Findings of the MAPS Songbird Netting Study at the Jug Bay Wetlands Sanctuary: 25 Years of Monitoring Data

Alexander (Sandy) Teliak and Christopher Swarth

DECEMBER 2016

TABLE OF CONTENTS

FIGURES AND TABLES

INTRODUCTION

In 2014, the Jug Bay Wetlands Sanctuary (JBWS) in Lothian, Maryland - a regional park within the Anne Arundel County Department of Recreation and Parks - completed its 25th year as a participant in the California-based Institute for Bird Populations (IBP) MAPS Program. MAPS is an acronym for Monitoring Avian Productivity and Survivorship. The Program started in 1989 with about 16 stations and now has hundreds of monitoring stations continent-wide (Sarracco et. al. 2009). Participating in the MAPS program since 1990, we are one of the longest operating stations on the East Coast and currently one of only two still operating in Maryland. The objective of the MAPS Program is to gather data on the population size, survival rates, and productivity for over 150 target migrant and resident species. Jug Bay, along with hundreds of other MAPS stations across the continent, collects data during the breeding season. The IBP analyzes this data using sophisticated statistical modeling to determine how those rates relate to environmental factors such as habitat structure, forest composition, and global climate change. Once this data is evaluated, and causes of avian population changes are determined, the IBP would be better able to suggest management actions to enhance survivorship and/or productivity, evaluate the effectiveness of management actions, and make the most out of the limited conservation dollars. (Smith et. al. 2009)

The populations of many songbird species in Maryland and throughout North America are in decline. Many causes for these declines have been identified but the loss, degradation and fragmentation of breeding and/or overwintering habitats is considered one of the main factors impacting songbird populations (Ellison 2010; Terborgh 1989).

Several other long-term monitoring efforts exist to assess bird populations on a continent-wide scale. The annual Christmas Bird Count (CBC) began over 100 years ago and is now coordinated by the National Audubon Society. The CBC data is used to monitor bird populations in winter. The North American Breeding Bird Survey, organized by the USGS Patuxent Wildlife Research Center, began in 1965 to monitor populations during summer, at the time many species are breeding. All of these efforts utilize professional ornithologists and volunteers to conduct surveys, counts and to monitor bird populations across North America. MAPS differs from these other monitoring efforts in a profound way because birds are captured, measured and banded. The initial capture and subsequent recapture data that the MAPS Program provides is critical in determining between the two main indicators of songbird declines: adult year-to-year survivorship and breeding productivity. While the other aforementioned monitoring efforts can provide an assessment of the degree of species presence in an area, they cannot estimate population decline.

This report provides a detailed history of our effort, the protocols used as they evolved over time, and a summary and detailed look of our data with a primary focus on productivity, survivorship, longevity and adult population trends as they relate to our top five migrant and top five resident species, including other select species. Others parameters measured are sex parity, banding rates by banding period, net productivity, and injury/mortality data. Our data set is small compared to avian populations at-large so our observations may or may not mirror other

stations in the area or reflect the state of avian populations on a larger scale. The data presentation herein is the result of extensive data mining. We have distilled a large volume of data into more manageable tables. While such presentations may be rudimentary, the data herein is factually correct. Any layman or "citizen scientist" can understand this report. Hopefully, an interested academic, intern, or volunteer will find some nugget of information herein that will prompt them to do a more academically rigorous study of our data.

ESTABLISHMENT OF THE MAPS EFFORT AT JUG BAY -1990

A. Why?

Chris Swarth, then Director of the Sanctuary with avian research experience and Danny Bystrak, Wildlife Biologist and Master Bander with extensive local banding experience, initiated the Jug Bay songbird monitoring study at JBWS for several reasons. The Sanctuary consists of relatively undisturbed and protected habitats that support a variety of songbirds. About 60 songbird species breed in the Sanctuary – most of whom are the focus of the MAPS Program's efforts. Therefore, a study of these birds in habitats that would remain relatively unchanged for the foreseeable future seemed promising from a MAPS research standpoint. Another motivation was to contribute data to a project that was at least regional in scope and that would address some of the issues affecting avian populations as well as the interplay of factors that determine population trends. Finally and perhaps most importantly, they wanted to learn more about birdlife in the Sanctuary and to collect data that would help determine if its populations were stable, declining, or increasing. In the process, they wanted to train others (volunteers) in bird netting and banding techniques,who would assist with the field work. The MAPS Program, which started in 1989, was perfect for their purposes and (one year after its start), was already operating on a continent-wide scale. The Sanctuary had an opportunity in 1990 to begin a new study and MAPS was a perfect match. Since then, the Sanctuary has evolved into a 1,700 acre environmental education center and ecological research station with a wide range of on-going research and monitoring projects.

B. MAPS Study Area - Site Selection and Habitat Description

The founders of the effort were looking for an area with good habitat, that was clearly defined, and one that had adequate food and water resources. The site selected is roughly triangular shaped and is bordered on the west by the tidal wetlands of the Patuxent River, on the east by the floodplain of Two Run Branch, on the southeast by a one-hectare beaver pond and to the north by the Railroad Bed Trail. Two Run Branch is a permanent stream. The MAPS protocol defines a MAPS study area as extending 100 meters out from the peripheral nets. Consequently, our study area currently is roughly 16 hectares. The elevation of the site varies from sea level to 30 feet above sea level. Three hiking trails (Otter Point, Railroad Bed and Two Run Branch) run along the periphery of, but within, the site. The site was logged once to several times over the last 50 to 150 years. Since 1974, when the land was purchased for protection, there has been no disturbance to the study area. Hikers and groups of school children use the hiking trails on a limited basis on days when we are not conducting our study.

The site is flat on the western portion of the study area and slopes gradually to slightly higher ground on the eastern part. The entire area is quite open, but with sparse to moderately dense shrub layering in some parts. Storm damage and over browsing by White-tailed Deer on herbaceous plants, shrubs and tree seedlings over the past decade has caused the study area to be more open than it was in the early 1990's.

Standardized vegetation surveys following MAPS protocols were conducted in 1992, 1995, 1999 and 2007 (Nott 2000). Results of the 2007 habitat survey determined that the core of our study area was predominantly lowland or submontane cold deciduous forest (National Vegetation Classification Standard (NVCS) code IB2Na) dominated by American Beech, oaks and hickories with some Virginia Pine, Sweet Gums, Red Maple, and Tulip Tree. The upperstory had a 95% canopy cover. The midstory and shrub layer consists mostly of American Holly, Dogwood, Black Willow, High-bush Blueberry, Viburnum, Paw-paw, and Sassafras and had a 15% cover. The understory had a 5% cover. Since a study area by MAPS definition extends 100 meters out from the outermost nets, we had several sub-habitats on the periphery. On the eastern side of the Two Run Branch flood plain area we had temporarily flooded cold deciduous forest (NVCS code IB2nd). On the western side we had tidal temperate perennial forb vegetation (NVCS code VB2ng) and on the southeast and southwest sides, small areas of tidal cold deciduous forest (NVCS code IB2nh).

Under the MAPS Program, the continent is divided into eight regions. The JBWS falls within the Southeast Region which encompasses all or parts of 16 states – DE, OH, NJ, IN, MD, VA, KY, IL, NC, TN, AL, GA, SC, MS, LA and FL.

Our MAPS station number is 16603 and our coordinates are 38 46 50 -076 42 14. We operate under banding permit #9517.

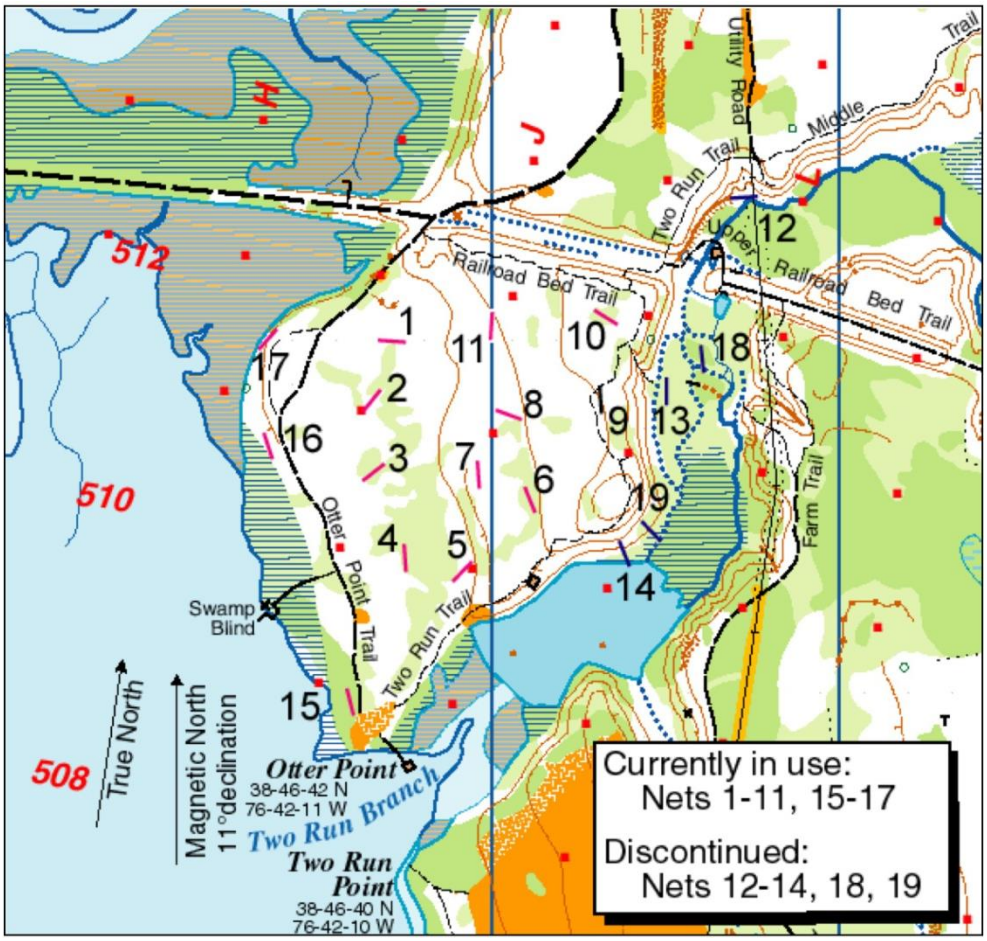


Figure 1. Jug Bay Wetland Sanctuary's MAPS Study Site with Net Locations. Map courtesy of Dave Linthicum.

STUDY PROTOCOLS 1990-2003 VS. 2004-2014

A core operational goal of the MAPS program is to maintain a constant effort from year-to-year in how data collection is conducted. This is accomplished by standardizing protocols so that data comparisons from year-to-year are possible. In our early years, like the MAPS program at large, we experimented with our protocols to try to optimize them. Protocols were subsequently changed by the MAPS program and/or us in the early years to embrace best practices. Changes in volunteer personnel or the study site itself (e.g. creation of the Beaver Pond) in some instances necessitated altering our protocols as noted below. Since 2004, our operating protocols have become far more standardized and consistent. For information on the design and objectives of the MAPS Program and desired MAPS protocols, see the most recent IBP MAPS Manual which details every aspect of site establishment, data collection, procedures, and reporting (DeSante et. al. 2014).

A. Net Locations/Years of Operation – We use black, four-tiered nylon mist nets that are 12 m X 2.6 m with 30 mm mesh. Nets are attached to tall pipes or trees and tethered with guy lines.

In 1990, the original nets 1-11 were put in place within the core of our study area. These 11 nets have never been moved from their original location and remain in use through 2014. By the end of the 1992 season, we were noting a limited number of captures of hatch year (HY) birds – especially Red-eyed Vireo – in our 11 nets. In the hope of capturing more HY birds, six more nets were placed along the periphery nearer water in 1993. Nets 15-17 were placed on the west side adjacent to the Patuxent River and the South Marsh. Nets 15-17 have been in continuous operations now from 1993 through 2014. Also in 1993, nets 12-14 were added on the east side of our study area in the Two Run Branch floodplain. Net 12 stayed in operation through 1999. In 2000, due to shifts in the Two Run Branch, nets 13 and 14 were relocated further northeast along the Two Run Branch and re-numbered as nets 18 and 19. Those two nets stayed in operation through 2003. Prior to the start of the 2004 season, the decision was made to cease operating the only three nets (nets 12, 18, 19) in the Two Run Branch flood plain area. This decision was based on changing water flow and soil conditions in the floodplain and the time required to travel to these nets. The unavoidable decision to subsequently terminate operations of any nets in the Two Run Branch flood plain came at a heavy cost. Net 14 (1993-1999) was our most productive net ever averaging 28 bandings per season. Nets 19 and 12 were our second and third most productive nets ever averaging 22 and 16 bandings per season, respectively. Nets 13 and 18 averaged nine bandings while operating placing them in the middle for productivity. The termination of nets in the Two Run Creek flood plain area led to significant declines in the captures of Louisiana Waterthrush, Hooded Warblers and White-eyed Vireos. Starting with the 2004 season, we have operated 14 nets – nets 1-11 and 15-17.

During the MAPS breeding season study, when not in use, nets remain hung but are closed and tied shut. We have not had any vandalism of our nets in the ensuing 25 years. At the end of each season, nets are removed, repaired, and stored.

(For detailed information on the UTM coordinates and latitude/longitude coordinates for all nets and their current status, see Table 1 (Appendix). These net locations are also posted on the map (Figure 1). For detailed information on our MAPS net usage and net hours of operation for 1990-2014, see Table Two in the Appendix.

B. MAPS Banding Operation Periods - In 1990 when the MAPS Program was established, the IBP broke the breeding season down into twelve 10-day periods starting on 1 May (Period One) and running through 28 August (Period Twelve) as noted in Table 3. From 1991-1996, we generally operated in Periods Two through Period Eleven and occasionally into Period Twelve.

Table 3. - MAPS Study Banding Periods

Period	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Start	1 May	11 May	21 May	31 May	10 Jun	20 Jun	30 Jun	10 Jul	20 Jul	30 Jul	9 Aug	19 Aug
Stop	10 May	20 May	30 May	9 Jun	19 Jun	29 Jun	9 Jul	19 Jul	29 Jul	8 Aug	18 Aug	28 Aug

For the start of the 1997 season, reinforcing that this is a breeding season study, the IBP changed the protocol to minimize the capture of non-breeding species that were in migration. As a result, banding Periods Eleven and Twelve were dropped altogether to prevent capture of any fall migrants. Furthermore, a MAPS station's starting Period was determined based on the station's latitude and altitude in an effort to minimize the capture of spring migrants. Our start Period became Period Three. While understandable, we missed not being able to capture non-breeding migrant warbler species passing through that we had banded in Periods Two, Eleven and Twelve in earlier years such as Bay-breasted, Black-throated Blue, Blue-winged, Chestnut-sided and Myrtle. Starting in 1997, we banded in eight consecutive periods from Three through Ten and have remained so since with two minor exceptions. We did band in what it was Period Eleven in 1999 and 2000 for some unknown reason giving us nine banding sessions in those years.

We usually operated one day within eight consecutive 10-day periods. The one exception to the one day per period effort was in 1991 when we experimented – with IBP's approval - banding two days in each of Periods Two-Eleven for a total of 20 banding days. We did not continue this in subsequent years as our productivity went from banding 18.6 birds per 100 net hours of operation in 1990 to only 9.1 birds per 100 hours of net operation in 1991. We had encountered the phenomena of bird net avoidance wherein breeding birds learn to avoid nets that are opened too frequently. Less frequent net operations reduces this problem.

(For detailed information on our banding periods and the number of days banded per year, see Table 4 in the Appendix page MM).

C. Net Round Times – On the first day (5 June) of the inaugural season (1990), the first round was conducted at 0610 with subsequent rounds seemingly starting at 0710/0810/0910/1010. Starting with the 2nd day of that season (13 June), it appears that the start of net round times were 0700/0800/0900/1000/1100. Many of the times posted in the inaugural year appear to represent the time the bird was being processed instead of the start of the round time. From 1991-2003, we conducted five rounds with start times of 0700/0800/0900/1000/1100. Starting in 2004, with the downsizing from 17 to 14 nets, we changed our round times by conducting six rounds at 50 minute intervals starting at 0700 followed by 0750/0840/0930/1020/1110. According to the MAPS Manual (DeSante, 2014), the standard opening time for nets is local sunrise and the standard closing time is six hours later although they give you some flexibility in this regard. We opted for a consistent start of opening nets at 0600, all nets open by approximately 0620-0625, first round at 0700, last round at 1110 during which nets are closed..

D. Conducting the Net Round - A core of 3-5 experienced banders and volunteers make net rounds according to the aforementioned schedule. We carry all our banding supplies in a bucket so that we can process and release the birds at the net to minimize disruption during the breeding season. Typically we carry size 0A through size 3 bands, band spreaders, assorted banding pliers, wing chord rulers, and spring scales. Captured birds are removed from the net, banded and identified to species, aged and sexed using methods described by Pyle (1997). Certain biometrics are collected (e.g. - wing chord, weight). Data is recorded on the proscribed MAPS banding and recapture data sheets by volunteers. To minimize processing time at the

net, we instituted a procedure of having two separate data recorders – one for the bandings and one for recaptures – who can be recording simultaneously. This permitted us to get through heavy rounds without getting too backlogged. Frequently visitors join us to observe our operation.

E. Site Breeding Status List - The banding and recapture data we provide IBP, along with the other MAPS stations, is the core data set from which IBP conducts their analysis. An adjunct to that, however, is completing the Breeding Status List. Our banders and volunteers listen for, and visually observe, avian activity within the study area during each session particularly looking for breeding/nesting behaviors such as nest building, courtship/copulation activity, territorial behavior, song/drumming etc. This data augments the banding/recapture data and helps IBP confirm whether a species we capture is a breeder (regular, usual or occasional) or non-breeder. In addition, this data facilitates IBP's developing a more complete picture of those species breeding at the Sanctuary whose foraging behavior may not result in their capture in MAPS nets in consonance with their actual relative abundance. For example, the Northern Parula is rarely captured in our nets due to their behavior of staying high in the tree tops. We know from fairly consistent aural and visual observations over the course of many breeding seasons that they are usual breeders. Their aural and visual absence since 2012 however, suggests they may not be breeding as much at Jug Bay. As an historical note, during the 1989-1990 MAPS seasons, the IBP required each station to conduct point counts – ideally at least 48 per season. This task proved too time-consuming for most MAPS stations – including Jug Bay – and the requirement was eliminated in 1991 although stations were encouraged to conduct them if resources were available. We never provided point count data.

F. Standardized Protocols Since 2004 – Since 2004 and continuing through 2014, we have operated under the same protocol:

(1) We operate 14 nets during each banding season (Nets 1-11, 15-17) for approximately 570 net hours (on average) per season.

(2) We conduct eight banding sessions per season.

(3) The season starts in Period Three (late May) and closes in Period Ten (late July- early August) .

(4) We have six net rounds per banding session at 50 minute intervals – 0700/0750/0840/0930/1020/1110.

(5) Net rounds are conducted in the following sequence of nets: 1, 17, 16, 2, 3, 15, 4, 5, 6, 7, 8, 9, 10, 11.

BANDING AND CAPTURE/RECAPTURE RESULTS

A. Overall Bandings – The very first bird banded was an adult male Northern Cardinal (0991-44228) banded during the 1st round (0610) on 5 June 1990 at net 2. Since then, we have

banded a total of 2,990 songbirds and woodpeckers of 64 species between1990-2014. Of the 64 species banded, 52 were neo-tropical migrants (as defined in the Neo-tropical Migratory Bird Conservation Act) and 12 were resident species. From Table 5A below, we see that our Top Five migrant species accounted for almost 50% of this station's bandings, the remaining 47 other migrant species accounted for about 26% of total bandings with migrants accounting for over 75% of all bandings. Similarly, our Top Five resident species accounted for almost 21% of this station's bandings, the remaining seven resident species for about 4%, and overall resident bandings accounted for about 25% of this station's total bandings.

Table 5A. Summary of Species Banded Including Top Five Migrant and Top Five Resident Species.

Top Five Migrant Species	Number of Bandings	As % of All Bandings	Top Five Resident Species	Number of Bandings	As % of All Bandings
Wood Thrush	437	14.6%	**Carolina Wren**	175	5.9%
Red-eyed Vireo	359	12.0%	**Northern Cardinal**	165	5.5%
Acadian Flycatcher	324	10.8%	**Tufted Titmouse**	142	4.7%
Ovenbird	209	7.0%	**Downy Woodpecker**	78	2.6%
Common Yellowthroat	153	5.1%	**Carolina Chickadee**	57	1.9%
Top Five Totals	1482	49.6%	**Top Five Totals**	617	20.6%
47 Other Migrant Species	769	25.7%	**7 Other Resident Species**	122	4.1%
Totals	2251	75.3%	**Totals**	739	24.7%

Collectively, these Top Five migrant and Top Five resident species accounted for about 70% of all of our bandings. Had we created an overall Top Ten list, the Louisiana Waterthrush (migrant) with 74 bandings (2% of total bandings) would have supplanted the Carolina Chickadee at #10.

The mean number of birds banded annually was 120 (SD 35.8), changing from a high of 155 (2013) to a low of 65 (2004). It is important to consider that some of the differences on the number of birds banded from year to year may be due to the fact that the number of nets that were operated during some seasons varied as did the number of days banded. As a result, it is not useful to just consider numbers banded without factoring in the number of nets in operation and days banded each season. To take into account variation in the numbers of nets and the number of days they were operated, we can normalize the data to some degree by dividing the numbers banded by the number of net-hours multiplied by 100. A net-hour is one net open for one hour. This gives us a standard metric of numbers of birds banded per 100 net-hours. This makes it possible to compare data from year-to-year (assuming all else to be equal). The mean number banded annually per 100 net-hours was 17.9 (SD 4.1) and numbers ranged from 27.1 per 100 net-hours (2013) to a low of 9.1 (1991). Since 2004 when we operated 14 nets

consistently for the past ten years, the mean number banded per 100 net-hours was 17.6 (SD 4.7), and numbers varied between 11.7 (2004) to 27.1 (2013).

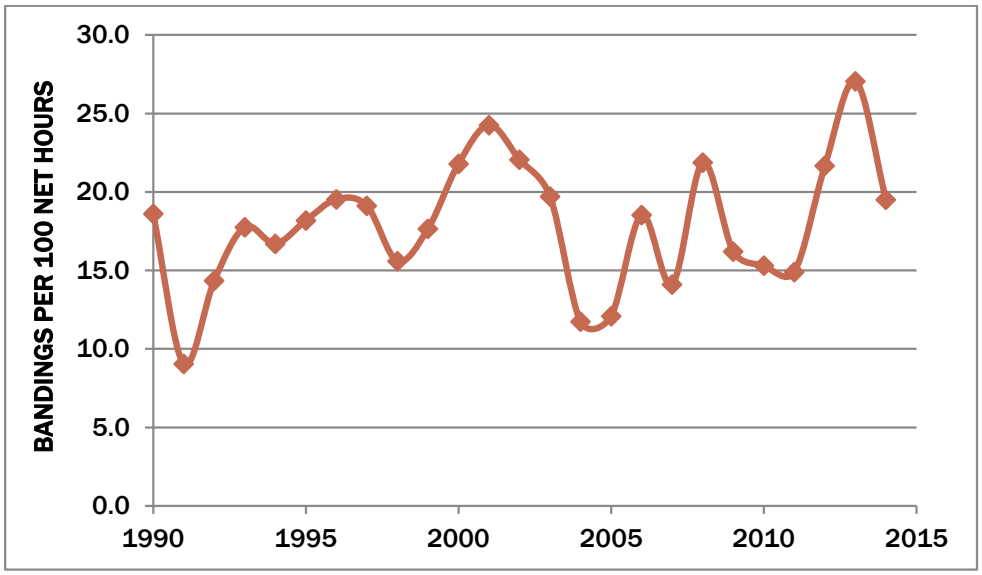


Figure 2. Bandings/100 Net Hours 1990-2014

We effectively monitor four of six species that the US Fish and Wildlife (USFWS) have identified as Birds of Conservation Concern in the mid-Atlantic region: Acadian Flycatcher, Wood Thrush, Prothonotary Warbler, and Louisiana Waterthrush (Nott et. al. 2008). We provide effective monitoring of 14 species of “greatest conservation concern” according to the “2005 Maryland Wildlife Diversity Conservation Plan” approved by the USFWS in May 2006: Acadian Flycatcher, Brown Thrasher, Eastern Towhee, Hairy Woodpecker, Louisiana Waterthrush, Northern Parula, Ovenbird, Prothonotary Warbler, Red-eyed Vireo, Scarlet and Summer Tanagers, Wood Thrush, Worm-eating Warbler and Yellow-throated Vireo.

Table 5B below fleshes out the annual banding rate for our Top Five resident and migrant species and all others combined.

Table 5B. Annual Variation in Bandings of Top Five Resident and Top Five Migrant and All Other Species

SPECIES	TOTAL BANDED	MEAN PER YEAR	SD	TOTAL PER 100 NET HOUR	MEAN PER 100 NET HOURS	SD PER 100 NET HOURS
Wood Thrush	437	17.5	6.3	67.0	2.7	1.0
Red-eyed Vireo	359	14.4	7.6	52.3	2.1	0.9
Acadian Flycatcher	324	13.0	5.9	48.4	1.9	0.8
Ovenbird	209	8.4	3.5	31.9	1.3	0.5
Common Yellowthroat	152	6.1	3.8	22.8	0.9	0.6
Carolina Wren	175	7.0	4.5	26.6	1.1	0.7
Northern Cardinal	165	6.6	3.6	25.5	1.0	0.6
Tufted Titmouse	142	5.7	3.5	22.3	0.9	0.6
Downy Woodpecker	78	3.1	2.4	11.8	0.5	0.3
Carolina Chickadee	57	2.3	2.8	8.1	0.3	0.4
All other 54 species	891	35.6	19.3	130.0	5.2	2.6
Total	2990	119.6	35.8	447.3	17.9	4.1

(For a detailed summary of the number of bandings by species per year, see Table 6A. Appendix Page XX . For a detailed summary of species banded, their four element Alpha code, scientific name, AOU#, recommended band size per Pyle (1997), breeding status, and migrant vs. resident status, see Table 6B. Appendix page LL).

B. Bandings of Warblers that Breed at Jug Bay - Of the 64 total species banded, 12 were warbler species that breed at Jug Bay and accounted for 685 (23%) of all of our bandings. Of those 12 warbler species, five (Ovenbird, Louisiana Waterthrush, Prothonotary, Common Yellowthroat and Yellow-throated) are regular breeders and accounted for 489 (16%) of our total bandings. One warbler species, the Northern Parula, is considered a usual breeder with 37 bandings (1%). Since 2004, however, we have only banded two Northern Parula and we haven't seen or heard any in our study area since 2012 so its status may change. The six remaining warbler species are considered occasional breeders (Worm-eating, Black and White, Kentucky, Hooded, American Redstart Yellow-breasted Chat) and accounted for 83 (3%) of our banding total.

C. Bandings of Warblers and Other Species That Do Not Breed at Jug Bay – Bandings of twelve other warbler species that do not breed at Jug Bay accounted for 76 (<3%) of our total bandings. In addition, we had 54 bandings (<2%) of four migrant species that do not breed at Jug Bay - Swainson's Thrush (32), Grey-cheeked Thrush (14), Veery (6) and Traill's Flycatcher (2). Most of these bandings were in part the result of our banding operations in Periods Two, Eleven and Twelve; during these periods some birds were probably captured while in route to/from their normal breeding area. In the case of Swainson's and Grey-cheeked Thrush, they are late migrants and may still be passing through the Jug Bay area during Period Three when

we start our MAPS season. We also had seven bandings of three species (Blue Grosbeak, Cedar Waxwing, and Song Sparrow) deemed as transients, meaning that our MAPS station is within the breeding range of the species but no individuals of the species is a summer resident at our station during any year.

D. Recaptures of JBWS Banded and Non-JBWS Banded Birds - From 1990-2014, our MAPS effort had 1,766 recaptures of 844 individual birds of 36 migrant and resident species. Not all of those recaptures, however, were of birds banded solely by our MAPS effort. Other banding activity occurs at the Sanctuary's nearby River Farm situated opposite our MAPS study area on the east side of the Two Run Branch floodplain. Banders at the River Farm have included: (1) The IBP for MAPS training purposes from 1998-2008, usually in the early part of May; (2) Personnel from the Smithsonian Environmental Research Center in Edgewater, MD, and Smithsonian Migratory Bird Center – National Zoo periodically conduct research e.g. looking for evidence of west Nile virus; and (3) A fall migration monitoring effort from 1995-2004. River Farm bandings by others accounted for 112 of our recaptures of 70 birds/22 species. In addition, we have captured birds banded by a property owner about 1.7 miles from our MAPS study area. Twenty-one recaptures of 15 birds/8 species fell into this category.

Our most significant capture of a bird not banded by us occurred on 21 May 1997 when we captured an adult female Common Yellowthroat (1680-47662) that was initially banded on 27 May 1995 as an adult/female at the Adventure MAPS site in Montgomery County, MD, some 33 miles away. This is the longest distanced recapture by us in 25 years. We have no information on any of our banded birds being recaptured distant from our station.

E. Captured But Not Banded – During the course of our MAPS effort, we captured but did not band 100 birds of 26 species. The decision for not banding these birds was the result of several factors: (1) Not having the necessary permit to band was the case with 39 Ruby-throated Hummingbirds that were captured and immediately released unharmed; (2) The captured bird is not part of the MAPS study effort because it doesn't breed at Jug Bay (this was not applied uniformly as we have numerous bandings of such species); (3) We did not carry the necessary band size; (4) The bird escaped our grasp after extraction from the net and before processing began ; or (5) The captured bird was stressed or injured at which point any processing of that bird ceases and the bird is immediately released.

Our most "unusual" unbanded captures were of three Pileated Woodpeckers (31 May 2005, 28 May 2013 and 30 July 2013) and two Red-shouldered Hawks (1 August 2004 and 15 July 2007).

KEY FINDINGS AND OBSERVATIONS ON PRODUCTIVITY, SURVIVORSHIP, LONGEVITY AND ADULT POPULATION TRENDS

A. Productivity and Hatch Year Birds - The IBP tries to answer the following question on a macro scale - Is the species producing enough hatch year birds (HY - born that breeding season) to sustain the population given the very high rate of avian mortality at the HY and adult

level (the survivorship aspect of MAPS)? The answer to that question requires voluminous data collection and complex statistical modeling to determine how those two variables (productivity) and (survivorship) interplay to ensure survival of the species.

Our HY bandings relative to adult bandings has been fairly consistent over the past 25 years. From 1990-1992, when using only our original 11 nets, HY birds accounted for 24% of all of our bandings that were aged. In 1993, hoping to increase our HY bandings particularly of Red-eyed Vireos, we established six more nets (12-17) on the periphery of our core study area. These new net locations were closer to water sources on both sides and had different habitats than our core study area (nets 1-11). These 17 nets stayed in operation through 1999. In 1999 and again in 2004, we altered our net configuration. Despite these four different net configurations overtime (nets 1-11 were in use through every configuration), our overall HY rate for all species that could be aged at banding has remained relatively stable between 23-27%. Our Top Five migrant and resident species however have shown some HY productivity improvements since 2000 but this improvement is tempered by a decline in all other species HY bandings since 2004 due to the loss of nets 12, 18-19.

Table 6. HY Banding Levels Under Different Net Configurations

	1990-1992	1993-1999	2000-2003	2004-2014
	Nets 1-11	**Nets 1-17**	**Nets 1-12, 15-19**	**Nets 1-11, 15-17**
Top 5 Migrants/Top 5 Residents	24% (48 of 201)	24% (158 of 667)	28% (123 of 446)	29% (230 of 781)
All other species	23% (8 of 35)	21% (72 of 350)	27% (48 of 179)	19% (61 of 318)
Combined Totals	24% (56 of 236)	23% (230 of 1017)	27% (171 of 625)	26% (291 of 1099)

Hatch year (HY) banding rates for our Top Five migrant and Top Five resident species and other select species is in Table 7 below. The HY data is presented in two ways: (1) the aggregate for all of our bandings which includes Periods Two, Eleven and Twelve in some banding seasons, and (2) Periods Three–Ten only, our breeding season specific periods.

As discussed earlier, bandings from Periods Two, Eleven and Twelve may not reflect solely those birds breeding at Jug Bay. Our Period Two data no doubt captured some adults still in migration to their breeding territory further distant from Jug Bay. We had 196 total bandings (36 species) in Period Two, all of them adults. In Periods Eleven and Twelve, we had 80 bandings (23 species) of which 58 were HY birds. Some of these may well have been adult and HY birds that had already started their fall migration and were not necessarily part of the Jug Bay breeding population. To minimize this non-Jug Bay breeder/bred data, we "stripped out" the Period Two, Eleven, and Twelve data. Nonetheless, we noticed only a very minor (3% or less), if any, change in our HY percentages.

Table 7 does present some interesting discussion points. One of the most surprising observations from our MAPS study is that from 1990-2014, we banded 359 Red-eyed Vireo of

which only 5 were hatch year birds. And only one of those was banded within this station's breeding season (Periods Three -Ten). The other four were banded in Periods Eleven and Twelve. This is all the more surprising given that we know the Red-eyed Vireo nests in our core study area containing nets 1-11 which have been operating for 25 years. Two possible explanations for our lack of Red-eyed Vireo HY bandings over these 25 years: (1) Either the HY Red-eyed Vireo immediately upon fledging leaves its natal area and goes to an entirely different habitat than that contained within our MAPS study area; or (2) the fledgling stays in the tree tops within its natal area and is fed by the adults until such time as it can depart the area and go to an entirely different habitat. In either case, the HY Red-eyed Vireo does not fly low enough to get caught in our MAPS nets nor do HY Red-eyed Vireos hatched elsewhere come into our MAPS study area habitat during natal dispersal during our Period Three -Ten breeding season.

We do note that all five of the Top Five migrant species had lower HY banding rates than four of the Top Five resident species. We will need to see how these HY banding rates match up to the survival rates of these species.

Continuing on with Table 7. We were surprised at the 32 Eastern Phoebe HY bandings. Only five were from our core nets of 1-11 (25 years of operation) suggesting that that part of our study area is not their nesting area. Nets 14 and 19 (seven and four years of operation, respectively) in the Two Run Creek flood plain accounted for 11 bandings; and nets 15-17 (22 years of operation) along the south marsh accounted for 16 bandings. The relatively high volume of Eastern Phoebe HY bandings in these two areas may suggest those nets are/were located in the Eastern Phoebe's nesting and/or natal dispersal area.

A similar explanation may apply to the Louisiana Waterthrush. Our core nets of 1-11 only produced seven hatch year bandings over 25 years. The five different nets in the Two Run Creek flood plain area that operated in part during 1993-2003 accounted for 28 HY bandings while the three south marsh nets (15-17) accounted for 11 HY bandings. Again, suggesting that these nets were proximate to the Louisiana Waterthrush's nesting and/or natal dispersal areas.

Similar explanations may relate to the Hooded Warbler, Common Yellowthroat and Prothonotary Warbler all of which showed higher HY bandings in the peripheral nets 15-17 or 12-14, 18-19 then the core nets 1-11.

Table 7. HY as % of Total Aged Bandings 1990-2014 for Our Top Five Migrant and Top Five Resident Species and Other Select Species

	HY AS % OF TOTAL AGED FOR PRDS 2-12	HY AS % OF TOTAL AGED FOR PRDS 3-10
Eastern Phoebe/M	77% (34 of 44)	75% (32 OF 42)
Carolina Wren/R (Top Five)	70% (122 of 175)	70% (116 OF 166)
Louisiana Waterthrush/M	62% (46 of 74)	62% (46 OF 74)
Downy Woodpecker/R (Top Five)	59% (46 of 78)	61% (43 OF 70)
Tufted Titmouse/R (Top Five)	46% (65 of 142)	46% (63 OF 136)
Hairy Woodpecker/R	45% (9 of 20)	47% (9 OF 19)
Carolina Chickadee/R (Top Five)	42% (24 of 57)	43% (24 OF 56)
Hooded Warbler/M	42% (21 of 50)	39% (13 OF 33)
Ovenbird/M (Top Five)	38% (80 of 209)	38% (74 OF 193)
Wood Thrush/M (Top Five)	26% (114 of 437)	27% (110 OF 410)
Prothonotary Warbler/M	24% (11 of 45)	21% (8 OF 39)
Northern Cardinal/R (Top Five)	24% (39 of 165)	25% (37 OF 147)
Common Yellowthroat/M (Top Five)	18% (27 of 152)	18% (25 OF 136)
Acadian Flycatcher/M (Top Five)	11% (37 of 324)	9% (26 OF 293)
Red-eyed Vireo/M (Top Five)	1% (5 of 359)	<1% (1 OF 326)

*R=Reside*nt, M=Migrant

Why do resident species need to have higher productivity rates than migrants in general? One answer may be the weather in Maryland over the winter. To survive, birds need access to food and water. The winters of 1995-1996 and 2009-2010 in our area were particularly noteworthy for at least one 24 inch plus snowfall in a single 2-day event in each season and cumulative totals of upwards of 63 and 77 inches in those respective winters. During our MAPS seasons of 1996 and 2010, we did not band or recapture a single Carolina Wren in either season. In the four years prior to 1996 and 2010, we averaged 4-6 adult Carolina Wren captures per season (new bandings and/or recaptures of birds banded in previous year). This suggests that the heavy snowfall in those winters deprived Carolina Wrens access to the food they needed to eat to survive and their population in our MAPS study area collapsed though not totally eradicated. In mid- and late-July 2010 we did hear a Carolina Wren in our MAPS study area (proving the value of completing the Breeding Status List). Normally we would hear/see Carolina Wren throughout the entire breeding season. Perhaps this Carolina Wren was a MAPS study area resident who survived but more likely it had moved into our study area due to the lack of competition. Interestingly, the winter of 2013-2014, was characterized by some aperiodic bouts of unseasonably cold temperatures (polar vortex) and a relatively modest snowfall of about 27 inches for the season over several events. This appears to have had some negative impact on our Carolina Wren populations as we banded only one adult and recaptured two adults that were banded in previous seasons. They had managed to survive the winter of 2013-2014. The

above suggests that the relatively harsh weather conditions some year-round resident species face in Maryland may necessitate higher productivity levels to sustain the species.

Since the resident Carolina Chickadee is smaller than the Carolina Wren (average weight 9.8 grams vs. 19.4 grams), we might expect them to be similarly affected. Our data set for them is too small (57 bandings) and sporadic over time (6 out of 25 years with no bandings or recaptures) to make any similar judgements.

(Very detailed summaries of the annual variance in Top Five migrant and resident bandings by age per year with concomitant totals, mean, standard deviation, and bandings per 100 net hours is contained in Tables 8B and 8C in the Appendix pages VV and YY)

B. Survivorship/Recaptures After Banding Year – Jug Bay's 25 years of continuous operation has provided invaluable data to the MAPS program responding to the question: How many of the adult species survive from one breeding season to the next and for how long? Survivorship and longevity data is only available through a mark-recapture effort such as banding conducted over a relative long period of time. Since every bird we band is given a unique band number, we can track its survivorship (and longevity) through time if the bird is recaptured in any years subsequent to its banding year. Breeding site loyalty will bring the adults back to the same breeding area (Jug Bay) if they have had success in previous years.

Tables 8A and 8B below reflect our recapture/survivorship data but they do require some explanation. Table 9A is data for those Top Five migrant and resident species that were aged as after hatch year (adult) at banding and Table 8B those that were aged as hatch year (born that breeding season) at banding. Using the Red-eyed Vireo data in Table 9A as an example: "Banded" reflects the number of adult Red-eyed Vireos banded (354) from 1990-2014. "Never Recap." reflects the number of Red-eyed Vireos (214 or 60%) that once banded were **never again** recaptured – not even in the same day as they were banded, same year they were banded, or in any subsequent years. Overall, 64% of adult Top Five migrants and 60% of adult Top Five residents, once banded, are **never again** recaptured. Thirty-nine of the 354 Red-eyed Vireos we banded (11%) were recaptured in their banding year but **never again**. Sixteen percent of our Top Five adult migrants and 14% of Top Five adult residents fell into this category. The "1" column reflects the number of Red-eyed Vireos (31 or ~9%) that were recaptured one year after their banding year and **never again** recaptured in any subsequent years. The "2" columns reflects the number of Red-eyed Vireos (22 or 6%) that were recaptured two years after their banding year and **never again** recaptured in any subsequent years. This same explanation applies for 3 through 10. The "Total Recaptured After Banding Year" tells us that we recaptured 101 different Red-eyed Vireos subsequent to their banding year. "Total as % of Banded" tells us that the 101 Red-eyed Vireos recaptured after their banding year represent 29% of all banded.

In the case of our Top Five migrant and resident species that were adults at banding (Table 8A), on average only about 20% of the Top Five adult migrants and 27% of the Top Five adult residents were recaptured in a year subsequent to their banding year. The majority of those adults that are not recaptured in subsequent years are due to either their mortality in the intervening time between breeding seasons – either during migration to/from their wintering

ground (for migrants) or during time spent on their wintering ground (for migrants and residents). Failure to successfully establish a nest in Jug Bay in a subsequent year and trying elsewhere and/or failure to recapture it even if it has returned to Jug Bay probably accounts for a relatively low percentage of the adult non-recaptures. From Table 9A we see that the Red-eyed Vireo shows not only a high percentage of recaptures in years subsequent to their banding year (29% - the highest for a migrant species) but also their recapture numbers (ten individuals) in 6 to 10 years after their banding year is far greater than any other species. Longevity for individuals of the species will be discussed in greater detail below.

Table 8A. Recapture of Adults for the Top Five Migrant and Resident Species.

	BANDED	NEVER RECAP	RECAP IN B. YR * THEN NEVER AGAIN	LONGEST # OF YRS BTWN BANDING. YR. AND LAST RECAPTURE THEN NEVER AGAIN										TOT. RECAP AFTER B. YR.	TOT. AS % OF BANDED
				1	2	3	4	5	6	7	8	9	10		
REVI	354	214	39	31	22	22	7	9	5	2	1	1	1	101	29%
ACFL	283	192	32	30	11	11	5	2						59	21%
WOTH	319	183	82	33	11	5	3	2						54	17%
OVEN	128	82	27	3	6	6	2	1				1		19	15%
COYE	125	101	14	4	5	1								10	8%
TOT.	**1209**	**772**	**194**	**101**	**55**	**45**	**17**	**14**	**5**	**2**	**1**	**2**	**1**	**243**	**20%**
DOWO	32	18	1	9	3	1	1							14	44%
TUTI	76	34	13	12	12	4					1			29	38%
NOCA	126	79	17	13	7	5	1	2	2					30	24%
CACH	32	25	2	3			1	1						5	16%
CARW	50	32	12	5	1									6	12%
TOT.	**316**	**188**	**44**	**42**	**23**	**10**	**3**	**3**	**2**	**0**	**1**	**0**	**0**	**84**	**27%**

Note: B. YR* = Banding Year

Migrants - REVI=Red-eyed Vireo , **ACFL**=Acadian Flycatcher, **WOTH**=Wood Thrush, **OVEN**=Ovenbird, **COYE**=Common Yellowthroat; **Residents** - **DOWO**=Downy Woodpecker, **TUTI**=Tufted Titmouse, **NOCA**=Northern Cardinal, **CACH**=Carolina Chickadee, **CARW**=Carolina Wren

In the case of birds banded during their hatching year and recaptured in subsequent years, the numbers are decidedly lower (Table 8B below). Only 4% of our Top Five migrant birds banded in their hatch year have been recaptured in years subsequent to their banding year. Only 9% of our Top Five resident hatch year birds have been recaptured in years subsequent to their banding year. Different factors come into play for hatch year birds than with adults of the same species. Studies show that the rigors of providing for themselves in the first few weeks after the adults stop feeding them (applies to migrants and residents), the rigors of the first migration itself (migrants only), and surviving their first year on their overwintering grounds (applies to both migrants and residents but probably impact residents more) result in a very low survivorship rate for hatch year birds. Lacking hard evidence, survivorship estimates of hatch year birds from population models can reach values up to 30%. A 2013 study of Prothonotary Warblers however, found that the average first-year survival rate was much lower at 11% and was less than half of the rate used by population modelers (McKim-Louder MI, 2013).

Those that do survive and return to Jug Bay and try to establish a breeding territory face the new challenges of breeding site territoriality by adults who have successfully nested at Jug Bay in previous years. Consequently, those that survive and return to Jug Bay and attempt to establish a breeding territory may not succeed and have to look elsewhere. All of these factors come into play making a determination of hatch year survivorship far more problematic. Consequently, the number of hatch year birds born at Jug Bay that survived to breed in a subsequent year is probably greater than our recapture rate of hatch year birds but still far less than adults.

Table 8B. Recapture of Hatch Year for the Top Five Migrant and Resident Species.

	BANDED	NEVER RECAP	RECAP IN B. YR* THEN NEVER AGAIN	LONGEST # OF YRS BTWN BANDING. YR. AND LAST RECAPTURE THEN NEVER AGAIN										TOT. RECAP AFTER B. YR.	TOT. AS % OF BANDED
				1	2	3	4	5	6	7	8	9	10		
WOTH	114	105	4	5										5	4%
OVEN	80	72	5	1			2							3	4%
COYE	27	24	2	1										1	4%
ACFL	37	35	1		1									1	3%
REVI	5	5												0	0%
TOT.	**263**	**241**	**12**	**7**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**4%**
TUTI	65	47	8	4	3	2		1						10	15%
CACH	24	18	3	1	1	1								3	13%
NOCA	39	34	1	0	3			1						4	10%
DOWO	46	42	1	3										3	7%
CARW	122	92	23	5	2									7	6%

TOT.	**296**	**233**	**36**	**13**	**9**	**3**	**0**	**2**	**0**	**0**	**0**	**0**	**27**	**9%**

Note: B. YR* = Banding Year

Migrants - REVI=Red-eyed Vireo , **ACFL**=Acadian Flycatcher, **WOTH**=Wood Thrush, **OVEN**=Ovenbird, **COYE**=Common Yellowthroat; **Residents** - **DOWO**=Downy Woodpecker, **TUTI**=Tufted Titmouse, **NOCA**=Northern Cardinal, **CACH**=Carolina Chickadee, **CARW**=Carolina Wren

C. Longevity – Recaptures in years after banding in Tables 8A and 8B above give us a sense of longevity or age. To compute a more precise age of birds, we use the formula posted by the Bird Banding Lab (Lutmerding and Love, 2014). Any bird aged as an after hatch year (AHY - most of our bandings) or second year at banding is an adult and deemed to have been born **no later than** the June of the year before the banding year. As an example, a bird banded in May 2010 and aged at banding as an AHY would be considered to have been born **no later than** June 2009. It would be **a minimum** of 11 months old at banding (May 2010), **a minimum** of one year old if recaptured in June 2010, **a minimum** of one year one month old if recaptured in July 2010 and **a minimum** of 4 years 11 months if recaptured in May 2014. The minimum age data from our MAPS study in Table 9 below is very telling. Of the 30 birds aged at a minimum of 6 years 0 months (an arbitrarily chosen floor minimum age) to our oldest at a minimum age of 10 years 11 months, seventeen (59%) are Red-eyed Vireos. Filling out the list of 30 are four Northern Cardinals, two each Ovenbird and Acadian Flycatcher and one each Tufted Titmouse, Scarlet Tanager, Eastern Wood-Pewee, White-eyed Vireo and Wood Thrush.

Most noteworthy is our Red-eyed Vireo (2031-91116) banded on 3 June 2003 as an adult (AHY). It was not recaptured again until 13 July 2010 and then again on 23 May 2013. Its sex, despite three captures, is unknown. This Red-eyed Vireo has been determined to be a minimum of 10 years 11 months old setting a new North American longevity record for this species. The previous record was 10 years 2 months. Another interesting and significant Red-eyed Vireo survivorship and longevity story involves an adult male (2091-03621) and an adult female (2091-03620) we banded on 15 May 1991, during the same net round, and captured in the same net (net 11). The male was recaptured two years later on 1 June 1993, again at net 11. Exactly six years, six days from their banding date, these same two Red-eyed Vireos were recaptured on the same day (21 May 1997), on the same net round, but in two different nets (the female at net 11 and the male at net 8) that are only 50 meters apart. Another interesting story of survivorship, longevity, breeding site fidelity, and perhaps even long-term mate fidelity.

Table 9. Longevity of Birds Banded at Jug Bay with a Minimum Age of 6 Years 0 Months Old at Last Recapture through 2014

	Band Number	Age	Sex	Last Recaptured	U.S. Longevity Record
Red-eyed Vireo	2031-91116	**10.11****	Unk	2013	**10.11**
Ovenbird	0960-77301	9.11	M	2003	11.0
Red-eyed Vireo	1561-92760	9.11	Unk	2006	10.11

	Band Number	Age	Sex	Last Recaptured	U.S. Longevity Record
Red-eyed Vireo	1551-23263	9.1	M	2009	10.11
Tufted Titmouse	1481-71621	9.0	Unk	2001	13.3
Red-eyed Vireo	0960-77388	8.0	Unk	2003	10.11
Red-eyed Vireo	2031-91042	8.0	M	2006	10.11
Scarlet Tanager	1481-71649	8.0	F	2001	11.11
Northern Cardinal	8071-82702	7.2	M	2000	15.9
Eastern Wood-Pewee	1830-75242	7.1	F	2002	8.2
Red-eyed Vireo	2061-23961	7.1	F	1996	10.11
Red-eyed Vireo	2031-91073	7.1	F	2006	10.11
Red-eyed Vireo	2031-91177	7.1	F	2012	10.11
Red-eyed Vireo	2091-03620	6.11	F	1997	10.11
Red-eyed Vireo	2091-03621	6.11	M	1997	10.11
Northern Cardinal	0991-44686	6.11	M	2000	15.9
Acadian Flycatcher	1830-75080	6.2	F	1995	12.1
Red-eyed Vireo	0960-77383	6.2	Unk	2000	10.11
Acadian Flycatcher	2560-66005	6.1	Unk	2014	12.1
Northern Cardinal	8071-82769	6.1	M	2002	15.9
Ovenbird	2031-91146	6.1	M	2009	11.0
Red-eyed Vireo	1551-23253	6.1	F	2006	10.11
Red-eyed Vireo	1551-23280	6.1	M	2007	10.11
Northern Cardinal	0941-87351	6.0	M	2013	15.9
Red-eyed Vireo	1601-23438	6.0	F	2014	10.11
Red-eyed Vireo	2091-03663	6.0	F	1998	10.11
Red-eyed Vireo	0960-77314	6.0	M	1999	10.11
Red-eyed Vireo	1551-23296	6.0	M	2007	10.11
White-eyed Vireo	1830-76716	6.0	F	1996	10.11
Wood Thrush	0941-87279	6.0	M	2011	10.2

**** North American longevity record**

To round out our Top Five oldest migrant and resident species that did not make it into Table 9 above: Carolina Chickadee/2170-94507/5.11/Unk/2007/10.8; Downy Woodpecker/1481-71661/5.0/M/1998/11.1; Common Yellowthroat/2170-94582/4.0//M/2007/10.11; and Carolina Wren/1361-85542/3.1/M/2014/7.8.

A detailed summary given by age at banding and sex of the mean (minimum) age at last recapture for all 364 of the Top Five resident and migrant species is in Table 10 below. In most cases, we get more males in subsequent years than females and the males usually have a larger mean (minimum) age. The one notable exception is the Red-eyed Vireo. While we recaptured more males (46) than females (28) in years subsequent to their banding year, the

mean (minimum) age of the females is surprisingly higher (50 months) than the males (42 months). When looking at the mean (minimum) age for the adults at last recapture, we came up with the following: Ovenbird (n=19)/47 months, Red-eyed Vireo (101)/46 months, Carolina Chickadee (5)/40 months, Northern Cardinal (30)/39 months, Acadian Flycatcher (59)/36 months, Tufted Titmouse (29)/35 months, Wood Thrush (54)/33 months, Common Yellowthroat (10)/32 months, Downy Woodpecker (14)/30 months and Carolina Wren (6)/26 months.

Looking at the 25-year aggregate, the adult Red-eyed Vireo is the most durable species at Jug Bay. It has the highest percentage of survivorship (29% from Table 8A.) of any Top Five migrant species and one of the highest mean (minimum) ages (46 months) at last recapture second only to the Ovenbird at 47 months.

Our Wood Thrush numbers show relatively low survivorship (17% recaptured after banding year from Table 8A) and relatively low mean (minimum) age (33 months) at last recapture suggesting that this may be cause for concern and a subject worthy of further study. The “durability” status of Red-eyed Vireos vs. Wood Thrush is all the more striking given the fact that the Wood Thrush is a larger bird (avg. weight=49 grams/wing=104mm) than the Red-eyed Vireo (avg. weight=17 grams/wing=78mm). Furthermore, the Wood Thrush flies a shorter distance to its wintering grounds in Central America than the Red-eyed Vireo which overwinters in the Amazon Basin.

We were surprised to see the adult Carolina Chickadee (5 bandings) had a robust mean (minimum) age of 40 months at last recapture. This is tempered by our small sample size and the longevity of two Carolina Chickadee which skews our results.

Table 10. Summary of Mean (Minimum) Age At Last Recapture of All 364 Top Five Migrant and Residents by Age at Banding and Sex

Top Five Migrants	Tot.	Mean (Min) Age in Months		Top Five Residents	Tot.	Mean (Min) Age in Months
REVI/AHY/F	28	50		NOCA/AHY/F	17	33
REVI/AHY/M	46	42		NOCA/AHY/M	13	48
REVI/AHY/U	27	48		NOCA/HY/F	1	24
REVI/HY	0			NOCA/HY/M	3	37
WOTH/AHY/F	19	30		CARW/AHY/F	2	24
WOTH/AHY/M	35	35		CARW/AHY/M	2	30
WOTH/HY/F	2	12		CARW/AHY/U	2	24
WOTH/HY/M	3	12		CARW/HY/F	5	12
				CARW/HY/U	2	24
OVEN/AHY/F	8	43				
OVEN/AHY/M	11	49		TUTI/AHY/F	4	30

Top Five Migrants	Tot.	Mean (Min) Age in Months		Top Five Residents	Tot.	Mean (Min) Age in Months
OVEN/HY/F	1	48		TUTI/AHY/M	11	32
OVEN/HY/M	1	48		TUTI/AHY/U	14	38
OVEN/HY/UNK	1	12		TUTI/HY/F	1	23
				TUTI/HY/M	4	30
ACFL/AHY/F	35	33		TUTI/HY/UNK	5	21
ACFL/AHY/M	6	34				
ACFL/AHY/U	18	40		CACH/AHY/F	1	23
ACFL/HY/U	1	24		CACH/AHY/M	1	24
				CACH/AHY/U	3	52
COYE/AHY/F	1	37		CACH/HY/U	3	24
COYE/AHY/M	9	32				
COYE/HY/M	1	12		DOWO/AHY/F	9	29
				DOWO/AHY/M	5	33
				DOWO/HY/F	2	11
				DOWO/HY/M	1	11

Detailed banding/recapture data for each of the 364 Top Five Migrant and Resident species recaptured in a subsequent year(s) after their banding year is available in Tables 12A to 12J found in the Appendix pages MM to RR. Each species has its own Table. For example, Table 12A for the Red-eyed Vireo contains a line for each of the 101 Red-eyed Vireos captured in a year subsequent to their banding year. Each line will contain the Red-eyed Vireo's banding year, unique band number, age at banding, sex, number of times recaptured within its banding year (if any), number of recaptures in subsequent years, number of years between banding year and last recapture year and the (minimum) age of that Red-eyed Vireo at last recapture. **For those birds banded in their hatch year (HY), the age is as noted and is not a minimum age.**

The tabular depiction in Tables 12A to 12J also provides a rudimentary insight into the recapture probability of each species in subsequent years. For example, if we band a bird in 2004 and it was last recaptured in 2008, breeding site loyalty would suggest the bird should have been present in our study area in each of those intervening years (2005, 2006, 2007). Yet we may have recaptured that bird in only 1, 2 or 3 of those intervening years – or not at all. Our recapture rate in intervening years for select species is as follows: Acadian Flycatcher/53% (24 of 45 intervening years), Northern Cardinal/37% (13 of 35), Ovenbird/25% (9 of 36), Red-eyed Vireo/39% (24 of 61) and Wood Thrush at 60% (16 of 27). This is not intended to be an absolute but a relative probability – i.e. – in our study, we have a higher chance of recapturing a Wood Thrush at least once in a breeding season (assuming it has returned and nested in our study area) than any other species. Non-recaptures in intervening years can suggest the bird may not

have successfully nested that year in our study area, its nesting location was on the periphery of our study area, or we simply didn't recapture it even though it was present in the study area.

D. Adult Population Trends – In order to compare data over time, and to minimize variability, we strive for "constancy of effort" in data collection. As described earlier, various facets of our protocols changed/evolved over time. This included numbers of nets used and net locations, seasonal start/stop periods, and numbers of banding days per period. While we can use birds banded per 100 net hours of operation to compare banding rates from one year to the next, this is somewhat rudimentary. Birds per 100 net hours of operation doesn't account for variability that do exist in our data collection techniques relative to the time frame banding occurs or the specific net used. Not all banding periods or nets are equal in their banding productivity.

To minimize the impact of variability on our data collection for our adult population trends analysis, we used only data collected from 1993 to 2014; periods Three thru Ten; nets 1-11, 15-17. Data collected for 1990-1992 was not used because: (1) in 1990 (our inaugural year) we did not start till Period Four and we only operated nets 1-11; (2) in 1991 we only operated nets 1-11 and we experimented with banding twice per period (but never again); (3) in 1992, we were still using only nets 1-11. We stripped out any Period Two, Eleven and Twelve data since we banded only aperiodically in those periods and some collection was of birds in Spring or Fall migration that were non-breeders to Jug Bay or species that do breed at Jug Bay but could have been just migrating during those periods. With very few exceptions, Period Three to Ten data reflects those birds on their breeding grounds at Jug Bay. We used only nets 1-11, 15-17 since they have been in use since 1993; used exclusively since 2004; and will likely be our nets of choice as we continue in the future.

We looked only at seven species: (1) our Top Five migrant species - Wood Thrush, Ovenbird, Acadian Flycatcher, Common Yellowthroat and Red-eyed Vireo and two of the Top Five resident species – Northern Cardinal and Tufted Titmouse. The relatively low numbers of adult captures of the other three resident species (Carolina Wren, Carolina Chickadee and Downy Woodpecker) precluded any useful analysis. What we determined is the number of unique adults that were captured/present (either banded or recapture of a previous year's banding) at least once during each breeding season from 1993-2014 within the aforementioned criteria (nets 1-11, 15-17; Periods Three-Ten). A complete accounting for each species and each year is contained in Table 13A (number of adults captured/present per year) and 13B (number of adults captured/present per 100 net hours of operation per year) in the Appendix page VV.

Table 11 below summarizes the Table 13A numbers. Using the Wood Thrush in Table11 for example: The mean number of individual adult Wood Thrush present per year within our study site was fifteen (SD 6.1). In 2011 (its worst year), there were only six individual Wood Thrush captured at least once within nets 1-11, 15-17 during Periods 3-10 in 2011 and in 2002 (its best year), there were twenty-seven individual Wood Thrush captured. Of those captures, some were new bandings and some may have been banded in a previous year. Thus the number per year reflects the number of individual adult Wood Thrush captured at least once in that year. How many of those Wood Thrush were successfully breeding at Jug Bay is unclear. As we noted earlier, about 57% of the Wood Thrush we band are never recaptured again after banding. Are

those one-timers merely unsuccessful in selecting a mate at Jug Bay and moving on? Or are they transients passing through the area (breeding nearby) searching for food or water? More study is needed.

It is encouraging to note that in all seven species, the best year was 2000 or later.

Table 11. Summary of the Number of Individual AHY Present; Nets 1-11, 15-17; Prds 3-10; 1993-2014

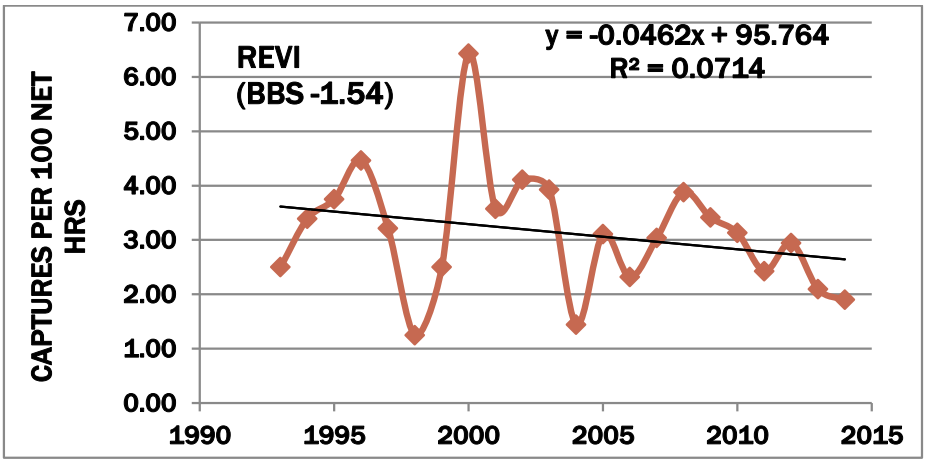
	TOT. ALL YRS.	MEAN PER YEAR	SD	BEST YEAR(S)	WORST YEARS(S)
WOTH	331	15	6.1	27/2002	6/2011
OVEN	129	5.9	3.4	16/2011	1/1994
REVI	389	17.7	6.3	36/2000	7/1998
COYE	99	4.5	2.6	10/2008	0/1994
NOCA	142	6.5	2.7	12/2003, 2009	2/1997
ACFL	295	13.4	4.8	24/2012	7/1996,1998, 2010
TUTI	117	5.3	2.7	12/2008	2/1997, 2001, 2004, 2007

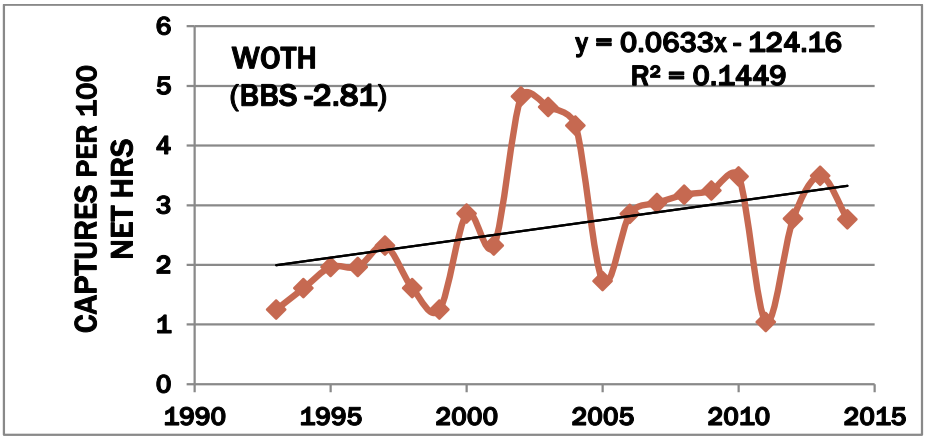
Figure 3 below plots out the number of individual birds per 100 net hours of operation for each of the seven species from Table 13B. (See Appendix page ZZ). A linear trend line is included. Also included in each chart is the Breeding Bird Survey (BBS) Trend Estimate for that species for the years 1993-2012 (last year available) for the Coastal Plain part of Maryland designated by the BBS as M30. For example, the BBS Trend Estimate for Wood Thrush in our region of Maryland (BBS designation M30) for the years 1993-2012 is a **negative** 2.81% meaning the population has **declined** on average 2.81% for every year between 1993 and 2012. Because of long-term declines in Wood Thrush populations throughout their range, the American Bird Conservancy has placed the Wood Thrush on the "United States Watchlist of Birds of Conservation Concern."

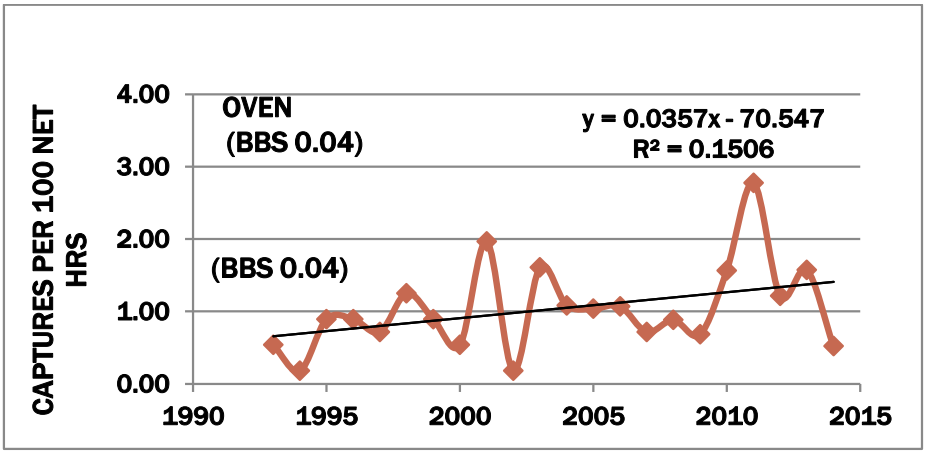
The BBS also shows **negative** trend estimates for the Common Yellowthroat and Red-eyed Vireo as well within the Coastal Plain of Maryland (M30). The BBS population trends for the four remaining species seem to be stable or trending slightly upwards (Sauer et. al. 2015).

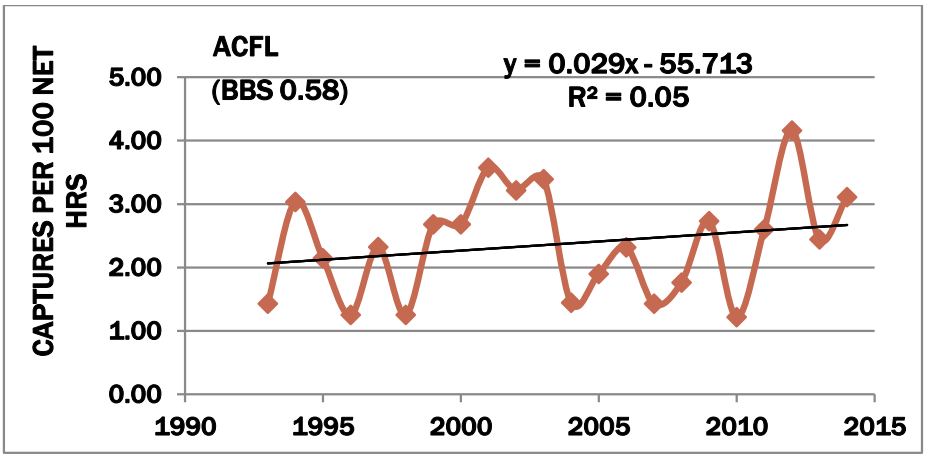
In our adult population trend analysis, all species, except for the Red-eyed Vireo, showed a positive trend line (none significant) suggesting that Jug Bay may be providing valuable breeding habitat particularly for Wood Thrush and the Common Yellowthroat. The negative linear trend line from our Red-eyed Vireo data may in fact be mirroring what is being observed by the BBS throughout the coastal plain area of Maryland. Nonetheless it is disappointing that it may be occurring at Jug Bay. Generally, Red-eyed Vireo population declines are attributable to deforestation and forest fragmentation brought about by suburbanization. This has not occurred within the immediate area of Jug Bay. Perhaps changes in our habitat understory over time

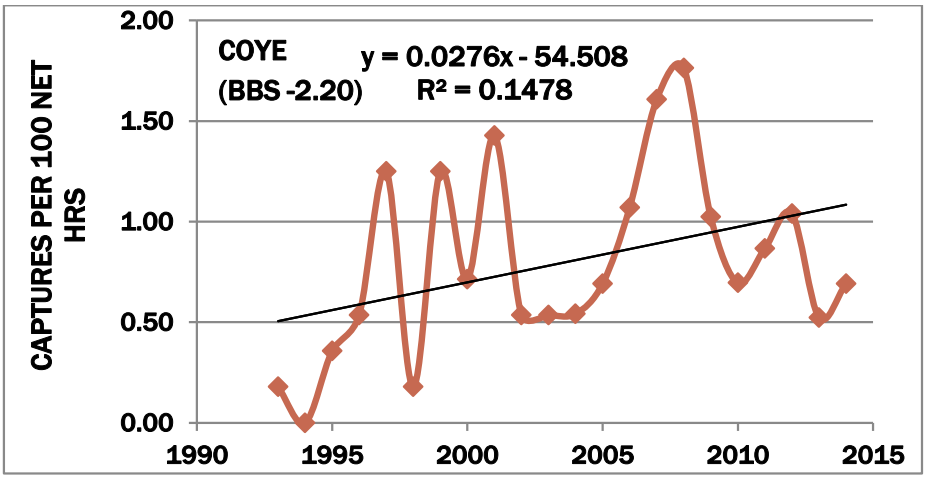
have made Jug Bay a less desirous nesting area. This decline is clearly an area warranting further study.

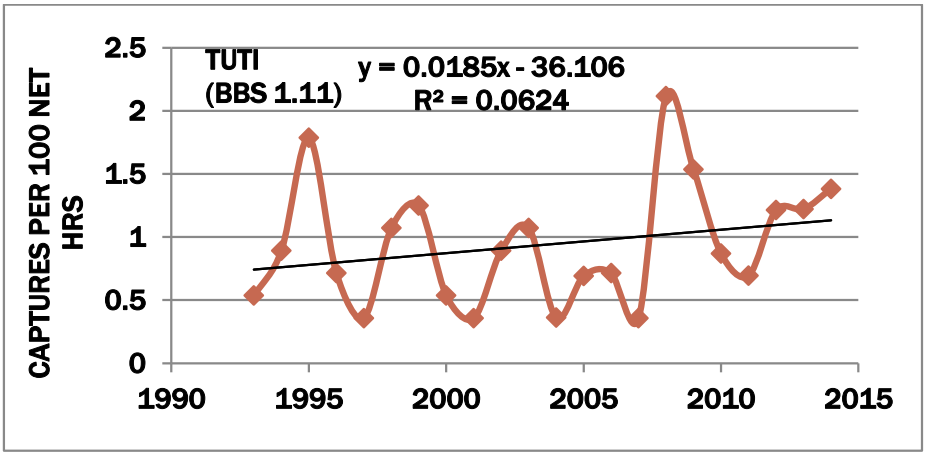







ACFL
(BBS 0.58)
y = 0.029x - 55.713
R² = 0.05
CAPTURES PER 100 NET HRS
5.00
4.00
3.00
2.00
1.00
0.00
1990
1995
2000
2005
2010
2015


COYE
(BBS -2.20)
y = 0.0276x - 54.508
R² = 0.1478
CAPTURES PER 100 NET HRS
2.00
1.50
1.00
0.50
0.00
1990
1995
2000
2005
2010
2015


TUTI
(BBS 1.11)
y = 0.0185x - 36.106
R² = 0.0624
CAPTURES PER 100 NET HRS
2.5
2
1.5
1
0.5
0
1990
1995
2000
2005
2010
2015

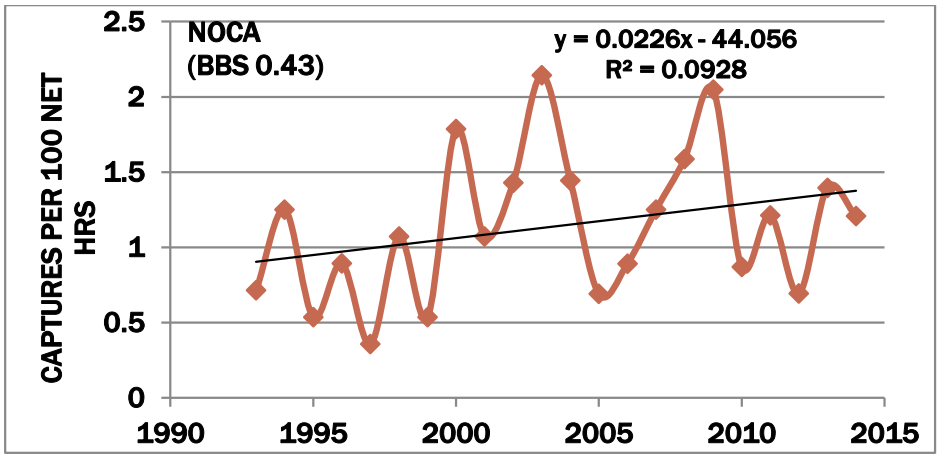


Figure 3. Individual Adult Captures Per 100 Net Hours; Nets 1-11, 15-17; Prds 3-10; 1993-2014 Only.

OTHER FINDINGS AND OBSERVATIONS

A. Sex Parity – Sexing captured birds in the field is not an exact science. Nonetheless, one would expect near parity between males and females. The two main ways we sex are by plumage and/or breeding condition sexual characteristics. With respect to plumages, some species are dimorphic in that the adult male and females of the species have a readily distinguishable plumage difference. Those differences however, may be more discreet and less obvious in the hatch year of the species. Within our Top Five migrant and resident species, three species – the Northern Cardinal, Common Yellowthroat, and Downy Woodpecker - show plumage dimorphism. Not surprisingly, as the Table below illustrates, our sex parity of those adults is near equal. Also within the Table are eleven other select dimorphic species (based on a minimum of at least ten adult bandings). They too show mostly sexual parity except for the Indigo Bunting which seems to be biased to males (32) vs. females (22) and the Scarlet Tanager biased to the females (42) vs. males (34). Interestingly, the nest parasitic Brown-headed Cowbirds are very heavily biased to the females (25) vs. males (2). This disparity must be tied in with the nest parasitism behavior of this species.

For those species that are monomorphic – the plumages of the male and female (to us) appear similar – we generally have to rely on the presence of certain sexual characteristics. If the captured bird is in a breeding state, it will show either an enlarged cloacal protuberance (CP) signifying a male or the presence of a brood patch (BP) to incubate the eggs, thus usually, **but not always**, signifying a female. Under MAPS protocol the BP has five stages of development (numbered 1-5, peaking at 3 at complete BP) which requires a subjective judgement. Complicating sexing is that the presence of a BP does not necessarily indicate a female. Males of several species that we band can assist in egg incubation and may develop a partial BP (1 or 5), incomplete BP (1, 2, 4, or 5) or complete BP (1, 2, 3, 4, or 5). Notable examples are male Red-eyed Vireos and Tufted Titmouse can develop an incomplete BP and any of the male

woodpeckers we band can develop a complete BP. With the adult woodpeckers, however, we can rely on their plumage dimorphism to accurately sex.

The lack of a plumage dimorphism, the absence of any of the aforementioned sexual characteristic because the captured bird is not yet in a breeding state, and/or the difficulty in making a numerical judgement on the state of development of a BP results in many birds not being sexed as noted in Table 12.

Sexing hatch year birds is even more challenging since they will not show any sexual characteristics and the plumage dimorphism, if it does exist in that species, is not always as pronounced as that of the adult of that species.

Table 12. Sex Parity Among Adult Top Five Migrant and Resident and Other Select Dimorphic Species

Species Common Name	Female	Male	Sex Unknown
Northern Cardinal*	63	62	1
Common Yellowthroat*	60	64	1
Downy Woodpecker*	18	14	0
Acadian Flycatcher	113	15	155
Red-eyed Vireo	66	127	161
Wood Thrush	134	144	41
Ovenbird	46	67	14
Carolina Wren	28	11	11
Tufted Titmouse	21	14	41
Carolina Chickadee	15	8	9
Brown-headed Cowbird*	25	2	0
Canada Warbler*	9	13	0
Eastern Towhee*	5	6	0
Hairy Woodpecker*	10	12	0
Hooded Warbler*	24	24	0
Indigo Bunting*	22	32	0
Northern Parula*	20	16	0
Prothonotary Warbler*	27	29	0
Red-bellied Woodpecker*	7	5	0
Scarlet Tanager*	42	34	0
Summer Tanager*	8	11	0

* denotes dimorphic species

B. Bandings by Period and Age

Table 3 (Repeated) - MAPS Study Banding Periods

Period	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Start	1 May	11 May	21 May	31 May	10 Jun	20 Jun	30 Jun	10 Jul	20 Jul	30 Jul	9 Aug	19 Aug
Stop	10 May	20 May	30 May	9 Jun	19 Jun	29 Jun	9 Jul	19 Jul	29 Jul	8 Aug	18 Aug	28 Aug

Tables13A and 13B (below), reflect our Top Five AHY migrant and resident species bandings by sex and Period from 1990-2014. Tables 13C and 13D reflect the Period that our Top Five hatch year (HY) migrant and resident and other species were banded from 1990-2014. While we banded in Period Two in 1991 thru 1996, we did not band any hatch year birds thus that banding period is not included here. Likewise, in the early years we did band in Periods Eleven and Twelve but many of those captures/bandings might have reflected the capture of birds starting their fall migration and not just those that breed or were born at Jug Bay, thus those numbers are not included herein.

Both Tables 13A and 13B show that bandings of adults - with few exceptions - steadily decrease as the season progresses from Period Three to Period Ten. Bandings in the first half of the season (Periods Three-Six) compared to the 2nd half (Periods Seven-Ten) are split 69%/31% for migrants and 77%/23% for residents. Several factors may influence this. Whether the species is in its reproductive cycle and subsequent post-nesting phase influences no doubt the level of activity. Another factor is that as birds are banded earlier in the season, the available population of unbanded birds decreases. Finally, there may be some degree of net avoidance in that the birds "learn" where the nets are and avoid them. The above factors may partially explain the decline of adult bandings as the season progresses.

While our banding numbers for most migrant species (Table 13A) are modest in light of the fact that it is collected over 25 years and parsed over eight banding periods, we will attempt to make some reasoned observations. The relatively high banding level for Acadian Flycatchers in Period Six compared to Period Five seems unusual and unexplained. The low banding levels for Common Yellowthroat in Periods Six and Eight compared to their surrounding periods may be explainable. We banded only one adult female Common Yellowthroat in Period Six and two in Period Eight (out of 51 adult females banded Periods Three thru Ten) suggesting our low levels may be due to some female Common Yellowthroats incubating eggs during those periods. Why we banded eight males in Period Nine compared to Periods Eight and Ten is unclear. In another case of low female bandings in Period Six, we banded 19 female Wood Thrush in Periods Five and Seven but only six female Wood Thrush in Period Six (out of 124 banded between Periods Three thru Ten). Again, female Wood Thrush incubating the eggs may account for this. Our Ovenbird banding data by sex and period is curious. While we experienced a drop in Ovenbird bandings in Period Six compared to the surrounding periods, the drop was not attributable to a lack of female bandings but rather male bandings. We must repeat the

cautionary note that our banding numbers over 25 years parsed among eight banding periods makes for mostly small sample sizes.

Table 13A. Top Five AHY Migrant Bandings by Sex and Period

	Period								
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tot.**
Acadian Flycatcher/F	14	13	13	20	10	**7**	**15**	**12**	**104**
Acadian Flycatcher/M	5	3	3	1	1	2			**15**
Acadian Flycatcher/U	27	41	22	29	13	8	2	2	**144**
Acadian Flycatcher/Total	46	57	38	**50**	24	17	17	14	**263**
Common Yellowthroat/F	26	4	6	**1**	6	**2**	3	3	**51**
Common Yellowthroat/M	16	8	10	6	6	4	**8**	1	**59**
Common Yellowthroat/U								1	**1**
Common Yellowthroat/Total	42	12	16	**7**	12	**6**	11	5	**111**
Ovenbird/F	7	10	9	8	5	3	2	1	**45**
Ovenbird/M	18	8	8	**3**	**12**	7	3	1	**60**
Ovenbird/U	1			1		2	3	6	**13**
Ovenbird/Total	26	18	17	**12**	17	12	8	8	**118**
Red-eyed Vireo/F	11	13	8	8	6	8	4	4	**62**
Red-eyed Vireo/M	33	25	21	10	13	8	7	3	**120**
Red-eyed Vireo/U	33	38	14	10	13	11	13	11	**143**
Red-eyed Vireo/Total	77	76	43	28	32	27	24	18	**325**
Wood Thrush/F	23	23	19	**6**	19	17	13	4	**124**
Wood Thrush/M	33	30	25	23	9	10	3	3	**136**
Wood Thrush/U	7	7	4	6	3	2	4	3	**36**
Wood Thrush/Total	63	60	48	35	31	29	20	10	**296**
Top Five AHY Migrant Totals	**254**	**223**	**162**	**132**	**116**	**91**	**80**	**55**	**1113**

Our Top Five resident bandings by sex and period in Table 13B below also requires caution due to low banding numbers and in some cases, difficulties in sexing – particularly of the smaller and/or monomorphic species (Carolina Chickadee, Carolina Wren, Tufted Titmouse). We do note that almost 50% of our AHY Carolina Chickadees were caught in Period Three and none in Period Eight. Carolina Wren bandings seemed to peak in Periods Three, Five, Seven and Nine. We banded no Downy Woodpeckers in Periods Seven or Ten and no males after Period Six.

Likewise, Tufted Titmouse were heavily banded in Periods Three and Four and dropped off decidedly after Period Six. While not a Top Five resident, we added the Hairy Woodpecker data despite our very small sample size. Interesting to note we banded no adults in Period Four and none after Period Seven. With respect to the Northern Cardinal, the relatively low number of female bandings in Period Four compared to Periods Three and Five may be reflective of females incubating. Much more analysis is needed to get a better understanding of the causes of these banding rates as the season progresses.

Table 13B. Top Five AHY Resident Bandings by Sex and Period

	Period								
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tot.**
Carolina Chickadee/F	7	2	3	1			1	1	**15**
Carolina Chickadee/M	5	1		1					**7**
Carolina Chickadee/U	3	1		1	2		1	1	**9**
Carolina Chickadee/Total	**15**	4	3	3	2		2	2	**31**
									0
Carolina Wren/F	4	1	1	2	4	2	6	5	**25**
Carolina Wren/M	4	2	1		2	1			**10**
Carolina Wren/U		1	5		2	1	2		**11**
Carolina Wren/Total	8	4	7	2	8	4	8	5	**46**
									0
Downy Woodpecker/F	8	2	3	1		2	1		**17**
Downy Woodpecker/M	2	4	2	2					**10**
Downy Woodpecker/Total	10	6	5	3		2	1		**27**
									0
Tufted Titmouse/F	6	7	2	4					**19**
Tufted Titmouse/M	9	3			1				**13**
Tufted Titmouse/U	17	11	6	3	1	1	1		**40**
Tufted Titmouse/Total	32	21	8	7	2	1	1		**72**
									0
Northern Cardinal/F	12	**7**	13	7	5	6	3	3	**56**
Northern Cardinal/M	12	13	10	6	3	2	4	3	**53**
Northern Cardinal/U	1								**1**
Northern Cardinal/Total	25	20	23	13	8	8	7	6	**110**
Top Five AHY Resident Totals	**90**	**55**	**46**	**28**	**20**	**15**	**19**	**13**	**286**

Hairy Woodpecker/F	2		2	1					**5**
Hairy Woodpecker/M	3		1	1					**5**
Hairy Woodpecker/Total	**5**		**3**	**2**					**10**

Table 13C reflects our Top Five Hatch Year migrant and other select migrant species bandings by period. In most cases, once hatch year bandings start for a migrant species, their banding numbers tend to increase as the MAPS season progresses as more hatch year birds are born and fledge over the course of the season. Some exceptions include: The Louisiana Waterthrush is one of the earliest migrants to return to Jug Bay (usually by around mid-April) whereas most of the other migrants don't typically start arriving till late April through mid-May. Consequently, the Louisiana Waterthrush probably starts its reproductive cycle earlier resulting in some hatch year bandings in Period Three. In many migrant species, the hatch year birds are the first to depart for their fall migration. The Louisiana Waterthrush begins its return to its overwintering grounds by mid-July – earlier than most other migrants - which may explain why we see the hatch years peak in Periods Five thru Seven with fewer hatch years in Periods Eight thru Ten. The Prothonotary warbler, like the Louisiana Waterthrush, is also an early returnee to its wintering grounds and starts to leave Jug Bay in the late July timeframe. This might help explain the absence of any Prothonotary hatch years in Period Ten (30 July-8 August). The Common Yellowthroat is another exception. Their hatch year bandings noticeably peaks in Period Eight then tails off. Not sure why. A surprising finding in Table 16C is the lateness of Eastern Phoebe hatch year bandings – not till Period Six. This was surprising given the fact that the Eastern Phoebe is the earliest migrant to return to Jug Bay (mid-to-late March) and would seemingly start their reproductive cycle earlier.

Table 13 C. Top Five HY (Hatch Year) Migrant and Other Select Migrant Species Bandings by Period

Species/Banding Period	3	4	5	6	7	8	9	10	Total
Wood Thrush		2	7	16	19	16	24	26	110
Ovenbird		1	5	7	7	11	22	21	74
Acadian Flycatcher			1	2	5	4	4	10	26
Common Yellowthroat				1	3	11	3	7	25
Prothonotary Warbler						3	5		8
Eastern Phoebe				3	6	4	10	9	32
Hooded Warbler				2		3	3	5	13
Louisiana Waterthrush	2	5	11	10	9	2	4	3	46
Top 5 and Other Select Migrant HY Totals	2	8	24	41	49	54	75	81	334

Since resident species start their reproductive cycle earlier, we see more hatch year resident birds earlier in the MAPS season (see Table 13D) than migrant hatch year. While most hatch year migrant species bandings peaked in Periods Nine and/or Ten, most resident species bandings peaked earlier in Period Six and/or Seven. Carolina Wren relatively higher HY banding numbers noted in Periods Four, Seven, Eight, Nine and Ten may be reflective of the fact that Carolina Wren may have several broods over the course of a breeding season. Note the

peaking of Northern Cardinal HY bandings in Periods Seven and Ten. Low levels of HY bandings on most other species preclude any type of judgements.

Table 13D. Top Five HY (Hatch Year) Resident and Other Select Resident Species Bandings by Period

Species/Banding Period	3	4	5	6	7	8	9	10	Total
Carolina Wren	8	15	9	6	24	18	17	20	117
Tufted Titmouse		1	11	19	11	5	12	4	63
Downy Woodpecker	1	2	7	6	13	5	7	2	43
Northern Cardinal		2	2	4	11	4	4	10	37
Carolina Chickadee	4	1	2	3	5	1	6	2	24
Blue Jay			1	2	1	1			5
Eastern Towhee			1	1	1		1	2	6
Hairy Woodpecker			1	3	2	1	1	1	9
Top 5 and Other Select Resident HY Totals	13	21	34	44	68	35	48	41	304

C. Bandings by Net – Over the course of our 25-year effort, we experimented with several additional net locations to supplement our core nets 1-11 in the hopes of enhancing our hatch year banding rate – particularly for Red-eyed Vireos. As noted earlier, despite these net reconfigurations, our HY banding rates stayed relatively static between 23-27% over the years. In 1993, we established three nets (15-17) on our west side facing the South Marsh of Jug Bay. They have remained in use through 2014. In that same year (1993), we established three nets (12-14) on the east side within the Two Run Creek flood plain area. Due to changes within the floodplain, nets 13 and 14 were re-located in 2000 further north and re-numbered as nets 18 and 19. After the 2003 season, we reluctantly terminated the nets 12, 18 and 19 due to constant wet conditions within the flood plain area and time necessary to process the birds.

Nets 14, 19 and 12 in the Two Run Creek area (no longer in use) were by far the most productive from a mean number of bandings per year standpoint than any other nets. Of the 17 nets currently in use, the top three most productive nets are 17, 1 and 15 but their productivity numbers pale in comparison to nets 14, 19 and 12 as noted below in Table 14.

Table 14. Most Productive Nets 1990-2014.

Net #	# Yrs Active	Mean/Yr.	Top Four Species Banded
14	7	28.3	Common Yellowthroat, Hooded Warbler, Red-eyed Vireo, Canada Warbler
19	4	22.3	Common Yellowthroat, Louisiana Waterthrush, Acadian Flycatcher, Red-eyed Vireo
12	11	16.3	Red-eyed Vireo, Wood Thrush, Acadian Flycatcher, Ovenbird
17	22	13.5	Common Yellowthroat, Acadian Flycatcher, Red-winged Blackbird, Red-eyed Vireo, Tufted Titmouse (tie)
1	25	9.7	Wood Thrush, Acadian Flycatcher, Ovenbird, Red-eyed Vireo
15	22	9.6	Carolina Wren, Common Yellowthroat, Red-winged Blackbird, Prothonotary Warbler

(Table 18 in the Appendix on Page YY provides details on the bandings at each net (1-19) of 15 select migrant or resident species and all other species combined.)

D. Injury and Mortality – The first rule of the North American Banding Council's "Bander's Code of Ethics" is: **"Banders are primarily responsible for the safety and welfare of the birds they study so that stress and risks of injury or death are minimized."** As in any other research project involving live specimens, injury or mortality can occur. The issue is whether it occurs at an ethically acceptable level. "The Handbook of Field Methods for Monitoring Landbirds" (Ralph et. al. 1993) provides a guideline of an acceptable mortality rate of 1% of captures. Since 1990, we have had 4,856 captures (bandings, recaptures and unbanded) and fifteen mortalities (the last in 2005) for a mortality rate of 0.31% - well below the 1% figure. A 2011 study of mist-netting, found that the mean mortality rate for 11 passerine large scale banding efforts was 0.27% SD 0.13 (Spotswood et. al, 2011) so our mortality rate is comparable.

Of our 15 mortalities, there were two each Red-eyed Vireos and Northern Cardinals; one each Wood Thrush, Acadian Flycatcher and Louisiana Waterthrush; and eight Ovenbirds. Ovenbirds nest and forage on the ground, thus their behavior makes them more susceptible to capture in the lowest panel of the mist net. This causes the net to sag closer to the ground exposing the Ovenbird to predation by terrestrial predators (squirrels, chipmunks etc.) as well as avian predators.

In six of the 15 instances, there was no obvious explanation of the cause of death merely that the bird was found dead. We had five cases where it was noted that the bird had sustained physical injury presumably from a predator and we had one confirmed kill by a Great Horned Owl. The most unusual predation incidences are three confirmed deaths caused by Eastern Box Turtle eating birds caught in the bottom panel of the net (Swarth, 2005). While we regret everymortality, we take some comfort in knowing we haven't had any since 2005 (1,619 captures ago).

Injury rates are more difficult to evaluate. Our MAPS station takes a very liberal and inclusive definition of "injured" and we have documented 40 "injured" birds: tongued birds (12 instances); stressed birds (puffing out feathers, closing of eyes etc.) (8); abrasions on wing, body or head (7); wing sprain (5); foot or leg injury (5); and no explanation beyond "injured bird" (3). In the case of tongued birds, four had blood in the mouth. The remaining eight tongued birds showed

no outward sign of injury but were assumed to have been stressed from the more difficult extraction of a tongued bird. Most “injured” birds are released immediately with little to no processing.

In nine instances, we have recaptured birds that were previously reported as having been injured. Our injury rate is 0.82%. The aforementioned 2011 study of mist netting that collected data from 11 passerine banding stations had a mean injury rate of 0.66%. More importantly however, they found no evidence for increased mortality over time of injured birds compared with uninjured birds (Spotswood et. al. 2011). It should be noted that the MAPS Protocol has a more stringent definition of “injured”. A bird is considered “injured” if its survival probability is thought to be compromised. Furthermore, a minor flesh wound or loss of a few feathers is generally not worthy of note (DeSante et. al. 2014). Under that criterion we would have had far fewer injuries manifested either by broken leg or blood in mouth that may have compromised the survival capability of the injured bird.

(For details on mortalities see Table 15A. Mortality Rates 1990-2014 in the Appendix. For details on our injured birds, see Table 15B. Incidences of Injury 1990-2014 are found in the Appendix).

AREAS FOR FUTURE STUDY

This report represents our first concerted effort to document the history of our effort, protocols used, and to synthesize and present our data in a way that may lend itself to further study by an academic, intern or volunteer. While we have learned a lot, perhaps more can be done:

-- Do we have enough recapture data for our Top Five species (Northern Cardinal, Wood Thrush, Red-eyed Vireo, Acadian Flycatcher, Ovenbird) to determine if the mean age of recaptures is declining over time? Are those that are surviving living longer, shorter or no change to earlier years?

-- Do we have enough data in any particular year(s) to see a correlation between when female Wood Thrush may be incubating (Period Six?) and subsequent increases in HY Wood Thrush bandings two-three Periods later?

-- The paucity of hatch year Red-eyed Vireo bandings in our 25-year MAPS effort requires further study. We know they breed in our core study area containing 11 nets yet we have only banded five HY REVI. The first thing that needs to be done is research the literature on Red-eyed Vireo (REVI) natal dispersal to see what we can learn. Then perhaps we can solicit from the IBP, REVI banding and recapture data from other long-running MAPS stations on the East Coast to see: (1) Are they banding HY REVI?, (2) In what habitat are they banding HY REVI? (3) What Periods are they banding HY REVI? (4) What is the ratio of adults to HY? (5) Are their adult REVI as “durable” as ours with respect to percentage that are recaptured in subsequent years after banding (29%) and the longevity of their recaptures (mean minimum age of 46 months)?

-- Perhaps some field work outside our MAPS area: Can we locate and monitor (by camera?) REVI nests? Can we monitor their natal dispersal? Can we set up temporary nets in locations where we suspect natal dispersal may occur? Such field work is notoriously difficult and would require a commitment by a dedicated student, intern and/or volunteer.

ACKNOWLEDGEMENTS

First and foremost, the authors wish to thank Danny Bystrak who helped establish this effort. Danny lent his considerable expertise and un-parallel dedication for 25 years. He helped training and educating numerous volunteers, visitors and students/academics on our MAPS effort and bird banding in general. Without them, this effort would never have gotten off the ground.

Over the 25 years, we have used scores of volunteers who have given a conservatively estimated 5,000 volunteer hours to this effort just for the field work. We can't begin to compute the time spent entering data and analyzing the data. We sincerely thank each and every one of them. One volunteer however needs special recognition. Mike Quinlan has been a stalwart volunteer at Jug Bay since 1997. He has lent his formidable expertise, organizational skills, and steady hand to many projects at Jug Bay to include MAPS.

The staff at Jug Bay and the Anne Arundel County Department of Recreation and Parks has always been supportive and encouraging. Furthermore, we thank the Friends of Jug Bay for providing financial support for the purchase of equipment.

We also wish to thank those who have read this study (Patricia Delgado, Mike Quinlan, Danny Bystrak) and offered advice and counsel. Any errors that remain are strictly the fault of the author(s).

We also would like to thank John Sauer at the Patuxent Wildlife Research Center in Laurel, MD. At our request, John created a new retrieval capability for the BBS Data set. Prior to our request, we were only able to retrieve species trend estimates down to the state of Maryland level which encompasses three different Bird Conservation Regions (28 – Appalachian Mountains, 29 – the Piedmont and 30 – New England Mid-Atlantic Coast. John parsed out the Maryland data for that portion of Maryland in the coastal plain and created a sub-category called M30 (Maryland within Bird Conservation Region 30 – Coastal Plain).

LITERATURE CITED

DeSante, D.F., K.M. Burton, P. Velez, D. Froelich, and D. Kaschube.2014. MAPS Manual: 2014 Protocol. The Institute for Bird Populations, Point Reyes, CA.

Ellison, W.G. (editor).2010.2nd Atlas of the Breeding Birds of Maryland and the District of Columbia. The Johns Hopkins University Press.

Saracco, J.F., D.F. DeSante, M.P. Nott, and D.R. Kaschube. 2009. Using the MAPS and MoSI Programs to Monitor Landbirds and Inform Conservation. Pp. 651-658 in: Proceedings of the Fourth International Partners in Flight Conference: Tundra to Tropics (T.D. Rich, C.D. Thompson, D. Demarest, and C. Arizmendi, editors). University of Texas-Pan American Press.

Lutmerding, J.A. and A.S. Love.2014.Longevity Records of North American Birds.Version 2014.1Patuxent Wildlife Research Center.Bird Banding Laboratory.Laurel, MD.

McKim-Louder, M.I., J.P. Hoover, T.J. Benson, and W.M. Schelsky.2013.Juvenile Survival in Neotropical Migratory Songbirds Is Lower Than Expected.PLoS ONE 8(2): e56059.doi:10.1371/journal.pone.0056059

Nott, M.P.2000.Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol. The Institute for Bird Populations, Point Reyes Station, CA.

Nott, M. P., K. Gordon, D. Kaschube, and T. Morris.2008. Landbird Demographic Monitoring in Virginia: An Analysis of Historical MAPS Data in Virginia and Surrounding Area (An analysis to determine spatio-temporal relationships between climate, weather, landscape patterns, and landbird demographics in Virginia and surrounding region). An Institute for Bird Populations report to: The State 0f Virginia Department of Game and Inland Fisheries.

Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin and D.F. DeSante.1993.Handbook of Field Methods For Monitoring Landbirds.United States Department of Agriculture Forest Service.Albany, CA.

Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W.A. Link.2014.The North American Breeding Bird Survey and Analysis 1966-2013. Version 01.30.2015 USGS Patuxent Wildlife Research Center, Laurel, MD.

Smith, C.M., D.R. Kaschube, and D. Collister.2009.Monitoring Avian Productivity and Survivorship (MAPS) at Inglewood Bird Sanctuary, Calgary, Alberta, 1992-2008. Unpublished technical report. Calgary Bird Banding Society, Calgary, AB.

Spotswood, E.N., K.R. Goodman, J. Carlisle, R.L. Cormier, D.L. Humple, J. Rousseau, S.L. Guers, and G.G. Barton.2011.How Safe is Mist Netting? Evaluating the risk of injury and mortality to birds.Methods in Ecology and Evolution.British Ecological Society. London, England.

Swarth, C.2005.Terrapene carolina carolina (Eastern Box Turtle) Predation. Herpetological Review 36:315.

Terborgh, J. 1989. Where Have All the Birds Gone? Essays on the Biology and Conservation of Birds That Migrate to the American Tropics. Princeton University Press.

APPENDIX

Table 1. MAPS Net Locations and Status

					Location (UTM)				Location (Geo)	
Net	First Year	Last Year	Status	Remarks	Easting	Northing	Error (+/- m)	Bearing (mag°)	Lat	Long
1	1990	2014	Current		352015	4293854	5	274/94	38°46'52"	-76°42'13"
2	1990	2014	Current		352008	4293810	5	39/219	38°46'50"	-76°42'14"
3	1990	2014	Current		352014	4293757	3	232/52	38°46'48"	-76°42'13"
4	1990	2014	Current		352047	4293700	4	356/176	38°46'47"	-76°42'12"
5	1990	2014	Current		352089	4293693	4	42/222	38°46'46"	-76°42'10"
6	1990	2014	Current		352137	4293756	3	158/338	38°46'49"	-76°42'08"
7	1990	2014	Current		352091	4293767	4	176/356	38°46'49"	-76°42'10"
8	1990	2014	Current		352113	4293810	3	111/291	38°46'50"	-76°42'09"
9	1990	2014	Current		352173	4293837	3	176/356	38°46'51"	-76°42'07"
10	1990	2014	Current		352170	4293893	3	302/122	38°46'53"	-76°42'07"
11	1990	2014	Current		352087	4293873	3	4/184	38°46'52"	-76°42'10"
12	1993	2003	Discontinued	in floodplain, habitat changed, difficult to reach	352255	4293994	3	86/266	38°46'56"	-76°42'03"
13	1993	1999	Relocated as Net 18	in floodplain, habitat changed, site flooded	352221	4293848	4	180/360	38°46'52"	-76°42'04"
14	1993	1999	Relocated as Net 19	in floodplain, habitat changed, site flooded	352209	4293729	2	158/338	38°46'48"	-76°42'05"
15	1993	2014	Current		352025	4293589	3	166/346	38°46'43"	-76°42'13"
16	1993	2014	Current		351942	4293768	2	159/339	38°46'49"	-76°42'16"
17	1993	2014	Current		351929	4293840	3	222/42	38°46'51"	-76°42'17"
18	2000	2003	Discontinued	in floodplain, habitat changed, site flooded	352243	4293875	4	174/354	38°46'52"	-76°42'04"
19	2000	2003	Discontinued	in floodplain, habitat changed, site flooded	352228	4293743	2	136/316	38°46'48"	-76°42'04"

Table courtesy of Mike Quinlan

Table 2. MAPS Net Usage 1990-2014/Net Hours of Operation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOT.	NET HRS.
1990	X	X	X	X	X	X	X	X	X	X	X									**11**	462
1991	X	X	X	X	X	X	X	X	X	X	X									**11**	895
1992	X	X	X	X	X	X	X	X	X	X	X									**11**	495
1993	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	918
1994	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	952
1995	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	935
1996	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	850
1997	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	680
1998	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	680
1999	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			**17**	765
2000	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	**17**	780
2001	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	**17**	680
2002	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	**17**	680
2003	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	**17**	680
2004	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	554
2005	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	579
2006	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	561
2007	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	560
2008	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	567
2009	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	586
2010	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	575
2011	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	577
2012	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	577
2013	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	573
2014	X	X	X	X	X	X	X	X	X	X	X				X	X	X			**14**	579
TOT.	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**11**	**7**	**7**	**22**	**22**	**22**	**4**	**4**		16,740

Table 4. Banding Periods and Number of Days Banding Occurred Per Period – 1990-2014

Yr./Prds.	2	3	4	5	6	7	8	9	10	11	12	Days Tot.
1990	0	0	1	1	1	1	1	1	1	1	0	**8**
1991	2	2	2	2	2	2	2	1	3	2	0	**20**
1992	1	1	1	1	1	1	1	1	1	0	0	**9**
1993	1	1	1	1	1	1	1	1	1	1	1	**11**
1994	1	1	1	1	1	1	1	1	1	1	1	**11**
1995	1	1	1	1	1	1	1	1	1	1	1	**11**
1996	1	1	1	1	1	1	1	1	1	1	0	**10**
1997	0	1	1	1	1	1	1	1	1	0	0	**8**
1998	0	1	1	1	1	1	1	1	1	0	0	**8**
1999	0	1	1	1	1	1	1	1	1	1	0	**9**
2000	0	1	1	1	1	1	1	1	1	1	0	**9**
2001	0	1	1	1	1	1	1	1	1	0	0	**8**
2002	0	1	1	1	1	1	1	1	1	0	0	**8**
2003	0	1	1	1	1	1	1	1	1	0	0	**8**
2004	0	1	1	1	1	1	1	1	1	0	0	**8**
2005	0	1	1	1	1	1	2	0	1	0	0	**8**
2006	0	1	1	1	0	2	1	1	1	0	0	**8**
2007	0	1	1	1	1	1	1	1	1	0	0	**8**
2008	0	1	1	1	1	1	1	1	1	0	0	**8**
2009	0	1	1	1	1	1	1	1	1	0	0	**8**
2010	0	1	1	1	1	1	1	1	1	0	0	**8**
2011	0	1	1	1	1	1	1	1	1	0	0	**8**
2012	0	1	1	1	1	1	1	1	1	0	0	**8**
2013	0	1	1	1	1	1	1	1	1	0	0	**8**
2014	0	1	1	1	1	1	1	1	1	0	0	**8**
Days Tot.	**7**	**25**	**26**	**26**	**25**	**27**	**27**	**24**	**27**	**9**	**3**	**226**

Table 6A. Banding Summary (Place holder one page)

Table 6B. Breeding and Residency Status List (Place holder one page)

Table 8B. Annual Variation in Bandings of Top Five Migrant Species by Age (Place holder one page)

Table 8C. Annual Variation in Bandings of Top Five Resident Species by Age (Place holder one page)

Tables 12A. to 12J. (Place holder, will require about 14 pages)

Table 13A. Number of Unique Select Species AHY Present per Year; Nets 1-11, 15-17; Prds 3-10; 1993-2014 Only (Place holder one page with 13B)

Table 13B. Number of Unique Select Species AHY Present Per Year Per 100 Net Hours; Nets 1-11, 15-17; Prds 3-10; 1993-2014 Only (Place holder one page with 13A)

Table 18. Net Productivity for Select Species and All Other Species Combined 1990-2014 (Place holder one page)

Table 15A. Mortality 1990-2014

Species	Band Number	Cause of Death	Date of Death
Acadian Flycatcher	1830-75071	Killed by Eastern Box Turtle	29-Jun-91
Red-eyed Vireo	Unbanded	Killed by Eastern Box turtle	25-Jun-96
Ovenbird	Unbanded	Killed by Eastern Box turtle	13-Jul-03
Wood Thrush	0941-87243	Killed by Great Horned Owl	10-Jul-05
Northern Cardinal	0991-44228	Died in net (NFI)	5-Jul-90
Northern Cardinal	0941-87197	Died in net (NFI)	22-Jun-03
Ovenbird	1561-92758	Died while banding (NFI)	13-Jul-97
Ovenbird	1551-23219	Died in net bag (NFI)	3-Jun-01
Ovenbird	1551-23291	Dead in net (NFI); cause unknown	11-Jul-04
Ovenbird	Unbanded	Died in net (NFI)	17-May-94
Ovenbird	Unbanded	Dead in net, neck skin ripped	23-May-02
Ovenbird	Unbanded	Dead in upper part of net; skin and feathers pulled off skull	25-May-05
Ovenbird	2031-91154	Died from apparent puncture wound in neck; dead in bottom panel	31-May-05
Red-eyed Vireo	Unbanded	Dead in net. Head bitten, left wing broken, unk predator (chipmunk??)	23-May-95
Louisiana Waterthrush	Unbanded	Dead in net, lowest tier, blood on head, killed by bird (Blue Jay?)	25-Jun-00

Table 15B. Injury 1990-2014

Species	Band Number	Injury	Injury Date	Recap
Northern Cardinal	0941-87697	WING BLEEDING, ABRAIDED IN NET	25-May-04	None
Wood Thrush	Not banded	RT SHOULDER ATTACKED BY TURTLE; FLEW OK	1-Aug-06	
Ovenbird	Not banded	FRESH SCALP WOUND ; FLEW OFF WEAKLY	13-Jul-10	
Tufted Titmouse	1361-85530	WING BLEEDING	11-Jun-13	None
Acadian Flycatcher	Not banded	BROKEN RT. TIBIA (ASSUME FROM CAPTURE)	25-Jun-96	
Red-eyed Vireo	2031-91042	LEG BROKEN ON EXTRACTION	12-Jun-05	4-Jun-06
Tufted Titmouse	2251-39995	DIFFICULT EXTRACTION; SKIN ON LEG SCRAPPED	1-Jul-09	None
Tufted Titmouse	1361-85519	BROKEN RIGHT LEG	26-Jun-11	None
Ovenbird	2091-03647	INJURED (NOT FURTHER SPECIFIED)	13-Jun-93	None
Eastern Phoebee	2031-91178	MINOR INJURY (NO FURTHER INFO)	16-Jul-06	None
Summer Tanager	1481-71649	BIRD IN SHOCK	22-May-94	19-Aug-95
Ovenbird	0960-77301	STRESSED	26-May-96	27-May-03
Ovenbird	1561-92782	STRESSED	24-May-01	None
Acadian Flycatcher	2440-19099	DIFFICULT EXTRACTION	21-Jun-09	15-Jun-10
Acadian Flycatcher	2560-66020	STRESSED BY EXTRACTION	13-Jul-10	None
Acadian Flycatcher	Not banded	STRESSED BY EXTRACTION; EVENTUALLY FLEW	26-Jun-11	
Acadian Flycatcher	Not banded	STRESSED; FLEW OFF AFTER RESTING	1-Jun-12	

Species	Band Number	Injury	Injury Date	Recap
Acadian Flycatcher	2260-69688	STRESSED	28-May-13	None
Hairy Woodpecker	0941-87310	TONGUED, LONG TIME TO EXTRACT	24-May-07	21-Jun-08
R-B Woodpecker	1202-08818	BADLY TONGUED	21-Jun-08	None
Common Grackle	Not banded	TONGUE INJURY	29-May-09	
Acadian Flycatcher	2560-66046	BADLY TONGUED	26-Jul-11	None
R-B Woodpecker	Not banded	BADLY TONGUED	28-May-13	
R-W Blackbird	Not banded	BADLY TONGUED	23-Jun-13	
R-W Blackbird	Not banded	BADLY TONGUED	8-Jun-14	
Common Grackle	Not banded	BADLY TONGUED	17-Jun-14	
American Goldfinch	2170-62483	BLOOD IN MOUTH	12-Jun-01	None
Wood Thrush	0941-87362	BLOOD IN MOUTH, TONGUE GONE	14-Jun-09	12-Jul-09
Wood Thrush	0941-87314	BADLY TONGUED, BLEEDING	14-Jun-11	None
R-W Blackbird	Not banded	Tongued, blood in mouth	22-Jul-14	
Ovenbird	2091-03640	BLOOD ON NECK (NO FURTHER INFO)	24-Jun-92	None
Lo. Waterthrush	1561-92725	GASH ON NECK	6-Aug-96	None
Carolina Wren	2251-39939	BLOOD ON HEAD, MISSING HEAD FEATHERS	31-Jul-07	None
Downy Woodpecker	1481-71648	INJURED RT. FOOT (UNCLEAR IF NEW OR OLD)	22-May-94	17-May-95
Ovenbird	0960-77325	INJURED BIRD (NO FURTHER INFO)	3-Jul-94	12-Jul-94
Y-B Chat	1641-50962	HOPPED VIGOROUSLY AT RELEASE	25-Jun-00	None
Wood Thrush	0941-87601	BIRD HOPPED AWAY DIDN'T FLY	15-Jul-01	None
Red-eyed Vireo	2031-91142	WING STRAINED	1-Jun-04	None
Northern Cardinal	0941-87381	HOPPER	30-Jun-09	None

Species	Band Number	Injury	Injury Date	Recap
Wood Thrush	0981-77908	HOPPER	16-Jul-10	None