Significant life experiences. Journal of Environmental Education 11:20-24.

Weaver, G. C., C. B. Russell, and D. J. Wink. Inquiry-based and research-based laboratory pedagogies in undergraduate science. Nature Chemical Biology 4(10):577-580.

Wei, C. A. and T. Woodin. 2011. Undergraduate research experiences in biology: alternatives to the apprenticeship model. CBE-Life Sciences Education 10:123-131.

Wood, W. B. 2009. Innovations in teaching undergraduate biology and why we need them. Annual Review of Cell and Developmental Biology 25:93-112.

Woodhouse, J. L. and C. E. Knapp. 2000. Place-based curriculum and instruction: outdoor and environmental education approaches. ERIC Digest, ERIC Clearinghouse on Rural Education and Small Schools, Charleston, West Virginia, USA.

CHAPTER III

TEMPORAL RELATIONSHIPS OF BREEDING LANDBIRDS AND LANDSCAPE PRODUCTIVITY ON THE EAST FOUNDATION'S EL SAUZ RANCH

ABSTRACT

The use of Normalized Difference Vegetation Index (NDVI), a measure of landscape "greenness," has been key to identifying wildlife-habitat relationships. NDVI has been used to assess species distributions, their habitats, and has been found to be positively linked to species evenness, richness, and abundance across a variety of taxonomic groups as predicted by the species-energy theory and More Individuals Hypothesis. Seasonal levels of productivity or energy have been strongly related to avian population dynamics suggesting their dependence upon biomass production for completion of different life stage tasks such as migration, breeding, and raising young in birds**.** Considering the breeding season is a critical component of the avian life cycle with higher nutritional requirements to feed young, maintaining protection from predators, and attracting mates, we set out to determine if the species-energy theory and More Individuals Hypothesis would be supported in subtropical subhumid-to-semiarid rangeland conditions of South Texas with extreme events of drought and rainfall. The objective of this study was to determine if landscape productivity (NDVI) positively affected avian abundance across time beginning in a recovery year, following a period of drought, into a wet, and average rainfall year. Positive relationships between avian abundance and NDVI were not always observed, these relationships depended upon the year (i.e., wet or normal rainfall year) and

This chapter is formatted following the guidelines of Ecological Processes.

NDVI levels in the month prior to the peak of the breeding season. My results do not completely support the species-energy theory and More Individuals Hypothesis, suggesting the climatic fluctuations that occur in South Texas landscapes do not always follow previously supported research. Rangeland conditions in months prior to the start of a biological survey can influence survey outcomes, thus these conditions should be taken into account when designing monitoring protocols. By combining on-the-ground monitoring and landscape ecology techniques and applying it to land management strategies through the use of biomass production, these tools can aid in delivering more than population information on a species or taxonomic group but land management recommendations to help sustain populations and better predict how environmental changes may affect avian dynamics.

INTRODUCTION

Rangelands are the most common landscape in the United States and in the world (Fuhlendorf and Engle 2001). They serve as an important ecosystem consisting of primarily native plant communities for grazing and browsing of domestic livestock and wildlife (Holechek et al. 1998). These lands provide goods and services to humans, like animal production, recreation, water and it is challenging to plan and sustain healthy rangelands that benefit animals and humans alike (Holechek et al. 1998; Augustine et al. 2011). The effort to maintain a healthy ecosystem is further complicated by fluctuations in environmental conditions that affect the vegetation that both domestic and wild species rely on. Extreme rainfall (Knapp et al. 2008; Heisler-White et al. 2009) or drought (Singh et al. 2003; Westoby 1979) events can drastically affect the growth of vegetation and plant communities that are needed by terrestrial species and their resources.

Vegetation can strongly influence animal distributions and dynamics, which is why it is imperative to assess how environmental changes such as climate change and habitat degradation can affect these species (Pettorelli et al. 2005). Determining and managing habitats that support diverse and ecologically important or threatened species has been a large concern for many years, particularly with migratory birds (Yagerman 1990; Franklin 1993; Skagen 2005; Lindenmayer and Fischer 2006). Avian presence can be monitored easily (Mac Nally et al. 2004) and thus may be a strong indicator of ecosystem function and provide reliable measures of changing environments (Morrison 1986; Furness and Greenwood 1993). Changes related to environmental energy availability and habitat fragmentation have been found to affect avian population dynamics (LaSorte and Boecklen 2005; Carrara and Vázquez 2010; Seymour and Dean 2010). Climate change has also become a challenge over the years causing population re-distributions, shifts, and other effects on avian species (Hitch and Leberg 2006; Miller-Rushing et al. 2008; Visser et al. 2009; Moller 2010; Saino et al. 2011). Avian response to these changes urges the need for the integration of climate and landscape data into studies of climate and landscape effects on avian species and their population sizes for enabling better predictions of the effects of environmental changes.

Environmental energy and changes in energy are reflected in the vegetation used by species and has been hypothesized to cause impacts to their population dynamics (Clarke and Gaston 2006; Cleland et al. 2007). The species-energy theory states that positive relationships exist between richness and energy, where energy is often measured as biomass (i.e., vegetation) production (Hutchinson 1959; Brown 1981; Wright 1983; Hurlbert 2004; Carrara and Vázquez 2010). Often connected to the species-energy theory is the More Individuals Hypothesis (MIH), which predicts an increase in species richness with higher energy due to more individuals being supported in an area (Hurlbert 2004). It is clear with these ideas that richness and abundance can be closely tied to biomass production. More specifically, seasonal levels of energy, such as spring and summer, appear to be more strongly related to biodiversity and abundance as compared to annual levels (Hurlbert and Haskell 2003). This shows a strong connection between the environment and ecology of the focal taxa, suggesting their dependence upon biomass production for completion of different life stage tasks such as migration, breeding, and raising young in birds.

The most important influence on vegetation is precipitation (Holechek et al. 1998), and it has been noted as the primary influence on the Normalized Difference Vegetation Index (hereafter NDVI) (Wang et al. 2003; Phillips et al. 2008). NDVI **is** commonly used as a surrogate for vegetation greenness, biomass productivity, or energy (Phillips et al. 2008) and is available from a variety of geospatial data resources (e.g., Landsat, ASTER, MODIS) (Kerr and Ostrovsky 2003; Pettorelli 2005; Xie et al. 2008). It has been used to assess species distributions, their habitats, and found to be positively linked to species evenness, richness, and abundance across a variety of taxonomic groups (Bailey et al. 2004; Hurlbert and White 2005; Phillips et al. 2008; Symonds and Johnson 2008; Mcfarland et al. 2011). Because of the usefulness of NDVI and its close tie to biodiversity on the landscape, it can be used as a tool to assess how environmental fluctuations may affect avian populations.

The aim of this study was to determine what landscape factors are affecting breeding bird numbers in South Texas. The specific objective was to determine if landscape productivity (i.e., NDVI) affects avian abundance during the breeding season on the El Sauz Ranch in South Texas, a region experiencing subtropical subhumid-to-semiarid regimes of high temperatures, little to no moisture, but also high humidity and occasional frosts (Fulbright et al. 1990). I hypothesized biomass production would recover post-drought and lead to positive relationships with bird abundance as NDVI increases throughout the study area. These relationships would also be observed over the years and in support of the species-energy theory and MIH. With a more productive landscape, it is anticipated that abundance would be greater since many rely on healthy, dense vegetation for shelter, nesting, and food during the period of breeding and migration (Jones 2001; Skagen et al. 2005; Tottrup et al. 2008; Hunter et al. 2012).

METHODS

Study Area

The El Sauz Ranch is 11,082 ha and approximately 10 km west of Port Mansfield along the south Texas coast within Willacy and Kenedy Counties (Fig. 3.1). There are 37 km of roads, 30.6 km of creeks, and 254 ha of water bodies on the ranch which is part of the Gulf Coast Prairies and Marshes ecoregion (Snelgrove et al. 2013; TPWD 2017). Dominant vegetation communities include: seacoast bluestem (*Schizachyrium scoparium*) and gulf dune paspalum (*Paspalum monostachyum*) of the Kenedy Sand Prairie, honey mesquite (*Prosopis glandulosa*) and granjeno (*Celtis pallida*) parks and live oak woods (*Quercus virginiana*) (Fulbright and Bryant 2003; Snelgrove et al. 2013). Gulf cordgrass (*Spartina* spp.) prairie patches, a diminishing habitat, are also present on the ranch (Haynes and Avila-Sanchez, Texas A&M University–Kingsville, personal communication).

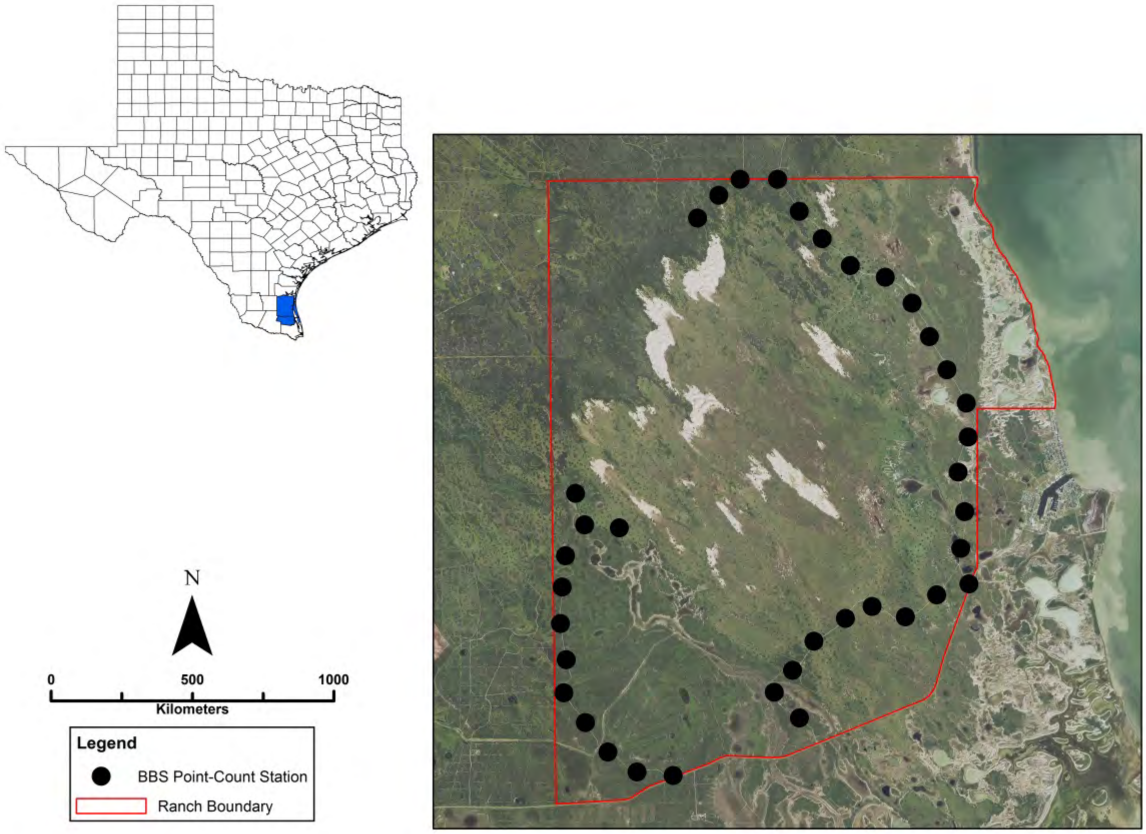


Figure 3.1. East Foundation's El Sauz Ranch is found along the South Texas coast within Willacy and Kenedy counties, Texas, USA. Black dots depict the 37 breeding bird survey (BBS) point-count stations.

This study was conducted from 2014–2016. Average daily temperatures for 2014, 2015, and 2016 for neighboring Port Mansfield was 295.23, 295.71, and 297.14 degrees Kelvin, respectively (NOAA 2016). Total annual precipitation for each year is represented from the end of one breeding season to the end of the next breeding season (e.g., July 2013–June 2014) (NOAA 2016; Fig. 3.2) and the average precipitation shown is calculated using by adding the totals for each year and dividing by the total number of years. For the purpose of this study, I have classified each year to reflect the amount of precipitation in the period prior to and during my avian population assessment. The year 2014 is considered a recovery year following the drought period (2010–2013) and received average precipitation of 61.52 cm. The year 2015 received above average precipitation and is classified as a wet year with 112.17 cm whereas 2016 received average precipitation of 69.75 cm. Study years and their respective total precipitation are indicated by the red arrows in Fig. 3.2.

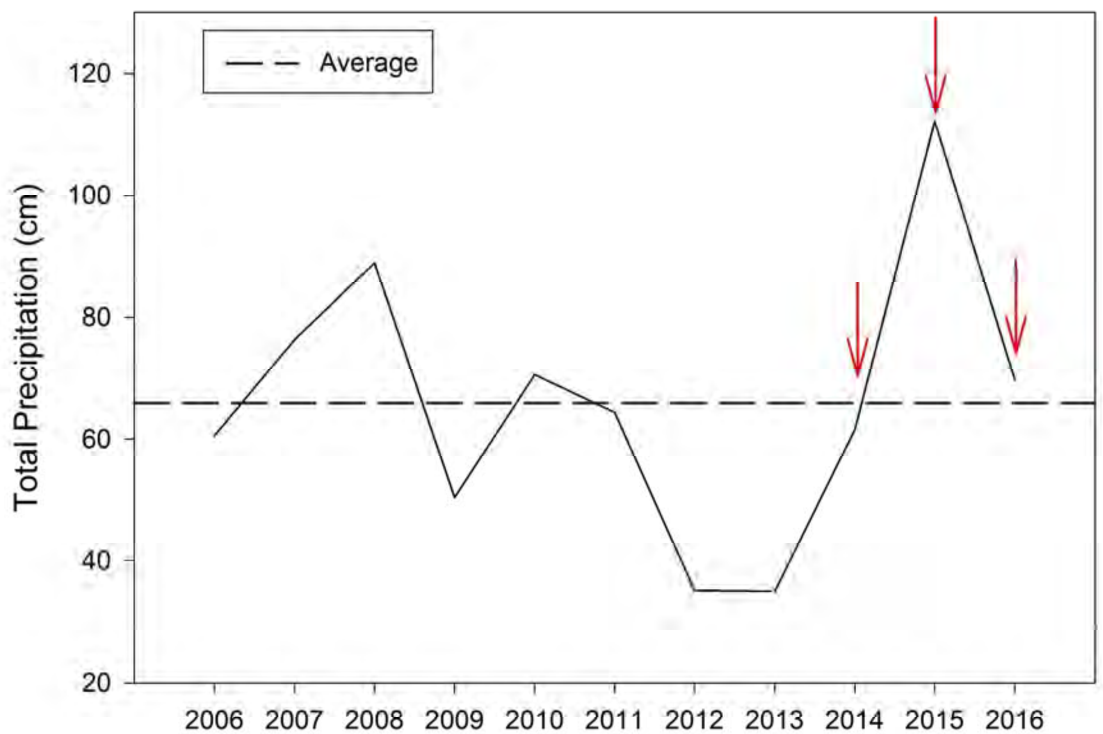


Figure 3.2. Total annual precipitation received from 2006–2016 by the neighboring town of Port Mansfield, Texas, USA, approximately 10 km east of the El Sauz Ranch. Precipitation is shown from 2006–2016 to show fluctuations in annual precipitation and drought beginning in 2010. The years of this study (2014–2016) are indicated by the red arrows. The year 2014 was a recovery,

post-drought year receiving average precipitation, 2015 was above average, and 2016 was an average year. Average annual precipitation is depicted by the dashed line.

Data Collection and Analysis

Breeding bird surveys (hereafter BBS) were conducted by one observer in May and June, at the peak of breeding season, from 2014–2016. This time frame also allowed for the capture of area breeders, potential migrants, and residents. Routes used were selected to mimic the official North American Breeding Bird Survey routes created by the United States Geological Survey (2001). Point-count surveys were established along driving routes totaling 29.6 km long, with one point every 800 m (USGS 2001) creating a total of 37 point-count stations (Fig. 3.1). Driving routes were placed in locations to sample as much area and habitat types possible within the ranch. Primary and secondary ranch roads were selected for the routes with a point-count every 800 m where possible. Routes were not surveyed in conditions of low visibility, with wind speeds greater than 4 on the Beaufort scale (13–18 mph/20–29 kmph) as determined by environmental cues described by the Beaufort scale, or in constant rainfall (Lipschutz 2016).

Surveys began 30 minutes before sunrise and were completed within 6.5 hours (USGS 2001). Counts were conducted from vehicle location at each station for three minute periods upon arrival. The observer recorded the number of individuals and species seen or heard flying over or directly using the habitat within the survey radius of 200 m. Following considerations from Hurlbert (2004), survey radii were adjusted from the national protocol of 400 m to improve the effectiveness of birds being seen and heard due to the thick vegetation cover present at the ranch. It is assumed that the noise of the vehicle did not cause enough disturbance to require a waiting period before birds resumed normal activity. All birds flying over the area to reach nearby habitats and those that are not known to breed in the area were recorded. However, aquatic, nocturnal, raptor, and scavenger species were excluded from analysis due to low encounter rates during these surveys (Hurlbert and Haskell 2003; Hurlbert 2004).

BBS were designed as an index of avian abundance and diversity, not a complete count or estimate of actual density (USGS 2001). For the purpose of my study, abundance is considered the total number of individuals observed and heard at each point-count station for each month of surveys. Total is used as an index of abundance, which is an incomplete and unadjusted count that allowed the determination of trends and should not be considered an estimate of population size (Nichols et al. 2009; Silvy 2012). Birds that were not identified to species due to quick flight, poor lighting, etc. (e.g., sparrows) were clumped within their proper taxonomic grouping and, therefore, were not used for analysis.

Monthly NDVI datasets (250 m spatial resolution, 16-day temporal resolution) values were acquired from MODIS Terra (MOD13Q1 NDVI) images from the United States Geological Survey Earth Explorer (Didan 2015) for April, May, and June of 2014–2016. Annual values of NDVI were not used as they may not be a strong predictor of bird data since surveys occur only two months out of each year (Hurlbert and Haskell 2003; Hurlbert 2004). NDVI is calculated from the reflectance in the near infrared and red portions of the electromagnetic spectrum and is represented by a ratio of the difference of the two bands divided by the sum of the two bands (Hurlbert 2004; Seto et al. 2004). It is measured on a scale of -1 to +1 with higher numbers signifying thicker, greener vegetation with much more photosynthetic activity whereas negative values indicate vegetation absence (Tucker et al. 1985; Myneni et al. 1995). The acquired monthly data corresponded to the month prior to and during the breeding season surveys for analysis. The acquired imagery was pre-processed using the HDF-EOS to GeoTIFF Conversion

Tool (HEG) (Raytheon Company; Riverdale, MD, USA) and imported into ArcMap 10.4. Using GPS coordinates for the 37 point-count stations, NDVI values were extracted for each image prior to (April) and during the survey period (May and June).

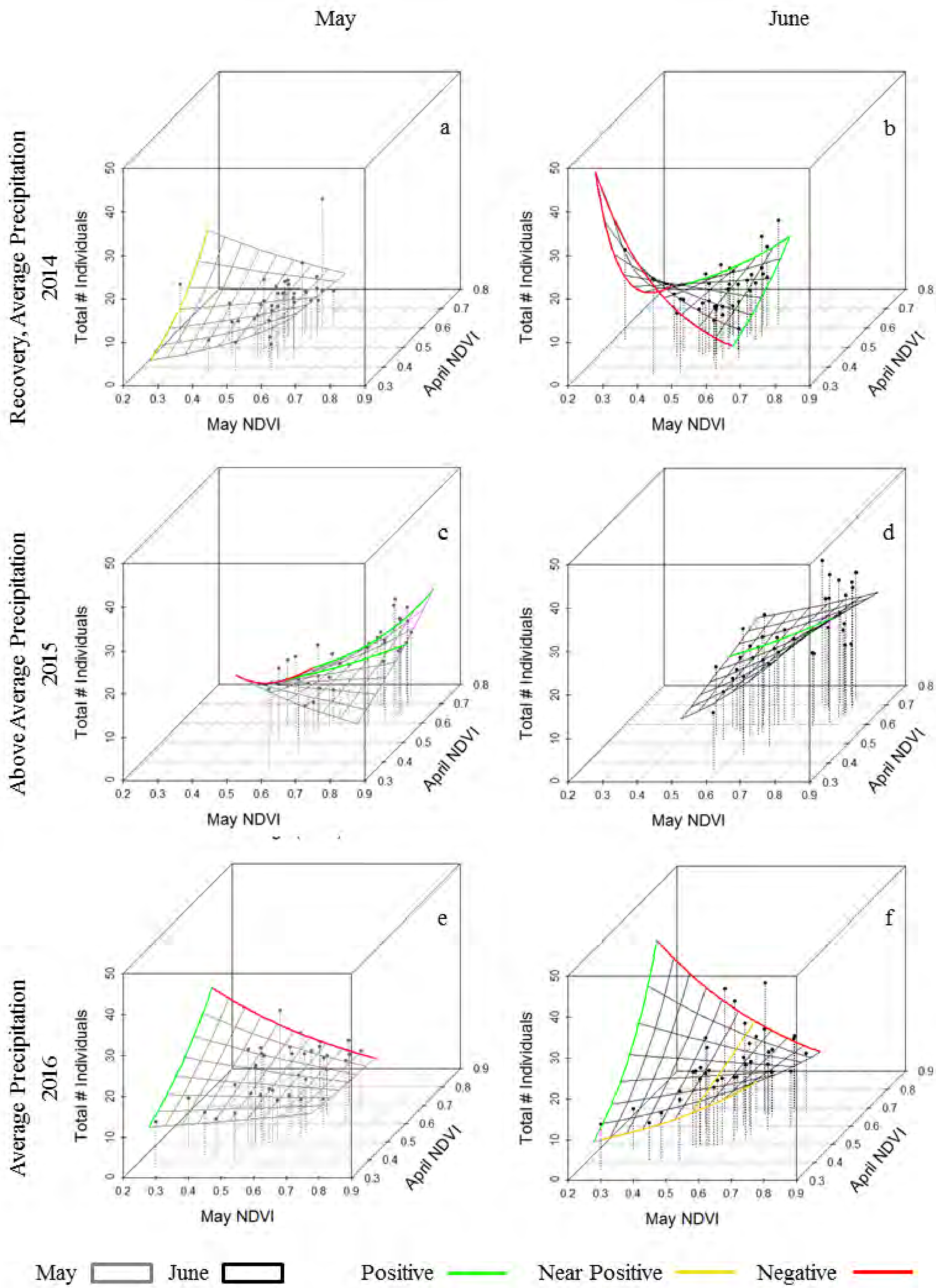
To quantify the effects of NDVI on avian abundance, a generalized linear mixed model was used. Abundances (number of individuals recorded per month) from May and June were used assuming a negative binomial distribution for a count response variable (NCSS 2016). Abundance was used instead of richness as it is more appropriate in combination with NDVI variables as suggested by Mcfarland et al. (2012). A first-order autoregressive variance-covariance structure was used to account for repeated measures at the 37 point-count stations (random effect) for the three consecutive years (Wang and Goonewardene 2004). The model included the following independent variables: NDVI values for May and June, year, and their interactions as fixed effects, and abundance as the dependent variable. Significant relationships among variables were considered below the 0.05 level and near significant relationships are recognized between the 0.05 and 0.10 levels. Although NDVI values for June were initially included in the model, the data was removed due to the lack of significance at 0.05. Statistical analysis was conducted in SAS 9.4 (SAS Institute, Inc., Cary, NC, USA).

RESULTS

The year of 2014 was the first year of average rainfall following a drought period in South Texas (Fig. 3.2). There was very little effect of May and April NDVI on bird numbers in May with only a positive relationship ($P = 0.0890$; Fig. 3.3a) at low May NDVI levels with increasing NDVI in the previous month (April). However, June numbers fluctuated based on the previous month’s levels of NDVI (Fig. 3.3b). There was a significant negative relationship when April NDVI was low even with increasing May values ($P = 0.0083$). In addition, even with high April NDVI, bird numbers still had a significant negative relationship with low May NDVI (*P* = 0.0153). Significant positive relationships can be seen only at high NDVI levels in May (*P* = 0.0155) and April (*P* = 0.0385) as long as values increased in either months.

Shifts in the response surfaces can be seen in 2015 which I have classified as a wet year and is evident with NDVI levels at 0.5 and above (Fig. 3.3c-d). A significant negative relationship in May bird numbers is observed at lower levels of May NDVI, although April levels were high (*P* = 0.0319). Three significant positive relationships can be seen across both survey months at mid-to-high levels of April NDVI (*P* = 0.0025 and 0.0021, respectively; Fig. 3.3c) for May bird numbers and only at mid-levels of April NDVI (*P* = 0.0064; Fig. 3.3d) for June.

Following a wet year, 2016 was documented with average rainfall at El Sauz (Fig. 3.2). Response surfaces shift back and appear almost identical among survey months spreading across NDVI levels of 0.2 to 0.7 (Fig. 3.3e-f). At high April NDVI levels, a significant negative relationship in bird numbers is observed even with increasing May NDVI in both survey months (May: *P* = 0.0492, June: *P* = 0.0160). With increasing NDVI in April, significant positive relationships with bird numbers are seen even if May NDVI was low across both survey months (May: *P* = 0.0344, June: *P* = 0.0009).



May
June
Recovery, Average Precipitation
2014
Above Average Precipitation
2015
Average Precipitation
2016
a
b
c
d
e
f
Total # Individuals
May NDVI
April NDVI
May
June
Positive
Near Positive
Negative

Figure 3.3. The effect of April and May NDVI on total number of birds recorded in 2014–2016 on El Sauz Ranch in South Texas, USA. May bird numbers are shown in a gray response surface and June in a black response surface for each year. Points and stems represent total number of individuals recorded at each point-count station at their respective NDVI level. Significant positive relationships shown in bright green, near significant positive relationships in yellow, and significant negative relationships in red. Relationship between May and April NDVI and 2014 May bird numbers (a), 2014 June bird numbers (b), 2015 May bird numbers (c), 2015 June bird numbers (d), 2016 May bird numbers (e), and 2016 June bird numbers (f). All point-count locations and their respective NDVI levels and abundance can be found in Appendix L.

DISCUSSION

The relationship between avian abundance and NDVI can be much more complex across time and space and should be considered when looking at the effects of environmental variables on avian dynamics. The relationships observed between avian abundance and NDVI depend upon the precipitation received in the year (i.e., above average or average) observations were conducted and the NDVI levels in the month prior to the survey and during the survey months. A portion of these results do not support the More Individuals Hypothesis nor does it support my hypothesis.

The More Individuals Hypothesis states that more individuals would be expected in areas with higher energy (i.e., biomass production), and I expected positive relationships between abundance and NDVI within and throughout the years of the study but that was not observed here. The MIH (i.e., species-energy theory) has been rejected previously in the literature with results indicating that observed changes in individuals with productivity were too small or negatively related and also could not account for richness changes (Currie et al. 2004). Furthermore, I agree with suggestions from Currie et al. (2004) to modify these hypotheses to accommodate differences in local conditions and geographical variations that are applicable to regional conditions rather than global occurrences (Currie et al. 2004). This iterates the notion that similar research must occur in different landscapes to gather information that is relevant and accurate to the area of interest.

Assessment of environmental conditions prior to the collection of field data is critical to understand how populations may be impacted. The month of April is a contributing factor in the relationships I observed during the peak of breeding season among the number of birds and NDVI levels. The biomass productivity pre-breeding season appears to be important as this may be a phase in which birds may be finding these highly productive areas to breed in and raise young. Hahn and Silverman (2006) revealed that habitat selection can occur during pre-breeding in migratory birds. However, Betts et al. (2008) claim that conditions during that time to enhance reproductive success may not be obvious upon their arrival (i.e., appropriate cues) causing birds to be misled and select unsuitable signals. To my knowledge, no other study has considered the months prior to the breeding season and their relation to abundance during the breeding season. Focus on avian abundance or richness and its relationship with NDVI has been limited to June (Bailey et al. 2003; Hurlbert and Haskell 2003; Hurlbert 2004; Seto et al. 2004; Mcfarland et al. 2012), annual values (Hurlbert and Haskell 2003; Evans et al. 2006), annual averages (Nieto et al. 2015; Phillips et al. 2008), and seasonal averages (Nieto et al. 2015). The mis-matched timing of NDVI and field collected data (Hurlbert and Haskell 2003; Hurlbert 2004) seem to be an overlooked issue when determining the effects of NDVI on avian dynamics and should be a consideration of future studies to prevent misleading results.

Many factors, in addition to NDVI, may contribute to the number and distribution of birds observed. Even with ideal conditions in a normal year of rainfall (i.e., 2016) and higher NDVI, positive relationships with avian abundance were not the only relationships observed. This suggests that birds on the landscape may seek an optimum range of productivity levels. This result may also complement previous research findings that birds may move or shift locations during the breeding season (Krebs 1971; Hoover 2003). Betts et al. (2008) also found that the presence of naïve individuals who may occupy sub-optimal sites initially may later move onto higher quality sites when available, with those sites, quite possibly, being of higher NDVI or much healthier vegetation. In addition, these naïve individuals may be saturating areas that are considered sub-optimal habitat in comparison to experienced individuals in greener, more optimal areas. Further research on individual use of sites varying in productivity can provide further insight into the movement of avian populations among a site and their selection of areas based upon productivity or NDVI.

My study provides support that avian populations can be resilient in times of environmental fluctuations of drought and extremely wet periods in South Texas, which may be one of the reasons I did not see positive relationships across all variables. Subtropical semihumid-to-semiarid rangelands, such as that described in this study, are more likely to be affected by annual variation in rainfall events, and it is possible that I will continue to see these fluctuations with the added effects of climate change (Golodets et al. 2013).

CONCLUSION

My results do not completely support the species-energy theory and MIH, suggesting the climatic fluctuations that occur in landscapes with extreme weather events do not always follow previously supported research. Rangeland conditions in months prior to the start of a biological survey can influence survey outcomes, thus these conditions should be taken into account when designing monitoring protocols. By combining on-the-ground monitoring and NDVI for land management strategies, these tools can aid in delivering land management recommendations to help sustain populations. Given that avian point-counts are a common monitoring method, it is possible to implement the same methods at a much larger scale since spatial data is now readily available at appropriate resolutions. This information can also aid in finding locations on the landscape that may not be conducive to abundant and potentially diverse bird populations, and hence provide management recommendations for restoration or other land altering methods. From an economic perspective, this information can assist landowners and managers by ways of ecotourism, hunting leases, and refining cattle production in combination with wildlife conservation by identifying times of low bird numbers and adjusting grazing regimes to fit the availability of vegetation for domestic and wild animals.

LITERATURE CITED

Augustine DJ, Veblen KE, Goheen JR, Riginos C, Young TP (2011) Pathways for Positive Cattle-Wildlife Interactions in Semiarid Rangelands. Smithson Contrib Zool 632:55-71.

Bailey SA, Horner-Devine MC, Luck G, Moore LA, Carney KM, Anderson S, Betrus C, Fleishman E (2004) Primary productivity and species richness: relationships among functional guilds, residency groups and vagility classes at multiple spatial scales. Ecography 27(2):207-217.

Barnett KL, Facey SL (2016) Grasslands, Invertebrates, and Precipitation: A Review of the Effects of Climate Change. Front Plant Sci 7:1196.

Betts MG, Rodenhouse NL, Sillett TS, Doran PJ, Holmes RT (2008) Dynamic occupancy models reveal within-breeding season movement up a habitat quality gradient by a migratory songbird. Ecography 31(5):592-600.

Brown JH (1981) Two decades of homage to Santa Rosalia: toward a general theory of diversity. Am Zool 21:877-888.

Carrara R, Vázquez D (2010) The species-energy theory: A role for energy variability. Ecography 33(5):942-948.

Clarke A, Gaston KJ (2006) Climate, energy, and diversity. Proc R Soc Lond B 273(1599):2257-2266.

Cleland EE, Chuine I, Menzel A, Mooney HA, Schwartz MD (2007) Shifting plant phenology in response to global change. Trends Ecol Evol 22(7):357-365.

Currie DJ, Mittelbach GG, Cornell HV, Field R, Guégan JF, Hawkins BA, Kaufman DM, Kerr JT, Oberdorff T, O'Brien E, Turner JRG (2004) Predictions and tests of climate-based hypotheses of broad-scale variation in taxonomic richness. Ecol Lett 7(12):1121-1134.

Didan K (2015) MOD13Q1 MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V006 [Data set]. NASA EOSDIS LP DAAC. doi: 10.5067/MODIS/MOD13Q1.006

Evans KL, James NA, Gaston KJ (2006) Abundance, species richness and energy availability in the North American avifauna. Global Ecol Biogeogr 15:372-385.

Fischer J, Lindenmayer DB (2006) Beyond fragmentation: the continuum model for fauna research and conservation in human-modified landscapes. Oikos 112(2):473-480.

Franklin JF (1993) Preserving biodiversity: species, ecosystems, or landscapes? Ecol Appl 3(2):202-205.

Fuhlendorf SD, Engle DM (2001) Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. BioScience 51(8):625-632.

Fulbright TE, Diamond DD, Rappole J,Norwine J(1990) The coastal sand plain of southern Texas. Rangelands 12(6):337-340.

Fulbright TE, Bryant FC (2003) The wild horse desert: climate and ecology. In: Forgason CA, Bryant FC, Genho PC (eds). Ranch management: integrating cattle, wildlife, and range. King Ranch, Kingsville, pp.35-58.

Furness RW, Greenwood JJD (eds) (1993) Birds as monitors of environmental change. Chapman and Hall, London.

Golodets C, Sternberg M, Kigel J, Boeken B, Henkin Z, Seligman NG, Ungar ED (2013) From desert to Mediterranean rangelands: will increasing drought and inter-annual rainfall variability affect herbaceous annual primary productivity? Climatic Change 119:785-798.

Hahn BA, Silverman ED (2006)Social cues facilitate habitat selection: American redstarts establish breeding territories in response to song. Biol Lett2:337-340.

Heisler-White JL, Blair JM, Kelley EF,Harmoney K, and Knapp AK(2009) Contingent productivity responses to more extreme rainfall regimes across a grassland biome. Glob Change Biol 15: 2894–2904.

Hitch AT, Leberg PL (2007) Breeding distributions of North American bird species moving north as a result of climate change. Conserv Biol 21(2):534-539.

Holechek JL, Pieper RD, Herbel CH (1998) Range management principles and practices. Prentice Hall, New Jersey.

Hoover JP (2003) Decisionrules for site fidelity in a migratory bird, the prothonotarywarbler. Ecology, 84: 416–430.

Hunter MD, Ohgushi T, Price PW (eds) (1992) Effects of resource distribution on animal-plant interactions. Academic Press Inc., California.

Hurlbert AH (2004) Species-energy relationships and habitat complexity in bird communities. Ecol Lett 7:714-720.

Hurlbert AH, Haskell JP (2003) The effect of energy and seasonality on avian species richness and community composition. Am Nat 161(1):83-97.

Hurlbert AH, White EP (2005) Disparity between range map and survey based analyses of species richness: patterns, processes and implications. Ecol Lett 8(3):319-327.

Hutchinson GE (1959) Homage to Santa Rosalia, or why are there so many kinds of animals? Am Nat 93:145-159.

Jones J (2001) Habitat selection studies in ecology: a critical review. Auk 118:557-562.

Kerr JT, Ostrovsky M (2003) From space to species: ecological applications for remote sensing. Trends Ecol Evol 18(6):299-305.

Knapp AK, Beier C, Briske DD, Classen AT, Luo Y, Reichstein M, Smith MD, Smith SD, Bell JE, Fay PA, Heisler JL, Leavitt SW, Sherry R, Smith B, Weng E (2008) Consequences of more extreme precipitation regimes for terrestrial ecosystems. BioScience 58(9): 811-821.

Krebs JR (1971) Territory and breeding density in the great tit (Parus major L.). Ecology 52:2-22.

La Sorte FA, Boecklen WJ (2005) Changes in the diversity structure of avian assemblages in North America. Glob Ecol Biogeogr 14:367-378.

Lipschutz ML (2016) Effects of drought and grazing on land bird populations in South Texas. Thesis, Texas A&M University-Kingsville.

Mac Nally R, Ellis M, Barrett G (2004) Avian biodiversity monitoring in Australian rangelands. Austral Ecol 29(1):93-99.

McDonald MB, Copeland LO (1997) Seed Production: Principles and Practices. Springer Science, New York.

Mcfarland TM, Van Riper III C, Johnson GE (2012) Evaluation of NDVI to assess avian abundance and richness along the upper San Pedro River. J Arid Environ 77:45-53.

Miller Rushing AJ, Lloyd-Evans TL, Primack RB, Satzinger P (2008) Bird migration times, climate change, and changing population sizes. Glob Change Biol 14(9):1959-1972.

Møller AP, Fiedler W, Berthold P (Eds) (2010) Effects of climate change on birds. Oxford University Press, New York.

Morrison ML (1986) Bird populations as indicators of environmental change. In: Johnston RF (ed). Current Ornithology, Vol 3. Springer, Massachusetts.

Myneni RB, Hall FG, Sellers PJ, Marshak AL (1995) The interpretation of spectral vegetation indexes. IEEE Trans Geosci Remote Sens 33(2):481-486.

NCSS. http://ncss.wpengine.netdnacdn.com/wpcontent/themes/ncss/pdf/Procedures/NCSS/ Negative_Binomial_Regression.pdf. Accessed 4 December 2017.

Nichols JD, Thomas L, Conn PB (2009) Inferences about landbird abundance from count data: recent advances and future directions. *In* Modeling demographic processes in marked populations. Springer, United States.

Nieto S, Flombaum P, Garbulsky MF (2015) Can temporal and spatial NDVI predict regional bird-species richness? Glob Ecol Cons 3:729-735.

National Oceanic and Atmospheric Administration (NOAA) (2016). National Centers for Environmental Information. Climate data for Port Mansfield, Texas.

Pettorelli, N, Vik JO, Mysterud A, Gaillard J-M, Tucker CJ, Stenseth NC (2005) Using satellite-derived NDVI to assess ecological responses to environmental change. Trends Eco Evol 20(9):503-510.

Phillips LB, Hansen AJ, Flather CH (2008) Evaluating the species energy relationship with the newest measures of ecosystem energy: NDVI versus MODIS primary production. Remote Sens Environ 112: 4381-4392.

Saino N, Ambrosini R, Rubolini D, von Hardenberg J, Provenzale A, Hüppop K, Lehikoinen A, Lehikoinen E, Rainio K, Romano M, Sokolov L (2011) Climate warming, ecological mismatch at arrival and population decline in migratory birds. Proc R Soc Lond [Biol] 278(1707):835-842.

Seto KC, Fleishman E, Fay JP, Betrus CJ (2004) Linking spatial patterns of bird and butterfly species richness with Landsat TM derived NDVI. Int J Remote Sens 25(20):4309-4324.

Seymour CL, Dean WRJ (2010) The influence of changes in habitat structure on the species composition of bird assemblages in the southern Kalahari. Austral Ecol 35(5):581-592.

Silvy NJ (ed) (2012) The Wildlife Techniques Manual─Research. The John Hopkins University Press, Maryland.

Skagen SK, Melcher CP, Hazelwood R (2005) Migration stopover ecology of western avian populations: a southwestern migration workshop. United States Geological Survey.

Singh RP, Roy S, Kogan, F (2003) Vegetation and temperature condition indices from NOAA AVHRR data for drought monitoring over India. Int J Remote Sens24(22):4393-4402.

Snelgrove A, Dube A, Skow K, Engeling A (2013) Atlas for the Tom T. East, Sr., Alice K. East, Alice H. East and Robert C. East Wildlife Foundation. Texas A&M Institute of Renewable Natural Resources. College Station, TX.

Symonds MR, Johnson CN (2008) Species richness and evenness in Australian birds. Am Nat 171(4):480-490.

Texas Parks and Wildlife Department (TPWD) (2017) Texas Ecoregions. https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions. Accessed 4 December 2017.

Tottrup AP, Thorup K, Rainio K, Yosef R, Lehikoinen E, Rahbek C (2008) Avian migrants adjust migration in response to environmental conditions en route. Biol Lett 4:685-688.

Tucker CJ, Sellers PJ (1986) Satellite remote sensing of primary production. Int J Remote Sens 7(11):1395-1416.

United States Geological Survey (USGS) Patuxent Wildlife Research Center (2001) North American Breeding Bird Survey. http://www. pwrc.usgs.gov/bbs/. Accessed 1 December 2017.

Visser ME, Perdeck AC, Van Balen JH, Both C (2009) Climate change leads to decreasing bird migration distances. Glob Change Biol 15:1859-1865.

Wang J, Rich PM, Price KP (2003) Temporal responses of NDVI to precipitation and temperature in the central Great Plains, USA. Int J Remote Sens 24(11):2345-2364.

Wang Z,Goonewardene LA(2004) The use of MIXED models in the analysis of animal experiments with repeated measures data. Can J Anim Sci 84:1-11.

Westoby M (1979) Elements of a theory of vegetation dynamics in arid rangelands. Israel J Bot 28(3-4):169-194.

Wilson MF, Traveset A (2000) The Ecology of Seed Dispersal. In: Fenner M (ed). Seeds: The Ecology of Regeneration in Plant Communities, 2nd Ed. CAB International.

Wright DH (1983) Species-energy theory: an extension of species–area theory. Oikos 41:496-506.

Xie Y, Zongyao S, Mei Y (2008) Remote sensing imagery in vegetation mapping: a review. J Plant Ecol 1(1):9-23.

Yagerman KS (1990) Protecting critical habitat under the federal Endangered Species Act. Environ Law 20:811.

Yarnell RW, Scott DM, Chimimba CT, Metcalfe DJ (2007) Untangling the roles of fire, grazing, and rainfall on small mammal communities in grassland ecosystems. Oecol 154(2):387-402.

APPENDIX A. LESSON PLAN EXAMPLE

The Basics of Birding

Identifying Common South Texas Birds

Topic: Wildlife Techniques

Caesar Kleberg WILDLIFE Research Institute — Texas A&M University-Kingsville

Learning Objectives

1. Identify 3 bird species by common names.
2. Define field marks.
3. Learn to adjust and use binoculars.

Lesson Concept

Bird identification requires the use of binoculars and attention to detail by the observer.

TEKS

(4) Scientific Investigation & Reasoning (A) use appropriate tools to **collect, record**, and analyze information, including **journals/notebooks**, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, **and other equipment** as needed to teach the curriculum.

Grade: 6
Subject: Science
Time Required: 2 hours
Group Size: Individual
Approx. Cost: $0*

TEXAS A&M UNIVERSITY KINGSVILLE

Birding is a hobby that encompasses bird watching, identification, and often recording the species and location in which you find them. To observe birds more closely, people use binoculars which allow you to zoom in and see the birds up close to look for identifying features. Many birders often carry with them a field guide such as Sibley's or Peterson's bird books that allow them to quickly look up a bird and aid in their identification. Guides provide images of birds in flight and stationary along with their seasonal ranges, identifying field marks, and other information.

Birds make up the class Aves and are classified by their scientific name which includes the genus and species. For example, the Orange-Crowned Warbler pictured to the right is called *Oreothlypis celata*. More often they are referred to by their common name which is used by the American Ornithologists' Union (AOU) to give each species an alpha code. The alpha code is usually made up of the first 2 letters of each word of the species' name. For the Orange-Crowned Warbler it is slightly different because of the hyphenated first word, the code is OCWA.

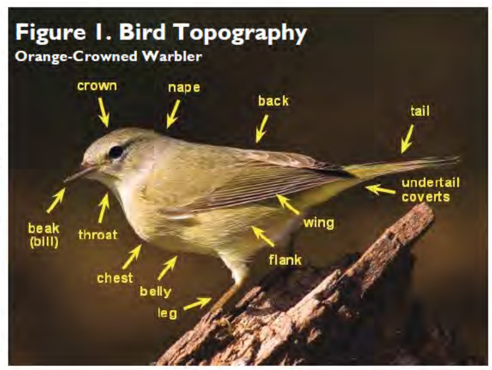


Figure 1. Bird Topography
Orange-Crowned Warbler

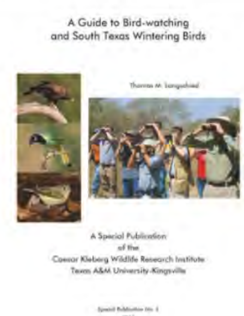
Learning to identify birds can be a challenging task. Using as many resources as you can will help aid the learning process. Studying is an important part of learning birds and it will take time and effort. When out in the field it is good practice to take notes and draw sketches of birds you are not quite sure of. Recognize distinct markings that stand out and can help you later on as you look through your bird guide. Create a memory snapshot of the birds in question, this will help you later! Happy birding!

Materials

EXPLORE #1:
- "Common South Texas Birds" PowerPoint

EXPLORE #2:
- "A Guide to Bird Watching and South Texas Wintering Birds" (1 copy/5 students) Pictured Right >>>
- "The Basics of Birding" Worksheet (1/student)
- Colored Pencils or Crayons (Class set)

EXPLORE #3:
- Binoculars (1/2 students)
- Field Notebook (1/student)
- Pencil (1/student)



FREE Download at:
http://ckwri.tamuk.edu
Publications > Special Publications

The Basics of Birding
Topic: Wildlife Techniques
Grade 6, Science

Vocabulary

Resident: species that remains in that location throughout the year
Migratory: species that moves from one location to another during a certain part of the year
Field Marks: identifying physical characteristics of a bird
Nape: back of the neck
Flank: side part of the body
Undertail Coverts: feathers under the tail
AOU Codes: 4-letter alpha codes for common names of bird species (developed by the American Ornithologists' Union)

Teacher Background

Figure 2. Field Marks of Ruby-Crowned Kinglet and Lincoln's Sparrow (Inset)

Begin by recognizing common resident species such as Green Jays, Great-Tailed Grackles, Great Kiskadees, and others found in the CKWRI bird guide. Those are rather common that you can pick them up very quickly. Then you can move onto the rarities and migratory species. In this lesson, we are going to focus on identifying birds by sight and later as all birders know, you must move onto identifying by sound since many species can be quite secretive or hard to see in the brush.

Observing the location of the bird (on the ground or in a tree) or even their behavior can help you ID a bird faster, but first let's focus on the appearance. To identify species you must look for specific "field marks" such as eye rings, wing bars, crown color, nape color, etc. For example in figure 2, the Ruby-Crowned Kinglet (RCKI) is light brown/olive in body color and has a distinct white eye ring. The lower wings are slightly yellow with a white wing bar right above the yellow. Its name also signifies another field mark, a ruby crown, but this is hardly ever seen in the field. Other important features to notice are the beak and leg/feet color of the bird. Eyes may also be a particular color as well. Be sure to note all these features so you can refer back to them when looking through a field guide. Most of all be patient, bird ID takes practice. Refer to the CKWRI guide introduction for more in-depth explanations and to the PowerPoint for common So. Texas birds with labeled field marks.

Engage

Take students outside to an area with trees or bushes

So what do you notice out here? (Trees, benches, etc., birds)

What about the birds? Do they all look the same? (They're flying around the tree/within the bushes……Yes/No)

-If yes: Do you know what those are called? Are they all hanging out together? (No…..Yes, are they a family?)

**become familiar with the species around your school beforehand and identify the bird species for the students*

-If no: What's different about them? (Their color/size/etc.)

Did you know that surrounding you there are hundreds of different types of birds? We only see a few here but because of the location of where we live many different birds move through our state.

How many birds can you name? (Students raise their hands or shout out names/numbers…)

Well today we are going to learn some of the birds here in South Texas you may see right outside your window. Let's head back inside to get started!

Procedure

TEACHER	STUDENT	CONCEPT
EXPLORE #1: (15 minutes) Display "Common South Texas Birds" PowerPoint on the projector.		
Go through each species, allowing students to participate in naming the bird if they have a guess. Present the common name and AOU code to the students. Point out field marks on each species (for example: eye ring on Mourning Dove, eye stripe on Great Kiskadee, crest on Northern Cardinal)	"Is that a dove?" …………………	South Texas consists of a diverse number of bird species and each have their own characteristics that make them identifiable.
After each species is covered, you can go back through each of the photos to practice again.		
EXPLORE #2: (45 minutes) Pass out a set of crayons or colored pencils for students to share along with a copy of "A Guide to Birdwatching and South Texas Wintering Birds".		
Pass out one worksheet per student and have students read the directions and complete the worksheet.		Attention to detail is key when identifying birds.
Remind students what a field mark is or ask them. Students will be drawing and coloring a few of the common species while labeling field marks.	"Something on the bird that helps you identify it?"	
EXPLORE #3: (1 hour) Guide students outside for bird observations. Have each student take a pencil, field notebook/paper, and their shared binoculars.		
Point students to groups of trees to go and observe birds, if no trees are available, a good place to start is by looking in the cafeteria area or outdoor lunch area. Birds love food scraps!		Observations are a key step in the scientific method.
Identify birds seen by their common name and have students begin to tally the number per species that they see.		
Encourage dialogue back and forth between students in the class. Have them discuss each bird and call out their field marks.	"Look there's a red bird!" "Is that a cardinal?" "It has the crest and black face." "It also has the red-orange bill!"	
WRAP UP & FOLLOW UP: End the exploration components with repeating the "Common South Texas Birds" PowerPoint. Allow students to record the bird species (by common name) shown in each picture and have students compare answers (THINK-PAIR-SHARE). For retention, one week later show them the PowerPoint again and see if they remember!		

Assessment

Pre-Assessment

Identify 3 birds by common names. (Objective 1)

Activity Embedded Assessment

Define field marks for common bird species of South Texas. (Objective 2)
Learn to use binoculars for bird identification and observation. (Objective 3)

Post-Assessment

Identify common South Texas birds by photos provided in PowerPoint (Materials). (Objective 1)

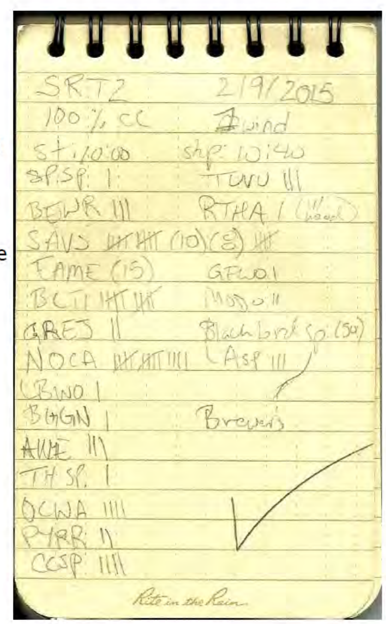
Activity Extensions

Every month you can increase the number of birds to identify. Beginning with the 3 birds selected in this lesson for you to focus on, you can expand to an additional 5. By the end of two months students will know 8 species. They will be expert birders in no time!

Activity Scaling

For younger students, begin by identifying only 3 species. It would probably be best to stick to the 3 most commonly found in your area or the 3 most unique looking species.

For older or advanced students, for the 5 species learned, have students memorize the AOU codes for each species. When out observing have them write codes and tally the number of individuals seen of each species (like the field notes to the right, you can also test them on their AOU codes by asking how many Northern Cardinals were seen during this survey, etc.). Repeat observations or surveys over the course of 3-5 days, whatever works best for the class' schedule. Using Excel, have students plot out the number of individuals of each species seen over time. You can have students develop hypotheses and see if their data supports or rejects the hypothesis.



Donations*

- Local Audubon chapters may have funding available to help you with needed birding equipment. Be sure to mention you are a teacher teaching __ grade and explain how the equipment would help supplement your classroom activities and learning.
- Contact a local university's wildlife department and ask if they have any old class sets of binoculars lying around that they wish to donate. It's worth a shot!
- Contact Texas Parks & Wildlife for funding opportunities in the GK-12 setting.
- Hard copies of the "**Guide to Bird-Watching and South Texas Wintering Birds**" can be requested by emailing Dr. April Conkey (april.conkey@tamuk.edu).

References

A Guide to Bird-Watching and South Texas Wintering Birds, Thomas Langschied
The Sibley Guide to Birds 2nd Ed., David Allen Sibley

Contact Information

Lesson Created By:
Janel Ortiz, TAMUKBirdsGK12@gmail.com

CKWRI Wildlife Education Specialist:
Dr. April Conkey, april.conkey@tamuk.edu

COASTAL BEND AUDUBON SOCIETY

SPECIAL THANK YOU TO THE COASTAL BEND AUDUBON SOCIETY, LEATRICE KOCH, AND WILLIAM COLSON FOR THEIR CONTRIBUTIONS TO THIS LESSON.

Caesar Kleberg Wildlife Research Institute
Texas A&M University-Kingsville
700 University Blvd., MSC 218
Kingsville, TX 78363

Project Funded By:
Elizabeth Huth Coates Charitable Foundation of 1992
[www.ckwri.tamuk.edu]

Spring 2015

APPENDIX B. PRE-PROGRAM SURVEY FOR FORMAL EDUCATORS

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

Pre-Program Survey for Teachers

Please complete the following.

What grade level(s) do you teach? ____________

Put a check mark on your answer.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am interested in wildlife.					
I am confident in my knowledge of bird biology.					
I can identify many bird species.					
I take time to stop and look at the wildlife I see.					
Habitat fragmentation affects wildlife populations.					

Circle answer.

1. How much time do you spend outside with your students during the school year?

0-1 hour 1-2 hours 3-5 hours 6-10 hours 10+ hours

2. Have you incorporated wildlife into your curriculum previously?

Yes Somewhat No

3. Have you heard of citizen science?

Yes Somewhat No

If yes, do you enjoy citizen science? Yes Somewhat No

If yes, do you incorporate citizen science into your curriculum? Yes Somewhat No

Please provide any questions or comments.

____

____

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

APPENDIX C. POST-PROGRAM SURVEY FOR FORMAL EDUCATORS

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

Post-Program Survey for Teachers

Please complete the following.

What grade level(s) did you teach? ___________

Put a check mark on your answer.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I am interested in wildlife.					
I am confident in my knowledge of bird biology.					
I can identify many bird species.					
I take time to stop and look at the wildlife I see.					
Habitat fragmentation affects wildlife populations.					
Overall, my students met the learning objectives of the lessons.					
Overall, the lessons improved my students' understanding and retention of the topics.					

Circle answer.

1. How much time do you expect to spend outside with your students during the school year?

0-1 hour 1-2 hours 3-5 hours 6-10 hours 10+ hours

2. Will you incorporate wildlife into your curriculum?

Yes Somewhat No

3. Do you enjoy citizen science?

Yes Somewhat No

4. Will you incorporate citizen science into your curriculum?

Yes Somewhat No

TURN TO BACK SIDE

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

Of the lesson plans, which did you conduct in class.

	Yes	No	If no, why not?
Buildings, Rivers, and Roads	☐	☐	____________________
Early bird catches the WORM?	☐	☐	____________________
Be a Bird Biologist	☐	☐	____________________
Basics of Birding	☐	☐	____________________
Citizen Science for South Texas Birds	☐	☐	____________________

Please provide any questions or comments.______________________________________

____

____

APPENDIX D. ONLINE GOOGLE FORMS© POST-WORKSHOP SURVEY FOR FORMAL EDUCATORS

Post-Workshop Survey for Teachers

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.
Thank you again for attending the Wild Bird Conservation Workshop held by the Caesar Kleberg Wildlife Research Institute. At the workshop you were trained on 5 lesson plans relating to bird techniques and research. We would like to follow-up to see how these lessons have benefited you and your students and how your attitudes towards wildlife have changed.

What grade level(s) do you teach? *

I am interested in wildlife. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

I am confident in my knowledge of bird biology. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

I can identify many bird species. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

I take time to stop and look at the wildlife I see. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

Habitat fragmentation affects wildlife populations. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

Will you incorporate wildlife into your curriculum? *
Yes
Somewhat
No

Do you enjoy citizen science? *
Yes
Somewhat
No

Will you incorporate citizen science into your curriculum? *
Yes
Somewhat
No

Did you use the Wild Bird Conservation Curriculum in the classroom or other educational setting? *
Yes
Somewhat
No
Have not had the opportunity to do so

If bird lessons were conducted in an educational setting: Your students met the learning objectives of the lessons. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree
Not Applicable

If bird lessons were conducted in an educational setting: The lessons improved my students' understanding and retention of the topics. *
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree
Not Applicable

The Wild Bird Conservation Curriculum caused the time spent outdoors with the students to... *
Increase
Decrease
Stay the same
Not Applicable

I conducted the following lessons in an educational setting....(select all that apply) *
Basics of Birding
Be a Bird Biologist
Citizen Science for South Texas Birds
Early bird catches the WORM??
Buildings, Rivers, and Roads: Environmental Barriers to Bird Movement
None

If one or more lessons were conducted, how would you describe the educational setting?

If no lessons were conducted, why not?

Please provide any questions or comments.

Thank you for your participation!

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS. IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

APPENDIX E. PRE-PROGRAM SURVEY FOR K-12 STUDENTS

Name: ______________________

- -

Pre-Program Survey for Students

Please complete the following.

Put a check mark on your answer.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I like wildlife.					
I know a lot about birds.					
I can identify many birds.					
I take time to stop and look at the wildlife I see.					
Habitat fragmentation affects wildlife populations.					
During my free time, I spend a lot of time outside.					
I do not disturb or harm animals and plants I see while outside.					
I like science.					
I would enjoy working with a scientist.					
I enjoy collecting data on birds.					

Circle answer.

1. How much time do you spend outside during class time during the school year?

   0-1 hour 1-2 hours 3-5 hours 6-10 hours 10+ hours

2. Do you have a favorite wild animal of Texas?

   Yes Somewhat No

   If yes or somewhat, what is/are your favorite Texas animal(s)?

   ____

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

APPENDIX F. POST-PROGRAM SURVEY FOR K-12 STUDENTS

Name: ____________________

Post-Program Survey for Students

Please complete the following.

Put a check mark on your answer.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I like wildlife.					
I know a lot about birds.					
I can identify many birds.					
I take time to stop and look at the wildlife I see.					
Habitat fragmentation affects wildlife populations.					
During my free time, I spend a lot of time outside.					
I do not disturb or harm animals and plants I see while outside.					
I like science.					
I would enjoy working with a scientist.					
I enjoy collecting data on birds.					

Circle answer.

1. How much time did you spend outside during class time this past year?

0-1 hour　　1-2 hours　　3-5 hours　　6-10 hours　　10+ hours

2. What was your favorite bird related activity and why?

____

____

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

APPENDIX G. TEACHER AND NON-TEACHER QUESTIONNAIRE

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

Teacher Questionnaire

Questions include but are not limited to the following.

1. What was your college major? ____________________
2. What is your highest level of formal education? ______________________________
3. How many science courses did you take during college and beyond? ________________
4. How many years have you been teaching? ___________________
5. Estimated number of students for the school year: ____________________
6. Is technology available in your classroom? ___________________

    If so, what technology (e.g. laptops, desktop computers)?

    ____
7. Are microscopes or magnifying glasses available to you for use in the classroom?

    ____
8. Do you enjoy science? ____
9. How do you feel about teaching science?

    ____

    ____

    ____
10. How would you describe your teaching method? (ex: lecture, textbook, hands-on, etc.)

    ____

    ____
11. How prepared do you feel to teach science?

    ____

    ____

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

Non-Teacher Questionnaire

Questions include but are not limited to the following.

1. What was your college major? ____________________
2. What is your highest level of formal education? ______________________________
3. How many science courses did you take during college and beyond? ________________
4. What is your position and how many years have you been in this field?
   ____
5. What student grade levels do you interact with in your position? How many students do you interact with in a school year? ____
6. Do you have technology available for student groups? ___________________

   If so, what technology (e.g. laptops, desktop computers)?

   ____
7. Are microscopes or magnifying glasses available for use with student groups?

   ____
8. Do you enjoy science? ____
9. How do you feel about science education?

   ____

   ____

   ____
10. What teaching method do you feel to be most effective? (ex: lecture, textbook, hands-on)

    ____

    ____
11. How prepared do you feel to lead science activities?

    ____

    ____

APPENDIX H. TRAINING WORKSHOP SURVEY

Bird Conservation Curriculum
Training Workshop Survey

This survey is designed to get your feedback on the training workshop you have just attended. Please take the time to answer the questions thoughtfully. If you do not wish to answer a particular question for any reason, please leave it blank. We appreciate your feedback and thanks for joining us!

If you are a teacher, what grade level(s) do you teach? ____________

Put a check mark on your answer.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**N/A**
The material was presented clearly at this workshop.						
The material will be useful in my teaching.						
I would recommend this workshop to a colleague.						
I will use this material in my class.						
This workshop met my expectations.						
This workshop was well organized.						

1. Which topics were of most interest to you?
   ____
2. Was too much or too little time spent on specific material? Please specify below.
   ____
   ____
3. If you are *not* a teacher, how do you plan to use this curriculum?
   ____
   ____
4. How did you hear about this workshop? ______________________________

Please provide any questions, comments or suggestions to improve future workshops.

____

____

THANK YOU!

APPENDIX I. PRE-SURVEY FOR UNDERGRADUATE STUDENTS

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

Citizen Science Pre-Survey

KU# ________________

You are participating in this survey voluntarily. Results of this survey will not affect your course grade.

Gender: Male ___ Female ___

1. **How would you describe yourself? (Circle all that apply)**

   White or Caucasian
   Black or African American
   Hispanic, Latino, or Spanish origin
   Native American or Alaska Native
   Asian
   Native Hawaiian or Other Pacific Islander
   Other ___________________________

2. **What county were you born in? ____________________ (if out of TX, specify state and county)**

3. **What population size best describes the city or town in which you grew up? Circle One.**

   <3,000   3,000-10,000   10,000-20,000   20,000-50,000   50,000+

4. **Ideal career in wildlife (list top 3, with 1 being most preferred, ex: game warden, consultant):**

   1) ________________ 2) __________________ 3) ____________________

5. **Circle the outdoor recreation activities you take part in at least once a month: (Circle all that apply)**

   Hunting   Fishing   Nature Photography
   Hiking   Biking   Camping
   Birdwatching   Kayaking/Canoeing   Other: _______________

6. **Have you heard of citizen science?** Yes No

   -If yes, how would you define citizen science?

   ____

   -If yes, are you a part of any projects, and if so, which one(s)?

   ____

7. **Do you attract birds to your place of residence?** (ex: bird feeder, water bath, etc.) Yes No

8. **Do you birdwatch outside of class activities?** Yes No

   -If yes, do you keep a bird list (i.e. record species and number of birds)? Yes No

   If yes to keeping a list, approximately how many species have you observed in Texas?_________

   -If no, are you interested in learning about birds? Yes No

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

KU# ____________

9. Have you conducted your own research (hypothesis, data collection, data analysis)? Yes No

10. Have you taken an ornithology course or any bird classes? Yes No

11. Have you heard of the South Texas Wintering Birds Citizen Science Project? Yes No

12. I can identify many (>20) birds to full common name. (Circle one)

Completely Disagree Disagree Unsure Agree Completely Agree

13. I enjoy collecting data on birds. (Circle one)

Completely Disagree Disagree Unsure Agree Completely Agree

14. I feel comfortable setting up my own bird survey research project. (Circle one)

Completely Disagree Disagree Unsure Agree Completely Agree

15. I am comfortable using binoculars. (Circle one)

Completely Disagree Disagree Unsure Agree Completely Agree

16. I am confident in my experience using Microsoft Excel. (Circle one)

Completely Disagree Disagree Unsure Agree Completely Agree

17. I am confident in writing an article/report in scientific journal format. (Circle one)

Completely Disagree Disagree Unsure Agree Completely Agree

18. Have you written an article/report in scientific journal format? Yes No

19. For the following birds, please identify by full common name (if possible) on the line below the photo. (For example: Grackle would be Great-tailed Grackle, if you do not know put "Do not know")

1____________ 2____________ 3____________ 4____________

(MORE PICTURES ON NEXT PAGE)

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

KU# ______________

5______________ 6______________ 7______________ 8______________

9______________ 10______________ 11______________ 12______________

13______________ 14______________ 15______________ 16______________

(MORE PICTURES ON NEXT PAGE)

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

KU# ________________

17________________
____

18________________
____

19________________
____

20________________
____

APPENDIX J. POST-SURVEY FOR UNDERGRADUATE STUDENTS

Caesar Kleberg WILDLIFE Research Institute

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

TEXAS A&M UNIVERSITY KINGSVILLE

Citizen Science Post-Survey

KU# ____________

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.
You are participating in this survey voluntarily. Results of this survey will not affect your course grade.

1. **What COUNTY were you born in?** ____________________ (if out of TX, specify state and COUNTY)
2. **Ideal career in wildlife (list top 3, with 1 being most preferred):**

   1) ______________ 2) ______________ 3) ______________
3. **Circle the outdoor recreation activities you take part in at least once a month: (Circle all that apply)**

   Hunting / Fishing / Nature Photography
   Hiking / Biking / Camping
   Birdwatching / Kayaking/Canoeing / Other: ____________
4. **Have you heard of citizen science?** Yes No

   -If yes, how would you define citizen science?

   ____
   ____

   -If yes, are you a part of any projects, and if so, which one(s)?

   ____
5. **Do you attract birds to your place of residence?** (ex: bird feeder, water bath, etc.)

   Yes No
6. **Do you birdwatch outside of class activities?** Yes No

   -If yes, do you keep a bird list (i.e. record species and number of birds)? Yes No

   If yes to keeping a list, approximately how many species have you observed in Texas?

   ____

   -If no, are you interested in learning about birds? Yes No
7. **Have you conducted your own research (hypothesis, data collection, data analysis)?** Yes No
8. **Have you heard of the South Texas Wintering Birds (STWB) Citizen Science Project?** Yes No
9. **I can identify many (>20) birds to full common name. (Circle one)**

   Completely Disagree / Disagree / Unsure / Agree / Completely Agree
10. **I enjoy collecting data on birds. (Circle one)**

    Completely Disagree / Disagree / Unsure / Agree / Completely Agree

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

KU# ________________

11. I feel comfortable setting up my own bird survey research project. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

12. I am comfortable using binoculars. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

13. I am confident in my experience using Microsoft Excel. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

14. I am confident in writing an article/report in scientific journal format. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

15. Have you written an article/report in scientific journal format? Yes   No

16. This course has helped improve my bird identification skills. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

17. This course has helped improve my understanding of bird surveys & experimental design. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

18. I will continue to use South Texas Wintering Birds (STWB) website. (Circle one)

Completely Disagree   Disagree   Unsure   Agree   Completely Agree

19. For the following birds, please identify by full common name (if possible) on the line below the photo. (For example: Grackle should be Great-tailed Grackle, if you do not know put "Do not know")

1________________ 2________________ 3________________ 4________________

(MORE PICTURES ON NEXT PAGE)

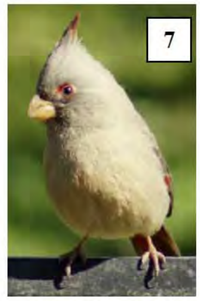
THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

KU# ________________

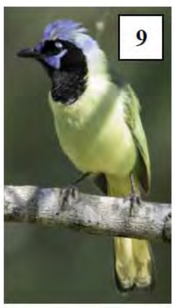
5 ________________

6 ________________



7 ________________

8 ________________



9 ________________

10 ________________

11 ________________

12 ________________

13 ________________

14 ________________

15 ________________

16 ________________

(MORE PICTURES ON NEXT PAGE)

THIS RESEARCH PROJECT HAS BEEN REVIEWED BY THE
TEXAS A&M UNIVERSITY-KINGSVILLE INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS.
IF YOU HAVE QUESTIONS OR CONCERNS THOSE QUESTIONS OR CONCERNS SHOULD BE DIRECTED TO
THE OFFICE OF RESEARCH AND SPONSORED PROGRAMS.
Phone: (361) 593-3344

DO NOT TAKE THIS SURVEY IF YOU ARE UNDER 18 YEARS OF AGE.

KU# ________________

17________________
____

18________________
____

19________________
____

20________________
____

APPENDIX K. FINAL REPORT RUBRIC

1. Abstract (10 points max) __________
   - ❑ Clearly summarizes entire study (2)
   - ❑ Provides 7 key words (2)
   - ❑ Formatted correctly (2)
   - ❑ Word count reached (2)
   - ❑ Separate page with proper titles and headings (2)

2. Introduction (15 points max) ________
   - ❑ Importance of study is presented (3)
   - ❑ Presents a clearly testable scientific question (3)
   - ❑ Gives background information related to the study w/ proper literature cited (3)
   - ❑ States a hypothesis related to the question (3)
   - ❑ Does this study provide information that is lacking? If so, how? (3)

3. Materials and Methods (10 points max) ________
   - ❑ Lists all materials (5)
   - ❑ Provides enough information to enable a repeated procedure (5)

4. Results (10 points max) ________
   - ❑ Data relevant to question is the only data presented (2)
   - ❑ Enough detail is given to understand data and implications (2)
   - ❑ All data has units (2)
   - ❑ Uses an appropriate type of graph (2)
   - ❑ Graph and axes are labeled correctly, captions are appropriate (2)

5. Discussion/Conclusion/Management Implications (15 points max) ________
   - ❑ Refers back to the original question and hypothesis (3)
   - ❑ Draws evidence-based conclusions and statements are supported by data (3)
   - ❑ Gives possible reasons for errors and/or suggests improvements for this study (3)
   - ❑ Suggests future experiments or ideas (3)
   - ❑ Provides information on how this study can be used for management (3)

6. Overall Report (20 points max) ________
   - ❑ References are adequate and properly cited (5)
   - ❑ Writing and organization are clear (5)
   - ❑ There are few spelling and grammar errors (5)
   - ❑ Proper formatting (5)

Total Score (out of 80): ______________

Very good “A” (5, 3,or 2 points)	Good “B” (4, 2, or 1.5 points)	Fair “C” (3, 1.5, or 1.0 point(s))	Poor “D” (1.5, 1, or 0.5 point(s))	Blank “F” (0 points)
Thorough and complete presentation of component	Mostly complete component	Missing half of component	Attempted to address (wrote something) but missed most of what was expected	Did not include at all

APPENDIX L. ABUNDANCE AND NDVI VALUES

Point-Count	Year	May	June	April NDVI	May NDVI	Year	May	June	April NDVI	May NDVI	Year	May	June	April NDVI	May NDVI
1	2014	6	12	0.6092	0.5946	2015	12	12	0.74605	0.77415	2016	10	10	0.6703	0.6179
2	2014	12	15	0.48995	0.58655	2015	15	16	0.6514	0.80815	2016	9	18	0.5293	0.6160
3	2014	29	18	0.6149	0.60325	2015	23	29	0.68445	0.81055	2016	17	32	0.6655	0.6000
4	2014	8	24	0.61535	0.635	2015	18	34	0.6104	0.7873	2016	24	30	0.6811	0.469
5	2014	10	22	0.57835	0.60715	2015	22	28	0.63985	0.81605	2016	19	22	0.6702	0.5359
6	2014	14	16	0.5519	0.6224	2015	26	32	0.6276	0.80335	2016	15	17	0.6369	0.638
7	2014	10	11	0.5537	0.52225	2015	15	29	0.73325	0.7938	2016	15	19	0.6631	0.5736
8	2014	12	15	0.571	0.5189	2015	19	27	0.69945	0.8043	2016	15	27	0.6805	0.4992
9	2014	12	15	0.55555	0.5369	2015	17	25	0.6874	0.73145	2016	15	20	0.6845	0.5876
10	2014	9	11	0.5269	0.382	2015	24	21	0.7021	0.765	2016	13	15	0.6689	0.6089
11	2014	13	21	0.53485	0.23505	2015	15	33	0.70465	0.71255	2016	17	18	0.674	0.6843
12	2014	13	11	0.488	0.5901	2015	16	26	0.6695	0.75095	2016	15	13	0.6089	0.7107
13	2014	12	11	0.5811	0.45295	2015	11	15	0.7116	0.5775	2016	7	16	0.5777	0.6591
14	2014	13	7	0.55655	0.5341	2015	17	17	0.56265	0.55275	2016	12	17	0.5954	0.5732
15	2014	11	11	0.4666	0.5388	2015	13	25	0.5331	0.5774	2016	23	18	0.4902	0.4776
16	2014	7	12	0.4785	0.4351	2015	12	16	0.5375	0.496	2016	11	15	0.4087	0.4826
17	2014	8	10	0.4527	0.4316	2015	16	11	0.5222	0.52685	2016	12	10	0.4713	0.3047
18	2014	8	22	0.359	0.41495	2015	18	13	0.36955	0.5809	2016	11	11	0.362	0.2642
19	2014	7	17	0.3702	0.4861	2015	17	18	0.44235	0.6309	2016	11	9	0.4145	0.3853
20	2014	6	14	0.38375	0.58125	2015		19	0.48605	0.68065	2016	9	11	0.4247	0.4146
21	2014	15	10	0.44265	0.56865	2015	15	11	0.5901	0.516	2016	22	24	0.4902	0.5195
22	2014	9	9	0.4358	0.5461	2015	7	20	0.54955	0.6135	2016	13	19	0.4740	0.4937
23	2014	12	12	0.44285	0.56975	2015	18	17	0.58715	0.7496	2016	18	16	0.5004	0.4924
24	2014	13	7	0.4388	0.617	2015	15	20	0.6372	0.80905	2016	13	16	0.4918	0.5499
25	2014	11	18	0.47385	0.50265	2015	6	23	0.64875	0.5751	2016	10	16	0.5044	0.558
26	2014	12	12	0.4719	0.5122	2015	11	18	0.5885	0.63715	2016	10	15	0.5324	0.5786
27	2014	8	10	0.47045	0.48565	2015		14	0.5706	0.538	2016	9	15	0.552	0.4813

28	2014	9	13	0.58545	0.5727	2015	10	18	0.6944	0.7356	2016	15	15	0.6642	0.7279
29	2014	7	10	0.6361	0.59185	2015	17	16	0.7611	0.745	2016	12	17	0.7110	0.6656
30	2014	13	15	0.49055	0.5606	2015	12	18	0.63535	0.66815	2016	21	18	0.5000	0.5207
31	2014	14	19	0.5011	0.53135	2015	20	22	0.557	0.6206	2016	19	19	0.4917	0.4996
32	2014	4	11	0.464	0.5343	2015	7	21	0.53345	0.59665	2016	14	13	0.4963	0.4326
33	2014	9	12	0.46045	0.50185	2015	10	16	0.58505	0.57605	2016	13	14	0.497	0.5378
34	2014	9	10	0.48675	0.5258	2015	8	17	0.5923	0.6472	2016	13	18	0.5494	0.6204
35	2014	10	10	0.56815	0.57875	2015	18	16	0.60805	0.74225	2016	17	20	0.6022	0.5870
36	2014	9	13	0.54045	0.61005	2015	11	15	0.59855	0.59975	2016	18	13	0.5779	0.5620
37	2014	17	13	0.5544	0.5783	2015	13	21	0.61545	0.65305	2016	18	21	0.6117	0.4487

VITA

JANEL LYNNETTE ORTIZ

EDUCATION

Ph.D. Wildlife Science, Texas A&M University-Kingsville, Kingsville, TX, May 2018
M.S. Biology, California State University, Los Angeles, Los Angeles, CA, June 2014
Certificate, Geographic Information Systems
B.S. Animal Science, University of California, Davis, Davis, CA, June 2009

TEACHING EXPERIENCE

Teaching Assistant, Texas A&M University-Kingsville, Fall 2017
Instructor, Texas A&M University-Kingsville, Fall 2016
Guest Lecturer, Texas A&M University-Kingsville, Spring 2016
Guest Lecturer, Texas A&M University-Kingsville, Fall 2015
Teaching Assistant, Texas A&M University-Kingsville, Spring 2015
Graduate Teaching Fellow, IMPACT LA NSF GK-12 Program, CSULA, 2012–2014

RECENT PRESENTATIONS

"**Conservation in the Classroom: Integrating Wild Birds into the 6th and 7th Grade Curriculum**" 2018 Oral Presentation at the American Ornithological Society, Tucson, NM
"**Taking Them Under My Wing: Integrating Wild Birds into the 6th and 7th Grade Classroom**" 2018 3rd Place Clarence Cottam Competition at the Texas Chapter of the Wildlife Society, Dallas, TX
"**Using the Gradient Concept to Visualize Breeding Bird Richness and Woody Structure Relationships On South Texas Rangelands**"
2018 Oral Presentation at the American Ornithological Society, Tucson, NM

PUBLICATIONS

Ortiz, J.L., Conkey, A.T., Brennan, L.A., Fedynich, L., and M. Green. In Review. Incorporating Research into the Undergraduate Wildlife Management Curriculum. *Wildlife Society Bulletin*.

Ortiz, J.L. and A. Arredondo. 2017. Cactus Wren Nest Characteristics in South Texas. *Bulletin of the Texas Ornithological Society* 50(1-2):75–79.

Ortiz, J.L. and A.E. Muchlinski. 2015. Food Selection of Coexisting Western Gray Squirrels and Eastern Fox Squirrels in a Native California Botanic Garden in Claremont, California. *Bulletin Southern California Academy of Sciences* 114(2):98–103.

CONTACT INFORMATION ortizjanel@gmail.com