THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF ECOSYSTEM SCIENCE AND MANAGEMENT

THE IMPACT OF BREEDING SEASON WEATHER ON MOURNING DOVE NEST SUCCESS

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SPRING 2014

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Wildlife and Fisheries Science
with honors in Wildlife and Fisheries Science

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ABSTRACT

Mourning doves are one of the most popular game birds in North America. Compared to other heavily harvested game bird species, factors which affect mourning dove abundance are still relatively poorly understood. In order to set responsible harvest limits for these birds, we need to understand their demographic responses to environmental variation. Conditions during the summer, when breeding occurs, lead to differences in fall population sizes during the hunting season. To better understand how annual weather variation influences mourning dove reproduction, I used mourning dove nest data collected by technicians at Iowa State University from 2005-2007 and weather data from NOAA to build a nest survival model with six weather covariates. I did not find strong support for a relationship between weather and daily survival rate of nests. There was some evidence for a relationship between precipitation and nest survival, but confidence intervals for the effect still included 0. Because there are many other important factors in mourning dove recruitment, future work should examine how weather affects other reproductive parameters such as nestling growth and nest initiation rates.

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Chapter 1 Introduction

The mourning dove (*Zenaida macroura*) is one of the most popular game birds in the United States, providing over 20 million harvested animals and three million days afield annually (AFWA 2008). Despite their popularity and importance, harvest management at the national scale is relatively uninformed as compared to other migratory gamebirds. Mourning dove managers across the country have developed a national strategic harvest management plan that uses population models to inform harvest management for this species (US Fish and Wildlife Service 2003). Coordinating regulations at a national scale is challenging as mourning doves breed in all 48 contiguous states and as a result face significant environmental variation. Understanding their demographic responses to environmental variables is important to developing accurate population models and predicting numbers of animals available for harvest each fall. In order to better understand the role of weather in determining summer recruitment, I investigated the effects of air temperature and precipitation on daily nest survival of mourning doves nesting in Central Iowa from 2005-2007.

Mourning doves have a unique reproductive strategy that consistently leads to high recruitment, but also makes them vulnerable to weather variations (Westmoreland 1986). Mourning Doves have the longest breeding season of any North American bird, fledging up to six clutches in six months (Swank 1955). They conduct a short courtship and nest building phase of three to five days, followed by clutch initiation two to three days later. Their nests are notably insubstantial. Like other columbids, mourning doves almost always lay two eggs per clutch. Both parents incubate and the eggs hatch after 13-14 days (Cowan 1952). Nests are often re-used (Nice 1922). Fledglings begin feeding themselves around 17 days of age, and are completely independent by 27 days of age (Hitchcock and Mirarchi 1984). Unlike most birds, mourning dove reproduction is not timed to coincide with abundance of a specific food source. Both parents feed the nestlings crop milk, a rich nutritional substance composed of the shed epithelial lining of the crop (Scanlon 1980). These adaptations allow mourning doves to consistently produce high numbers of offspring.

Mourning doves are able to achieve their prolific numbers through a very careful reproductive energy budget. Multiple experiments have shown that increasing energy demands on dove parents creates significant developmental stress in nestlings. Blockstein (1989) found that nests with an artificially added third nestling produced fledglings with lower mean weights than their two-fledgling conspecifics, indicating that crop milk production is a significant limiting factor in mourning dove reproduction. Westmoreland and Best (1987) also observed lower fledgling weights, as well as lower nestling survival rates and a longer period of dependence, in artificially enlarged nests. Miller (2010,a,b) showed that although mourning dove nestlings are able to prioritize growth for flight, nutritional stress in the nestling stage has a long-term impact on the birds' viability.

Several studies suggest that cold, wet spring weather has a negative impact on mourning dove reproduction. McClure (1939) reported that doves in southwestern Iowa ceased calling and reproductive activity during a period of cold rain. Another study conducted in Texas observed nesting preceded by "an extended courtship, the intensity seemingly varying with the weather," with decreased reproductive behavior in cool, wet weather (Swank 1955). It has also been reported that spring weather affects mourning dove nesting density and success (Miller et al. 2010a). In order to successfully manage this species, the impact of weather on nest success and the mechanism of that impact must be understood.

I determined the relationship of nesting success of mourning doves related to within-season variation in weather at four locations in Central Iowa, which were surveyed from 2005-2007 by students and technicians from Iowa State University. I specifically examined how precipitation amounts and extreme temperatures were related to daily survival rates of nests. I hypothesize that the number of days with a minimum temperature below 10ºc or a high above 32 ºc and the number of days of precipitation a nest experiences will have a negative impact on nest success.

Chapter 2 Methods

Data for this study were collected by David Miller at Iowa State University in Central Iowa from April 5 to September 5 2005-2007. There were four sites: Ames (42º3.7 N, 93º 35.99 W), Big Creek (41º48.65" N, 93º45.29" W), Hendrickson Marsh (41º56.28" N, 93º14.6" W), and Rhodes Farm (41º53.68" N, 93º13.39" W). The study area is a matrix of agricultural fields, remnant grasslands, and in the case of Ames, a college campus and metropolitan area.

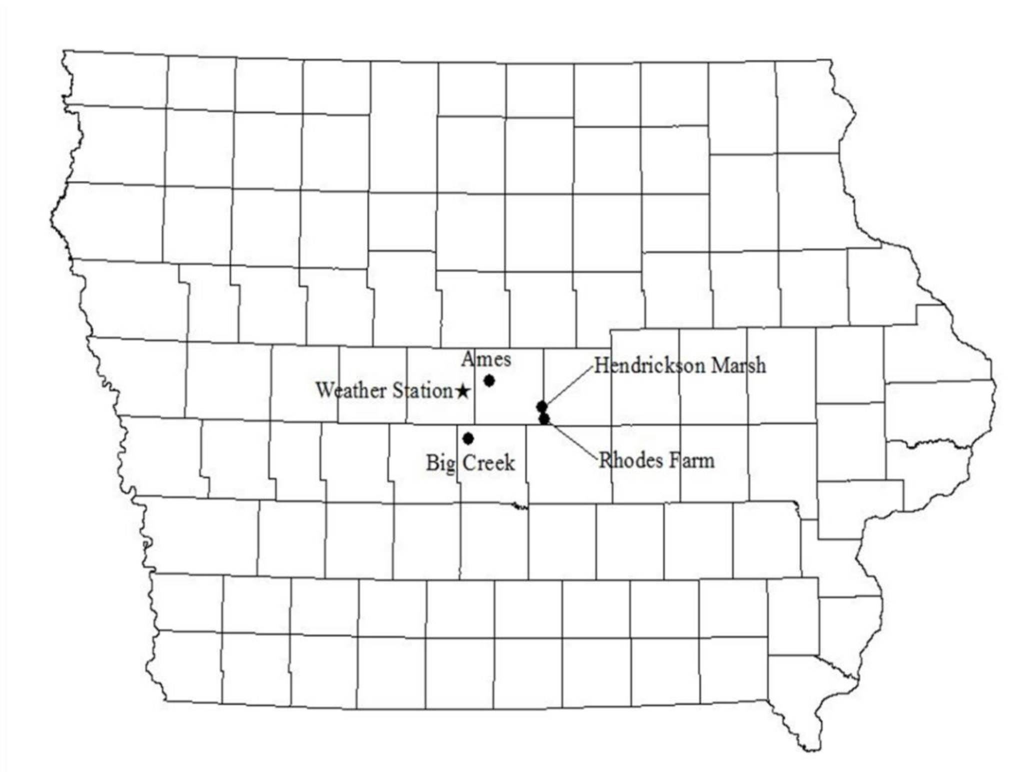

Figure 1: Mourning dove nests were surveyed at four sites in central Iowa from 2005-2007

Data Collection

Field technicians from Iowa State University searched for and monitored dove nests using systematic searches of habitat within the study areas. Most nests were located in shrubs and small trees (1-5m tall) along field borders and in old fields that were in early stages of woody succession. When incubating nests were discovered, technicians candled the eggs to determine date of nest initiation and nests were revisited every three days. Monitoring ceased when the nestlings fledged or when nest loss occurred due to predation or other causes. Because there was some uncertainty regarding the fate of nests as they neared the fledging stage, we right-censored nest records to only include visits prior the 9^{th} day post-hatching. Birds typically fledge between 10 and 14 days after hatch and determining whether a nest was depredated or young fledged could be ambiguous in some cases after the 9^{th} day post hatching. Weather data were retrieved for the AMES 8 WSW weather station (42.0208, -93.7741) using NOAA's National Climate Data Center (www.ncdc.noaa.gov; accessed 13 January 2014).

Analysis

I evaluated the effects of three air temperature and precipitation covariates on mourning dove daily survival rate of nests (DSR). Using these weather covariates, I constructed a set of nest survival (Dinsmore et al. 2002) models in Program MARK (White and Burnham 1999). These three covariates were calculated for three-day and 14-day intervals to provide both an immediate and a longer-term picture of the conditions for nesting doves. For air temperature, I considered the number of days the low temperature was below 10ºc (cold) and the number of days the maximum observed air temperature exceeded 32ºc (hot). These temperature ranges were chosen to include the temperature range within which mourning doves are most likely to call (McClure

1939). I also considered the effect of precipitation, calculation the number of days for which the precipitation was greater than one centimeter. The nest survival analysis I used (Dinsmore et al. 2002) calculates the probability that any mourning dove nest will survive on any given day, rather the probability that an individual nest will survive to the end of the reproductive cycle. This method requires weather covariates to be calculated for calendar days, so that all nests active during a single day would be given the same probability of surviving that day. The covariates describe the days immediately preceding the day in question. For example, the three day "cold" covariate for May 5 describes the number of days from May 2-4 that the low temperature was equal to or less than 10°c. All three-day covariates have a possible value of 0, 1, 2, or 3. Fourteen-day covariates include the preceding 14 days and have possible values of whole numbers from 0 to 14.

I entered nest records in the form of encounter histories. The encounter history included the day of the nesting season on which the nest was found, the date the nest was initiated (because nests are found at different stages), the last day the nest was checked alive, the last day the nest was checked, and the fate of the nest (0=successful, 1=failure). I input these encounter histories into MARK and calculated DSR for every day in the mourning dove breeding season 2005-2007.

I then fit the DSR values to weather covariates for each of 19 candidate models, which differed in which variables were included. All models included effects for year and season (early, middle, or late) to account for potential temporal variation in nest survival unrelated to weather. Each season comprised 31 days, or a third of the total nesting season. I used these values to create a null model without weather covariates against which the weather models were assessed. Each model included a different combination of weather covariates. Each weather covariate (3-day hot, 3-day cold, 3-day precip, 14-day hot, 14-day cold, 14-day precip) was tested separately. I also tested all combinations of 3-day covariates and 14-day covariates. Because of the literature suggesting an effect of cold and wet weather, I also included models with an interaction between the number of days with precipitation and the number of cold days.

Models have traditionally been understood as detailed and static descriptions of systems. However, simple models can be valuable tools for hypothesis testing (Starfield 1997). The relative quality of models is assessed using the Akaike information criterion (AIC). MARK uses maximum likelihood analysis when building models. Maximum likelihood analysis considers many possible models that would fit the data provided and chooses the most probable one. Likelihood ranges from 0 to 1, with 0 being an impossible model, and 1 being a perfectly fitting model.

$$AIC = -2\log\left(\mathcal{L}(\hat{\theta} \mid \mathrm{y})\right) + 2\mathrm{K} \quad \text{Eq. } 1$$

AIC assesses the relative fit of a model while taking the number of parameters into account. A model with more parameters may have a higher likelihood than one with fewer parameters but that doesn’t mean that it necessarily will predict data better (Burnham and Anderson 1998). A smaller AIC indicates a better-fitting model. I reported AIC values in the form of ΔAIC values in order to provide a better picture of the model fits in relation to each other. If a model had a smaller AIC than the null, that model was considered to be significant. For those models that were indicated to be significant, I graphed the relationship between DSR and covariates to show the size of the relationship.

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Chapter 3 Results

Nests were monitored from day 95 to day 249, 2005-2007. Technicians found a total of 534 nests over the course of the study. The sample size was 189 nests in 2005, 172 in 2006, and 173 in 2007. The maximum observed daily temperature during the period in which nests were monitored was 33.9 degrees, observed in 2006, and the minimum observed daily temperature was -10, observed in 2007There was significant inter-season variation, but little inter-annual variation (fig 2).

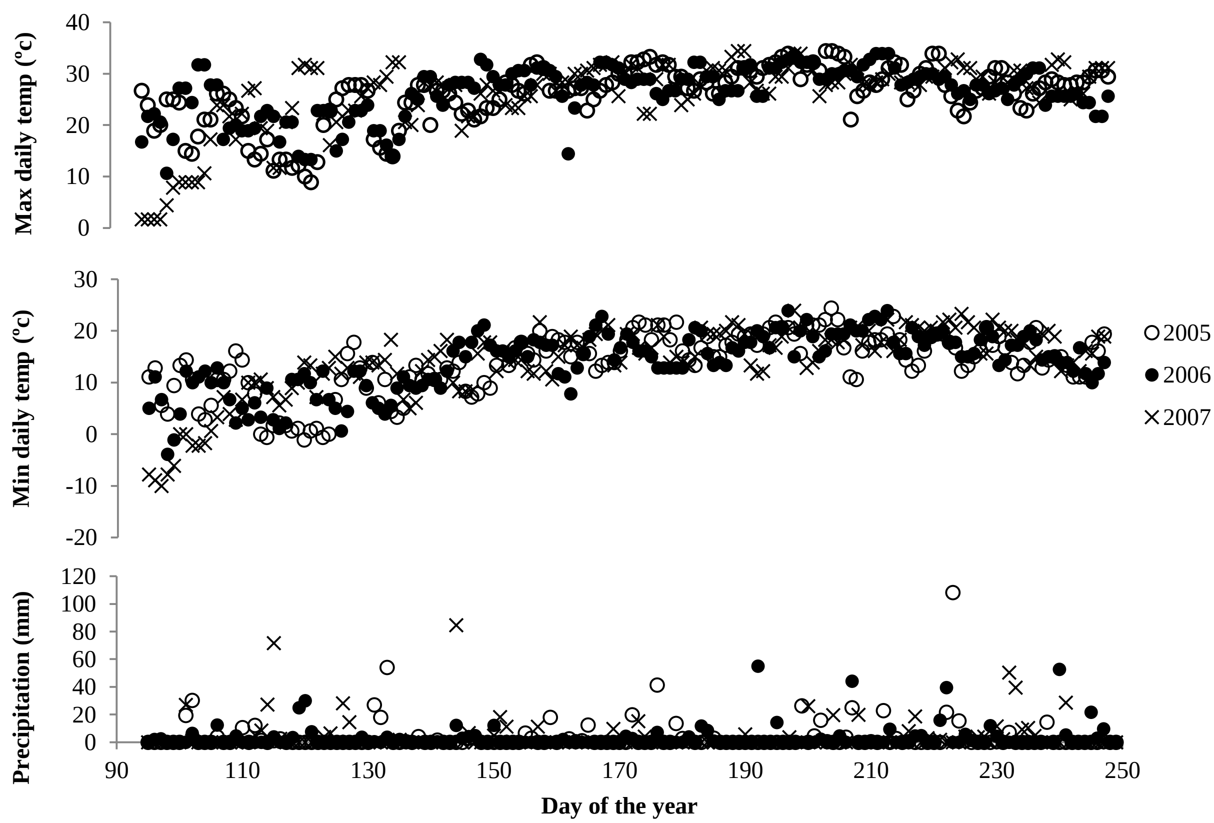

Figure 2: Daily high and low temperatures and precipitation values from the Ames 8 SWS weather station during the mourning dove breeding season 2005-2007. There was significant inter-season variation in weather covariates, but little inter-annual variation. Maximum daily temperature was highest in the middle season, and lowest in the early and late seasons. Minimum daily temperature was also lower in the early and late seasons and higher in the middle season. There was more precipitation in the early and late seasons than in the middle season.

Table 1: Results of weather models where delta AIC <2.5

Model	ΔAIC_c	AIC_c Weights	Num. Par
3-day precipitation	0	0.20	6
Null	0.84	0.13	5
3-day cold + precipitation	1.50	0.09	7
3-day hot + precipitation	1.85	0.08	7
14-day hot	2.25	0.06	6

I tested nest survival models, including every combination of weather covariates and a null model. The only model with an AIC value smaller than that of the null model was the three-day precipitation model (Table 1). The beta value for three-day precipitation was 0.29 with a standard error of 0.18. This indicates that the number of days of precipitation in a three-day period has a positive impact on DSR. The lower bound of the 95% confidence interval was -0.07 and the upper bound was 0.65.

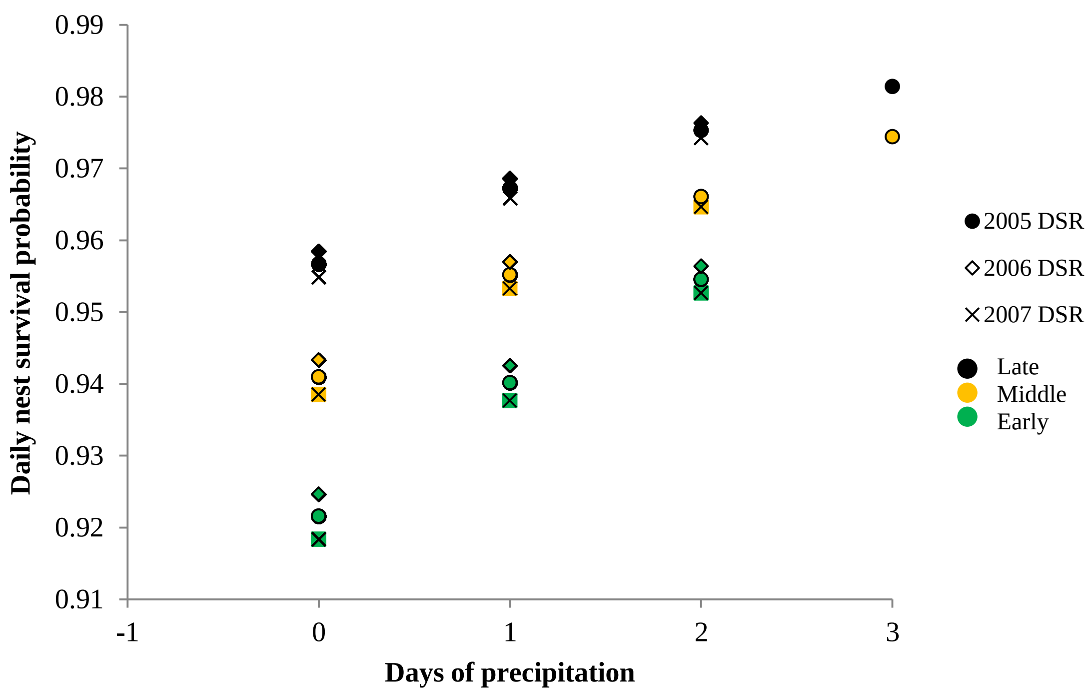

Figure 3: Daily survival rates of mourning dove nests from 2005-2007. Higher 3-day precipitation rates were correlated with increased daily survival rate in all seasons and all years. There was also a pronounced season effect and a slight year effect. DSR increased from the early to middle to late season in all years.

Although the relationship between three-day precipitation and daily nest survival was strong, the confidence interval still included 0 (Fig. 3). Figure 3 shows the relationship between days of precipitation and daily probability of nest survival. There was almost no difference in DSR among years, but we did observe strong seasonal effects. Daily nest survival probabilities resolved into three clusters that corresponded to early, middle, and late season. DSR was lowest in the early season and increased as the season progressed. Despite the year and season effects, the relationship between precipitation and daily nest survival was clear across all years and all seasons.

Chapter 4 Discussion

Mourning doves are an important game bird whose management is a developing science. The objective of this study was to assess the impact of breeding season weather conditions on mourning dove daily nest survival. I hypothesized that the number of days with a high temperature above 32°c, the number of days with a low below 10°c, and the number of days of precipitation a nest experienced would all negatively impact daily nest survival.

Three-day precipitation was positively correlated with daily nest survival. There was also a marked season effect with DSR increasing from the early to middle to late seasons in all three years. The positive impact of precipitation is not evident in the 14-day model, indicating that the effect is short-term. It has been shown that avian parental activity is correlated with nest predation (Muchai et al. 2005). Birds, including mourning doves and avian nest predators, may have been less active in the rain. The presence of one or both adults at the nest also discourages other predators. The longer precipitation lasted, the less active parents and predators would have been during that period, leading to increased DSR. This hypothesis is supported by the fact that mourning doves are adapted for long periods on the nests. Most birds have to leave their nests frequently during incubation to forage, but mourning doves are capable of holding a large amount of food in their crop and digesting as needed to decrease their time away from the nest and shorten their incubation period (Westmoreland et al. 1986). Because they feed their nestlings with crop milk and seeds, they also have a food supply for their nestlings if the nest is in the nestling stage. If the doves in the study system had foraged before the precipitation event, they would have had no need to leave their nests during the precipitation event, limiting their activity and discouraging predators.

The season effect I observed may actually have been a nest site selection effect. Martin et al. (2000) observed that daily nest survival in a grassland bird system increased over the course of the breeding season as nests transitioned from the incubation stage to the nestling stage and the parents made more trips to and from the nest to forage for the nestlings. When they controlled for nest site selection, however, parental activity actually had a strong negative effect on nest survival. At the beginning of the season, many birds choose unsuitable nest sites or are forced to use less than optimal nest sites and materials. These sites are exposed and easy for predators to find, leading to low daily nest survival early in the season. Mourning doves begin nesting very early in the spring, and poor choices in nest sites or lack of adequate nesting resources may be a factor in their low early season nest survival.

The increase in daily nest survival over the course of the season may also have been due to the improving skill of mourning dove parents. Multiple studies (Ollason and Dunnett 1978; Lozano et al. 1995; Perrins and McCleery 1983) have shown that more experienced birds have greater reproductive success than less experienced birds, especially when pair bonds are maintained between reproductive attempts. Most birds only make one to three reproductive attempts per breeding season, and have to wait and survive an entire year to implement what they learned from the previous nesting season. Mourning doves make up to six reproductive attempts per season, and gain more nesting experience with each attempt. It has even been observed that experienced mourning doves will overlap broods, laying a new clutch while the male continues to feed the nestlings or fledglings from the previous clutch (Westmoreland et al. 1986). As the seasons progressed, the mourning doves in the study system would have become more experienced parents, providing better care and increasing their DSR as a result. It is also possible that the reproductive skill of individual birds does not improve, but rather that the lower-quality individuals do not survive to make a multiple reproductive attempts. In either scenario, this process would be accelerated in multiple-brooding mourning doves. The resulting reproductive success change that occurs across years in other species could occur in the course of a season for mourning doves.

One significant limitation to this analysis was that it did not include nest stage. As previously discussed, parental activity is negatively correlated with daily nest survival. Parental activity increases as the nest progresses from the incubation stage to the nestling stage (Martin et al. 2000). Because mourning doves produce multiple clutches in a season, there were nests in the system in different nest stages during the same time period. Consequently, individual nests may have been affected differently by the weather in the same time period. Future analyses should investigate the effect of the interaction between stage and weather on daily nest survival. Weather may not have a strong effect on mourning dove daily nest survival. However, recruitment is also a function of the number of nest initiations and of nestling growth and development, both of which may be more directly impacted by weather. Future work should consider how weather affects these other components of recruitment.

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ACADEMIC VITA

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Education

The Pennsylvania State University Expected to graduate in 2014
Bachelor of Science in Wildlife and Fisheries Science
Minor: English

Schreyer Honors College
Honors Curriculum: Statistical Techniques in Entomology, Populations and Communities, Genetics, Forest Biometrics, Wildlife and Fisheries Conservation, Wildlife and Fisheries Measurements, Biology Independent Study, Rhetoric and Composition, Chemical Principles I

Honors Thesis: My honors thesis is a student-designed study assessing the impact on mourning dove nest survival and nestling condition by breeding season temperature and precipitation.

Other Relevant Courses
Wildlife Management, Population Dynamics (scheduled), Ornithology, Ornithology Lab, Wildlife Behavior, Biometrics, Mapping and GIS, Wilderness First Aid, Human Dimensions of Natural Resources, The Vertebrates, Vertebrates Lab, Function and Development of Organisms

Professional Appointments

Pennsylvania Fish and Wildlife Cooperative Research Unit
Undergraduate Research Technician *October 2011-present*
The Pennsylvania State University

The co-op unit is an interagency research body formed in part by Penn State University and the Pennsylvania Game Commission. I conduct interviews with hunters to assess the harvest location, movement, and health of radio-collared and tagged deer. These data are then entered into a Microsoft Access database.

Hubbard Brook Experimental Forest
Point Count Technician *May 2013-August 2013*
White Mountain National Forest

Hubbard Brook is an ecosystem-wide study of a small watershed in the White Mountains. I conducted point counts for breeding birds across the valley and entered the data using a filemaker database. I also conducted Lepidoptera surveys, and conducted and processed Lepidoptera samples. At the end of the season, I created a foliage height profile using a specially modified camera.

Penn State Arboretum Bird Banding Project
Volunteer Bird Bander *Fall 2012-Fall 2013*
The Pennsylvania State University

Penn State bands birds in the botanical gardens and attached parkland during spring and fall migration to assess bird population levels, age structure, health, and arrival and departure dates. I assist with the set up and break down of mist nets, bird extraction, banding, and assessment of age, sex, and fat stores. I also record banding data, and educate the public about bird banding.

Missouri Ozark Forest Ecosystem Project
Bird Research Crew *May-August 2012*
Peck Ranch Conservation Area, Winona, Missouri

The Missouri Ozark Forest Ecosystem Project is a large-scale, long-term manipulative forestry experiment. I worked in the bird division assessing the abundance and distribution of focal breeding bird species in southern Missouri. I plotted spot maps, conducted point counts, searched for and monitored nests, and mist netted for forest passerines. To ensure spatially accurate results, I utilized orienteering skills, GPS, and GIS technologies.

United States Fish and Wildlife Service
Fisheries Research Intern *May-August 2011*
Northeast Fishery Center, Lamar, PA

At the Northeast Fishery Center, I assisted with research both in the field and at the center. I electrofished for eastern brook trout and monitored water quality in trout streams across Pennsylvania’s northern tier to investigate the pattern of natural brook trout population fluctuations. At the center, I maintained captive trout, salmon, paddlefish, and sturgeon populations and assisted with fish breeding and nutrition studies. I also conducted fisheries education and outreach programs for the local community.

Shea Ecology Lab
Invasive Plant Research Assistant *January-May 2011*
The Pennsylvania State University

The Shea Ecology Lab investigates the dynamics and survival strategies of invasive plants and animals. I worked on a project examining the effect of drought on the spread of invasive thistles. My daily duties included dissecting thistle heads from different populations, recording the number and quality of seeds, and conducting terminal velocity drops with seeds to assess their wind dispersal potential. I was also responsible for entering thistle data.

Stauffer Fisheries Systematics Lab
Research Assistant *September-December 2010*
The Pennsylvania State University

The Fisheries Systematics Lab monitors the health of several streams near an on-going road construction project through macroinvertebrate analysis. I extracted macroinvertebrates from preserved samples of stream substrate and vegetation and sorted them for later study.

Other Experience

Penn State Office of Residence Life
Resident Assistant *August 2012-Present*
The Pennsylvania State University

As a resident assistant for freshman students, I am responsible for building community and enforcing residence hall policy. I create opportunities for residents to interact in a casual and friendly setting so that they can make friends on the floor. I have also helped students overcome such diverse issues as alcohol poisoning, academic difficulties, and interpersonal conflict.

Penn State Learning
Writing Tutor *August 2011-Present*
The Pennsylvania State University

Penn State's free tutoring service, Penn State Learning, follows a discussion-based tutorial model emphasizing mutual respect and cultural understanding. I tutor writers from all over the world on papers ranging from freshman English compositions to scientific articles being prepared for publication.

Camp Onas
Counselor and Nature Director *Summer 2007-2010*
Ottsville, PA

Camp Onas is a Quaker sleep-away summer camp that emphasizes the Quaker values of simplicity and environmental stewardship. Campers and staff live outside together in tents or pavilions. I was responsible for the safety and well-being of my campers as well as the environmental program for the whole camp. This included caring for a wide variety of domestic and wild animals, planting and maintaining a sustainable garden with campers, overseeing the camp's compost program, running environmental education activities, and leading trips on the Appalachian Trail and the Delaware River.