

## Final Report for W-162-R-2

### The Forests and Woodlands Campaign of the Illinois Wildlife Action Plan – Segment 2

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### Overview and Objectives of Segment 2

The Forests and Woodlands Campaign (Forest Campaign hereafter) is one of the important campaigns outlined in the Illinois Comprehensive Wildlife Conservation Plan and Strategy (wildlife action plan). The wildlife action plan highlights very well the many current conservation issues involving Illinois' wooded habitats including the alteration or loss of natural disturbance processes, changing composition of forested habitats away from oak-hickory dominance to maple dominance, general decline in forest quality caused by increasing numbers of invasive exotic plant species, and extensive forest fragmentation. While the wildlife action

plan provides direction in the form of a general list of priority actions, the Forest Campaign, over the next several years will specifically move the wildlife action plan forward by addressing the following needs:

- 1) Forging new and reinvigorating existing conservation partnerships consisting of those groups committed to improving Illinois' forests and forest wildlife;
- 2) Identifying and collaborating with organizations that are implementing specific forest wildlife conservation activities, particularly those emphasizing the already-identified Conservation Opportunity Areas (COAs) around the state;
- 3) Developing strategies to facilitate additional priority forest management actions outlined in the wildlife action plan;
- 4) Establishing goals and specific targets for what the response of the wildlife and habitat to these actions should be;
- 5) Using the best science available to establish monitoring protocols to measure the effectiveness of management activities and determine whether or not wildlife and habitat goals are being achieved;
- 6) Establishing demonstration sites where land managers and the public can observe and learn more about forest management in action and how it benefits wildlife.

In addressing these needs, the Forest Campaign will establish or reinforce forest management partnerships in Illinois, create protocols for monitoring the effects of forest management activities on Illinois' wildlife, and document whether or not forest management activities are successfully promoting populations of focal wildlife species and meeting the goals of the wildlife action plan.

To better understand the response of wildlife populations to forest management activities under the wildlife action plan, Segment 2 of the Forest Campaign was devised to meet the following objectives during the first year of the campaign (1 September 2011 through 30 August 2012):

- 1) Implement monitoring protocols that measure the response of forest wildlife to various forest management tools that include, but are not limited to, thinning, fire, re-forestation that reduces forest fragmentation, and the removal of invasive exotic plant species;
- 2) Use a “before-after-treatment-control” monitoring framework (with replication) in a number of sites across Illinois to begin documenting the effects of forest management on populations of forest and woodland-dwelling birds;
- 3) Identify existing and begin developing new demonstration sites that highlight successful forest management techniques and actions, and that can be used to inform and educate various constituencies.

Following Segment 2, additional grant segments will focus on continuing to monitor the response of the forest wildlife to management activities, adding more species to monitoring protocols, measuring various aspects of the vegetation (e.g. forest structure and composition) at survey points, adding more sites/locations to the Forest Campaign, and working with partners to develop various demonstration sites that highlight successful forest management techniques and actions. Efforts to enter and analyze data are continuing, and sites will be repeatedly monitored over time as additional research is completed in the coming years. As additional analyses are completed, new information will be passed along to agency and site administrators and managers. A summary of the number of bird survey locations at each site and the forest management treatments associated with them is provided in Table 1. Included below are

general site descriptions and summaries of what was accomplished at various sites during Segment 2 of the Forest Campaign.

### **Oakwood Bottoms Research Summary**

Oakwood Bottoms Greentree Reservoir, located in Jackson County northeast of Grand Tower, Illinois, has been managed since 1964. Pin oaks and scattered cherrybark oaks are flooded during the fall and drained before the onset of the growing season to simulate flooding conditions that would naturally be expected in the Mississippi River bottomlands. Because the Big Muddy River levee prevents natural flooding of this site, flooding is accomplished by pumping water. As a result of tight soils and little drainage relief, the area is primarily a wet forest.

Beginning in 2007 thinning was employed to open the forest canopy on almost 1400 acres of the forest, nearly 17,000 container stock oaks were planted, and prescribed fires were initiated when and where conditions allowed. The thinning is being done within smaller subplots (ranging in size from 1 to 7 acres) within various units of the site and includes the thinning of non-oaks in the understory and overstory within sub-plots. Smaller trees and saplings are cut down while larger non-oak trees are girdled. Fire is also being used in some areas, as conditions and feasibility allow. In combination, this approach provides greater light and less competition for the oak seedlings and saplings present in the understory while leaving the larger non-oaks to serve as snags and cavity trees for use by various wildlife.

*Breeding Bird Survey Data.* A total of 46 species were documented at bird survey points in Oakwood Bottoms. For the purposes of a general summary, bird surveys associated with the different forest management treatment types were grouped together into four simple categories (Table 2). Because there was relatively little forest that received prescribed fire only, conclusions should not be drawn regarding effects of a fire-only treatment based on the data from the 5 survey points established in that type of treatment and presented in Table 2. A

summary of the bird survey results from the 2012 breeding season at Oakwood Bottoms yielded results that strongly support the conclusion that the thinning, and potentially prescribed fire in conjunction with thinning, are having a positive effect on the relative abundance of several species of forest birds (Table 2), particularly when comparing the non-managed areas of forest to those with thinning or thinning + prescribed fire (Figures 1-3). American Goldfinches were not highlighted in Table 2 because they do not breed in the forest. Sixteen species of forest birds showed a strong positive response to the thinning at Oakwood Bottoms (Figures 1-3), including a number of species that are on the SGNC list for Illinois (Red-shouldered Hawk, Red-headed Woodpecker, Yellow-billed Cuckoo, Prothonotary Warbler, Kentucky Warbler, and Yellow-breasted Chat). A number of other species that are known to associate strongly with more-open forest canopies, more-complex (heterogeneous) forest structure, or more-dense shrub layer and ground cover were also more abundant in the forest units where thinning has occurred (Table 2). We eventually hope to tease apart the more subtle relationships between management practices and their effects on forest structure and composition (e.g. thinning alone vs. thinning + prescribed fire), which in turn has the potential to enhance or diminish the abundance of various species of forest birds.

*Cowbird-to-host Ratio.* A concern for breeding forest songbirds when thinning is used to open up the forest canopy is the potential for increased brood parasitism of songbird nests by Brown-headed Cowbirds. Female cowbirds may cue in on or use more heavily areas of the forest where the canopy has been opened up. The more-open overstory may make it easier for female cowbirds to view the nest building and mating activities of potential hosts while the cowbirds are searching for nests to parasitize. This could lead to higher rates of cowbird parasitism in forests that are thinned than those not thinned. In Illinois, the cowbird-to-host ratio (ratio of female cowbirds detected to the available hosts detected) at a given site is a good predictor of what the community-wide parasitism rate is (higher ratio equals more parasitism,

lower ratio equals less). The cowbird-to-host ratio in Oakwood Bottoms (overall ratio is 0.009) is relatively low compared to other forests in southern Illinois. In addition, the cowbird-to-host ratios calculated for the three main categories of forest management at the site (None, Thinning, and Thinning + Prescribed Fire) show that thinning and prescribed fire do not elevate the cowbird-to-host ratio above what it is in the non-managed forest. Therefore, it is likely that the current forest management practices at Oakwood Bottoms will not increase cowbird parasitism.

### **Lake Shelbyville Research Summary**

At the Lake Shelbyville Wildlife Management Area located in east-central Illinois, oak, hickory and hard maple flourish in the uplands. Improvements to the forest which consist of thinning the trees to enhance mast production and understory growth (150 acres in 2008, 370 acres in 2009 and 337 in 2010), nesting cover establishment, prescribed burning, and invasive species eradication (such as bush honeysuckle and autumn olive), are all being implemented on Lake Shelbyville to enhance the overall habitat. The active management on the site, including thinning, prescribed fire, and invasive-exotic plant species eradication, lends itself to obtaining before-after-treatment-control data to better understand the effects of this management on various species of forest birds.

*Breeding Bird Survey Data.* A total of 42 species were documented at bird survey points in the forests at Lake Shelbyville. For the purposes of a general summary, bird surveys associated with the different forest management treatment types were grouped together into two simple categories (Table 3). A summary of the bird survey results from the 2012 breeding season at Lake Shelbyville yielded results that support the conclusion that the thinning had a positive effect on the relative abundance of several species of forest birds (Table 3). Fourteen species of forest birds showed a strong positive response to the thinning at Lake Shelbyville, including a couple of species that are on the SGNC list for Illinois (Northern Flicker and Red-headed Woodpecker). A number of other species that are known to associate strongly with

more-open forest canopies, more-complex (heterogeneous) forest structure, or more-dense shrub layer and ground cover were also more abundant in the forest units where thinning has occurred (Table 3). There were, however, some species from the SGNC list that were more abundant in the non-managed forest than those forests where thinning had occurred (e.g. Kentucky Warbler, Wood Thrush, Acadian Flycatcher; Table 3). This illustrates the importance of collecting several years of data to understand both the immediate and long-term effects of forest management on bird populations. Often there can be an initial (in the year or two after management) negative response of birds to particular forest management practices that become neutral or even positive as years accrue post-management. With additional years of data, we will tease apart the more subtle relationships between management practices and their effects on forest structure and composition and the short- and long-term abundance of various species of forest birds.

### **Cache River Research Summary**

The Cache River Joint Venture Partnership (JVP; TNC, ILDNR, and USFWS) 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 19 years, the JVP has successfully acquired and re-forested 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. The ongoing conservation activities in the Cache River watershed should result in increased densities and increased nesting success for many bottomland forest birds. We are now taking 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 songbirds breeding within a large bottomland forest ecosystem.

The bottomland forests in the Cache River watershed are diverse in tree-species composition, but are predominantly oak-hickory with representation of various other species including elm, ash, maple, hackberry and sycamore. There are also some vast areas of baldcypress and water tupelo that exist in the wetter zones of the watershed. The primary forest management occurring in the watershed has been the acquisition and re-forestation of non-forested land, with the priority being to reduce forest fragmentation by consolidating and connecting existing tracts of bottomland forest. This approach has resulted in there being bottomland forest sites that fall along a gradient from those that have had little or no reforestation in the surrounding landscape to those that have had much re-forestation. We now have the opportunity to document how the degree of re-forestation in the surrounding landscape affects populations of our target species of wildlife in the original tracts of mature forest.

*Cowbird Parasitism.* Nests of various species of breeding birds were found and monitored at the Cache River sites (382 nests), and 539 active Prothonotary Warbler nest boxes were monitored in the Cache River watershed. Collectively, the 1,000 nests of various species found during 2010-2012 along with the 1,200 found during 1993-1995 will be plotted in a GIS program and we will eventually estimate habitat characteristics (e.g. distance to edge, edge density, forest cover within varying distances) for analyses of the effects of land-use configuration (in association with restoration) on rates of nest predation and cowbird parasitism. Qualitatively, the pattern of the past 2 years (2010-2011) of relatively low rates of cowbird parasitism in those study sites surrounded by mostly restored (i.e. reforested) land remained consistent through this most recent year (2012) of data collection supporting the conclusion that re-forestation in the Cache has significantly reduced the problem of cowbird parasitism. Cowbird parasitism has dropped markedly in the study sites since the period 1993-1995 (see Figures 5 and 6).



*Nest Predation.* A preliminary assessment of the data used to determine rates of nest predation for Acadian Flycatchers and the other 6 main species monitored was also completed. With the 2012 data added, overall rate of nest predation for Acadian Flycatchers was 7% lower during 2010-2012 (51%) compared to 1993-1995 (58%) and was lower on 3 of 5 study sites (Figure 7). The overall rate of nest predation for the other 6 species (averaged across species) was 12% lower during 2010-2012 (52%) compared to 1993-1995 (64%) and was lower on 4 of 5 study sites (Figure 8). Similar to, but not as dramatic as, the result with cowbird parasitism, these changes are likely a result of land acquisition and re-forestation that has occurred to more and less of an extent in proximity to the various study sites. Our goal is to eventually be able to determine quantitatively how the changes in land use that have occurred between the early period (1993-1995) and the present have affected the rates of both nest predation and cowbird parasitism.

*Drought Effects.* Finally, we conducted an initial assessment of the 2012 Prothonotary Warbler data to determine if there was an effect of the 2012 drought on productivity (number of warblers fledged from nest boxes) in this species. We compiled data from 12 study sites, each monitored similarly during 2010-2012. We compared the average productivity of 2010-2011 to that of 2012 for each site. Across all 12 study sites, we found that the number of warblers fledged in 2012 was on average **32% lower** than in the previous two years (2010-2011). Productivity of the warblers was lower in 2012 on **all 12** study sites in the comparison (range = 9% to 73% lower). We are now trying to determine how the drought caused this decline (e.g. increased nestling starvation, reduced re-nesting by females, shortened breeding season, food limitation, etc.).

### **Siloam Springs State Park Research Summary**

Siloam Springs State Park and the associated Buckhorn Unit stand out as one of the most heavily forested areas within the relatively non-forested west-central part of Illinois. The

site has over 3,000 acres of land, with much of it consisting of ridge/gully and rolling topography that is primarily wooded. Challenges in implementing timber management, minimal use of prescribed fire, and the influx of invasive-exotic plant species have all contributed to a reduction in the amount of oak-hickory and open woodland habitat present on the site.

There is a lot of potential at Siloam Springs State Park to manage the site more extensively for upland oak-hickory forest, open woodland and savanna habitat, as well as prairie remnants. There are a few areas in the park, particularly in the southern portion to the south of the lake, where thinning and fire are being used to promote open oak woodlands. Our goal at this site was to gather baseline information on breeding birds from survey points distributed throughout the site (over 150 locations surveyed, data still being entered for subsequent analyses; Table 1) to compare to what happens at the site as more areas of the park are actively managed. This site has great potential to showcase a substantial amount of a forest-woodland-savanna-prairie habitat mosaic. We are now poised to document any changes in populations of breeding birds in response to emerging management at the site.

### **Using Forest Birds to Measure Responses to Management**

Breeding forest songbirds in Illinois include more than 50 different species that fall into various guilds (e.g. nesting on the ground, in shrubs, sub-canopy, or canopy; foraging in leaf litter, on bark, on shrub or tree foliage; nesting on or near the ground, in shrubs, or in the canopy; etc.), making them highly responsive to changes in forest structure and composition and, therefore, a great group to monitor in association with various forest management practices. Over 20 of these species are on the list of Species in Greatest Need of Conservation (SGNC) for Illinois. There are additional species of raptors and wading birds that are on the SGNC and also associate with the various types of forest being managed.

There are a number of attributes of forest songbirds that make them particularly well suited for studying responses to forest management. One is that most if not all of these species

are territorial during the breeding season and their territory sizes are typically between 1-3 acres in size. Therefore local forest management activities done at scales of 1, 5, 10, 50, or 100 acres are all highly relevant to these birds that occupy a relatively small area throughout the breeding season. Another attribute of songbirds is that several species are known to return the next breeding season to places where they reproduced successfully, and to move away from those areas where they failed to reproduce. This behavior tends to lead to an increase in densities in the “better” habitats and a decrease in densities in the “poorer” habitats. In this regard, relative densities are a good predictor of habitat quality with densities being highest in the best habitats. These two attributes in combination should make the songbirds highly responsive to the various types of forest management being done, and changes in their densities will tell us whether the forest management is having a positive, negative, or neutral effect on their local populations.

There is a large body of literature associated with the effects of habitat loss and fragmentation (forest loss and fragmentation here) on populations of breeding forest songbirds. In general, species diversity and the densities of some “area sensitive” species tend to decrease with decreasing forest tract size. In addition, rates of nest predation and cowbird parasitism tend to be higher in small tracts of forest and in landscapes where the forests are more highly fragmented by permanent non-forest land uses. These patterns have been well documented in Midwestern forests. Forests with a mosaic of habitat (e.g. forests where disturbance – either natural or management related – creates structural and compositional complexity) tend to have higher songbird species diversity than a similarly-sized forest lacking disturbance. In addition, disturbances within the forest, as long as they do not remain non-forest permanently, tend to have little or no long-term negative effect on rates of nest predation and cowbird parasitism.

Much of what we know about habitat requirements and habitat use in songbirds comes from observational studies documenting attributes of the forest where songbirds set up their territories. This has led to recommendations to manage forests for songbirds by achieving a

particular tree species composition or vegetation structure and complexity, but the actual responses of the songbirds to the management have usually not been measured. There have been some studies that have documented songbird responses to various kinds of silvicultural practices, but relatively few have had a research design that included a before-after-treatment-control approach. The data on songbird responses to different types of forest management (e.g. prescribed fire, thinning, re-forestation, etc.) being collected as part of the Forests and Woodlands Campaign will add valuable and much needed information to the vast songbird literature. In addition, in the next few years we hope to determine which species of songbirds respond positively to forest management in parallel with positive responses of wild turkeys to the same management. In this way, there may be several species of breeding forest songbirds that could serve as indicators of higher and lower quality forest habitat for wild turkeys.

### **Additional Locations to Monitor Wildlife Responses to Forest Management**

Monitoring will continue with Segment 3 of the Forest Campaign at four additional sites in Illinois. These additional sites were selected based on the potential for there to be, at each site, multiple units or plots that are going to be or are being managed (treatments) as well as areas that are not being managed (controls). A goal is to have, at each location, a number of replicates each of treatment and control areas. The additional sites include Trail of Tears State Forest (management activities being planned), Hidden Springs State Forest (management activities underway sponsored in part by the National Wild Turkey Federation), three forests in the Lake County Forest Preserve system (management activities underway: various amounts of thinning and understory removal), and portions of the eastern Shawnee National Forest (management activities being planned). These areas all have the capacity for the establishment of programs monitoring wildlife responses to forest management (i.e. a before-after-treatment-control monitoring protocol).

In addition, all of these various sites are situated in landscapes dominated by or containing a fair amount of non-forest land-use. As such, the relative amounts of forest in the surrounding landscape can vary considerably from site to site. This provides us with the potential to look at not only local effects (e.g. considering land-use within a 1-km radius) of habitat fragmentation on populations of our target species, but also the effects of habitat fragmentation at larger spatial scales (e.g. 5-km radius, 10-km radius). In order to maximize the effectiveness of our monitoring protocols, we will work closely and continue to communicate regularly with site managers and staff, biologists, and foresters associated with these locations.

### **Additional Monitoring Techniques Added in Segment 3**

*Turkey Call Playback Surveys.* Surveys will take place during early spring and early summer, and will begin each day a half-hour before sunrise and go until mid- to late-morning. At each predetermined survey point, observers will stand for 10 minutes. During the first 3 minutes observers will quietly listen and look for any sign of the presence of turkeys, will then broadcast gobble calls via an MP3-player/speaker system for the next 2 minutes, and will then listen and look for the presence of turkeys for the remaining 5 minutes. The wild turkey surveys will not interfere with turkey hunters or turkey hunting seasons. Likely locations for turkey-call surveys include Oakwood Bottoms, Lake Shelbyville, and Hidden Springs State Forest.

*Game/Trail Camera Deployment.* Game/trail cameras (6-10) will be deployed at various locations in different forest management units where there is a clear line of sight for 75-150 feet. The cameras are mounted on trees, locked in place with a cable, and a sign hung with each one describing that they are for university research (with researcher contact information provided). Cameras are weatherproof and will be set up to take color images once every 5-6 seconds during daylight hours, and will be programmed to also take 20 images (1 image per second for 20 seconds) each time the heat-sensing mechanism is triggered (usually medium- to large-sized mammals are responsible for this). These cameras will be able to detect the presence of large

birds (e.g. wild turkeys) and medium- to large-sized mammals walking across the line of sight of the camera. We will use the number of detections of various animals (controlling for effort) as an index of “activity” or “use” of various forest management regimes at each study area. Each camera deployment will be for 3-5 days (typical rechargeable battery and memory card capacity for camera) and then batteries and memory card will be changed out and camera moved to a new location. Likely locations for camera deployment include Oakwood Bottoms, Lake Shelbyville, and Hidden Springs.

### **Establishment of Demonstration Sites**

Oakwood Bottoms has an ongoing forest management plan involving fire and thinning to promote oak regeneration and a return to an oak-dominated forest composition. Oakwood Bottoms also has multiple units or plots that are going to be or are being managed (treatments) and also has areas that are not being managed (controls), allowing for a true assessment of how the management is affecting both the forest and wildlife. The Lake County Forest Preserve forests are highly accessible to hundreds of thousands of people, are also being managed with thinning and fire, but the management units are much smaller in size than Oakwood Bottoms. The Cache River Joint Venture site possesses areas where there has been much, little, or no re-forestation, again providing for comparisons that allow assessment of how this approach to managing bottomland forests, with an emphasis on “unfragmenting” the forests, affects wildlife. All three of these locations are excellent candidates for demonstration areas.

Ultimately, our goal for the Forests and Woodlands Campaign in Illinois is to contribute substantially to the growing body of research associated with the effects of forest management on populations of wildlife, and to use the data collected in Illinois to reinforce existing or establish new approaches to forest management that are applicable to forests throughout Illinois and other states in the Midwest.

Table 1. Study sites, management units, and number of points surveyed during Segment 2 of the Forest Campaign.

Location	Management	Points Surveyed	Replicates
Oakwood Bottoms (Shawnee National Forest)	No Management	20	2
	Rx Fire Only (2010)	5	2
	Thinning (2007)	6	2
	Thinning (2008)	5	2
	Thinning (2009)	5	2
	Thinning (2010)	20	2
	Thinning (2011)	20	2
	Thinning (2011) + Rx Fire (2010)	10	2
	Thinning (2011) + Rx Fire (2011)	20	2
	Thinning (2012) + Rx Fire (2010)	10	2
Lake Shelbyville (Army Corps Land)	No Management	20	2
	Rx Fire Only	20	2
	Thinning 2008	15	2
	Thinning 2008 + Rx Fire	15	2
	Thinning 2009	20	2
	Thinning 2009 + Rx Fire	20	2
	Thinning 2010	20	2
Siloam Springs State Park (and Buckhorn Unit)	Pending	150	2

Table 2. Results of bird surveys completed during the 2012 breeding season at Oakwood Bottoms forest management area in the Shawnee National Forest. Species ranked from least to most abundant based on total point counts.

Species code	Species*	Number per 100-m radius point				TOTAL (n=121)
		Management (general)				
		None (n=20)	Rx Fire Only (n=5)	Thinning** (n=56)	Thinning + Rx (n=40)	
BAOR	Baltimore Oriole	0.00	0.00	0.00	0.03	0.01
BEVI	<b><i>Bell's Vireo</i></b>	0.00	0.00	0.00	0.03	0.01
EABL	Eastern Bluebird	0.00	0.00	0.00	0.03	0.01
EAPH	Eastern Phoebe	0.00	0.00	0.02	0.00	0.01
FISP	<b><i>Field Sparrow</i></b>	0.00	0.00	0.02	0.00	0.01
GBHE	Great Blue Heron	0.05	0.00	0.00	0.00	0.01
RTHA	Red-tailed Hawk	0.00	0.00	0.02	0.00	0.01
WAVI	Warbling Vireo	0.05	0.00	0.00	0.00	0.01
WOTH	<b><i>Wood Thrush</i></b>	0.05	0.00	0.00	0.00	0.01
GREG	Great Egret	0.00	0.00	0.00	0.05	0.02
HAWO	Hairy Woodpecker	0.05	0.00	0.04	0.00	0.02
CEWX	Cedar Waxwing	0.00	0.00	0.00	0.10	0.03
BLJA	Blue Jay	0.00	0.00	0.07	0.03	0.04
AMRE	American Redstart	0.00	0.00	0.11	0.00	0.05
RSHA	<b><i>Red-shouldered Hawk</i></b>	0.00	0.00	0.04	0.13	0.06
AMCR	American Crow	0.10	0.00	0.09	0.03	0.07
YTWA	Yellow-throated Warbler	0.00	0.00	0.14	0.00	0.07
FICR	Fish Crow	0.05	0.00	0.14	0.00	0.07
RHWO	<b><i>Red-headed Woodpecker</i></b>	0.00	0.00	0.11	0.15	0.10
PIWO	Pileated Woodpecker	0.05	0.20	0.13	0.13	0.12
SUTA	Summer Tanager	0.20	0.00	0.18	0.10	0.15
YBCU	<b><i>Yellow-billed Cuckoo</i></b>	0.20	0.40	0.32	0.33	0.31
BHCO	Brown-headed Cowbird	0.30	0.00	0.32	0.40	0.33
RTHU	Ruby-throated Hummingbird	0.30	0.20	0.39	0.28	0.33
RBWO	Red-bellied Woodpecker	0.35	0.00	0.39	0.35	0.36
RSTO	Rufous-sided Towhee	0.00	0.00	0.68	0.25	0.40
AMGO	American Goldfinch	0.15	0.80	0.41	0.50	0.41
PROW	<b><i>Prothonotary Warbler</i></b>	0.10	0.00	0.73	0.30	0.45
YBCH	<b><i>Yellow-breasted Chat</i></b>	0.00	0.00	0.43	0.83	0.47
REVI	Red-eyed Vireo	0.85	0.00	0.55	0.30	0.50
GCFL	Great Crested Flycatcher	0.00	0.00	0.64	0.70	0.53
KEWA	<b><i>Kentucky Warbler</i></b>	0.35	0.00	0.82	0.48	0.60
WBNU	White-breasted Nuthatch	0.50	0.00	0.66	0.90	0.69
CACH	Carolina Chickadee	0.85	0.00	0.86	0.65	0.75
EWPE	Eastern Wood Peewee	0.45	0.20	0.71	1.05	0.76
YTVI	Yellow-throated Vireo	0.25	1.00	0.98	0.88	0.83
NOCA	Northern Cardinal	0.85	0.00	1.07	0.73	0.88
DOWO	Downy Woodpecker	0.90	0.40	1.02	0.93	0.94
TUTI	Tufted Titmouse	1.40	0.60	1.05	0.93	1.05
CARW	Carolina Wren	0.90	0.80	1.25	1.18	1.08
NOPA	Northern Parula	0.65	1.80	1.48	1.13	1.24
COYE	Common Yellowthroat	0.30	2.40	1.34	1.75	1.35
WEVI	White-eyed Vireo	0.95	0.00	1.77	1.13	1.35
BGGN	Blue-gray Gnatcatcher	1.85	0.40	1.89	1.60	1.73
INBU	Indigo Bunting	1.40	4.00	2.18	2.45	2.21
ACFL	<b><i>Acadian Flycatcher</i></b>	2.85	1.80	3.02	2.68	2.83

\* Species on the Species in Greatest Need of Conservation (SGNC) list are given in bold and italics.

\*\* Thinning refers to thinning out some trees in some areas (1-7 acres) within forested units by cutting down small non-oak trees and girdling larger non-oak trees.

= species that were less abundant overall but responded positively to forest management.

= species that were more abundant overall and responded positively to forest management.



Table 3. Results of bird surveys completed during the 2012 breeding season at Lake Shelbyville forest management area run by the Army Corps of Engineers. Species ranked from least to most abundant based on total point counts.

Species code	Species*	Number per 100-m radius point		
		Management (general)		TOTAL (n=110)
		None (n=20)	Some Thinning** (n=55)	
EABL	Eastern Bluebird	0.00	0.05	0.03
PROW	<b><i>Prothonotary Warbler</i></b>	0.08	0.00	0.03
RSTO	Rufous-sided Towhee	0.08	0.00	0.03
RWBB	Red-winged Blackbird	0.00	0.05	0.03
SCTA	Scarlet Tanager	0.08	0.00	0.03
SOSP	Song Sparrow	0.00	0.05	0.03
TRSW	Tree Swallow	0.00	0.05	0.03
WAVI	Warbling Vireo	0.00	0.05	0.03
COGR	Common Grackle	0.00	0.10	0.06
FISP	<b><i>Field Sparrow</i></b>	0.00	0.10	0.06
MODO	Mourning Dove	0.17	0.00	0.06
OVEN	<b><i>Ovenbird</i></b>	0.08	0.05	0.06
YTWA	Yellow-throated Warbler	0.08	0.05	0.06
PIWO	Pileated Woodpecker	0.17	0.05	0.09
BAOR	Baltimore Oriole	0.00	0.20	0.13
HAWO	Hairy Woodpecker	0.08	0.15	0.13
NOPA	Northern Parula	0.33	0.00	0.13
KEWA	<b><i>Kentucky Warbler</i></b>	0.33	0.05	0.16
AMGO	American Goldfinch	0.42	0.05	0.19
NOFL	<b><i>Northern Flicker</i></b>	0.08	0.25	0.19
REVI	Red-eyed Vireo	0.33	0.10	0.19
AMCR	American Crow	0.50	0.05	0.22
CARW	Carolina Wren	0.50	0.05	0.22
RHWO	<b><i>Red-headed Woodpecker</i></b>	0.08	0.35	0.25
RTHU	Ruby-throated Hummingbird	0.33	0.20	0.25
WOTH	<b><i>Wood Thrush</i></b>	0.75	0.00	0.28
YTVI	Yellow-throated Vireo	0.25	0.45	0.38
BHCO	Brown-headed Cowbird	0.58	0.45	0.50
SUTA	Summer Tanager	0.25	0.65	0.50
RBWO	Red-bellied Woodpecker	0.25	0.80	0.59
ACFL	<b><i>Acadian Flycatcher</i></b>	1.08	0.40	0.66
DOWO	Downy Woodpecker	0.50	1.00	0.81
BLJA	Blue Jay	0.92	0.90	0.91
NOCA	Northern Cardinal	1.50	0.55	0.91
INBU	Indigo Bunting	1.58	0.60	0.97
GCFL	Great Crested Flycatcher	0.33	1.45	1.03
BGGN	Blue-gray Gnatcatcher	1.50	0.85	1.09
CACH	Carolina Chickadee	0.83	1.30	1.13
EWPE	Eastern Wood Peewee	0.83	1.65	1.34
WBNU	White-breasted Nuthatch	0.75	1.70	1.34
AMRO	American Robin	1.00	1.60	1.38
TUTI	Tufted Titmouse	0.83	1.80	1.44

\* Species on the Species in Greatest Need of Conservation (SGNC) list are given in bold and italics.

\*\* Thinning refers to cutting down some small non-oak trees and girdling some larger non-oak trees in order to increase the openness of the canopy.

= species that were less abundant overall but responded positively to forest management.

= species that were more abundant overall and responded positively to forest management.

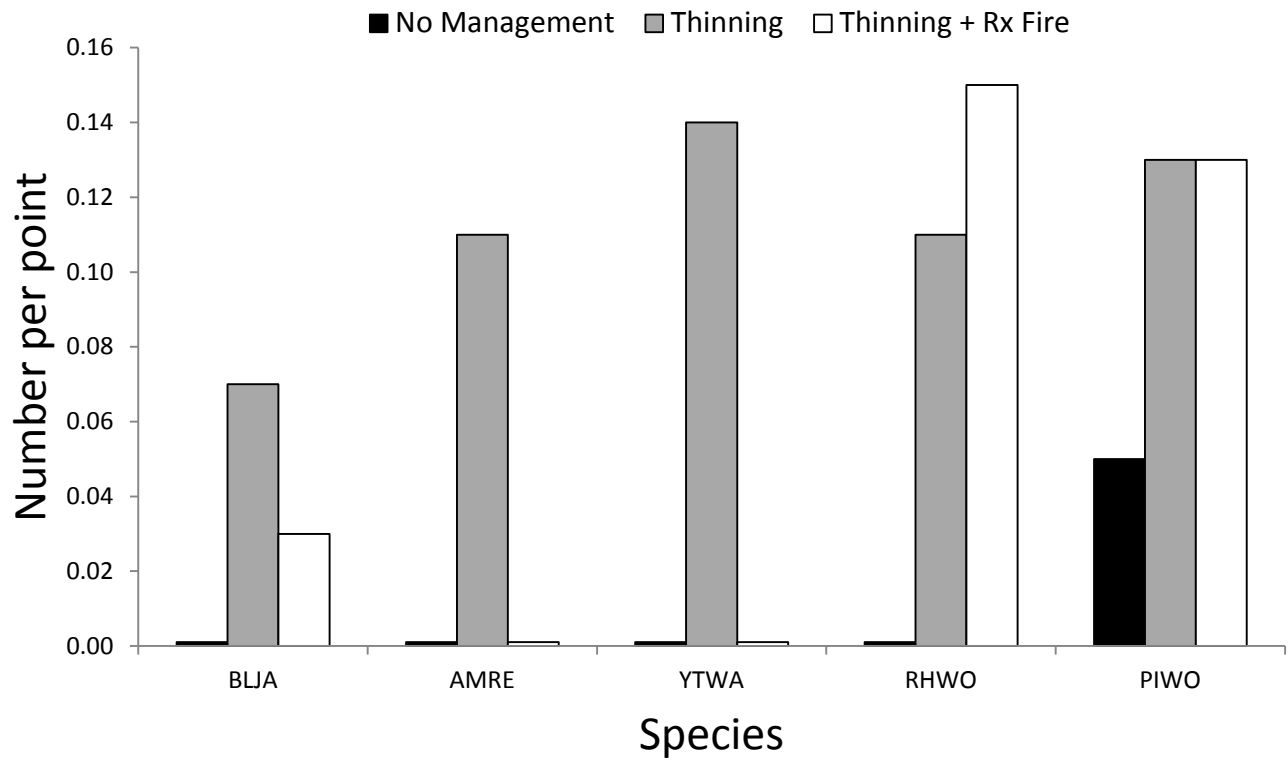


Figure 1. Relative abundance (number of individuals observed per 100-m-radius survey point) of various bird species at **Oakwood Bottoms** during the 2012 breeding season in forests that have experienced different types of management. Species codes are given in Table 1.

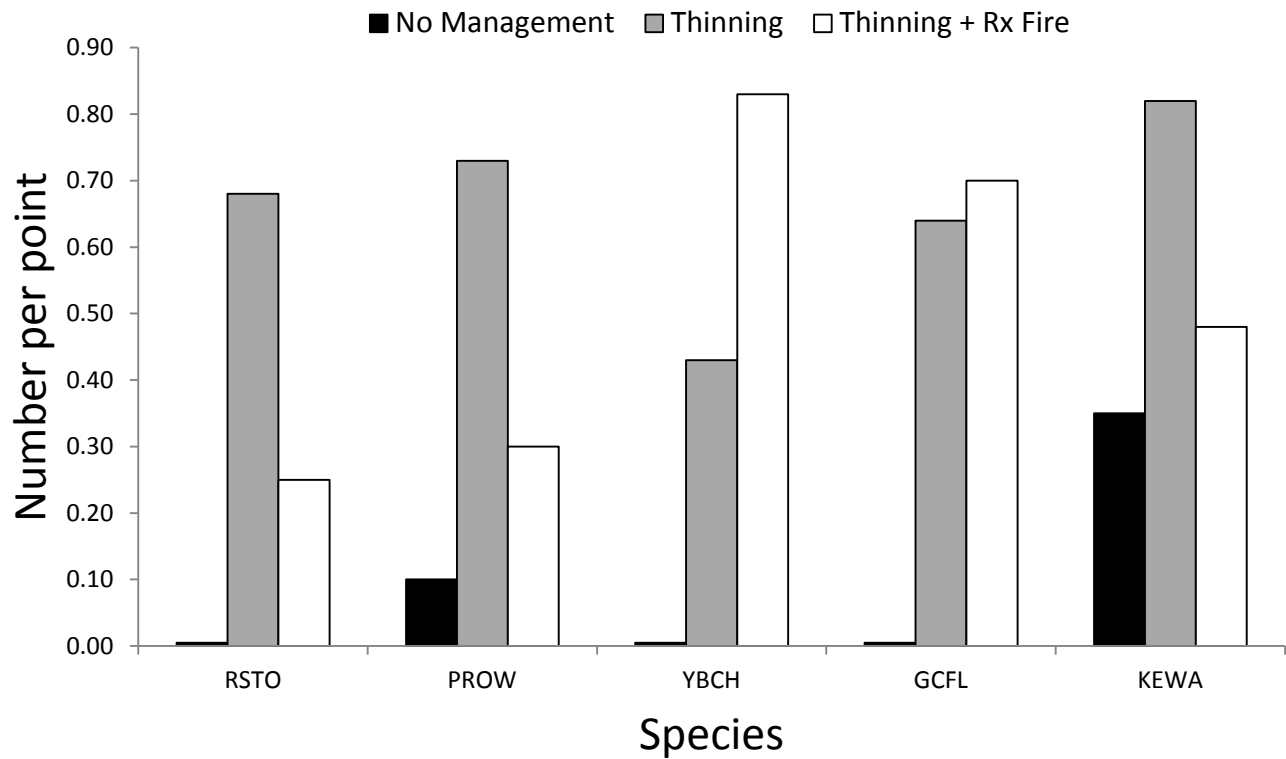


Figure 2. Relative abundance (number of individuals observed per 100-m-radius survey point) of various bird species at **Oakwood Bottoms** during the 2012 breeding season in forests that have experienced different types of management. Species codes are given in Table 1.

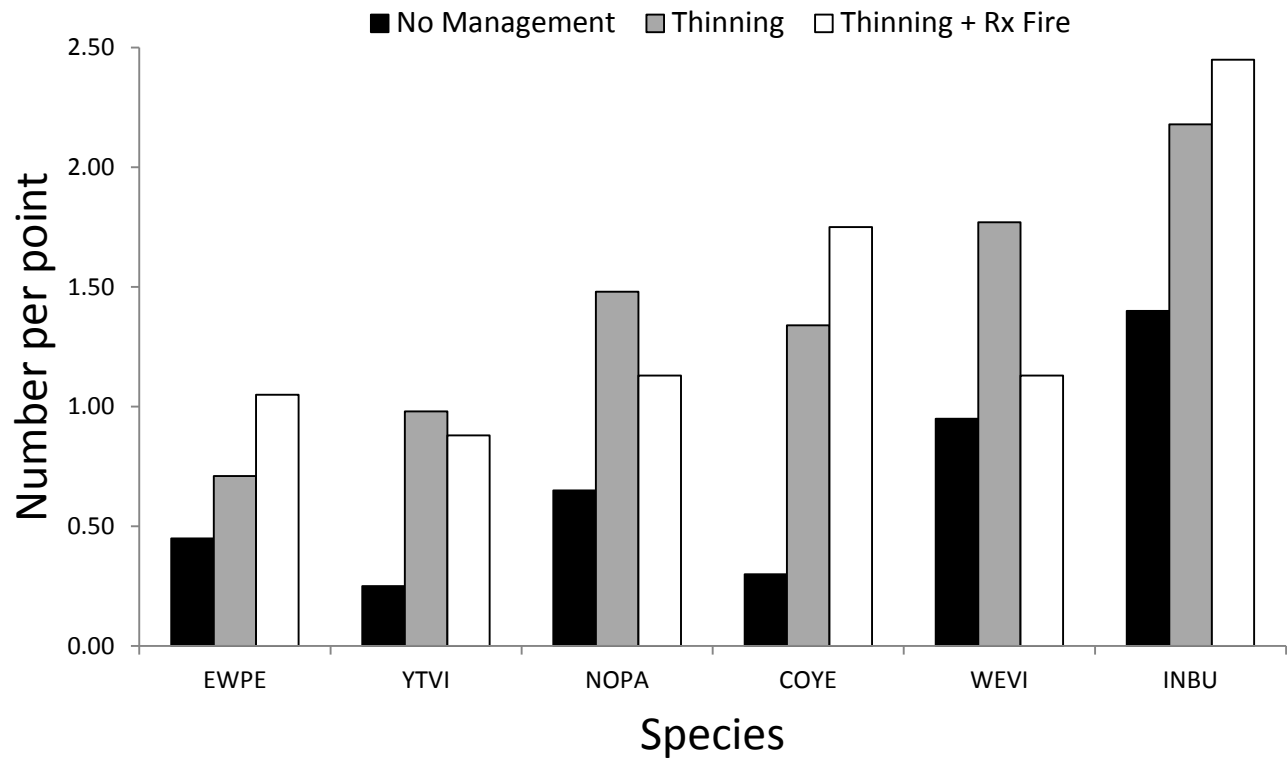


Figure 3. Relative abundance (number of individuals observed per 100-m-radius survey point) of various bird species at **Oakwood Bottoms** during the 2012 breeding season in forests that have experienced different types of management. Species codes are given in Table 1.

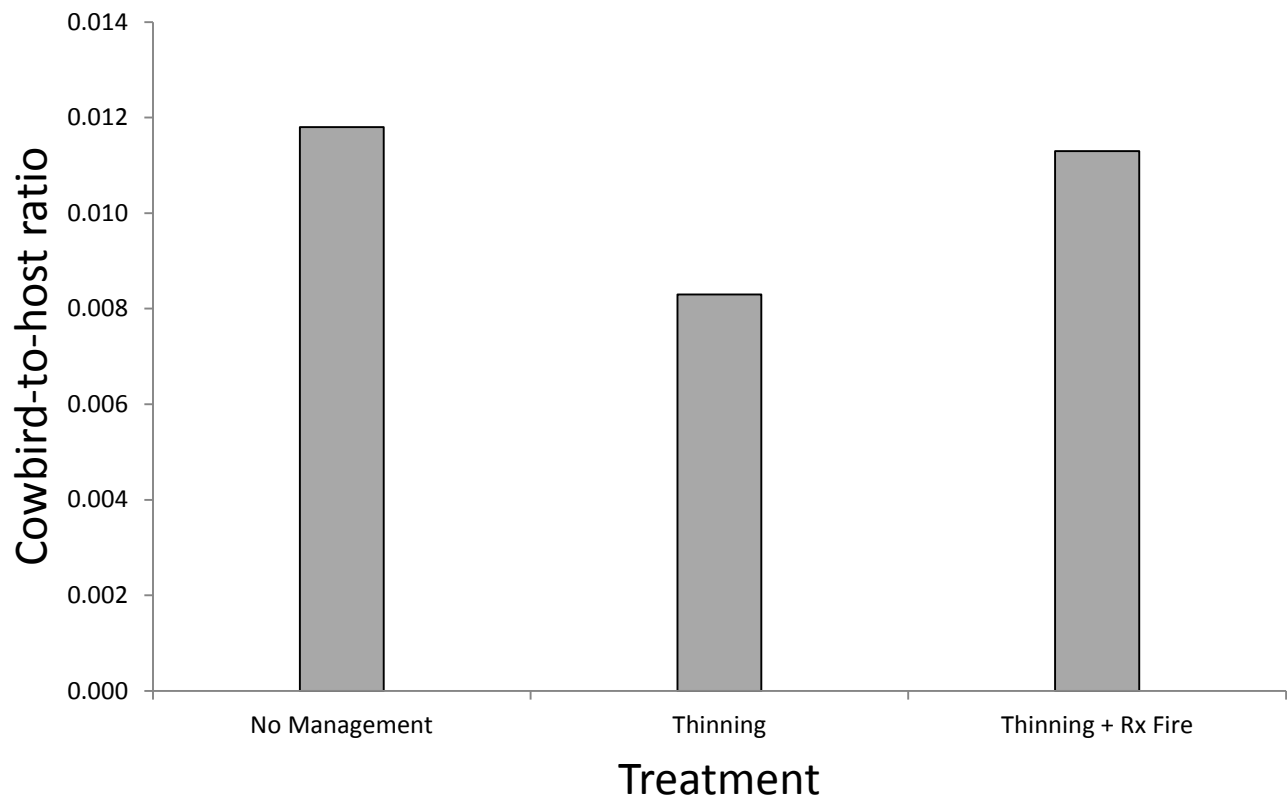


Figure 4. Cowbird-to-host ratio at **Oakwood Bottoms** during the 2012 breeding season in forests that have experienced different types of management. Ratio calculated by dividing the number of female cowbirds heard or seen per survey point by the number of “good” hosts per survey point within the different treatment groups.

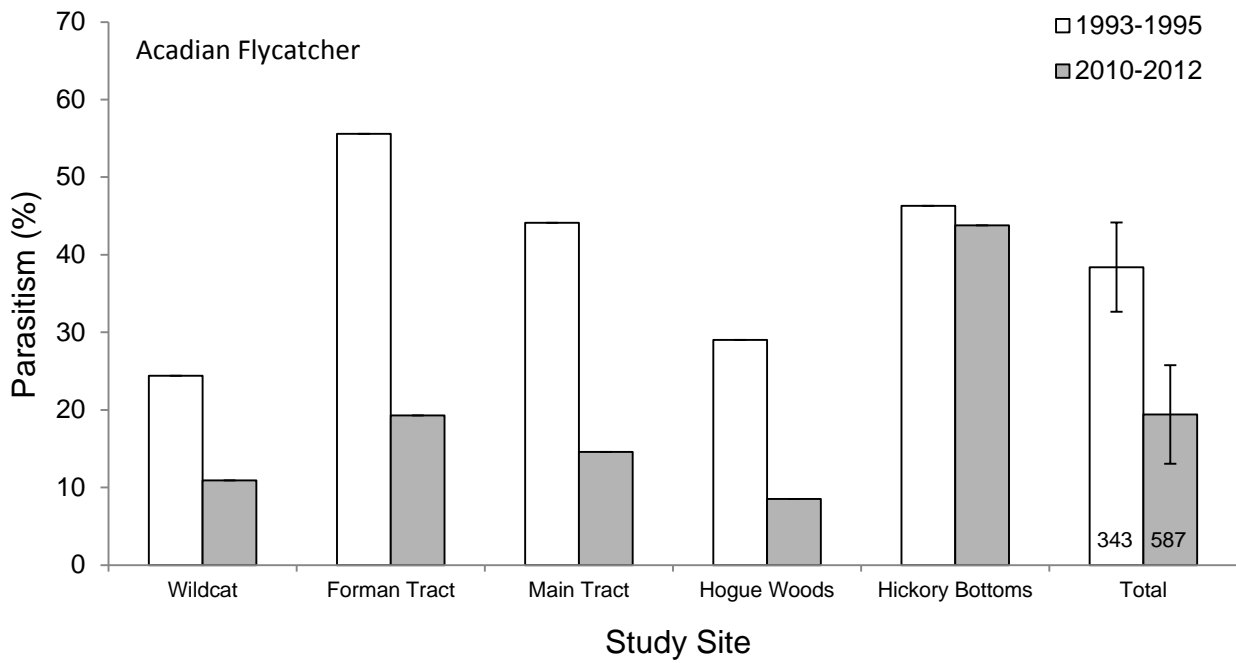


Figure 5. Rates of **cowbird parasitism** for Acadian Flycatchers nesting in the **Cache River** watershed during 1993-1995 and 2010-2012. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total number of nests during each time period given inside of bars in the “Total” category. Hickory Bottoms site has had the least reforestation adjacent to it.

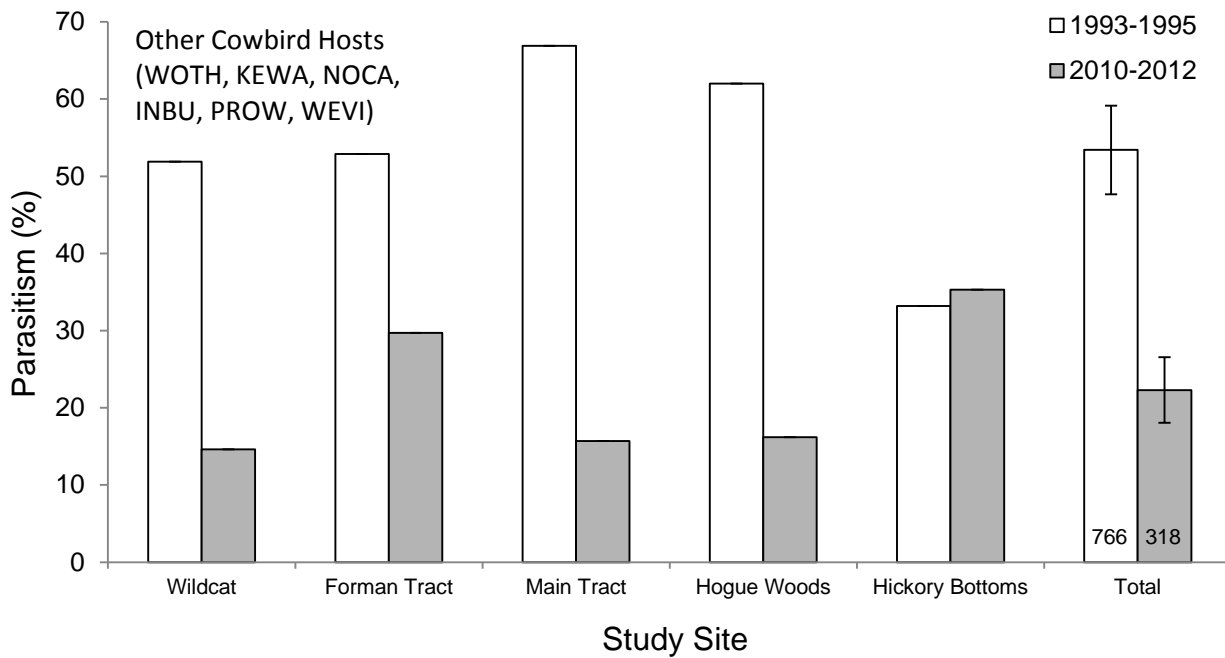


Figure 6. Rates of **cowbird parasitism** for other cowbird hosts nesting in the **Cache River** watershed during 1993-1995 and 2010-2012. Other hosts include Wood Thrush, Kentucky Warbler, Northern Cardinal, Indigo Bunting, Prothonotary Warbler, and White-eyed Vireo. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total number of nests during each time period given inside of bars in the “Total” category. Hickory Bottoms site has had the least reforestation adjacent to it.

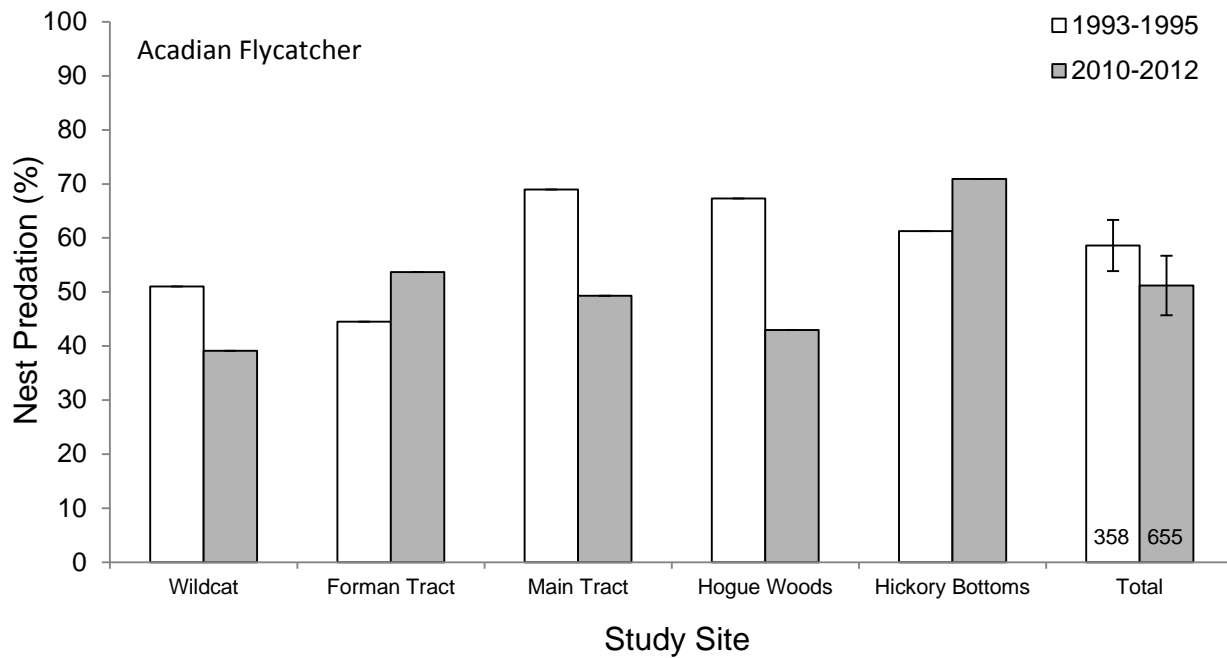


Figure 7. Rates of **nest predation** for Acadian Flycatchers nesting in the **Cache River** watershed during 1993-1995 and 2010-2012. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total number of nests during each time period given inside of bars in the “Total” category. Hickory Bottoms site has had the least reforestation adjacent to it.



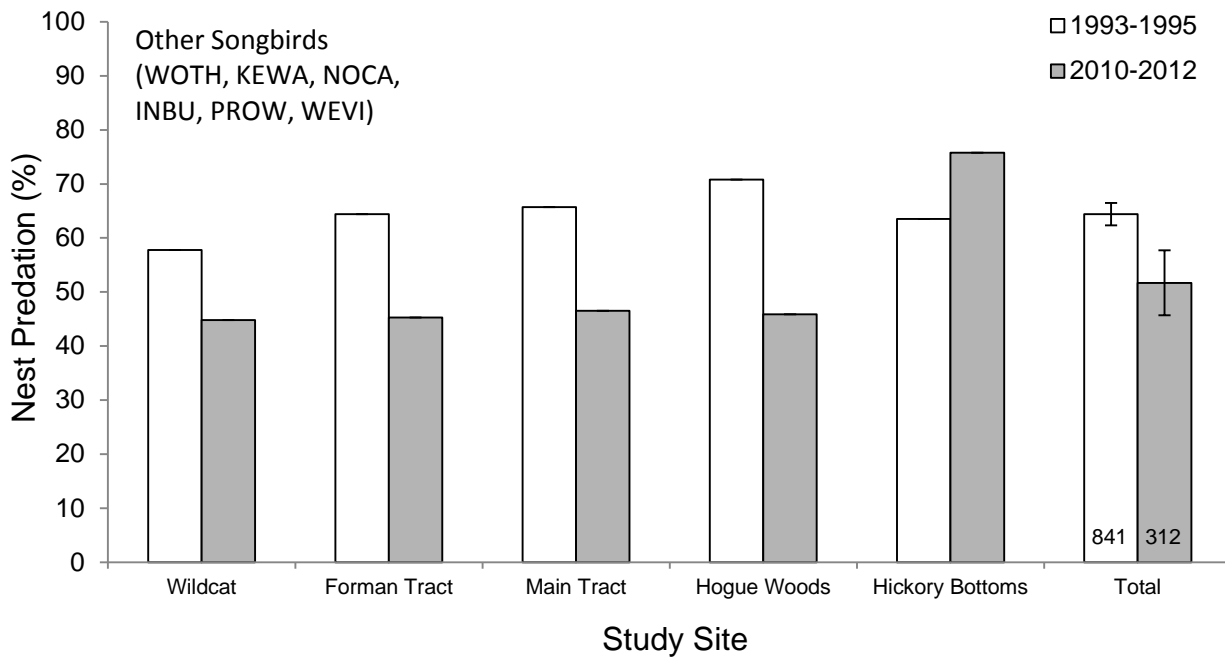


Figure 8. Rates of **nest predation** for other songbirds nesting in the **Cache River** watershed during 1993-1995 and 2010-2012. Other songbirds include Wood Thrush, Kentucky Warbler, Northern Cardinal, Indigo Bunting, Prothonotary Warbler, and White-eyed Vireo. Rates for each site are averaged across years. Values for total nests within each time period ( $\pm 1SE$ ) are averaged across sites. Total number of nests during each time period given inside of bars in the “Total” category. Hickory Bottoms site has had the least reforestation adjacent to it.