The Monitoring Avian Productivity and Survivorship (MAPS) Program at Navy Information Operations Command (NIOC) Sugar Grove, WV and George Washington National Forest, WV

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EXECUTIVE SUMMARY

Background

Since 1989, The Institute for Bird Populations has coordinated the Monitoring Avian Productivity and Survivorship (MAPS) Program, a cooperative effort among public and private agencies and individual bird banders in North America, to operate a continent-wide network of constant-effort mist-netting and banding stations. The purpose of the MAPS program is to provide annual indices of adult population size and post-fledging productivity, as well as estimates of adult survivorship and recruitment into the adult population, for various landbird species. The broad-scale productivity and survivorship data are needed to provide crucial information to support research and management actions aimed at reversing the recently documented declines in North American landbird populations. Military installations and national forests in the United States are ideal locations for this large-scale, long-term bird monitoring because they provide extensive areas of breeding habitat for Neotropical migratory landbirds that are subject to varying management practices, but otherwise remain relatively undisturbed by recreational activities.

A more specific objective of the MAPS program is to provide standardized population and demographic data for the landbirds found on federally managed public lands, such as military installations, national forests, national parks, and wildlife refuges. It is expected that these population and demographic data will aid research and management efforts on these federal lands, to protect and enhance their avifauna and ecological integrity while simultaneously helping to fulfill their missions in an optimal manner.

Results of the 2008 MAPS season

In 2008, IBP completed the eighth year of operating MAPS stations at Navy Information Operations Command (NIOC) Sugar Grove (SUGR): the South Fork Potomac River station in bottomland riparian/mixed forest habitat, and the Beaver Creek station in open upland forest habitat. We also completed four years of MAPS monitoring at two stations on adjacent lands of the George Washington National Forest (GWNF), the Lick Run station, intended to be in similar habitats as the South Fork Potomac River station, and the Flesh Run station, in similar habitats as the Beaver Creek station. In 2008, nets at permanently fixed positions were opened for six morning hours per day, on one day per 10-day period for eight consecutive 10-day periods between May 18 and August 3. In accordance with ancillary sampling protocols designed by IBP in collaboration with the Center for Tropical Research at UC Los Angeles, feather samples and cloacal swabs were taken from ~50% of birds to track the genetic variability and incidence of West Nile Virus and avian influenza viruses, both emerging infectious diseases of humans.

For the 126 species recorded at the four stations, a total of 312 captures of 38 species were recorded. Total adult population sizes in 2008 were highest at South Fork Potomac River (94.7 adults per 600 net-hours), followed by Flesh Run (60.9), Lick Run (45.6), and Beaver Creek (18.9). Reproductive index (number of young to adults) was highest at Lick Run (1.13) followed

by South Fork Potomac River (0.38), Flesh Run (0.27), and Beaver Creek (0.14). Species of management concern (because they are locally declining and are listed by the U.S. Fish and Wildlife Service as Birds of Conservation Concern) that were caught at the four stations include Worm-eating Warbler (among the most abundantly captured species), Louisiana Waterthrush, and Wood Thrush.

Species-specific summaries of 2001-2008 analyses

Annual variation in the effort-adjusted adult numbers of each of eight species (for which sufficient data existed for analysis) and all species pooled is shown in Figure 1 and annual variation in productivity is shown in Figure 2. For all species pooled the number of adults steadily declined non-significantly ($P<=0.05$) to a level ~30% less than that recorded in 2001. Likewise, productivity declined by a similar percentage to adults but was more variable due to high productivity in 2003 and 2004 when the numbers of adults were low. Below we summarize the demographic performance (2001-2008) of eight species.

Tufted Titmouse - usually breeds (> 1/2, not all, years) within the boundaries of the South Fork Potomac River monitoring station and breeds regularly (all years) at the other three stations. Annual numbers of adults were highly variable but the population level recorded in 2008 differed little from that in 2001. Annual productivity was highest in 2001, dropped to near zero in 2002, but has since recovered to ~70% of the 2001 index.

Carolina Wren - breeds regularly at all four stations and although high numbers were captured in 2001 and 2002 the population level has since remained at about 25% of the 2001 level. Since 2003, the numbers of adults steadily increased (20-25 per 600 net-hours) and productivity steadily decreased.

Gray Catbird - breeds regularly at and although the population remained stable (~12 adults per 600 net-hours) between 2001 and 2007, 26 adults were captured in 2008. However, productivity declined since the high levels of 2001 and 2004 and few young were captured in any year.

Worm-eating Warbler - breeds regularly within the boundaries of the South Fork Potomac River and Lick Run monitoring stations. Annual numbers of adults were relatively stable and although they dropped by 50% in 2004, the 2008 level (6.6 adults per 600 net-hours) was similar to the 2001 level. Productivity was highly variable but declined overall to a level ~50% of that recorded in 2001 (1.33), which is regarded high. It is possible that appropriate management could increase productivity.

Ovenbird - breeds regularly at Lick Run and Flesh Run monitoring stations and usually at the remaining two stations. Adult populations were highly variable and increased by 100% between 2001 and 2008. Conversely, annual productivity was highly variable and decreased by 50% over the same period.

Song Sparrow - breeds regularly within the boundaries of South Fork Potomac River monitoring

station but numbers of adults significantly declined ($P<0.05$) since 2001 such that only 3.9 individuals per 600 net-hours were captured in 2008. Productivity peaked in 2003 and remained stable but slightly increasing since 2004 to a value of 0.67 in 2008. Again, appropriate management may benefit Song Sparrow populations on the South Fork Potomac River.

Northern Cardinal - breeds occasionally at Beaver Creek but regularly at all other stations. Adult populations were high in 2001 but by 2003 they had declined by 75% and have since recovered to 4.8 adults per 600 net-hours in 2008. Productivity peaked in 2003 but overall steadily declined such that no young birds were captured in 2008.

Indigo Bunting - breeds regularly at all stations. Numbers of adults crashed between 2003 and 2004 but have since recovered to a level of 8.4 adults per 600 net-hours. Productivity has remained fairly stable and was recorded as 0.11 in 2008.

Recent demographic patterns

Breeding populations, numbers of young, and reproductive success all showed slight increases between 2007 and 2008. This was the third year in a row in which all three parameters have changed in synch, after increasing between 2006 and 2007 and declining between 2007 and 2008. In past years at MAPS stations (including during 2001-2005 at Sugar Grove) our data showed an alternating cycle whereby low productivity one year resulted in low populations the next year, which have higher breeding success resulting in higher populations the following year, etc. The fact that this alternating pattern at MAPS stations (including Sugar Grove and George Washington) seems to have shifted to one where all three parameters are more in synchrony is of interest and perhaps of potential concern. It could indicate that normal processes are being disrupted, perhaps by global climate change. It will be very interesting to see if this pattern continues at Sugar Grove and George Washington National Forest in the future.

A primary goal of the MAPS program is to determine the proximate causes (productivity or survival) accounting for declining landbird population sizes. In this year's report we were able to add two more species to the list for which reasonable survivorship estimates could be provided, and we have thus expanded our analyses aimed at assessing the causes for the observed population trends to nine target species at the two locations.

The overall reproductive index of 0.76 for landbirds at Sugar Grove and George Washington National Forest during 2001-2008 is excellent as compared with the mean value of 0.31 calculated for the Northeast MAPS Region during the 15-year period 1992-2006. Among target species, four species showed higher productivity at the MAPS stations than in the Northeast Region, three species showed slightly higher values, and only one species showed lower productivity at the MAPS stations than in the Northeast Region. In addition, when compared to values expected based on body mass, higher-than-expected productivity appears to be occurring in five or six of the eight species at Sugar Grove whereas slightly lower-than expected productivity is only occurring in two species, reinforcing the fact that productivity is higher at Sugar Grove and George Washington than is indicated for the Northeast Region. The population

dynamics of Sugar Grove's breeding species thus could be affected through appropriate management action which may serve to enhance productivity.

Management considerations

Management could be applied to increase the productivity of Indigo Bunting, a species with lower-than-expected productivity and a declining population trend at Sugar Grove; the Breeding Bird Survey also shows a long term decline of Indigo Buntings across West Virginia. Management actions designed to increase nesting opportunities by ensuring the availability of dense understory in open edgy woodland may increase local productivity and lead to higher rates of recruitment. Such habitat is common to regenerating forest gaps and the edges of cut areas. The availability of understory vegetation can be seriously depleted by foraging white-tailed deer that are overpopulated across the northeastern United States. Recent security fence enclosure of the Sugar Grove satellite dish site, (site of S. Fork Potomac River MAPS station) may have effects on bird populations by excluding deer from foraging in the forest understory. Deer exclusion may allow more dense foliage to develop. However, the soils of the ridge and valley geology are thin and poor such that tree growth is slow, and along riparian corridors invasive plant species, especially vines, tend to choke undergrowth. Further south, in Georgia, Indigo Bunting populations have also been reported to respond positively to Red-cockaded Woodpecker management by increased numbers and productivity three years after an understory burn.

Regional demography comparisons

Using eight years of data from the two Sugar Grove stations, estimates of adult survival and recapture probabilities could be obtained for seven of the nine target species breeding at NIOC Sugar Grove, an increase of two species from last season's analysis, based on our ability to apply transient models to four-year's of data collected at George Washington. The mean survival for the seven species at Sugar Grove and George Washington in 2001-2008 was 0.488, slightly higher than the 0.465 estimate from the Appalachian Region as a whole during 1992-2003. Two species, Worm-eating Warbler and Indigo Bunting showed higher survival rates at Sugar Grove than in the Appalachian Region overall. However, Black-capped Chickadee, Ovenbird, and Northern Cardinal showed slightly lower survival, and Gray Catbird and Song Sparrow showed lower survival at Sugar Grove and George Washington than in the region overall. These results reinforce the notion that survival is roughly as expected at Sugar Grove in comparison to values from the Northeast Region. The mean C.V. for estimates of these seven species based on the transient model was 37.6% which is still considered high, but it is lower than the mean of 42.9% recorded for five species after seven years of data had been collected, indicating the increased precision of our estimates with increased years or data collection.

With additional years of data and the addition of data collected at stations in comparable habitats at George Washington National Forest, we hope to better understand the population dynamics at Sugar Grove and the causes for the general declines noted in populations there. As more years of data accumulate we will be able to make more informed inferences regarding the effect of productivity and survivorship on population dynamics. Pooling data at this level will also allow

comparison between NIOC Sugar Grove, George Washington National Forest, and other protected and unprotected areas at which MAPS stations are operated in the region.

Future monitoring and research with a regional perspective

The long-term goal for the NIOC Sugar Grove and George Washington MAPS program is to provide critical information to clarify the ecological processes leading from environmental stressors to landbird population responses. We will accomplish this by including NIOC Sugar Grove and George Washington National Forest data in analyses of data from other central Appalachian MAPS stations to: (a) determine spatial patterns in productivity indices and survival rate estimates as a function of spatial patterns in population trends for target species; (b) determine the proximate demographic factors causing observed population trends; (c) identify relationships between landscape-level habitat and/or weather characteristics and the primary demographic responses (productivity and survival rates) of target species; (d) generate hypotheses regarding the ultimate environmental causes of the population trends; and (e) make comprehensive recommendations for habitat and use-related management goals both at local scale of the installation and the larger scale of the central Appalachians.

In addition, MAPS data from NIOC Sugar Grove and George Washington National Forest will provide an important contribution to the determination of accurate indices of adult population size and productivity and precise estimates of adult survival rates on the still larger region-wide scale (e.g., northeastern North America) for many landbird species. Very recently we undertook an analysis of the entire MAPS program in the Northeastern Region for the Northeast Coordinated Bird Monitoring Partnership. In our report it was recommended that the MAPS program be increased by about 50% throughout the Northeastern United States. All four of the Sugar Grove and George Washington stations were contributing adequately to our understanding of population dynamics for species of concern within Bird Conservation Region 28, the Appalachian Mountains, receiving a mean priority score of 35.8, compared with a mean score of 28.4 for all MAPS stations in the region; thus, the recommendation of the report was that all four stations were of significant contribution to the MAPS Program in the Northeast Region and in BCR 28 (The Appalachian Region), and that all four stations should be continued.

We conclude that the MAPS protocol is well-suited to provide an integral component of NIOC Sugar Grove's long-term ecological monitoring effort, and we recommend the continued operation of the NIOC Sugar Grove MAPS stations well into the future. We recommend continued monitoring either side of the new security fence at the upper satellite site to asses the effect of exclusion of white-tailed deer.

INTRODUCTION

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) Program, a cooperative effort among public and private agencies and individual bird banders in North America, to operate a continent-wide network of over 1000 constant-effort mist-netting and banding stations. MAPS was designed to provide information on the vital rates (productivity or birth rate, and survivorship or death rate) of landbirds that is critically needed for efforts to identify demographic causes of the severe and sometimes accelerating population declines documented for many species of North American landbirds (Robbins *et al.* 1989; Terborgh 1989; DeSante 1992; DeSante *et al.* 1995, 1999, 2001; Peterjohn et al.1995). Such data on vital rates are also critically needed in efforts to identify management strategies to reverse such population declines (DeSante 1995, DeSante and Rosenberg 1998).

Recent important results from the MAPS program include the following:

- Trend data from the North American Breeding Bird Survey (BBS), as well as from the MAPS program, suggest that many populations of migratory songbirds are declining. Yet, knowledge of declines is not enough to effectively design management and conservation action capable of reversing these declines and maintaining healthy populations. Demographic data from MAPS can help to focus conservation efforts by providing information on proximate causes of observed population trends. We illustrated how demographic data from MAPS can provide unique insights into drivers of population trend in a recent analysis of 12 years (1992-2003) of MAPS data for Yellow Warbler published in the November 2008 issue of the Journal of Wildlife Management (Saracco *et al.* 2008).
- Sugar Grove MAPS data were included in an analysis reported in Journal of Wildlife Management paper, we reported results of similar analyses for an additional 38 species of migratory bird in a report that we recently submitted to the National Fish and Wildlife Foundation (Saracco and Desante 2008). These results indicate that (1) enhancing survival, especially of first-year birds, may be the most important conservation strategy for slowing declines and achieving stable populations of many migratory songbird species, (2) enhancing productivity may be necessary to recover populations whose declines have been arrested, and (3) relationships between landbird vital rates and winter weather and habitat characteristics must be identified and described.
- Sugar Grove MAPS data contributed to a regional report submitted to the Virginia Division of Natural Resources which documented landbird demographics for 23 species of greatest conservation need within Virginia and 150km of the Virginia border. Of those 23 species Sugar Grove contributed data for six species: Gray Catbird, Black-and-white Warbler, Worm-eating Warbler, Ovenbird, Louisiana Waterthrush, and Eastern Towhee (Nott *et al.* 2008).
- A number of large military installations in North Carolina, Indiana, Kentucky, Missouri, and Texas have been monitored since 1994 by IBP under an agreement

with the DoD Legacy Resources Management Office. Performance measures of population demographics and landscape showed that, in general, the installations managed large tracts of forest which represented a higher percentage of the land compared to the percentage of forested land within a 20km radius of the installations' boundaries. These forests also featured large "core areas" known to be beneficial to forest species. Consequently, the survival rate estimates and productivity indices of forest bird populations were higher than those of the surrounding MAPS or North American Bird Conservation Initiative's (NABCI) Bird Conservation Regions (Nott and Morris 2007).

- Analyses describing relationships between four demographic parameters (adult population size, population trend, number of young, and productivity) and landscape-level habitat characteristics for bird species of conservation concern have been completed for 13 military installations in south-central and southeastern United States. From these relationships we have formulated conservation management strategies that are currently being validated by follow-up monitoring or "effectiveness monitoring" (Nott *et al.* 2003a).
- Productivity of landbirds breeding in Pacific Northwest national forests is affected by global climate cycles including the El Niño Southern Oscillation and the North Atlantic Oscillation, in such a manner that productivity of Neotropical migratory species is determined more by late winter and early spring weather conditions on their wintering grounds than by late spring and summer weather conditions on their breeding grounds (Nott *et al.* 2002).
- Modeling spatial variation in MAPS productivity indices and survival-rate estimates as a function of spatial variation in population trends provides a successful means for identifying the proximate demographic cause(s) of population change at multiple spatial scales (DeSante *et al.* 2001).
- Patterns of productivity from MAPS at two large spatial scales (eastern North America and the Sierra Nevada) not only agreed with those found by direct nest monitoring and those predicted from theoretical considerations, but were in general agreement with current life-history theory and were robust with respect to both time and space (DeSante 2000).
- Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales (DeSante *et al.* 1999).
- Age ratios obtained during late summer banding provided a good index to actual productivity in the Kirtland's Warbler (Bart *et al.* 1999).

MAPS is organized to fulfill three sets of goals and objectives: monitoring, research, and management. The specific monitoring goals of MAPS are to provide, for over 100 target species, including Neotropical-wintering migrants, temperate-wintering migrants, and permanent residents: (a) annual indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured; and (b) annual estimates of adult population size, adult survival rates, proportions of residents, and recruitment into the adult population from modified Cormack- Jolly-Seber analyses of mark-recapture data on adult birds.

The specific research goals of MAPS are to identify and describe: (a) temporal and spatial patterns in these demographic indices and estimates at a variety of spatial scales ranging from the local landscape to the entire continent; and (b) relationships between these patterns and ecological characteristics of the target species, population trends of the target species, station-specific and landscape-level habitat characteristics, and spatially-explicit weather variables.

The specific management goals of MAPS are to use these patterns and relationships, at the appropriate spatial scales, to: (a) identify thresholds and trigger points to notify appropriate agencies and organizations of the need for further research and/or management actions; (b) determine the proximate demographic cause(s) of population change; 8) suggest management actions and conservation strategies to reverse population declines and maintain stable or increasing populations; and (d) evaluate the effectiveness of the management actions and conservation strategies actually implemented through an adaptive management framework.

All of these monitoring, research, and management goals are in agreement with the Department of Defense (DoD) and USDA Forest Service's Partners-in-Flight (PIF) strategies. Moreover, because birds are excellent indicators of the health of ecological systems, they can serve as a sensitive barometer of the overall effectiveness of efforts to maintain the biodiversity and ecological integrity of military installations. Accordingly, the MAPS program was initiated on select military installations beginning in 1992 and soon became one of the focus projects of the DoD PIF program. It was expected that information from the MAPS program would be capable of aiding research and management efforts on these military installations to protect and enhance the installations' avifauna and ecological integrity, while allowing them to fulfill their military mission.

More recently, the MAPS program was established on NIOC Sugar Grove in 2001 and adjacent George Washington National Forest in 2005. It is expected that information from the MAPS program will be capable of aiding research and management efforts at Sugar Grove and George Washington National Forest to protect and enhance their avifauna and ecological integrity, while helping them fulfill their military and forestry missions in an optimal manner.

The initial objective of the MAPS Program on DoD installations and national forests was to identify generalized management guidelines and formulate specific management actions that could be implemented at these locations and elsewhere to reverse the population declines of target landbird species and to maintain the populations of stable or increasing species. The identification and formulation of these management guidelines and actions has been achieved for many installations by modeling the vital rates (productivity and survivorship) of the various landbird species as a function of landscape-level habitat characteristics and spatially explicit weather variables. The goal was to identify relationships between adult population size, numbers of young produced, productivity (ratio of young to adults), and trends in those parameters and these habitat and weather variables. Resultant management strategies were designed to involve efforts to modify the habitat from characteristics associated with low population size, population trend, or productivity to characteristics associated with high population size, population trend, or productivity (especially for species for which low

productivity was found to be driving the population decline).

The Legacy Resource Management Program funded IBP to undertake these analyses and formulate management strategies. These analyses were completed in 2003 and management guidelines were formulated for ten bird species of conservation concern that breed in the southeastern United States (Nott *et al.* 2003a). With additional funding from the Legacy Resource Management Program, we are currently implementing these guidelines through management actions on eight military installations in conjunction with efforts to increase military Readiness and Range Sustainment (Nott and Michel 2005). The strategy for implementing these guidelines includes the establishment of new MAPS stations to monitor the effectiveness of such proposed or on-going management, the discontinuance of an equal number of old stations, and the continued operation of others of the old stations to serve as controls for the new management stations. In this way, the total number of stations operated will remain the same.

Because the MAPS program has only been operated for eight years at NIOC Sugar Grove, we are not yet ready to formulate management strategies specific to this installation. However, with the addition of a eighth year of data we are better able to estimate survival and population trends for up to eight species breeding at NIOC Sugar Grove and George Washington National Forest.

We are pleased to report continuing improvement in the number and scope of analyses made possible by the accumulated size of the dataset. In our report of three years ago (Pyle *et al.* 2006) we performed cluster analysis (Ward's Method) based on species-specific numbers of adults captured per 600 net-hours, to test our selection of stations at George Washington National Forest to mimic those already established at Sugar Grove. Two years ago, we began to assess how population dynamics of landbirds at NIOC Sugar Grove might be influenced by annual productivity and apparent survival rates (Nott *et al.* 2007). Last year, we expanded the assessment to establishing the relationships between a) survival and bird mass, and b) productivity and bird mass for 5 species across the entire MAPS dataset (Nott *et al.* 2008). We calculated similar data for the pooled Sugar Grove and George Washington National Forest data and assessed whether those relationships were better or worse than expected by the MAPS-wide relationships. This year we successfully applied a transient survival model to the Sugar Grove and George Washington National Forest data that resulted in estimates for two additional species. Thus, we can now assess the relationships of survival and productivity to bird mass for seven species total.

METHODS

Two MAPS stations were re-established and operated on NIOC Sugar Grove in 2008, at the same locations at which they were originally established in 2001 and operated in 2002-2007. The two stations were located as follows: (1) the South Fork Potomac River station on the main base in a riparian corridor of mixed forest bordering the southern branch of the Potomac River southern fork; and (2) the Beaver Creek station bordering the George Washington National Forest in open mixed forest on a steep slope. In order to better assess landbird population dynamics at Sugar Grove, two additional stations were established in 2005 on the adjacent George Washington National Forest, and have been operated during 2006-2008. The two stations were located as follows: (3) the Lick Run station in mixed deciduous and Virginia pine forest with adequate understory in a riparian valley, and (4) the Flesh Run station in open, mixed pine and maple forest on the side of a ridge. These stations were established in an attempt to mirror the two Sugar Grove stations, the Lick Run station was established in similar habitats as the South Fork Potomac River station and the Flesh Run station was established in similar habitats as the Beaver Creek station. A summary of the major habitats represented at each of the four stations is presented in Table 1 along with a summary of the 2008 operation of each station.

The four stations were re-established for operation by IBP Biologist interns Craig Campeau and Mack Frantz, along with IBP biologist Danielle Kaschube, during May 17-22, 2008. The two field biologist interns had received intensive training during a comprehensive course in mist-netting and bird-banding techniques given by IBP biologists James Junda and Ron Lothian, which took place May 1st-15th at the Jug Bay Wetlands Sanctuary in Maryland. The two interns set up and operated the Sugar Grove and George Washington stations during the period, May 18-23. In 2008, nets at permanently fixed positions were opened for six morning hours per day, (beginning at local sunrise) on one day in each of eight consecutive 10-day periods between Period 3 (beginning May 21), and Period 10 (beginning July 30). The operation of all stations occurred on schedule during each of the eight periods (Table 1), however grace periods in the MAPS protocol allowed stations to be operated in Period 3 starting May 18.

In accordance with ancillary sampling protocols designed by IBP in collaboration with the Center for Tropical Research at UC Los Angeles, feather samples and cloacal swabs were taken from ~50% of birds to track the genetic variability and incidence of West Nile Virus and avian influenza viruses, both emerging infectious diseases of humans.

Collection of MAPS Data

All MAPS stations were operated in accordance with the highly standardized banding protocols established by The Institute for Bird Populations for use by the MAPS Program throughout North America (see MAPS Manual DeSante *et al*. 2008). On each day of operation each year, one 12-m long, 30-mm mesh, 4-tier nylon mist net was erected at each of ten fixed mist-net sites within the interior eight ha of each 20-ha station. With few exceptions, all birds captured during the course of the study were identified to species, age, and sex and, if unbanded, were banded

with USGS/BRD numbered aluminum bands. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety would be compromised. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms (DeSante *et al.* 2008):

(1) capture code (newly banded, recaptured, band changed, unbanded);
(2) band number;
(3) species;
(4) age and how aged;
(5) sex (if possible) and how sexed (if applicable);
(6) extent of skull pneumaticization;
(7) breeding condition of adults (i.e., extent of cloacal protuberance or brood patch);
(8) extent of juvenal plumage in young birds;
(9) extent of body and flight-feather molt;
(10) extent of primary-feather wear;
(11) presence of molt limits and plumage characteristics;
(12) wing chord;
(13) fat class and body mass;
(14) date and time of capture (net-run time);
(15) station and net site where captured; and
(16) any pertinent notes.

Effort data (i.e., the number and timing of net-hours on each day of operation) were also collected in a standardized manner. In order to allow constant-effort comparisons of data to be made, the times of opening and closing the array of mist nets and of beginning each net check were recorded to the nearest ten minutes. The breeding (summer residency) status (confirmed breeder, likely breeder, non-breeder) of each species seen, heard, or captured at each MAPS station on each day of operation was recorded using techniques similar to those employed for breeding bird atlas projects.

In accordance with sampling protocols designed by IBP in collaboration with the Center for Tropical Research (UC Los Angeles) feather samples and cloacal swabs were taken from ~50% of birds to track the genetic variability and incidence of West Nile Virus and avian influenza viruses, both emerging infectious diseases of humans.

The computer entry, proofing, and verification of all banding, effort, and breeding status data were completed by IBP biologists using specially designed data entry, verification, and editing programs. The critical data for each banding record (capture code, band number, species, age, sex, date, capture time, station, and net number) were proofed by hand against the raw data and any computer-entry errors were corrected. All banding data were then run through a series of verification programs as follows:

(1) Clean-up programs to check the validity of all codes entered and the ranges of all numerical data;

(2) Cross-check programs to compare station, date, and net fields from the banding data with those from the effort and breeding status data;
(3) Cross-check programs to compare species, age, and sex determinations against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), extent of juvenal plumage, extent of body and flight-feather molt, extent of primary-feather wear, and presence of molt limits and plumage characteristics;
(4) Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species; and
(5) Verification programs to screen banding data from all years of operation for inconsistent species, age, or sex determinations for each band number.

Any discrepancies or suspicious data identified by any of these programs were examined manually and corrected if necessary. Wing chord, body mass, fat content, date and station of capture, and any pertinent notes were used as supplementary information for the correct determination of species, age, and sex in all of these verification processes.

Data Analysis

To facilitate analyses, we first classified the landbird species captured in mist nets into five groups based upon their breeding or summer residency status (breeding status). Each species was classified as one of the following: a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station during all years that the station was operated; a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station during more than half but not all of the years that the station was operated; an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station during half or fewer of the years that the station was operated; a transient (T) if the species was never a breeder or summer resident at the station, but the station was within the overall breeding range of the species; and a migrant (M) if the station was not located within the overall breeding range of the species. Data from a station for a species classified as a migrant (M) at the station were not included in any analyses, except those used to produce Table 3. The breeding status of all species seen, heard, or banded are given in Appendix 1.

Population-Size and Productivity Analyses

The proofed, verified, and corrected banding data from 2008 were run through a series of analysis programs that calculated for each species and for all species combined at each station and for all stations pooled:

(1) the numbers of newly banded birds, recaptured birds, and birds released unbanded;
(2) the numbers and capture rates (per 600 net-hours) of first captures (in 2008) of individual adult and young birds; and
(3) the reproductive index.

Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach *et al.* 1996), the number of adult birds captured was used as an index of adult population size. As our index of post-fledging productivity we are now using "reproductive index" (number of young divided by number of adults) as opposed to "proportion of young in the catch" previously used. Reproductive index is a more intuitive value for productivity, and it is also more comparable to other calculated MAPS parameters such as recruitment indices.

For each station, we calculated percent changes between 2007 and 2008 in the numbers of adult and young birds captured, and actual changes in the reproductive index. These between-year comparisons were made in a "constant-effort" manner by means of a specially designed analysis program that used actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by-period basis to exclude captures that occurred in a given net in a given period in one year during the time when that net was not operated in that period in the other year. We determined the statistical significance of between-year changes in the indices of adult population size and post-fledging productivity according to methods developed by the BTO in their CES scheme (Peach *et al.* 1996), by using confidence intervals derived from the standard errors of the mean percentage changes of all six stations. The statistical significance of the overall change at a given station was inferred from a one-sided binomial test on the proportion of species at that station that increased (or decreased). Throughout this report, we use an alpha level of 0.05 for statistical significance, and we use the term 'near-significant' or 'nearly significant' for differences for which $0.05 < P < 0.10$.

For each of the four stations and for each location combined we calculated eight-year (Sugar Grove stations) and four-year (George Washington stations) means for the numbers of adult and young birds captured per 600 net hours and the reproductive index for each individual species and for all species pooled.

Analyses of trends in adult population size and productivity

For all four stations combined we examined eight-year (2001-2008) trends in indices of adult population size and productivity, for each target species for which we recorded an average of at least 2.5 individual adults per year at the two stations combined, at stations at which the species was a regular (B) or usual (U) breeder. For trends in adult population size, we first calculated adult population indices for each species in each of the eight years based on an arbitrary starting index of 1.0 in 2001. Constant-effort changes (as defined above) were used to calculate these "chain" indices in each subsequent year by multiplying the proportional change between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

$$PSI_{i+1} = PSI_i + PSI_i * (d_i/100)$$

where PSI_i is the population size index for year I and d_i is the percentage change in constant-effort numbers from year i to year i+1. A regression analysis was then run to determine the

slope of these indices over the eight years (PT). Because the indices for adult population size were based on percentage changes, we further calculated the annual percent change (*APC*), defined as the average change per year over the eight-year period, to provide an estimate of the population trend for the species; *APC* was calculated as:

(slope of the regression line / predicted value for the first year)*100

We present *APC*, the standard error of the slope (*SE*), the correlation coefficient (*r*), and the significance of the correlation (*P*) to describe each trend.

Trends in productivity, *PrT*, were calculated in an analogous manner by starting with actual reproductive index values in 2001 and calculating each successive year's value based on the constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r*), and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends.

Estimates of Survivorship

Survival of target species was estimated using Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992). We present to sets of estimates, one based on eight years (2001-2008) of capture histories of adult birds from the two Sugar Grove stations combined using a transient model and one based on data from all four stations using a non-transient model. Target species were those for which, on average, at least 2.5 individual adults per year and at least two between-year returns were recorded from the all stations pooled, at which the species was a breeder during more than half of the years the station was operated. Using the computer program TMSURVIV (White 1983, Hines *et al.* 2003), we calculated, using the transient model on Sugar Grove data, maximum-likelihood estimates and standard errors (SEs) for adult survival rate, adult recapture probability, and the proportion of residents among newly captured adults using time-constant models (Pradel *et al.* 1997, Nott and DeSante 2002, Hines *et al.* 2003). The use of the transient model accounts for the existence of transient adults (dispersing and floater individuals which are only captured once) in the sample of newly captured birds, and provides survival estimates that are unbiased with respect to these transient individuals (Pradel *et al.* 1997). Recapture probability is defined as the conditional probability of recapturing a bird in a subsequent year that was banded in a previous year, given that it survived and returned to the place it was originally banded. The use of the non-transient rather than transient model on the entire data set is necessitated by the fact that only four years of data are available from the two George Washington stations. At least four years of date are needed for the transient model, so we will be able to use it on the entire data set next season.

RESULTS

In 2008, IBP completed the eighth year of operating MAPS stations at Navy Information Operations Command (NIOC) Sugar Grove (SUGR): the South Fork Potomac River station in bottomland riparian/mixed forest habitat, and the Beaver Creek station in open upland forest habitat. We also completed four years of MAPS monitoring at two stations on adjacent lands of the George Washington National Forest (GWNF), the Lick Run station, intended to be in similar habitats as the South Fork Potomac River station, and the Flesh Run station, in similar habitats as the Beaver Creek station.

We achieved 1810.5 net-hours of banding effort at the four MAPS stations operated at NIOC Sugar Grove and George Washington National Forest in 2008 (Table 1). Data from 1200.3 of these net-hours could be compared directly to 2007 data in a constant-effort manner. The reason for the low amount of comparable effort is that the first two periods of 2007 were missed due to funding uncertainties.

Indices of Adult Population Size and Post-fledging Productivity

Annual variation in the effort-adjusted adult numbers of each of eight species (for which sufficient data existed for analysis) and all species pooled is shown in Figure 1 and annual variation in productivity is shown in Figure 2. For all species pooled the number of adults steadily declined non-significantly ($P<=0.05$) to a level ~30% less than that recorded in 2001. Likewise, productivity declined by a similar percentage to adults but was more variable due to high productivity in 2003 and 2004 when the numbers of adults were low. Below we summarize the demographic performance (2001-2008) of eight species.

Eight species summary

Tufted Titmouse – usually breeds (> 1/2, not all, years) at South Fork Potomac River monitoring station and regularly (all years) at the other three stations. Annual numbers of adults were highly variable but the population level in 2008 differed little from that in 2001. Annual productivity was highest in 2001, dropped to near zero in 2002, but has since recovered to ~70% of the 2001 index.

Carolina Wren also breeds regularly at all four stations and although high numbers were captured in 2001 and 2002 the population level has since remained at about 25% of the 2001 level. Since 2003, the numbers of adults steadily increased (20-25 per 600 net-hours) and productivity steadily decreased.

Gray Catbird – breeds regularly at and although the population remained stable (~12 adults per 600 net-hours) between 2001 and 2007, 26 adults were captured in 2008. However, productivity declined since the high levels of 2001 and 2004 and few young were captured in any year.

Worm-eating Warbler - breeds regularly within the boundaries of the South Fork Potomac River

and Lick Run monitoring stations. Annual numbers of adults were relatively stable and although they dropped by 50% in 2004, the 2008 level (6.6 adults per 600 net-hours) was similar to the 2001 level. Productivity was highly variable but declined overall to a level ~50% of that recorded in 2001 (1.33), which is regarded high. It is possible that appropriate management could increase productivity.

Ovenbird - breeds regularly at Lick Run and Flesh Run monitoring stations and usually at the remaining two stations. Adult populations were highly variable and increased by 100% between 2001 and 2008. Conversely, annual productivity was highly variable and decreased by 50% over the same period.

Song Sparrow - breeds regularly within the boundaries of South Fork Potomac River monitoring station but numbers of adults significantly declined ($P<0.05$) since 2001 such that only 3.9 individuals per 600 net-hours were captured in 2008. Productivity peaked in 2003 and remained stable but slightly increasing since 2004 to a value of 0.67 in 2008. Again, appropriate management may benefit Song Sparrow populations on the South Fork Potomac River.

Northern Cardinal - breeds occasionally at Beaver Creek but regularly at all other stations. Adult populations were high in 2001 but by 2003 they had declined by 75% and have since recovered to 4.8 adults per 600 net-hours in 2008. Productivity peaked in 2003 but overall steadily declined such that no young birds were captured in 2008.

Indigo Bunting - breeds regularly at all stations. Numbers of adults crashed between 2003 and 2004 but have since recovered to a level of 8.4 adults per 600 net-hours. Productivity has remained fairly stable and was recorded as 0.11 in 2008.

2008 MAPS season

The 2008 capture summary of the numbers of newly-banded, unbanded, and recaptured birds is presented in Table 2 for each species and all species pooled, at each of the four stations and at all four stations combined. A total of 312 captures of 38 species was recorded at the four stations combined. The greatest number of captures (133) was recorded at the South Fork Potomac River station and the least number of captures (18) was recorded at the Beaver Creek station. Species richness was greatest at South Fork Potomac River (24 species) and was lowest at Beaver Creek (9 species). Overall, the most abundantly captured species at the four stations was, Worm-eating Warbler, followed by Gray Catbird, Ovenbird, Indigo Bunting, Carolina Wren, and Red-eyed Vireo (Table 2). Three species of management concern (Nott *et al.* 2003a) were caught at the four stations, Worm-eating Warbler, Louisiana Waterthrush, and Wood Thrush. These species are locally declining and are listed by the U.S. Fish and Wildlife Service as Birds of Conservation Concern.

In order to standardize the number of captures with respect to variation in mist-netting effort (due to unsuitable weather conditions and accidental net damage; see Table 1), we present capture rates (per 600 net-hours) of individual adult and young birds, as well as reproductive

index, for each species and for all species pooled, at each station and for all stations combined, in Table 3. These capture indices suggest that the total adult population size in 2008 was highest at South Fork Potomac River (94.7 adults per 600 net-hours), followed by Flesh Run (60.9), Lick Run (40.4), and Beaver Creek (18.9). Captures of young of all species pooled were highest at Lick Run (45.6) and lowest at Beaver Creek (2.7). Reproductive index (number of young to adults) was highest at Lick Run (1.13) followed by South Fork Potomac River (0.38), Flesh Run (0.27), and Beaver Creek (0.14).

Overall, the highest breeding populations at the two stations, based on adults captured per 600 net-hours, were Gray Catbird, Indigo Bunting, Worm-eating Warbler, Ovenbird, Red-eyed Vireo, and Northern Cardinal (Table 3). The following is a list of the common breeding species (captured at a rate of at least 3.0 adults per 600 net-hours), in decreasing order, at each station in 2008 (species of concern in italics):

South Fork Potomac River
Gray Catbird
Worm-eating Warbler
Northern Cardinal
Carolina Wren
American Robin
Eastern Towhee
Song Sparrow
Ovenbird†
Indigo Bunting†

Lick Run
Indigo Bunting
Worm-eating Warbler
Ovenbird*
Tufted Titmouse†
Louisiana Waterthrush†
Scarlet Tanager†
Northern Cardinal†

Beaver Creek
Ovenbird
Indigo Bunting
Worm-eating Warbler†

Flesh Run
Red-eyed Vireo*
Chipping Sparrow*
Indigo Bunting
Blue-headed Vireo
Blue-gray Gnatcatcher*
Ovenbird*
American Goldfinch†
Black-capped Chickadee†
Tufted Titmouse†
Cedar Waxwing†

* Did not exceed 3.0 adults per 600 net hours in 2007.
† Exceeded 3.0 adults per 600 net hours in 2007 but not in 2008.

Comparisons between 2007 and 2008 data

Constant-effort comparisons between 2007 and 2008 were undertaken at all four stations for numbers of adult birds captured (index of adult population size; Table 4), numbers of young birds captured (Table 5), and number of young per adult (reproductive index; Table 6).

Adult population size for all species pooled at all four stations combined increased by +28.1%

between 2007 and 2008 (Table 4), a non-significant change. Increases between 2007 and 2008 were recorded for 15 of 30 species, a proportion not significantly greater than 0.50. The number of adults captured of all species pooled increased at three of the four stations, by amounts ranging from +25.6% at South Fork Potomac River to +78.6% at Lick Run, whereas it decreased at Beaver Creek by -28.6%. The proportion of increasing or decreasing species was not significantly greater than 0.50 at any station, and no species experienced significant or near-significant increases or declines across stations.

The number of young birds captured, of all species pooled and for both stations combined, also showed a non-significant increase, by 76.3, at all four stations combined (Table 5). Increases between 2007 and 2008 were recorded for 8 of 21 species, a proportion not significantly greater than 0.50. Young captured for all species pooled increased at two stations, South Fork Potomac River (+92.9%0 and Lick Run (+275%), remained the same at Beaver Creek (0.0% change), and decreased at Flesh Run (by -42.9%). The proportion of decreasing species (9 of 12) was near-significantly greater than 0.50 at Flesh Run. One species, Ovenbird, showed a near-significant increase across stations whereas no species showed such significant or near-significant decline.

Reproductive index (the number of young per adult) likewise showed a non-significant absolute increase of +0.161, from 0.427 in 2007 to 0.588 in 2008, for all species and stations combined (Table 6). Increases in productivity were recorded for 6 of 16 species, a difference not significantly different from 0.50. Reproductive index decreased at three of four stations, by amounts ranging from +0.057 at Beaver Creek to +0.629 at Lick Run, and it decreased (by -0.370) at Flesh Run. The proportion of increasing or decreasing species was not significantly greater than 0.50 at any station. One species, Worm-eating Warbler, showed a near-significant increase across stations whereas no species showed such significant or near-significant decline.

Thus, breeding populations, numbers of young and reproductive success all showed non-significant increases between 2007 and 2008, which appeared to be species wide but varied among the stations. In particular both breeding populations declined at Beaver Creek and both young captured and reproductive success decreased at Flesh Run.
All three parameters increased between 2005 and 2006 and decreased between 2006 and 2007.

Eight-year and four-year mean population size and productivity values

Mean numbers of individual adults (an index of adult population size) and young captured per 600 net-hours, and reproductive index (a measure of productivity), averaged over the eight-year period 2001-2008 for the Sugar Grove stations and over the four-year period (2005-2008) for the George Washington stations, are presented in Table 7, for all four stations and for both stations at each location combined. As mentioned in previous reports, there is a disparity in capture rates of adults and young between South Fork Potomac River (97.1 and 68.4 individuals per 600 net-hours, respectively) and Beaver Creek (25.0 and 17.1 per 600 net-hours).

Productivity (number of young per adult), however, continues to be overall higher at Beaver Creek (0.83) than at South Fork Potomac River (0.71), despite very low productivity at Beaver

Creek in 2008 (Table 3). After three years of data had been collected the two George Washington stations had shown comparable capture rates of adults but the disparity between those at Lick Run (36.7 per 600 net-hours) and those at Flesh Run (44.6) seems to be widening now that four years of data (2005-2008) have been collected. The disparity in reproductive index between Lick Run (0.94 young per adult) and Flesh Run (0.47 young per adult) also widened with the addition of a fourth year of data, given that productivity increased at Lick Run and decreased at Flesh Run between 2007 and 2008 (Table 6).

As mentioned in last years report, Lick Run and Beaver Creek will be good stations with which to compare population dynamics between Sugar Grove and George Washington National Forest, but South Fork Potomac River and Flesh Run will not be comparable, as hoped for, probably because of the increased edge habitat found at South Fork Potomac River. However, when the two stations at each location are combined, reproductive success values are very similar (0.71 young/adult at Sugar Grove and 0.76 young/adult at George Washington). We thus believe that we can compare trends and other dynamics involving productivity between the two locations.

The overall reproductive index of 0.76 at Sugar Grove and George Washington (Table 7) is excellent as compared with the mean value of 0.31 calculated for all species pooled based on MAPS (see the NBII/IBP Demographics Query Interface) for the Northeast MAPS Region, during the 15-year period 1992-2006. Of the eight target species, four (Tufted Titmouse, Carolina Wren, Worm-eating Warbler, and Ovenbird) showed >50% higher productivity at Sugar Grove and George Washington National Forest than in the Northeast Region, three (Gray Catbird, Northern Cardinal, and Indigo Bunting) showed slightly higher productivity values, and only one species (Song Sparrow) showed slightly lower productivity at Sugar Grove and George Washington National Forest than in the Northeast Region. This indicates that productivity is good at Sugar Grove and George Washington, at least in comparison with the region as a whole.

Eight-year trends in adult population size and productivity

"Chain" indices of adult population size and productivity, at all four stations combined, are presented in Figures 1 and 2 for eight target species and for all species pooled. See Methods for an explanation of the calculations used to obtain these indices. We used the slope of the regression line for each species to calculate the Annual Percentage Change (*APC*) and Productivity Trend (*PrT*) for the population. APC and *PrT* along with the standard errors of the slopes (*SE*), the correlation coefficients (*r*), and the significance levels of the correlations (*P*) for each target species and for all species pooled are included in Figures 1 and 2.

The population trend for all species pooled was non- significantly ($P < 0.10$) negative between 2001 and 2008 (Figure 1), showing an annual decrease of 4.2%. This is similar to the values recorded after seven years of data (2001-2007) had been analyzed, as expected based on the slight overall increases recorded between 2007 and 2008 (Table 4). Overall eight-year declines were noted for three of the eight species, with that of Song Sparrow being highly significant ($P = 0.001$), that of Indigo Bunting being significant ($P = 0.024$), and that of Carolina Wren being nearly significant ($P = 0.095$). The remaining five species showed non-significant trends, with

that of Ovenbird being positive and highly fluctuating (*SE* of the slope > 0.055), that of Tufted Titmouse being negative and fluctuating, and those of Worm-eating Warbler and Northern Cardinal being relatively flat and stable.

Trends in productivity for all species pooled decreased non-significantly between 2001 and 2008 (Figure 2). A non-significant decrease in productivity was noted for Worm-eating Warbler, Gray Catbird, Ovenbird, and Northern Cardinal and non-significant increases were noted for Carolina Wren and Song Sparrow, Tufted Titmouse and Indigo Bunting.

Estimates of Adult Survivorship

Estimates of adult survival and recapture probabilities could be obtained for seven species applying transient models using eight years (2001-2008) of data from Sugar Grove and four years of data from George Washington National Forest, combined (Table 8). This represents an increase of two species (Black-capped Chickadee and Ovenbird) from these analyses based on seven and three years of data, respectively. This is due to the fact that, after four years we can combine the data from George Washington into the same transient models we use for the Sugar Grove data set, rather than splitting the data sets and running a non-transient model on George Washington, as we had to do last year based on only three years of data. The remaining two target species (Tufted Titmouse and Carolina Wren) had unrealistic estimates of either 0.0 or 1.0 for survival and/or recapture probability due to too few captures and/or too few recaptures. Survival rate (φ) for the seven species ranged from 0.291 for Song Sparrow to 0.764 for Indigo Bunting, with a mean of 0.488 (Table 8). Recapture probability ranged from 0.130 for Gray Catbird to 0.752 for Ovenbird, with a mean of 0.368. Proportion of residents ranged from 0.077 for Ovenbird to 1.000 for four species (Table 8), with a mean of 0.758. The mean C.V. for estimates of these seven species based on the transient model (Table 8) was 37.6% which is still considered high, but it is lower than the mean of 42.9% recorded for five species after seven years of data had been collected.

In order to assess survival rate estimates with those of surrounding areas, we compared survival values at Sugar Grove to values estimated from MAPS stations operated in 1992-2003 within Bird Conservation Region (BCR) 28, the Appalachian Mountain Region, in which Sugar Grove is located (Table 8). The mean survival for the seven species at Sugar Grove and George Washington in 2001-2008 was 0.488, slightly higher than the 0.465 estimate from the Appalachian Region as a whole during 1992-2003. Among species, Worm-eating Warbler and Indigo Bunting showed higher survival at Sugar Grove than in the Appalachian Region overall, Black-capped Chickadee, Ovenbird, and Northern Cardinal showed slightly lower survival, and Gray Catbird and Song Sparrow showed lower survival at Sugar Grove and George Washington than in the region overall.

Productivity and Survival as a Function of Body Mass

It has previously been shown that both productivity and survival of birds vary with body mass: on average, the larger the bird the lower the productivity and the higher the survival. Thus, body

mass must be considered in order to assess whether or not productivity or survival in a given species is higher or lower than expected. Figure 3 shows mean productivity indices (Table 7) and non-transient annual adult survival-rate estimates (Table 8), recorded at all four stations combined, as a function of mean body mass (log transformed) for 8 (productivity) and 4 (survival) target species for which these parameters could be estimated. The purpose of this analysis was to determine which species showed higher or lower productivity or survival than might be expected given their body mass. The regression line presented on each graph indicates the relationship of productivity and survival with body mass, using data from 210 (productivity) and 89 (survival) species from MAPS data collected across the entire North American continent.

Three of the species shown in Figure 3 (species alpha codes in bold uppercase letters) showed population declines at NIOC Sugar Grove and George Washington National Forest (Figure 1). Carolina Wren (CARW) appears to show higher than average productivity, which is also increasing (Figure 2), but we could not estimate survival for comparison, although with more years of data we may be able to obtain this estimate. Song Sparrow (SOSP) shows slightly higher-than-expected productivity and slightly lower-than-expected survival, suggesting that lower survival may be driving population declines. Indigo Bunting (INBU) showed the opposite pattern, with slightly lower-than-expected productivity and higher-than-expected survival, suggesting that low productivity at Sugar Grove may be driving the decline. One species shown in Figure 3 (in regular-font uppercase letters), Gray Catbird (GRCA), showed a increasing population trend (Figure 1). This species showed fairly balanced productivity and survival values, making it difficult to determine which factor (if not both) might be driving the population increase.

The remaining five species shown in Figure 3 (in lower-case letters) showed non-significant population trends (Figure 1). Four of these species, Black-capped Chickadee (bcch), Worm-eating Warbler (wewa), Ovenbird (oven), and Tufted Titmouse (tuti), showed higher-than-expected productivity, with Worm-eating Warbler and Ovenbird also showing slightly higher-than-expected survival and Black-capped Chickadee showing slightly lower-than-expected survival. This suggests that high productivity at Sugar Grove is helping to maintain stable populations for these species, although the declining productivity noted for Worm-eating Warbler and (to a lesser degree) Ovenbird (Figure 2) may be of concern. The other species, Northern Cardinal (noca), showed close-to-expected productivity and survival values, which would be expected in populations showing stable population trends.

Thus, in summary, higher-than-expected productivity appears to be occurring in five or six of the eight species at Sugar Grove and George Washington National Forest, whereas slightly lower-than-expected productivity is only occurring in two species. Survival is higher-than-expected in one species and close-to-expected in six species, although slightly lower-than expected in Song Sparrow. These results reinforce those presented above, indicating that productivity is higher at Sugar Grove and George Washington and survival is as roughly expected, compared with values for the Northeast Region as a whole.

The breeding status of all species seen, heard, or banded are given in Appendix 1. A total of 126

species have been recorded in the breeding status list for the four stations.

DISCUSSION

In previous year's reports (Pyle *et al.* 2006, Nott *et al.* 2007, Nott *et al.* 2008), based on 5-7 years of MAPS data, we noted that both species richness and abundance of adult birds at the South Fork Potomac River station, located in bottomland riparian habitat, was higher than that at the other three stations, which are found in relatively pristine forested habitat. In contrast, the South Fork Potomac River station is adjacent to managed areas (e.g., lawns) that include a lot more habitat edge, which can carry more importance to landbird numbers than physiographic strata (flood plain vs. ridge) or understory thickness. Although our original goal of providing a counterpart to the South Fork Potomac River station in the George Washington National Forest (Lick Run station) was not realized we feel that we are sampling a nice balance of habitats with the four on-going stations, and that these data are increasingly providing important results.

Recent demographic patterns

Breeding populations, numbers of young, and reproductive success all showed slight increases between 2007 and 2008. This was the third year in a row in which all three parameters have changed in synch, after increasing between 2006 and 2007 and declining between 2007 and 2008. In past years at MAPS stations (including during 2001-2005 at Sugar Grove) our data showed an alternating cycle whereby low productivity one year resulted in low populations the next year, which have higher breeding success resulting in higher populations the following year, etc. The fact that this alternating pattern at MAPS stations (including Sugar Grove and George Washington) seems to have shifted to one where all three parameters are more in synchrony is of interest and perhaps of potential concern. It could indicate that normal processes are being disrupted, perhaps by global climate change. It will be very interesting to see if this pattern continues at Sugar Grove and George Washington National Forest in the future.

A primary goal of the MAPS program is to determine the proximate causes (productivity or survival) accounting for declining landbird population sizes. In this year's report we were able to add two more species to the list for which reasonable survivorship estimates could be provided, and we have thus expanded our analyses aimed at assessing the causes for the observed population trends to nine target species at the two locations.

The overall reproductive index of 0.76 for landbirds at Sugar Grove and George Washington National Forest during 2001-2008 is excellent as compared with the mean value of 0.31 calculated for the Northeast MAPS Region during the 15-year period 1992-2006. Among target species, four species showed higher productivity at the MAPS stations than in the Northeast Region, three species showed slightly higher values, and only one species (Song Sparrow) showed lower productivity at the MAPS stations than in the Northeast Region. In addition, when compared to values expected based on body mass, higher-than-expected productivity appears to be occurring in five or six of the eight species at Sugar Grove whereas slightly lower-than expected productivity is only occurring in two species, reinforcing the fact that productivity is higher at Sugar Grove and George Washington than is indicated for the Northeast Region. The population dynamics of Sugar Grove's breeding species thus could be affected through

appropriate management action which may serve to enhance productivity.

Management considerations

Management could be applied to increase the productivity of Indigo Bunting and Worm-eating Warbler at Sugar Grove; the Breeding Bird Survey also shows a long term decline of Indigo Buntings across West Virginia. Management actions designed to increase nesting opportunities by ensuring the availability of dense understory in open edgy woodland may increase local productivity and lead to higher rates of recruitment. Such habitat is common to regenerating forest gaps and the edges of cut areas. The availability of understory vegetation can be seriously depleted by foraging white-tailed deer that are overpopulated across the northeastern United States. Recent security fence enclosure of the Sugar Grove satellite dish site, (site of S. Fork Potomac River MAPS station) may have effects on bird populations by excluding deer from foraging in the forest understory. Deer exclusion may allow more dense foliage to develop. However, the soils of the ridge and valley geology are thin and poor such that tree growth is slow, and along riparian corridors invasive plant species, especially vines, tend to choke undergrowth. Further south, in Georgia, Indigo Bunting populations have also been reported to respond positively to Red-cockaded Woodpecker management by increased numbers and productivity three years after an understory burn.

Regional demography comparisons

Using eight years of data from the two Sugar Grove stations, estimates of adult survival and recapture probabilities could be obtained for seven of the nine target species breeding at NIOC Sugar Grove, an increase of two species from last season's analysis, based on our ability to apply transient models to four-year's of data collected at George Washington. The mean survival for the seven species at Sugar Grove and George Washington in 2001-2008 was 0.488, slightly higher than the 0.465 estimate from the Appalachian Region as a whole during 1992-2003. Two species, Worm-eating Warbler and Indigo Bunting showed higher survival rates at Sugar Grove than in the Appalachian Region overall. However, Black-capped Chickadee, Ovenbird, and Northern Cardinal showed slightly lower survival, and Gray Catbird and Song Sparrow showed lower survival at Sugar Grove and George Washington than in the region overall. These results reinforce the notion that survival is roughly as expected at Sugar Grove in comparison to values from the Northeast Region. The mean C.V. for estimates of these seven species based on the transient model was 37.6% which is still considered high, but it is lower than the mean of 42.9% recorded for five species after seven years of data had been collected, indicating the increased precision of our estimates with increased years or data collection.

With additional years of data and the addition of data collected at stations in comparable habitats at George Washington National Forest, we hope to better understand the population dynamics at Sugar Grove and the causes for the general declines noted in populations there. As more years of data accumulate we will be able to make more informed inferences regarding the effect of productivity and survivorship on population dynamics. Pooling data at this level will also allow comparison between NIOC Sugar Grove, George Washington National Forest, and other

protected and unprotected areas at which MAPS stations are operated in the region.

Future monitoring and research with a regional perspective

The long-term goal for the NIOC Sugar Grove and George Washington MAPS program is to provide critical information to clarify the ecological processes leading from environmental stressors to landbird population responses. We will accomplish this by including NIOC Sugar Grove and George Washington National Forest data in analyses of data from other central Appalachian MAPS stations to: (a) determine spatial patterns in productivity indices and survival rate estimates as a function of spatial patterns in population trends for target species; (b) determine the proximate demographic factors causing observed population trends; (c) identify relationships between landscape-level habitat and/or weather characteristics and the primary demographic responses (productivity and survival rates) of target species; (d) generate hypotheses regarding the ultimate environmental causes of the population trends; and (e) make comprehensive recommendations for habitat and use-related management goals both at local scale of the installation and the larger scale of the central Appalachians.

In addition, MAPS data from NIOC Sugar Grove and George Washington National Forest will provide an important contribution to the determination of accurate indices of adult population size and productivity and precise estimates of adult survival rates on the still larger region-wide scale (e.g., northeastern North America) for many landbird species. Very recently we undertook an analysis of the entire MAPS program in the Northeastern Region for the Northeast Coordinated Bird Monitoring Partnership. In our report it was recommended that the MAPS program be increased by about 50% throughout the Northeastern United States. All four of the Sugar Grove and George Washington stations were contributing adequately to our understanding of population dynamics for species of concern within Bird Conservation Region 28, the Appalachian Mountains, receiving a mean priority score of 35.8, compared with a mean score of 28.4 for all MAPS stations in the region; thus, the recommendation of the report was that all four stations were of significant contribution to the MAPS Program in the Northeast Region and in BCR 28 (The Appalachian Region), and that all four stations should be continued.

We conclude that the MAPS protocol is well-suited to provide an integral component of NIOC Sugar Grove's long-term ecological monitoring effort, and we recommend the continued operation of the NIOC Sugar Grove MAPS stations well into the future. We recommend continued monitoring either side of the new security fence at the upper satellite site to asses the effect of exclusion of white-tailed deer.

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Table 1. Summary of the 2008 MAPS program on Navy Information Operations Command (NIOC) Sugar Grove and the George Washington National Forest.

STATION						2008 operation		
LOCATION Name	Code	No.	Major Habitat Type	Latitude-longitude	Elev. (m)	Total number of net-hours[1]	No. of periods	Inclusive dates
NIOC SUGAR GROVE								
South Fork Potomac River	SFPR	15627	Gentle slope, riparian corridor, mixed forest, grassland edge	38°34'44"N -79°16'13"W	536	462.3 (340.5)	8	5/19 - 8/03
Beaver Creek	BECR	15628	Steep slope, open mixed forest, grassland edge; no understory	38°30'40"N -79°16'26"W	658	444.7 (284.2)	8	5/22 - 8/02
GEORGE WASHINGTON NF								
Lick Run	LIRU	15665	Mixed deciduous riparian woodland and Virginia pine	38°30'23"N -79°16'59"W	625	460.2 (329.3)	8	5/18 - 7/30
Flesh Run	FLRU	15666	Virginia pine forest on steep ridgeside, open maple woodland	38°27'18"N -79°17'36"W	718	443.3 (246.3)	8	5/23 - 8/01
ALL STATIONS COMBINED						1810.5 (1200.3)	8	5/18 - 8/03

[1] Total net-hours in 2008. Net-hours in 2008 that could be compared in a constant-effort manner to 2007 are shown in parentheses.

Table 2. Capture summary for the four individual MAPS stations, and all stations pooled, operated on NIOC Sugar Grove and the George Washington National Forest in 2008. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All stations pooled		
SPECIES	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Wild Turkey											1			1	
Ruby-throated Hummingbird		3						3			2			8	
Downy Woodpecker							2						2		
Hairy Woodpecker									1	1		1	1		2
Pileated Woodpecker											3			3	
Eastern Wood-Pewee				1						1			2		
Acadian Flycatcher							1	1					1	1	
Eastern Phoebe	2						3			3			8		
Great Crested Flycatcher				1									1		
Blue-headed Vireo							1			3			4		
Philadelphia Vireo							1						1		
Red-eyed Vireo	3						1			10		1	14		1
Blue Jay	1			2									3		
Black-capped Chickadee	1			1			4		2	3			9		2
Tufted Titmouse	2					1	6	1		3		1	11	1	2
Carolina Wren	8	3	6		1		2			2			12	4	6
Blue-gray Gnatcatcher										3			3		
Wood Thrush	1						1						2		
American Robin	6		2										6		2
Gray Catbird	22	1	11										22	1	11
Brown Thrasher	2		1										2		1
Northern Parula										1			1		
Magnolia Warbler	1												1		
Black-throated Green Warbler									1			1			
Blackburnian Warbler										2			2		
Black-and-white Warbler	1						2			1			4		
Worm-eating Warbler	20	1	2				10	1	6	2			32	2	8
Ovenbird	3			5		1	13		4	7			28		5

	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All stations pooled		
SPECIES	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Northern Waterthrush	3		1	1			1						5		1
Louisiana Waterthrush			1					1						1	1
Common Yellowthroat	2												2		
Eastern Towhee	3		2										3		2
Chipping Sparrow	1									8		3	9		3
Song Sparrow	5												5		
Northern Cardinal	3		5				2			1		2	6		7
Indigo Bunting	2			2		2	9		9	3		2	16		13
Common Grackle	1	1											1	1	
American Goldfinch										2			2		
ALL SPECIES POOLED	93	9	31	13	1	4	59	7	22	57	6	10	222	23	67
Total Number of Captures		133			18			88			73			312	
Total Number of Species	22	5	9	7	1	3	16	5	5	19	3	6	34	10	16

Table 3. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated NIOC Sugar Grove and the George Washington National Forest in 2008.

	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All stations pooled		
SPECIES	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.
Downy Woodpecker							0.0	2.6	und.				0.0	0.9	und.
Hairy Woodpecker							1.3	0.0	0.00	2.7	0.0	0.00	1.3	0.0	0.00
Eastern Wood-Pewee				1.3	0.0	0.00				1.4	0.0	0.00	0.9	0.0	0.00
Acadian Flycatcher							1.3	0.0	0.00				0.4	0.0	0.00
Eastern Phoebe	1.3	1.3	1.00				2.6	1.3	0.50	1.4	2.7	2.00	1.8	1.8	1.00
Great Crested Flycatcher				1.3	0.0	0.00							0.4	0.0	0.00
Blue-headed Vireo							1.3	0.0	0.00	4.1	0.0	0.00	1.8	0.0	0.00
Red-eyed Vireo	3.9	0.0	0.00				1.3	0.0	0.00	10.8	0.0	0.00	5.3	0.0	0.00
Blue Jay	1.3	0.0	0.00	2.7	0.0	0.00							1.3	0.0	0.00
Black-capped Chickadee	1.3	0.0	0.00	1.3	0.0	0.00	1.3	5.2	4.00	2.7	1.4	0.50	2.2	2.2	1.00
Tufted Titmouse	1.3	1.3	1.00	1.3	0.0	0.00	1.3	6.5	5.00	1.4	4.1	3.00	1.8	4.0	2.25
Carolina Wren	6.5	3.9	0.60				0.0	2.6	und.	1.4	0.0	0.00	2.6	2.2	0.83
Blue-gray Gnatcatcher										4.1	0.0	0.00	1.3	0.0	0.00
Wood Thrush	0.0	1.3	und.				0.0	1.3	und.				0.0	0.9	und.
American Robin	5.2	2.6	0.50										1.8	0.9	0.50
Gray Catbird	26.0	3.9	0.15										8.8	1.3	0.15
Brown Thrasher	2.6	0.0	0.00										0.9	0.0	0.00
Northern Parula										1.4	0.0	0.00	0.4	0.0	0.00
Magnolia Warbler	1.3	0.0	0.00										0.4	0.0	0.00
Black-throated Green Warbler										1.4	0.0	0.00	0.4	0.0	0.00
Blackburnian Warbler										1.4	0.0	0.00	0.4	0.0	0.00
Black-and-white Warbler	1.3	0.0	0.00				0.0	2.6	und.	1.4	0.0	0.00	0.9	0.9	1.00
Worm-eating Warbler	10.4	16.9	1.63				7.8	7.8	1.00	1.4	1.4	1.00	6.6	8.8	1.33
Ovenbird	2.6	1.3	0.50	5.4	2.7	0.50	6.5	11.7	1.80	4.1	5.4	1.33	6.2	7.0	1.14
Northern Waterthrush	2.6	1.3	0.50	1.3	0.0	0.00	0.0	1.3	und.				1.3	0.9	0.67
Louisiana Waterthrush	1.3	0.0	0.00										0.4	0.0	0.00
Common Yellowthroat	2.6	0.0	0.00										0.9	0.0	0.00

	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All stations pooled		
SPECIES	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.	Ad.	Yng.	Prop. Yng.
Eastern Towhee	5.2	0.0	0.00										1.8	0.0	0.00
Chipping Sparrow	1.3	0.0	0.00							9.5	1.4	0.14	3.5	0.4	0.13
Song Sparrow	3.9	2.6	0.67										1.3	0.9	0.67
Northern Cardinal	9.1	0.0	0.00				2.6	0.0	0.00	2.7	0.0	0.00	4.8	0.0	0.00
Indigo Bunting	2.6	0.0	0.00	4.0	0.0	0.00	13.0	2.6	0.20	5.4	0.0	0.00	8.4	0.9	0.11
Common Grackle	1.3	0.0	0.00										0.4	0.0	0.00
American Goldfinch										2.7	0.0	0.00	0.9	0.0	0.00
ALL SPECIES POOLED	94.7	36.3	0.38	18.9	2.7	0.14	40.4	45.6	1.13	60.9	16.2	0.27	71.7	33.9	0.47
Number of Species	22	10		8	1		11	11		19	6		32	15	
Total Number of Species		23			8			16			19			34	

Table 4. Percentage changes between 2007 and 2008 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on NIOC Sugar Grove and the George Washington National Forest.

SPECIES	S. Fork. Potomac River	Beaver Creek	Lick Run	Flesh Run	N[1]	All stations pooled: Number of adults 2007	All stations pooled: Number of adults 2008	All stations pooled: Percent change	SE[2]
Downy Woodpecker					0	0	0		
Hairy Woodpecker			++++	++++	2	0	3	++++	
Northern Flicker		-100.0			1	1	0	-100.0	
Eastern Wood-Pewee	-100.0				1	1	0	-100.0	
Acadian Flycatcher			++++		1	0	1	++++	
Eastern Phoebe	++++		++++	++++	3	0	3	++++	
Great Crested Flycatcher		++++			1	0	1	++++	
Blue-headed Vireo				++++	1	0	1	++++	
Red-eyed Vireo	-100.0		++++	700.0	3	2	9	350.0	354.4
Blue Jay	++++	++++			2	0	3	++++	
Black-capped Chickadee	++++		0.0	-66.7	3	4	3	-25.0	49.6
Tufted Titmouse	++++	0.0	-50.0	-50.0	4	5	4	-20.0	30.6
White-breasted Nuthatch					0	0	0		
Carolina Wren	25.0			++++	2	4	6	50.0	50.0
Veery					0	0	0		
Wood Thrush					0	0	0		
American Robin	0.0				1	2	2	0.0	
Gray Catbird	225.0				1	4	13	225.0	
Cedar Waxwing				-100.0	1	2	0	-100.0	
Northern Parula				++++	1	0	1	++++	
Black-throated Green Warbler				0.0	1	1	1	0.0	
Blackburnian Warbler				++++	1	0	1	++++	
Black-and-white Warbler	++++		-100.0	0.0	3	2	2	0.0	86.6
Worm-eating Warbler	0.0	-100.0	200.0	-100.0	4	16	14	-12.5	45.1
Ovenbird	-50.0	33.3	300.0	++++	4	8	12	50.0	74.3
Northern Waterthrush					0	0	0		
Louisiana Waterthrush	-100.0		-100.0		2	3	0	-100.0	88.9
Scarlet Tanager		-100.0			1	1	0	-100.0	

SPECIES	S. Fork. Potomac River	Beaver Creek	Lick Run	Flesh Run	N[1]	All stations pooled: Number of adults 2007	All stations pooled: Number of adults 2008	All stations pooled: Percent change	All stations pooled: SE[2]
Eastern Towhee	50.0		-100.0		2	3	3	0.0	66.7
Chipping Sparrow	++++			300.0	2	1	5	400.0	200.0
Song Sparrow	50.0				1	2	3	50.0	
Northern Cardinal	66.7		-50.0	++++	3	5	7	40.0	54.1
Indigo Bunting	-66.7	-33.3	300.0	-40.0	4	16	15	-6.3	53.1
Baltimore Oriole	-100.0				1	1	0	-100.0	
American Goldfinch				-80.0	1	5	1	-80.0	
ALL SPECIES POOLED	25.6	-28.6	78.6	36.4	4	89	114	28.1	14.0
No. species that increased[4]	11 (6)	3 (2)	7 (4)	10 (8)				15 (8)	
No. species that decreased[5]	6 (4)	4 (3)	5 (3)	6 (2)				11 (6)	
No. species remained same	2	1	1	2				4	
Proportion of increasing (decreasing) species	0.579	(0.500)	0.538	0.556				0.500	
Sig. of increase (decrease)[6]	0.324	(0.637)	0.500	0.407				0.572	
TOTAL NO. OF SPECIES	19	8	13	18					

[1] Number of stations at which at least one adult bird was captured in either year.
[2] Standard error of the % change in the number of adult birds captured.
[3] Increase indeterminate (infinite) because no adult was captured during 2007.
[4] No. of species for which adults were captured in 2008 but not in 2007 are in parentheses.
[5] No. of species for which adults were captured in 2007 but not in 2008 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$.

Table 5. Percentage changes between 2007 and 2008 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on NIOC Sugar Grove and the George Washington National Forest.

SPECIES	S. Fork. Potomac River	Beaver Creek	Lick Run	Flesh Run	n[1]	All stations pooled: Number of young 2007	All stations pooled: Number of young 2008	All stations pooled: Percent change	SE[2]
Downy Woodpecker		-100.0	++++	-100.0	3	2	2	0.0	150.0
Hairy Woodpecker					0	0	0		
Northern Flicker					0	0	0		
Eastern Wood-Pewee					0	0	0		
Acadian Flycatcher					0	0	0		
Eastern Phoebe	++++		++++		2	0	2	++++	
Great Crested Flycatcher					0	0	0		
Blue-headed Vireo				-100.0	1	1	0	-100.0	
Red-eyed Vireo				-100.0	1	1	0	-100.0	
Blue Jay					0	0	0		
Black-capped Chickadee			++++	-75.0	2	4	5	25.0	200.0
Tufted Titmouse	++++		400.0	++++	3	1	9	800.0	624.5
White-breasted Nuthatch				-100.0	1	1	0	-100.0	
Carolina Wren	-40.0		-50.0		2	7	4	-42.9	4.1
Veery			-100.0		1	1	0	-100.0	
Wood Thrush	++++		-100.0		2	1	1	0.0	200.0
American Robin	-50.0				1	4	2	-50.0	
Gray Catbird	50.0				1	2	3	50.0	
Cedar Waxwing					0	0	0		
Northern Parula					0	0	0		
Black-throated Green Warbler					0	0	0		
Blackburnian Warbler					0	0	0		
Black-and-white Warbler			100.0	-100.0	2	3	2	-33.3	88.9
Worm-eating Warbler	1200.0		++++	++++	3	1	20	1900.0	1135.8
Ovenbird	++++	100.0	500.0	200.0	4	3	12	300.0	121.7
Northern Waterthrush	-100.0		++++		2	1	1	0.0	200.0
Louisiana Waterthrush					0	0	0		
Scarlet Tanager					0	0	0		

SPECIES	S. Fork. Potomac River	Beaver Creek	Lick Run	Flesh Run	n[1]	All stations pooled: Number of young 2007	All stations pooled: Number of young 2008	All stations pooled: Percent change	All stations pooled: SE[2]
Eastern Towhee					0	0	0		
Table 5 (continued)									
Chipping Sparrow				-100.0	1	1	0	-100.0	
Song Sparrow	100.0				1	1	2	100.0	
Northern Cardinal			-100.0		1	1	0	-100.0	
Indigo Bunting			++++	-100.0	2	1	2	100.0	400.0
Baltimore Oriole					0	0	0		
American Goldfinch				-100.0	1	1	0	-100.0	
ALL SPECIES POOLED	92.9	0.0	275.0	-42.9	4	38	67	76.3	70.5
No. species that increased[4]	7 (1)	1 (1)	9 (4)	3 (2)				8 (1)	
No. species that decreased[5]	3 (1)	1 (1)	4 (3)	9 (8)				10 (7)	
No. species remained same	0	1	1	2				3	
Proportion of increasing (decreasing) species	0.700	0.500	0.692	(0.750)				0.381	
Sig. of increase (decrease)[6]	0.172	0.750	0.133	(0.073)				0.905	
TOTAL NO. OF SPECIES	10	2	13	12					

[1] Number of stations at which at least one young bird was captured in either year.
[2] Standard error of the % change in the number of young birds captured.
[3] Increase indeterminate (infinite) because no young was captured during 2007.
[4] No. of species for which young were captured in 2008 but not in 2007 are in parentheses.
[5] No. of species for which young were captured in 2007 but not in 2008 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$.

Table 6. Absolute changes between 2007 and 2008 in the PROPORTION OF YOUNG in the catch at four constant-effort MAPS stations on NIOC Sugar Grove and the George Washington National Forest.

	S. Fork. Potomac					All stations poolede			
						Proportion young		Absolute	
SPECIES	River	Beaver Creek	Lick Run	Flesh Run	n[1]	2007	2008	change	SE[2]
Downy Woodpecker		nc.	nc.	nc.	3	------	------	nc.	
Hairy Woodpecker			nc.	nc.	2	------	0.000	nc.	
Northern Flicker		nc.			1	0.000	------	nc.	
Eastern Wood-Pewee	nc.				1	0.000	------	nc.	
Acadian Flycatcher			nc.		1	------	0.000	nc.	
Eastern Phoebe	nc.		nc.	nc.	3	------	0.667	nc.	
Great Crested Flycatcher		nc.			1	------	0.000	nc.	
Blue-headed Vireo				nc.	1	------	0.000	nc.	
Red-eyed Vireo	nc.		nc.	-1.000	3	0.500	0.000	-0.500	0.433
Blue Jay	nc.	nc.			2	------	0.000	nc.	
Black-capped Chickadee	nc.		4.000	-0.333	3	1.000	1.667	0.667	1.277
Tufted Titmouse	nc.	0.000	4.500	3.000	4	0.200	2.250	2.050	1.122
White-breasted Nuthatch				nc.	1	------	------	nc.	
Carolina Wren	-0.650		nc.	nc.	3	1.750	0.667	-1.083	0.903
Veery			nc.		1	------	------	nc.	
Wood Thrush	nc.		nc.		2	------	------	nc.	
American Robin	-1.000				1	2.000	1.000	-1.000	
Gray Catbird	-0.269				1	0.500	0.231	-0.269	
Cedar Waxwing				nc.	1	0.000	------	nc.	
Northern Parula				nc.	1	------	0.000	nc.	
Black-throated Green Warbler				0.000	1	0.000	0.000	0.000	
Blackburnian Warbler				nc.	1	------	0.000	nc.	
Black-and-white Warbler	nc.		nc.	-2.000	3	1.500	1.000	-0.500	1.561
Worm-eating Warbler	1.500	nc.	1.000	nc.	4	0.063	1.429	1.366	0.266
Ovenbird	0.500	0.167	0.500	nc.	4	0.375	1.000	0.625	0.411
Northern Waterthrush	nc.		nc.		2	------	------	nc.	
Louisiana Waterthrush	nc.		nc.		2	0.000	------	nc.	
Scarlet Tanager		nc.			1	0.000	------	nc.	

SPECIES	S. Fork. Potomac River	Beaver Creek	Lick Run	Flesh Run	n[1]	All stations poolede Proportion young 2007	2008	Absolute change	SE[2]
Eastern Towhee	0.000		nc.		2	0.000	0.000	0.000	0.000
Chipping Sparrow	nc.			-1.000	2	1.000	0.000	-1.000	0.000
Song Sparrow	0.167				1	0.500	0.667	0.167	
Northern Cardinal	0.000		-0.500	nc.	3	0.200	0.000	-0.200	0.208
Indigo Bunting	0.000	0.000	0.250	-0.200	4	0.063	0.133	0.071	0.102
Baltimore Oriole	nc.				1	0.000	------	nc.	
American Goldfinch				-0.200	1	0.200	0.000	-0.200	
ALL SPECIES POOLED	0.192	0.057	0.629	-0.370	4	0.427	0.588	0.161	0.209
No. species that increased[4]	3		1		5		1		
No. species that decreased[5]	3		0		1		6		
No. species remained same	3		2		0		1		
Proportion of increasing (decreasing) species	0.333	0.333	0.833	(0.750)				0.375	
Sig. of increase (decrease)[6]	0.910	0.875	0.109	(0.145)				0.895	
TOTAL NO. OF SPECIES	9	3	6	8				16	

[1] Number of stations at which at least one aged bird was captured in either year.
[2] Standard error of the change in the proportion of young.
[3] The change in the proportion of young is undefined at this station because no aged individual of the species was captured in one of the two years.
[4] Proportion of young not given because no aged individual of the species was captured in the year shown.
[5] Species for which the change in the proportion of young is undefined are not included.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$

Table 7. Mean numbers of adult (Ad.) and young (Yng.) individual birds captured per 600 net-hours and reproductive index (RI) at the four individual MAPS stations operated on NIOC Sugar Grove and the George Washington National Forest averaged over the eight years, 2001-2008[1]. Data for each species are included only from stations that lie within the breeding range of the species.

	South Fork Potomac River 2001-2008			Beaver Creek 2001-2008			Both NIOC stations pooled 2001-2008			Lick Run 2005-2008			Flesh Run 2005-2008			Both George W. stations pooled 2005-2008			All stations pooled 2001-2008[1,3]		
SPECIES	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]
Yellow-billed Cuckoo				0.2	0.0	0.00	0.1	0.0	0.00				0.3	0.0	0.00	0.2	0.0	0.00	0.1	0.0	0.00
Downy Woodpecker	0.3	0.5	0.50	0.0	0.4	und.	0.2	0.5	0.50	0.0	1.6	und.	0.0	0.4	und.	0.0	1.0	und.	0.2	0.6	0.50
Hairy Woodpecker	0.0	0.2	und.	0.3	0.0	0.00	0.2	0.1	0.50	0.6	0.6	1.00	1.0	0.9	0.00	0.8	0.8	1.67	0.3	0.3	0.88
Northern Flicker	0.2	0.0	0.00	0.2	0.0	0.00	0.2	0.0	0.00										0.1	0.0	0.00
Eastern Wood-Pewee	0.2	0.0	0.00	0.2	0.0	0.00	0.2	0.0	0.00				0.3	0.0	0.00	0.2	0.0	0.00	0.1	0.0	0.00
Acadian Flycatcher										1.0	0.3	0.25				0.5	0.2	0.25	0.1	0.0	0.25
Eastern Phoebe	1.0	0.2	0.25	0.3	0.0	0.00	0.7	0.1	0.25	0.7	1.3	0.50	0.7	0.7	1.00	0.7	1.0	1.00	0.7	0.3	0.50
Great Crested Flycatcher	0.2	0.0	0.00	0.5	0.0	0.00	0.4	0.0	0.00	0.3	0.0	0.00				0.2	0.0	0.00	0.3	0.0	0.00
Eastern Kingbird	0.2	0.0	0.00				0.1	0.0	0.00										*0.0*	*0.0*	*0.00*
White-eyed Vireo	2.7	0.5	0.13				1.4	0.3	0.13										1.3	0.3	0.13
Blue-headed Vireo				0.2	0.3	2.00	0.1	0.2	2.00	0.3	0.6	0.00	1.7	0.4	0.00	1.0	0.5	0.00	0.3	0.2	1.33
Red-eyed Vireo	2.4	0.0	0.00	0.0	0.2	und.	1.2	0.1	0.14	1.6	0.0	0.00	5.5	0.4	0.25	3.5	0.2	0.25	1.7	0.1	0.21
Blue Jay	1.0	0.0	0.00	1.2	0.4	0.25	1.1	0.2	0.33	0.3	0.3	1.00	0.7	0.0	0.00	0.5	0.2	0.33	0.9	0.2	0.35
Carolina Chickadee	0.2	0.0	0.00	0.0	0.4	und.	0.1	0.2	0.00										0.0	0.2	und.
Black-capped Chickadee	1.4	0.8	0.42	1.4	1.5	0.40	1.4	1.1	1.07	3.0	4.2	1.69	4.6	3.7	0.67	3.8	4.0	1.17	2.1	2.0	1.18
Tufted Titmouse	2.0	2.1	1.21	2.1	3.9	1.50	2.0	3.0	1.28	3.2	4.4	1.73	1.9	3.0	2.00	2.5	3.7	1.53	2.2	3.5	1.52
White-breasted Nuthatch				0.0	0.2	und.	0.0	0.1	und.				0.0	0.4	und.	0.0	0.2	und.	0.0	0.1	und.
Carolina Wren	7.9	7.6	1.05	0.2	1.8	5.00	4.1	4.8	1.23	0.6	3.1	1.50	0.3	0.7	0.00	0.5	2.0	2.00	3.2	4.0	1.39
House Wren	0.0	0.2	und.				0.0	0.1	und.										0.0	0.1	und.
Blue-gray Gnatcatcher				0.2	0.0	0.00	0.1	0.0	0.00				1.0	0.0	0.00	0.5	0.0	0.00	0.2	0.0	0.00
Veery										0.0	0.4	und.				0.0	0.2	und.	0.0	0.1	und.
Hermit Thrush				0.5	0.0	0.00	0.3	0.0	0.00										0.1	0.0	0.00
Wood Thrush	0.0	0.5	und.				0.0	0.2	und.	0.0	1.1	und.				0.0	0.6	und.	0.0	0.3	und.
American Robin	1.9	2.3	0.92	0.2	0.0	0.00	1.1	1.2	0.79				0.3	1.6	5.00	0.2	0.8	5.00	0.7	1.0	1.00
Gray Catbird	15.6	4.5	0.30				8.0	2.3	0.30	0.0	0.3	und.				0.0	0.2	und.	5.8	1.8	0.32
Brown Thrasher	1.4	1.2	0.30				0.7	0.6	0.30										0.5	0.6	0.30
Cedar Waxwing	0.5	0.0	0.00				0.3	0.0	0.00				1.2	0.0	0.00	0.6	0.0	0.00	0.4	0.0	0.00
Northern Parula				0.4	0.0	0.00	0.2	0.0	0.00	0.3	0.0	0.00	1.0	0.0	0.00	0.7	0.0	0.00	0.3	0.0	0.00
Yellow Warbler	0.2	0.0	0.00				0.1	0.0	0.00										0.1	0.0	0.00

	South Fork Potomac River 2001-2008			Beaver Creek 2001-2008			Both NIOC stations pooled 2001-2008			Lick Run 2005-2008			Flesh Run 2005-2008			Both George W. stations pooled 2005-2008			All stations pooled 2001-2008[1,3]		
SPECIES	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]	Ad.	Yng.	RI[2]
Chestnut-sided Warbler	0.2	0.0	0.00				0.1	0.0	0.00										*0.0*	*0.0*	*0.00*
Magnolia Warbler	0.5	0.0	0.00				0.3	0.0	0.00				0.3	0.0	0.00	0.2	0.0	0.00	0.3	0.0	0.00
Black-thrt Blue Warbler	0.2	0.0	0.00	0.0	0.2	und.	0.1	0.1	0.00										0.0	0.1	und.
Black-thrt Green Warb.	0.0	0.2	und.				0.0	0.1	und.				1.8	0.4	0.25	0.9	0.2	0.25	0.2	0.1	0.25
Blackburnian Warbler													0.3	0.0	0.00	0.2	0.0	0.00	*0.0*	*0.0*	*0.00*
Pine Warbler				0.2	0.3	1.00	0.1	0.2	1.00				0.0	0.3	und.	0.0	0.2	und.	0.0	0.2	2.00
Black-&-white Warbler	2.6	1.2	0.70	0.2	0.6	0.00	1.4	0.9	1.27	0.8	1.4	1.00	1.1	1.9	0.67	0.9	1.6	1.33	1.3	1.3	1.52
American Redstart	1.2	0.3	0.33				0.6	0.2	0.33				0.0	0.4	und.	0.0	0.2	und.	0.5	0.2	0.33
Worm-eating Warbler	13.6	28.9	2.23	4.1	0.8	0.50	9.1	15.3	1.84	5.1	4.3	0.73	0.8	0.3	0.50	3.0	2.3	0.73	7.5	13.9	1.79
Ovenbird	7.2	7.5	1.34	4.4	1.6	0.76	5.9	4.6	1.12	3.4	5.6	1.58	2.6	1.8	0.44	3.0	3.7	1.29	4.9	5.1	1.25
Northern Waterthrush	1.6	0.5	0.20	0.5	0.0	0.00	1.1	0.3	0.13	0.0	0.3	und.				0.0	0.2	und.	0.9	0.2	0.20
Louisiana Waterthrush	1.8	1.3	0.60	1.2	1.4	0.58	1.5	1.4	0.57	2.8	2.9	1.00	0.3	0.6	0.00	1.6	1.8	1.11	1.4	1.4	0.67
Mourning Warbler	0.3	0.0	0.00				0.2	0.0	0.00										0.1	0.0	0.00
Common Yellowthroat	1.6	0.0	0.00	0.2	0.0	0.00	0.9	0.0	0.00										0.6	0.0	0.00
Hooded Warbler	0.2	0.0	0.00	0.2	0.0	0.00	0.2	0.0	0.00	0.0	0.3	und.				0.0	0.2	und.	0.1	0.0	0.00
Canada Warbler	0.0	0.5	und.				0.0	0.3	und.										0.0	0.3	und.
Scarlet Tanager	0.3	0.2	0.00	0.9	0.0	0.00	0.6	0.1	0.00										0.4	0.1	0.00
Eastern Towhee	2.6	0.5	0.28				1.3	0.3	0.28	0.4	0.0	0.00				0.2	0.0	0.00	1.0	0.2	0.28
Chipping Sparrow	0.2	0.0	0.00	0.7	2.6	1.67	0.4	1.2	1.25				4.5	0.8	0.29	2.2	0.4	0.29	0.9	1.0	0.58
Song Sparrow	7.0	4.0	0.58				3.6	2.1	0.58										3.2	1.9	0.58
Northern Cardinal	6.9	0.8	0.19				3.5	0.4	0.19	2.5	0.4	0.13	1.0	0.3	0.00	1.7	0.4	0.38	3.0	0.5	0.23
Indigo Bunting	8.3	1.9	0.18	3.9	0.5	0.05	6.2	1.3	0.17	9.7	2.2	0.20	6.8	0.8	0.10	8.3	1.5	0.18	6.9	1.5	0.19
Common Grackle	0.5	0.0	0.00				0.3	0.0	0.00										0.2	0.0	0.00
Baltimore Oriole	0.9	0.0	0.00				0.5	0.0	0.00										0.4	0.0	0.00
American Goldfinch	0.2	0.0	0.00	0.6	0.0	0.00	0.3	0.0	0.00				4.5	0.4	0.05	2.3	0.2	0.05	0.8	0.1	0.04
ALL SPECIES POOLED	97.1	68.4	0.71	25.0	17.1	0.83	62.4	43.8	0.71	36.7	35.9	0.94	44.6	20.7	0.47	40.6	28.4	0.71	56.7	43.8	0.76
Number of Species	39	25		27	17		46	33		18	20		25	21		28	28		46	35	
Total No. of Species		44			32			51			24			29			37			54	

Table 7 (cont.).

[1] Data for eight years (2001-2008) is included for the South Fork Potomac River and Beaver Creek stations and for four years (2005-2008) for the Lick Run and Flesh Run stations.
2 Years for which the reproductive index was undefined (no adult birds were captured in the year) are not included in the mean reproductive index.
3 For numbers presented in italics, the mean number of adults or young is greater than 0.1 at one or more stations, but over the entire location the mean number is less than 0.05. The species is counted in the number of species over all stations pooled.
4 The reproductive index is undefined at this station because no young individual of the species was ever captured in the same year as an adult individual of the species.

Table 8. Estimates of adult annual apparent survival rates (ASR), recapture probabilities, and proportion of residents among newly captures adults using a time-constant model for seven species breeding at the four MAPS stations operated on NIOC Sugar Grove and the George Washington National Forest obtained from eight years (2001-2008)[1] of mark-recapture data.

SPECIES	Num. sta2.[2]	Num. inds.[3]	Num. caps.[4]	Num. rets.[5]	Apparent Survival Rate (ASR)[6]	ASR C.V.[7]	Recapture probability[8]	Proportion of residents[9]	Appalachian Mountains ASR 1992-2003[10]
Black-capped Chickadee	3	33	42	5	0.338 (0.216)	63.9	0.370 (0.335)	1.000 (1.023)	0.362 (0.092)
Gray Catbird	1	86	118	5	0.383 (0.202)	52.7	0.130 (0.147)	1.000 (1.086)	0.499 (0.025)
Worm-eating Warbler	3	101	133	15	**0.570** (0.125)	21.8	0.227 (0.111)	0.674 (0.353)	0.470 (0.071)
Ovenbird	3	75	106	8	0.544 (0.148)	27.3	0.752 (0.212)	0.077 (0.058)	0.576 (0.029)
Song Sparrow	1	35	57	5	0.291 (0.173)	59.6	0.387 (0.336)	1.000 (1.006)	0.401 (0.051)
Northern Cardinal	3	38	70	12	0.523 (0.137)	26.1	0.438 (0.175)	1.000 (0.491)	0.536 (0.046)
Indigo Bunting	3	90	144	25	**0.764** (0.091)	11.9	0.271 (0.078)	0.554 (0.186)	0.409 (0.046)

[1] Analysis of all stations pooled include data from 2001-2008 from the South Fork Potomac River and Beaver Creek stations and from 2005-2008 from the Flesh Run and Lick Run stations.
[2] Number of super-stations where the species was a regular or usual breeder at which adults of the species were captured.
[3] Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).
[4] Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.
[5] Total number of returns. A return is the first recapture in a given year of a bird originally banded at the same station in a previous year.
[6] Apparent survival rate presented as the maximum likelihood estimate (standard error of the estimate). Estimates in bold type denote higher value than regional estimates (see 10).
[7] The coefficient of variation for apparent survival rate.
[8] Recapture probability presented as the maximum likelihood estimate (standard error of the estimate).
[9] The proportion of residents among newly captured adults presented as the maximum likelihood estimate (standard error of the estimate).
[10] Apparent survival rate (φ) presented as the maximum likelihood estimate (standard error of the estimate) for Bird Conservation Region 28, the Appalachian Mountains, over the 12 years 1992-2003.

* Time-constant model was not marked by $QAIC_C$, but is shown for comparison with other species.

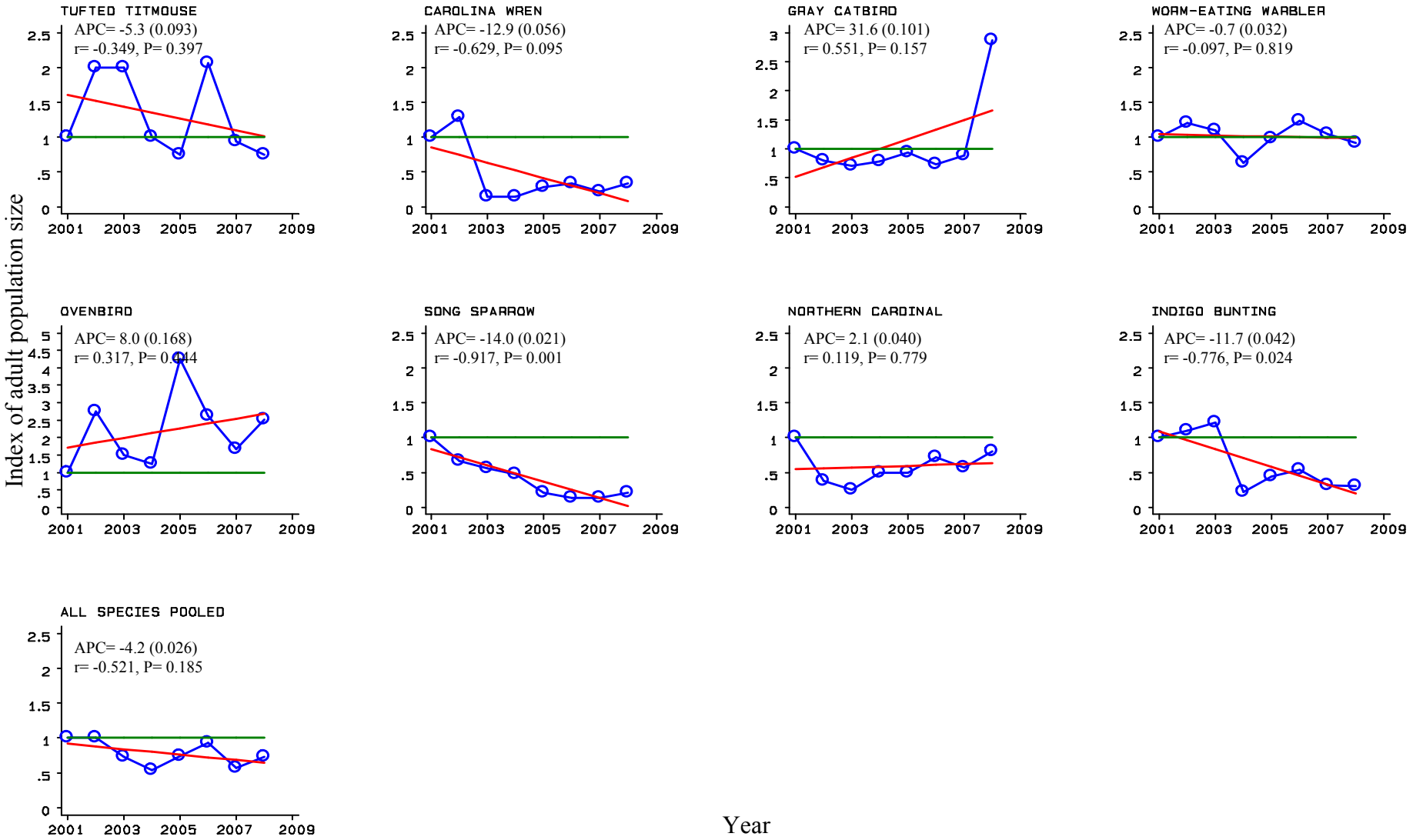

Figure 1. Population trends for eight species and all species pooled at the four MAPS stations combined on Navy Information Operations Command (NIOC) Sugar Grove and the George Washington National Forest over the eight years 2001-2008 (2001-2008 for the two NIOC Sugar Grove stations and 2005-2008 for the two George Washington NF stations). The index of population size was arbitrarily defined as 1.0 in 2001. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

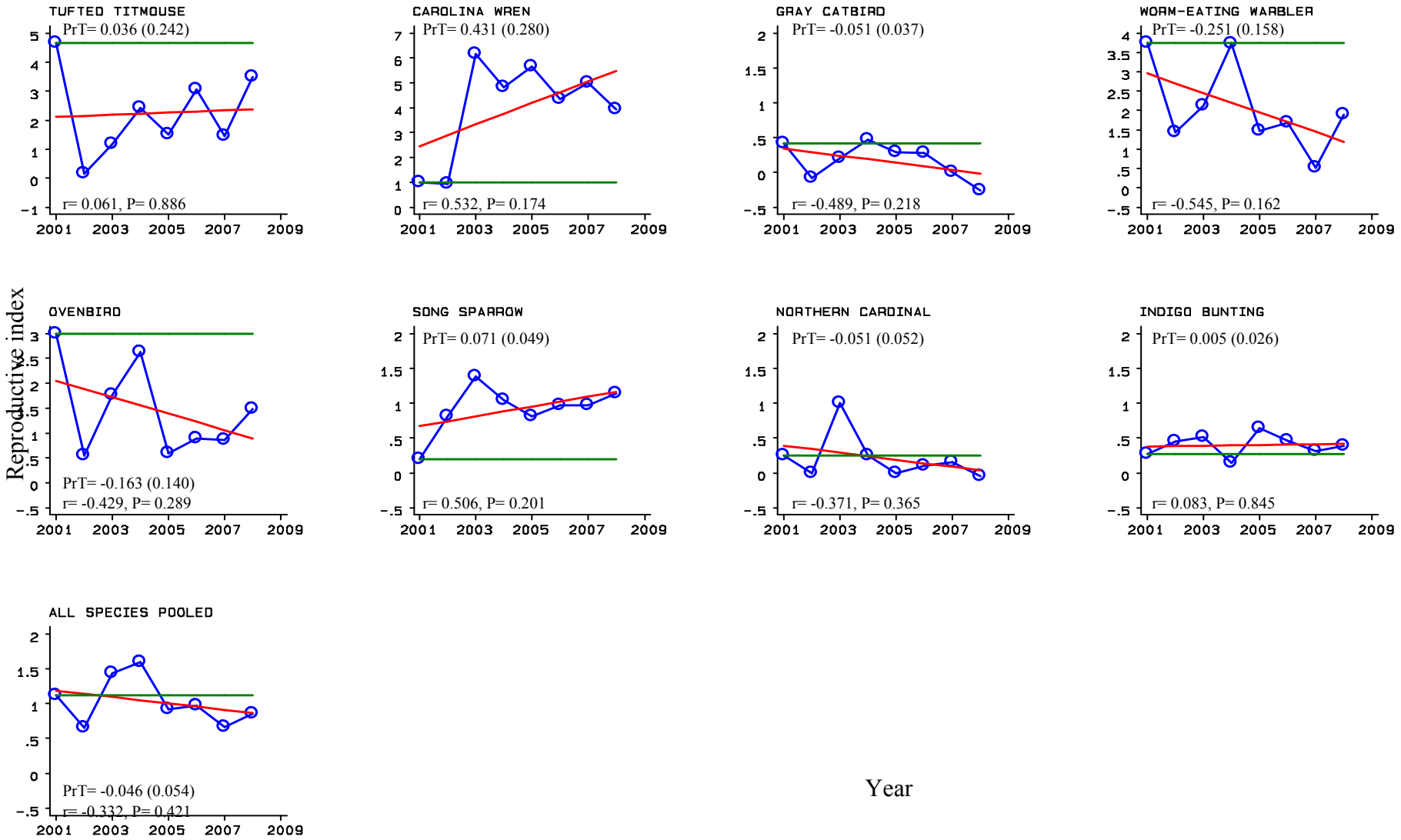

Figure 2. Trend in productivity for eight species and all species pooled in <location> over the eight years 2001-2008. The productivity index was defined as the actual productivity value in 2001. Indices for subsequent years were determined from constant-effort between-year changes in proportion of young in the catch from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (*PrT*), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are also shown on each graph.

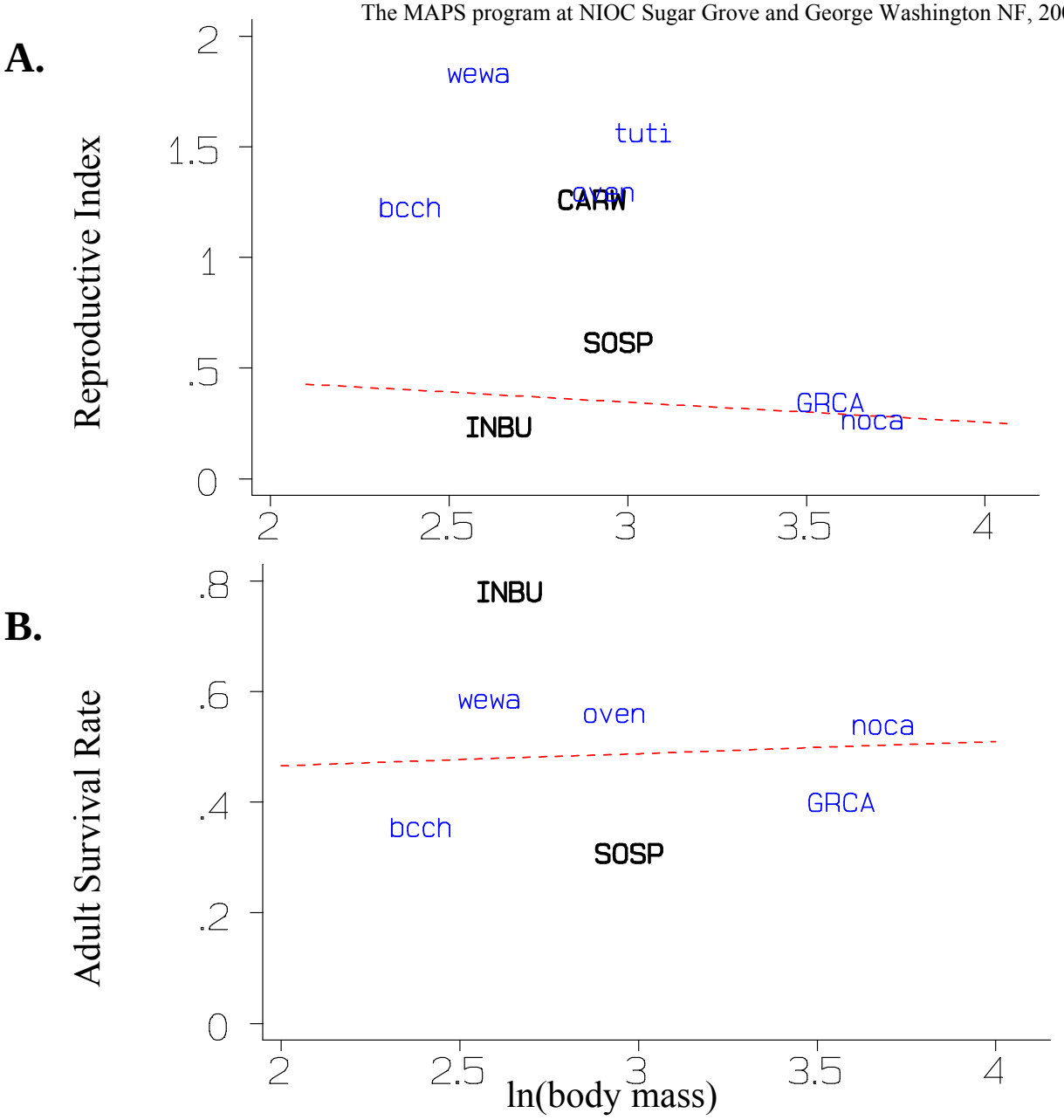

Figure 3. Regressions of mean reproductive index (A) and transient time-constant annual adult survival rate (B) at the four stations combined on Navy Information Operations Command (NIOC) Sugar Grove Sugar Grove and the George Washington National Forest on the natural log of body mass (g) for seven target species for which survival estimates could be provided and all nine target species for the eight years 2001-2008 (data was only available for the four years (2005-2008) for the stations on the George Washington NF). Four-letter codes (see Appendix I and text in Results) in bold upper-case letters represent species that had decreasing population trends (r>0.5); those in non-bold upper-case letters had increasing trends (r>0.5); and those in lower-case letters had very weak trends (r<0.5; Figure 1). A regression line is presented comparing these parameters with mass for species throughout North America (see text).

Appendix I. Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the eight years, 2001-2008, of the MAPS Program on the four stations operated on The MAPS program at NIOC Sugar Grove and George Washington National Forest. Cumulative breeding status for all years in which each station was operated are also included (B = Regular Breeder (all years); U = Usual Breeder (>½, not all, years); O = Occasional Breeder (<½ years); T = Transient; M = Migrant; A= Altitudinal Disperser.

NUMB	SPEC	SPECIES NAME	South Fork Potomac R. (SFPR)	Beaver Creek (BECR)	Lick Run (LIRU)	Flesh Run (FLRU)
00860	DCCO	Double-crested Cormorant	M			
01010	GBHE	Great Blue Heron	T	T	T	
01130	GRHE	Green Heron	U			
01290	BLVU	Black Vulture	T	T	T	T
01300	TUVU	Turkey Vulture	T	O	U	U
01460	CANG	Canada Goose	U	T	T	
01570	WODU	Wood Duck	O	T		
01630	MALL	Mallard	T	T		
02020	OSPR	Osprey	T			
02130	BAEA	Bald Eagle	T	T		
02170	NOHA	Northern Harrier		T		
02200	SSHA	Sharp-shinned Hawk		T		
02210	COHA	Cooper's Hawk	T	T	T	O
02380	RSHA	Red-shouldered Hawk		O	T	U
02400	BWHA	Broad-winged Hawk	T	O	U	T
02460	RTHA	Red-tailed Hawk	T	T	T	T
02510	GOEA	Golden Eagle		T		
02630	AMKE	American Kestrel	T	T		
02940	RUGR	Ruffed Grouse	O	O	O	T
03040	WITU	Wild Turkey		U	O	O
03750	SEPL	Semipalmated Plover		M		
03780	KILL	Killdeer	B	B	O	
03970	SOSA	Solitary Sandpiper		M		
04020	SPSA	Spotted Sandpiper	T	T		
04490	AMWO	American Woodcock				T
05570	MODO	Mourning Dove	O	U	B	U
06400	BBCU	Black-billed Cuckoo	T		T	
06410	YBCU	Yellow-billed Cuckoo	U	U	B	U
06680	EASO	Eastern Screech-Owl	T	O		
06800	GHOW	Great Horned Owl	T	T	T	
06950	BADO	Barred Owl		T		
07080	CONI	Common Nighthawk		O		
07230	WPWI	Whip-poor-will		T	T	O
07400	CHSW	Chimney Swift	O	U	T	T
08630	RTHU	Ruby-throated Hummingbird	U	O	U	U
09110	BEKI	Belted Kingfisher	U	O	T	T
09550	RBWO	Red-bellied Woodpecker	O	T	T	T
09650	DOWO	Downy Woodpecker	U	U	B	O
09660	HAWO	Hairy Woodpecker	U	U	B	B

NUMB	SPEC	SPECIES NAME	South Fork Potomac R. (SFPR)	Beaver Creek (BECR)	Lick Run (LIRU)	Flesh Run (FLRU)
09800	YSFL	Yellow-shafted Flicker	U	U	U	U
09860	PIWO	Pileated Woodpecker	U	B	U	U
11390	EAWP	Eastern Wood-Pewee	O	O	T	T
11450	YBFL	Yellow-bellied Flycatcher		M		
11460	ACFL	Acadian Flycatcher		O	O	O
11610	EAPH	Eastern Phoebe	U	O	U	B
11760	GCFL	Great Crested Flycatcher	U	U	U	U
12030	EAKI	Eastern Kingbird	U	T		T
12550	WEVI	White-eyed Vireo	U		T	
12690	YTVI	Yellow-throated Vireo	O	T		T
12720	BHVI	Blue-headed Vireo	T	O	T	B
12760	WAVI	Warbling Vireo	O	T		
12780	PHVI	Philadelphia Vireo		M	M	M
12790	REVI	Red-eyed Vireo	B	B	B	B
12930	BLJA	Blue Jay	U	B	B	B
13190	AMCR	American Crow	B	B	B	B
13270	FICR	Fish Crow	O			
13300	CORA	Common Raven	U	B	B	U
13340	PUMA	Purple Martin	U	T		
13410	TRES	Tree Swallow	U	O		
13490	NRWS	N Rough-winged Swallow	O			
13510	BANS	Bank Swallow	O			
13520	CLSW	Cliff Swallow	T			
13540	BARS	Barn Swallow	O	U	T	
13560	CACH	Carolina Chickadee	T	O	O	O
13570	BCCH	Black-capped Chickadee	U	B	B	B
13660	TUTI	Tufted Titmouse	U	B	B	B
13690	RBNU	Red-breasted Nuthatch	T	O	U	O
13700	WBNU	White-breasted Nuthatch	O	U	B	U
13730	BRCR	Brown Creeper		O		
14000	CARW	Carolina Wren	B	O	B	U
14070	HOWR	House Wren	O			
14250	RCKI	Ruby-crowned Kinglet	M			
14350	BGGN	Blue-gray Gnatcatcher	U	O	U	O
14560	EABL	Eastern Bluebird	O	T		
14780	VEER	Veery			T	
14790	GCTH	Gray-cheeked Thrush	M			
14820	HETH	Hermit Thrush		O	T	
14830	WOTH	Wood Thrush	T	T	O	T
15000	AMRO	American Robin	B	U	O	O
15130	GRCA	Gray Catbird	B		T	
15150	NOMO	Northern Mockingbird	T			
15200	BRTH	Brown Thrasher	U		O	T
15370	EUST	European Starling	U			
15510	AMPI	American Pipit		M		
15550	CEDW	Cedar Waxwing	U	U	O	U
15630	BWWA	Blue-winged Warbler		T		

NUMB	SPEC	SPECIES NAME	South Fork Potomac R. (SFPR)	Beaver Creek (BECR)	Lick Run (LIRU)	Flesh Run (FLRU)
15730	NOPA	Northern Parula	O	U	U	U
15750	YWAR	Yellow Warbler	T		T	
15760	CSWA	Chestnut-sided Warbler	T			T
15770	MAWA	Magnolia Warbler	T			T
15790	BTBW	Black-thr. Blue Warbler	T	T	T	O
15800	MYWA	Myrtle Warbler	T			
15830	BTNW	Black-thr.Green Warbler	T	O	O	B
15860	BLBW	Blackburnian Warbler		T		T
15910	PIWA	Pine Warbler	T	U	O	U
15930	PRAW	Prairie Warbler		T		
15970	BLPW	Blackpoll Warbler	M	M		
16030	BAWW	Black-and-white Warbler	U	T	U	U
16040	AMRE	American Redstart	O	T		T
16060	WEWA	Worm-eating Warbler	B	U	B	U
16080	OVEN	Ovenbird	U	U	B	B
16090	NOWA	Northern Waterthrush	T	T	T	
16100	LOWA	Louisiana Waterthrush	U	O	U	O
16130	MOWA	Mourning Warbler	T			
16150	COYE	Common Yellowthroat	O	T		T
16280	HOWA	Hooded Warbler	T	T	T	
16290	WIWA	Wilson's Warbler	M			
16300	CAWA	Canada Warbler	T			
16830	SCTA	Scarlet Tanager	O	B	O	U
17820	EATO	Eastern Towhee	B	T	O	B
18020	CHSP	Chipping Sparrow	U	B	O	B
18050	FISP	Field Sparrow	T			
18140	GRSP	Grasshopper Sparrow		U		
18230	SOSP	Song Sparrow	B		T	
18270	WTSP	White-throated Sparrow	M			
18560	NOCA	Northern Cardinal	B	O	B	B
18600	RBGR	Rose-breasted Grosbeak	T			
18670	INBU	Indigo Bunting	B	B	B	B
18730	RWBL	Red-winged Blackbird	U	T		
18800	EAME	Eastern Meadowlark	O	T		
18870	COGR	Common Grackle	U	T	O	
18960	BHCO	Brown-headed Cowbird	O	O		
19160	BAOR	Baltimore Oriole	U			
19370	HOFI	House Finch	O	O	T	
19510	AMGO	American Goldfinch	B	B	B	B
19920	HOSP	House Sparrow	O			