MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) AT STRAWBERRY PLAINS AUDUBON CENTER: 2017-2018

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INTRODUCTION

Pronounced declines in populations of many North American landbird species are evident in count-based data analyses from large-scale, long-term monitoring programs (Robbins et al. 1989, Peterjohn et al. 1995, Bart 2005; e.g., North American Breeding Bird Survey). Although these findings are useful for describing geographic and temporal changes, they do not provide the causes for declines or, more specifically, information regarding which life-cycle stage accounts most for observed population changes (Temple and Wiens 1989, Sherry and Holmes 1995). Thus there is a critical need for demographics data to delineate proximate and ultimate causes of bird population changes across spatial and temporal scales so proper conservation and management actions can be prescribed (DeSante 1995, Sillett and Holmes 2002, Julliard 2004, DeSante et al. 2005).

In 1989, the Institute for Bird Populations (IBP) developed Monitoring Avian Productivity and Survivorship (MAPS), a cooperative, constant-effort, bird banding program that occurs during the breeding season to provide critical demographic information. This is done through evaluating capture-recapture data to show long-term trends of demographic parameters (i.e. vital rates) such as population size, adult survivorship, productivity, and recruitment into the adult population (DeSante et al. 1993, 1995). The MAPS program has grown to include over 1,400 banding stations across the USA and Canada, operated by individuals, government entities, and non-governmental organizations (IBP 2017). Over two million bird capture records have been processed, and hundreds of papers and reports have been published (https://www.birdpop.org/pages/maps.php) from the data. MAPS results have been combined with other large-scale bird census data to provide valuable insights regarding the influence of vital rates on population metrics (Saracco et al. 2009, George et al. 2015). Recently, IBP has analyzed MAPS data spanning from 1992 to 2006 including 682,119 banding records from 628 banding stations to launch the website "Vital Rates of North American Landbirds" (DeSante et al. 2015). For 158 landbird species, this website provides vital rates that can aid scientists, planners, and managers to direct conservation efforts at specific annual stages which limit populations (Saracco et al. 2008).

To contribute to MAPS efforts in Mississippi, I collaborated with Strawberry Plains Audubon Center (SPAC) Director, Mike Muraco and Conservation Education Manager, Mitchell Robinson to initiate a MAPS program at SPAC during 2017. We aligned our MAPS objectives with those of IBP. Objectives for the MAPS program are to provide (1) annual indices of adult populations and post-fledging productivity, and (2) annual estimates of adult survivorship, adult population size, and recruitment into the adult population (DeSante 2000).

METHODS

Study Site

Large-scale bird conservation projects in North America are often modeled within the framework of Bird Conservation Regions (BCRs), which are defined by the North American Bird Conservation Initiative as "ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues" (http://nabci-us.org/resources/bird-conservation-regions/). Our MAPS study site is located near Holly Springs, Mississippi, at SPAC, a 2,600 acre nature preserve with several diverse landscapes, including upland and lowland mixed forests, prairies, wetlands, and shrublands. SPAC is within the Southeastern Coastal Plain (SCP) BCR, which extends from west Tennessee south to the Gulf Coast and east to the Atlantic Coast, bordered by the Appalachian Mountains to the north (Figure 1).

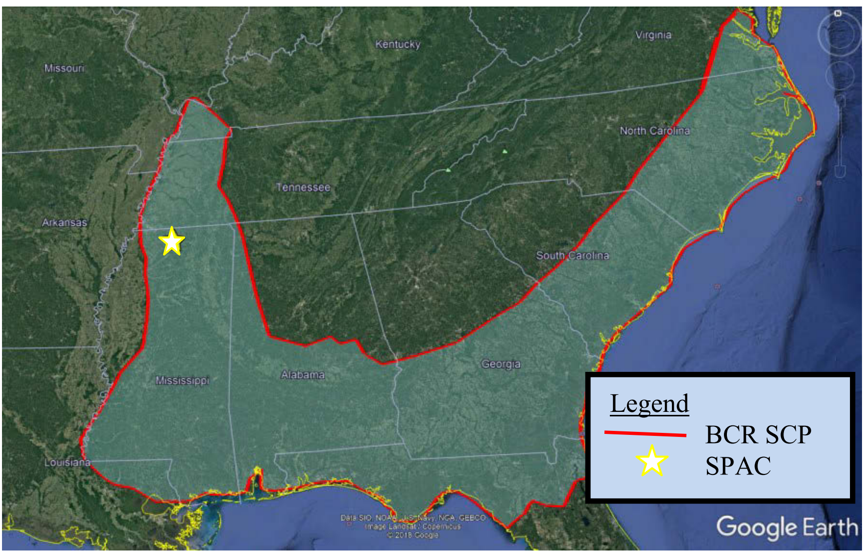

Figure 1. Location of Strawberry Plains Audubon Center (SPAC) within the Southeastern Coastal Plain (SCP) Bird Conservation Region (BCR).

Research Objectives

Effective analyses of population demographics data require at least four years of data collection (DeSante 2000, Albert et al. 2016). Given the newness of our MAPS station, the scope of this paper is limited to reporting productivity analyses using data available to date (2017 and 2018). We conducted a limited productivity analysis for species in which we captured ≥30 aged unique individuals in both years combined. These data may provide insight on whether productivity is a limiting factor for breeding birds at SPAC compared to populations at larger geographical scales.

Data Collection

MAPS stations are located where human development is limited, and nets are spread out across the landscape to be representative of the habitat (all methods summarized in DeSante et al. 2016). Stations are operated one out of every ten days during designated "periods" throughout the breeding season. There were eight banding sessions from May to August 2017 and 2018. Birds were captured in "mist nets" (dimensions: 12 m long and 2.5 m tall) made of a fine material specifically for the purpose of safely and humanely trapping birds. The mesh size we used, 30-mm, captured our target populations (i.e. songbirds, woodpeckers, cuckoos) most effectively. The MAPS protocol suggests operation of seven to 20 mist nets opened around sunrise for four to six hours, using the same net locations each year to standardize capture data. For the SPAC MAPS station, we operated 20 nets for five hours per day. Nets were spread 100 m apart, across 36.2 ha of upland hardwood forest and early successional prairie and shrubland (Figure 2). The banding station included all area that was within 100 m of each net.

During banding sessions, we checked nets every 30 min. Birds were quickly extracted and placed into breathable cloth bags, then brought to a central station and processed as quickly as possible. At the banding station, birds were first marked with a uniquely-numbered United States Geological Survey (USGS)

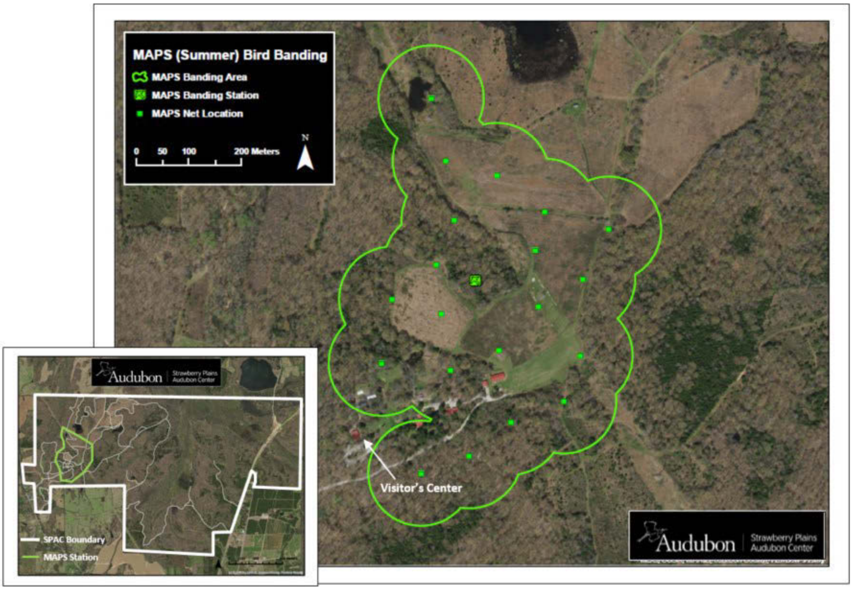

Figure 2. SPAC MAPS banding station location. Station included 20 nets with 100 m buffer surrounding all nets.

lightweight aluminum band before taking data (i.e. band number, capture status [new or recapture], species, age, sex, ageing and sexing criteria, physical condition including breeding status data, capture time, station, and net number; e.g., Figures 3-7). We used ageing and sexing guidelines established by Pyle (1997, 2004) and exhibited in photographs by Froehlich (2003). After processing, birds were released at the station. Females with brood patches (Figure 8) and fledglings were processed and released first.

Other data collected for MAPS were effort (number of hours each net was open), habitat data, and breeding (summer residency) status. Effort was calculated through the standardization and recording of net opening and closing times for each period, and was reported as “net hours”. We conducted habitat surveys in 2018 across the banding station using IBP’s Habitat Structure

Figure 3. After hatch year (adult, left) and hatch year (young, right) White-eyed Vireos. Note difference in eye color. Photograph by Thomas Blevins.

Figure 4. After hatch year (adult, left) and hatch year (young, right) Tufted Titmice. Note difference in plumage condition. Photograph by Thomas Blevins.

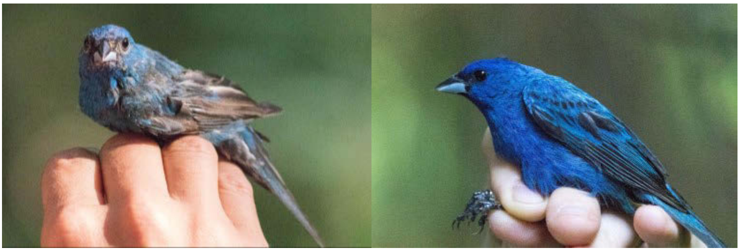

Figure 5. Male Indigo Buntings. Left is a second year male (born the previous calendar year); right shows after second year male (born ≥two calendar years before). Second year male Indigo Buntings show more brown coloration in their overall plumage. Photograph by Thomas Blevins.

Figure 6. Male (left) and female (right) adult (after hatch year) Kentucky Warblers. Note the more extensive black face mask and gray crown feathers of male. Photograph by Fields Falcone.

Figure 7. Hatch year (born in current year) Northern Cardinal male receiving an aluminum USGS band. Note black on bill and red-orange tie dye appearance of body plumage which characterizes this bird's age and sex. Photograph by Thomas Blevins.

Figure 8. Brood patch on female Yellow-breasted Chat. During incubation, birds lose the feathers on their lower abdomen to provide more direct heat to eggs and young. Photograph by Mitchell Robinson.

Assessment protocol to evaluate vegetation type and structure (Nott et al. 2003). Breeding status was recorded for all birds detected during the banding session, employing methods similar to those used for Breeding Bird Atlas surveys (e.g., Mass Audubon 2008).

All data were entered into the computer program MAPSPROG (Froehlich et al. 2006). This program vetted all banding, effort, and breeding status data to verify coding and consistency of banding and species records (Albert et al. 2016). We also uploaded our MAPS data into Bandit, the software program administered by the USGS Bird Banding Lab to catalog all banded birds in the USA and Canada.

Data Analysis

Productivity rates were calculated from the proportions of young and adults captured for six species in which we captured ≥30 aged unique individuals in both years combined: White-eyed Vireo (*Vireo griseus*; n = 49), Carolina Wren (*Thryothorus ludovicianus*; n = 34), Yellow-breasted Chat (*Icteria virens*; n = 88), Common Yellowthroat (*Geothlypis trichas*; n = 50), Northern Cardinal (*Cardinalis cardinalis*; n = 30), and Indigo Bunting (*Passerina cyanea*; n = 84). Differences in productivity between species and year were tested using a two-way ANOVA that included species and year as independent variables. This test was performed using the R statistical computing package (v 2.1, Boston, MA, USA). To compare the productivity differences (numerical response variables) of the six species across the three geographic scales (SPAC, SCP BCR, entire breeding range of each species; categorical predictors), we performed a Welch's t-test using Microsoft Excel software. This test was appropriate because the samples were of unequal size and had unequal variances. We tested for significance using $\alpha = 0.05$ (95% confidence interval).

RESULTS AND DISCUSSION

We collected data from 322 banded birds comprising 35 species during 2017 (Appendix Table 1). Total net hours for 2017 was 640.50, resulting in a capture rate of 0.503 birds per net hour. We collected data from 285 birds comprising 32 species during 2018 (Appendix Table 1). Total net hours for 2018 was 654.84, resulting in a capture rate of 0.435 birds per net hour. These numbers include all newly banded birds plus unique recaptures (birds not banded during the current MAPS season), but they do not include unbanded birds: Ruby-throated Hummingbirds (20 in 2017, 11 in 2018) and birds that escaped or were released before banding (20 in 2017, 19 in 2018). The total species captured for both years was 40. Overall productivity results show that in 2017, 20.2% of our captures were hatch year birds from 19 species. In 2018, 16.5% of our captures were hatch year birds from 20 species.

Mean productivity at SPAC varied by species (ANOVA; $F_{5,6} = 6.083$, $p = 0.035$) but not by year (ANOVA; $F_{1,6} = 0.424$, $p = 0.543$; Figure 9). Though not significant, Common Yellowthroat productivity varied the most between years (SD = 0.114) by increasing from 2017 to 2018. Northern Cardinals showed a slight non-significant decrease in productivity from 2017 to 2018 (SD = 0.078). Mean productivity observed at SPAC for all six species combined did not differ significantly from that observed at the SCP BCR (ANOVA; $F_{5,6} = 1.87$, $p = 0.055$) or the entire breeding range for all species (ANOVA; $F_{5,7} = 1.41$, $p = 0.100$).

In 2018, we determined the MAPS banding station habitat composition: 62% was lowland or submontane cold-deciduous forest dominated by red and white oaks (*Quercus* sp.) and musclewood (*Ostrya virginica*); 25% was temperate cold-deciduous shrubland dominated by sweetgum (*Liquidambar styraciflua*), sawtooth blackberry (*Rubus argutus*), and Canada goldenrod (*Solidago canadensis*); 13% of the banding station was tall sod temperate grassland dominated by big bluestem (*Andropogon gerardii*), broomsedge bluestem (*Andropogon virginicus*), sawtooth blackberry, and Canada goldenrod.

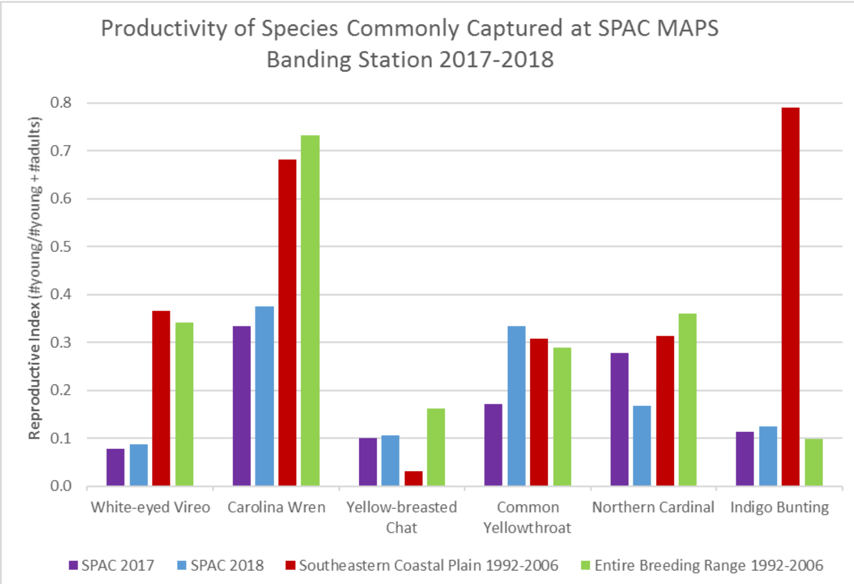

Figure 9. Productivity means of the six most commonly captured species (n ≥30 for each species) at SPAC MAPS banding station during 2017-2018, and their respective productivity means across the SCP BCR (1992-2006) and their entire breeding range (1992-2006).

Our breeding status survey effort varied between 2017 and 2018 as we developed the monitoring protocol. Consequently, I do not present the results or analysis here.

Plans for Future Research

SPAC MAPS 2017-2018 productivity data should be considered lightly as it is too soon to use these data to create definitive assumptions of SPAC's productivity levels of breeding birds compared to their respective larger breeding ranges. It is important to also emphasize that productivity is only one of a few important vital rates that drive populations. For example, Yellow-breasted Chats may have high productivity at SPAC, but their recruitment and adult survivorship could be low; thus their population at SPAC could be declining.

Ultimate, long-term goals for SPAC MAPS research are to identify sources of population change, to prescribe conservation management to address population declines, and to measure the effectiveness of implemented conservation approaches (DeSante 2000). After the 2020 MAPS field season, we will send our four-year dataset to IBP statisticians. They will evaluate data using capture-mark-recapture models and general linear mixed models to measure population change, adult apparent survival probability, residency, recruitment, index of adults per station, index of young birds per station, productivity, and post-breeding effects across space and time (Albert et al. 2016). We will use the results provided by IBP to interpret SPAC demographic parameters compared to similar parameters across various geographic scales.

Additionally, we have plans to augment SPAC MAPS results with SPAC breeding bird survey data collected intermittently from 2006 through 2017, to compare results. SPAC breeding bird surveys, modeled using North American Breeding Bird Survey methodology (Sauer et al. 2013) modified to fit SPAC's size and research needs, consist of 10-min point counts for all birds conducted once per breeding season at selected points. Several are located within or near the MAPS banding station.

In conclusion, we will continue to conduct habitat surveys once every five years across the banding station. We will collect several years of point count survey and MAPS data before analyzing and reporting breeding bird-habitat relationships at SPAC. We foresee that results from this comprehensive data collection and interpretation will help guide conservation management actions that target integral life stages for birds at SPAC. We are hopeful that our data will be a useful part of the larger pool of vital rates data used by research institutions, conservation groups, local and regional government offices, and other non-profit organizations to understand the demographic elements of declining bird populations and to facilitate cooperative conservation.

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APPENDIX

Appendix Table 1. Species captured during SPAC MAPS 2017 and 2018. Most of the species caught were common breeders among the varied habitats within the banding station.

Species	# Adults/young processed 2017[1]	# Adults/young processed 2018[1]
Yellow-billed Cuckoo (*Coccyzus americanus*)	2/0	0/0
Ruby-throated Hummingbird (*Archilochus colubris*)[2]	0/0	1/0
Downy Woodpecker (*Dryobates pubescens)*	0/1	1/1
Great Crested Flycatcher *(Myiarchus crinitus*)	0/0	4/0
Eastern Kingbird (*Tyrannus tyrannus*)	0/0	1/0
Eastern Wood-Pewee (*Contopus virens*)	3/5	7/1
Acadian Flycatcher (*Empidonax virescens*)	12/1	10/1
Eastern Phoebe (*Sayornis phoebe*)	5/2	0/1
White-eyed Vireo (*Vireo griseus*)	24/2	21/2
Yellow-throated Vireo (*Vireo flavifrons*)	1/0	0/0
Red-eyed Vireo (*Vireo olivaceus*)	3/0	3/0
Carolina Chickadee (*Poecile carolinensis*)	2/0	0/1
Tufted Titmouse (*Baeolophus bicolor*)	5/2	4/3

Species	# Adults/young processed 2017[1]	# Adults/young processed 2018[1]
Carolina Wren (*Thryothorus ludovicianus*)	12/6	10/6
Blue-gray Gnatcatcher (*Polioptila caerulea*)	1/0	1/0
Eastern Bluebird (*Sialia sialis*)	5/0	5/0
Wood Thrush (*Hylocichla mustelina*)	6/2	17/1
American Robin (*Turdus migratorius*)	0/1	0/0
Brown Thrasher (*Toxostoma rufum*)	0/1	0/0
Northern Mockingbird (*Mimus polyglottos*)	1/0	0/0
American Goldfinch (*Spinus tristis*)	6/0	4/0
Eastern Towhee (*Pipilo erythrophthalmus*)	1/0	5/3
Field Sparrow (*Spizella pusilla*)	8/0	6/1
Yellow-breasted Chat (*Icteria virens*)	45/5	34/4
Orchard Oriole (*Icterus spurius*)	6/12	3/1
Brown-headed Cowbird (*Molothrus ater*)	0/0	1/0
Worm-eating Warbler (*Helmitheros vermivorum*)	0/0	0/1
Louisiana Waterthrush (*Parkesia motacilla*)	5/0	3/3

Species	# Adults/young processed 2017[1]	# Adults/young processed 2018[1]
Black-and-white Warbler (*Mniotilta varia*)	0/2	0/0
Prothonotary Warbler (*Protonotaria citrea*)	3/0	1/0
Kentucky Warbler (*Geothlypis formosa*)	10/4	10/1
Common Yellowthroat (*Geothlypis trichas*)	24/5	14/7
Hooded Warbler (*Setophaga citrina*)	1/0	0/0
Northern Parula (*Setophaga americana*)	1/0	1/0
Yellow Warbler (*Setophaga petechia*)[3]	1/0	0/0
Prairie Warbler (*Setophaga discolor*)	6/1	7/0
Summer Tanager (*Piranga rubra*)	5/3	9/1
Northern Cardinal (*Cardinalis cardinalis*)	13/5	10/2
Blue Grosbeak (*Passerina caerulea*)	1/0	5/0
Indigo Bunting (*Passerina cyanea*)	39/5	35/5

[1]Includes all newly banded birds and novel recaptures (i.e. birds not banded within named MAPS season). Birds that we were unable to age (n = 6 from 2018 MAPS banding) are not included in Table 1 or in 2018 population productivity estimate; they are included in total birds processed.
[2]We captured many Ruby-throated Hummingbirds at our SPAC MAPS station, but we released them unbanded. This single 2018 record was for a female that was a foreign recapture (not banded at our station) for which we did record data.
[3]Late migrant; likely did not breed at SPAC.