Spring 5-10-2013

Trends in Avian Populations of Kentucky and Implications in Conservation

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TRENDS IN AVIAN POPULATIONS OF KENTUCKY AND IMPLICATIONS IN CONSERVATION

A Capstone Experience/Thesis Project

Presented in Partial Fulfillment of the Requirements for

the Degree Bachelor of Science with

Honors College Graduate Distinction at Western Kentucky University

By

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Western Kentucky University
2013

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ABSTRACT

The North American Breeding Bird Survey (BBS) and other avian monitoring projects have been used as evidence that many bird species are declining. Two guilds which have seen major declines are the grassland obligate and woodland species (Wentworth et al 2010; Peterjohn and Sauer 1994). Some species have been experiencing an increase, including the Brown-headed Cowbird; a brood-parasite which can cause decreased fitness in host species (Brittingham and Temple 1983). BBS data collected in Kentucky from 1998-2011 was used for statistical analysis for this project. This data was used to answer 4 questions. The first was did the Kentucky Upper Green River Watershed Conservation Reserve Enhancement Program (UGRW CREP) have a significant effect on any common grassland or grassland obligate species? We found no species showing any significant change in populations overtime due to the instillation of CREP. The second question was directed at determining if any species show a preference for deep forest, mixed, or agricultural land cover type? Species showing a significant preference for a certain of cover type were the Pileated woodpecker (p=0.031), Wood Thrush (p=0.001), Red-Eyed Vireo (p=0.0001), Kentucky Warbler (p=0.039), Acadian Flycatcher (p=0.021), Eastern Wood Peewee (p=0.025), Worm-eating Warbler (p=0.015), and the American Redstart (p=0.029). The last part of this study was to see if any species had a preference for routes with high, medium, or low Brown-headed

Cowbird counts. Species who's populations showed a significant relationship to Brown-headed Cowbird densities included the American Robin (p=0.01), the Wood Thrush (p=0.023), the Field Sparrow (p=0.0001), the Ruby-throated Hummingbird (p=0.003), and the Brown Thrasher (p=0.01).

Key terms: Grassland obligates, CREP, Brown-headed Cowbird, Woodland Species, BBS

DEDICATION

To my advisor, Dr. Albert Meier, for your patience, guidance, acceptance, and humor. Thank you for your advocacy of women in science and for your passion for your student's success. Thank you for helping me to see the world isn't such a big place after all.

To my family for your collective encouragement and devotion. To my Mother and Father, for the unconditional love and support you have given to me my entire life. Thank you for showing me the trees, for always answering my questions, and for giving me a sense of importance and responsibility. If am anything today, it is because of you.

To my Brother and Sister, for sharing a childhood in the woods and for allowing me to learn from your experiences, you will always be my best friends.

Lastly, to Mr. Wayne Mason, the kindest man I have ever had the pleasure of knowing. Thank you so much for all your years as a professor at Western Kentucky University. You have educated, entertained, and inspired the next generation of biologist and the entire WKU community will always owe you their collective gratitude. Thank you so much for teaching me about the birds and sharing your passion with your students. You will always be dearly loved by me, and undoubtedly all you past students.

ACKNOWLEGDEMENTS

I would like to extend my gratitude to my committee for their assistance in completing this process. Thank you all for your patience and willingness to help. Thank you to Dr. Albert Meier for helping me re-learn statistics and for your willingness to meet and talk to me about this project. Thank you to Mr. Wayne Mason for graciously agreeing to take on the responsibility of second reader in his last semester before retirement. Thank you to Dr. Courte Van Voorhees for you helpful feedback and critiques.

I would also like to thank the North American Breeding Bird Survey for providing the avian monitoring data for this project. Thank you to Victoria Gilkerson for all your hard work accessing the BBS database and rearranging datasets for part of my study. Thank you to Rachel Wigginton for helping me brainstorm and for your assistance with the statistics software and methods.

I would also like to thank all of the friends who offered me support through this trying process—Joseph Gunning, Samantha Jaquay, Morgan Button, and Holly Thompson. Thank you all so much for your love, support, pep-talks, and perspective; I am so lucky.

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FIELD OF STUDY

Major Field: Biology

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CHAPTER ONE

INTRODUCTION

The decline in avian populations across the world has been of concern to conservationists since the 1960s (Robbins et al. 1989). According to the National Audubon Society's 2009 'State of the Birds' report, of the approximate 800 avian species in the United States, 67 are listed as federally endangered or threatened, and 184 are species of conservation concern. The cause for this major decline has been the subject of much research in the last 4 decades. The most cited contributing factors to this decline have been loss of habitat to agriculture, deforestation, and urban sprawl, as well as the introduction and success of invasive species (Murphy 2003; Temple and Clay 1988). Additionally, over hunting has lead to the decline and extinction of multiple avian species including the Carolina Parakeet and the Passenger Pigeon (. Two avian guilds which are of particular concern to Kentucky conservation are grassland obligates, who utilize the small amount of grassland left in the state, and forest interior dwellers who use large forested areas as breeding sites.

Grassland Obligates

It has been argued that no group of bird species has been more negatively impacted than grassland obligate species, which have seen the most substantial decline in North America (Wentworth et al. 2010; McCoy et al 1999). According to data analyzed from the Breeding Bird Survey, more breeding bird species are in decline than increasing in the Northern Prairies (Droege and Sauer 1994). This decline is due to many factors, but none is as detrimental as the huge loss of native grass land habitats, caused by rural development, fire suppression, agriculture and general environmental degradation (McCoy et al. 1999; Gill et al. 2006). Since the settlement of North America by Europeans in the late 15th century, there has been a drastic decline in the native prairies that once dominated Midwestern states. Before European settlement there were approximately 94 million acres of tallgrass prairie; this has been reduced by 83 to greater than 99% in tallgrass prairies of Midwestern states (Ryan 2000). The body of research concentrating on the degradation and loss of the prairie in the Midwest and Great Plains is extremely extensive, with much less research effort going towards the tall-grass prairies and barrens of the eastern United States.

One specific region of conservation concern in the eastern U.S. is the Kentucky Karst Plain which contains the region known as the 'Big Barrens' (Baskin et al. 1999). This area historically supported barren ecosystems; barrens are open, deep-soil grasslands, scattered with small trees and shrubs, with interspersed groves of trees (Baskin et al. 1999). This region was one of the largest barren ecosystems at the time of European settlement with only about 15,000 square kilometers remaining, none of which is original pre-settlement barrens (Heikens and Robertson 1994; Baskin et al. 1999).)

The formation of this area has been suggested to be due to many transitions between grasslands and forests; an alternate hypothesis is that this area was formed during an extreme drought (Heikens and Robertson 1994). However, a more likely hypothesis is that this region is an extension of the prairies of the Midwest due to natural occurring and Native American set fires (Heikens and Robertson 1994; Baskin et al.

1999; Guyette et al. 2003). The vast fire suppression which has taken place since European settlement has caused succession of these barrens to forests, causing most of this land to be either agricultural land or successional forests (Heikens and Robertson 1994; Guyette et al. 2003).

Though the huge losses in native barrens can never be reversed, one initiative concerned with restoring degraded habitats may be a large contributor to the success of reestablishing native grasslands in North America. The Conservation Restoration Program, hereafter CRP, is a provision of the 1985 Food Security Act which paid farmers to retire highly erodible cropland from agriculture production to plant native vegetation. (Best et al. 1997) The goal of this was to bring supply and demand for crop supplies to be more in line while compensating farmers and conserving soil and water in sensitive areas (Best et al. 1997). Restoring habitat for wildlife was a secondary goal. (Johnson et al. 1995). The Conservation Reserve Enhancement Program, CREP, is an initiative built upon the success of CRP. CREP is an option within CRP which concentrates on conserving and restoring ecologically sensitive areas. Most agriculture land is eligible for CRP, but most areas eligible for CREP are on highly erodible land within 1000 feet of any qualifying body of water, or are suitable for wetland restoration (Maryland CREP 2009). Landowners may be provided with higher rental rates and added monetary incentives under CREP as opposed to CRP (Maryland CREP 2009).

The Kentucky Green River Conservation Reserve Enhancement Program is a project to restore up to 99,500 acres in south central Kentucky's Green River Watershed. The Kentucky UGRW CREP was an initiative proposed in 2000 and began in 2001, with approximately 24,000 acres participating by 2007 (Sole 2005). This specific area CREP is intended to protect is Mammoth Cave National Park and the biologically diverse Green River. The goals of the Kentucky Green River Watershed CREP are to reduce pollutants entering the Green River and Mammoth Cave System, protect the wildlife in the area, and restore riparian and subterranean ecosystems (USDA 2007). The replanting of native grasses is often a critical part in any plan to reduce erosion, and plays the dual role of replenishing Kentucky diminishing grasslands habitats.

Grassland birds are the most rapidly declining avian guild within North America, monitoring their populations is of ever growing concern (Wentworth 2010). An analysis of population trends based on BBS data found that only 3 of 28 grassland species increased significantly from 1966-2002, while 17 of those species decreased (Sauer et al. 2003). For many species, the cause of this decline is due to human activity destroying their breeding, migrating, and wintering habitat.

Forest-Dwellers

An additional threat to the health of song bird populations is fragmentation of once-continuous deciduous forests (Brittingham and Temple 1983; Temple and Clay 1988). Species which have been most affected by this are the forest-dwelling songbirds which are specialized in forest breeding including many warblers, thrushes, and flycatchers (Ambuel and Temple 1982). These species breed in mainly deciduous forests characterized by Northern red oak, chestnut oak, red maple, and hickory. They then migrate great distances to over-winter in the tropics, another thoroughly degraded ecosystem (Robbins et al. 1989).

As forests shrink, these forest interior birds are subject to many more stressors such as closer proximity to residential areas, which bring threats such as communication towers and feral cats. Deforestation, both in the eastern deciduous forests and in the neotropical wintering grounds, has been suggested to be one of the main stressors on bird populations breeding in the eastern U.S.(Ambuel and Temple 1983; Keast and Morton 1980). In addition to these stressors, more edge and open forests cause these birds to be at a greater risk of nest parasitism by species such as the Brown-headed Cowbird (Temple and Clay 1988).

Brown-headed Cowbird

An additional concern to healthy populations of many North American migrant birds is brood parasitism. The Brown-headed Cowbird originated in the Great Plains, but since the 1900s, has increased its habitat to include areas further east and west (Shaffer et al. 2003). Cowbirds were once located mainly west of the Mississippi River, because they are tied to open habitat. With the clearing of once unbroken forest, cowbirds began to increase their range into the eastern United States (Brittingham and Temple 1983). The greatest numbers of cowbirds are still found in the Great Plains, but they are now widely distributed from northwest Canada to northern Mexico (Shaffer et al. 2003.) Limiting factors to cowbird populations include host availability in agricultural areas and are limited by feeding sites in forested areas (Shaffer et al. l2003).

The Brown-headed Cowbird is an extremely widespread species and though not a songbird, is of extreme concern when dealing with songbird management. This is because they are a brood parasite, laying their eggs in nests of many North American songbirds (Goguen and Mathews 2001). The abundance of cowbirds in the eastern United Stated has increased in since the 1900s. (Brittingham and Temple 1983). This regional increase has been attributed to the increase in winter food supply and winter habitat added to the area with the increase in agriculture waste grain left in fields after cultivation, providing ample food in the winter (Brittingham and Temple 1983). This increase comes in tandem with growing concern with the decrease in forest dwelling songbirds in this same region (Brittingham and Temple 1983). Brood parasitism has the potential to greatly reduce reproductive success in hosts. It can be particularly detrimental to birds with short life spans that will only reproduce a few times, including forest dwelling song birds (Brittingham and Temple 1983).

Brood parasitism is an advantage to the cowbirds in multiple ways. They do not have to invest energy into rearing young, allowing them to invest more energy in mating, feeding, and producing eggs. In addition to this, forcing other birds to rear their young allows cowbirds the freedom to feed and breed in different areas. (Rothstein, Verner and Stevens 1984).Would be host species of the Brown-headed Cowbird employ several defenses against the brood parasites. Some species practice nest reconstruction, destruction, or desertion when they encounter a cowbird egg in their nest (Robertson and Norman 1976). This is the only option for some smaller birds, but this is an extremely labor intensive form of control. A more energetically efficient way to lessen cowbird parasitic success is for the host to eject cowbird eggs from nests (Robertson and Norman 1976). Additionally, aggressively defending the nest site is an effective way for some species to avoid brood parasitism (Robertson and Norman 1976).

The objectives of this study are to determine trends in various Kentucky avian populations. The first goal of this study is aimed at determining if the Kentucky Upper Green River Conservation Reserve Enhancement program has had any effect on the state's avian populations since its' implementation. Second, we are interested in the possible effects of large forested areas in Kentucky on avian species. Our final goal was to access the possible effect of the parasitic Brown-headed Cowbird on other avian species. Based on these objectives, 3 hypotheses were formed:

1) Avian abundance counts will change after the initiation of CREP, showing if any species has experienced a significant population change associated with the change in landcover and conservation practices.
2) Avian abundance will differ in many species between 3 land cover types: Agricultural, Mixed, and Deep Forest. Differences in land cover preference may correlate with guild type in some species.
3) Avian abundance will differ in areas of high, medium, and low Brown-headed Cowbird abundance.

The alternative hypothesis to the CREP section of our analysis is that grassland obligates and some shrub-scrub species would show significant increases overtime in areas associated with the Upper Green River Watershed CREP. For the woodland bird alternative hypothesis, it was assumed that species known to utilize forest interiors would be sensitive to edges and show a preference for deep forest Landcover. Because Brown-headed cowbirds have the ability to reduce the reproductive success of multiple species, it was hypothesized that those species which are targeted as hosts would show a preference for areas associated with low Brown-headed Cowbird counts.

The overall goal of this study is to identify circumstances which breeding birds are most commonly found in Kentucky. With the constant threat to migrant bird populations, the first step in protecting populations experiencing decline is to identify which areas they are breeding and inhabiting with the most frequency. When that has been established, real and targeted conservation projects such as the can be initiated to protect areas of high avian use.

CHAPTER 2

MATERIALS AND METHODS

North American Breeding Bird Survey

All the bird population data I used for analysis was accessed with permission from the North American Breeding Bird Survey (BBS) raw data archives. The North American BBS is a monitoring initiative started in the 1966, and was the first wide-spread, systematic survey of bird species in North America (Johnson and Igl 2001). This survey's main purpose is to estimate population trends of bird species which breed in North America and migrate across international borders (Robbins 1986). It is comprised of permanent survey routes established on secondary roads randomly throughout the continental United States and southern Canada (Peterjohn et al. 1994 in Herkert 1998).

Data for this monitoring initiative is collected by identifiers surveying 39.5 kilometer routes throughout North America. Each of these routes contains 50 stops located at 0.8 kilometer intervals; at each of these routes a 0.4 kilometer radius is surveyed for 3 minutes and every bird seen or heard in this radius is recorded (National Atlas, 2013). This data is made publically accessible and provides a great service to those studying ornithological patterns. Ideally each route is surveyed annually, but many routes have gone through periods of inactivity usually due to loss of observers.

Grassland Obligates

To test for significant differences between grassland bird population in CREP and Non CREP areas over time, I compiled data from 1998-2011 for 10 routes in the BBS. Five routes are located in counties participating in the Kentucky Upper Green River Watershed CREP, while the other 5 were in counties not participating in CREP (Non-CREP.) All routes were located in south central Kentucky. I used Breeding Bird Survey data from 1998-2000 as my ‘before’ treatment group, with the installation of CREP as the treatment. Data from 2009-2011 was used as an ‘after’ group to the installation of CREP. To test for significance in the interaction of Condition (i.e. CREP or non-CREP) over time, I performed repeated measure one-way ANOVAs and Friedman’s Tests.

First, I reviewed literature to identify many of the grassland obligates which include Kentucky in their range. I then compiled the data for 13 species. The species which were tested fell into three groups: grassland birds, shrub-scrub species, and generalist commonly found in grasslands. Five species tested are grassland obligated including the Song Sparrow (*Melospiza melodia),* Indigo Bunting (*Passerina cyanea),* Northern Bobwhite (*Colinus virginianus),* Eastern Meadowlark (*Sturnella magna),* and Grasshopper Sparrow (*Ammodramus savannarum*). We hypothesized that these species would show a significant increase since UGRW CREP installation. Those species which are common in grassland, but considered shrub-scrub species, include the Field Sparrow (*Spizella pusilla),* Common Yellow-throat (*Geothlypis trichas)*, Blue Grosbeak (*Passerina caerulea*), and the Red-winged Blackbird (*Agelaius phoenieus).* Those species tested which fell into the category of generalist utilizing grasslands includes the American Goldfinch (*Spinus tristis),* Brown-headed Cowbird (*Molothrus ater),* Yellow-breasted Chat (*Icteria virens)*, and Northern Cardinal (*Cardinalis cardinalis)* (USGS, National Prairie Wildlife Research Center 2013). I graphed the means of each species from 1998-2011 to aid in the visualization of any change in populations over the past decade.

Using SPSS to perform a Shapiro-Wilk's test for normality as well as creating Q-Q plots for each species. Of the 13 species tested, the Field Sparrow, Indigo Bunting, and Northern Cardinal were all already normal. The Common Yellowthroat, the American Goldfinch, the Eastern Meadowlark and the Brown-headed Cowbird were all normalized in SPSS using a square-root transform. The Red-winged Blackbird was still not normal after this transformation, so a log transformation was used. Because there are zeros in this dataset, I added a value of '1' to every species count to avoid a computing error. The equations entered into SPSS' 'Compute Variable' tool would therefore be Sqrt(x+1), for the square-root transformation and Ln(x+1) for the log base transformation.

The remaining 5 species which could not be normalized using these, square transformations or sine transformations were analyzed using a Friedman's test, the non-parametric equivalent to a repeated one-way ANOVA. These species were the Common Yellowthroat, Yellow-breasted Chat, Grasshopper Sparrow, Blue Grosbeak, and the Northern Bobwhite. For this test I organized data into four groups per species, with a before and after column for each condition. For example, the Song Sparrow count was arranged into four groups: 'Song Sparrow before CREP', 'Song Sparrow after CREP', 'Song Sparrow before Non-CREP', and 'Song Sparrow after Non-CREP'.

Forest-Dwellers

To access which species are utilizing deep forest stand in Kentucky, I used BBS data from 2011. I then utilized an interactive national route map provided by NationalAtlas (2013). This map includes the North American BBS routes, and layers including 'Land Cover Distribution' in which different types of cover (i.e. deciduous forest, pasture/hay, mixed forest, urban areas, etc.) are mapped in detail. Using this layer, I identified routes which fall into 3 categories. The first is 'Deep forest Routes', containing 6 routes located in >80% deciduous or mixed forest land cover. The second group, 'Mixed Cover Routes' contains 8 routes located in 80%-30% deciduous or mixed forest land cover. The final group 'Agricultural Routes' contains 7 routes which lie in <30% deciduous or mixed forest land cover (most land in this group is agricultural land cover).

I then extracted data for 13 species of forest obligates and those which commonly utilize deep forest stands for these 21 routes. These species include the Pileated Woodpecker (*Dryocopus pileatus),* Wood Thrush (*Hylocichla mustelina),* Kentucky Warbler (*Geothlypis formosa)*, Red-Eyed Vireo (*Vireo olivaceus*), Acadian Flycatcher (*Empidonax virscens*), Eastern Wood Peewee (*Contopus virens*), Hooded Warbler (*Setophaga citrina*), Worm-eating Warbler (*Helmitheros vermivorum*), Ovenbird (*Seiurus aurocapilla),* American Redstart (*Setophaga ruticilla),* Black-throated Green Warbler (*Setophaga virens),* Northern Cardinal (*Cardinalis cardinalis*), Scarlet Tanager (*Piranga olivacea),* and American Robin (*Turdus migratorius).* I performed a Shapiro-Wilk's test for normality as and created Q-Q plots to determine if any of the data needed to be transformed. Data for the Brown-headed Cowbird was already normally distributed. The methods used to log transform Grassland obligate data was also used to normalize the Eastern Wood Peewee, Acadian Flycatcher, Red-eyed Vireo, and Wood Thrush. I then used SPSS to run one-way ANOVAs on each of these 6 species to see if land cover distribution had a significant effect on species route counts in 2011. The other 7 species were analyzed using a Kruskal-Wallis, nonparametric test.

Brown-headed Cowbird

To access the effects of Brown-headed Cowbirds on particular species, I used data from the years 2006-2011 from 23 Kentucky routes which reported counts. First, I compiled the annual cowbird counts for each route and used this data to calculate the average abundance per route for these 6 years. Using the mean cowbird abundance per route, I sorted the routes into 3 cowbird density categories. The first, “1-low annual mean” includes 9 routes with annual cowbird means ranging from 4.67-9.5 observed per route. The second group is labeled as “2-medium annual mean” and contains routes which experience a moderate level of cowbird use, with means ranging from 10.3-14.45 observed per route. Those routes which reported the largest average cowbird counts were categorized as “3-high annual mean,” with means ranging from 18.16-26.3 observed per route.

I then gathered data on 10 species of birds for this time period for these routes. Five of these are ‘Host’ species, which are targeted by the parasitic Brown-headed Cowbirds. This group included the Red-winged Blackbird (*Agelaius phoenieus),* Yellow Warlber (*Setophaga petechial),* Eastern Phoebe (*Sayornis phoebe),* Wood Thrush (*Hylocichla mustelina),* and Field Sparrow (*Spizella pusilla).* The other group, ‘Non-Host’ species, have either not been historically targeted by cowbirds, or perform some defensive behavior to prevent brood-parasitism. This group included the American Robin (*Turdus migratorius)*, Brown Thrasher (*Toxostoma rufum)*, Ruby-throated Hummingbird (*Archilochus colubirs*), and the Gray Catbird (*Dumetella carolinensis*).

As with the other two data sets, I utilized a Shaprio-Wilk's test for normality and found that none of these species counts were normally distributed. The American Robin and Field Sparrow were normalized using a square-root transformation using the same methods as the square-root transformation done on some Grassland Obligates. For these two species I performed one-way ANOVAs to determine if there is a significant relationship between cowbird abundance and abundance of other species. For the other eight species I performed a Kruskal-Wallis Nonparametric test.

CHAPTER THREE

RESULTS

Grassland obligates

To test the effect of CREP in Kentucky, I tested 13 species to see if their populations had changed significantly in CREP associated areas, since the initiation of CREP. There was no significant difference found in any of the species tested using a repeated measures one-way ANOVA. The following significance was found for each species: Field Sparrow ($p=0.574$), Indigo Bunting ($p=0.593$), Northern Cardinal ($p=0.079$), Common Yellowthroat ($p=0.334$), American Goldfinch ($p=0.308$), Red-winged Blackbird ($p=0.837$), Eastern Meadowlark ($p=0.327$), and Brown-headed Cowbird ($p=0.528$).

For species whose counts could not be normalized, a Freidman's Test was used for analysis. The Song Sparrow ($p=0.051$), Yellow-breasted Chat ($p=0.054$), Grasshopper Sparrow ($p=0.116$), Blue Grosbeak ($p=0.415$), and the Northern Bobwhite ($p=0.237$) were all tested using this method. None of these counts showed any significant difference between the 4 groups within each species.

The graphed means show a large difference between CREP associated routes (not involved in CREP for all years graphed) and Non-CREP associated routes in 5 species. The Northern Bobwhite (Figure 1) mean annual abundance trend for CREP routes does not fall below 5.6 (2009) in any year and reach a maximum mean of 17 (2000), while Non-CREP routes reach means as low as 2 (2007) and never went above 11.6 (2002). In addition, CREP routes for this species were above a mean of 10 for 12 of the years graphed, while Non-CREP routes only reach a mean of 10 or more in 2 years. The Grasshopper Sparrow showed a similar pattern, with means at least 1.4 greater in CREP than Non-CREP areas for each year respectively (Figure 2). The Yellow-breasted Chat showed the opposite pattern, seemingly more abundant in Non-CREP areas. This species has a maximum mean value of 8.4 and a minimum mean of 4 in CREP routes, while having a maximum of 14.75 and a minimum of 7 (Figure 3). The Eastern Meadowlark also seems to be using current CREP associated routes more than Non-CREP. This species reached a maximum mean of 59.8 in CREP fields while only reaching a maximum mean of 23.6 in Non-CREP areas. The means for this species was never higher in Non-CREP areas than CREP areas in any year (Figure 4).

Forest-Dwellers

I preformed one-way ANOVAs on 14 species to see if any were utilizing one type of cover significantly more than other types. The three cover groups were ‘Forest Cover’, ‘Mixed Cover’ and ‘Agricultural Cover’. Of those species tested using a one-way ANOVA, all 5 were found to be significant and an analysis of a Tukey’s post hoc was done to determine the significant difference between cover types. The Acadian Flycatcher had an overall p-value of <0.021 (adjusted $r^2 = 0.278$), with a significant difference between ‘Forest Cover’ and ‘Agricultural Cover’ ($p=0.022$), and ‘Mixed Cover’ populations having no significant difference from either ‘Forest Cover’ ($p=0.062$) or ‘Agricultural Cover’ ($p=0.803$). The Eastern Wood Peewee ($p=0.025$) showed a significant difference between ‘Forest Cover’ and ‘Agricultural Cover’ (p=0.044), and between ‘Mixed Cover’ and ‘Agricultural Cover’ (p=0.043). This species did not show a significant difference between ‘Forest Cover’ and ‘Mixed Cover’ (p=0.983). Graphs of means for these first two species clearly suggest that both the Acadian Flycatcher and Eastern Wood Peewee are using ‘Forest Cover’ significantly more than ‘Agricultural Cover’ (Figure 8; Figure 4). The Red-eyed Vireo is using areas with deep forest cover more often than areas of mixed cover (p=0.001) or agricultural cover (p=0.0001), and shows a preference for mixed cover over agricultural cover (p=0.007). The graph of means for this species reveals a significantly higher use of ‘Forest Cover’ than any other cover, and a higher use of ‘Mixed Cover’ than ‘Agricultural Cover’ (Figure 9). The Wood Thrush (p=0.001) is also using areas with deep forest cover more often than areas of mixed cover (p=0.009) or agricultural cover (p=0.001), while there is no difference between agricultural of mixed cover use (p=0.332) (Figure 7).

When a Kurskal-Wallis was run on the other 9 species which could not be normalized, 4 species were found to have a significant difference between cover types: the Pileated Woodpecker (p=0.031), Worm-eating Warbler (p=0.015), Kentucky Warbler (p=0.039) and American Redstart (p=0.029). Graphs for all of these species suggest that these significance results are in favor of deeper forest cover (Figure 6; Figure 10; Figure 11 Figure 12; Figure 13).

Those species which did not show a significant difference between cover types included the Ovenbird (p=0.056), Hooded Warbler (p=0.07), Yellow-throated Warbler (p=0.058), Black-throated Green Warbler (p=0.162), and the Scarlet Tanager (p=0.218).

Brown-headed Cowbirds

The one-way ANOVA could only be used to analyze the American Robin (p=0.01) and Field Sparrow (p=0.0001). A Tukey's post-hoc test of the American Robin reveals a significant difference between the 'Low' and 'Medium' (p=0.028) areas of Cowbird abundance as well as between 'Medium' and 'High'(p=0.032). A graph of the individuals based on Cowbird abundance shows that the significant difference 'Medium' and other levels, indicating a preference for areas of 'Low' and 'High' Cowbird abundance (Figure 14). The Field Sparrow Tukey's post-hoc test reveals a significant difference between the 'Low' and 'Medium' (p=0.0001) areas of Cowbird abundance as well as between 'Medium' and 'High'(p=0.002). The graph of this species shows Field Sparrow to be most abundant in areas of high cowbird abundance, and least abundant in areas of low cowbird abundance (Figure 15).

The Kurskal-Wallis analysis of the remaining species yielded significant results in 3 of the remaining species: The Brown Thrasher (p=0.01), Ruby-throated Hummingbird (p=0.003), and the Wood Thrush (p=0.023). Graphs of the Brown thrasher and Ruby-throated Hummingbird suggest the same pattern as the Field Sparrow, with greater counts reported in areas of high cowbird abundance with the lowest counts in areas of low cowbird abundance (Figure 13; Figure 14). The Wood Thrush (Figure 16) suggests the same pattern as the American Robin, with the least abundance associated with areas of medium cowbird counts.

CHAPTER FOUR

DISCUSSION

Grassland Obligates

It has been suggested by many studies that CRP has had a positive effect on grassland species (Johnson and Igl 1995; Ryan et al. 1998). One such study, conducted within the Chester River Field Research Center in Maryland, reported rapid colonization of multiple grassland obligates within a few years of CRP installation (Gill et al. 2006). The first part of my study was concerned with determining if CREP has had the same effect in south-central Kentucky. The results of the repeated measure one-way ANOVAs yielded no significance in any of the species tested. Similarly, the Friedman's test did not yield any significant results. Because of this we must accept our null hypothesis, that the installations of CREP had no effect on grassland species at the level which we tested. It is necessary to note that multiple species including the Song Sparrow and Yellow-breasted Chat p-values of 0.051 and 0.054. If the BBS conducted more surveys within the UGRW CREP, and this studied could have included more than 5 routes under each condition, we may have found significant results.

A study conducted within Kentucky Upper Green River CREP fields, found some species to be significantly more abundant in these fields than agricultural fields (Hulsey *et al.* 2008). Another study done within these fields tested these species for a change over time and reported similar results, with no significant increases in CREP populations between 2004 and 2007 (Hamilton 2009). A similar study, also based on BBS data, was done in North Dakota and found that in the first five years of CRP, there was a significant reversal in the North Dakota populations of grasshopper sparrow and lark buntings (Reynolds *et al.* 1994). Though we did not see a significant increase as a result of CREP in this species, our results were similar to this study in that they found a negative or no effect on 16 other grassland species. We did not find that CREP had any positive effect over time on the 13 species we tested.

The success of management practices such as this can be measured on a small and large scale; when measured on a small scale, data collection is done within the area being managed (i.e. field level), large scale studies, such as mine, use data collected from the area associated with the management practice (i.e. county level). The effects of CRP on avian species have been very well studied on a small and large scale since its implementation in the late 1980's. A small scale study done of CRP fields in Midwest states suggested that there is was a similar number of bird species in rowcrop and CRP fields, but bird abundance to be 1.4-10.5 times greater in management areas (Best et al 1997). Johnson and Igl (1995) conducted counts of the Le Conte's sparrow within North Great Plain CRP fields. This study documented an increase from no breeding pair in the first survey year (1990) to a count of 290 breeding pairs in CRP fields just four years later. We did not include the Le Conte's sparrow in our analysis because its migration range includes only the regions in far northern regions of North America (Sauer et al 2012). However, the rapid reclamation of CRP areas by this grassland species is important to note because we did not see this in any of the species tested even though our study was based on a similar timeline.

Another small scale study performed by McCoy et al. (1999) tested the fecundity of seven grassland species within CRP fields in Missouri. They observed a high enough fecundity to maintain stable populations in the Grasshopper Sparrow, American Goldfinch, Field Sparrow, and Eastern Meadowlark, indicating that CRP areas are serving as source habitat in this area for these species. This study only collected data from in years after CRP installation (1993-1995) with no data for this area before CRP. Because this study lacks data from before CRP, it does not have proper controls and raises the question of whether stable populations of these species were present in these areas before CRP; if this is the case environmental factors other than CRP are influencing source populations.

One large scale study compiled BBS data on the Grasshopper Sparrow from the eight years preceding and eight years after CRP instillation in the area and ran paired t-tests on these two groups (Herkert 1998). These tests indicated a positive change in mean slope from before to after CRP. This did not agree with the results of the Friedman's test I conducted on this species in CREP areas in Kentucky. This is a species that we would expect to get positive effects from CREP in the UGRW CREP region because of its dominance in tall grass ecosystems (Klute et al 1997).

Herkert (2007) compiled BBS data for all states in Henslow's Sparrow range from 1987-2005 to compare population trend slopes for each route with the amount of CRP enrolled in the county. This study found a correlation between the amount of CRP in this region and slopes of route population trends, with trends in areas with relatively high enrollment in CRP increasing more than in areas with less CRP enrollment. However, route slopes were highly variable, with CRP explaining little of this variability. Though this species was not analyzed in this study due to the small numbers recorded, it could have been included as its distribution includes the UGRW CREP (Sauer 2012). Population trends estimated by the breeding bird survey indicate a 5.9% change in this species in Kentucky since 1996 (Saucer 2012). Whether this long-term increase is associated with CRP is unclear because the increase does not coincide with the instillation of CRP in the area.

Reynolds et al (1994) conducted a large scale study estimating state wide population trends of eight grassland birds using North Dakota BBS data. They found that four of these species, including the Grasshopper Sparrow and Lark Bunting, which were previously experiencing long-term declines experienced population increases from 1987-1992, after CRP installation. This same study found that trends in population of grassland species had increased more than those species which do not utilize grasslands in this region. This study is very similar to ours in timeline (five years period after installment,) scale, and methods yet we did not see these increased trends in the UGRW CREP. One possible explanation for this is that the previously mentions study (Reynolds et al 1994) used data from an area with high enrollment in CRP (Herkert 1998).

Because CREP is a more recent program, it has not yet been as deeply investigated but studies such as mine are adding to the literature on the subject. One small scale study mentioned previously, in Maryland CREP fields documented rapid colonization of grassland species in restored areas, some establishing territory in as little as a month after planting of seven species of warm-season grasses. This study also indicated a high level of annual return of Grasshopper Sparrows to these areas. (Gill et al 2006). However, another study conducted from 2003-2006 within Maryland CREP buffer zones found grassland dependent birds to be the least common guild found in conservation buffers. The study sites the reason for this to possibly be because the buffer strips are too narrow to support these obligates who require large expansive grasslands (Blank and Gill 2006).

Another small scale study of roadside data collected in 2001 and 2002 indicated that grassland species of concern tend to be more abundant on routes within CREP fields than on control routes in Wisconsin (Allen 2005). A similar study conducted in Pennsylvania, found that CREP had a positive effect on five species of grassland species including the Eastern Meadowlark, a negative effect on three and no effect on two (Pabian *et al.* 2013).

Another study, performed in Pennsylvania's Lower Susquehanna River Basin CREP fields, performed bird surveys from 2002-2004 and calculated species density and richness. They did not find numerous amounts of grassland obligates and found that the species richness of grassland obligates to be negatively associated with year from 2002-2004 (Wilson et al. 2010). They found that CREP areas are providing habitat shrub-scrub and grassland obligate species, with shrub-scrub preferring smaller, more densely vegetated fields and grassland obligates preferring larger, more open fields. Further study should include analysis of more shrub-scrub species to determine if these species are experiencing positive effects from Kentucky CREP.

Wentworth et al. (2010) performed a study within this same area in Pennsylvania, in which survey fields were randomly selected in CREP enrolled counties. This study is very useful to consider because it is the most similar to ours in design and results. They found that there were not numerous amounts of grassland obligates utilizing these fields, with the grasshopper sparrow being the most numerous. In addition, they found grassland obligate species richness to be negatively associated with year. Their findings also suggest that CREP counties in Pennsylvania are providing habitat for shrub-scub species with more frequency than grassland obligates. Though we did not test the effects on species grouped by guilds, a visual analysis of the graphed means of individual shrub-scrub species suggests that the same pattern Wentworth et al. (2010) observed for this guild may be seen in UGRW CREP.

Forest Dwellers

Our findings suggest that the Acadian Flycatchers are forest species, but can utilize edge and less forested areas as well. This overlap in habitat has been suggested by Hespenheide (1984) however, he suggests that this overlap is small, with this flycatcher normally requiring canopy cover and dense vegetation (1971). There is some debate over this though as Kroodsma (1984), found this species to be utilizing interior over edge.

The Eastern Wood Peewee has been classified as an edge or shrub-scrub species, associated with discontinuous vegetation, and infrequent in clear-cut areas (Stelke and Dickson 1980). Therefore our results of greater use in 'Forest' and 'Mixed' cover over 'Agricultural Cover', with no difference in the first two groups, was expected. There was no difference in Deep Forest and Mixed because this is an edge species and can utilize a variety of woodland habitats, as well as disturbed areas such as orchards (NCWC 2013). This species is of specific concern to this study, because the highest densities are in the Piedmont of Virginia and West Virginia, two of Kentucky's eastern border states (NCWC 2013).

The Red-Eyed Vireo and Wood Thrush have both been cited as a forest-dwelling species in other studies, so it was predicted that this species would be utilizing the deep forested area of Kentucky more than the mixed cover or agricultural areas (Hamilton 2009; Askins and Philbrick 1987). Though it is often cited as a mature forest species, the Wood Thrush has been reported to use a variety of forests, including small woodlots. However, there is also evidence to suggest that reproductive success of Wood Thrushes is negatively impacted in these small, fragmented areas because they do not supply all the requirements for sustainable populations (Rosenburg et al. 2003).

Pileated woodpeckers utilize large, dead tree stumps for nesting sites which are more commonly located in old growth deciduous forests (Bull & Holthausen 1993). This species preference for deeper forests was predicted. Worm-eating Warblers are sensitive to forest fragmentation and were found by Wenny et al. (1993) to be in large forest stands significantly more than smaller forest stands (1993). This same study found that Kentucky Warblers are not negatively affected by edges, even though they were hypothesized to prefer deeper woodlands.

Habitat preference for the American Redstart includes many types of forests including early successional, mature, and a combination of stand ages (Hunt1996). Because of this, it was expected to find a difference between ‘Agricultural Cover’ and both other covers, but no difference between ‘Forest’ and ‘Mixed’ Cover. Though there was a significant difference, the graph of the individuals shows an almost equal number of birds in ‘Agricultural’ and ‘Mixed’ cover. It was expected that if two groups were not significantly different it would be ‘Forest’ and ‘Mixed’ cover, due to this species acting as generalist within forested habitat.

Many studies have concentrated on monitoring and accessing the suggested decline in forest-dwelling avian species. Ambuel and Temple (1982) found that there was a decline in frequency of occurrence of multiple forest-dwelling species between 1954 and 1979. These species include the American Redstart, Ovenbird, and Scarlet Tanager; they also found an increase in Red-winged blackbirds. This same project found the percentage of forest dwelling species decreased between the first and last year of this study; when first surveyed, 70-80% of bird species surveyed were forest-dwellers, falling to 40-50% by the end of the study. Askins and Philbrick (1987), report a 45-100% decline in the American Redstart, Hooded Warbler, Oven bird, Red-Eyed Vireo, and the Black-throated Green Warbler in the last 30 years in six preserves in eastern North America. A huge study of the declining neotroical birds was done using BBS data and found these migrants to be in a general decline throughout North America (Robbins et al. 1989).

Brown-headed Cowbird

Of the 11 species tested for cowbird density preference, five showed a significant difference between areas with varying levels of cowbird activity. However, no species was found significantly less in areas associated with high Brown-headed Cowbird counts, suggesting that none of the species tested are avoiding cowbirds to evade becoming hosts. The Field Sparrow, Wood Thrush, and Brown Thrasher are all found in greater abundance in areas of high cowbird activity. This significance is likely due to other environmental factors, and not cowbird densities. Areas of high cowbird use are likely areas of high quality habitat. An alternate explanation is that cowbirds are seeking host species out in these areas containing high concentrations of viable host species. This significance is also not likely a result of cowbirds preference for areas with high numbers of Brown Thrashers and Ruby-throated Hummingbird, as they are not a common host of these cowbirds (Hergenrader 1962, Love *et al* 1953).

The Wood Thrush is a common host and accepts cowbird eggs, but it has been suggested that parasitism by cowbirds may have less of a negative effect on the reproductive success of this species (Hoover and Brittingham 1993). This is because they are a larger host and can often successful raise its own young as well the parasitic fledgling (Rothstein 1975). Additionally, this species eggs have a similar incubation time as Brown-headed Cowbirds and can re-nest in the same season, both increasing the chances of reproductive success when parasitized (Rothstein 1975; Hoover and Brittingham 1993). These measures against brood-parasites could explain why Wood Thrushes do not seem to be avoiding areas associated with high cowbird counts.

The American Robin was found significantly more in areas associates with high and low cowbirds counts. It is a possible host species which has several defenses against cowbird parasitism. It has been suggested to be aggressive toward these cowbirds and lays eggs which are visible different than cowbird eggs, making ejection of the parasitic egg possible (Robertson and Norman1976). This species exhibited an interesting pattern of being more abundant in areas associated with low and high cowbird activity over a medium level of activity. Similarly to the Wood Thrush, having multiple measures for avoiding parasitism could explain why they do not show a preference for areas with low cowbird counts and again, the significant differences seen in this species are also likely due to other environmental factors outside of Brown-headed Cowbird abundance.

The significant relationship between areas of high cowbird counts and Field

Sparrow counts may be due to their preference for similar edge and patchy habitats. (Coker and Capen 1995). It has been suggested that cowbirds are at an advantage in parasitizing Field Sparrows due to the habitat they utilize. The taller, denser woody vegetation and shrub woodland of edge and shrub-scrub habitat may provide a better vantage point for watching Field Sparrows build nests. (Best 1978). However, this species defends their nests from brood parasites by chasing them from their territories (Best 1978). This aggressive behavior could make it unnecessary for the Field Sparrow to avoid areas associated with high cowbird counts.

Though they are not host specific, the most cited host species of Brown-headed Cowbirds include the Red-winged Blackbird, Wood Thrush, and Red-eyed Vireo (Hoover and Brittingham 1993, Clotfelter 1998). Because the Red-winged Blackbird is a field species it is not surprising that it is a common host, due to the overlap in habitat. However, the Wood Thrush and Red-Eyed Vireo were both found in the literature and by study to be interior woodland species. The use of these species as hosts by these cowbirds therefore indicates that they are infiltrating woodlands, outside their normal habitat, to locate host nests.

The results of my analysis of Brown-headed Cowbird densities are inconclusive, and do not suggest that species are spatially avoiding this brood-parasites. There have been multiple other studies suggesting that cowbirds may be a contributing factor to declines in songbird populations (Brittingham and Temple 1983). Cowbirds are likely to have an a negative effect on the reproductive success of many of their hosts, and could have played a role in the historic decline of songbirds since the 1960s including the Wood Thrush and the Song Sparrow (Smith *et al.* 2002, Hoover and Brittingham 1993).

Though our findings were inconclusive, brood-parasitism could play a role in the decline of songbirds in Kentucky. Further testing and nest sampling would need to be done to assess this.

The North American Breeding Bird Survey has been used by many researchers to track population trends and has been very useful in conservation efforts to reestablish healthy populations of avian species. It is, however, not without complications and inconsistencies. Factors such as uneven distribution of sampling routes, inconsistent route surveying, missing years of data and multiple observer effects must be considered when using this data source (Kendall *et al.* 1996). The most difficult factor to neutralize is observer inconsistency. According to Sauer et al (1994, in Kendall et al. 1996), there is a trend for more experienced observers to record a greater number of individuals and species. It is logical that observer skill will increase with practice, but this could cause false increases in populations merely because their skill, and not avian abundance, is increasing. The other side of this problem is that of less skilled observers, especially first time observers, possibly reporting inaccurate numbers due to inexperience. Kendall's (1996) extensive analysis suggests that this "first-time observer effect" may significantly distort population trends of nearly all species.

In 1994, Saucer reported that some routes have been surveyed by only one observer, while others have routes had been surveyed by up to 11 different observers by this time. This many observers only increases the possible inconsistences in data collection. Other, more subtle observer differences have also been suggested, such as a decrease in birds heard as a long time observer's hearing declines (Kendall et al. 1996). It is important that we acknowledge the amount of possible error which comes with using Breeding Bird Survey Data.

CONCLUSION

The first hypothesis we presented was that there would be a difference in bird populations overtime in CREP associated areas and Non-CREP associated areas. Specifically, we hypothesized that the grassland obligates in this study would be positively affected overtime by the installation of CREP. After statistical analysis, we found there was no difference between before and after UGRW CREP installation. Because of this we must reject or original alternative hypothesis and accept our null hypothesis, that the installation of UGRW CREP has had no effect on any of the avian species tested. Therefore if any difference exists between these species counts, it is not due to the installation of CREP.

Now we have to ask ourselves why CREP has not had a significant effect on grassland obligates and other avian species populations. Gill et al 2006, found that grassland obligates were reestablishing in CREP areas in as little as one month after planting of warm-season grasses, therefore we can assume that the lack in significance detected was not due to the time these areas have been involved in CREP. Multiple studies have suggested that grassland-obligate bird species require large CREP areas, due to large sections of undisturbed grasslands required by many of these species (Gill and Blank 2006; Wentworth et al. 2010). Wentworth et al. (2010) suggests that the abundance of shrub-scrub species was highest on smaller fields and that CREP may benefit these species more than grassland obligates.

After CREP research was completed, I moved on to asking questions about Forest Interior avian species. Our hypothesis for this was that many bird species will be using deeply forested, mixed cover, and agricultural cover areas unequally. We found that many species are using one type of cover significantly more than the other types, so we can reject our null hypothesis and accept our alternative hypothesis. These results were all expected, since these species had all been suggested as woodland and forest interior species in the past. However, it is important to identify which stands these species are utilizing in KY as well as identifying species that are sensitive to fragmentation and deforestation. The next step for this part of the experiment would be to conduct small scale studies within deep forest stands in Mammoth Cave National Park and the Appalachian forests of eastern Kentucky. Fecundity could be tested and has the potential to make a stronger argument for this area as source habitat for interior woodland species.

The results for the last aspect of our experiment yielded some significant, but inconclusive results. Though a few species were found to have a significant difference between differing levels of cowbird counts, the patterns of association suggest that factors outside of brood parasitism are the source of this significance. The next step in this experiment would be to sample nests of possible hosts in the area, calculate the reproductive success and compare these findings in areas associated with differing cowbird abundance. This would give us a much better idea of the effect of Brown-headed Cowbirds on specific species in Kentucky.

Successful conservation requires information and research on every species to ensure the survival of endangered and threatened species as well as maintaining healthy populations of all species. It is highly important to monitor the avian species diversity and abundance because of this. There have been success stories in avian conservation including saving the American Bald Eagle and California Condor from the brink of extinction, as well as the promising response of wetland birds to restored CREP associated wetlands (O'Neal et al. 2008). However, it is all too easy to forget our own history, and the reasons these species were driven to such small numbers. Though we have managed to conserve a few of the vast number of species we have negatively affected, Humankind's pursuit of progress will be the one major predictor for the health of our world. If we cannot balance our own accomplishments with the needs of the rest of the organism on the planet, the extinction of many more species is sure to come by our hand.

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APPENDIX 1

TABLES AND FIGURES:

Table 1: Species Studied and which Analysis in which they were included:

Species:	*Common Name:*	*CREP:*	*Cover Type:*	*Brown-headed Cowbird:*
Ammodramus savannarum	Grasshopper Sparrow	X		
Sturnella magna	Eastern Meadowlark	X		
Colinus virginianus	Northern Bobwhite	X		
Spizella pusilla	Field Sparrow	X		X
Melospiza melodia	Song Sparrow	X		
Passerina cyanea	Indigo Bunting	X		
Hylocichla mustelina	Wood Thrush		X	X
Dryocopus pileatus	Pileated Woodpecker		X	
Geothlypis formosa	Kentucky Warbler		X	
Vireo olivaceus	Red-Eyed Vireo		X	
Empidonax virescens	Acadian flycatcher		X	
Contopus virens	Eastern Wood-Peewee		X	
Setophaga citrina	Hooded Warbler		X	
Helmitheros vermivorum	Worm-eating Warbler		X	
Seiurus aurocapilla	Ovenbird		X	
Setophaga ruticilla	American Redstart		X	
Setophaga virens	Black-throated Green Warbler		X	
Cardinalis cardinalis	Northern Cardinal	X	X	
Spinus tristis	American Goldfinch	X		
Molothrus ater	Brown-headed Cowbird	X		
Archilochus colubris	Ruby-throated Hummingbird			X

Table 1: Species Studied and which Analysis in which they were included continued:

Agelaius phoeniceus	Red-winged Blackbird	X		X
Sayornis phoebe	Eastern Phoebe			X
Turdus migratorius	American Robin			X
Geothlypis trichas	Common Yellow-throat	X		
Icteria virens	Yellow-breasted Chat	X		
Setophaga petechia	Yellow Warbler			X
Dumetella carolinensis	Gray Catbird			X
Toxostoma rufum	Brown Thrasher			X
Passerina caerulea	Blue Grosbeak	X		
Setophaga dominica	Yellow-throated Warbler	X		
Piranga olivacea	Scarlet Tanager		X	

Table 2: Species studied by guild as reported by the Cornell lab of Ornithology:

Species:	Common Name:	Grassland:	Woodland:	Generalist:	Shrub-Scrub:
Ammodramus savannarum	Grasshopper Sparrow	X			
Sturnella magna	Eastern Meadowlark	X			
Colinus virginianus	Northern Bobwhite	X			
Spizella pusilla	Field Sparrow				X
Melospiza melodia	Song Sparrow	X			
Passerina cyanea	Indigo Bunting	X			
Hylocichla mustelina	Wood Thrush		X		
Dryocopus pileatus	Pileated Woodpecker		X		
Geothlypis formosa	Kentucky Warbler		X		
Vireo olivaceus	Red-Eyed Vireo		X		
Empidonax virescens	Acadian flycatcher		X		
Contopus virens	Eastern Wood-Peewee		X		
Setophaga citrina	Hooded Warbler		X		
Helmitheros vermivorum	Worm-eating Warbler		X		
Seiurus aurocapilla	Ovenbird		X		
Setophaga ruticilla	American Redstart		X		
Setophaga virens	Black-throated Green Warbler		X		
Cardinalis cardinalis	Northern Cardinal			X	
Spinus tristis	American Goldfinch			X	

Table 2: Species studied by guild as reported by the Cornell lab of Ornithology Continued:

Molothrus ater	Brown-headed Cowbird			X	
Archilochus colubris	Ruby-throated Hummingbird			X	
Agelaius phoeniceus	Red-winged Blackbird	X		X	
Sayornis phoebe	Eastern Phoebe			X	
Turdus migratorius	American Robin			X	
Geothlypis trichas	Common Yellow-throat			X	X
Piranga olivacea	Scarlet Tanager		X		
Icteria virens	Yellow-breasted Chat				X
Setophaga petechia	Yellow Warbler				X
Dumetella carolinensis	Gray Catbird				X
Toxostoma rufum	Brown Thrasher				X
Passerina caerulea	Blue Grosbeak			X	
Setophaga dominica	Yellow-throated Warbler		X		X

Table 3: Repeated-Measures One-Way ANOVA Results comparing abundance counts collected on Breeding Bird Survey Routes in South Central Kentucky. Five routes were within counties involved in UGRW CREP and five routes were within counties surrounding the UGRW CREP and were considered NonCREP routes. Data for the before treatment group was collected from 1998-2000 and data for the after treatment group was collected from 2009-2011.

Species	*df*	*F*	*n*	*p*
Field Sparrow	1	0.32	60	0.574
Indigo Bunting	1	0.289	60	0.593
American Goldfinch	1	1.55	60	0.308
Eastern Meadowlark	1	0.078	60	0.327
Brown-headed Cowbird	1	0.403	60	0.538
Red-winged Blackbird	1	0.046	60	0.831
Northern Cardinal	1	3.201	60	0.079
Common Yellowthroat	1	0.94	60	0.334

Confidence level= 95%

Table 4: Nonparametric Friedman's test Results comparing abundance counts collected on Breeding Bird Survey Routes in South Central Kentucky. Five routes were within counties involved in UGRW CREP and five routes were within counties surrounding the UGRW CREP and were considered NonCREP routes. Data for the before treatment group was collected from 1998-2000 and data for the after treatment group was collected from 2009-2011:

Species	*df*	*Chi-sq*	*n*	*p*
Yellow-breasted Chat	3	7.623	15	0.054
Grasshopper Sparrow	3	5.908	15	0.116
Blue Grosbeak	3	2.854	15	0.415
Northern Bobwhite	3	4.241	15	0.237
Song Sparrow	3	7.767	15	0.051

Confidence level= 95%

Table 5: One-way ANOVA Results comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance of 4 species between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

Species	*df*	*F*	*n*	*p*
Eastern Wood Pee-wee	2	4.588	21	0.025
Acadian Flycatcher	2	4.841	21	0.021
Red-Eyed Vireo	2	32.873	21	0.0001
Wood Thrush	2	11.131	21	0.001

Confidence level= 95%

Table 6: Nonparametric Kruskal-Wallis Results comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance of 9 species between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

Species	*df*	*n*	*p*
Pileated Woodpecker	2	21	0.031
Kentucky Warbler	2	21	0.039
Hooded Warbler	2	21	0.07
Worm-eating Warbler	2	21	0.015
Ovenbird	2	21	0.056
American Redstart	2	21	0.029
Black-throated Green Warbler	2	21	0.162
Yellowthroated Warbler	2	21	0.058
Scarlet Tanager	2	21	0.218

Confidence level= 95%

Table 7: One-way ANOVA results comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- "low annual mean", 2- "medium annual mean", 3-"High annual mean").

Species	*df*	*n*	*f*	*p*
American Robin	2	115	9.226	0.0001
Field Sparrow	2	115	4.778	0.01

Confidence level= 95%

Table 8: Kruskal-Wallis results comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- "low annual mean", 2- "medium annual mean", 3-"High annual mean"):

Species	*df*	*n*	*p*
Red-winged Blackbird	2	115	0.137
Yellow Warbler	2	115	0.636
Eastern Pheobe	2	115	0.429
Wood Thrush	2	115	0.023
Ruby-throated Hummingbird	2	115	0.003
Gray Catbird	2	115	0.12
Brown Thrasher	2	115	0.01

Confidence level= 95%

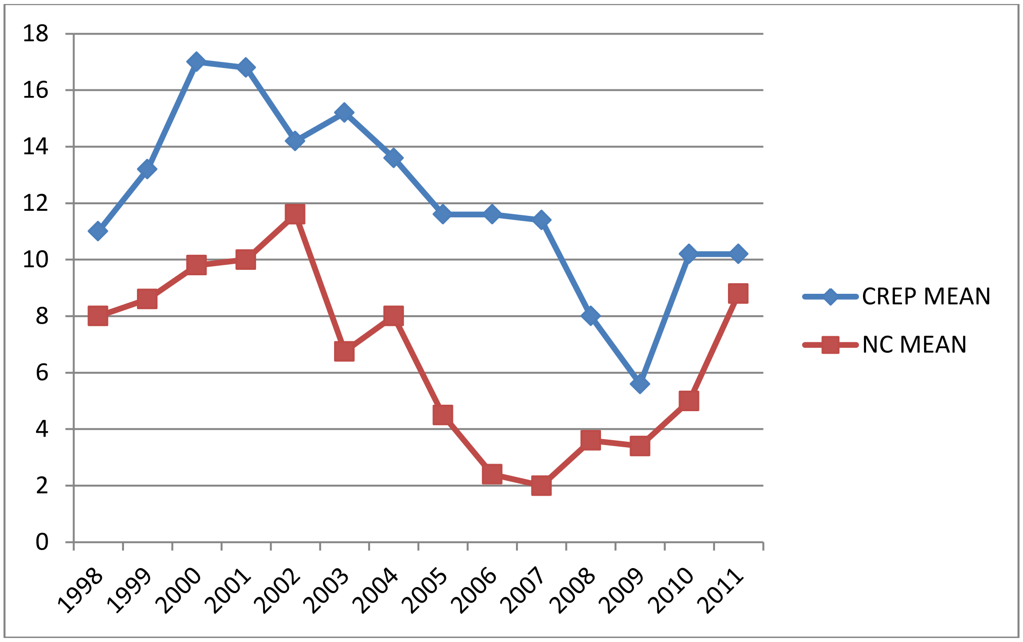

Figure 1: Population Mean of the Northern Bobwhite on CREP routes and Non CREP routes from 1998-2011 in South Central Kentucky. CREP routes are those Breeding Bird Survey routes conducted within counties participating in the UGRW CREP. NonCREP routes are those conducted in the counties surrounding the UGRW CREP.

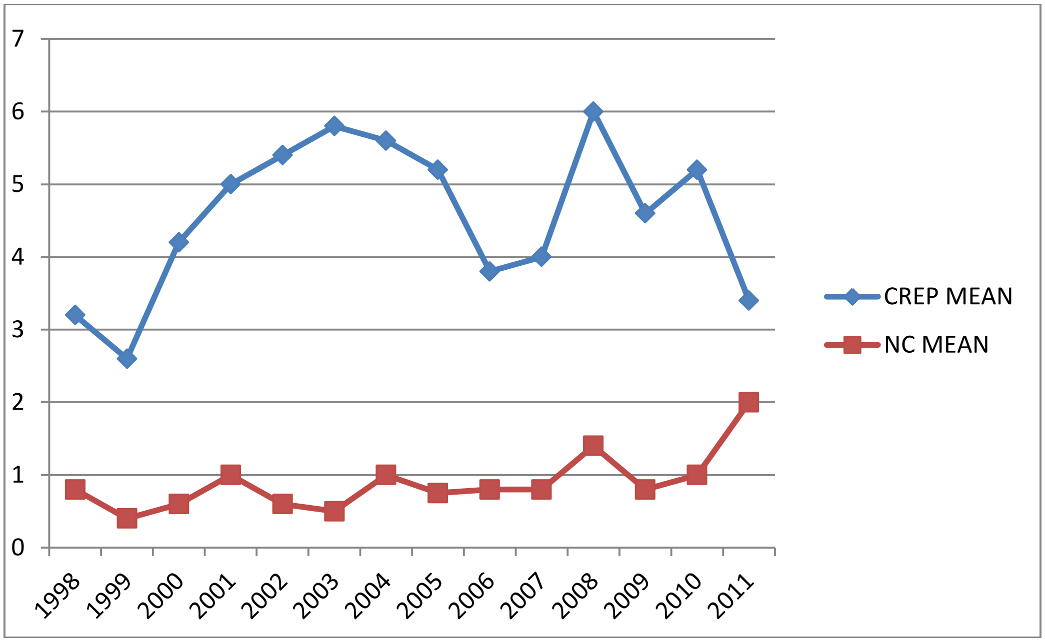

Figure 2: Population Mean of the Grasshopper Sparrow on CREP routes and Non CREP routes from 1998-2011 in South Central Kentucky. CREP routes are those Breeding Bird Survey routes conducted within counties participating in the UGRW CREP. NonCREP routes are those conducted in the counties surrounding the UGRW CREP.

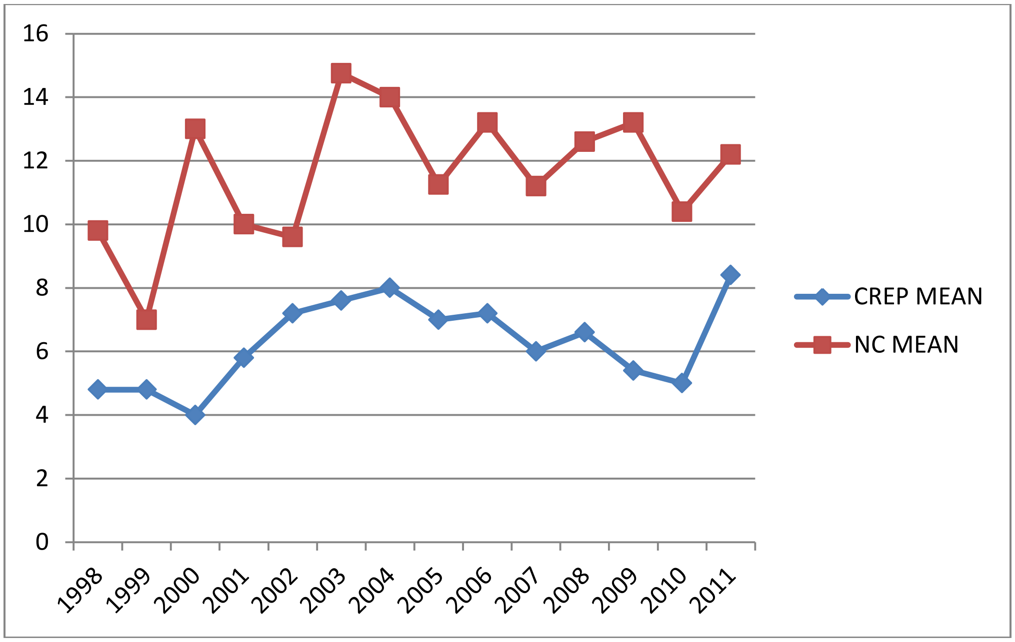

Figure 3: Population Mean of the Yellow-breasted Chat on CREP routes and Non CREP routes from 1998-2011 in South Central Kentucky. CREP routes are those Breeding Bird Survey routes conducted within counties participating in the UGRW CREP. NonCREP routes are those conducted in the counties surrounding the UGRW CREP.

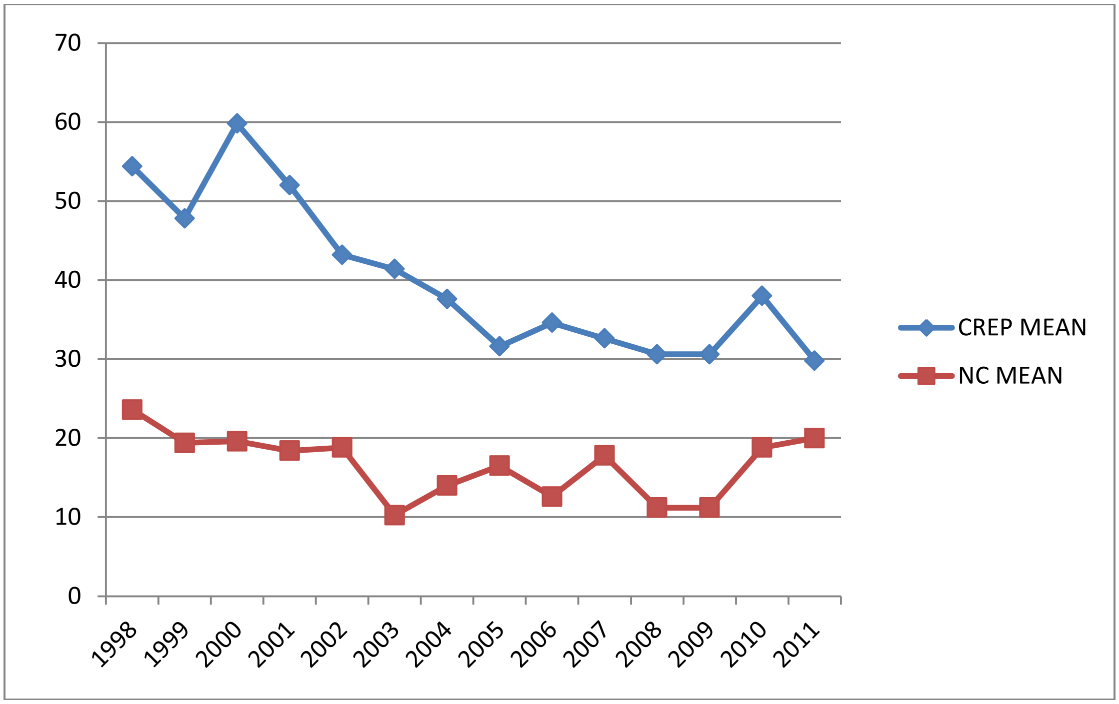

Figure 4: Population Mean of the Yellow-breasted Chat on CREP routes and Non CREP routes from 1998-2011 in South Central Kentucky. CREP routes are those Breeding Bird Survey routes conducted within counties participating in the UGRW CREP. NonCREP routes are those conducted in the counties surrounding the UGRW CREP.

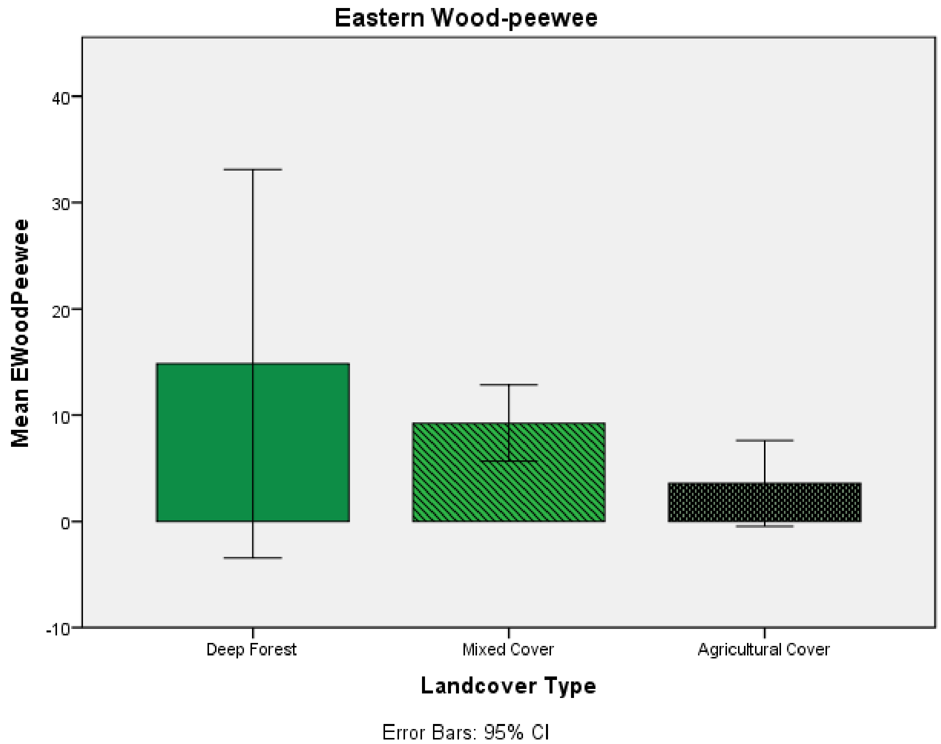

Figure 5: Graphed Results for Eastern Wood Pee-wee for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

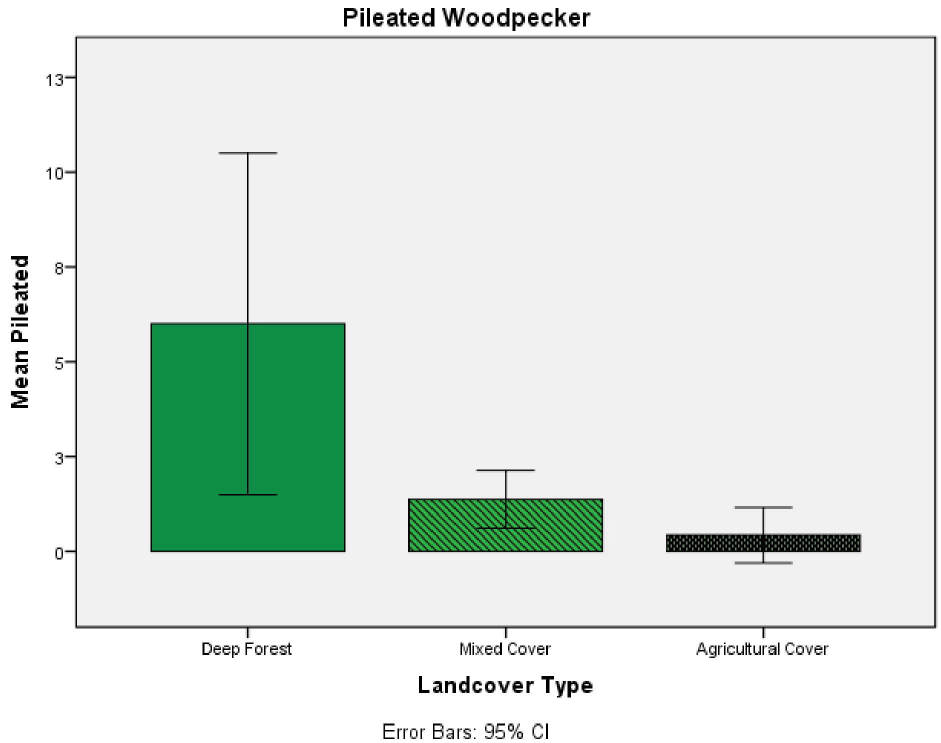

Figure 6: Graphed Results for Pileated Woodpecker for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

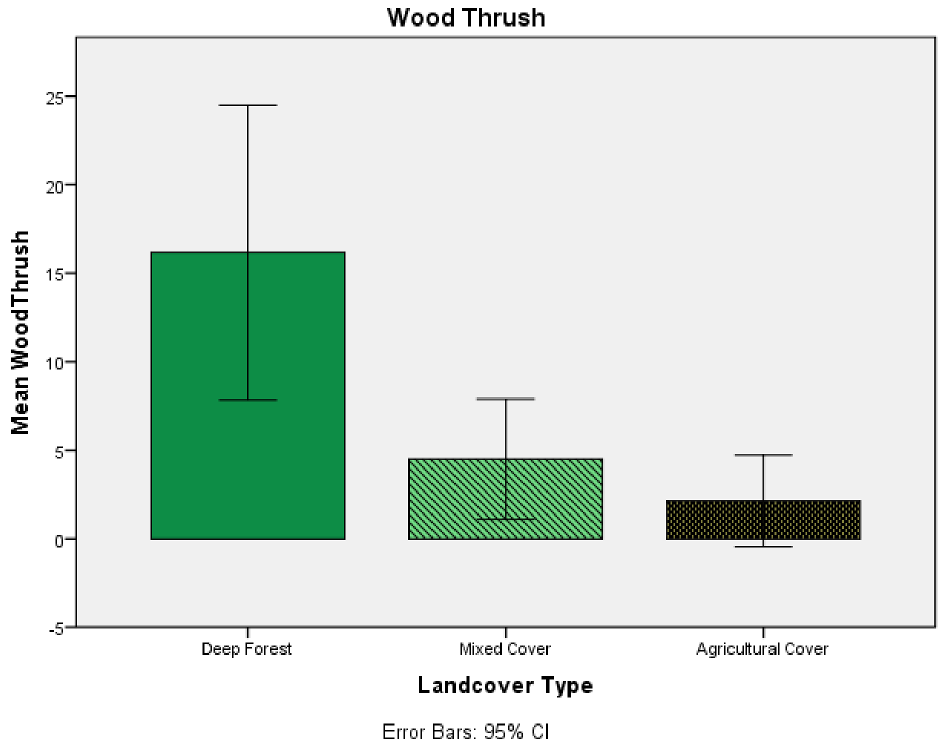

Figure 7: Graphed Results for the Wood Thrush for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

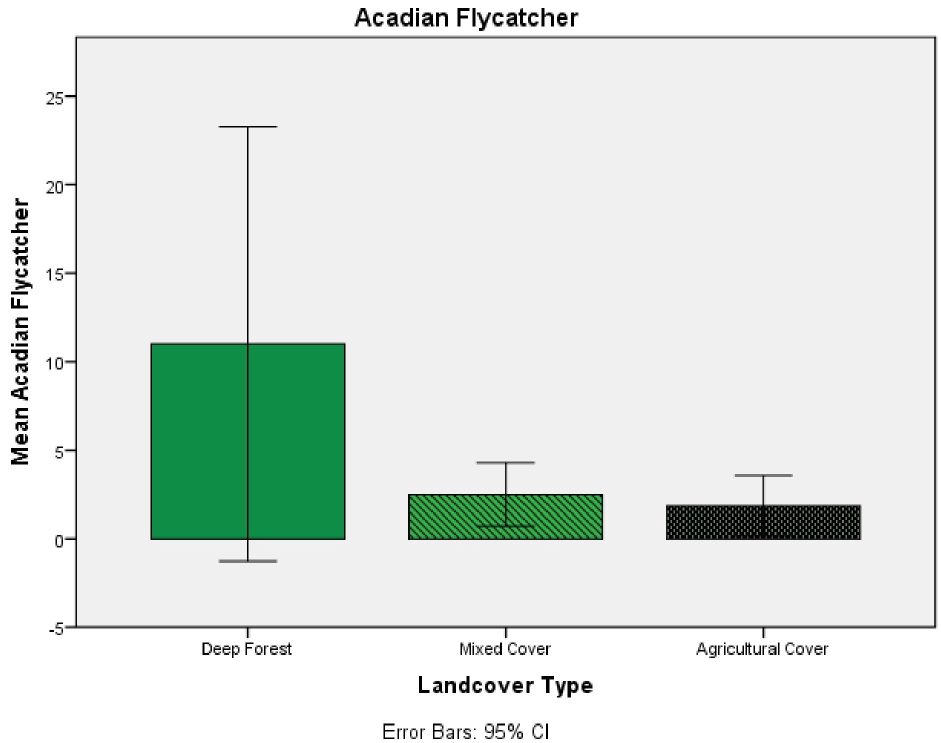

Figure 8: Graphed Results for the Acadian Flycatcher for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

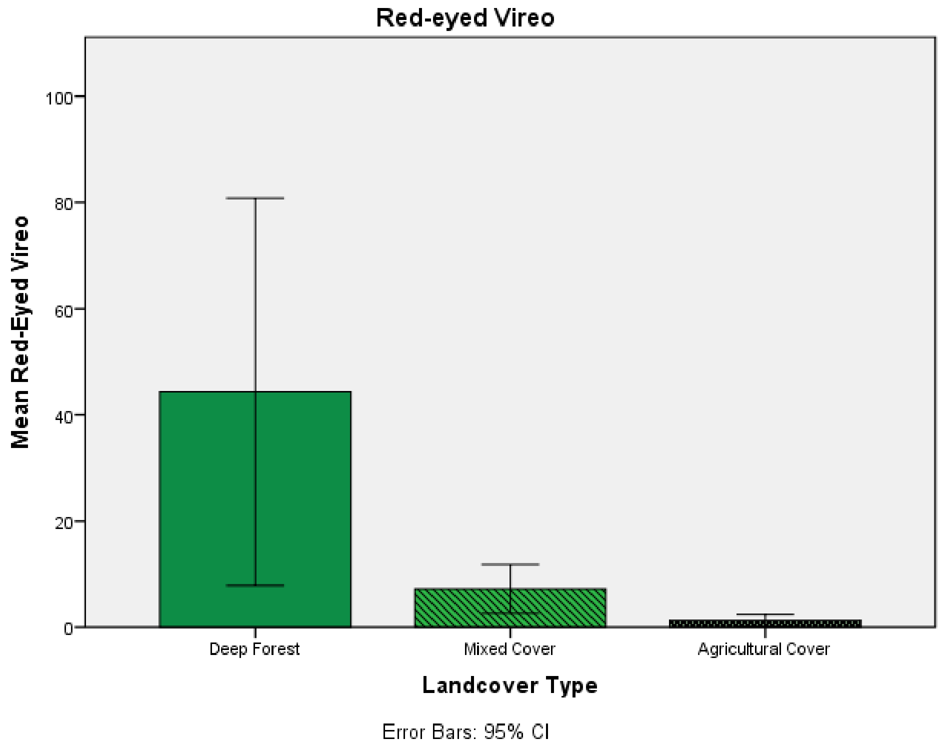

Figure 9: Graphed Results for Red-eyed Vireo for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

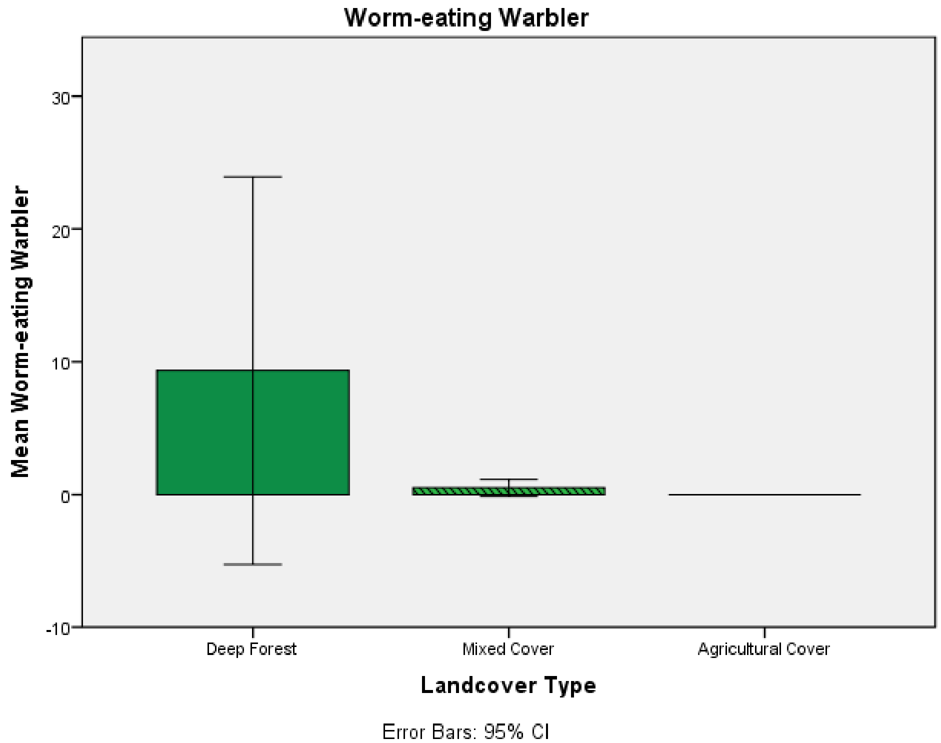

Figure 10: Graphed Results for the Worm-eating Warbler for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

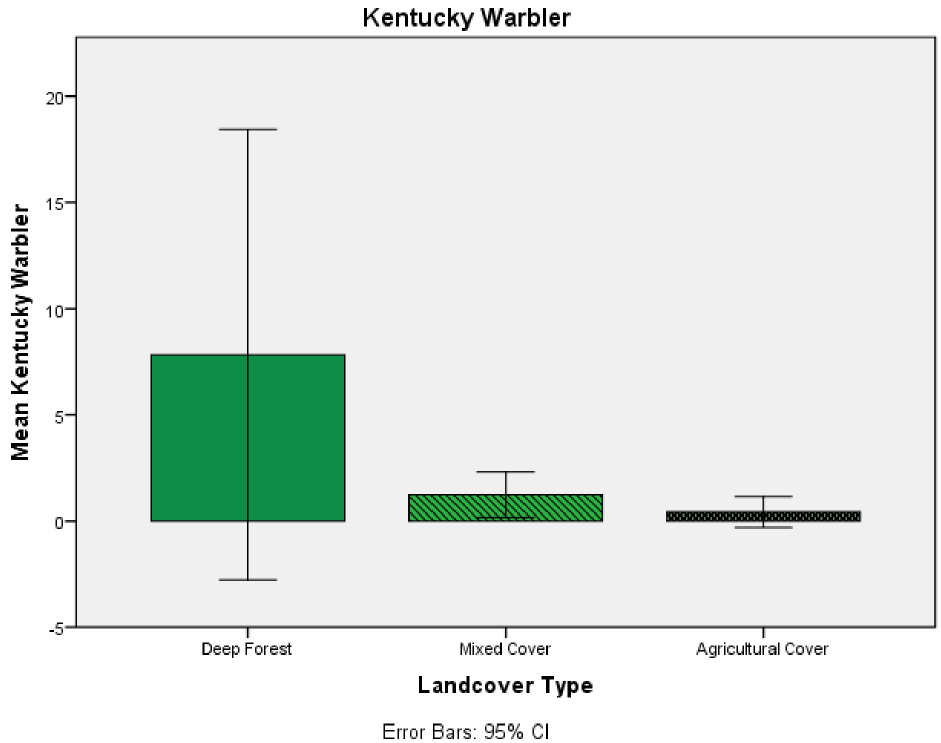

Figure 11: Graphed Results for the Kentucky Warbler for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

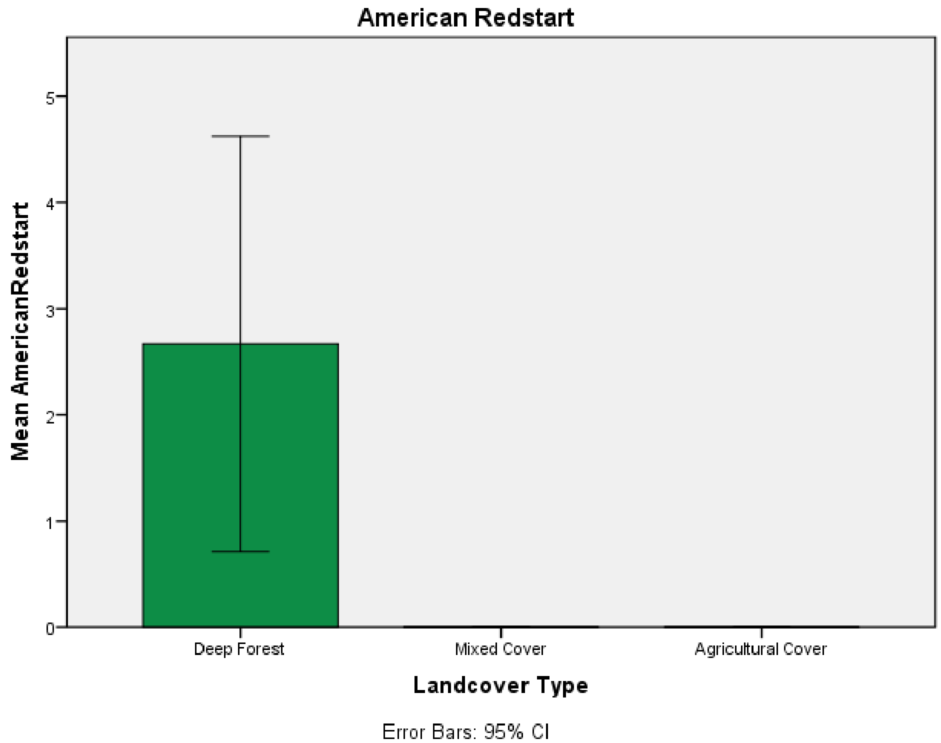

Figure 12: Graphed Results for American Redstart for Landcover Type analysis comparing abundance counts collected on Breeding Bird Survey Routes in Kentucky in 2011. This test compared difference in abundance between three cover types. Six routes, which were located in >80% forest land cover, were considered deep forest cover routes; Eight routes, which were located in 80-30% forest cover were considered mixed cover routes; Seven route, which were located in <30% forest cover, were considered Agricultural cover routes.

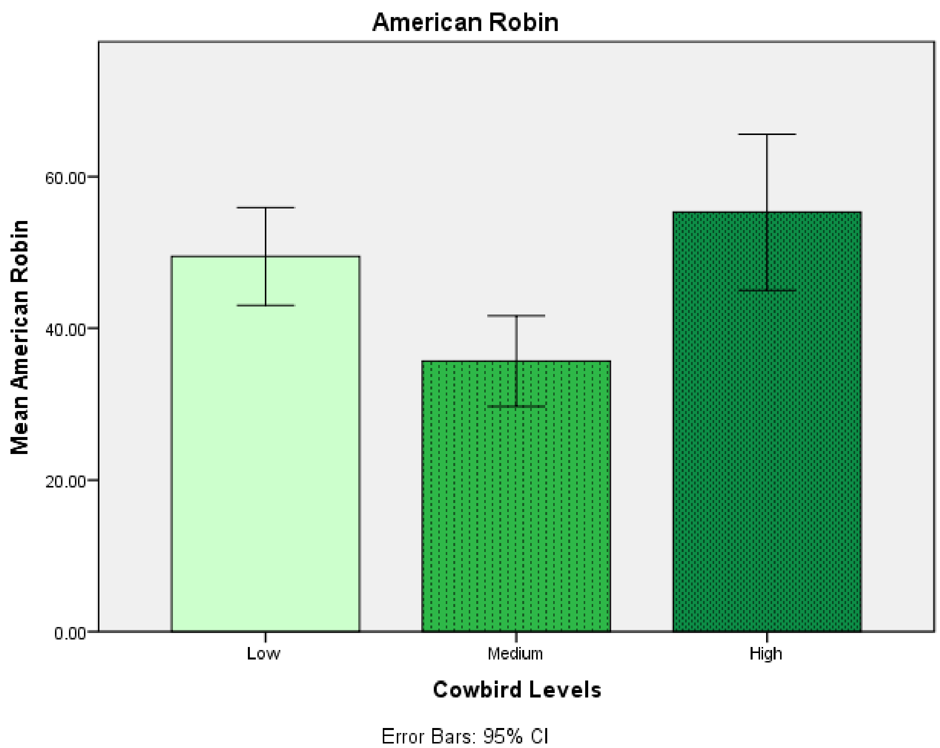

Figure 13: Graphed Results for American Robin, Brown-headed Cowbird abundance analysis. Analysis compared abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- “low annual mean”, 2- “medium annual mean”, 3-“High annual mean”).

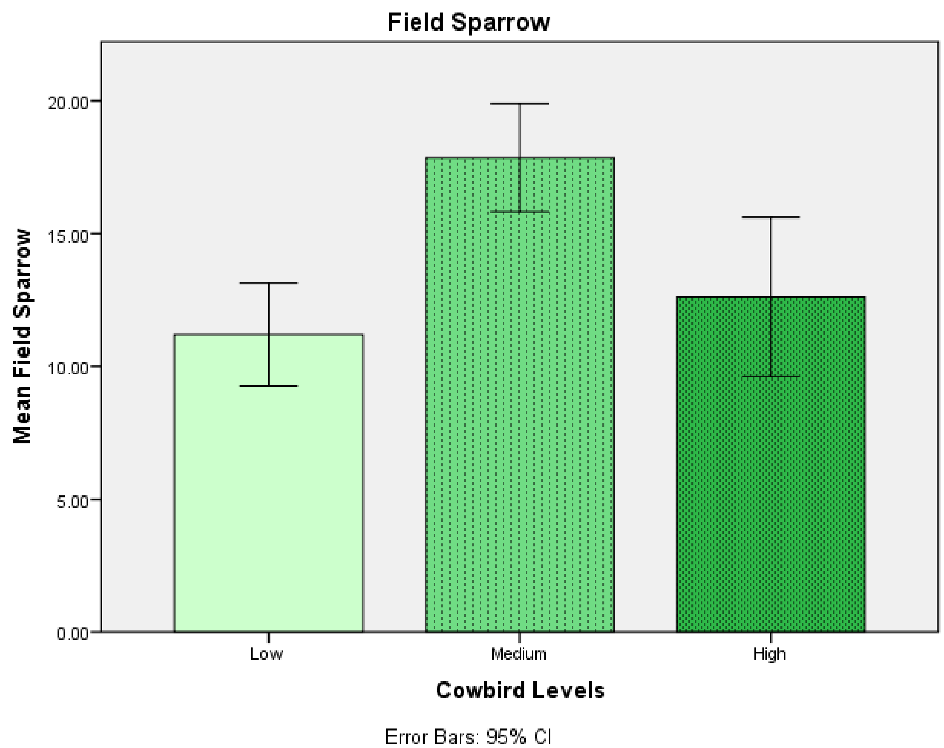

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Figure 14: Graphed Results for Field Sparrow, Brown-headed Cowbird abundance analysis. Analysis compared abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- “low annual mean”, 2- “medium annual mean”, 3-“High annual mean”).

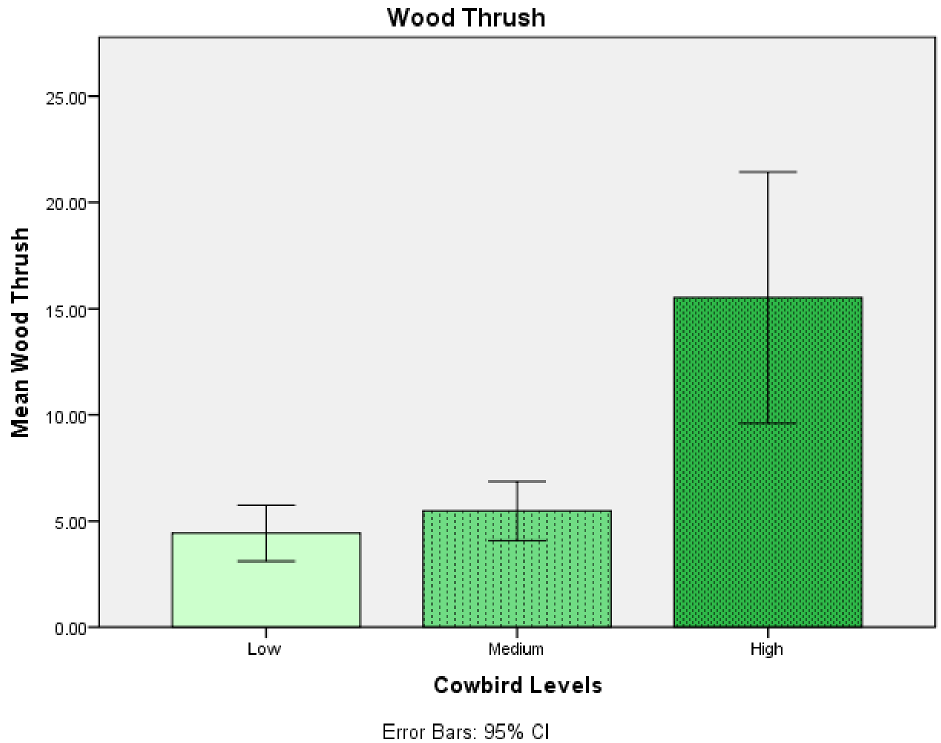

Figure 15: Graphed Results for Wood Thrush, Brown-headed Cowbird abundance analysis. Analysis compared abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- “low annual mean”, 2- “medium annual mean”, 3-“High annual mean”).

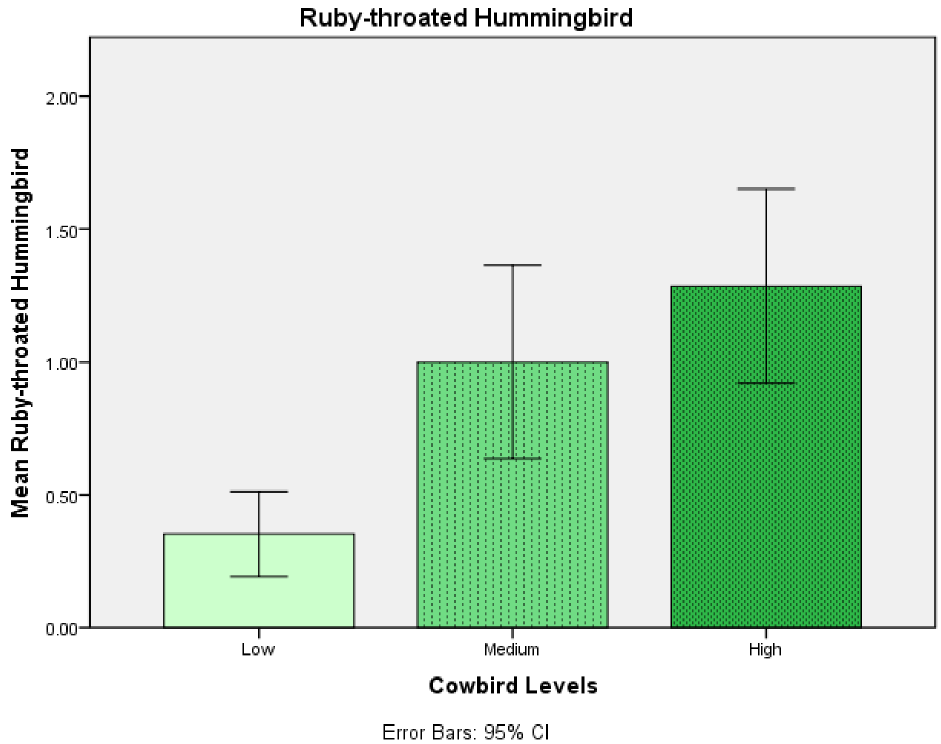

Figure 16: Graphed Results for American Robin, Brown-headed Cowbird abundance analysis. Analysis compared abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- "low annual mean", 2- "medium annual mean", 3-"High annual mean").

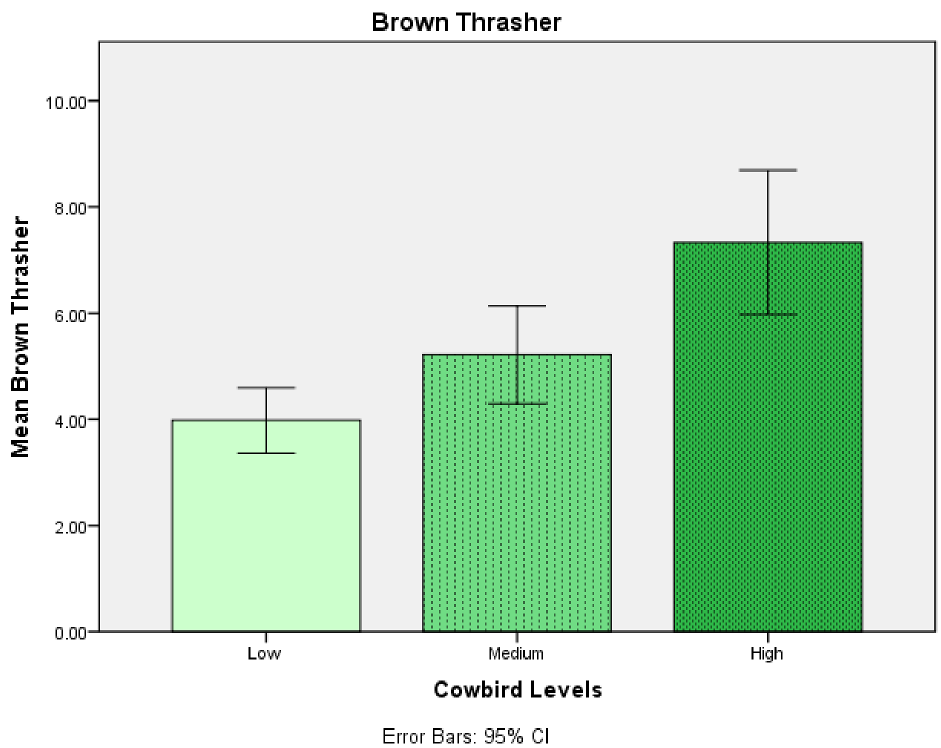

Figure 13: Graphed Results for Brown Thrasher, Brown-headed Cowbird abundance analysis. Analysis compared abundance counts collected on Breeding Bird Survey Routes in Kentucky from 2006-2011. Routes were sorted into three categories determined by the mean abundance of Brown-headed Cowbirds per route (1- "low annual mean", 2- "medium annual mean", 3-"High annual mean").