THE 2004 ANNUAL REPORT OF THE
MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP
(MAPS) PROGRAM
AT NAVAL SECURITY GROUP ACTIVITY (NSGA)
SUGAR GROVE

Peter Pyle, David F. DeSante, and Danielle Kaschube

THE INSTITUTE FOR BIRD POPULATIONS
P.O. Box 1346
Point Reyes Station, CA 94956-1346

(415) 663-1436

ddesante@birdpop.org

March 15, 2005

TABLE OF CONTENTS

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-fledging 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 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 (NSGA) Sugar Grove in 2004: the South Fork Potomac River station in bottomland riparian/mixed forest habitat, and the Beaver Creek station in open upland forest habitat. Ten mist nets at each station were set up in the exact same locations at which they were established in 2001-2003, and were operated for six morning hours per day, on one day per 10-day period for eight consecutive 10-day periods between May 19 and July 30.

A total of 185 captures of 29 species were recorded at the two stations combined. The index of adult population size for all species pooled in 2004 at the South Fork Potomac River station was 70.2 birds per 600 net hours, nearly five times as high as that recorded at Beaver Creek (15.2 birds per 600 net hours). Captures of young of all species pooled at South Fork Potomac River in 2004 (81.8) was also nearly four times as high as at Beaver Creek (21.5). The riparian/mixed forest habitat at South Fork Potomac River appears to support larger numbers of birds than the more open forested habitat of Beaver Creek. Despite these large differences, however, the disparity between these two stations actually decreased in 2004, with capture rates of both adults and young decreasing substantially between 2003 and 2004 at South Fork Potomac River and increasing at Beaver Creek. It is possible that a pond constructed in the vicinity of the Beaver Creek station in 2001 was beginning to develop surrounding native grass habitat, that might be attracting more birds to the vicinity of this station.

Between-year comparisons of the four years of operation at the two stations on NSGA Sugar Grove, using multivariate ANOVAs, not only confirmed the between-station differences in adult population sizes, but also revealed that adult population sizes tended to be near-significantly lower in 2004 than in all three previous years (2001-2003). The breeding population size for Indigo Bunting dropped from 8.1 adults per 600 net-hours in 2003 to 1.9 in 2004, and it should be watched closely in upcoming years.

Logistic regression analyses indicated that productivity was significantly lower in 2002 than it was in 2004, whereas productivity in 2001 and 2003 were slightly lower than that of 2004. Thus, the drop in breeding populations during 2004 has been accompanied by a concurrent increase in productivity. This pattern has often been observed at other MAPS locations and likely reflects density-dependent effects. Lower breeding populations result in less competition between adults and a higher average age of the adult population, and each of these factors contribute to higher reproductive success per adult.

The most important result from the MAPS program at Sugar Grove, after four years of data have been collected, is that the population trend for all species pooled decreased substantially and significantly between 2001 and 2004, showing a mean annual decline of 12%. Substantial declines were also noted for five of seven target species, Carolina Wren, Gray Catbird, Worm-eating Warbler, Song Sparrow, and Indigo Bunting.

Using four years of data from the two stations, estimates of adult survival and recapture probabilities could be obtained for three target species breeding at NSGA Sugar Grove, Worm-eating Warbler, Song Sparrow, and Indigo Bunting. Although reasonable estimates for these species were obtained, the CV(ϕ)s were high, indicating that the precision was low. We anticipate that after additional years of data have been collected we should be able to obtain more precise survival estimates for more species breeding at NSGA Sugar Grove.

With four years of data we can begin to assess the causes for the five species with population declines noted at Sugar Grove, by comparing mean vital rates for all species pooled with similar data collected during the MAPS program throughout the Northeast Region for the years 1992-2001 and available at the IBP website at http://www.birdpop.org/nbii/NBIIHome.asp. Productivity at Sugar Grove was lower than that for the Northeast Region of the MAPS program for Gray Catbird (0.33 vs. 0.43, respectively), Song Sparrow (0.65 vs. 1.12), and Indigo Bunting (0.20 vs. 0.22), whereas adult survival estimates compared favorably at Sugar Grove for Song Sparrow (0.474 vs 0.336) and Indigo Bunting (0.447 vs. 0.465); survival for Gray Catbird could not be estimated. These results indicate that low productivity is likely the primary contributing factor to declines in these species.

The reproductive index value for Carolina Wren (1.22) was higher than that for the Northeast as a whole (0.46) and our data indicate that survival is low, suggesting that low survival is the cause for population declines. Because Carolina Wren is a resident species, these problems in survival are likely occurring on or in the vicinity of Sugar Grove. For Worm-eating Warbler, both reproductive index (2.66) and estimated adult survival (0.776) at Sugar Grove were substantially higher than these values in the Northeast Region as a whole (0.72 and 0.520, respectively), suggesting that some other factor, such as juvenile survival away from Sugar Grove and/or recruitment into the population, may be low.

Thus, overall, it appears that productivity at Sugar Grove may be driving or influencing the population dynamics of three of the five species showing declining trends, and that survival of one resident species at Sugar Grove is driving or influencing trends in a fourth species. This indicates that the population dynamics of most of Sugar Grove's breeding species are being affected by events at the Grove, and could be within the DOD's ability to influence through management action.

Despite the fact that the NSGA Sugar Grove MAPS stations have been operated for only four years, we have documented a significant decline in landbird populations when all species were pooled, and have suggested preliminary causes for the substantial declines in five individual species. As more years of data accumulate we will be able to make inferences about the effects of weather on productivity and the effect of changes in productivity on population size. We will also be able to make more precise inferences regarding the effects of productivity and survivorship on population dynamics. Pooling data at this level will also allow comparison between NSGA Sugar Grove and other protected and unprotected areas at which MAPS stations are operated in the Appalachian region.

The long-term goal for the NSGA Sugar Grove MAPS program is to continue to monitor the primary demographic parameters of landbirds in order to provide critical information to clarify the ecological processes leading from environmental stressors to population responses. We will accomplish this by including NSGA Sugar Grove 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 obtained funding from the state of Virginia to begin this work, and continued operation of Sugar Grove stations will be critical in understanding bird dynamics throughout the entire Appalachians.

In addition, MAPS data from NSGA Sugar Grove 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 NSGA Sugar Grove's long-term ecological monitoring effort, and we recommend the continued operation of the NSGA Sugar Grove MAPS stations well into the future.

INTRODUCTION

The United States Department of Defense (DoD), including the Department of the Navy, has assumed responsibility for managing natural resources on lands under their jurisdiction in a manner that, as much as possible considering their military mission, maintains the ecological integrity and species diversity of the ecosystems present on those lands. In order to carry out this responsibility, integrated long-term programs are needed to monitor both the natural resources on military installations and the effects of varying management practices on those resources.

The development and implementation of an effective long-term monitoring program on military installations can be of even wider importance than aiding the Department of Defense in its management of those resources. Because military lands often provide large areas of multiple and often relatively pristine ecosystems subject to varying management practices, studies conducted on these lands provide invaluable information for understanding natural ecological processes and for evaluating the effects of large-scale, even global, environmental changes. Thus, long-term monitoring data from military installations can provide information that is crucial for efforts to preserve natural resources and biodiversity on a continental or even global scale.

Landbirds

Landbirds, because of their high body temperature, rapid metabolism, and high ecological position on most food webs, are excellent indicators of the effects of local, regional, and global environmental change in terrestrial ecosystems. Furthermore, their abundance and diversity in virtually all terrestrial habitats, diurnal nature, discrete reproductive seasonality, and intermediate longevity facilitate the monitoring of their population and demographic parameters. It is not surprising, therefore, that landbirds have been selected by the DoD to receive high priority for monitoring. Nor is it surprising that several large-scale monitoring programs that provide annual population estimates and long-term population trends for landbirds are already in place on this continent. They include the North American Breeding Bird Survey (BBS), the Breeding Bird Census, the Winter Bird Population Study, and the Christmas Bird Count.

Recent analyses of data from several of these programs, particularly the BBS, suggest that populations of many landbirds, including forest-, scrubland-, and grassland-inhabiting species, are in serious decline (Peterjohn et al. 1995). Indeed, populations of most landbird species appear to be declining on a global basis. Nearctic-Neotropical migratory landbirds (species that breed in North America and winter in Central and South America and the West Indies; hereafter, Neotropical migratory birds) constitute one group for which pronounced population declines have been documented (Robbins et al. 1989, Terborgh 1989). In response to these declines, the Neotropical Migratory Bird Conservation Program, "Partners in Flight - Aves de las Americas," was initiated in 1991 (Finch and Stangel 1993). The major goal of Partners in Flight (PIF) is to reverse the declines in Neotropical migratory birds through a coordinated program of monitoring, research, management, education, and international cooperation. As one of the major cooperating agencies in PIF, the DoD has established long-term avian monitoring efforts at military installations using protocols developed by the Monitoring Working Group of PIF. Clearly, the long-term monitoring goals of the DoD and the monitoring and research goals of PIF share many common elements.

Primary Demographic Parameters

Existing population-trend data on Neotropical migrants, while suggesting severe and sometimes accelerating declines, provide no information on primary demographic parameters (productivity and survivorship) of these birds. Thus, population-trend data alone provide no means for determining at what point(s) in the life cycles problems are occurring, or to what extent the observed population trends are being driven by causal factors that affect birth rates, death rates, or both (DeSante 1995). In particular, large-scale North American avian monitoring programs that provide only population-trend data have been unable to determine to what extent forest fragmentation and deforestation on the temperate breeding grounds, versus that on the tropical wintering grounds, are causes for declining populations of Neotropical migrants. Without critical data on productivity and survivorship, it will be extremely difficult to identify effective management and conservation actions to reverse current population declines (DeSante 1992).

The ability to monitor primary demographic parameters of target species must also be an important component of any successful long-term inventory and monitoring program that aims to monitor the ecological processes leading from environmental stressors to population responses (DeSante and Rosenberg 1998). This is because environmental factors and management actions affect primary demographic parameters directly and these effects can be observed over a short time period (Temple and Wiens 1989). Because of the buffering effects of floater individuals and density-dependent responses of populations, there may be substantial timelags between changes in primary parameters and resulting changes in population size or density as measured by census or survey methods (DeSante and George 1994). Thus, a population could be in trouble long before this becomes evident from survey data. Moreover, because of the vagility of many animal species, especially birds, local variations in secondary parameters (e.g., population size or density) may be masked by recruitment from a wider region (George et al. 1992) or accentuated by lack of recruitment from a wider area (DeSante 1990). A successful monitoring program should be able to account for these factors.

MAPS

In 1989, The Institute for Bird Populations (IBP) established the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among public agencies, private organizations, and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting and banding stations to provide long-term demographic data on landbirds (DeSante et al. 1995). The design of the MAPS program was patterned after the very successful British Constant Effort Sites (CES) Scheme that has been operated by the British Trust for Ornithology since 1981 (Peach et al. 1996). The MAPS program was endorsed in 1991 by both the Monitoring Working Group of PIF and the USDI Bird Banding Laboratory, and a four-year pilot project (1992-1995) was approved by the USDI Fish and Wildlife Service and National Biological Service (now the Biological Resources Division [BRD] of the U.S. Geological Survey [USGS]) to evaluate its utility and effectiveness for monitoring demographic parameters of landbirds.

Now in its 16th year (13th year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to nearly 500 stations in 2004. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies in PIF, including the Department of Defense, Department of the Navy, Department of the Army, Texas Army National Guard, National Park Service, USDA Forest Service, and US Fish and Wildlife Service. Within the past ten years, for example, IBP has been contracted to operate as many as 157 MAPS stations per year on federal properties, including 76 stations on military installations administered by the DoD and the Texas Army National Guard.

Goals and Objectives of MAPS

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.

The overall objectives of MAPS are to achieve the above-outlined goals by means of long-term monitoring at two major spatial scales. The first is a very large scale — effectively the entire North American continent divided into eight geographical regions. It is envisioned that DoD military installations, along with national parks, national forests, and other publicly owned lands, will provide a major subset of sites for this large-scale objective.

The second, smaller-scale but still long-term objective is to fulfill the above-outlined goals for specific geographical areas (perhaps based on physiographic strata or Bird Conservation Regions) or specific locations (such as individual military installations, national forests, or national parks) to aid research and management efforts within the installations, forests, or parks to protect and enhance their avifauna and ecological integrity. The sampling strategy utilized at these smaller scales should be hypothesis-driven and should be integrated with other research and monitoring efforts. DeSante et al. (1999) showed that measures of productivity and survival derived from MAPS data were consistent with observed populations changes at these smaller spatial scales. This provides considerable assurance that the goals and objectives outlined above can be achieved.

All of these monitoring, research, and management goals are in agreement with the Department of Defense (DoD) Partners-in-Flight (PIF) strategy. 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 established on Naval Security Group Activity (NSGA) Sugar Grove in 2001. It is expected that information from the MAPS program will be capable of aiding research and management efforts on NSGA Sugar Grove to protect and enhance the installation's avifauna and ecological integrity, while helping it fulfill its military mission in an optimal manner.

Recent Important Results from MAPS

Recent important results from MAPS reported in the peer-reviewed literature include the following. (1) 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). (2) Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales (DeSante et al. 1999). (3) 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). (4) 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). (5) 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, allowing conservation management strategies to be formulated and tested (Nott et al. 2003b). These results indicate that MAPS is capable of achieving, and in some cases is already achieving, its objectives and goals.

SPECIFICS OF THE NSGA SUGAR GROVE MAPS PROGRAM

Two MAPS stations were re-established and operated on NSGA Sugar Grove in 2004, at the same locations at which they were originally established in 2001. The stations were re-established, and the first period was run by IBP Biologist Richard Gibbons, with assistance from IBP biologist interns Erin Cashion and Adam Perry, during the third week of May, 2004. The two stations are 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. A summary of the major habitats represented at each of the two stations is presented in Table 1 along with a summary of the 2004 operation of each station. Richard Gibbons proceeded to operate the stations during the remainder of 2004.

All ten net sites at each station were established without difficulty at the exact same locations where they were operated in 2001-2003. Each station was operated for six morning hours per day (beginning at local sunrise) on one day in each of eight consecutive 10-day periods between Period 3 (May 19-20 for the two stations) and Period 10 (July 29-30). The operation of all stations occurred on schedule during each of the eight 10-day periods.

METHODS

The operation of each of the two stations during 2004 followed MAPS protocol, as established for use by the MAPS Program throughout North America and spelled out in the MAPS Manual (DeSante et al. 2004a). An overview of both the field and analytical techniques is presented here.

Data Collection

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 comprised. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms (DeSante et al. 2004a):

(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 (period) 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.

For each of the two stations operated, simple habitat maps were prepared on which up to four major habitat types, as well as the locations of all structures, roads, trails, and streams, were identified and delineated. The pattern and extent of cover of each major habitat type identified at each station, as well as the pattern and extent of cover of each of four major vertical layers of vegetation (upperstory, midstory, understory, and ground cover) in each major habitat type, were classified into one of twelve pattern types and eleven cover categories according to guidelines spelled out in the MAPS Habitat Structure Assessment (HSA) Protocol, developed by IBP Landscape Ecologist, Philip Nott, and the IBP staff (Nott et al. 2003b).

Computer Data Entry and Verification
The computer entry of all banding data was completed by John W. Shipman of Zoological Data Processing, Socorro, NM. 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. Computer entry of effort, breeding status, and vegetation data was completed by IBP biologists using specially designed data entry programs. 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 2.

A. Population-Size and Productivity Analyses — The proofed, verified, and corrected banding data from 2004 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 2004) 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 2003 and 2004 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 according to methods developed by the BTO in their CES scheme (Peach et al. 1996). Thus, for species captured at both stations at NSGA Sugar Grove, we statistically inferred the significance of installation-wide annual changes in the indices of adult population size and post-fledging productivity by using confidence intervals derived from the standard errors of the mean percentage changes. Because of the sample size of only two stations, between-year changes for any given species at NSGA Sugar Grove are unlikely to reach statistical significance unless the changes at the two stations are substantial and very nearly the same. 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 two stations operated for the four years, 2001-2004, and for both stations combined, we calculated four-year 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. While these mean numbers provide an indication of the relative adult population size and productivity of the various species at each station and at all stations pooled, they don't provide sufficient information by themselves for statistical inference of the differences in adult population size or reproductive index among years or between stations. In order to make such inferences, we conducted multivariate analyses of variance (of numbers of adults captured) and logistic regression analyses (of productivity index, or the probability that a captured bird is young).

B. Multivariate analyses on adult population size — We conducted multivariate ANOVAs on indices of adult population size (mean number of adult birds captured) as a function of year and station. Because year and station are incorporated into the ANOVAs as non-continuous variables, the analysis format requires the designation of a reference station or reference group against which the relative mean number of adults for the other stations or groups are compared. For both multivariate ANOVAs and logistic regressions (see below), we chose 2004 as the reference year and South Fork Potomac River as the reference station. The relative number of adults for the reference year and station was set to zero. The multivariate ANOVAs estimated differences among years and between stations after controlling for the other variable. The ANOVAs also included a net-hour term to adjust for the variable amount of effort that occurred at each station.

Data preparation for the ANOVA analyses was completed using data-management programs in dBASE5.7. The multivariate ANOVAs themselves were completed using the statistical-analysis package STATA (Stata Corporation 1995), and statistical significance was determined based on the F-statistic. We conducted these multivariate ANOVAs for all species pooled and for each target species for which we recorded an average of 2.5 or more individual adults per year and at least 2 between-year captures were recorded at the two stations combined, and at which the species was a regular (B) or usual (U) breeder.

C. Logistic regression analyses of productivity — In a similar manner to multivariate ANOVA, the use of logistic regression provides an analytical framework for examining productivity as a function of year and station while controlling for the other variable. Logistic regression, when used in productivity analyses, estimates the probability of an individual bird captured at random being a young bird. The "odds ratio", the term used for the probability value produced by logistic regression, is the odds of a captured individual being a young bird after both other variables (year and station) have been accounted for. As with multivariate ANOVAs, the logistic-regression analysis format requires the designation of a reference year (2004) and reference station (South Fork Potomac River); however, when adults captured or productivity was zero at the designated reference station a surrogate reference station was used. Data preparation for the logistic regression analyses was completed using data-management programs in dBASE5.7, and the logistic regression analyses themselves were completed on all species pooled and each target species using the statistical-analysis package STATA (Stata Corporation 1995). Statistical significance in logistic regression was determined based on the z-statistic (or Wald Statistic) which equates to the maximum likelihood estimate based on the odds ratio divided by the standard error (Stata Corporation 1995).

D. Analyses of trends in adult population size and productivity — We examined four-year (2001-2004) trends in indices of adult population size and productivity for each target species for which we recorded an average of 2.5 or more individual adults per year and at least 2 between-year captures were recorded at the two stations combined, and 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 four 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 four 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 four-year period, to provide an estimate of the population trend for the species; *APC* was calculated as:

(actual 2001 value of *PSI* / predicted 2001 value of *PSI* 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. Again, we use an alpha level of 0.05 for statistical significance and we use the terms “nearly significant” or “near-significant” for trends for which $0.05 \leq P < 0.10$. 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 $SE \leq 0.219$ (for four-year trends) are considered to have a stable trend; and those for which $-0.5 \leq r \leq 0.5$ and $SE > 0.219$ (for four-year trends) 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 *(r),* and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends, except that productivity trends are considered to be highly fluctuating if the *SE* of the slope > 0.125 (for four-year productivity trends).

<u>E. Survivorship analyses</u> —Survival was estimated for 3 target species using modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) on four years (2001-2004) of capture histories of adult birds from both stations combined. Target species were those for which, on average, at least 2.5 individual adults per year and at least five between-year returns were recorded from data pooled from each of the stations at which the species was a breeder during more than half of the years that 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 (*SE*s) for adult survival probability (ϕ), adult recapture probability (p), and the proportion of residents among newly captured adults (τ) using a time-constant, between- and within-year transient model (Pradel et al. 1997, Nott and DeSante 2002, Hines et al. 2003). The use of the transient model ($\phi p \tau$) 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.

Because we had only four years of data, we used a time-constant transient model for estimating survival and recapture probabilities and the proportion of residents among newly captured adults. We did not consider models that included time-dependence, as four years of data are generally insufficient to provide time-dependent estimates with any reasonable precision. We limited our consideration to models that produced estimates for both survival and recapture probability that were neither 0 nor 1, and to models that fit the data. The goodness of fit of the models was tested by using a Pearson's goodness-of-fit test.

RESULTS

A total of 935.2 net-hours was accumulated at the two MAPS stations operated at NSGA Sugar Grove in 2004 (Table 1). Data from 757.0 of these net-hours could be compared directly to 2003 data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

A. 2004 values. The 2004 capture summary of the numbers of newly-banded, unbanded, and recaptured birds is presented for each species and all species pooled at each of the two stations in Table 2. A total of 151 captures of 25 species was recorded at the South Fork Potomac River station, while Beaver Creek produced only 34 captures of 14 species. Overall, the most abundantly captured species at the two stations were Worm-eating Warbler, followed by Ovenbird, Gray Catbird, Song Sparrow, Tufted Titmouse, and Carolina Wren (Table 2).

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 in Table 3. These capture indices suggest that the total adult population size in 2004 was over four times as high at South Fork Potomac River (70.2 birds per 600 net hours) than it was at Beaver Creek (15.2 birds per 600 net hours). Captures of young of all species pooled at South Fork Potomac River in 2004 (81.8) was also nearly four times as high as at Beaver Creek (21.5). The discrepancies in these two values, however, has decreased over those of 2003, when South Fork Potomac River had a capture rate of adults nearly 12 times higher than Beaver Creek and a capture rate of young nearly five times higher (DeSante et al. 2004b). As in previous years, productivity, as determined by reproductive index or the number of young to adults, was higher at Beaver Creek (1.42) than at South Fork Potomac River (1.17), and was 1.21 with both stations combined. Overall, the highest breeding populations at the two stations, based on adults captured per 600 net-hours, were Gray Catbird, Worm-eating Warbler, Song Sparrow, Ovenbird, Tufted Titmouse, and Northern Cardinal (Table 3).

B. Comparisons between 2003 and 2004. Constant-effort comparisons between 2003 and 2004 were undertaken at both NSGA Sugar Grove 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 both stations combined decreased substantially but non-significantly, by -27.7% between 2003 and 2004 (Table 4), very similar to the 27.2% decline noted between 2002 and 2003. Decreases between 2003 and 2004 were recorded for 14 of 27 species, a proportion not significantly greater than 0.50. The number of adults captured of all species pooled decreased at South Fork Potomac River (by -32.9%) but increased at Beaver Creek (by +75.0%). The proportion of increasing or decreasing species was not significantly greater than 0.50 at either station. The only species showing widespread declines at both stations was Indigo Bunting, which declined by 80% at South Fork Potomac River and 100% at Beaver Creek. The breeding population size for this species, at both stations pooled, dropped from 8.1 adults per 600 net-hours in 2003 to 1.9 in 2004.

The number of young birds captured, of all species pooled and for both stations combined, decreased by -8.1%, a non-significant change (Table 5). Increases between 2003 and 2004 were recorded for 11 of 23 species, a proportion not significantly greater than 0.50. As with adults captured, change in young captured for all species pooled decreased at South Fork Potomac River (by -16.0%) and increased at Beaver Creek (by +45.5%). The proportion of increasing or decreasing species was not significantly greater than 0.50 at either station. Among individual species, Carolina Wren showed a consistent decrease in the number of young at both stations whereas Louisiana Waterthrush showed a consistent increase.

Reproductive index (the number of young per adult) showed an absolute increase of +0.281, from 1.036 in 2003 to 1.317 in 2004 for all species pooled and both stations combined (Table 6). However, increases in productivity were recorded for only 5 of 16 species. In contrast to adults and young captured, reproductive index increased at South Fork Potomac River (by +0.239) but decreased at Beaver Creek (by -0.464). The reason that the increase with both stations combined (+0.281) is apparently larger than one might expect, given the changes at each station, is caused by the reduced overall captures and adult-to-young ratio in 2004 as compared with 2003. The proportion of increasing species was not significantly greater than 0.50 at either station, and there were no species that showed consistent decreases or increases in productivity at both stations.

Thus, in general, both breeding populations and young captured decreased at South Fork Potomac River but increased at Beaver Creek; however, productivity showed the opposite pattern, increasing at South Fork Potomac River and decreasing at Beaver Creek. None of the changes, including those of the proportions of species showing decreases or increases, were significant. The installation-wide decrease from 2003 to 2004 in Indigo Buntings was notable.

C. Four-year mean population size and productivity values. Mean numbers of individual adults (an index of adult population size) and young captured per 600 net-hours, and reproductive index (a measure of productivity), averaged over the four-year period 2001-2004, are presented in Table 7, for each station and both stations combined. Examination of values for all species pooled confirms that the large disparity in capture rates of adults and young between South Fork Potomac River (100.2 and 93.8 per 600 net-hours, respectively) and Beaver Creek (18.7 and 20.9 per 600 net-hours) has been fairly consistent over the four-year period, although the disparity decreased after the addition of 2004 data (see above). Productivity (number of young per adult), however, has tended to be higher at Beaver Creek (1.31) than at South Fork Potomac River (0.97), although, again, the disparity is decreasing. Examination of individual species indicates that the species composition between the two stations also differs substantially, nine of 17 species with adults recorded at Beaver Creek showing higher values than at South Fork Potomac River, despite the much lower capture rates overall at Beaver Creek. For both stations combined and all four years pooled, the highest breeding populations were recorded for Worm-eating Warbler, followed by Gray Catbird, Indigo Bunting (despite substantial declines in 2004), Song Sparrow, Ovenbird, Carolina Wren, Northern Cardinal, White-eyed Vireo, and Tufted Titmouse (Table 7).

D. Multivariate analyses of variance of adult population size. Multivariate analyses assessing variation in numbers of adults captured by year and station, for all species combined and for eight target species, are shown in Figure 1**A**-**B**. Controlling for station and effort (net hours), near-significantly fewer adults (of all species pooled) were captured in 2004, the reference year, than in each of the three other years (Fig. 1**A**). Among the eight individual species, it is apparent that this difference has been driven primarily by similar patterns among two of the more common species, Worm-eating Warbler and Indigo Bunting, although the decreased values for 2004 were not significant or near-significant for these individual species. There were also no significant between-year differences among the other six species, most of them showing very consistent values from 2001 to 2004.

For all species combined, a significantly greater number of adults was captured at the South Fork Potomac River station than at the Beaver Creek station, after controlling for interannual variation and net-hours (Fig. 1**B**). This difference was similar and significant or near-significant for White-eyed Vireo, Gray Catbird, Worm-eating Warbler, and Song Sparrow. There were no significant or near-significant differences among the other four species, and the values for just two woodland species, Carolina Chickadee and Tufted Titmouse, were slightly higher at Beaver Creek than at South Fork Potomac River.

E. Logistic regression analyses of productivity. The odds ratios for productivity indices for all species combined and for the eight target species are presented in Figure 1**C**-**D**. After controlling for station and effort, productivity of all species pooled was significantly lower in 2002 than it was in 2004, whereas productivity in 2001 and 2003 was slightly but non-significantly lower than that of 2004 (Fig. 1**C**). Productivity was also significantly lower in 2002 than 2004 for Gray Catbird, and for White-eyed Vireo it was significantly lower (0.00) in both 2002 and 2004 than it was in 2001 (the surrogate reference year since productivity was 0.00 in 2004). For these two species as well as for Song Sparrow, station was not controlled because no individuals were captured at Beaver Creek. Productivity for Indigo Bunting was also zero in 2004. For the remaining five species there were no significant or near-significant between-year differences in productivity.

For all species combined, productivity at the South Fork Potomac River was slightly and non-significantly lower than that of the Beaver Creek station, when controlling for interannual variation (Fig. 1**D**). This pattern was similar for Black-capped Chickadee, Tufted Titmouse, and Indigo Bunting (productivity could not be compared for Gray Catbird and Song Sparrow, for which none were captured at Beaver Creek in 2001-2004). For Carolina Wren, young but no adults were captured at Beaver Creek, yielding a significantly higher (but undefined) productivity value. Finally, for Worm-eating Warbler, productivity was significantly higher at South Fork Potomac River than it was at Beaver Creek (0.00).

F. Four-year trends in adult population size and productivity. "Chain" indices of adult population size, at the two stations combined, are presented in Figure 2 for seven of the eight target species and for all species pooled. Trends could not be calculated for Black-capped Chickadee, for which no adults were captured in 2003 (so the value was 0 in 2003). 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*) for the population. *APC* along with the standard error of the slope (SE), the correlation coefficient *(r)*, and the significance of the correlation (*P*) for each target species and for all species pooled are included in Figure 2.

The population trend for all species pooled was substantially (absolute $r > 0.5$) and significantly ($P = 0.037$) negative between 2001 and 2004 (Fig. 2), showing an annual decline of 12%. Declines were also noted for 5 of the 7 species, with those of Carolina Wren, Gray Catbird, Worm-eating Warbler, and Indigo Bunting being substantial, and that of Song Sparrow being substantial and nearly significant. Significant trends are difficult to achieve with only four data points; should these tendencies continue we will likely see more significant trends after five or more years of data have been collected. The trend for Tufted Titmouse was flat (slope = 0) and showed wide inter-annual fluctuation (*SE* of the slope > 0.219). Only one species showed a slightly positive trend, White-eyed Vireo, which we consider stable (neither substantial nor widely fluctuating).

Trends in productivity for all species pooled increased substantially but non-significantly between 2001 and 2004 (Fig. 3). Similar substantial increases in productivity were recorded for Carolina Wren and Song Sparrow. Non-substantial but widely fluctuating (*SE* of the slope > 0.125) trends were recorded for Tufted Titmouse, Gray Catbird, and Worm-eating Warbler. For Indigo Bunting, the productivity trend was slightly negative but should be considered essentially stable (absolute $r < 0.5$ and $SE \leq 0.125$), and for White-eyed Vireo the trend was substantially (but non-significantly) negative.

Estimates of Adult Survivorship

Using four years of data from the two stations, estimates of adult survival and recapture probabilities could be obtained for only three (Worm-eating Warbler, Song Sparrow, and Indigo Bunting) of the eight target species breeding at NSGA Sugar Grove (Table 8). For the remaining five species we obtained survival or recapture 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 0.447 for Indigo Bunting to 0.776 for Worm-eating Warbler, with a mean of 0.566. Recapture probability ranged from 0.194 (Worm-eating Warbler) to 0.289 (Song Sparrow), with a mean of 0.232. Proportion of residents was estimated at 1.000 for Song Sparrow and Indigo Bunting, whereas it was 0.492 for Worm-eating Warbler (indicating the presence of transient individuals or non-breeding "floaters" in the data set). Although these are reasonable estimates for these species, the C.V.(ϕ) was high (> 30% for all three species) indicating that the precision was low.

DISCUSSION

Four years (2001-2004) of MAPS data from two stations on NSGA Sugar Grove confirm that both species richness and the abundance of adult birds at the South Fork Potomac River station, located in bottomland riparian/mixed forest habitat, was substantially higher than that at the Beaver Creek station, located in open upland forest habitat. We believe that riparian/mixed forest habitat can support larger breeding populations due to its denser more diverse canopy and richer understory than more open habitat that largely lacks an understory. In 2004, however, the disparity in both adults captured and young captured between these two stations decreased. Capture rates of both adults and young decreased substantially between 2003 and 2004 at South Fork Potomac River, whereas those between-year capture rates each increased at Beaver Creek. While operating the stations, IBP biologists noted that a pond constructed in the vicinity of the Beaver Creek station in 2001 was beginning to develop surrounding native grass habitat, that might be attracting more birds to the vicinity of this station. Alternatively, the general population declines noted at Sugar Grove and especially at the South Fork Potomac River station (see below) may also be contributing to this decrease in disparity.

Between-year comparisons of the four years of operation at the two stations on NSGA Sugar Grove, using multivariate ANOVAs, not only confirmed the between-station differences in adult population sizes, but also revealed that adult population sizes tended to be near-significantly lower in 2004 than in all three previous years (2001-2003). The lower values in 2004 were caused primarily by similar patterns recorded for two common species, Worm-eating Warbler and Indigo Bunting. The breeding population size for Indigo Bunting dropped from 8.1 adults per 600 net-hours in 2003 to 1.9 in 2004, and it should be watched closely in upcoming years.

Logistic regression analyses indicated that productivity was significantly lower in 2002 than it was in 2004, whereas productivity in 2001 and 2003 were slightly lower than that of 2004. Thus, the drop in breeding populations during 2004 has been accompanied by a concurrent increase in productivity. This pattern has often been observed at other MAPS locations and likely reflects density-dependent effects. Lower breeding populations result in less competition between adults and a higher average age of the adult population (due to lack of recruitment), each contributing to higher reproductive success.

The most important result from the MAPS program at Sugar Grove, after four years of data have been collected, is that the population trend for all species pooled decreased substantially and significantly between 2001 and 2004, showing a mean annual decline of 12%. Substantial declines were also noted for five of seven target species, Carolina Wren, Gray Catbird, Worm-eating Warbler, Song Sparrow, and Indigo Bunting. Although based upon only four years of data, this is cause for considerable concern.

Using four years of data from the two stations, estimates of adult survival and recapture probabilities could be obtained for three target species breeding at NSGA Sugar Grove, Worm-eating Warbler, Song Sparrow, and Indigo Bunting. Although reasonable estimates for these species were obtained, the CV(ϕ)'s were high, indicating low precision. We anticipate that, after more years of data have been collected at NSGA Sugar Grove, we should be able to obtain more precise survival estimates for more breeding species.

A primary goal of the MAPS program is to determine the proximate causes (productivity or survival) accounting for declining landbird population sizes. With four years of data we can begin to assess the causes for the five species with population declines noted at Sugar Grove. To do this we compare mean vital rates for all species pooled to similar data collected during the MAPS program throughout the Northeast Region for the years 1992-2001 and available at the IBP website at http://www.birdpop.org/nbii/NBIIHome.asp.

Productivity (reproductive index) for both Sugar Grove stations and all four years combined (Table 7) was lower than that for the Northeast Region of the MAPS program for Gray Catbird (0.33 vs. 0.43, respectively), Song Sparrow (0.65 vs. 1.12), and Indigo Bunting (0.20 vs. 0.22). On the other hand, adult survival estimates compared favorably at Sugar Grove for Song Sparrow (0.474 vs 0.336 in the Northeast Region) and Indigo Bunting (0.447 vs. 0.465). These results indicate that low productivity could be contributing to declines in these species. Among these three species, productivity trends were increasing substantially for Song Sparrow, fluctuating widely for Gray Catbird, and declining slightly for Indigo Bunting, indicating increasing levels of concern for the future population sizes of these last two species.

The reproductive index value for Carolina Wren (1.22) was higher than that for the Northeast as a whole (0.46) and the productivity trend was increasing substantially, suggesting that productivity may not be contributing substantially to the population decline observed in this species. We were unable to calculate adult survival for this species because capture probability was estimated at an unrealistic 1.0. When this happens, however, it is generally an indication of low survival and suggests that low survival is the cause for Carolina Wren population declines at Sugar Grove. Because Carolina Wren is a resident species, these problems in survival are likely occurring on or in the vicinity of Sugar Grove.

For Worm-eating Warbler, both reproductive index (2.66) and estimated adult survival (0.776) at Sugar Grove were substantially higher than these values in the Northeast Region as a whole (0.72 and 0.520, respectively), which may at first seem contrary to the fact that populations are declining substantially at Sugar Grove. In such cases we suspect that juvenile survival away from Sugar Grove and/or recruitment into the population may be low. With more years of data from Sugar Grove we will be able to assess these parameters by performing survival analyses in reverse (to estimate recruitment) and, if possible, by taking into account individuals aged SY (one-year old) or ASY (two years old or older) among the data.

Thus, overall, it appears that productivity at Sugar Grove may be driving or influencing the population dynamics of three of the five species showing declining trends, and that survival of one resident species at Sugar Grove is driving or influencing trends in a fourth species. This indicates that the population dynamics of most of Sugar Grove's breeding species are being affected by events at the Grove, and could be within the DOD's ability to influence through management action.

Despite the fact that the NSGA Sugar Grove MAPS stations have been operated for only four years, we have documented a significant decline in landbird populations when all species were pooled, and have obtained preliminary causes for substantial declines in five individual species. 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 size. We will also be able to make more precise inferences regarding longer-term trends for the various species and causes of those trends. Finally, we will be able to better examine 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 NSGA Sugar Grove and other protected and unprotected areas at which MAPS stations are operated in the region. Finally, MAPS data from NSGA 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 NSGA Sugar Grove MAPS program is to continue to monitor the primary demographic parameters of the installation's landbirds in order to provide critical information that can be used to aid our understanding of the ecological processes leading from environmental stressors to population responses. This is to be accomplished by including data from NSGA Sugar Grove in analyses of data from other central Appalachian MAPS stations 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) better 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); (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 installation and elsewhere (Nott 2000, Nott et al. 2003a). We have recently obtained funding from the state of Virginia to begin this work, and continued operation of Sugar Grove stations will be critical in understanding bird dynamics throughout the entire Appalachians.

In addition, MAPS data from NSGA Sugar Grove 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 NSGA Sugar Grove's long-term ecological monitoring effort, and we recommend the continued operation of the NSGA Sugar Grove MAPS stations well into the future.

ACKNOWLEDGMENTS

All data collected for the MAPS Program at NSGA Sugar Grove in 2004 were gathered by Richard Gibbons, with assistance from IBP biologist interns Erin Cashion and Adam Perry. We thank these people for their excellent work in re-establishing and operating the NSGA Sugar Grove MAPS stations. We thank Ken Burton 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 for logistical support and for their assistance in the initial establishment of the stations. 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 257 of The Institute for Bird Populations.

LITERATURE CITED

Bart, J., Kepler, C., Sykes, P., & Bocetti, C. 1999. Evaluation of mist-net sampling as an index to productivity in Kirtland's Warblers. Auk 116:1147-1151.

DeSante, D.F. 1990. The role of recruitment in the dynamics of a Sierran subalpine bird community. *American Naturalist* 136:429-455.

DeSante, D.F. 1992. Monitoring Avian Productivity and Survivorship (MAPS): a sharp, rather than blunt, tool for monitoring and assessing landbird populations. Pp. 511-521 *in*: D.R. McCullough and R.H. Barrett (eds.), *Wildlife 2001: Populations*. Elsevier Applied Science, London, U.K.

DeSante, D.F. 1995. Suggestions for future directions for studies of marked migratory landbirds from the perspective of a practitioner in population management and conservation. *Journal Applied Statistics* 22:949-965.

DeSante, D.F. 2000. Patterns of productivity and survivorship from the MAPS Program. *In* Bonney, R., D.N. Pashley, R. Cooper, and L. Niles (eds.), Strategies for Bird Conservation: the Partners in Flight Planning Process. Proceedings RMRS-P-16. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

DeSante, D.F., K.M. Burton, J.F. Saracco, and B.L. Walker. 1995. Productivity indices and survival rate estimates from MAPS, a continent-wide programme of constant-effort mist netting in North America. *Journal Applied Statistics* 22:935-947.

DeSante, D.F., K.M. Burton, P. Velez, and D. Froehlich. 2004a. *MAPS Manual*. The Institute for Bird Populations, Point Reyes Station, CA. 49 pp.

DeSante, D.F., and T.L. George.1994. Population trends in the landbirds of western North America. Pp. 173-190 *in*: J.R. Jehl, Jr. and N.K. Johnson (eds.), A Century of Avifaunal Change in Western North America, *Studies in Avian Biology*, No. 15, (Cooper Ornithological Society).

DeSante, D.F., M.P. Nott, and D.R. O'Grady, D.R. 2001. Identifying the proximate demographic cause(s) of population change by modeling spatial variation in productivity, survivorship, and population trends. *Ardea* 89(special issue):185-207.

DeSante, D.F., D.R. O'Grady, and P. Pyle. 1999. Measures of productivity and survival derived from standardized mist-netting are consistent with observed population changes. *Bird Study* 46(suppl.):S178-188.

DeSante, D.F., Pyle, P., & Kaschube, D. (2004b) The 2003 report of the Monitoring Avian Productivity and Survivorship (MAPS) Program at Naval Security Group Activity (NSGA) Sugar Grove. Point Reyes Station, CA: The Institute for Bird Populations; 23 pp.

DeSante, D.F., and D.K. Rosenberg. 1998. What do we need to monitor in order to manage landbirds? Pp. 93-106 *in*: J. Marzluff and R. Sallabanks (eds.), *Avian Conservation: Research Needs and Effective Implementation*. Island Press, Washington, DC.

Finch, D.M., and P.W. Stangel. 1993. *Status and Management of Neotropical Migratory Birds*. USDA Forest Service, General Technical Report RM-229. 422 pp.

George, T.L., A.C. Fowler, R.L. Knight, and L.C. McEwen. 1992. Impacts of a severe drought on grassland birds in western North America. *Ecological Applications* 2:275-284.

Hines, J.E., Kendall, W.L., & Nichols, J.D. (2003) On the use of the robust design with transient capture-recapture models. Auk, 120, pp.1151-1158

Lebreton, J.-D., Burnham, K.P., Clobert, J., & Anderson, D.R. (1992) Modeling survival and testing biological hypotheses using marked animals: a unified approach with case studies, Ecological Monographs, 62, pp. 67-118.

Nott, M.P. 2000. Identifying management actions on DoD installations to reverse declines in Neotropical birds. Unpubl. report to the U.S. Department of Defense Legacy Resource Management Program. The Institute for Bird Populations, Point Reyes Station, CA 18 pp.

Nott, M.P. 2002. Climate, weather, and landscape effects on landbird survival and reproductive success in Texas. Unpublished report to the U.S. Department of Defense Legacy Resource Management Program, Adjutant Generals Department of Texas, and USGS/BRD Patuxent Wildlife Research Center. The Institute for Bird Populations, Point Reyes Station, CA. 29 pp.

Nott, M.P., & DeSante, D.F. (2002) Demographic monitoring and the identification of transients in mark-recapture models. Pp. 727-736 *in:* J.M. Scott, P. Heglund, et al. (eds.), Predicting Species Occurrences: Issues of Scale and Accuracy. Island Press, NY.

Nott, M.P., D.F. DeSante, R.B. Siegel, and P. Pyle. 2002. Influences of the El Niño/Southern Oscillation and the North Atlantic Oscillation on avian productivity in forests of the Pacific Northwest of North America. *Global Ecology and Biogeography* 11:333-342.

Nott, M.P., D.F. DeSante, and N. Michel. 2003a. Management strategies for reversing declines in landbirds of conservation concern on military installations: A landscape-scale analysis of MAPS data. The Institute for Bird Populations, Pt. Reyes Station, CA.

Nott, M.P., D.F. DeSante, and N. Michel. 2003b. *Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HSA) Protocol*. The Institute for Bird Populations, Point Reyes Station, CA. 43 pp.

Peach, W.J., S.T. Buckland, and S.R. Baillie. 1996. The use of constant effort mist-netting to measure between-year changes in the abundance and productivity of common passerines. *Bird Study* 43:142-156.

Peterjohn, B.G., J.R. Sauer, and C.S. Robbins. 1995. Population trends from the North American

Breeding Bird Survey. Pp. 3-39 *in*: T.E. Martin and D.M. Finch (eds.), *Ecology and Management of Neotropical Migratory Birds*. Oxford University Press, New York.

Pollock, K.H., Nichols, J.D., Brownie, C., & Hines, J.E. (1990) Statistical inference for capture-recapture experiments, Wildlife Monographs, No. 107.

Pradel, R., Hines, J., Lebreton, J.-D., & Nichols, J.D. (1997) Estimating survival probabilities and proportions of transients' using capture-recapture data. Biometrics, 53:60-72.

Robbins, C.S., J.R. Sauer, R.S. Greenberg, and S. Droege. 1989. Population declines in North American birds that migrate to the Neotropics. *Proceedings of the National Academy of Sciences (USA)* 86:7658-7662.

Stata Corporation (1995) Reference Manual, Release 4. Stata Press, College Station, TX. 1601.

Temple, S.A., and J.A. Wiens. 1989. Bird populations and environmental changes: can birds be bio-indicators? *American Birds* 43:260-270.

Terborgh, J. 1989. *Where Have All the Birds Gone?, Essays on the Biology and Conservation of Birds that Migrate to the American Tropics*. Princeton Univ Press, Princeton, NJ. 207 pp.

White, G.C. (1983) Numerical estimation of survival rates from band-recovery and biotelemetry data. J. Wildlife Management, 47, pp. 716-728.

Table 1. Summary of the 2004 MAPS program on Naval Security Group Activity Sugar Grove.

Station						2003 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of periods	Inclusive dates
South Fork Potomac River	SFPR	15627	Gentle slope, riparian corridor, mixed forest, hayfield edge	38˚34'44"N, -79˚16'13"W	536	461.8 (447.5)	8	5/19 - 7/30
Beaver Creek	BECR	15628	Steep slope, open mixed forest, grassland edge; no understory	38˚30'40"N, -79˚16'26"W	658	473.3 (309.5)	8	5/20 - 7/29
ALL STATIONS COMBINED						935.2 (757.0)	8	5/19 - 7/30

[1] Total net-hours in 2004. Net-hours in 2004 that could be compared in a constant-effort manner to 2003 are shown in parentheses.

Table 2. Capture summary for the two individual MAPS stations, and both stations pooled, operated on Naval Security Group Activity Sugar Grove in 2004. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	South Fork Potomac River			Beaver Creek			Both stations pooled		
Species	N	U	R	N	U	R	N	U	R
Ruby-throated Hummingbird		4			1			5	
Downy Woodpecker	1						1		
Great Crested Flycatcher				1			1		
White-eyed Vireo	1		6				1		6
Blue Jay		1		1			1	1	
Black-capped Chickadee	2			3		1	5		1
Tufted Titmouse	2		1	7			9		1
Carolina Wren	5	1	4				5	1	4
Wood Thrush	1						1		
American Robin	4						4		
Gray Catbird	15		2				15		2
Brown Thrasher	2	1					2	1	
Black-throated Blue Warbler				1			1		
Pine Warbler				1			1		
Black-and-white Warbler	3			4			7		
American Redstart	1						1		
Worm-eating Warbler	33	3	8	3			36	3	8
Ovenbird	13		2	3	1	3	16	1	5
Northern Waterthrush	2			1			3		
Louisiana Waterthrush	2		1	1			3		1
Mourning Warbler	1						1		
Common Yellowthroat	1						1		
Hooded Warbler	1						1		
Canada Warbler	1						1		
Scarlet Tanager				1			1		
Eastern Towhee			1						1
Song Sparrow	11	2	3				11	2	3
Northern Cardinal	4		1				4		1
Indigo Bunting	1		3	1			2		3
ALL SPECIES POOLED	107	12	32	28	2	4	135	14	36
Total Number of Captures		151			34			185	
Number of Species	22	6	11	13	2	2	27	7	12
Total Number of Species		25			14			29	

Table 3. Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the two individual MAPS stations, and both stations pooled, operated on Naval Security Group Activity Sugar Grove in 2004.

	South Fork Potomac River			Beaver Creek			Both stations pooled		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Downy Woodpecker	1.3	0.0	0.00				0.6	0.0	0.00
Great Crested Flycatcher				1.3	0.0	0.00	0.6	0.0	0.00
White-eyed Vireo	5.2	0.0	0.00				2.6	0.0	0.00
Blue Jay				1.3	0.0	0.00	0.6	0.0	0.00
Black-capped Chickadee	1.3	1.3	1.00	2.5	2.5	1.00	1.9	1.9	1.00
Tufted Titmouse	2.6	0.0	0.00	2.5	6.3	2.50	2.6	3.2	1.25
Carolina Wren	3.9	2.6	0.67				1.9	1.3	0.67
Wood Thrush	0.0	1.3	undf.[1]				0.0	0.6	undf.[1]
American Robin	0.0	5.2	undf.				0.0	2.6	undf.
Gray Catbird	13.0	7.8	0.60				6.4	3.9	0.60
Brown Thrasher	2.6	0.0	0.00				1.3	0.0	0.00
Black-throated Blue Warbler				0.0	1.3	undf.[1]	0.0	0.6	undf.
Pine Warbler				0.0	1.3	undf.	0.0	0.6	undf.
Black-and-white Warbler	1.3	2.6	2.00	0.0	5.1	undf.	0.6	3.9	6.00
American Redstart	0.0	1.3	undf.				0.0	0.6	undf.
Worm-eating Warbler	10.4	36.4	3.50	1.3	2.5	2.00	5.8	19.2	3.33
Ovenbird	3.9	13.0	3.33	2.5	1.3	0.50	3.2	7.1	2.20
Northern Waterthrush	2.6	0.0	0.00	1.3	0.0	0.00	1.9	0.0	0.00
Louisiana Waterthrush	0.0	2.6	undf.	0.0	1.3	undf.	0.0	1.9	undf.
Mourning Warbler	1.3	0.0	0.00				0.6	0.0	0.00
Common Yellowthroat	1.3	0.0	0.00				0.6	0.0	0.00
Hooded Warbler	1.3	0.0	0.00				0.6	0.0	0.00
Canada Warbler	0.0	1.3	undf.				0.0	0.6	undf.
Scarlet Tanager				1.3	0.0	0.00	0.6	0.0	0.00
Eastern Towhee	1.3	0.0	0.00				0.6	0.0	0.00
Song Sparrow	9.1	5.2	0.57				4.5	2.6	0.57
Northern Cardinal	5.2	1.3	0.25				2.6	0.6	0.25
Indigo Bunting	2.6	0.0	0.00	1.3	0.0	0.00	1.9	0.0	0.00
ALL SPECIES POOLED	70.2	81.8	1.17	15.2	21.5	1.42	42.3	51.3	1.21
Number of Species	18	13		9	8		21	16	
Total Number of Species		23			13			28	

[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 2003 and 2004 in the numbers of individual ADULT birds captured at two constant-effort MAPS stations on Naval Security Group Activity Sugar Grove.

				All six stations combined			
				Number of adults			
Species	S. Fork Potomac	Beaver Creek	n[1]	2003	2004	Percent change	SE[2]
Downy Woodpecker	0.0		1	1	1	0.0	
Great Crested Flycatcher		++++[3]	1	0	1	++++[3]	
White-eyed Vireo	0.0		1	4	4	0.0	
Red-eyed Vireo	-100.0		1	3	0	-100.0	
Blue Jay	-100.0	++++	2	2	1	-50.0	100.0
Black-capped Chickadee	0.0	++++	2	1	3	200.0	400.0
Tufted Titmouse	0.0	-100.0	2	4	2	-50.0	50.0
Carolina Wren	0.0		1	3	3	0.0	
Wood Thrush			0	0	0		
American Robin	-100.0		1	1	0	-100.0	
Gray Catbird	11.1		1	9	10	11.1	
Brown Thrasher	++++[3]		1	0	2	++++	
Cedar Waxwing	-100.0		1	2	0	-100.0	
Black-throated Blue Warbler			0	0	0		
Pine Warbler			0	0	0		
Black-and-white Warbler	0.0		1	1	1	0.0	
American Redstart	-100.0		1	3	0	-100.0	
Worm-eating Warbler	-42.9		1	14	8	-42.9	
Ovenbird	-40.0	100.0	2	6	5	-16.7	38.9
Northern Waterthrush	-33.3		1	3	2	-33.3	
Louisiana Waterthrush	-100.0		1	1	0	-100.0	
Mourning Warbler	++++		1	0	1	++++	
Common Yellowthroat	-50.0		1	2	1	-50.0	
Hooded Warbler	++++		1	0	1	++++	
Canada Warbler			0	0	0		
Scarlet Tanager		++++	1	0	1	++++	
Eastern Towhee	0.0		1	1	1	0.0	
Chipping Sparrow			0	0	0		
Song Sparrow	-14.3		1	7	6	-14.3	
Northern Cardinal	100.0		1	2	4	100.0	
Indigo Bunting	-80.0	-100.0	2	11	2	-81.8	3.3
Baltimore Oriole	-100.0		1	2	0	-100.0	
ALL SPECIES POOLED	-32.9	75.0	2	83	60	-27.7	9.9

Table 4. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual ADULT birds captured at two constant-effort MAPS stations on Naval Security Group Activity Sugar Grove.

Species	S. Fork Potomac	Beaver Creek	All six stations combined
No. species that increased4	5(3)	5(4)	8(5)
No. species that decreased5	13(7)	2(2)	14(6)
No. species remained same	7	0	5
Total Number of Species	25	7	27
Proportion of increasing (decreasing) species	(0.520)	0.714	(0.519)
Sig. of increase (decrease)[6]	(0.500)	0.227	(0.500)

[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 2003.
[4] No. of species for which adults were captured in 2004 but not in 2003 are in parentheses.
[5] No. of species for which adults were captured in 2003 but not in 2004 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 2003 and 2004 in the numbers of individual YOUNG birds captured at two constant-effort MAPS stations on Naval Security Group Activity Sugar Grove.

				All six stations combined			
				Number of young			
Species	S. Fork Potomac	Beaver Creek	n[1]	2003	2004	Percent change	SE[2]
Downy Woodpecker	-100.0		1	1	0	-100.0	
Great Crested Flycatcher			0	0	0		
White-eyed Vireo	-100.0		1	2	0	-100.0	
Red-eyed Vireo			0	0	0		
Blue Jay			0	0	0		
Black-capped Chickadee	0.0	-33.3	2	4	3	-25.0	12.5
Tufted Titmouse	-100.0	400.0	2	5	5	0.0	160.0
Carolina Wren	-66.7	-100.0	2	7	2	-71.4	8.2
Wood Thrush	++++[3]		1	0	1	++++[3]	
American Robin	300.0		1	1	4	300.0	
Gray Catbird	100.0		1	3	6	100.0	
Brown Thrasher	-100.0		1	3	0	-100.0	
Cedar Waxwing			0	0	0		
Black-throated Blue Warbler		++++[3]	1	0	1	++++	
Pine Warbler		++++	1	0	1	++++	
Black-and-white Warbler	0.0	++++	2	2	5	150.0	300.0
American Redstart	++++		1	0	1	++++	
Worm-eating Warbler	-3.4	++++	2	29	30	3.4	13.8
Ovenbird	42.9	0.0	2	8	11	37.5	9.4
Northern Waterthrush			0	0	0		
Louisiana Waterthrush	100.0	++++	2	1	3	200.0	200.0
Mourning Warbler			0	0	0		
Common Yellowthroat			0	0	0		
Hooded Warbler			0	0	0		
Canada Warbler	0.0		1	1	1	0.0	
Scarlet Tanager	-100.0		1	1	0	-100.0	
Eastern Towhee	-100.0		1	1	0	-100.0	
Chipping Sparrow		-100.0	1	5	0	-100.0	
Song Sparrow	-42.9		1	7	4	-42.9	
Northern Cardinal	-50.0		1	2	1	-50.0	
Indigo Bunting	-100.0		1	3	0	-100.0	
Baltimore Oriole			0	0	0		
ALL SPECIES POOLED	-16.0	45.5	2	86	79	-8.1	13.7

Table 5. (cont.) Percentage changes between 2003 and 2004 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on Naval Security Group Activity Sugar Grove.

Species	S. Fork Potomac	Beaver Creek	All six stations combined
No. species that increased[4]	6(2)	6(5)	10(4)
No. species that decreased[5]	11(7)	3(2)	11(7)
No. species remained same	3	1	2
Total Number of Species	20	10	23
Proportion of increasing (decreasing) species	(0.550)	0.600	(0.478)
Sig. of increase (decrease)[6]	(0.412)	0.377	(0.661)

[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 2003.
[4] No. of species for which young birds were captured in 2004 but not in 2003 are in parentheses.
[5] No. of species for which young birds were captured in 2003 but not in 2004 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. Absolute changes between 2003 and 2004 in the REPRODUCTIVE INDEX (young/adult) at two constant-effort MAPS stations on Naval Security Group Activity Sugar Grove.

				All six stations combined			
				Reproductive Index			
Species	S. Fork Potomac	Beaver Creek	n[1]	2003	2004	Change	SE[2]
Downy Woodpecker	-1.000		1	1.000	0.000	-1.000	
Great Crested Flycatcher		+-+-+[3]	1	undf.[4]	0.000	+-+-+[3]	
White-eyed Vireo	-0.500		1	0.500	0.000	-0.500	
Red-eyed Vireo	+-+-+[3]		1	0.000	undf.[4]	+-+-+	
Blue Jay	+-+-+	+-+-+	2	0.000	0.000	0.000	0.000
Black-capped Chickadee	0.000	+-+-+	2	4.000	1.000	-3.000	6.000
Tufted Titmouse	-2.000	+-+-+	2	1.250	2.500	1.250	5.056
Carolina Wren	-1.333	+-+-+	2	2.333	0.667	-1.667	
Wood Thrush	+-+-+		1	undf.	undf.	+-+-+	
American Robin	+-+-+		1	1.000	undf.	+-+-+	
Gray Catbird	0.267		1	0.333	0.600	0.267	
Brown Thrasher	+-+-+		1	undf.	0.000	+-+-+	
Cedar Waxwing	+-+-+		1	0.000	undf.	+-+-+	
Black-throated Blue Warbler		+-+-+	1	undf.	undf.	+-+-+	
Pine Warbler		+-+-+	1	undf.	undf.	+-+-+	
Black-and-white Warbler	0.000	+-+-+	2	2.000	5.000	3.000	6.000
American Redstart	+-+-+		1	0.000	undf.	+-+-+	
Worm-eating Warbler	1.429	+-+-+	2	2.071	3.750	1.679	0.500
Ovenbird	1.933	-0.500	2	1.333	2.200	0.867	1.365
Northern Waterthrush	0.000		1	0.000	0.000	0.000	
Louisiana Waterthrush	+-+-+	+-+-+	2	1.000	undf.	+-+-+	
Mourning Warbler	+-+-+		1	undf.	0.000	+-+-+	
Common Yellowthroat	0.000		1	0.000	0.000	0.000	
Hooded Warbler	+-+-+		1	undf.	0.000	+-+-+	
Canada Warbler	+-+-+		1	undf.	undf.	+-+-+	
Scarlet Tanager	+-+-+	+-+-+	2	undf.	0.000	+-+-+	
Eastern Towhee	-1.000		1	1.000	0.000	-1.000	
Chipping Sparrow		+-+-+	1	undf.	undf.	+-+-+	
Song Sparrow	-0.333		1	1.000	0.667	-0.333	
Northern Cardinal	-0.750		1	1.000	0.250	-0.750	
Indigo Bunting	-0.300	+-+-+	2	0.273	0.000	-0.273	0.050
Baltimore Oriole	+-+-+		1	0.000	undf.	+-+-+	
ALL SPECIES POOLED	0.239	-0.464	2	1.036	1.317	0.281	0.280

Table 6. Absolute changes between 2003 and 2004 in the REPRODUCTIVE INDEX (young/adult) at two constant-effort MAPS stations on Naval Security Group Activity Sugar Grove.

Species	S. Fork Potomac	Beaver Creek	All six stations combined
No. species that increased	3	0	5
No. species that decreased	8	1	8
No. species remained same	4	0	3
Total Number of Species5	15	1	16
Proportion of increasing (decreasing) species	0.200	n/a	0.313
Sig. of increase (decrease)[6]	0.996	n/a	0.962

[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.
*** $P < 0.01$; ** $0.01 \le P < 0.05$; * $0.05 \le P < 0.10$

Table 7. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the two individual MAPS stations operated on Naval Security Group Activity Sugar Grove averaged over the four years, 2001-2004. Data for each species are included only from stations that lie within the breeding range of the species.

	South Fork Potomac River			Beaver Creek			Both Stations Pooled		
Species	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]
Yellow-billed Cuckoo				0.4	0.0	0.00	0.2	0.0	0.00
Downy Woodpecker	0.6	1.0	0.50				0.3	0.5	0.50
Hairy Woodpecker	0.0	0.4	undf.[3]	0.4	0.0	0.00	0.2	0.2	1.00
Eastern Phoebe	1.1	0.0	0.00				0.6	0.0	0.00
Great Crested Flycatcher	0.4	0.0	0.00	0.3	0.0	0.00	0.4	0.0	0.00
White-eyed Vireo	4.8	1.0	0.19				2.5	0.6	0.19
Red-eyed Vireo	1.7	0.0	0.00	0.0	0.4	undf.[3]	0.9	0.2	0.33
Blue Jay	1.1	0.0	0.00	0.3	0.4	0.00	0.7	0.2	0.33
Carolina Chickadee				0.0	0.8	undf.	0.0	0.4	undf.[3]
Black-capped Chickadee	1.8	0.6	0.50	1.8	2.7	0.67	1.8	1.6	1.38
Tufted Titmouse	2.1	2.8	1.50	2.7	6.0	2.13	2.3	4.5	1.92
White-breasted Nuthatch				0.0	0.4	undf.	0.0	0.2	undf.
Carolina Wren	8.2	8.0	1.11	0.0	0.9	undf.	4.2	4.6	1.22
House Wren	0.0	0.4	undf.				0.0	0.2	undf.
Blue-gray Gnatcatcher				0.4	0.0	0.00	0.2	0.0	0.00
Wood Thrush	0.0	0.3	undf.				0.0	0.2	undf.
American Robin	0.7	1.6	0.50	0.4	0.0	0.00	0.6	0.8	0.33
Gray Catbird	14.1	4.7	0.33				7.3	2.4	0.33
Brown Thrasher	1.5	2.1	0.25				0.7	1.1	0.25
Cedar Waxwing	0.6	0.0	0.00				0.4	0.0	0.00
Northern Parula				0.4	0.0	0.00	0.2	0.0	0.00
Yellow Warbler	0.4	0.0	0.00				0.2	0.0	0.00
Black-throated Blue Warbler				0.0	0.3	undf.	0.0	0.2	undf.
Black-throated Green Warbler	0.0	0.4	undf.				0.0	0.2	undf.
Pine Warbler				0.0	0.3	undf.	0.0	0.2	undf.
Black-and-white Warbler	2.5	2.0	1.17	0.0	1.3	undf.	1.3	1.7	2.17
American Redstart	1.3	0.7	0.50				0.7	0.3	0.50
Worm-eating Warbler	13.7	42.6	3.33	3.9	1.0	0.75	9.1	22.6	2.66
Ovenbird	8.1	12.0	2.16	1.5	2.0	1.50	4.9	7.2	1.89
Northern Waterthrush	2.0	0.0	0.00	0.3	0.0	0.00	1.2	0.0	0.00
Louisiana Waterthrush	1.5	1.4	0.50	0.4	0.7	0.00	1.0	1.1	0.67
Mourning Warbler	0.3	0.0	0.00				0.2	0.0	0.00
Common Yellowthroat	1.0	0.0	0.00				0.5	0.0	0.00
Hooded Warbler	0.3	0.0	0.00				0.2	0.0	0.00
Canada Warbler	0.0	1.0	undf.				0.0	0.5	undf.
Scarlet Tanager	0.4	0.3	0.00	0.7	0.0	0.00	0.5	0.2	0.00

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the two individual MAPS stations operated on Naval Security Group Activity Sugar Grove averaged over the four years, 2001-2004. Data for each species are included only from stations that lie within the breeding range of the species.

	South Fork Potomac River			Beaver Creek			Both Stations Pooled		
Species	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]
Eastern Towhee	2.1	0.3	0.33				1.1	0.2	0.33
Chipping Sparrow				0.8	2.5	0.50	0.4	1.1	0.50
Song Sparrow	10.6	6.3	0.65				5.5	3.3	0.65
Northern Cardinal	6.0	1.7	0.38				3.1	0.9	0.38
Indigo Bunting	9.4	2.2	0.15	3.7	1.1	0.11	6.8	1.7	0.20
Common Grackle	0.8	0.0	0.00				0.4	0.0	0.00
Baltimore Oriole	1.1	0.0	0.00				0.6	0.0	0.00
American Goldfinch				0.4	0.0	0.00	0.2	0.0	0.00
ALL SPECIES POOLED	100.2	93.8	0.97	18.7	20.9	1.31	61.4	59.0	0.99
Number of Species	30	23		17	15		36	30	
Total Number of Species		35			24			44	

[1] Years for which the reproductive index was undefined (no adult birds were captured in the year) are not included in the mean reproductive index.
[2] For numbers presented in italics, the mean number of adults or young is greater than 0.1 at one or more stations, but over the entire location the mean number is less than 0.05. The species is counted in the number of species over all stations pooled.
[3] 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 three species breeding at MAPS stations on Naval Security Group Activity Sugar Grove obtained from four years (2001-2004) 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]
Worm-eating Warbler ‡	2	44	54	5	0.776 (0.417)	53.8	0.194 (0.200)	0.492 0.472
Song Sparrow †‡	1	26	46	4	0.474 (0.311)	65.5	0.289 (0.296)	1.000 0.989
Indigo Bunting †‡	2	32	50	4	0.447 (0.337)	75.5	0.214 (0.245)	1.000 1.003

[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).

‡ 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(ϕ)>0.200 or CV(ϕ)>50.0%).
† The estimate for survival probability, recapture probability, or both may be biased low because the estimate for τ was 1.000.

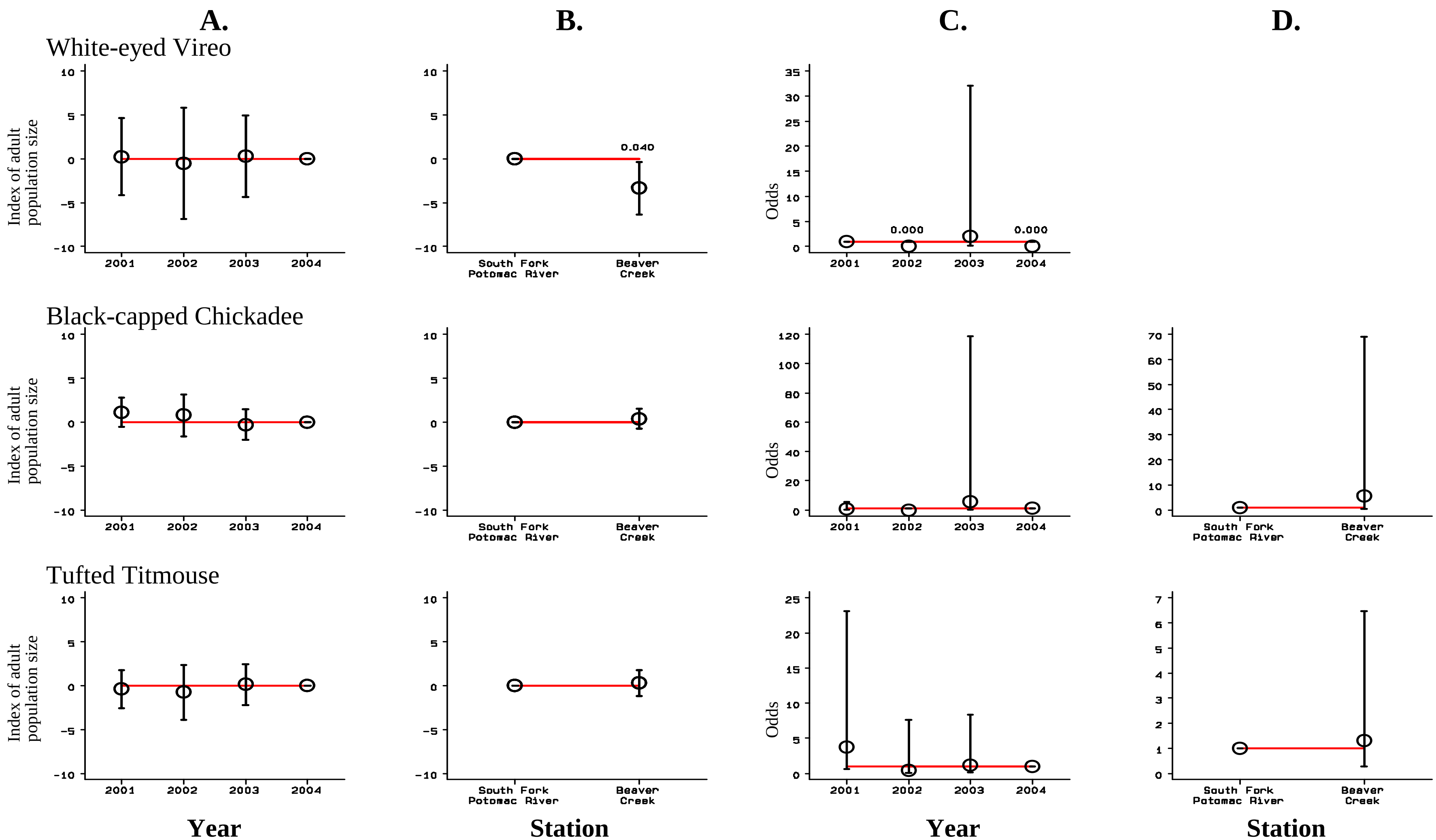

Figure 1. Relative mean numbers of adults (A,B) and odds ratios for productivity indices (C,D) with 95% confidence intervals for 11 target species and all species pooled captured at two stations on Naval Security Group Activity Sugar Grove. Relative mean numbers of adults were estimated using multivariate ANOVA and the odds ratio for each design variable was estimated using multivariate logistic regression, thus controlling for the other variable while calculating the differences in the target variable. The variables included were year (A,C) and station (B,D) and the ANOVAs also controlled for effort (net-hours). For each variable, the estimates were compared to a reference point (lacking a 95% confidence interval and equivalent to the reference line), and the reference point and a reference line are plotted for ease of comparison. *P*-values are indicated for significant and near-significant comparisons.

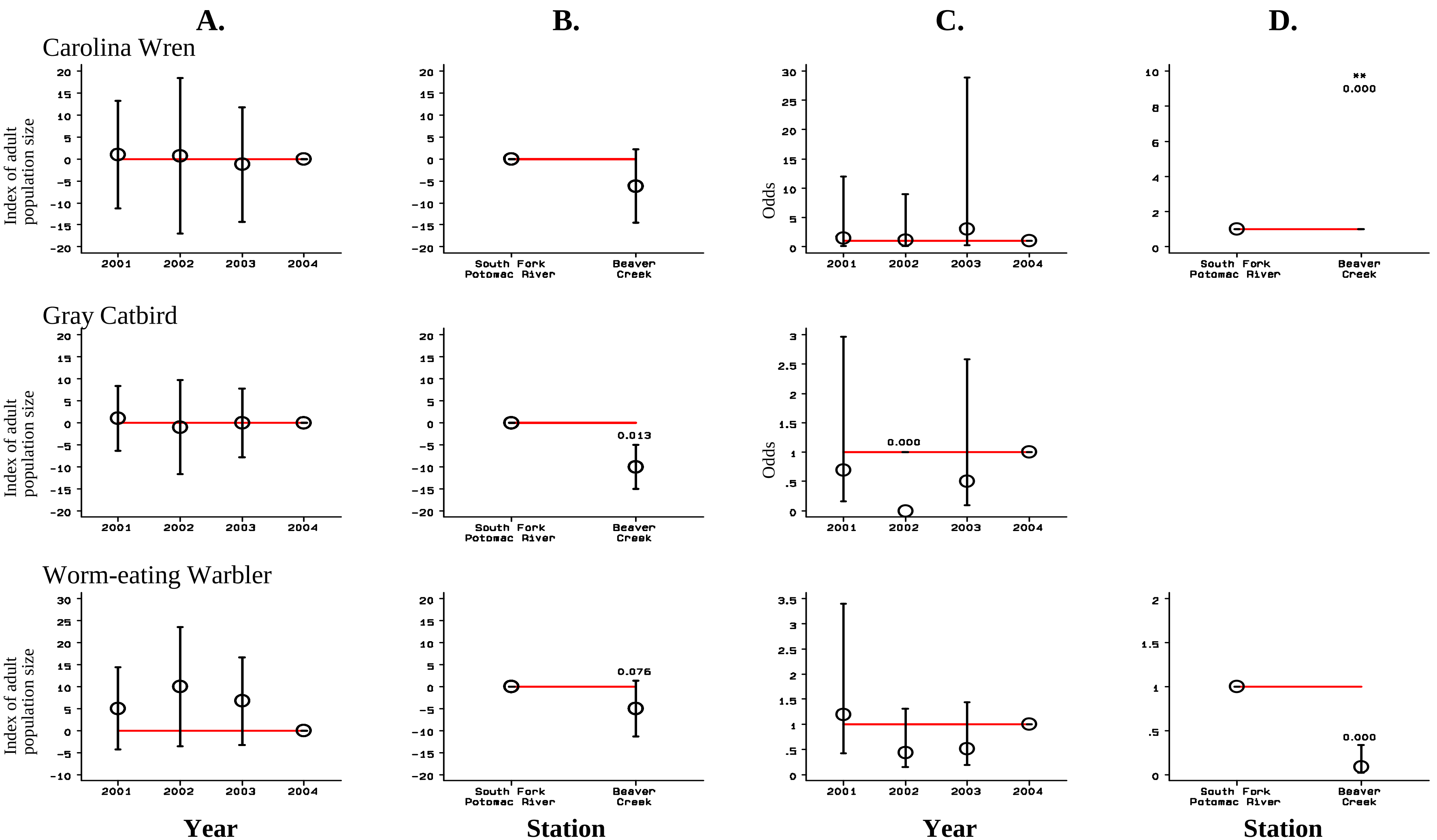

Figure 1. (cont.) Relative mean numbers of adults (A,B) and odds ratios for productivity indices (C,D) with 95% confidence intervals for 11 target species and all species pooled captured at two stations on Naval Security Group Activity Sugar Grove. Relative mean numbers of adults were estimated using multivariate ANOVA and the odds ratio for each design variable was estimated using multivariate logistic regression, thus controlling for the other variable while calculating the differences in the target variable. The variables included were year (A,C) and station (B,D) and the ANOVAs also controlled for effort (net-hours). For each variable, the estimates were compared to a reference point (lacking a 95% confidence interval and equivalent to the reference line), and the reference point and a reference line are plotted for ease of comparison. *P*-values are indicated for significant and near-significant comparisons.

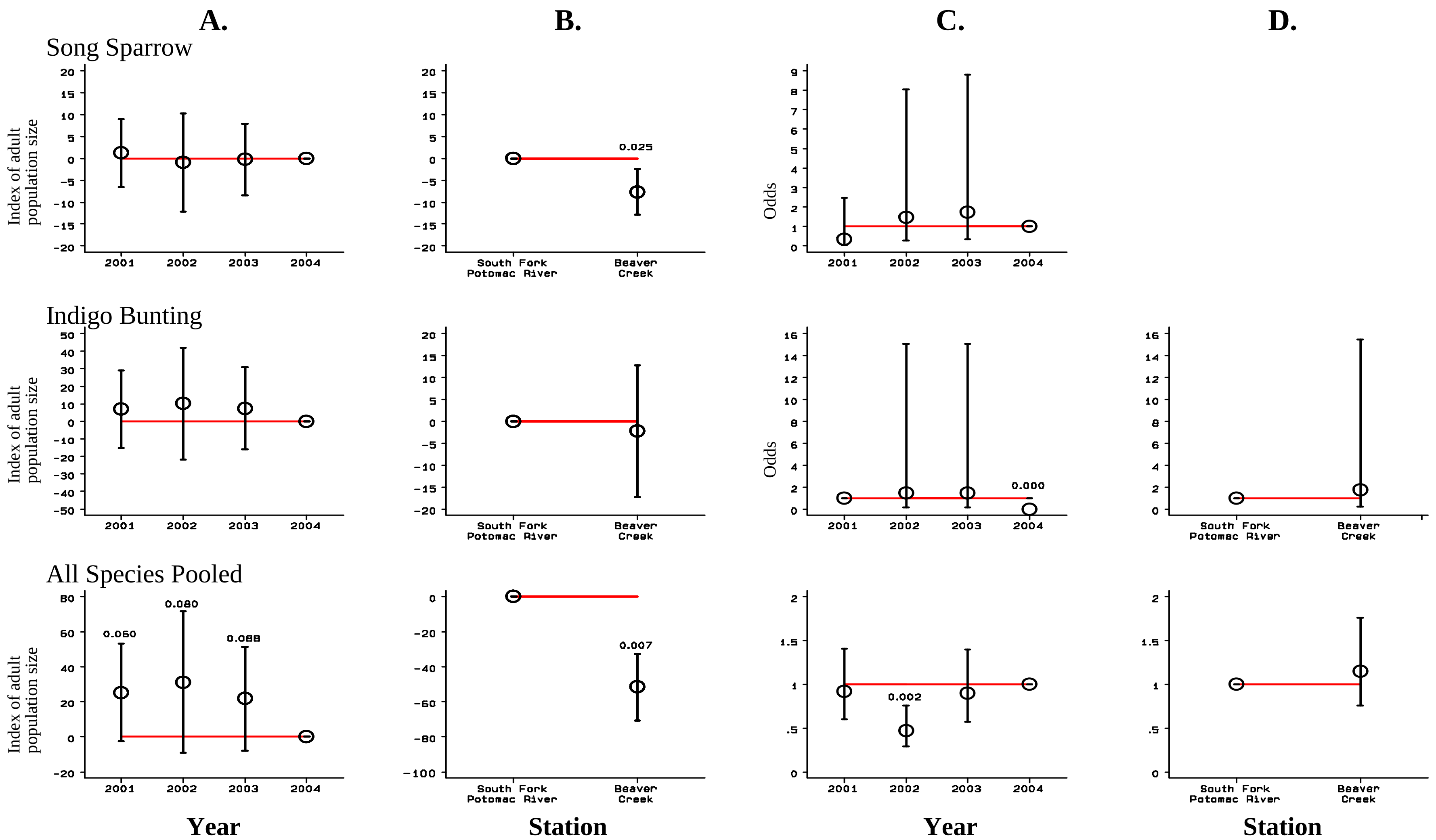

Figure 1. (cont.) Relative mean numbers of adults (A,B) and odds ratios for productivity indices (C,D) with 95% confidence intervals for 11 target species and all species pooled captured at two stations on Naval Security Group Activity Sugar Grove. Relative mean numbers of adults were estimated using multivariate ANOVA and the odds ratio for each design variable was estimated using multivariate logistic regression, thus controlling for the other variable while calculating the differences in the target variable. The variables included were year (A,C) and station (B,D) and the ANOVAs also controlled for effort (net-hours). For each variable, the estimates were compared to a reference point (lacking a 95% confidence interval and equivalent to the reference line), and the reference point and a reference line are plotted for ease of comparison. *P*-values are indicated for significant and near-significant comparisons.

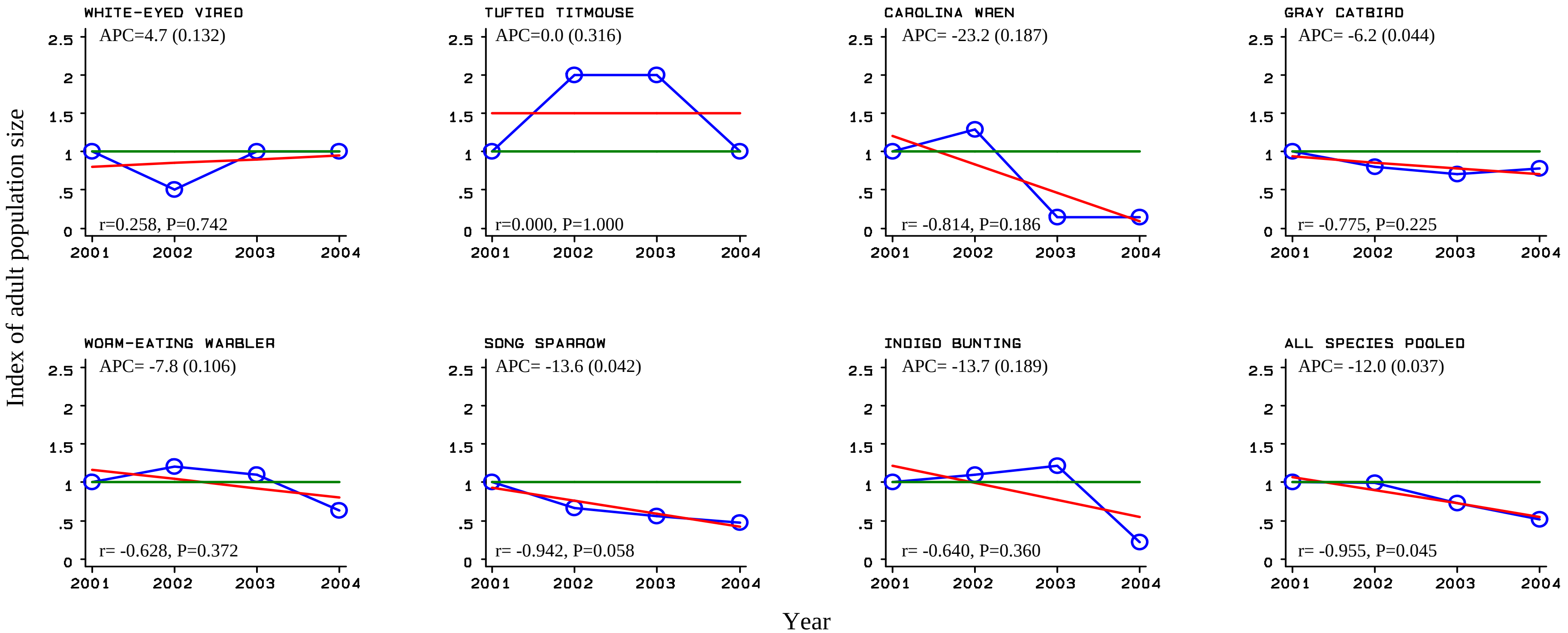

Figure 2. Population trends for seven species and all species pooled on Naval Security Group Activity Sugar Grove over the four years 2001-2004. The index of population size was arbitrarily defined as 1.0 in 2001. Indices for subsequent years were determined from constant-effort between-year changes 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.

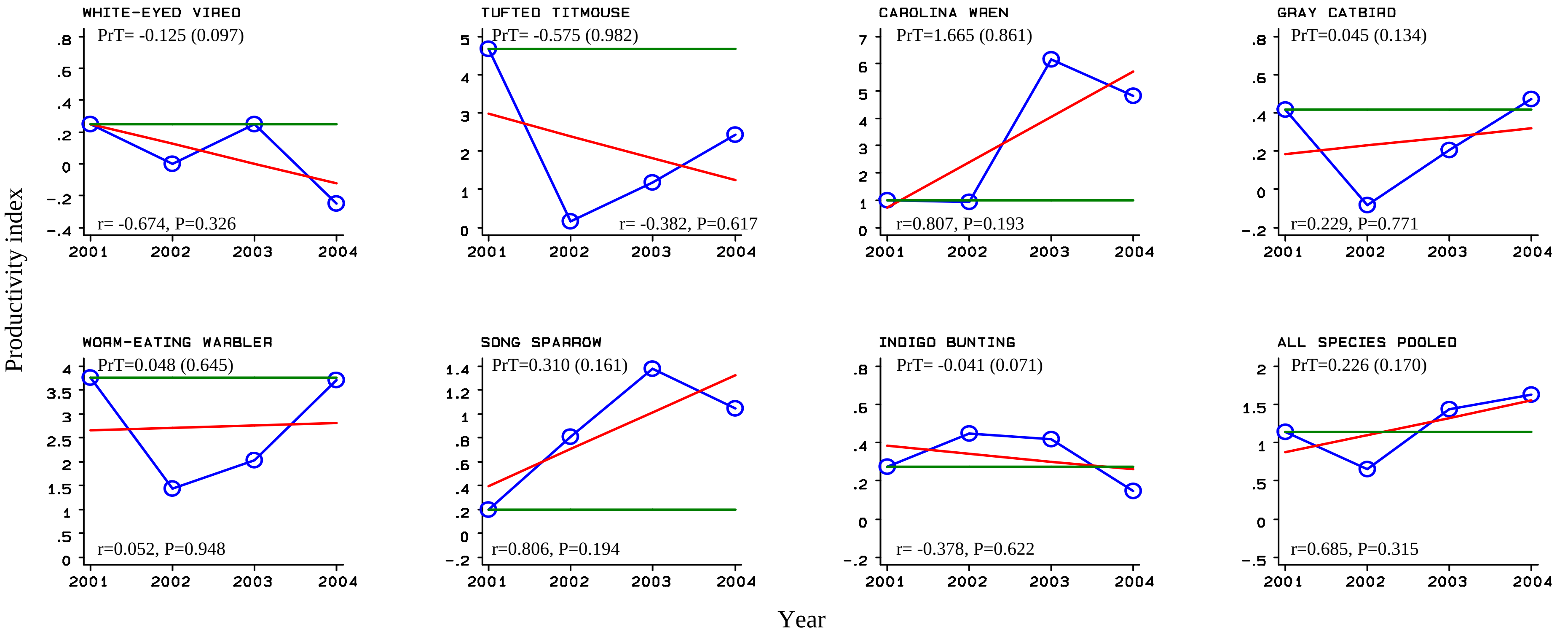

Figure 3. Trend in productivity for seven species and all species pooled on Naval Security Group Activity Sugar Grove over the four years 2001-2004. The productivity index was defined as the actual productivity value in 2001. Indices for subsequent years were determined from constant-effort between-year 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.