



**ILLINOIS NATURAL  
HISTORY SURVEY**  
PRAIRIE RESEARCH INSTITUTE

University of Illinois at Urbana-Champaign  
Prairie Research Institute  
William Shilts, Executive Director

ILLINOIS NATURAL HISTORY SURVEY  
Brian D. Anderson, Director  
1816 South Oak Street  
Champaign, IL 61820  
217-333-6830

## Effects of Bottomland Forest Restoration on the Breeding Bird Community in the Cache River Watershed – Year 2

Dr. Jeff Hoover

Duration of Research: September 28, 2009 to June 30, 2011

Prepared for: The Illinois Department of Natural Resources

Grant / Project Number: IDNR RC10L16W

**Project Title:** Effects of Bottomland Forest Restoration on the Breeding Bird Community in the Cache River Watershed

**Project Type:** Site Inventories & Surveys, Research, and Measuring Success of Restoration

**Project Period:** September 28, 2009 to June 30, 2011

**Proposed by:** Dr. Jeff Hoover  
Illinois Natural History Survey  
1816 S. Oak Street  
Champaign, IL 61820

**Contact Person:** Dr. Jeff Hoover

**Telephone Number:** 217-244-2922

**E-mail Address:** j-hoover@illinois.edu

**Alternate Telephone Number:** 217-417-8277

**Award Number:** IDNR RC10L16W (D74391, 1-596042-375002-191100)

**Funding from the Illinois Department of Natural Resources:** \$15,000

## **Project Summary:**

The Cache River Joint Venture Partnership (JVP; ILDNR, USFWS, and TNC) formed in 1991 in an effort to conserve and restore some 60,000 acres of bottomland forest habitat in the Cache River watershed of southern Illinois. During the past 18 years, the JVP has successfully acquired and reforested over 20,000 acres of non-forested land. With the backing of the JVP, scientists from the Illinois Natural History Survey collected baseline data during 1993-1995 documenting breeding bird densities, breeding bird diversity, and nesting success of various species of bird prior to most of this land-use conversion. These conservation activities should result in increased nesting success and increased densities for many bottomland forest birds. We now have the unique opportunity to document how the restoration of bottomland forests (acquiring and “reforesting” non-forested land) has affected the diversity, abundance, and nesting success of Neotropical migratory birds breeding within a bottomland forest ecosystem.

This grant funded data collection during the **first year** of what is to be a **3-year** project designed to meet several objectives including 1) determine the response of the breeding bird community to bottomland reforestation, 2) document baseline conditions for birds breeding in forested wetlands likely to be affected by the partial reconnection of the upper and lower Cache River, 3) measure the success of the restoration efforts of conservation partners (ILDNR, TNC, and USFWS), and 4) provide results that are directly applicable to conservation plans and restoration efforts in other bottomland forest ecosystems.

This research represents the merging of scientific research with conservation in action and continues the partnership between INHS and the members of the Cache River JVP. The research proposed here will expand our knowledge and increase our ability to effectively and efficiently restore and manage bottomland forests. This research will ultimately provide guidelines to promote restoration and management practices that will provide the greatest benefit to Neotropical migratory birds residing in bottomland forest ecosystems, and will factor prominently in land conservation plans and land acquisition priorities. Also, the conservation issues being addressed and the results of this research have broad application and will assist with other bottomland forest restoration efforts in the Midwest and throughout the United States.

I include the project justification and objectives for the entire 3-year research endeavor, and provide a summary of what has been accomplished to date, data from the 2010 (Year 1 field season when the money was spent) and some preliminary results from the second year (2011).

**This summary will be updated upon the completion of the 3-year project and all future technical reports and publications associated with this 3-year research project will be passed along to IDNR.**

## **Project Justification:**

Neotropical migratory birds face continued threats resulting from the fragmentation and degradation of natural habitats (Askins 2000). Research during the past 20 years has led to a better understanding of the negative effects of habitat fragmentation (increased brood parasitism by cowbirds and increased nest predation) on migratory songbirds breeding in temperate bottomland forests, and land acquisition/conservation efforts that “unfragment” forests are possibly the best solution to restore or improve bottomland forest ecosystems.

In 1991, the Cache River Joint Venture Partnership (JVP) formed in an effort to conserve and restore (through land acquisition and reforestation) bottomland forest habitat in the Cache River watershed in Illinois. During 1993-1995, prior to most land acquisition and reforestation, we collected nesting data from seven focal sites within the Cache River watershed and obtained information on rates of nest predation and cowbird parasitism from nearly 2,000 nests (species include the Prothonotary Warbler, *Protonotaria citrea*; Kentucky Warbler, *Oporornis formosus*; Louisiana Waterthrush, *Seiurus motacilla*; Acadian Flycatcher, *Empidonax vireescens*; Wood Thrush, *Hylocichla mustelina*; Indigo Bunting, *Passerina cyanea*; and Northern Cardinal, *Cardinalis cardinalis*). During that same period, we conducted point counts in >30 tracts of bottomland forest (at least 10 points per tract) throughout the watershed and documented bird abundance and diversity. Since then, over 20,000 acres of non-forested land have been acquired by the JVP and are in different stages of succession (1-16 years post-agriculture).

We now have the opportunity to complete a 3-year follow-up study to determine whether or not rates of nest predation and cowbird parasitism have decreased relative to the amount of restoration that has occurred. Each of the hundreds of point-count locations will be revisited to determine the current abundance and diversity of breeding birds and to determine cowbird-to-host ratios (this ratio is a good index of the community-wide rate of cowbird parasitism; Robinson et al. 2000, Hoover et al. 2006). This current data will allow us to compare changes in nesting success, bird abundance and bird diversity to changes in habitat configuration that are a direct result of the restoration efforts of the JVP.

Too often the effects (i.e. success) of conservation/restoration efforts are not measured in terms of responses of the biota to the specific conservation actions. The research described in this proposal is designed to evaluate the success to date of conservation actions that should benefit birds breeding in bottomland forests. That evaluation will involve determining how changes in land-use in the Cache River watershed during the past 15 years, which are a direct result of land acquisition and restoration activities, affect bird diversity, bird densities, and nesting success. Therefore the success of this research and monitoring project will be measured in terms of our ability to collect the necessary census and nesting data that will allow us to determine the benefits of bottomland forest restoration for these breeding birds. Results from this research will ultimately provide guidelines to promote restoration and management practices that will provide the greatest benefit to birds breeding in bottomland forest ecosystems. Also, the questions being addressed and the results of this research have broad application and will assist with other bottomland forest restoration efforts throughout the U.S.

## **Project Objectives:**

By comparing current conditions to the preliminary data gathered during 1993-1995, I will:

- 1) Test the prediction that rates of nest predation and cowbird parasitism have decreased more in areas where there has been land acquisition and bottomland forest restoration than where there has been little restoration activity. This information will be critical to identifying where “source” habitats exist and will aid in prioritizing land acquisition.
- 2) Document changes in bird densities, species diversity, and the cowbird-to-host ratio in relation to restoration. This information will tell us how changes in landscape configuration that result from restoration may benefit the diversity and density of breeding forest birds (including area-sensitive species) while at the same time reducing the community-wide rate of cowbird parasitism.
- 3) Survey restoration plots that vary in age (e.g. 1, 3, 5, 7, 10, 16 years post-agriculture) to document how the bird community changes in the restored areas (and the adjacent forest) as these agricultural fields transition to grassland, shrubland, and eventually to mature forest. This will provide important information to land managers at other sites who are managing for particular successional stages and their associated bird communities.
- 4) Collect preliminary data (prior to partial reconnection) from sites that will be affected by the proposed partial reconnection project which will divert a portion of the flow from the upper Cache River into the lower Cache River. We will collect baseline data on the flooded surface area and average water depth (during the breeding season of birds) within the affected swamps to the west of where the partial reconnection is to occur (Porter Bottoms, Main Tract, Section Eight Woods), quantify the pre-reconnection bird community, and measure the pre-reconnection nesting success of the Prothonotary Warbler (a forested wetland specialist), for comparison with future conditions after the partial reconnection is completed.
- 5) Determine the effects and success of restoration efforts in the Cache River watershed to date, and provide information critical to the continued conservation efforts of the JVP and other bottomland forest restoration projects throughout the U.S. This proposed research will result in a comprehensive (management-oriented) report and several peer-reviewed manuscripts that will provide information that will further the science of restoration ecology and be useful to both local and regional ecosystem management efforts.

## **Project Methodology (applies to all 3 years):**

- 1) The field crew will search for, find, and monitor the nests of a variety of bottomland forest bird species (including the Prothonotary Warbler, Kentucky Warbler, Louisiana Waterthrush, Acadian Flycatcher, Wood Thrush, Indigo Bunting, and Northern Cardinal) during April through mid-August during 2010 on the same seven sites where nesting success was monitored intensively during 1993-1995. Using standard nest monitoring protocols, they will record the status (active or inactive) of each nest every 4 days, the number of cowbird eggs present in each nest, the ultimate fate of each nesting attempt (success or failure) and the number of offspring that fledge. Prothonotary Warbler nest boxes, which are distributed among these sites and an additional 20 sites, will be monitored to determine rates of cowbird parasitism over the spectrum of sites surrounded by more versus less restored habitat. Modern analytical tools (Chapa-Vargas and Robinson 2006, 2007) will be used to determine the effects of changes in land-use configuration (as a byproduct of restoration that has occurred) on rates of nest

predation, cowbird parasitism, and productivity of the forest songbirds. We will use this information to identify where “source” habitats exist and determine the role that habitat restoration has played in producing source habitat.

- 2) J. Hoover will re-survey the birds at the >300 census point locations (initially surveyed during 1993-1995) during the breeding season (15-May through June 2010) using a standardized point-count method. Each point will be visited twice during the survey period, one time by each observer. Data from these censuses will result in a list of the species present on each site (diversity) as well as a density estimate for each species. Pre-restoration (1993-1995) bird diversity and breeding bird densities will be compared to present estimates, and changes in diversity and density will be compared to changes in land-use that have occurred as a result of restoration efforts. The cowbird-to-host ratio will be documented for each site and we will determine whether restoration efforts have reduced this ratio (and therefore reduced the risk of cowbird parasitism).
- 3) Reforested sites that vary in age (e.g. 1, 3, 5, 7, 10, 16 years post-agriculture) will be surveyed to determine how the breeding bird community responds to the succession from agriculture to bottomland forest. We will select two sites in each age category, survey the birds at 10 locations per site using a standardized point-count method, and visit each site two times during the survey period (15 May through June). We will also collect basic vegetation data (e.g. structure) at each location in each site. Data from these censuses will result in a list of the species present on each site (diversity) as well as a density estimate for each species. We will then compare the bird communities across the different successional stages that correspond with number of years post-agriculture to identify when the grassland bird community transitions into a shrubland and ultimately a bottomland forest bird community, and determine the vegetative structure associated with those transitions.
- 4) We will measure the perimeter and flooded surface area of various swamps that are likely to be affected by the proposed partial reconnection of the upper Cache River to the lower Cache River as a baseline to determine changes in the flooded surface area that are attributable to the eventual restoration process (partial reconnection). We will measure the flooded surface area in each month during April through July in 2010. During the same time period, we will monitor nest boxes (for Prothonotary Warblers) already in place within these swamps. Nest boxes consist of 1.9-liter milk and juice cartons placed approximately 1.7 m above ground on trees over water within forested wetlands. Nesting success in nest boxes is similar to that in natural cavities (Hoover 2003). We will monitor nest boxes every four days from April through July and measure the water depth beneath each nest box on every visit. Nesting success for these warblers increases with an increase in water depth beneath nests (Hoover 2006). For every nest predation event, we will identify the nest predator (based on the condition of the nest and its contents) and document the depth of the water beneath the nest at the time of predation. For each swamp we will create a hydrologic profile (flooded surface area and depth of water) for the breeding season, and record all nesting activity and the fate of each nest. Rates of nest predation will be estimated for water-depth categories within the range of 0-150 cm. We will survey the breeding bird community in these swamps as part of Objective 1 above.
- 5) Upon completion of this project we will analyze data, synthesize results and create management recommendations that will be distributed to the Joint Venture Partners (USFWS, ILDNR, TNC) as well as to the Forest Service, Natural Resources Conservation Service, and other relevant agencies and organizations. We will also prepare various manuscripts to be

submitted to journals such as Applied Ecology, Landscape Ecology, Restoration Ecology and Conservation Biology.

### **Year 1 Results:**

These results come from the first year (2010) of what will be a 3-year study to follow-up on the bird research done in the Cache during 1993-1995. After the present 3-year period (2010-2012), we will compare all of the data between the two time periods to see how conditions have changed for breeding birds in association with bottomland forest restoration.

*Point-count data:* During the first field season in 2010, 175 census points were visited. Data are being entered, evaluated and summarized. As preliminary values of various attributes of the bird community (bird diversity, relative abundances, and the cowbird-to-host ratio) are determined, the information will be submitted to a representative of the granting agency.

*Prothonotary Warbler nest box data:* Data were collected from approximately 700 nesting attempts of warblers (300 pairs of color-banded adults; 1,000 warbler nestlings banded) from over 20 sites in the watershed. Data are being entered, evaluated and summarized. Data from these nests will yield rates of cowbird parasitism from all of these various sites.

*Nesting data from other species:* Approximately 320 nests total (12 different species) from 8 study sites were located and monitored. Nesting data are being entered, and will eventually be analyzed using program MARK to estimate rates of nest survival, and Generalized Linear Mixed Models to analyze rates of cowbird parasitism. As a preliminary summary of the nesting data, I have provided some simple comparisons of past data with present data to look at overall rates of nest predation and cowbird parasitism for Acadian Flycatchers (the species we have the most data from), and a comparison of cowbird parasitism only for the other 11 species combined.

My preliminary assessment of the Acadian Flycatcher (ACFL) data, the "bread and butter" species that we can find adequate nests of to make comparisons across all sites and years, shows that rates of cowbird parasitism in 2010 are much lower compared to 1993-1995. Overall, the parasitism rate for ACFLs **this year** was **12.5%** (n=255 nests) compared to an average rate of parasitism of **40%** (n=351 nests) over the **combined 3-year** period from 1993-1995.

For 5 of the individual sites with data from both time periods, cowbird parasitism of Acadian Flycatcher nests was as follows:

<u>Site</u>	<u>1993-1995</u>	<u>2010</u>
Hickory Bottoms	46%	31%
Hogue Woods	29%	11%
Main Tract	44%	20%
Forman Tract	55%	14%
Wildcat Bluff	25%	10%

The average rate of cowbird parasitism for the other 11 host species combined was **61%** (n=693 nests) over the **combined 3-year** period from 1993-1995, compared to an average rate of **37%** (n=67 nests) in **2010**.

This apparent reduction in cowbird parasitism over time is quite amazing and is likely a result of land acquisition in association with restoration efforts leading to there being less suitable foraging habitat for cowbirds within close proximity to these sites now compared to conditions in 1993-1995. Continued data collection over the entire current 3-year period will tell us how robust these patterns are and will also document the relative change in parasitism over time compared to the relative amount of land-use conversion within proximity of each nest and study site that has occurred.

*Preliminary rates of nest predation:* For rates of nest predation, on average **59%** of Acadian Flycatcher nests were lost to nest predators during **1993-1995**, compared to **39%** this year. Again, these are very promising results and we will be doing more sophisticated analyses as the data are entered and as the land-cover data are obtained.

### **Preliminary Results from Year 2:**

These results come from the second year (2011) of this 3-year study to follow-up on the bird research done in the Cache River watershed during 1993-1995. After the present 3-year period (2010-2012), we will compare all of the data between the two time periods to see how conditions have changed for breeding birds in association with bottomland forest restoration.

*Point-count data:* During the second field season in 2011, 125 bird survey points were visited. Data are being entered, evaluated and summarized. As preliminary values of various attributes of the bird community (bird diversity, relative abundances, and the cowbird-to-host ratio) are determined, the information will be submitted to a representative of the granting agency.

*Prothonotary Warbler nest box data:* Data were collected from approximately 600 nesting attempts of warblers (250 pairs of color-banded adults; 800 warbler nestlings banded) from over 20 sites in the watershed. Data are being entered, evaluated and summarized. Data from these nests will yield rates of cowbird parasitism from all of these various sites.

*The flood of 2011:* The record flood delayed by 2-3 weeks the nesting of many species (particularly Prothonotary Warblers and Kentucky Warblers) in the bottomland forests of the Cache River watershed. Once the flood waters receded, the Prothonotary Warblers quickly began nesting and by mid-summer had reached densities similar to previous years. Favorable nesting conditions for the warblers extended into early August (2 weeks later than usual) leading to overall reproductive output similar to previous years. The habitat of species nesting on or near the ground (e.g. Kentucky Warblers) was inundated and subsequently so altered that only in late June and July were there any Kentucky Warbler nests built in the floodplain forests of the Cache. In this regard, there was only a small percentage (e.g. 10-15%) of the typical number of pairs of Kentucky Warblers nesting in the floodplain forests. While the short-term effects of the flood on Kentucky Warblers were negative, the scouring of vast areas of the understory should lead to excellent nesting habitat (dense ground cover) for the 2012 breeding season and beyond.

*Nesting data from other species:* Approximately 600 nests total (primarily from 7 different species) were located and monitored during 2011. Nesting data are being entered, and will eventually be analyzed using program MARK to estimate rates of nest survival. Generalized Linear Mixed Models will be used to analyze rates of cowbird parasitism. As a preliminary summary of the nesting data, I

have calculated basic rates of nest predation and cowbird parasitism for Acadian Flycatchers (averaged across 2010 and 2011), and also for a combination of six other species representing the bulk of the non-Acadian Flycatcher nests (averaged across 2010 and 2011). Overall total average rates and average rates per site were compared between the past (1993-1995) and present (2010-2011) time periods.

### Cowbird Parasitism

Acadian Flycatcher Data: Analysis of the Acadian Flycatcher (ACFL) data, the "bread and butter" species that we can find adequate nests of to make comparisons across all sites and years, shows that rates of cowbird parasitism during 2010-2011 were ***much lower*** than during 1993-1995. Overall, the average rate of parasitism for ACFLs during **2010-2011** was **20%** (n=486 nests) compared to an average rate of parasitism of **38%** (n=343 nests) during **1993-1995** (Figure 1). Among the individual sites, rates of parasitism were lower during 2010-2011 than during 1993-1995 for all sites with the exception of the Hickory Bottoms site where rates were unchanged (Figure 1). Of the five sites, Hickory Bottoms has changed the least in terms of the amount of restored land in close proximity to the site.

Other Songbird Data: Rates of cowbird parasitism for the other six common host species combined (Wood Thrush, Kentucky Warbler, Northern Cardinal, Indigo Bunting, Prothonotary Warbler, and White-eyed Vireo) followed a pattern identical to that of the Acadian Flycatcher. Overall, the average rate of parasitism for these species during **2010-2011** was **23%** (n=202 nests) compared to an average rate of parasitism of **53%** (n=766 nests) during **1993-1995** (Figure 2). Among the individual sites, rates of parasitism were lower during 2010-2011 than during 1993-1995 on all sites with the exception of the Hickory Bottoms where rates again were not lower (Figure 2).

This apparent reduction in cowbird parasitism over time is quite amazing and is likely a result of land acquisition in association with restoration efforts leading to there being less suitable foraging habitat for cowbirds within close proximity to these sites now compared to conditions in 1993-1995. Even more promising is that the data have been consistent during the first two years (2010 and 2011) of the current 3-year period, including that the site with the least change in land-use adjacent to it (Hickory Bottoms) has not seen a decrease in cowbird parasitism. A third year of data collection will confirm that this pattern is indeed robust.

### Nest Predation

Acadian Flycatcher Data: Analysis of the ACFLs shows that rates of nest predation during 2010-2011 were somewhat lower than during 1993-1995. Overall, the rate of nest predation for ACFLs during **2010-2011** was **49%** (n=546 nests) compared to an average rate of **59%** (n=358 nests) during **1993-1995** (Figure 3). Among the individual sites, rates of nest predation were lower during 2010-2011 than during 1993-1995 for three of five sites with the Hickory Bottoms and Forman Tract sites having rates that were similar between time periods (Figure 3). Of the five sites, Hickory Bottoms has changed the least in terms of the amount of restored land in close proximity to the site and currently has the highest rates of nest predation for ACFLs.

Other Songbird Data: Rates of nest predation for the other six common host species combined (Wood Thrush, Kentucky Warbler, Northern Cardinal, Indigo Bunting, Prothonotary Warbler, and White-eyed Vireo) showed a more dramatic reduction in nest predation between the early and current time periods. Overall, the average rate of nest predation for these species during **2010-2011** was **44%** (n=202 nests) compared to an average rate of nest predation of **64%** (n=841 nests) during **1993-1995** (Figure 4). Among the individual sites, rates of nest predation were lower during 2010-2011 than during 1993-

1995 on all sites with the exception of Hickory Bottoms where rates again were not lower (Figure 4).

Collectively, the data on changes in rates of nest predation are also very promising, and suggest a substantial positive effect of bottomland forest restoration (re-foresting areas adjacent to pre-existing forest). The reduction in the amount of edge and openland habitat (habitat that various species of nest predator find attractive) near mature forests is a likely explanation for the reduction in rates of nest predation that have occurred over time. After the third year of data collection, a thorough analysis of nests at multiple spatial scales (e.g. changes in landscape composition at various distances from nests) will be used to determine how changes in landscape composition associated with restoration (or the lack thereof) have affected rates of nest predation and cowbird parasitism. During the third and final year of the project, we will assess land-use change with ARC INFO and GIS software, comparing the landscape of 1993-1995 with that of 2010-2012, and attempt to pinpoint those landscape attributes (proximity to edge, type of edge, amount of edge, percent landscape forested, etc.) that best explain changes and differences in rates of nest predation and cowbird parasitism.

**Cowbird telemetry:** Radio transmitters (1.4 g) were attached to 5 adult Brown-headed Cowbird females captured within putative breeding areas, located in two forested wetlands (Hickory Bottoms in the Cypress Creek NWR and Main Tract in the Cache River SNA). Each female was observed 1 to 5 times a week throughout the life of the transmitter (~ 10 weeks). During the morning hours, each individual female cowbird was predictably located within their respective forest “territories” (~ 6 ha in size) in the vicinity of their initial capture location. Females departed the forested wetlands at variable times during the afternoon hours (~2-5 pm). When located out of the forest, females were typically found foraging within agriculture fields and grass lawns adjacent to houses (0.5 – 1.5 km from their respective breeding territories in the forest). Most females observed in agriculture were found foraging in unplanted fields and recently planted soybeans. However, as the water levels dropped within the swamps during late June and early July, females were occasionally observed foraging on the exposed mudflats of drained swamps within the forest near their respective breeding areas.

We placed transmitters (0.9 g) on 10 juvenile cowbirds prior to fledging from Prothonotary Warbler nestboxes (early June - early July). We attempted to detect any interaction between adult female cowbirds and juvenile cowbirds by attaching transmitters on juvenile cowbirds that fledged from a nestbox located within the “territory” of a radio-tracked adult female cowbird. Of the 10 juveniles, 5 were preyed upon within the first two days after fledging and 1 died of unknown causes 2 weeks after fledging. Juveniles became independent from their host (warbler) parents 20-25 days after fledging (n = 4). Each juvenile found after dispersing (n = 3), was located in small cowbird flocks foraging in grass lawns (n = 2) or recently planted soybean (n = 1). Juveniles dispersed 0.5-0.8 km from their respective nestboxes. We failed to locate one juvenile after it apparently dispersed from the forest. Although adult females were often observed within close proximity of juvenile cowbird fledglings, it remains unclear if female cowbirds lead juvenile cowbirds out of the forest to foraging areas.

#### **Literature Cited:**

- Askins, R. A. 2000. Restoring North America's birds. Yale University Press, New Haven, CT, USA.
- Chapa-Vargas, L. and S. K. Robinson. 2006. Nesting success of a songbird in a complex floodplain forest landscape in Illinois, USA: local fragmentation vs. vegetation structure. *Landscape Ecology* 21:525-537.
- Chapa-Vargas, L. and S. K. Robinson. 2007. Nesting success of Acadian Flycatchers (*Empidonax virescens*) in floodplain forest corridors. *Auk* 124:1267-1280.

- Hoover, J. P. 2003. Decision rules for site fidelity in a migratory bird, the Prothonotary Warbler. *Ecology* 84:416-430
- Hoover, J. P. 2006. Water depth influences nest predation for a wetland-dependent bird in fragmented bottomland forests. *Biological Conservation* 127:37-45.
- Hoover, J. P., T. H. Tear, and M. E. Baltz. 2006. Edge effects reduce the nesting success of Acadian Flycatchers in a moderately fragmented forest. *Journal of Field Ornithology* 77:425-436.
- Robinson, S. K., J. P. Hoover, and J. R. Herkert. 2000a. Cowbird parasitism in a fragmented landscape: effects of tract size, habitat, and abundance of cowbirds and hosts. Pp. 280-297 in *Ecology and Management of Cowbirds and Their Hosts* (J. N. M. Smith, T. Cook, S. I. Rothstein, S. K. Robinson, and S. G. Sealy, eds.). University of Texas Press, Austin, Texas.

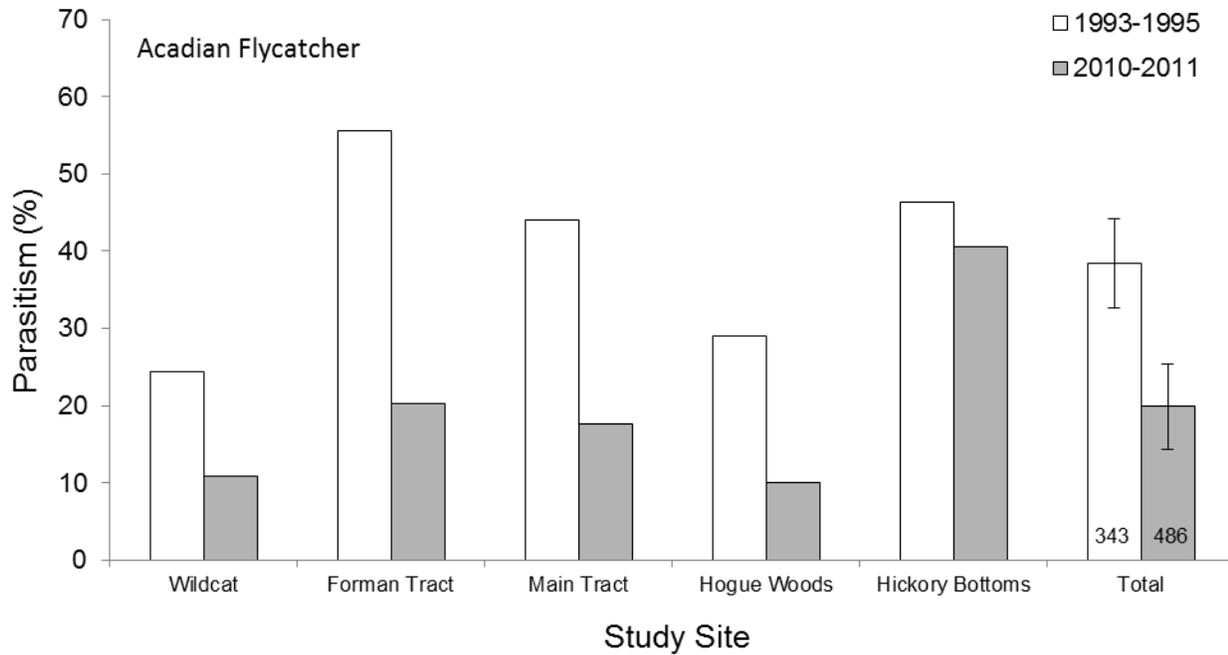


Figure 1. Rates of cowbird parasitism for Acadian Flycatchers nesting in the Cache River watershed during 1993-1995 and 2010-2011. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1$ SE) are averaged across sites. Total numbers of nests during each time period are given inside of bars in the “Total” category.

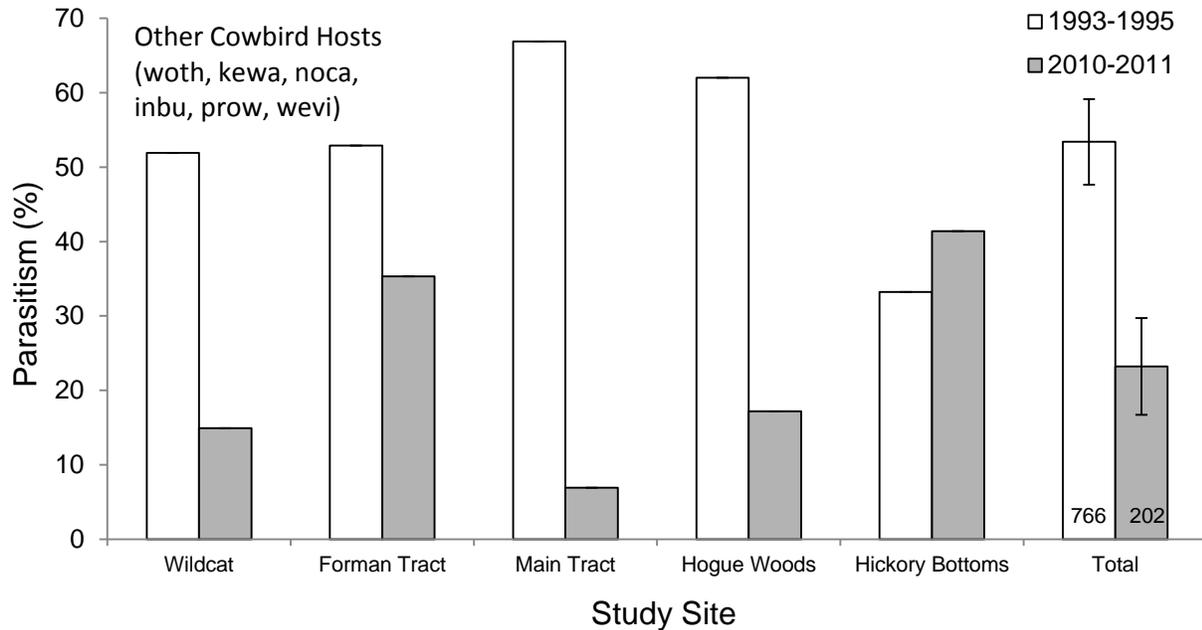


Figure 2. Average rates of cowbird parasitism for other cowbird hosts nesting in the Cache River watershed during 1993-1995 and 2010-2011. Other hosts include Wood Thrush, Kentucky Warbler, Northern Cardinal, Indigo Bunting, Prothonotary Warbler, and White-eyed Vireo. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total numbers of nests during each time period are given inside of bars in the “Total” category.

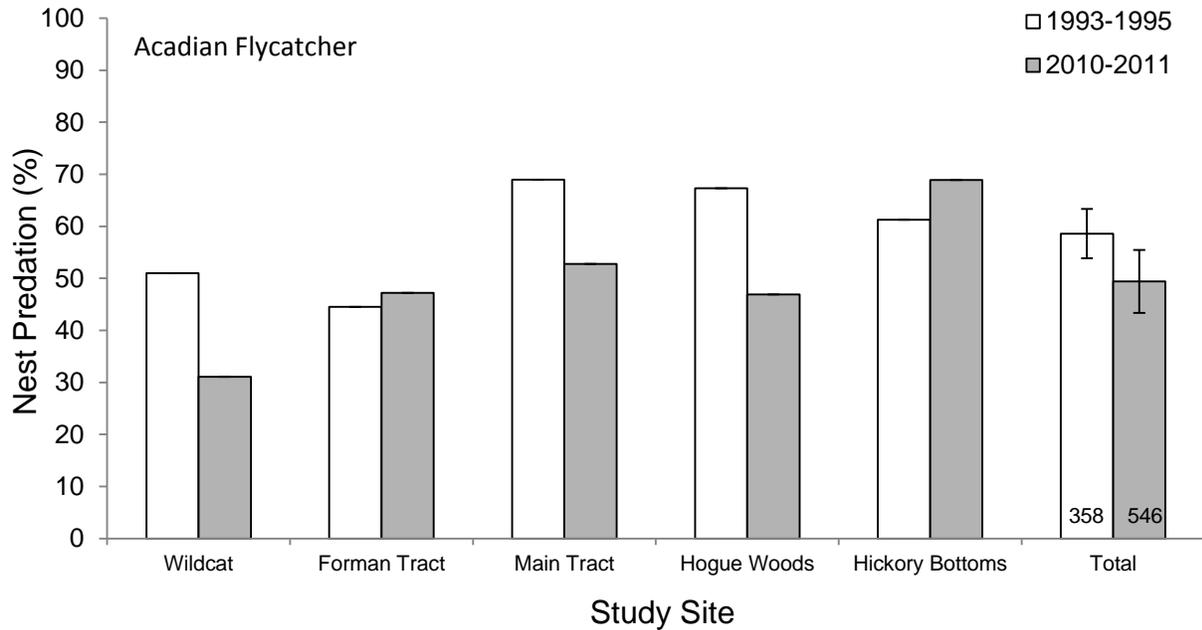


Figure 3. Rates of nest predation for Acadian Flycatchers nesting in the Cache River watershed during 1993-1995 and 2010-2011. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total numbers of nests during each time period are given inside of bars in the “Total” category.

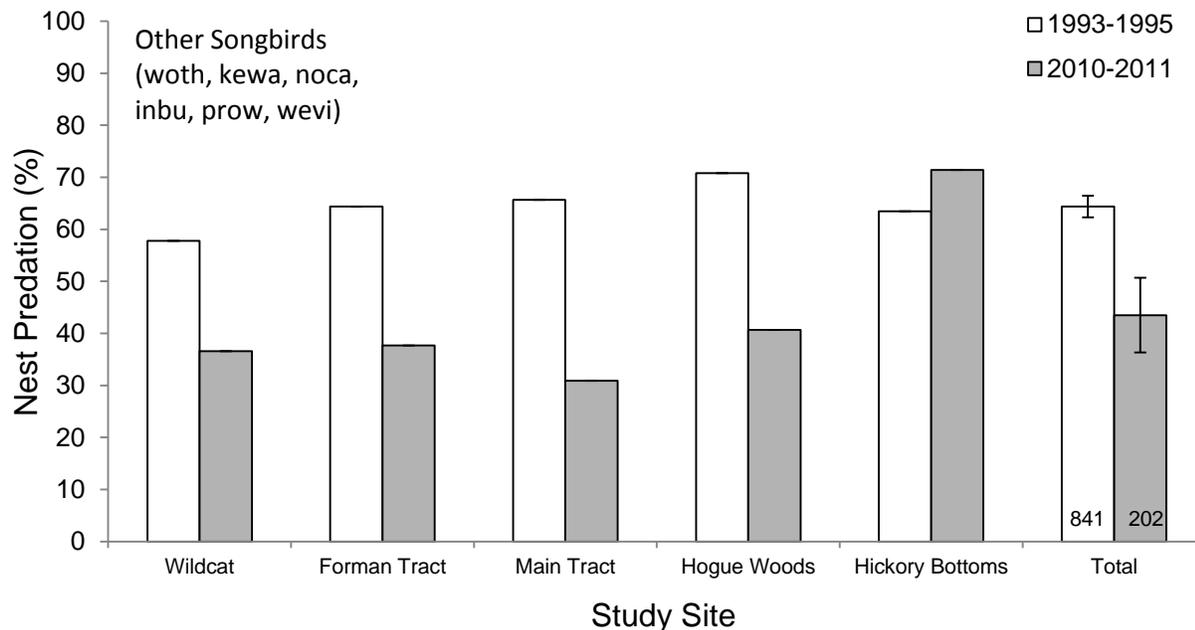


Figure 4. Average Rates of nest predation for other songbirds nesting in the Cache River watershed during 1993-1995 and 2010-2011. Other songbirds include Wood Thrush, Kentucky Warbler, Northern Cardinal, Indigo Bunting, Prothonotary Warbler, and White-eyed Vireo. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total numbers of nests during each time period are given inside of bars in the "Total" category.