THE 2001 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM AT NAVAL SECURITY GROUP ACTIVITY (NSGA) SUGAR GROVE

David F. DeSante, Sara Martin, and Danielle O'Grady

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

(415) 663-1436

ddesante@birdpop.org

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EXECUTIVE SUMMARY

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) Program, a cooperative effort among public and private agencies and individual bird banders in North America, to operate a continent-wide network of constant-effort mist-netting and banding stations. The purpose of the MAPS program is to provide annual indices of adult population size and post-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. The system of military installations in the United States may provide one group of ideal locations for this large-scale, long-term biomonitoring because they provide large 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 established and operated two MAPS stations at Navy Security Group Activity Sugar Grove in 2001, the South Fork Potomac River station in bottomland riparian/mixed forest habitat, and the Beaver Creek station in ridgetop/open forest habitat. With few exceptions, the ten net sites per station were operated for six morning hours per day on one day per 10-day period for seven consecutive 10-day periods between June 4 and August 7.

A total of 206 individual birds of 29 species was banded at the two stations during the summer of 2001, various individuals of these species were recaptured a total of 59 times, and 15 birds (mostly hummingbirds which we are not permitted to band) were captured and released unbanded. Thus, a total of 280 captures of 30 species was recorded. The greatest number of captures was recorded at the South Fork Potomac River station (231 captures of 26 species), while the Beaver Creek station had 49 captures of 13 species.

The index of adult population size for all species pooled in 2001 at the South Fork Potomac River station was 105.9 birds per 600 net hours, more than 3.5 times as high as that at the Beaver Creek station (30.5 birds per 600 net hours), and similar to that for six stations in Shenandoah National Park (2001 mean 100.2 birds per 600 net hours). Species richness of adults at the South Fork Potomac River station (18 species) was nearly twice as high as the Beaver Creek station (10 species), and was also similar to the six Shenandoah stations (2001 mean 18.8 species). Finally, productivity indices in

2001 at both the South Fork Potomac River and Beaver Creek stations (0.54 and 0.49, respectively) were quite high for stations in eastern North America, and averaged substantially higher than that for the six stations in Shenandoah National Park (2001 mean 0.38). This suggests that habitat quality in the landscape at NSGA Sugar Grove is very good.

Species composition differed dramatically between the two stations at NSGA Sugar Grove; only two of the nine species with the highest adult population size indices at South Fork Potomac River, Worm-eating Warbler and Indigo Bunting, were captured *at all* at Beaver Creek. The high indices of adult population size and very high overall productivity index for Worm-eating Warbler at NSGA Sugar Grove are noteworthy, as this is generally a relatively uncommon species everywhere in its range. In contrast to most species, Indigo Bunting showed higher adult population size and productivity indices at the Beaver Creek station.

The higher species richness, larger adult population size index, and somewhat higher productivity index at the South Fork Potomac River station than at the Beaver Creek station suggest that the habitat at the South Fork Potomac River station can support a larger, more varied, and more productive adult breeding population than the habitat at the Beaver Creek Station. This may be a result of higher habitat diversity and a denser more diverse understory at the South Fork Potomac River station, as compared to the Beaver Creek station.

As more years of data accumulate, we will be able to examine 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 examine trends in breeding population size and productivity and make inferences about the long-term prospects of the various species. And we will be able to examine annual survival-rate estimates, capture probabilities, and proportion of residents in order to make inferences regarding the effect of survivorship on population dynamics. Examining the variation over time of population size indices, productivity indices, and survival-rate estimates, furthermore, will allow the installation personnel to determine what effect their management actions, or lack thereof, have on the population dynamics of the birds species breeding on NSGA Sugar Grove.

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 other central Appalachian 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 factor (i.e., productivity or survivorship) causing observed population trends; (c) link MAPS data with landscape-level habitat data and spatially explicit weather data in a geographical information system (GIS); (d) identify relationships between landscape-level habitat and/or weather characteristics and the primary demographic responses (productivity and survival rates) of target species; (e) generate hypotheses regarding the ultimate environmental causes of the population trends; and (f) make comprehensive recommendations for habitat and use-related management goals both at the installation and central Appalachian scale.

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 a region-wide basis (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. Based on the above information, 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 the natural resources on military installations and to monitor 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 can 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, may be 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, appear to be 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 defined its role in the program to include the establishment of 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 thirteenth year (tenth year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to over 500 stations in 2001. 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 tiers of goals and objectives: monitoring, research, and management.

? The specific monitoring goals of MAPS are to provide, for over 100 target species, including many 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, recruitment into the adult population, and population growth rates from modified Cormack-Jolly-Seber (CJS) analyses of mark-recapture data on adult birds.

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? The specific research goals of MAPS are to identify and describe:

(1) 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

(2) 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.

Both long-term objectives are in agreement with the Department of Defense’s avian monitoring program. 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.

SPECIFICS OF THE NSGA SUGAR GROVE MAPS PROGRAM

Two MAPS stations were established and operated in NSGA Sugar Grove in 2001. The sites for these stations were selected on April 27, 2001 by Jack Markham (Horticulturalist/Urban Forester, Atlantic Division, Naval Facilities Engineering Command) and Steve Niethamer (Environmental Programs Manager at NSGA Sugar Grove), with the assistance of MAPS field biologists, Amy McAndrews and Amy Finfera. The stations were then established and set-up by the two field biologists with the help of field biologist interns, Jorge Montego and Devin Taylor, on April 28 and 29. 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 2001 operation of the 2001 NSGA Sugar Grove MAPS stations.

The NSGA Sugar Grove stations were operated in 2001 by MAPS field biologist interns, Jorge Montego and Devin Taylor, who were also responsible for operating the six MAPS stations in Shenandoah National Park. Jorge and Devin received two weeks of intensive training in a comprehensive course in mist netting and bird-banding techniques given by IBP biologists Amy McAndrews and Amy Finfera, which took place May 1-14 at the Jug Bay Wetlands Sanctuary in southern Maryland. The interns then received two weeks of further training setting-up and operating actual MAPS stations at Indian Head Naval Weapons Support Center, Maryland, Dahlgren Naval Surface Warfare Center, Fort Belvoir, and Shenandoah National Park, all in Virginia. The interns began operation of the NSGA Sugar Grove stations on June 4, and received one-third-time supervision by Amy McAndrews for the duration of the field season.

All ten net sites at each station were established without difficulty. However, two net sites at the Beaver Creek station were moved after Period 5 (June 10-19) to better facilitate captures. One 12-m, 30-mm-mesh, 4-tier, nylon mist net was erected at each of the ten net sites on each day of operation. Each station was operated for six morning hours per day (beginning at local sunrise) on one day in each of seven consecutive 10-day periods between Period 4 (May 31- June 9) and Period 10 (July 30 - Aug. 8). With very few exceptions, the operation of all stations occurred on schedule during each of the seven 10-day periods.

METHODS

The operation of each of the two stations during 2001 followed MAPS protocol, as established for use by the MAPS Program throughout North America and spelled out in the MAPS Manual (DeSante et al. 2001). 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 if situations arose where bird safety would be comprised. Such situations could involve exceptionally large numbers of birds being captured at once, or the sudden onset of adverse weather conditions such as high winds or heavy rainfall. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms (DeSante et al. 2001):

(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., presence or absence of a 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) fat class;
(12) wing chord and weight;
(13) date and time of capture (net-run time); and
(14) station and net site where captured.

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 2001).

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 summary of mist netting effort 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), and extent of body and flight-feather molt, primary-feather wear, and juvenal plumage for each record;
(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, weight, station of capture, date, 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. At NSGA Sugar Grove, the status codes 'U' and 'O' were not used since the stations have only been in operation for one year. 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 Tables 2 and 4.

A. Population-Size and Productivity Analyses — The proofed, verified, and corrected banding data from 2001 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 2001) of individual adult and young birds; and
(3) the proportion of young in the catch.

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, while the proportion of young in the catch was used as an index of post-fledging productivity.

When two or more years of data are available for each station, we will calculate percent changes between the two years in the numbers of adult and young birds captured and actual changes in the proportion of young in the catch (productivity). We will determine the statistical significance of the changes that occurred according to methods pioneered by the BTO in their CES scheme (Peach et al. 1996). These year-to-year comparisons will be made in a "constant-effort" manner by means of a specially-designed analysis program that will use 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 and given period in one year during the time when that net was not operated in that period in the other year. For species captured at several stations, the significance of region-wide annual changes in the indices of adult population size and post-fledging productivity will be inferred statistically using confidence intervals derived from the standard errors of the mean percentage changes. The statistical significance of the overall change at a given station will be inferred from a one-sided binomial test on the proportion of species at that station that increased or decreased.

B. Analyses of Trends in Adult Population Size and Productivity — When three or more years of data have been collected we will be able to calculate "chain indices" for adult population size and productivity based on the corresponding constant-effort year-to-year changes. We will then use the slope of the regression line of these chain indices as a measure of the population trend and trend in productivity for each study species.

C. Survivorship Analyses — When three years of data have been collected, we will be able to estimate survival and capture probability using standard Cormack-Jolly Seber (CJS) mark-recapture models. The survival estimates obtained from standard CJS models are biased low by the presence of transient (non-resident) individuals in the sample of captured birds. When four or more consecutive years of data have been collected, we will be able to use both within- and between-year transient models in modified CJS mark-recapture analyses to produce unbiased estimates of adult survival rates and estimates of the proportion of residents among newly captured adults. With four or more years of data, we will also be able to begin to examine time-dependence in survival- and recapture-rate estimates and estimates of the proportion of residents.

RESULTS

A total of 831.0 net-hours was accumulated at the two MAPS stations operated at NSGA Sugar Grove in 2001 (Table 1).

The 2001 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. The greatest number of total captures, 231, was recorded at the South Fork Potomac River station, while Beaver Creek produced only 49 captures. The South Fork Potomac River station also had the highest species richness with 26 species, while Beaver Creek had only 13 species. The most abundantly captured species (with over ten captures recorded) at South Fork Potomac River were, in order of abundance: Worm-eating Warbler, Gray Catbird, Song Sparrow, Carolina Wren, Ovenbird, Northern Cardinal, and White-eyed Vireo. For only two species, Tufted Titmouse and Indigo Bunting, were there more than ten captures at Beaver Creek.

In order to standardize the number of captures with respect to variability of mist-netting effort expended at the two stations (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 the percentage of young in the catch, 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 2001 was over three times as high at South Fork Potomac River as at Beaver Creek. Captures of young of all species pooled at South Fork Potomac River in 2001 was over four times as high as at Beaver Creek. The index of productivity, as determined by the percentage of young in the catch, although somewhat similar between the two stations, was also higher at South Fork Potomac River (0.54) than at Beaver Creek (0.49).

The following is a list of the common breeding species (captured at a rate of at least 6.0 adults per 600 net-hours), in decreasing order, at each station in 2001 (see Table 3):

South Fork Potomac Branch	Beaver Creek
Gray Catbird	Indigo Bunting
Song Sparrow	
Worm-Eating Warbler	
Northern Cardinal	
Carolina Wren	

Table 4 summarizes the banding results at both of the 2001 NSGA Sugar Grove MAPS stations combined. Altogether, a total of 280 captures of 30 species was recorded during the 2001 breeding season. Newly-banded birds comprised 73.6% of the total captures. Overall, Worm-Eating Warbler was by far the most frequently captured, followed by Gray Catbird, Song Sparrow, Carolina Wren, Ovenbird, Tufted Titmouse, and Indigo Bunting. The six most abundant breeding species at the two NSGA Sugar Grove MAPS stations in 2001 (as determined by adults captured per 600 net-hours), in decreasing order, were Gray Catbird, Worm-Eating Warbler, Indigo Bunting, Song Sparrow, Northern Cardinal, and Carolina Wren.

DISCUSSION

Despite the fact that the NSGA Sugar Grove MAPS stations have been run for only one year, important data have been gathered on breeding populations and productivity for many summer resident landbirds at the installation. Data from each of the MAPS stations on NSGA Sugar Grove can be compared and data from both stations can be pooled to provide installation-wide indices of breeding population size and productivity. As more years of data accumulate we will be able to examine 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 examine trends in breeding population size and productivity and make inferences about the long-term prospects of the various species. And we will be able to examine annual survival-rate estimates, capture probabilities, and proportion of residents in order to make inferences regarding the effect of survivorship on population dynamics. Pooling data at this level will also allow comparison between NSGA Sugar Grove and other regional stations that may participate in the MAPS program in the future, as well as comparisons between NSGA Sugar Grove and other unprotected areas 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.

Although statistical comparison of breeding populations between stations and among species could not be performed at this time (due to the single year of data from only two stations), we can get some sense of habitat relationships among breeding birds based on adult capture rates in the two habitat types. The species richness of adults at the South Fork Potomac River station (18), located in bottomland riparian/mixed forest habitat, was nearly twice that at the Beaver Creek station (10), located in ridgetop/open forest habitat. Moreover, the capture rate of adults at the bottomland riparian/mixed forest station (105.9 birds per 600 net hours) was nearly 3.5 times higher than the capture rate of adults at the ridgetop/open forest station (30.6 birds per 600 net hours), suggesting that the bottomland riparian/mixed forest habitat can support substantially larger breeding populations than the ridgetop/open forest habitat. Furthermore, the proportion of birds recaptured at the bottomland riparian/mixed forest habitat (0.333) was much greater than at the ridgetop/open forest habitat (0.098), suggesting that a greater proportion of adults at the ridgetop station were transients rather than actual breeders. Confirmation of this hypothesis, however, must await four years of data when we will actually be able to formally estimate both recapture probability and proportion of residents among newly captured adults from mark-recapture analysis. It is possible that the windier, more exposed conditions at the ridgetop station and the paucity of understory vegetation there caused much lower capture and recapture probabilities than at the bottomland station, and that the low observed capture rates and recapture rates at the ridgetop station reflected this difference in capture probabilities as well as, or rather than, lower actual population sizes and proportions of residents. On the other hand, the paucity of the understory vegetation in the ridgetop habitat may be a major factor limiting its ability to support large breeding populations. Indeed, the thick understory layer of the bottomland may well have contributed to its ability to support large breeding populations by providing additional habitats for breeding birds. The obvious management recommendation to emerge from this would be that, in order to support higher landbird breeding populations, bottomland forest habitats with significant understory should be maintained or restored at NSGA Sugar Grove.

How do indices of adult population size at the two NSGA Sugar Grove stations compare with stations elsewhere in the central Appalachians? Indices of adult population size at six stations at Shenandoah National Park, for example, varied from 78.3 to 121.4 birds per 600 net hours, with a value for all stations combined of 100.4 birds per 600 net hours. Thus, adult population sizes at the South Fork Potomac River station are right in line with stations at Shenandoah National Park, while populations at the Beaver Creek station appear truly to be very low.

Of additional interest is the fact that productivity (the proportion of young in the catch) was also higher, although not by a great amount, at the South Fork Potomac River station (0.54) than at the Beaver Creek station (0.49); the index for both stations combined was 0.53. Because MAPS productivity indices reflect productivity of the surrounding landscape, as well as that of the station itself, this result is not really surprising. The most important point, however, is that both of these productivity values are quite high, especially for stations in eastern North America. Productivity indices for all species pooled for the six stations in Shenandoah National Park in 2001, for example, ranged from 0.32 to 0.51; the index for all six stations combined was 0.39. Thus, productivity in 2001 at NSGA Sugar Grove must be considered to have been excellent, a result that suggests that habitat quality in the landscape at NSGA Sugar Grove is very good.

In addition to overall population size differences between the two stations, species composition at the two stations was radically different. Indeed, only two of the nine species with capture rates at the

South Fork Potomac River station of over five adults per 600 net hours, Worm-eating Warbler and Indigo Bunting, were captured *at all* at the Beaver Creek station. These two species were the only species with capture rates at Beaver Creek of over five adults per 600 net hours. The high relative abundance of Worm-eating Warblers at both of the stations is noteworthy as the species is generally an uncommon species throughout its range. Indeed, for both stations combined, Worm-eating Warbler tied with Gray Catbird as the most abundant breeding species at NSGA Sugar Grove. Even more striking was the species' very high productivity index (0.79 for both stations combined), very much higher than any of the five other species with overall capture rates greater than five adults per 600 net hours. The excellent productivity for Worm-eating Warbler, in fact, was a major contributor to the overall high productivity index for NSGA Sugar Grove in 2001. If data from Worm-eating Warbler is excluded, the overall productivity index at NSGA Sugar Grove in 2001 was 0.43, much more similar to, but still higher than, the overall 2001 productivity index at Shenandoah National Park.

It is also noteworthy that, while the South Fork Potomac River station supported larger overall breeding bird populations, the Beaver Creek station supported a larger adult population of Indigo Buntings which had a higher productivity index as well. This may indicate a preference for ridgetop or open woodland habitat (or both) for Indigo Bunting, a hypothesis supported by the lack of any juvenile Indigo Buntings at the South Fork Potomac River station, suggesting that the species may not have reproduced at all at the bottomland/mixed forest station. Thus, the open woodlands may provide an important breeding habitat for Indigo Buntings at NSGA Sugar Grove, which should be considered in management strategies for the installation.

The long-term goal for the NSGA Sugar Grove MAPS program is to continue to monitor the primary demographic parameters of NSGA Sugar Grove'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 populations responses. This is to be accomplished by including data from NSGA Sugar Grove with additional MAPS data from other central Appalachian 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; (2) determine the proximate demographic factor (i.e., productivity or survivorship) causing observed population trends in the target species; (3) link MAPS data with landscape-level habitat data and spatially explicit weather data in a geographical information system (GIS); (4) identify relationships between landscape-level habitat and/or weather characteristics and the primary demographic responses (productivity and survival rates) of the target species; (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. We conclude that the MAPS protocol is very well-suited to provide one component of NSGA Sugar Groves' long-term ecological monitoring goals, and recommend continuing the program well into the future.

CONCLUSIONS AND RECOMMENDATIONS

(1) Data from the two MAPS stations on NSGA Sugar Grove were used to provide station-specific and installation-wide indices of adult population size and productivity for 2001. The index of adult population size for all species pooled at the South Fork Potomac River station, located in bottomland/mixed forest habitat, was 105.9 birds per 600 net hours, more than 3.5 times as high as that at the Beaver Creek station (30.5 birds per 600 net hours), located in ridgetop/open forest habitat, and similar to six stations in Shenandoah National Park (2001 mean 100.2 birds per 600 net hours). Species richness of adults at the South Fork Potomac River station (18 species) was nearly twice as high as the Beaver Creek station (10 species), and was also similar to Shenandoah stations (2001 mean 18.8 species). Productivity indices in 2001 at both the South Fork Potomac River and Beaver Creek stations (0.54 and 0.49, respectively), however, were quite high for stations in eastern North America, and averaged substantially higher than for the six stations in Shenandoah National Park (2001 mean 0.38). This suggest that habitat quality in the landscape at NSGA Sugar Grove is very good.

(2) Species composition differed dramatically between the two stations at NSGA Sugar Grove; only two of the nine species with the highest adult population size indices at South Fork Potomac River, Worm-eating Warbler and Indigo Bunting, were captured *at all* at Beaver Creek. The high indices of adult population size and very high overall productivity index for Worm-eating Warbler at NSGA Sugar Grove are noteworthy, as this is generally a relatively uncommon species everywhere in its range. In contrast to most species, Indigo Bunting showed higher adult population size and productivity indices at the Beaver Creek station.

(3) The higher species richness, larger adult population size index, and somewhat higher productivity index at the South Fork Potomac River station than at the Beaver Creek station suggest that the habitat at the South Fork Potomac River station can support a larger, more varied, and more productive adult breeding population than the habitat at the Beaver Creek Station. This may be a result of higher habitat diversity and a denser more diverse understory at the South Fork Potomac River station, as compared to the Beaver Creek station.

(4) As more years of data accumulate we will be able to examine 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 examine trends in breeding population size and productivity and make inferences about the long-term prospects of the various species. And we will be able to examine annual survival-rate estimates, capture probabilities, and proportion of residents in order to make inferences regarding the effect of survivorship on population dynamics. Examining the variation over time of population size indices, productivity indices, and survival-rate estimates, furthermore, will allow the installation personnel to determine what effect their management actions, or lack thereof, have on the population dynamics of the birds species breeding on NSGA Sugar Grove.

(5) The long-term goal for the NSGA Sugar Grove MAPS program is to continue to monitor the primary demographic parameters of NSGA's landbirds in order to provide critical information to clarify the ecological processes leading from environmental stressors to population responses. We intend to accomplish this by including NSGA Sugar Grove data in analyses of other central Appalachian 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 factor (i.e., productivity or survivorship) causing observed population trends; (c) link MAPS data with landscape-level habitat data and spatially explicit weather data in a geographical information system (GIS); (d) identify relationships between landscape-level habitat and/or weather characteristics and the primary demographic responses (productivity and survival rates) of target species; (e) generate hypotheses regarding the ultimate environmental causes of the population trends; and (f) make comprehensive recommendations for habitat and use-related management goals both at the installation and central Appalachian scale.

(6) 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 a region-wide basis (e.g., northeastern North American) for a substantial number of landbird species.

(7) We conclude that the MAPS protocol is well-suited to provide an integral component of NSGA Sugar Grove's long-term ecological monitoring effort. Based on the above information, we recommend the continued operation of the NSGA Sugar Grove MAPS stations well into the future.

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Table 1. Summary of the 2001 MAPS program on Naval Security Group Activity Sugar Grove.

Station						2001 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	419.3	7	6/05-8/07
Beaver Creek	BECR	15628	Steep slope, open mixed forest, grassland edge	38°30'40"N, 79°16'26"W	658	411.7	7	6/04-8/06
BOTH STATIONS COMBINED						831.0	7	6/04-8/07

Table 2. Capture summary for the two individual MAPS stations operated on Naval Security Group Activity Sugar Grove in 2001. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	South Fork Potomac River			Beaver Creek		
Species	N	U	R	N	U	R
Yellow-billed Cuckoo				1		
Ruby-throated Hummingbird		8			4	
Downy Woodpecker	2					
Hairy Woodpecker	1			1		
Eastern Phoebe	2					
White-eyed Vireo	5		6			
Red-eyed Vireo	2			1		
Black-capped Chickadee	2			4		
Tufted Titmouse	4			13		1
White-breasted Nuthatch				1		
Carolina Wren	14		8			
House Wren	1					
American Robin				1		
Gray Catbird	17		7			
Brown Thrasher	3	1	1			
Black-throated Green Warbler	1					
Black-and-white Warbler	5	1	1			
American Redstart	2					
Worm-eating Warbler	51	1	12	5		
Ovenbird	18		1			
Northern Waterthrush	1					
Louisiana Waterthrush	1			1		
Canada Warbler	1					
Scarlet Tanager	1			1		
Eastern Towhee	4		3			
Chipping Sparrow				2		
Song Sparrow	12		11			
Northern Cardinal	10		4			
Indigo Bunting	4		1	10		3
Common Grackle	1					
ALL SPECIES POOLED	165	11	55	41	4	4
TOTAL NUMBER OF CAPTURES		231			49	
NUMBER OF SPECIES	25	4	11	12	1	2
TOTAL NUMBER OF SPECIES		26			13	

Table 3. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the two individual MAPS stations operated on Naval Security Group Activity Sugar Grove in 2001.

Species	South Fork Potomac River Ad.	South Fork Potomac River Yg.	South Fork Potomac River Prop. Yg.	Beaver Creek Ad.	Beaver Creek Yg.	Beaver Creek Prop. Yg.
Yellow-billed Cuckoo				1.5	0.0	0.00
Downy Woodpecker	0.0	2.9	1.00			
Hairy Woodpecker	0.0	1.4	1.00	1.5	0.0	0.00
Eastern Phoebe	2.9	0.0	0.00			
White-eyed Vireo	5.7	1.4	0.20			
Red-eyed Vireo	1.4	0.0	0.00	0.0	1.5	1.00
Black-capped Chickadee	2.9	0.0	0.00	2.9	2.9	0.50
Tufted Titmouse	1.4	4.3	0.75	2.9	16.0	0.85
White-breasted Nuthatch				0.0	1.5	1.00
Carolina Wren	10.0	10.0	0.50			
House Wren	0.0	1.4	1.00			
American Robin				1.5	0.0	0.00
Gray Catbird	17.2	7.2	0.29			
Brown Thrasher	0.0	2.9	1.00			
Black-throated Green	0.0	1.4	1.00			
Black-and-white Warbler	4.3	2.9	0.40			
American Redstart	1.4	1.4	0.50			
Worm-eating Warbler	11.4	63.0	0.85	5.8	1.5	0.20
Ovenbird	5.7	17.2	0.75			
Louisiana Waterthrush	1.4	0.0	0.00	1.5	0.0	0.00
Canada Warbler	0.0	1.4	1.00			
Scarlet Tanager	1.4	0.0	0.00	1.5	0.0	0.00
Eastern Towhee	5.7	0.0	0.00			
Chipping Sparrow				1.5	1.5	0.50
Song Sparrow	14.3	2.9	0.17			
Northern Cardinal	11.4	2.9	0.20			
Indigo Bunting	5.7	0.0	0.00	10.2	4.4	0.30
Common Grackle	1.4	0.0	0.00			
ALL SPECIES POOLED	105.9	124.5	0.54	30.6	29.2	0.49
NUMBER OF SPECIES	18	16		10	7	
TOTAL NUMBER OF SPECIES		24			12	

Table 4. Summary of results for both Naval Security Group Activity Sugar Grove MAPS stations combined in 2001.

Species	Birds captured: Newly banded	Un-banded	Recap-tured	Birds/600net-hours: Adults	Young	Prop. Young
Yellow-billed Cuckoo	1			0.7	0.0	0.00
Ruby-throated Hummingbird		12				
Downy Woodpecker	2			0.0	1.4	1.00
Hairy Woodpecker	2			0.7	0.7	0.50
Eastern Phoebe	2			1.4	0.0	0.00
White-eyed Vireo	5		6	2.9	0.7	0.20
Red-eyed Vireo	3			0.7	0.7	0.50
Black-capped Chickadee	6			2.9	1.4	0.33
Tufted Titmouse	17		1	2.2	10.1	0.82
White-breasted Nuthatch	1			0.0	0.7	1.00
Carolina Wren	14		8	5.1	5.1	0.50
House Wren	1			0.0	0.7	1.00
American Robin	1			0.7	0.0	0.00
Gray Catbird	17		7	8.7	3.6	0.29
Brown Thrasher	3	1	1	0.0	1.4	1.00
Black-throated Green Warbler	1			0.0	0.7	1.00
Black-and-white Warbler	5	1	1	2.2	1.4	0.40
American Redstart	2			0.7	0.7	0.50
Worm-eating Warbler	56	1	12	8.7	32.5	0.79
Ovenbird	18		1	2.9	8.7	0.75
Northern Waterthrush	1					
Louisiana Waterthrush	2			1.4	0.0	0.00
Canada Warbler	1			0.0	0.7	1.00
Scarlet Tanager	2			1.4	0.0	0.00
Eastern Towhee	4		3	2.9	0.0	0.00
Chipping Sparrow	2			0.7	0.7	0.50
Song Sparrow	12		11	7.2	1.4	0.17
Northern Cardinal	10		4	5.8	1.4	0.20
Indigo Bunting	14		4	7.9	2.2	0.21
Common Grackle	1			0.7	0.0	0.00
ALL SPECIES POOLED	206	15	59	68.6	77.3	0.53
TOTAL NUMBER OF CAPTURES		280				
NUMBER OF SPECIES	29	4	12	22	21	
TOTAL NUMBER OF SPECIES		30			28	