The effect of climate change on the phenology of use and the condition of migrant birds of conservation concern in stop-over habitat

Project Summary:

The effects of climate change on the timing and use of stop-over habitat by migratory birds are mostly not understood. Of key concern is that linkages between the timing of prey emergences and the passage of migratory birds may be disrupted. We propose to replicate the sampling of migratory birds (including many birds of priority conservation concern) done in 2003 and 2004 at the St. Francis Sunken Lands in 2012 and 2013 to examine possible changes in chronology and linkages related to recent climate change and to develop management recommendations.

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Total Project Cost: $111,390

Total Amount of SWG Money Requested: $72,400

Total ASU Match: $38,990 (35%)

Source of Matching Funds: Salary and fringe benefits = $13,451
Indirect Costs = $25,540

A. **Need:** The anthropogenic discharge of greenhouse gasses has led to increases in the mean global surface temperature, and recent years have been among the warmest on record (Intergovernmental Panel on Climate Change [IPCC] 2001). Current assessments (IPCC 2001) predict that global mean temperature will increase an additional 1.4 to 5.8ºC in the 21st Century. Many of these changes in climate have been pronounced at higher latitudes (Easterling et al. 1997, Zhang et al. 2000) and have included decreases in duration of ice coverage of northern lakes (Schindler et al. 1990, Anderson et al. 1996). These changes in temperature, and associated changes in precipitation, snow cover, lake- and river-ice, and sea-level have led to a multitude of effects on plant and animal communities (Parmesan and Yohe 2003, Root et al. 2003).

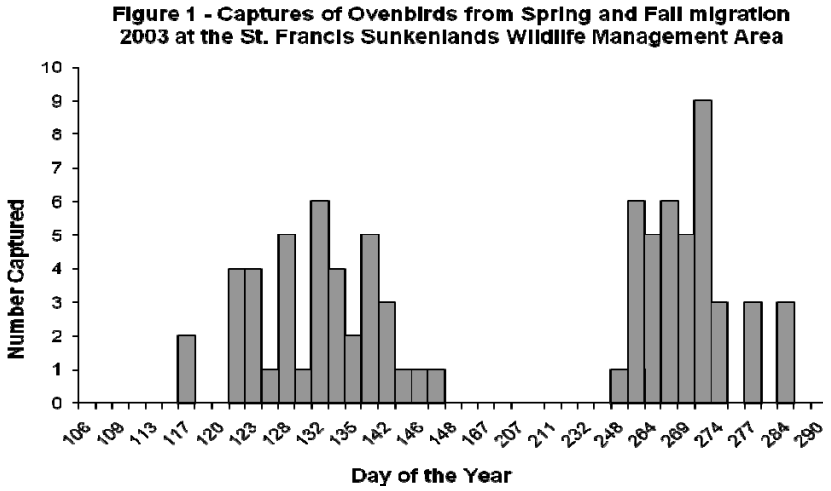
Recently, the IPCC (2008) reported that the last 11 of 12 years (1995–2006) have been the warmest years on record, and mean global temperatures have rose 0.74ºC between 1906 and 2005. Based on geological records, temperatures fluctuate over time, but when the past 150 years of data are compared to historical data (e.g., ice core samples), the most recent rate of temperature change is relatively large and sudden compared to the last 10,000 years (Parmesan and Matthews 2006). In addition, higher carbon dioxide levels are highly correlated with the increases of temperatures (IPCC 2001). Since 1910, atmospheric CO_2 levels have risen 36%, far beyond the scope of natural variation over the last half million years (Parmesan and Matthews 2006). Climatologists collectively agree that earth's mean temperature has risen and this is mostly due to human-induced increases in greenhouse gas concentrations (Crowley 2000, IPCC 2001, Karoly et al. 2003).

In a meta-analysis of animals and plants, Root et al. (2003) found that >80% of 1,468 species considered in 143 studies showed changes consistent with the effects of global warming. These climate-change effects have ranged from tropical to polar ecosystems and have included changes in reproductive timing, species distributions, the chronology of events, and changes in interactions between species (Parmesan and Yohe 2003, Root et al. 2003). Many studies examining the effects of climate change on birds have documented northward shifts in range. For example, Niven et al. (2009) reported that 58% of 305 bird species analyzed in North America have shifted their ranges significantly northward based on Christmas Bird Count data. Another commonly reported effect of climate change has been the significant advancement of biological events, such as the dates of egg-laying or nesting (e.g., Bradley et al. 1999, Sparks et al. 2005). Whether these changes in the timing of biological events will adversely impact most species is unknown. However, research and data on the effects of climate change on the wildlife of Arkansas are mostly nonexistent. One exception involving Arkansas is the thorough analysis of winter waterfowl numbers using the Mississippi Flyway between 1955 and 2004 by Benson et al. (in review). These authors found a significant northward shift of most wintering waterfowl populations, especially dabblers, in the Mississippi Flyway. Benson et al. (in review) found that climate variables most effectively predicted this northward shift in ducks in the last 50 years compared to alternative potential casual factors and that Arkansas and the other states in the southern portion of the flyway may have already lost approximately 25% of the wintering Mallard population.

The effects of climate change on the timing and use of stop-over habitat by migratory birds is poorly understood and studied. However, Strode (2003) reported that North American wood warblers (Parulidae, Neotropical migrants) are not migrating earlier and that their primary prey sources at stop-over habitat may be less abundant during migration due to earlier hatching, blooming, and development. If this phenomena is occurring, this could have substantial adverse effects on many migratory birds of greatest conservation concern, not only here in Arkansas, but throughout North America. Here, we propose to examine this potential adverse effect related to climate change on migratory bird stop-over habitat in Arkansas.

Specifically, Bednarz and students at Arkansas State University have been mist-netting and banding migratory birds, including many species of conservation need both in Arkansas and that breed at northern latitudes in the Mississippi Flyway at the Saint Francis Sunken Lands (SFSL) since 1998.

Effort has varied from a couple days of mist-net sampling in spring and fall to a full migratory season of netting. The most intense sampling occurred in 2003 and 2004 when netting was done approximately 4 days a week throughout the entire migration season both in spring and fall. For example, during 2004, Bednarz's team sampled 24 net days between 16 April and 29 May in the spring and 30 net days between 24 August and 16 October in the fall. All individuals, including 73 species sampled in 2004, were banded, weighed, and measured. With the standard mass and wing chord measurements collected, we can calculate condition indices (see Benson and Bednarz 2010) for all 1,346 individual birds sampled in 2004. With this proposal, we request funds to duplicate full-season mist netting sampling at the same location in the SFSL in 2012 and 2013. We will then compare both the phenology of migration and the condition indices of birds between these two sample periods to assess effects of recent climate change on migratory birds. An example of the type of phenology data that may be produced by mist net sampling is shown in Figure 1.



B. **Objectives:**

1. Fully analyze the past sampling data collected in 2003–2004, document the phenology of migratory birds, and calculate mean condition indices as a measure of habit quality.
2. Duplicate full migration season sampling in both the spring and fall in 2012 and 2013 at the same migratory stop-over site sampled in 2003 and 2004.
3. Compare migration phenologies and condition indices of migrants using the SFSL stop-over site to assess potential changes in response to climate change in the last 10 years. This analysis will test the hypothesis that climate change may adversely affect the linkages between prey availability phenology and avian use of stop-over sites.
4. Based on the results of this comparison, we will develop conservation recommendations related to the establishment and management of wildlife management areas (WMAs) to minimize and negative effects of climate change on migratory bird use of stop-over habitat on AGFC lands.
5. The documented migratory bird use and condition from both the 2003–2004 and 2012–2013 periods will provide baseline data sets that can be compared to future sampling to examine the long-term effects of climate change on migratory birds of greatest conservation need.

C. Expected Results and Benefits to Species of Concern: Little information is available on the effects that climate change is having and will have on the birds of Arkansas. Further, very little research has addressed how climate change may affect migratory bird use of stop-over habitat. This proposed study will take advantage of a rather substantial data set (>2400 birds of >80 species) that we collected during the migratory periods in 2003 and 2004. Specifically, this existing baseline of data will allow us to repeat this sampling nearly 10 years later and assess if there have been recent changes in migratory phenology and the body condition of migrants. As climate change has especially accelerated in the last 10 years globally (IPCC 2008), it is within this period that we should most likely be able to detect any effects on migratory birds. Importantly, this project will use common migrants (probably at least 10 species) to assess the effects of climate change on all

migratory songbirds, including species of greatest conservation concern. Relatively common local species that we will evaluate in the proposed project include Ovenbirds, Yellow-breasted Chats, Kentucky Warblers, Prothonotary Warblers, Worm-eating Warblers, Black and White Warblers, Acadian Flycatchers, and others. Many of these species are of some conservation concern locally. Furthermore, we will be able to assess the effect of climate change on Neotropical migrants of greatest concern that breed north of Arkansas, including Golden-winged Warblers, Palm Warblers, Mourning Warblers, Black-throated Green Warblers, Tennessee Warblers, Gray-cheeked Thrushes, Swainson's Thrushes, and others. Importantly, AGFC wildlife management areas, which provide stop over habitat, are crucial to the health of many migratory populations of birds of greatest conservation concern that breed to the north. Thus, this proposed study will address both the need of local birds of conservation interest and global birds of conservation concern. Moreover, the results of this proposed project will allow us to provide recommendations to the AGFC and other resource agencies related to the management of existing WMAs and refuges and the establishment of future WMAs to address the long-term conservation consequences of climate change.

D. **Approach:** During the spring and fall migration periods, we will mist net migratory songbirds at the SFSL in Craighead County, AR. We will sample in the Hatchie Coon Island field that consists of large fallow fields planted partially with food plots, and a mix planted pines and deciduous trees surrounded by mature bottomland hardwood forest. We will sample in the exact locations on the north side of Hatchie Coon Island where we have been sampling birds since 1998. We will erect 20-25 nets along fire-break paths between food plots and rows of pine trees. Nets will be opened ca. 30 min prior to sunrise and closed mid-day, depending on capture rates and weather conditions. Standard nets (12 × 2.6 m) will be checked every 30 min and birds will be removed from mist nets, placed in bird bags, and transferred to a central banding station for processing.

Each bird will receive a numbered USGS aluminum band. Wing chord and mass measurements will be collected along with the age and gender using Pyle et al. (1997). Each individual bird's general condition will be assessed using two different subjective measures: fat and pectoral class (scored 1–3). Condition indices will be calculated by regressing mass on wing chord measurements and residuals will be used as an index of condition (e.g., Brown 1996, Benson et al. 2010).

Data collected during 2003 and 2004 will be fully analyzed to document phenological patterns and to calculate condition indices for that period. The identical data collected in 2012 and 2013 will be compared, by species, to the earlier sample (2003–2004) to assess the recent effects of climate change on migratory birds using stop-over habitats in Arkansas.

E. **Location of Work:** This research project will be conducted at the St. Francis Sunkenlands Wildlife Management Area in the Mississippi Alluvial Plain Ecoregion in Craighead County.

F. **Budget: 24 months (1 January 2012 to 31 December 2013)***

Salary and benefits	$ 65,554
Tuition	5,280
Travel	5,400
Supplies	3,034
Total operating expenses	$ 79,268
Indirect costs	32,122
Total Costs	**$111,390**

Amount requested from SWG	$ 72,400
In-kind match from ASU	38,990
Total project cost	**$111,390**

***A 2-month project extension would be required to allow us to implement this proposed project in the spring and fall of 2011 and 2012, and to prepare a final report at the end of 2012.

Qualifications:

James Bednarz, Ph.D., Professor of Wildlife Ecology, will manage the overall project and work closely with a M.S. graduate student and research technicians coordinating the field portion of this project. Jim will work with the M.S. student in developing field data collection protocols, collecting the data, participating in the analysis and interpretation of the data and contributing to the writing of the report. Jim Bednarz has conducted research on six continents for over two decades emphasizing avian population ecology and conservation. Most of this work has been focused on birds of prey, woodpeckers, game birds, and songbirds. Topics of research have included effects of habitat and landscape fragmentation and other human activities on migratory bird population demography, impacts of hydroelectric development on wetland areas and wildlife, radiotelemetry and habitat use studies on a variety of wildlife species, development of endangered species conservation plans, completion of site suitability analyses (e.g., Mexican wolf), design of mitigation plans for habitat and wildlife populations, and basic questions about avian ecology. Jim has published 49 journal articles or monographs, provided 8 contributions to books, 10 papers to conference proceedings, 4 published book reviews, and completed 68 funded project reports.

Brandon L. Noel, Ph.D. Candidate, Conservation Biologist, has studied Pileated Woodpecker habitat use and ecology while working on his Ph.D. since 2007. Brandon plans to finish his Ph.D. at Arkansas State University in May 2011 and will continue to work closely with Bednarz and recruited students on project implementation including, but not limited to, study design, data collection, and data analysis. Brandon received his B.S. in marine biology from the University of West Florida, M.S. in Biology from Georgia Southern University working with endangered Piping Plovers. He has 10 years of conservation research experience (marine and avian), 4 research publications, 3 submitted manuscripts, completed 3 funded project reports, and intends to submit at least 5 more manuscripts in 2011 and 2012.

M.S. Student. One M.S. students will be recruited if funds are awarded. The students will be competent ornithologists and analytical biologists, with previous B.S. degree in Wildlife Biology or Ecology, and with experience and interest in avian sampling, analytical techniques, and conservation science.

Appendix: Literature Cited

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