

**THE 2006 ANNUAL REPORT OF THE
MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS)
PROGRAM AT
NAVY INFORMATION OPERATIONS COMMAND
SUGAR GROVE, WV
AND
USDA FOREST SERVICE
GEORGE WASHINGTON NATIONAL FOREST, WV**

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April 24, 2007

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EXECUTIVE SUMMARY

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 constant-effort mist-netting and banding stations. The purpose of the MAPS program is to provide annual indices of adult population size and post-ledge productivity, as well as estimates of adult survivorship and recruitment into the adult population, for various landbird species. Broad-scale data on productivity and survivorship are not obtained from any other avian monitoring program in North America and are needed to provide crucial information upon which to initiate research and management actions to reverse 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 biomonitoring because they provide substantial areas of breeding habitat for Neotropical migratory landbirds that are subject to varying management practices.

A second 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. In this vein, it is expected that population and demographic data on the landbirds found on any given military installation will aid research and management efforts on the installation, to protect and enhance its avifauna and ecological integrity while simultaneously helping it fulfill its military mission in an optimal manner.

We re-established and operated two MAPS stations at Navy Security Group Activity (NIOC) Sugar Grove in 2006: the South Fork Potomac River station in bottomland riparian/mixed forest habitat, and the Beaver Creek station in open upland forest habitat, and two stations on adjacent lands of the George Washington National Forest, the Lick Run station in similar habitats as the South Fork Potomac River station and the Flesh Run station in similar habitats as the Beaver Creek station. Ten mist nets at each station were operated in the exact same locations at which they were established in 2001 (Sugar Grove) or 2005 (George Washington National Forest). Nets remained open for six morning hours per day, on one day per 10-day period for eight consecutive 10-day periods between May 18 and August 2.

A total of 363 captures of 42 species were recorded at the four stations combined. Total adult population sizes in 2006 were highest at South Fork Potomac River (113.4 adults per 600 net-hours), followed by Flesh Run (55.2), Beaver Creek (43.6), and Lick Run (41.5). Reproductive index (number of young to adults) was highest by far at Lick Run (0.97) followed by Beaver Creek (0.78), and South Fork Potomac River and Flesh Run (each at 0.52). 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 (the most abundantly captured species), Louisiana Waterthrush, and Wood Thrush.

Breeding populations, numbers of young, and reproductive success all showed increases between 2005 and 2006 which were generally both region wide and species wide. It is unusual to have all three parameters change in the same direction at a MAPS location between two years. Thus, 2006 was an extremely productive year for landbirds in the Appalachian Region, perhaps due to weather or climatic influences. With a few more years of data we hope to be able to quantify the influence of both local weather conditions and global climatic phenomena on the varying landbird population dynamics at Sugar Grove and George Washington National Forest.

The population trend for all species pooled was slightly positive between 2001 and 2006, showing an annual increase of 1.9%. This compares with a decreasing trend of 7.8% per year after five years of data (2001-2005) had been analyzed, a change that reflects the increased breeding populations in 2006 and shows how these values can vary after just 5-6 years of data have been collected. Six-year declines were noted for five of the nine species, whereas the remaining four species showed positive population trends. Trends in productivity for all species pooled decreased slightly and non-significantly between 2001 and 2006, with decreasing trends noted for six of nine species and increasing trends noted for three species.

The overall reproductive index of 0.86 at Sugar Grove and George Washington National Forest is excellent as compared with the mean value of 0.44 calculated for all species pooled in the [Northeast MAPS Region](#), during the ten-year period 1992-2001. Four species showed substantially higher productivity at the MAPS stations than in the Northeast Region, whereas only two species showed substantially lower productivity at the MAPS stations than in the Northeast Region. This indicates that productivity may be higher than it should be for many species at Sugar Grove and George Washington, at least during the six-year period 2001-2006. In addition, when compared to values expected based on body mass, good productivity appears to be occurring in five of the nine species at Sugar Grove whereas poorer productivity is only occurring in two species. The population dynamics of Sugar Grove's breeding species thus could be affected through appropriate management action which may serve to enhance productivity. In this regard, it might be worth investigating management actions to increase the productivity of White-eyed Vireo, a species with lower-than-expected productivity and a declining populations trend.

Using six years of data from the two Sugar Grove stations, estimates of adult survival and recapture probabilities could be obtained for four of the nine target species breeding at NIOC Sugar Grove. Using a non-transient model, the apparent annual adult survival rate showed a mean of 0.452. This compares with a survival estimate of 0.558 with the same four species after five years of data (2001-2005) had been collected, indicating that the winter of 2005-2006 was probably a poor year for survival. This mean value of 0.452 compares to a value of 0.445 for the same four species at [MAPS stations operated in 1992-2003](#) within [Bird Conservation Region \(BCR\) 28](#), the Appalachian Mountain Region. It thus appears that the mean annual survival rate of landbirds at Sugar Grove is comparable to that of the region, for the four sampled species at least. The mean C.V. for these four species was 49.2% a slight improvement of this value for these four species with five years of data (51.9%).

Despite the fact that the NIOC Sugar Grove and George Washington National Forest MAPS stations have been operated for only six and two years, respectively, we have been able to compare productivity and (to a lesser extent) survival estimates with those of the region, to begin to understand some of the population dynamics affecting landbirds at these locations. As more years of data accumulate we will be able to make inferences about the effects of weather on productivity and the effects of productivity and survivorship on population dynamics. Pooling data at this level will also allow comparison between NIOC Sugar Grove and George Washington National Forest as well as other protected and unprotected areas at which MAPS stations are operated in the Appalachian region.

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.

We have recently completed an example of such analyses, to which the Sugar Grove were included in analyses of banding data from stations in Virginia and within 150km of the Virginia border. The data contributed to demographic analyses for six of the 23 landbird species included in that study. Continuation of these data collections will be critical in understanding bird dynamics throughout the entire 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 American) for a substantial number of landbird species. 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 and George Washington National Forest MAPS stations well into the future.

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 500 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 (Robbins et al. 1989, Terborgh 1989, Peterjohn et al. 1995) for many species of North American landbirds (DeSante 1992, DeSante et al. 1995, 1999, [2001](#)). 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 MAPS reported in the peer-reviewed literature include the following:

- Age ratios obtained during late summer, population-wide mist netting provided a good index to actual productivity in the Kirtland's Warbler (Bart et al. 1999).
- Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales (DeSante et al. 1999).
- 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).
- 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](#)).
- 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](#)).
- 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](#)).

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; (c) 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, in 2001, the MAPS program was established on Navy Information Operations Command (NIOC) Sugar Grove and adjacent George Washington National Forest. 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 has been 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 allowed us 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. 2003](#)). 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 six years at NIOC Sugar Grove, we are not yet ready to formulate management strategies specific to this installation. However, with the addition of a sixth year of data we are better able to estimate survival and population trends for up to 9 species breeding at NIOC Sugar Grove and George Washington National Forest.

In last year's report (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. This year we will begin to assess how population dynamics of landbirds at NIOC Sugar Grove are affected by reproductive success, survival, or both.

METHODS

Two MAPS stations were re-established and operated on NIOC Sugar Grove in 2006, at the same locations at which they were originally established in 2001. 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. 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 2006 operation of each station.

The four stations were re-established for operation by IBP Biologist interns Valerie Alzner and Lauren Scopel during May 15-17, 2006. The two field biologist interns had received intensive training during a comprehensive course in mist netting and bird-banding techniques given by IBP biologists Amy Finfera and Ron Taylor, which took place May 1-12 at the Jug Bay Wetlands Sanctuary in Maryland. The two interns began operation of the Sugar Grove and George Washington stations May 21-24. Each station was operated for six morning hours per day (beginning at local sunrise) on one day in each of seven consecutive 10-day periods between Period 3 (beginning May 21), and Period 10 (beginning July 29). The operation of all stations occurred on schedule during each of the eight 10-day periods (Table 1).

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 and spelled out in detail in the MAPS Manual ([DeSante et al. 2006](#)). 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. 2006](#)):

- (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.

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 and recapture 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. 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.

A. Population-Size and Productivity Analyses — The proofed, verified, and corrected banding data from 2006 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 2006) 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 2005 and 2006 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 $0.05 \leq P < 0.10$.

For each of the four stations and for each location combined we calculated six-year (Sugar Grove stations) and two-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.

B. Analyses of trends in adult population size and productivity — For the two Sugar Grove stations we examined six-year (2001-2006) 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 six 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 six 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 six-year period, to provide an estimate of the population trend for the species; APC was calculated as:

$$(\text{actual 2002 value of } PSI / \text{predicted 2001 value of } PSI \text{ based on the regression}) * PT.$$

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. Species for which $r > 0.5$ are considered to have a substantially increasing trend; those for which $r < -0.5$ are considered to have a substantially decreasing trend; those for which $-0.5 \leq r \leq 0.5$ and $SE \leq 0.097$ (for six-year trends) are considered to have a stable trend; and those for which $-0.5 \leq r \leq 0.5$ and $SE > 0.097$ are considered to have widely fluctuating values but no substantial 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 ρ), and the significance of the correlation (P). Productivity trends are characterized in a manner analogous to that for population trends, except that we do not categorize productivity trends as highly fluctuating.

C. 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) on six years (2001-2006) of capture histories of adult birds from the two Sugar Grove stations combined. 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 two 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, for each target species, maximum-likelihood estimates and standard errors (SEs) for adult survival probability, 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.

RESULTS

A total of 1783.7 net-hours was accumulated at the four MAPS stations operated at NIOC Sugar Grove and George Washington National Forest in 2006 (Table 1). Data from 1756.7 of these net-hours could be compared directly to 2005 data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

A. 2006 values. The 2006 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 363 captures of 42 species was recorded at the four stations combined. The greatest number of captures (151) were recorded at the South Fork Potomac River station and the least number of captures (68) was recorded at the Beaver Creek station. Species richness was greatest at South Fork Potomac River (28 species) and was lowest at Lick Run (13 species). Overall, the most abundantly captured species at the four stations were Worm-eating Warbler, followed by Tufted Titmouse, Indigo Bunting, Carolina Wren, Black-capped Chickadee, Ovenbird, Louisiana Waterthrush, and Gray Catbird (Table 2). Species of management concern ([Nott et al. 2003](#)) 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 (the most abundantly captured species), Louisiana Waterthrush, and Wood Thrush.

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 2006 was highest at South Fork Potomac River (113.4 adults per 600 net-hours), followed by Flesh Run (55.2), Beaver Creek (43.6), and Lick Run (41.5). Captures of young of all species pooled were highest at South Fork Potomac River in 2006 (58.8) and lowest at Flesh Run (28.9). Reproductive index (number of young to adults) was highest by far at Lick Run (0.97) followed by Beaver Creek (0.78), and South Fork Potomac River and Flesh Run (each at 0.52).

Overall, the highest breeding populations at the two stations, based on adults captured per 600 net-hours, were Indigo Bunting, Worm-eating Warbler, Ovenbird, Tufted Titmouse, Black-capped Chickadee, Gray Catbird, Louisiana Waterthrush, 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 2006 (species of concern in italics):

South Fork Potomac River

Worm-eating Warbler
Gray Catbird
Northern Cardinal
Carolina Wren
Indigo Bunting
Black-and-white Warbler
Ovenbird
Red-eyed Vireo
American Redstart
Louisiana Waterthrush
Eastern Towhee

Beaver Creek

Ovenbird
Louisiana Waterthrush
Blue Jay
Hermit Thrush

Lick Run

Indigo Bunting
Tufted Titmouse
Black-capped Chickadee
Worm-eating Warbler
Louisiana Waterthrush

Flesh Run

Red-eyed Vireo
Black-capped Chickadee
Indigo Bunting
Chipping Sparrow
American Goldfinch

B. Comparisons between 2005 and 2006. Constant-effort comparisons between 2005 and 2006 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 substantially but non-significantly, by +28.9% between 2005 and 2006 (Table 4). Increases between 2005 and 2006 were recorded for 25 of 42 species, a proportion not significantly greater than 0.50. The number of adults captured of all species pooled increased at Flesh Run (by +129.4%), South

Fork Potomac River (by +25.8%) and Beaver Creek (by +11.1%), and it decreased at Lick Run (by -3.1%). The proportion of increasing species was significantly greater than 0.50 at Flesh Run. Interestingly, the only notable change among species was for Ovenbird, which showed a significant decline.

The number of young birds captured, of all species pooled and for both stations combined, showed a very similar change to that of adults, increasing substantially but non-significantly (by +37.9%) for all four stations combined (Table 5). Increases between 2005 and 2006 were recorded for 13 of 25 species, a proportion not significantly greater than 0.50. As with adults, young captured for all species pooled increased at Flesh Run (by +266.7%), Beaver Creek (by +150.0%), South Fork Potomac River (by +19.4%), and it decreased at Lick Run (by -14.3%). The proportion of increasing or decreasing species was not significantly greater than 0.50 at any station and no significant or near-significant changes were noted among species.

Reproductive index (the number of young per adult) showed a slight absolute decrease of +0.043, from 0.613 in 2005 to 0.656 in 2006 for all species and stations combined (Table 6). Increases in productivity were recorded for 10 of 24 species, a difference not significantly different from 0.50. Reproductive index increased at Beaver Creek (by +0.463) and Flesh Run (by +0.211) and it decreased at South Fork Potomac River (by -0.027) and Lick Run (by -0.126). The proportion of increasing species was not significantly greater than 0.50 at any station. Blue Jay showed a significant decrease across stations whereas Tufted Titmouse showed a near-significant increase.

Thus, breeding populations, numbers of young, and reproductive success all showed increases between 2005 and 2006 which were generally both region wide and species wide. It is unusual to have all three parameters change in the same direction at a MAPS location between two years.

C. Six-year and two-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 six-year period 2001-2006 for the Sugar Grove stations and over the two-year period (2005-2006) 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 large disparity in capture rates of adults and young between South Fork Potomac River (102.2 and 80.9 individuals per 600 net-hours, respectively) and Beaver Creek (25.9 and 21.8 per 600 net-hours), although the disparity seems to be decreasing slightly after the addition of each successive year's data. Productivity (number of young per adult), however, has been higher at Beaver Creek (1.06) than at South Fork Potomac River (0.82).

The two George Washington stations have capture rates of adults (40.8 per 600 net-hours at Lick Run and 38.9 at Flesh Run, for the two years 2005-2006 combined) that appear to be comparable if not a bit higher than that at Beaver Creek. Reproductive index at Lick Run (1.03 young per adult) is also comparable to that at Beaver Creek, but reproductive index at Flesh Run (0.43

young per adult) is substantially lower than at the other three stations. Thus, as mentioned in last years report, Lick Run and Beaver Creek will be good stations to compare between Sugar Grove and George Washington National Forest, but South Fork Potomac River and Flesh Run will not be comparable, probably because of the increased edge habitat found at South Fork Potomac River.

The overall reproductive index of 0.86 is excellent as compared with the mean value of 0.44 calculated for all species pooled in the [Northeast MAPS Region](#), during the ten-year period 1992-2001. Of the nine target species, four (Tufted Titmouse, Carolina Wren, Worm-eating Warbler, and Ovenbird) showed substantially (> 50%) higher productivity at Sugar Grove and George Washington National Forest than in the Northeast Region, three (Gray Catbird, Song Sparrow, and Indigo Bunting) showed comparable productivity values, and two (White-eyed Vireo and Northern Cardinal) showed substantially lower productivity at Sugar Grove and George Washington National Forest than in the Northeast Region. This indicates that productivity may be higher than it should be for many species at Sugar Grove and George Washington, at least during the six-year period 2001-2006.

D. Six-year trends in adult population size and productivity. "Chain" indices of adult population size and productivity, at the two Sugar Grove stations combined, are presented in Figures 1 and 2 for nine of ten target species and for all species pooled. Trends could not be calculated for Black-capped Chickadee, for which no adults were captured in 2003, precluding analysis. 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 (\textcircled{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 slightly and not significantly ($P = 0.846$) positive between 2001 and 2006 (Fig. 1), showing an annual increase of 1.9%. This compares with a decreasing trend of 7.8% per year after five years of data (2001-2005) had been analyzed, a change that reflects the increased breeding populations in 2006 and shows how these values can vary after just 5-6 years of data have been collected. Six-year declines were noted for five of the nine species, with that of White-eyed Vireo being substantial ($\textcircled{r} > 0.5$) and significant ($P = 0.048$), and those of Tufted Titmouse, Worm-eating Warbler, Ovenbird, and Northern Cardinal being non-substantial ($\textcircled{r} < 0.5$) and showing wide fluctuation (*SE* of the slope > 0.097). The remaining four species showed positive population trends, with that of Carolina Wren being substantial but not significant, and those of Gray Catbird, Song Sparrow, and Indigo Bunting being non-substantial and non-fluctuating (*SE* of the slope < 0.097).

Trends in productivity for all species pooled decreased slightly and non-significantly between 2001 and 2006 (Fig. 2). Decreases in productivity were noted for six of nine species, with that of Song Sparrow being highly substantial and significant ($P = 0.001$), those of White-eyed Vireo, Carolina Wren, and Indigo Bunting being substantial but non-significant, and those of Tufted Titmouse and Gray Catbird being non-substantial. Increasing, non-substantial

productivity trends were noted for three species, Worm-eating Warbler, Ovenbird, and Northern Cardinal.

Estimates of Adult Survivorship

Using six years of data from the two Sugar Grove stations, estimates of adult survival and recapture probabilities could be obtained for four (Gray Catbird, Worm-eating Warbler, Song Sparrow, and Indigo Bunting) of the nine target species breeding at NIOC Sugar Grove (Table 8). For the remaining five species we obtained estimates of 0.0 or 1.0 for survival and/or recapture probability, and the estimates were thus not realistic. Using the non-transient model, the apparent annual adult survival rate (ϕ) ranged from 0.319 for Song Sparrow to 0.561 for Indigo Bunting, with a mean of 0.452. This compares with a survival estimate of 0.558 with the same four species after five years of data (2001-2005) had been collected, indicating that the winter of 2005-2006 was probably a poor year for survival. Recapture probability ranged from 0.106 (Gray Catbird) to 0.393 (Song Sparrow), with a mean of 0.274. Proportion of residents ranged from 0.598 for Indigo Bunting to 1.000 for Gray Catbird and Song Sparrow, with a mean of 0.848. The mean C.V. for these four species was 49.2% which is still considered high (ideally it should be < 30% for accurate survival estimates). However, the mean C.V. for these four species with five years of data was 51.9%, indicating improvement with the additional year of data.

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. The mean survival for the four species in the Appalachian Region during 1992-2003 was 0.445, comparable to the 0.452 estimate for these four species during 2001-2006 at Sugar Grove. Among species, Worm-eating Warbler and Indigo Bunting showed slightly higher survival at Sugar Grove than in the Appalachian Region overall, whereas Gray Catbird and Song Sparrow showed slightly lower survival at Sugar Grove than in the region overall. At any rate, it appears that survival of landbirds at Sugar Grove is comparable to that of the region, for these four species at least, although this comparison could be affected by the differing time-frames for analysis.

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, in order to assess whether or not productivity or survival in a given species is higher or lower than expected, body mass needs to be accounted for. Figure 3 shows mean productivity indices and time-constant annual adult survival rate estimates recorded at Sugar Grove as a function of mean body mass (log transformed) for 9 (productivity) and 4 (survival) target species for which these parameters could be estimated. The purpose of this analysis was to determine which species at Sugar Grove showed higher or lower productivity or survival than might be expected given their body mass. Two regression lines are presented on each graph, one (solid) for the 9 (productivity) or 4 (survival) target species using data from Sugar Grove during 2001-2006, and

one (dashed) using data from 210 (productivity) and 89 (survival) species for which these parameters could be estimated from MAPS data collected from stations distributed across the entire North American continent. For productivity (Fig. 3A), the regression line based on data from the 9 species at Sugar Grove is well above that based on data from North America as a whole, indicating good productivity at Sugar Grove. For survival, the line based on the four species is similar in magnitude to that based on species across North America, but shows a steeper slope, perhaps indicating that smaller birds have relatively good survival at Sugar Grove compared to larger birds, although data (four species) are too few to state this with certainty.

Three of the species shown in Figure 3 (species alpha codes in bold uppercase letters) showed population declines (Fig. 1). One of these species, White-eyed Vireo (**WEVI**) showed lower-than-expected productivity (survival could not be estimated), indicating that low productivity at Sugar Grove may be the cause of the declining population. The other two species, Worm-eating Warbler (**WEWA**) and Ovenbird (**OVEN**) showed higher-than-expected productivity, indicating that this is not the problem leading to the declines. Interestingly, survival for Worm-eating Warbler was also slightly higher-than-expected, suggesting that some other factor such as low first-year survival or recruitment may be a problem. These data may suggest that Sugar Grove is serving as a “source population” for surrounding areas, which is a positive thing, although this does not explain why populations are declining there. Survival for Ovenbird could not be estimated, although with more years of data we may be able to obtain an estimate.

Three species shown in Figure 3 (in regular-font uppercase letters) showed substantial increases (Fig. 1). Two of these species, Carolina Wren (**CARW**) and Song Sparrow (**SOSP**) showed higher-than-expected productivity, suggesting that high productivity may be contributing to the increasing populations. Song Sparrow showed lower-than-expected survival, which also points to high productivity as the driving force for the population increase (survival in Carolina Wren could not be estimated). The third species, Indigo Bunting (**INBU**), showed lower than expected productivity but higher-than-expected survival, indicating that high survival may be contributing to the increase of this species.

The remaining three species shown in Figure 3 (in lower-case letters) showed non-substantial population trends that were highly fluctuating, and thus showed intermediate trends among the 9 species sampled. Two of these species, Gray Catbird (**GRCA**) and Northern Cardinal (**NOCA**) showed close-to-expected productivity, with Gray Catbird also showing close-to-expected survival, as would be expected for non-trending populations (survival for Northern Cardinal could not be estimated). The third species, Tufted Titmouse (**TUTI**), showed higher-than-expected productivity. It is possible that this may be offset by lower-than-expected survival (which could not be estimated for this species), leading to the non-substantial and fluctuating population trend. Resident species such as titmice that nest in cavities often show high productivity but low survival, and fluctuating populations due to variation in survival with variation in severity of local winter conditions.

Thus, in summary, higher-than-expected productivity appears to be occurring in five of the nine species at Sugar Grove whereas slightly lower-than-expected productivity is only occurring in

two species. Survival is slightly higher-than-expected in two species and slightly-lower-than-expected in two species. These results reinforce those presented above, indicating that productivity is higher at Sugar Grove than is indicated for the northeast region.

DISCUSSION

In last year's report (Pyle et al. 2006) based on five years (2001-2006) of MAPS data we compared data across stations, noting that both species richness and abundance of adult birds at the South Fork Potomac River station, located in bottomland riparian habitat, was substantially higher than that at the Beaver Creek station, located in open upland forest habitat. Cluster analysis (Ward's Method) revealed that the Flesh Run and Beaver Creek stations were similar but that the Lick Run station was more similar to these two stations than it was to the South Fork Potomac River station. Thus, to compare results from NIOC Sugar Grove with those at George Washington National Forest, we succeeded in duplicating the Beaver Creek station (with the Flesh Run station) but were unsuccessful in duplicating the South Fork Potomac River station, primarily due to differences between this station and Lick Run in captures of adult Gray Catbirds and Black-capped Chickadees. The underlying cause for these results is that Beaver Creek and both George Washington stations are found in relatively pristine forested habitat whereas the South Fork Potomac River station is adjacent to managed areas (e.g., lawns) that includes a lot more habitat edge, which seems to carry more importance to landbird numbers than physiographic strata (flood plain vs. ridge) or understory thickness. Results from six years of data from Sugar Grove and two year's of data from George Washington National Forest (e.g., Table 7) continue to support these conclusions.

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 expand our analyses aimed at assessing the causes for the observed population trends for the nine target species at the two locations.

The overall reproductive index of 0.86 at Sugar Grove and George Washington National Forest is excellent as compared with the mean value of 0.44 calculated for all species pooled in the [Northeast MAPS Region](#), during the ten-year period 1992-2001. Four species showed substantially higher productivity at the MAPS stations than in the Northeast Region, whereas only two species showed substantially lower productivity at the MAPS stations than in the Northeast Region. This indicates that productivity may be higher than it should be for many species at Sugar Grove and George Washington, at least during the six-year period 2001-2006. In addition, when compared to values expected based on body mass, higher-than-expected productivity appears to be occurring in five of the nine 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 server to enhance productivity. In this regard, it might be worth investigating management actions to increase the productivity of White-eyed Vireo, a species with lower-than-expected productivity and a declining populations trend.

With additional years of data and, especially, the addition of data collected at stations in comparable habitats at George Washington National Forest, we hope to be able to fully

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 examine additional between-year changes in these indices in order to make inferences about the effects of weather on productivity and the effect of changes in productivity on population sizes and trends. We will also be able to examine more precise annual survival-rate estimates, recapture probabilities, and proportions of residents among newly captured adults in order to make more precise inferences regarding the effect of 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. Finally, MAPS data from NIOC Sugar Grove will be pooled with MAPS data from outside the installation to provide regional (or even continental) indices and estimates of (and longer-term trends in) these key demographic parameters.

The long-term goal for the NIOC Sugar Grove and George Washington National Forest MAPS program is to continue to monitor the primary demographic parameters of landbirds on these installations, to: (1) determine spatial patterns in productivity indices and survival rate estimates as a function of spatial patterns in populations trends for target species (DeSante 2000, DeSante et al. 1999, [2001](#)); (2) determine the proximate demographic factor(s) (i.e., productivity or survivorship) causing observed population trends in the target species (DeSante et al. [2001](#)); (3) link MAPS data with landscape-level habitat data and spatially explicit weather data in a geographical information system (GIS) (Nott 2002); (4) identify relationships between landscape-level habitat and/or weather characteristics and the primary demographic responses (productivity and survival rates) of the target species (Nott 2002, [Nott et al. 2002](#), [Nott et al. 2003a](#), [Nott and Michel 2005](#)); (5) generate hypotheses regarding the ultimate environmental causes of the population trends; and (6) make comprehensive recommendations for habitat and use-related management strategies both on the installations and elsewhere (Nott 2000, [Nott et al. 2003a](#)). We conclude that the MAPS protocol is very well-suited to achieving these long-term ecological goals and recommend continuing the MAPS program at Sugar Grove well into the future.

Sugar Grove data also contributed to a recent 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.

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 American) for a substantial number of landbird species. 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.

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ACKNOWLEDGMENTS

All data collected for the MAPS Program at NIOC Sugar Grove and George Washington National Forest in 2006 were gathered by Valerie Alzner and Lauren Scopel with assistance from Amy Finfera, Andrew Thornton, Angela Burns, and Andrew Strong. We thank these people for their excellent work. We also thank Ralph Parker for assistance with repairs, Amy Finfera for assistance with training the interns, and Chris Swarth and Danny Bystrak of Jug Bay Wetlands Sanctuary for facilitating this training. We also thank Jack Markham, Steven Niethamer, and Debbie Kirkpatrick of NIOC Sugar Grove for logistical support and for their assistance in the initial establishment of the stations, and Bob Tennyson, Terry Slater, and Carol Hardy of the U.S. Forest Service for cooperation and assistance establishing the stations at George Washington National Forest. Financial support for the MAPS Program and housing for the field biologist interns, for which we are very grateful, were provided by Navy Security Group Activity Sugar Grove through a Cooperative Agreement between the Atlantic Division, Naval Facilities Engineering Command and The Institute for Bird Populations. We thank Jack Markham for facilitating this agreement. This is Contribution Number 317 of The Institute for Bird Populations.

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Table 1. Summary of the 2006 MAPS program on Naval Security Group Activity (NSGA) Sugar Grove and the George Washington National Forest.

Station		No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	2006 operation		
Name	Code					Total number of net-hours	No. of periods	Inclusive dates
<u>NSGA Sugar Grove</u>								
South Fork Potomac River	SFPR	15627	Gentle slope, riparian corridor, mixed forest, hayfield edge	38°34'44"N, -79°16'13"W	536	439.0 (437.7)	8	5/21 - 8/02
Beaver Creek	BECR	15628	Steep slope, open mixed forest, grassland edge; no understory	38°30'40"N, -79°16'26"W	658	440.0 (418.3)	8	5/23 - 8/01
<u>George Washington National Forest</u>								
Lick Run	LIRU	15665	Mixed deciduous woodland in riparian valley, Virginia pine forest	38°30'23"N, -79°16'59"W	625	448.0 (447.3)	8	05/22 - 7/31
Flesh Run	FLRU	15666	Virginia pine forest on steep ridgeside, open maple woodland	38°27'18"N, -79°17'36"W	718	456.7 (453.3)	8	5/24 - 7/30
ALL STATIONS COMBINED						1783.7(1756.7)	8	5/21 - 8/02

¹ Total net-hours in 2006. Net-hours in 2006 that could be compared in a constant-effort manner to 2005 are shown in parentheses.

Table 2. Capture summary for the four individual MAPS stations, and all stations pooled, operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest in 2006. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All four stations combined		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Mourning Dove		1													1
Ruby-throated Hummingbird		1													1
Hairy Woodpecker										1			1		
Pileated Woodpecker					1										1
Acadian Flycatcher							3						3		
Eastern Phoebe							1			1			2		
Great Crested Flycatcher				1	1								1	1	
White-eyed Vireo	1												1		
Blue-headed Vireo										2			2		
Red-eyed Vireo	3		1							6		1	9		2
Blue Jay	2			3	1		2			2			9	1	
Carolina Chickadee	1												1		
Black-capped Chickadee	2		1	1			6		3	11		1	20		5
Tufted Titmouse	4	1	1	5		1	12		1	8			29	1	3
Carolina Wren	9	1	5	6	1	1	2	1	1				17	3	7
Gray-cheeked Thrush	1												1		
Hermit Thrush				3		1							3		1
Wood Thrush							1						1		
American Robin	3									6	2		9	2	
Gray Catbird	14		6				1						15		6
Brown Thrasher	2												2		
Northern Parula				1						2			3		
Magnolia Warbler										1			1		
Black-throated Green Warbler					1					2			2	1	
Pine Warbler				2						1			3		

Table 2. (cont.) Capture summary for the four individual MAPS stations, and all stations pooled, operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest in 2006. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All four stations combined		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Black-and-white Warbler	5		1	1						3			9		1
American Redstart	3												3		
Worm-eating Warbler	29	2	3	3			7	2	2				39	4	5
Ovenbird	8		1	3	1	4	5	1		2			18	2	5
Louisiana Waterthrush	5			7		2	7			1			20		2
Mourning Warbler	1												1		
Common Yellowthroat	1			1									2		
Hooded Warbler				1									1		
Wilson's Warbler	1												1		
Eastern Towhee	5		1								1		5	1	1
Chipping Sparrow				10						4		2	14		2
Song Sparrow	2	1	1										2	1	1
Northern Cardinal	7		3				1	1		1			9	1	3
Indigo Bunting	6		2	1		2	6		5	5		3	18		12
Common Grackle		1												1	
Baltimore Oriole	1												1		
American Goldfinch	1			2						4			7		
ALL SPECIES POOLED	117	8	26	51	6	11	54	5	12	63	3	7	285	22	56
Total Number of Captures		151			68			71			73			363	
Number of Species	25	7	12	17	6	6	13	4	5	19	2	4	38	15	15
Total Number of Species		28			19			13			20			42	

Table 3. Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the four individual MAPS stations, and all stations pooled, operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest in 2006.

Species	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All four stations combined		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Hairy Woodpecker										1.3	0.0	0.00	0.3	0.0	0.00
Acadian Flycatcher							2.7	1.3	0.50				0.7	0.3	0.50
Eastern Phoebe							0.0	1.3	und. ¹	1.3	0.0	0.00	0.3	0.3	1.00
Great Crested Flycatcher				1.4	0.0	0.00							0.3	0.0	0.00
White-eyed Vireo	1.4	0.0	0.00										0.3	0.0	0.00
Blue-headed Vireo										2.6	0.0	0.00	0.7	0.0	0.00
Red-eyed Vireo	4.1	0.0	0.00							7.9	0.0	0.00	3.0	0.0	0.00
Blue Jay	2.7	0.0	0.00	4.1	0.0	0.00	1.3	1.3	1.00	2.6	0.0	0.00	2.7	0.3	0.13
Carolina Chickadee	1.4	0.0	0.00										0.3	0.0	0.00
Black-capped Chickadee	2.7	1.4	0.50	0.0	1.4	und. ¹	5.4	4.0	0.75	7.9	6.6	0.83	4.0	3.4	0.83
Tufted Titmouse	2.7	4.1	1.50	2.7	5.5	2.00	6.7	9.4	1.40	2.6	7.9	3.00	3.7	6.7	1.82
Carolina Wren	9.6	5.5	0.57	1.4	6.8	5.00	0.0	2.7	und.				2.7	3.7	1.38
Hermit Thrush				4.1	0.0	0.00							1.0	0.0	0.00
Wood Thrush							0.0	1.3	und.				0.0	0.3	und. ¹
American Robin	1.4	2.7	2.00							1.3	6.6	5.00	0.7	2.4	3.50
Gray Catbird	15.0	4.1	0.27				0.0	1.3	und.				3.7	1.3	0.36
Brown Thrasher	1.4	1.4	1.00										0.3	0.3	1.00
Northern Parula				1.4	0.0	0.00				2.6	0.0	0.00	1.0	0.0	0.00
Magnolia Warbler										1.3	0.0	0.00	0.3	0.0	0.00
Black-throated Green Warbler										2.6	0.0	0.00	0.7	0.0	0.00
Pine Warbler				1.4	1.4	1.00				0.0	1.3	und. ¹	0.3	0.7	2.00
Black-and-white Warbler	5.5	1.4	0.25	1.4	0.0	0.00				0.0	3.9	und.	1.7	1.3	0.80

Table 3. (cont.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the four individual MAPS stations, and all stations pooled, operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest in 2006.

Species	South Fork Potomac River			Beaver Creek			Lick Run			Flesh Run			All four stations combined		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
American Redstart	4.1	0.0	0.00										1.0	0.0	0.00
Worm-eating Warbler	17.8	23.2	1.31	2.7	1.4	0.50	5.4	6.7	1.25				6.4	7.7	1.21
Ovenbird	5.5	6.8	1.25	6.8	0.0	0.00	2.7	4.0	1.50	2.6	0.0	0.00	4.4	2.7	0.62
Louisiana Waterthrush	4.1	2.7	0.67	5.5	6.8	1.25	4.0	5.4	1.33	1.3	0.0	0.00	3.4	3.4	1.00
Mourning Warbler	1.4	0.0	0.00										0.3	0.0	0.00
Common Yellowthroat	1.4	0.0	0.00	1.4	0.0	0.00							0.7	0.0	0.00
Hooded Warbler				1.4	0.0	0.00							0.3	0.0	0.00
Eastern Towhee	4.1	2.7	0.67										1.0	0.7	0.67
Chipping Sparrow				2.7	10.9	4.00				5.3	0.0	0.00	2.0	2.7	1.33
Song Sparrow	2.7	1.4	0.50										0.7	0.3	0.50
Northern Cardinal	12.3	0.0	0.00				1.3	0.0	0.00	0.0	1.3	und.	3.4	0.3	0.10
Indigo Bunting	9.6	1.4	0.14	2.7	0.0	0.00	12.1	1.3	0.11	6.6	1.3	0.20	7.7	1.0	0.13
Baltimore Oriole	1.4	0.0	0.00										0.3	0.0	0.00
American Goldfinch	1.4	0.0	0.00	2.7	0.0	0.00				5.3	0.0	0.00	2.4	0.0	0.00
ALL SPECIES POOLED	113.4	58.8	0.52	43.6	34.1	0.78	41.5	40.2	0.97	55.2	28.9	0.52	62.9	40.0	0.64
Number of Species	23	13		16	7		9	12		16	7		35	20	
Total Number of Species		23			17			13			19			36	

¹ Reproductive index (young/adult) is undefined because no adults of this species were captured at this station in this year.

Table 4. Percentage changes between 2005 and 2006 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest .

Species	All four stations combined								
	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	n ¹	Number of adults		Percent change	SE ²
						2005	2006		
Yellow-billed Cuckoo				-100.0	1	1	0	-100.0	
Downy Woodpecker					0	0	0		
Hairy Woodpecker		-100.0	-100.0	+ ³	3	2	1	-50.0	75.0
Northern Flicker	-100.0				1	1	0	-100.0	
Acadian Flycatcher			+ ³		1	0	2	+ ³	
Eastern Phoebe	-100.0	-100.0			2	3	0	-100.0	88.9
Great Crested Flycatcher		+ ³	-100.0		2	1	1	0.0	200.0
Eastern Kingbird	-100.0				1	1	0	-100.0	
White-eyed Vireo	0.0				1	1	1	0.0	
Blue-headed Vireo		-100.0		+	2	1	2	100.0	400.0
Red-eyed Vireo	200.0		-100.0	500.0	3	6	9	50.0	156.1
Blue Jay	+ ³	100.0	+	+	4	1	6	500.0	541.6
Carolina Chickadee	+				1	0	1	+	
Black-capped Chickadee	+	-100.0	33.3	200.0	4	7	12	71.4	80.3
Tufted Titmouse	-33.3	+	400.0	+	4	4	11	175.0	208.4
Carolina Wren	75.0	+	-100.0		3	6	8	33.3	67.4
Hermit Thrush		+			1	0	3	+	
Wood Thrush					0	0	0		
American Robin	0.0			+	2	1	2	100.0	200.0
Gray Catbird	-21.4				1	14	11	-21.4	
Brown Thrasher	0.0				1	1	1	0.0	
Cedar Waxwing				-100.0	1	1	0	-100.0	
Northern Parula			-100.0	+	2	1	2	100.0	400.0
Chestnut-sided Warbler	-100.0				1	1	0	-100.0	

Table 4. (cont.) Percentage changes between 2005 and 2006 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest .

Species	All four stations combined								
	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	n ¹	Number of adults		Percent change	SE ²
						2005	2006		
Black-throated Blue Warbler	-100.0				1	1	0	-100.0	
Black-throated Green Warbler				100.0	1	1	2	100.0	
Pine Warbler		+			1	0	1	+	
Black-and-white Warbler	100.0	+	-100.0	-100.0	4	4	5	25.0	72.9
American Redstart	+				1	0	3	+	
Worm-eating Warbler	44.4	-33.3	33.3		3	15	19	26.7	19.7
Ovenbird	-42.9	-44.4	0.0	-33.3	4	21	13	-38.1	5.6 ***
Northern Waterthrush	-100.0	-100.0			2	3	0	-100.0	88.9
Louisiana Waterthrush	200.0	100.0	0.0	+	4	6	11	83.3	56.8
Mourning Warbler	+				1	0	1	+	
Common Yellowthroat	-66.7	+			2	3	2	-33.3	66.7
Hooded Warbler		+			1	0	1	+	
Scarlet Tanager	-100.0	-100.0			2	3	0	-100.0	88.9
Eastern Towhee	+				1	0	3	+	
Chipping Sparrow		+		300.0	2	1	6	500.0	400.0
Song Sparrow	-33.3				1	3	2	-33.3	
Northern Cardinal	125.0		-50.0	-100.0	3	7	10	42.9	70.6
Indigo Bunting	75.0	-33.3	12.5	25.0	4	19	23	21.1	17.0
Baltimore Oriole	+				1	0	1	+	
American Goldfinch	+	+		300.0	3	1	7	600.0	458.3
ALL SPECIES POOLED	25.8	11.1	-3.1	129.4	4	142	183	28.9	16.7

Table 4. (cont.) Percentage changes between 2005 and 2006 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest .

Species	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	All four stations combined
No. species that increased ⁴	15(8)	12(10)	6(2)	13(7)	25(9)
No. species that decreased ⁵	12(7)	9(6)	7(6)	5(4)	14(9)
No. species remained same	3	0	2	0	3
Total Number of Species	30	21	15	18	42
Proportion of increasing (decreasing) species	0.500	0.571	(0.467)	0.722	0.595
Sig. of increase (decrease) ⁶	0.572	0.332	(0.696)	0.048	0.140
				**	

¹ Number of stations lying within the breeding range of the species at which at least one individual adult bird of the species was captured in either year.

² Standard error of the percent change in the number of individual adults captured.

³ Increase indeterminate (infinite) because no adult was captured during 2005.

⁴ No. of species for which adults were captured in 2006 but not in 2005 are in parentheses.

⁵ No. of species for which adults were captured in 2005 but not in 2006 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.

*** $P < 0.01$; ** $0.01 < P < 0.05$; * $0.05 < P < 0.10$.

Table 5. Percentage changes between 2005 and 2006 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest.

Species	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	n ¹	All four stations combined			
						Number of young		Percent change	SE ²
						2005	2006		
Yellow-billed Cuckoo					0	0	0		
Downy Woodpecker		-100.0	-100.0		2	4	0	-100.0	88.9
Hairy Woodpecker			-100.0	-100.0	2	5	0	-100.0	88.9
Northern Flicker					0	0	0		
Acadian Flycatcher			+		1	0	1	+	
Eastern Phoebe			-50.0		1	2	1	-50.0	
Great Crested Flycatcher					0	0	0		
Eastern Kingbird					0	0	0		
White-eyed Vireo					0	0	0		
Blue-headed Vireo		-100.0	-100.0		2	4	0	-100.0	88.9
Red-eyed Vireo					0	0	0		
Blue Jay		-100.0	+		2	1	1	0.0	200.0
Carolina Chickadee					0	0	0		
Black-capped Chickadee	-50.0	+	-50.0	+	4	8	10	25.0	100.5
Tufted Titmouse	+	300.0	+	+	4	1	20	1900.0	2160.2
Carolina Wren	-55.6	66.7	-33.3	-100.0	4	16	11	-31.3	26.9
Hermit Thrush					0	0	0		
Wood Thrush	-100.0		+		2	1	1	0.0	200.0
American Robin	+			+	2	0	7	+	
Gray Catbird	-25.0		+		2	4	4	0.0	50.0
Brown Thrasher	+				1	0	1	+	
Cedar Waxwing					0	0	0		
Northern Parula					0	0	0		
Chestnut-sided Warbler					0	0	0		

Table 5. (cont.) Percentage changes between 2005 and 2006 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest.

Species	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	n ¹	All four stations combined			
						Number of young		Percent change	SE ²
						2005	2006		
Black-throated Blue Warbler					0	0	0		
Black-throated Green Warbler					0	0	0		
Pine Warbler		+		+	2	0	2	+	
Black-and-white Warbler	+		-100.0	+	3	1	4	300.0	624.5
American Redstart					0	0	0		
Worm-eating Warbler	41.7	0.0	150.0		3	15	23	53.3	20.0
Ovenbird	66.7		-25.0		2	7	8	14.3	44.9
Northern Waterthrush	-100.0				1	1	0	-100.0	
Louisiana Waterthrush	100.0	400.0	-20.0	-100.0	4	9	11	22.2	64.5
Mourning Warbler					0	0	0		
Common Yellowthroat					0	0	0		
Hooded Warbler			-100.0		1	1	0	-100.0	
Scarlet Tanager					0	0	0		
Eastern Towhee	+				1	0	2	+	
Chipping Sparrow		+			1	0	8	+	
Song Sparrow	0.0				1	1	1	0.0	
Northern Cardinal				+	1	0	1	+	
Indigo Bunting	-50.0		-75.0	+	3	6	3	-50.0	28.9
Baltimore Oriole					0	0	0		
American Goldfinch					0	0	0		
ALL SPECIES POOLED	19.4	150.0	-14.3	266.7	4	87	120	37.9	34.9

Table 5. (cont.) Percentage changes between 2005 and 2006 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest.

Species	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	All four stations combined
No. species that increased ⁴	8(5)	6(3)	6(5)	7(7)	13(7)
No. species that decreased ⁵	6(2)	3(3)	11(5)	3(3)	8(5)
No. species remained same	1	1	0	0	4
Total Number of Species	15	10	17	10	25
Proportion of increasing (decreasing) species	0.533	0.600	(0.647)	0.700	0.520
Sig. of increase (decrease) ⁶	0.500	0.377	(0.166)	0.172	0.500

¹ Number of stations lying within the breeding range of the species at which at least one individual young bird of the species was captured in either year.

² Standard error of the percent change in the number of individual young captured.

³ Increase indeterminate (infinite) because no young bird was captured during 2005.

⁴ No. of species for which young birds were captured in 2006 but not in 2005 are in parentheses.

⁵ No. of species for which young birds were captured in 2005 but not in 2006 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.

*** $P < 0.01$; ** $0.01 < P < 0.05$; * $0.05 < P < 0.10$.

Table 6. Changes between 2005 and 2006 in the REPRODUCTIVE INDEX (young/adult) at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest.

Species	All four stations combined								
	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	n ¹	Reproductive Index			
						2005	2006	Change	SE ²
Yellow-billed Cuckoo				nc. ³	1	0.000	und. ⁴	nc. ³	
Downy Woodpecker		nc. ³	nc. ³		2	und. ⁴	und.	nc.	
Hairy Woodpecker		nc.	nc.	nc.	3	2.500	0.000	-2.500	2.411
Northern Flicker	nc. ³				1	0.000	und.	nc.	
Acadian Flycatcher			nc.		1	und.	0.500	nc.	
Eastern Phoebe	nc.	nc.	nc.		3	0.667	und.	nc.	
Great Crested Flycatcher		nc.	nc.		2	0.000	0.000	0.000	0.000
Eastern Kingbird	nc.				1	0.000	und.	nc.	
White-eyed Vireo	0.000				1	0.000	0.000	0.000	
Blue-headed Vireo		nc.	nc.	nc.	3	4.000	0.000	-4.000	3.464
Red-eyed Vireo	0.000		nc.	0.000	3	0.000	0.000	0.000	0.000
Blue Jay	nc.	-1.000	nc.	nc.	4	1.000	0.167	-0.833	0.187 **
Carolina Chickadee	nc.				1	und.	0.000	nc.	
Black-capped Chickadee	nc.	nc.	-1.250	0.833	4	1.143	0.833	-0.310	0.766
Tufted Titmouse	1.500	nc.	1.400	nc.	4	0.250	1.818	1.568	0.501 *
Carolina Wren	-1.679	nc.	nc.	nc.	4	2.667	1.375	-1.292	1.300
Hermit Thrush		nc.			1	und.	0.000	nc.	
Wood Thrush	nc.		nc.		2	und.	und.	nc.	
American Robin	2.000			nc.	2	0.000	3.500	3.500	1.500
Gray Catbird	-0.013		nc.		2	0.286	0.364	0.078	
Brown Thrasher	1.000				1	0.000	1.000	1.000	
Cedar Waxwing				nc.	1	0.000	und.	nc.	
Northern Parula			nc.	nc.	2	0.000	0.000	0.000	0.000
Chestnut-sided Warbler	nc.				1	0.000	und.	nc.	

Table 6. (cont.) Changes between 2005 and 2006 in the REPRODUCTIVE INDEX (young/adult) at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest.

Species	All four stations combined								
	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	n ¹	Reproductive Index			
						2005	2006	Change	SE ²
Black-throated Blue Warbler	nc.				1	0.000	und.	nc.	
Black-throated Green Warbler				0.000	1	0.000	0.000	0.000	
Pine Warbler		nc.		nc.	2	und.	2.000	nc.	
Black-and-white Warbler	0.250	nc.	nc.	nc.	4	0.250	0.800	0.550	0.919
American Redstart	nc.				1	und.	0.000	nc.	
Worm-eating Warbler	-0.026	0.167	0.583		3	1.000	1.211	0.211	0.329
Ovenbird	0.821	0.000	-0.500	0.000	4	0.333	0.615	0.282	0.477
Northern Waterthrush	nc.	nc.			2	0.333	und.	nc.	
Louisiana Waterthrush	-0.333	0.750	-0.333	nc.	4	1.500	1.000	-0.500	0.599
Mourning Warbler	nc.				1	und.	0.000	nc.	
Common Yellowthroat	0.000	nc.			2	0.000	0.000	0.000	0.000
Hooded Warbler		nc.	nc.		2	und.	0.000	nc.	
Scarlet Tanager	nc.	nc.			2	0.000	und.	nc.	
Eastern Towhee	nc.				1	und.	0.667	nc.	
Chipping Sparrow		nc.		0.000	2	0.000	1.333	1.333	1.778
Song Sparrow	0.167				1	0.333	0.500	0.167	
Northern Cardinal	0.000		0.000	nc.	3	0.000	0.100	0.100	0.165
Indigo Bunting	-0.357	0.000	-0.389	0.200	4	0.316	0.130	-0.185	0.141
Baltimore Oriole	nc.				1	und.	0.000	nc.	
American Goldfinch	nc.	nc.		0.000	3	0.000	0.000	0.000	0.000
ALL SPECIES POOLED	-0.027	0.463	-0.126	0.211	4	0.613	0.656	0.043	0.178

Table 6. (cont.) Changes between 2005 and 2006 in the REPRODUCTIVE INDEX (young/adult) at four constant-effort MAPS stations on Naval Security Group Activity Sugar Grove and the George Washington National Forest.

Species	S. Fork. Potomac R	Beaver Creek	Lick Run	Flesh Run	All four stations combined
No. species that increased	6	2	2	2	10
No. species that decreased	5	1	4	0	7
No. species remained same	4	2	1	5	7
Total Number of Species ⁵	15	5	7	7	24
Proportion of increasing (decreasing) species	(0.333)	0.400	(0.571)	0.286	0.417
Sig. of increase (decrease) ⁶	(0.941)	0.813	(0.500)	0.938	0.846

¹ Number of stations lying within the breeding range of the species at which at least one individual aged bird of the species was captured in either year.

² Standard error of the change in the reproductive index.

³ The change in reproductive index is undefined at this station because no adult individual of the species was captured in one of the two years.

⁴ Reproductive index not given because no adult individual of the species was captured in the year shown.

⁵ Species for which the change in the reproductive index 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 aged individual birds captured per 600 net-hours and reproductive index at the four individual MAPS stations operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest averaged over the four years, 2001-2006¹. Data for each species are included only from stations that lie within the breeding range of the species.

Species	South Fork Potomac River 2001-2006			Beaver Creek 2001-2006			Both NGSAs stations pooled 2001-2006			Lick Run 2005-2006			Flesh Run 2005-2006			Both George W. stations pooled 2005-2006			All four stations pooled 2001-2006 ¹		
	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²
Yellow-billed Cuckoo				0.2	0.0	0.00	0.1	0.0	0.00				0.6	0.0	0.00	0.3	0.0	0.00	0.2	0.0	0.00
Downy Woodpecker	0.4	0.7	0.50	0.0	0.2	und. ⁴	0.2	0.5	0.50	0.0	1.9	und. ⁴				0.0	0.9	und. ⁴	0.2	0.6	0.50
Hairy Woodpecker	0.0	0.2	und. ⁴	0.5	0.0	0.00	0.2	0.1	0.50	0.6	1.3	2.00	0.7	1.9	0.00	0.6	1.6	2.50	0.3	0.4	1.17
Northern Flicker	0.2	0.0	0.00				0.1	0.0	0.00										0.1	0.0	0.00
Acadian Flycatcher										1.3	0.7	0.50				0.7	0.3	0.50	0.1	0.1	0.50
Eastern Phoebe	1.2	0.0	0.00	0.4	0.0	0.00	0.8	0.0	0.00	0.0	1.9	und.	0.7	0.0	0.00	0.3	1.0	1.00	0.6	0.2	0.38
Great Crested Flycatcher	0.3	0.0	0.00	0.4	0.0	0.00	0.4	0.0	0.00	0.6	0.0	0.00				0.3	0.0	0.00	0.4	0.0	0.00
Eastern Kingbird	0.2	0.0	0.00				0.1	0.0	0.00										0.1	0.0	0.00
White-eyed Vireo	3.7	0.7	0.13				1.9	0.4	0.13										1.8	0.4	0.13
Blue-headed Vireo				0.2	0.4	2.00	0.1	0.2	2.00	0.0	1.3	und.	1.3	0.0	0.00	0.7	0.6	0.00	0.2	0.2	2.00
Red-eyed Vireo	2.3	0.0	0.00	0.0	0.2	und.	1.2	0.1	0.20	2.5	0.0	0.00	4.6	0.0	0.00	3.6	0.0	0.00	1.5	0.1	0.20
Blue Jay	1.2	0.0	0.00	1.1	0.5	0.33	1.2	0.2	0.40	0.7	0.7	1.00	1.3	0.0	0.00	1.0	0.3	0.33	1.0	0.2	0.43
Carolina Chickadee	0.2	0.0	0.00	0.0	0.6	und.	0.1	0.3	0.00										0.1	0.3	0.00
Black-capped Chickadee	1.6	1.1	0.50	1.6	2.0	0.50	1.6	1.5	1.25	4.6	5.8	1.38	5.2	3.3	0.42	4.9	4.5	1.00	2.2	2.0	1.25
Tufted Titmouse	2.5	2.5	1.25	2.2	5.1	2.10	2.3	3.9	1.63	4.0	4.7	0.70	1.3	3.9	3.00	2.6	4.3	0.93	2.4	4.1	1.62
White-breasted Nuthatch				0.0	0.2	und.	0.0	0.1	und. ⁴										0.0	0.1	und. ⁴
Carolina Wren	8.3	8.1	1.09	0.2	2.4	5.00	4.3	5.3	1.34	1.3	3.2	1.50	0.0	0.6	und. ⁴	0.6	1.9	2.00	3.7	4.5	1.38
House Wren	0.0	0.2	und.				0.0	0.1	und.										0.0	0.1	und.
Blue-gray Gnatcatcher				0.3	0.0	0.00	0.1	0.0	0.00										0.1	0.0	0.00
Hermit Thrush				0.7	0.0	0.00	0.3	0.0	0.00										0.2	0.0	0.00
Wood Thrush	0.0	0.4	und.				0.0	0.2	und.	0.0	0.7	und.				0.0	0.3	und.	0.0	0.2	und.
American Robin	1.1	1.5	0.75	0.2	0.0	0.00	0.7	0.8	0.60				0.7	3.3	5.00	0.3	1.7	5.00	0.6	0.9	0.90
Gray Catbird	14.8	4.9	0.32				7.6	2.5	0.32	0.0	0.7	und.				0.0	0.3	und.	6.2	2.1	0.34
Brown Thrasher	1.4	1.6	0.38				0.7	0.9	0.38										0.6	0.8	0.38
Cedar Waxwing	0.6	0.0	0.00				0.4	0.0	0.00				0.6	0.0	0.00	0.3	0.0	0.00	0.4	0.0	0.00
Northern Parula				0.5	0.0	0.00	0.3	0.0	0.00	0.6	0.0	0.00	1.3	0.0	0.00	1.0	0.0	0.00	0.4	0.0	0.00
Yellow Warbler	0.3	0.0	0.00				0.1	0.0	0.00										0.1	0.0	0.00
Chestnut-sided Warbler	0.2	0.0	0.00				0.1	0.0	0.00										0.1	0.0	0.00

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the four individual MAPS stations operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest averaged over the four years, 2001-2006¹. Data for each species are included only from stations that lie within the breeding range of the species.

Species	South Fork Potomac River 2001-2006			Beaver Creek 2001-2006			Both NGSAs stations pooled 2001-2006			Lick Run 2005-2006			Flesh Run 2005-2006			Both George W. stations pooled 2005-2006			All four stations pooled 2001-2006 ¹		
	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²	Ad.	Yg.	Repr. Ind. ²
Magnolia Warbler	0.4	0.0	0.00				0.2	0.0	0.00				0.7	0.0	0.00	0.3	0.0	0.00	0.3	0.0	0.00
Black-throated Blue Warbler	0.2	0.0	0.00	0.0	0.2	und.	0.1	0.1	0.00										0.1	0.1	0.00
Black-throated Green Warb.	0.0	0.2	und.				0.0	0.1	und.				1.9	0.0	0.00	1.0	0.0	0.00	0.2	0.1	0.00
Pine Warbler				0.2	0.4	1.00	0.1	0.2	1.00				0.0	0.7	und.	0.0	0.3	und.	0.1	0.2	2.00
Black-and-white Warbler	3.2	1.6	0.82	0.2	0.8	0.00	1.8	1.2	1.48	0.6	0.6	1.00	0.6	2.0	0.00	0.6	1.3	0.50	1.4	1.4	1.61
American Redstart	1.6	0.5	0.33				0.8	0.2	0.33										0.7	0.2	0.33
Worm-eating Warbler	14.2	35.2	2.67	3.9	1.1	0.60	9.3	18.7	2.15	4.6	4.6	0.96				2.3	2.3	0.96	8.0	17.3	2.14
Ovenbird	8.0	9.8	1.71	4.1	1.3	0.90	6.1	5.7	1.39	2.6	4.5	1.75	3.2	0.0	0.00	2.9	2.3	0.78	5.2	5.6	1.42
Northern Waterthrush	1.7	0.2	0.13	0.4	0.0	0.00	1.1	0.1	0.08										1.0	0.1	0.08
Louisiana Waterthrush	1.9	1.8	0.83	1.6	1.8	0.58	1.8	1.8	0.80	3.9	5.8	1.50	0.7	1.3	0.00	2.3	3.5	1.67	1.6	1.9	0.93
Mourning Warbler	0.4	0.0	0.00				0.2	0.0	0.00										0.2	0.0	0.00
Common Yellowthroat	1.7	0.0	0.00	0.2	0.0	0.00	1.0	0.0	0.00										0.7	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	0.6	und.				0.0	0.3	und.	0.2	0.1	0.00
Canada Warbler	0.0	0.7	und.				0.0	0.4	und.										0.0	0.4	und.
Scarlet Tanager	0.4	0.2	0.00	0.9	0.0	0.00	0.7	0.1	0.00										0.5	0.1	0.00
Eastern Towhee	2.1	0.7	0.42				1.1	0.4	0.42										0.9	0.2	0.42
Chipping Sparrow				1.0	3.5	1.67	0.5	1.6	1.67				3.3	0.0	0.00	1.6	0.0	0.00	0.6	1.2	0.58
Song Sparrow	8.1	4.7	0.57				4.2	2.4	0.57										3.9	2.3	0.57
Northern Cardinal	6.9	1.1	0.25				3.5	0.6	0.25	1.9	0.0	0.00	0.6	0.7	0.00	1.3	0.3	0.50	3.0	0.7	0.27
Indigo Bunting	8.9	2.3	0.22	3.6	0.7	0.07	6.4	1.6	0.22	11.0	3.2	0.31	6.4	0.7	0.10	8.7	1.9	0.23	6.9	1.7	0.21
Common Grackle	0.5	0.0	0.00				0.3	0.0	0.00										0.3	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	0.7	0.0	0.00	0.5	0.0	0.00				3.3	0.0	0.00	1.6	0.0	0.00	0.6	0.0	0.00
ALL SPECIES POOLED	102.2	80.9	0.82	25.9	21.8	1.06	65.5	52.5	0.84	40.8	42.0	1.03	38.9	18.2	0.43	39.9	30.1	0.77	59.9	50.9	0.86
Number of Species	37	24		25	17		45	32		15	17		20	10		24	20		47	35	
Total Number of Species		42			30			50			21			22			29				51

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the four individual MAPS stations operated on Naval Security Group Activity Sugar Grove and the George Washington National Forest averaged over the four years, 2001-2006¹. Data for each species are included only from stations that lie within the breeding range of the species.

¹ Data for four years (2001-2006) is included for the South Fork Potomac River and Beaver Creek stations and for two years (2005-2006) 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 0.5. 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 survival and recapture probabilities and proportion of residents among newly captures adults using a time-constant model for four species breeding at MAPS stations on Naval Security Group Activity Sugar Grove obtained from six years (2001-2006) of mark-recapture data.

Species	Num. sta. ¹	Num. ind. ²	Num. caps. ³	Num. ret. ⁴	Survival probability ⁵	Surv. C.V. ⁶	Recapture probability ⁷	Proportion of residents ⁸	Survival prob. Appalachian Mountains 1992-2003 ⁹
Gray Catbird ‡+	1	62	82	3	0.391 (0.299)	76.4	0.106 (0.172)	1.000 (1.464)	0.499 (0.025)
Worm-eating Warbler	2	69	90	9	0.538 (0.183)	34.1	0.217 (0.148)	0.793 (0.580)	0.470 (0.071)
Song Sparrow ‡+	1	30	52	5	0.319 (0.191)	59.9	0.393 (0.348)	1.000 (0.999)	0.401 (0.051)
Indigo Bunting	2	43	69	10	0.561 (0.148)	26.4	0.380 (0.172)	0.598 (0.333)	0.409 (0.046)

¹ Number of stations where the species was a regular or usual breeder and at which adults of the species were captured. Stations within one km of each other were combined into a single super-station to prevent individuals whose home ranges included portions of two or more stations from being counted as multiple individuals.

² Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).

³ Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.

⁴ 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.

⁵ Survival probability presented as the maximum likelihood estimate (standard error of the estimate).

⁶ The coefficient of variation for survival probability.

⁷ Recapture probability presented as the maximum likelihood estimate (standard error of the estimate).

⁸ The proportion of residents among newly captured adults presented as the maximum likelihood estimate (standard error of the estimate).

⁹ Survival probability (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.

‡ The estimate for survival probability should be viewed with caution because it is based on fewer than five between-year recaptures, or the estimate is very imprecise ($SE(\phi) > 0.200$ or $CV(\phi) > 50.0\%$).

† The estimate for survival probability, recapture probability, or both may be biased low because the estimate for τ was 1.000.

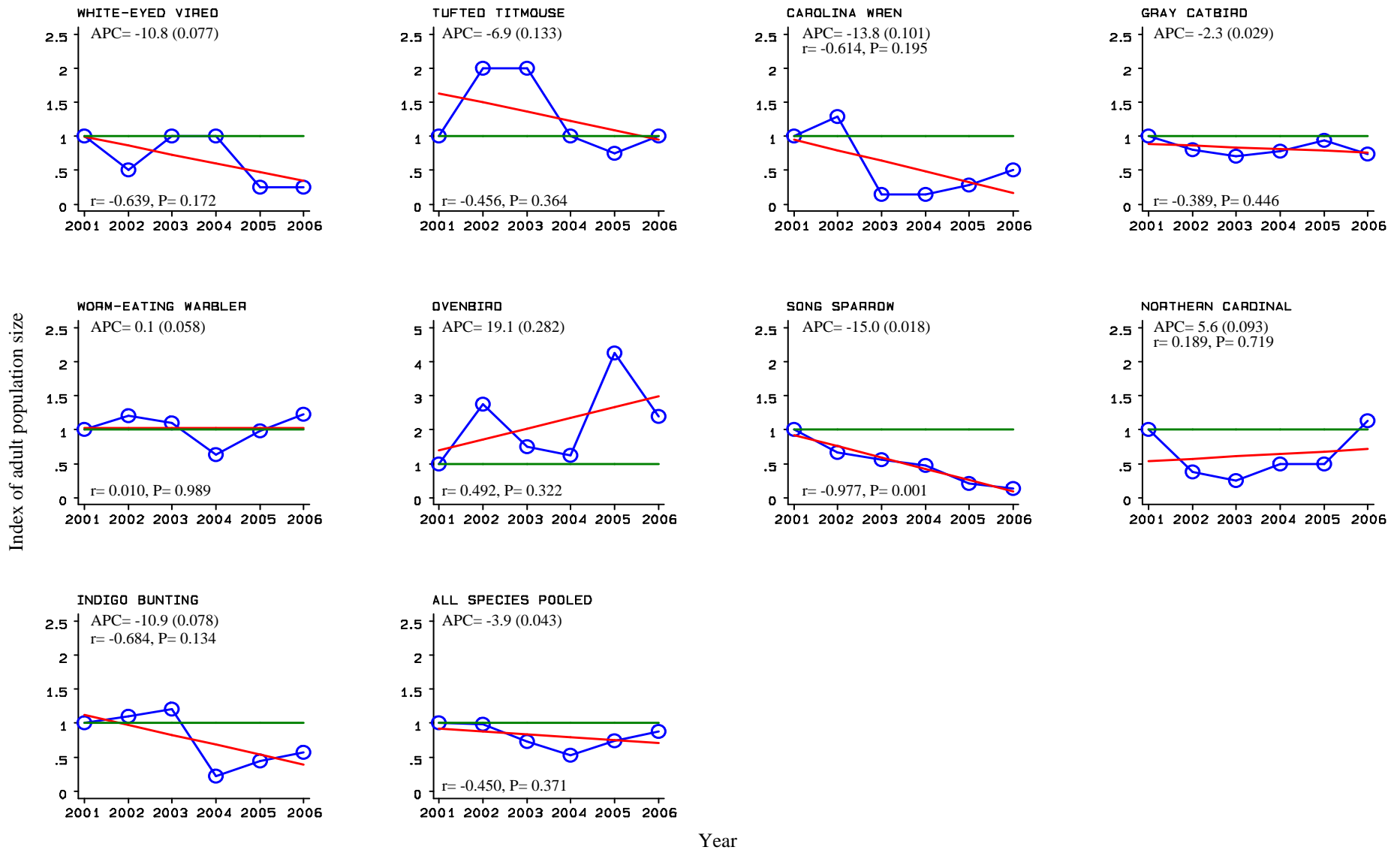


Figure 1. Population trends for nine species and all species pooled at the two stations (South Fork Potomac River and Beaver Creek) combined on Naval Security Group Activity Sugar Grove over the six years 2001-2006. The index of population size was arbitrarily defined as 1.0 in 2001. Indices for subsequent 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.

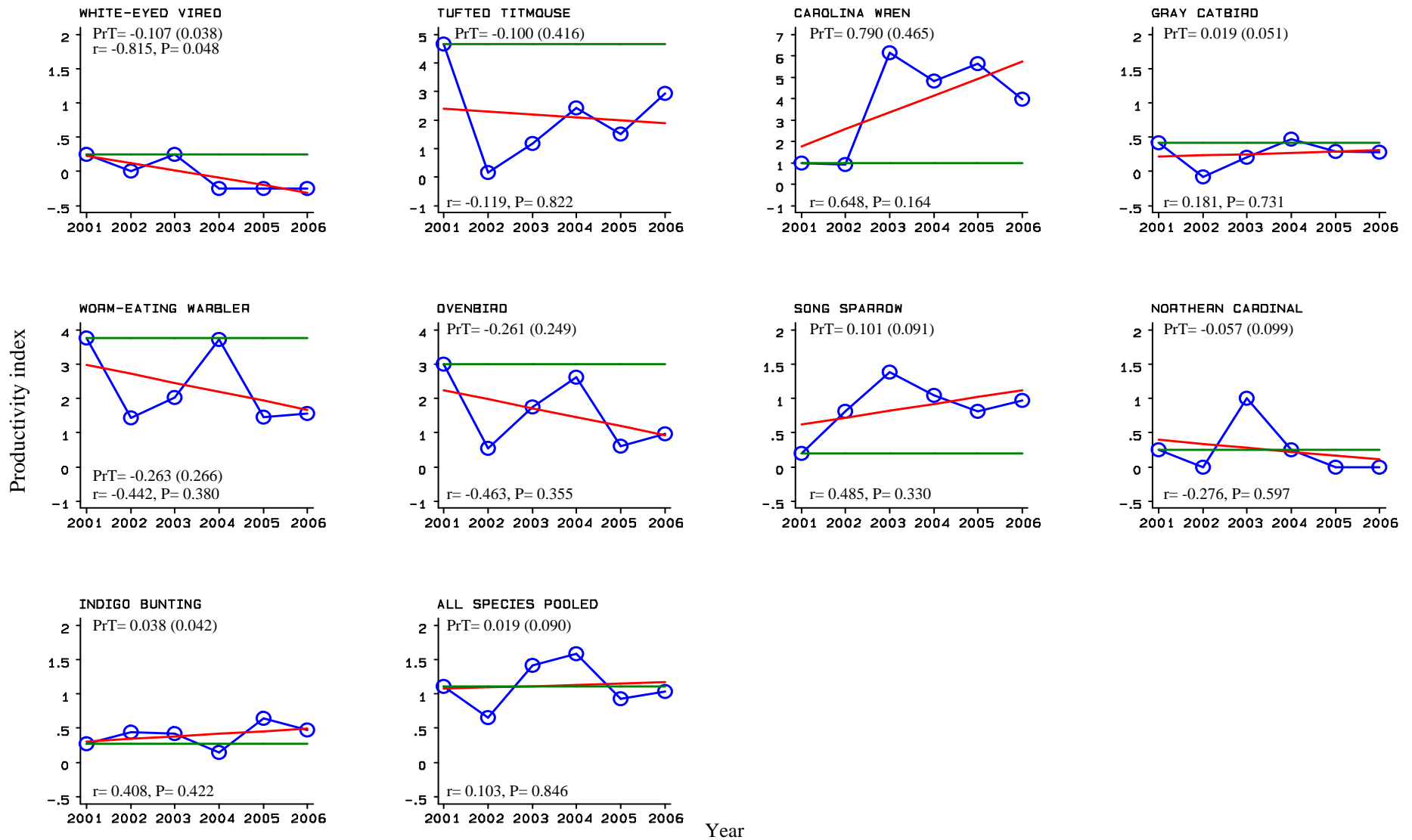


Figure 2. Trend in productivity for xxx species and all species pooled at the two stations (South Fork Potomac River and Beaver Creek) combined on Naval Security Group Activity Sugar Grove over the six years 2001-2006. The productivity index was defined as the actual productivity value in 2001. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index 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.

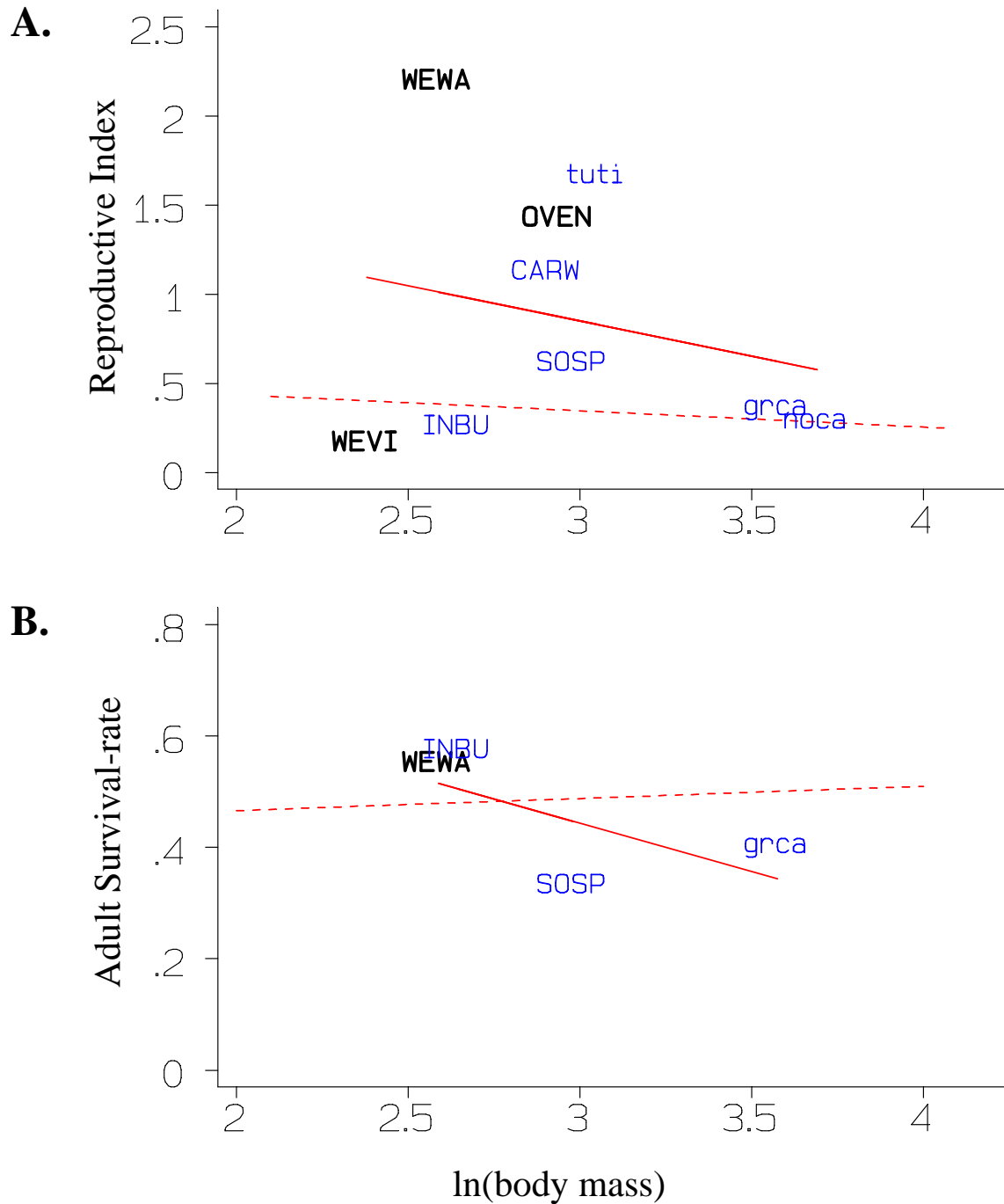


Figure 3. Regressions of mean reproductive index (**A**) and time-constant annual adult survival rate (**B**) at the two stations (South Fork Potomac River and Beaver Creek) combined on Naval Security Group Activity Sugar Grove on the natural log of body mass for target species for which survival estimates could be provided (4 species) and for which reproductive index was not zero in any years for the four years 2001-2006 (9 species). Four-letter codes (see Appendix I) in bold upper-case letters represent species that had decreasing population trends; those in non-bold upper-case letters had substantially increasing trends; and those in lower-case letters had highly fluctuating data without any substantial linear trend. Regression lines are presented for the target species at Naval Security Group Activity Sugar Grove (solid line) and for all species throughout all of North America (dashed line; 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 six years, 2001-2006, of the MAPS Program on the four stations operated on Naval Security Group Activity (NSGA) Sugar Grove and the on 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 (>1/2, not all, years); O = Occasional Breeder (≤1/2 years); T = Transient; M = Migrant; A= Altitudinal Disperser; ? = Uncertain Species ID

NUMB	SPEC	SPECIES NAME	South Fork Potomac River (SFPR)	Beaver Creek (BECK)	Lick Run (LIRU)	Flesh Run (FLRU)
00860	DCCO	Double-crested Cormorant	M			
01010	GBHE	Great Blue Heron	T	T	T	
01130	GRHE	Green Heron	B			
01290	BLVU	Black Vulture		T		
01300	TUVU	Turkey Vulture	T	O	B	B
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		
02380	RSHA	Red-shouldered Hawk		O	T	B
02400	BWHA	Broad-winged Hawk	T	U	B	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	T	T
03040	WITU	Wild Turkey		U	T	T
03750	SEPL	Semipalmated Plover		M		
03780	KILL	Killdeer	B	B	T	
03970	SOSA	Solitary Sandpiper		M		
04020	SPSA	Spotted Sandpiper	T	T		
04490	AMWO	American Woodcock				T
05570	MODO	Mourning Dove	O	U	B	B
06400	BBCU	Black-billed Cuckoo	T			
06410	YBCU	Yellow-billed Cuckoo	U	U	B	B
06680	EASO	Eastern Screech-Owl	T	O		
06800	GHOW	Great Horned Owl		T	T	

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	SFPR	BECR	LIRU	FLRU
06950	BADO	Barred Owl		T		
07080	CONI	Common Nighthawk		O		
07230	WPWI	Whip-poor-will		T		
07400	CHSW	Chimney Swift	O	U	T	T
08630	RTHU	Ruby-throated Hummingbird	U	O	O	O
09110	BEKI	Belted Kingfisher	U	O	T	T
09550	RBWO	Red-bellied Woodpecker	O	T	T	T
09650	DOWO	Downy Woodpecker	B	U	B	O
09660	HAWO	Hairy Woodpecker	U	U	B	B
09800	YSFL	Yellow-shafted Flicker	U	U	O	O
09860	PIWO	Pileated Woodpecker	U	B	B	B
11390	EAWP	Eastern Wood-Pewee	O	O	T	T
11450	YBFL	Yellow-bellied Flycatcher		M		
11460	ACFL	Acadian Flycatcher		O	O	B
11610	EAPH	Eastern Phoebe	U	O	B	B
11760	GCFL	Great Crested Flycatcher	B	U	B	B
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	U	T	B
12760	WAVI	Warbling Vireo	O	T		
12780	PHVI	Philadelphia Vireo		M		
12790	REVI	Red-eyed Vireo	B	B	B	B
12930	BLJA	Blue Jay	B	B	B	B
13190	AMCR	American Crow	B	B	B	B
13270	FICR	Fish Crow	O			
13300	CORA	Common Raven	O	B	B	B
13340	PUMA	Purple Martin	U	T		
13410	TRES	Tree Swallow	O	O		
13490	NRWS	Northern Rough-winged Swallow	O			
13510	BANS	Bank Swallow	O			
13520	CLSW	Cliff Swallow	T			
13540	BARS	Barn Swallow	U	U	T	
13560	CACH	Carolina Chickadee	T	O	O	O
13570	BCCH	Black-capped Chickadee	U	B	B	B
13575	UPCH	Unidentified Poecile Chickadee	?			
13660	TUTI	Tufted Titmouse	B	B	B	B
13690	RBNU	Red-breasted Nuthatch	T	O	B	B
13700	WBNU	White-breasted Nuthatch	O	U	B	O
13730	BRCR	Brown Creeper		O		

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	SFPR	BECR	LIRU	FLRU
14000	CARW	Carolina Wren	B	O	B	B
14070	HOWR	House Wren	O			
14250	RCKI	Ruby-crowned Kinglet	M			
14350	BGGN	Blue-gray Gnatcatcher	U	O	B	O
14560	EABL	Eastern Bluebird	O	T		
14790	GCTH	Gray-cheeked Thrush	M			
14820	HETH	Hermit Thrush		O	T	
14830	WOTH	Wood Thrush	T	T	T	
15000	AMRO	American Robin	B	U	T	O
15130	GRCA	Gray Catbird	B		T	
15150	NOMO	Northern Mockingbird	T			
15200	BRTH	Brown Thrasher	B			
15370	EUST	European Starling	U			
15510	AMPI	American Pipit		M		
15550	CEDW	Cedar Waxwing	B	B	O	B
15630	BWWA	Blue-winged Warbler		T		
15730	NOPA	Northern Parula	O	B	B	B
15750	YWAR	Yellow Warbler	T			
15760	CSWA	Chestnut-sided Warbler	T			
15770	MAWA	Magnolia Warbler	T			T
15790	BTBW	Black-throated Blue Warbler	T	T	T	O
15800	MYWA	Myrtle Warbler	T			
15830	BTNW	Black-throated Green Warbler	T	O	B	B
15860	BLBW	Blackburnian Warbler		T		T
15910	PIWA	Pine Warbler	T	U	B	B
15930	PRAW	Prairie Warbler		T		
15970	BLPW	Blackpoll Warbler	M	M		
16030	BAWW	Black-and-white Warbler	U	T	B	O
16040	AMRE	American Redstart	O	T		
16060	WEWA	Worm-eating Warbler	B	B	B	B
16080	OVEN	Ovenbird	U	U	B	B
16090	NOWA	Northern Waterthrush	T	T	T	
16100	LOWA	Louisiana Waterthrush	U	O	B	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	U	B	B	B
17820	EATO	Eastern Towhee	B	T	B	B

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	SFPR	BECR	LIRU	FLRU
18020	CHSP	Chipping Sparrow	O	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	O
18600	RBGR	Rose-breasted Grosbeak	T			
18670	INBU	Indigo Bunting	B	B	B	B
18730	RWBL	Red-winged Blackbird	B	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	B			
19370	HOFI	House Finch	O	O		
19510	AMGO	American Goldfinch	B	B	B	B
19920	HOSP	House Sparrow	O			
20085	UNBI	Unidentified Bird	?			