



The Monitoring Avian Productivity and Survivorship (MAPS) Program at Naval Air Station Brunswick and Redington Training Facility, Maine



Phil Nott, Peter Pyle, and Danielle R. Kaschube

The Institute for Bird Populations

P.O. Box 1346, Point Reyes Station, CA 94956-1346

www.birdpop.org

15 May 2009

Citation: Nott, M.P., P. Pyle, and D. Kaschube. 2009. The 2008 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) Program at Naval Air Station Brunswick and Redington Training Facility. This is Contribution Number 374 of The Institute for Bird Populations, Point Reyes, CA. (<http://www.birdpop.org>)

TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
Background	3
Results of the 2008 MAPS season	3
Recent demographic patterns	4
Population and productivity dynamics based on 2003-2008 data	4
Management considerations	7
Future monitoring and research with a regional perspective	7
INTRODUCTION	9
METHODS	13
Collection of MAPS Data	13
Data Analysis	15
<i>Population-Size and Productivity Analyses</i>	15
<i>Analyses of trends in adult population size and productivity</i>	16
<i>Estimates of Survivorship</i>	17
Comparisons between 2007 and 2008	20
Six-year mean population size and productivity values in relation to the Northeast Region	21
Six-year trends in adult population size and productivity	21
Estimates of Adult Survivorship	22
Productivity and Survival as a Function of Body Mass	23
DISCUSSION	24
Recent demographic patterns	25
Management considerations	28
Future monitoring and research with a regional perspective	29
ACKNOWLEDGMENTS	31
LITERATURE CITED	32

The MAPS program at Brunswick and Redington, 2008

EXECUTIVE SUMMARY

Background

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

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

Results of the 2008 MAPS season

In 2008, IBP completed the sixth year of operating MAPS stations at Naval Air Station Brunswick and Redington Training Facility (hereafter "Brunswick and Redington"), operating two stations at Brunswick (Golf Course and Chimney Rock in mixed balsam fir/eastern hemlock and deciduous forest at 13-18 m elevation), and four stations at Redington (Potato Nubble, Redington Pond, Blueline Trail, and Highland, in maple, birch, balsam fir, Eastern hemlock, and red spruce habitats at 488-724 m elevation). In 2008, nets at permanently fixed positions were opened for six morning hours per day, on one day per 10-day period for eight consecutive 10-day periods between June 14 and August 4. In accordance with ancillary sampling protocols designed by IBP in collaboration with the Center for Tropical Research at UC Los Angeles, feather samples and cloacal swabs were taken from ~50% of birds to track the genetic variability and incidence of West Nile Virus and avian influenza viruses, both emerging infectious diseases of humans.

A total of 415 captures of 42 species were recorded at Brunswick and Redington. Total adult population sizes in 2008 were highest at Redington Pond (160.2 adults captured per 600 net-hours), followed Blueline Trail (119.0), Potato Nubble (89.5), Highland (62.4), Golf Course (60.7), and Chimney Rock (49.1). The most abundant breeding species in 2008, as determined by adults captured per 600 net-hrs, were Swainson's Thrush, Magnolia Warbler, Ovenbird, White-throated Sparrow, Hermit Thrush, Black-throated Blue Warbler, Common Yellowthroat, Traill's Flycatcher, Least Flycatcher, and Red-eyed Vireo. Reproductive index, as determined by

the number of young captured per adult captured, was highest at Blueline Trail (0.41), followed by Redington Pond (0.40), Potato Nubble (0.22), Chimney Rock (0.20), Highland (0.12), and Golf Course (0.10).

Recent demographic patterns

Adult breeding populations, numbers of young birds captured, and overall reproductive success all showed decreases between 2007 and 2008 for the second straight year, with those of adult breeding populations not as severe as those of young captured or reproductive success. However, these changes were not region wide and they follow increasing trends in these three population parameters between 2003 and 2006. The synchrony of these parameters documented here is of interest and perhaps of potential concern. It could indicate that normal processes are being disrupted, perhaps by global climate change. It may also indicate that dynamics in the Northeast are driven by cyclic climate phenomena such as the North Atlantic Oscillation. In this regard, it is interesting to note that these MAPS stations are on the southern edge of the geographic breeding range of many species and these species might be expected to decline under the current continental warming trend.

Population and productivity dynamics based on 2003-2008 data

Annual variation in the effort-adjusted adult numbers of each of 22 species (for which sufficient data existed for analysis) and all species pooled is shown in Figure 1 and annual variation in productivity is shown in Figure 2. The population trend for all species pooled was non-significantly ($P = 0.385$) positive during the six-year period 2003-2008, showing an annual increase of 1.4%. This trend was characterized by a three-year increase between 2003 and 2006, followed by a two-year decline between 2006 and 2008. Substantial six-year increases were recorded for seven of the 22 species (Blue-headed Vireo, Red-eyed Vireo, Swainson's Thrush, Black-throated Blue Warbler, Ovenbird, White-throated Sparrow, and Dark-eyed Junco) whereas substantial declines were recorded for two species (Yellow-bellied Flycatcher and Nashville Warbler). The six-year trend in productivity for all species pooled also increased non-significantly between 2003 and 2008, showing an annual increase of 0.6%. Six species (Red-eyed Vireo, Black-capped Chickadee, Veery, Nashville Warbler, American Redstart, and Canada Warbler) showed substantial increases and four (Blue-headed Vireo, Hermit Thrush, Swainson's Thrush, and White-throated Sparrow) showed substantial decreases.

A primary goal of the MAPS program is to determine the proximate causes (productivity or survival) accounting for declining landbird population sizes. In this year's report we were able to add four more species to the list for which reasonable survivorship estimates could be provided, and we have thus expanded our analyses aimed at assessing the causes for the observed population trends to 15 target species.

Reproductive index at Brunswick/Redington during 2003-2008 is fairly low compared with the mean value calculated for all species pooled in the Northeast MAPS Region, during the 12-year period 1992-2003. Seven of nine target species showed lower productivity whereas only two species showed higher productivity at Brunswick/Redington than in the Northeast Region. However, productivity is much lower at the two Brunswick stations than at the four Redington

stations, where it is comparable to that of the Northeast Region as a whole. By contrast, survival of landbirds at Brunswick and Redington appears to be good, being higher than that of the Northeast MAPS Region as a whole for nine of 14 target species. Lower-than-expected productivity (in comparison with body mass) also appears to be driving population dynamics in up to eight species (two declining, four increasing, and two stable) whereas lower-than-expected survival may be influencing the dynamics of two species (one increasing and one declining), reinforcing our conclusion that productivity is lower (especially at NAS Brunswick) and survival higher at Brunswick and Redington than is indicated for the region and the continent. Calculation of intrinsic population growth rates (λ), recruitment values, and juvenal survival using advanced mark-recapture analyses could help us refine our understanding of the causes for population decline at Brunswick and Redington.

Species-specific summaries of 2003-2008 analyses

We summarize the demographic performance (2003-2008) of 13 species with sufficient data (a mean of >2.5 adults captured per year) or that are species of particular concern in the area. We compare population trend data with that reported by the Breeding Bird Survey (BBS) for the state of Maine for 1966-2007 and 2003-2007 ([Sauer et al. 2008](#)).

Red-eyed Vireo - breeds at all six stations, although only occasionally (< 50% of years) at Highland. Populations have shown a substantial 5-year increase (particularly marked between 2004 and 2006) according to MAPS data, with 2.5 adults captured per 600 net hours in 2008. This coincides with significant ($P < 0.01$) increases in Maine for both 1966-2007 (2.15% per year) and 2003-2007 (2.88% per year) according to BBS data. Productivity showed a steady but small increase between 2003 and 2007, followed by a decline to 2006 levels in 2008.

Black-capped Chickadee - breeds at all six stations, although in most but not all years at Golf Course. Populations according to MAPS data have shown a general and non-significant decline between 2003 and 2008 (to 1.8 adults captured per 600 net hours in 2008) while productivity showed a general increase of similar magnitude (0.8 young per adults in 2008). BBS data indicated a near-significant ($P < 0.10$) decline during 2003-2008 in Maine, whereas longer-term (1966-2007) BBS data indicated a significant ($P < 0.05$) increase of 0.87% per year.

Veery - breeds commonly at Brunswick but less commonly at Redington, where breeding was only confirmed at Potato Nubble (< 50% of years) and Blueline Trail (most but not all years). Population size fluctuated widely between 2003 and 2008 but showed little trend according to MAPS data (1.8 adults captured per 600 net hours in 2008); this compares with significant declines recorded in Maine with BBS data for both 1966-2007 ($P < 0.001$; -2.89% per year) and 2003-2007 ($P < 0.05$, -6.40% per year). At MAPS stations young were captured in only one year, 2007.

Swainson's Thrush - breeds at all six stations, although only occasionally (< 50% of years) at the two Brunswick stations. Populations showed a near-significant increase (to 11.1 adults captured per 600 net hours in 2008) according to MAPS data whereas productivity showed a near-significant decrease (to 0.2 young per adult in 2008). BBS data indicate no trend in Maine for either 1966-2007 or 2003-2007.

Hermit Thrush - breeds at all six stations, although only occasionally at Potato Nubble and Highland (< 50% of years). The 5-year population trend at MAPS stations showed a slight but non-significant increase (most notably during 2005-2007), with 6.1 adults captured per 600 net hours in 2008; BBS trends in Maine were also non-significantly positive. Productivity showed a slight but consistent decline through the period according to MAPS data (no young captured in 2008).

Nashville Warbler - breeds at Golf Course and all four Redington Stations, in most years only at Potato Nubble and Redington Pond. Populations showed a near-significant increase (to 1.4 adults captured per 600 net hours in 2008) according to the MAPS data whereas productivity showed a near-significant decrease (to 1.5 young per adults in 2008). BBS data indicate no trend in Maine for either 1966-2007 or 2003-2007.

Magnolia Warbler - breeds at all four Redington stations and occasionally (< 50% of years) at Golf Course station at Brunswick. Populations were fairly stable during 2003-2008 according to MAPS data, with 8.6 adults captured per 600 net hours in 2008. This coincides with BBS data during 2003-2008, which also showed no trend in Maine (BBS trend was significantly positive for 1966-2007, with populations increasing at 3.46% per year). Productivity at MAPS stations increased linearly between 2003 to 2007, after which it decreased substantially in 2008 (0.33 young per adults), to below the 2003 level.

Black-throated Blue Warbler - breeds at all four Redington stations, although in most years only at Blueline Trail and only occasionally (< 50% of years) at Highland. Both population size and productivity were highly variable at MAPS stations, with population sizes showing a non-significant increasing trend (most noticeably between 2005 and 2007) and productivity showing little discernable trend. BBS data showed near-significant ($P < 0.10$) positive trends in Maine for both 1966-2007 (4.07% increase per year) and 2003-2008 (13.43% increase per year). A total of 6.1 adults were captured per 600 net hours and 0.4 young per adult in 2008.

Black-throated Green Warbler - breeds regularly at all six stations. Populations fluctuated widely between 2003 and 2008 according to MAPS data, slightly increasing overall but then declined dramatically between 2007 and 2008 (1.4 adults captured per 600 net hours). BBS data indicated no trend in 1966-2007 but a significantly ($P < 0.05$) positive trend of 6.50% per year in Maine for 2003-2008. Productivity according to MAPS data declined between 2003 and 2005, after which it increased through 2008, to slightly higher levels than in 2003 (0.5 young per adult in 2008).

Ovenbird - breeds at all six stations, although only occasionally (< 50% of years) at Blueline Trail and Highland. Populations increased significantly between 2003 and 2008 (to 7.5 adults captured per 600 net hours in 2008) at MAPS stations whereas productivity remained relatively stable (0.1 young per adult in 2008). BBS data indicated no trend in 1966-2007 but a significantly ($P < 0.05$) positive trend of 4.78% per year in Maine for 2003-2008.

Common Yellowthroat - breeds at all six stations, although in most but not all years at Highland

and only occasionally (< 50% of years) at Redington Pond. Population size was stable during the 5-year period at MAPS stations (3.9 adults captured per 600 net hours in 2008), and productivity slight increased (to 0.2 young per adult in 2008). BBS data also indicated a stable population during 2003-2008 in Maine (but showed a highly significant decline of -1.02% per year for 1966-2008).

Canada Warbler - breeds only at Potato Nubble (most but not all years) and at Highland (< 50% of years). Population size at MAPS stations fluctuated widely during the 5-year period, with an apparent peak in 2005 and dropping to a low of 1.1 adults captured per 600 net hours in 2008. BBS data indicate a near-significant ($P < 0.10$) declining trend (-2.72 per year) for 1966-2007 but a non-significant positive trend for 2003-2008 in Maine. Productivity increased steadily between 2003 and 2007 at MAPS stations, after which it decreased substantially in 2008, to slightly above the 2003 level (0.3 young per adult).

White-throated Sparrow - breeds at all four Redington stations and occasionally (< 50% of years) at Golf Course. Populations showed a general increase between 2003 and 2008 (although dropping between 2007 and 2008, to 6.8 adults captured per 600 net hours in 2008) whereas productivity showed a highly significant 5-year decline, to a low of 0.7 young per adult in 2008. This decline is concerning although BBS data for 2003-2008 indicate no trend in Maine; longer-term data (1966-2007) indicated a significant ($P < 0.01$) decline of 2.69% per year.

Management considerations

Overall, it appears that high survival at Brunswick and Redington may be counterbalancing the low productivity, resulting in stable or increasing six-year population trends for many species. While on the surface this may appear to be a favorable situation, it is opposite to results from other MAPS stations across the continent, generally indicating that low survival, particularly for Neotropical migrants, is the primary factor driving population declines. Thus, should survival of the populations at NAS Brunswick decline, we will likely be facing some severe population declines at this installation. Low productivity combined with increasing populations may also indicate that NAS Brunswick may be harboring a sink population, that is being supported primarily by higher productivity from surrounding regions. One of the goals of the MAPS program is to identify such populations, such that management actions can be taken to increase productivity.

Management could be applied to increase the productivity of landbirds at the two locations, particularly Brunswick. Target species for which attention may be especially important according to our data include Yellow-bellied Flycatcher, Red-eyed Vireo, Hermit Thrush, American Robin, Blackpoll Warbler, American Redstart, Ovenbird, Common Yellowthroat, and White-throated Sparrow. Management actions designed to increase nesting opportunities by ensuring the availability of dense understory in open edge woodland may increase local productivity and lead to higher rates of recruitment. Such habitat is common to regenerating forest gaps and the edges of cut areas.

Future monitoring and research with a regional perspective

Recently we undertook an analysis of the entire MAPS program in the Northeastern Region for

the Northeast Coordinated Bird Monitoring Partnership ([DeSante et al. 2008](#)). In our report it was recommended that the MAPS program be increased by about 50% throughout the Northeastern United States. Five of the six stations at Brunswick and Redington (all but Chimney Rock) were recommended to be continued as contributing adequately to our understanding of population dynamics for species of concern within Bird Conservation Region 14 the Atlantic Northern Forest. It was recommended that the Chimney Rock station be discontinued and preferably relocated to another more productive area on the Brunswick installation. We strongly recommend the continuation of all four stations at Redington, and that the two stations at Brunswick be re-evaluated and possibly relocated.

The long-term goal for the Brunswick and Redington MAPS program is to provide critical information to clarify the ecological processes leading from environmental stressors to landbird population responses. We will accomplish this by including Brunswick and Redington data in analyses of data from other MAPS stations in the Northeast, 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; (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 Northeastern MAPS region. In addition, MAPS data from NIOC Brunswick and Redington will provide an important contribution to the determination of accurate indices of adult population size and productivity and precise estimates of adult survival rates on the still larger region-wide scale (e.g., northeastern North America) for many landbird species.

As more years of data accumulate we will be able to make better assessments of population trends as well as inferences about the effects of weather on productivity and the effect of changes in productivity on population size. The precision of our survival estimates will improve substantially as more data is collected, up to and even beyond 12 years of data collection. MAPS data from Brunswick and Redington can be pooled with other MAPS data to provide large-scale regional (or even continental) indices and estimates of (and longer-term trends in) these key demographic parameters, as we have provided in this report regarding productivity in the Northeastern MAPS region and adult survival in Bird Conservation Region 14. We conclude that the MAPS protocol is well-suited to provide an integral component of Brunswick and Redington's long-term ecological monitoring effort, and we recommend the continued operation of the Brunswick and Redington MAPS stations well into the future.

INTRODUCTION

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

Recent important results from the MAPS program include the following:

- Trend data from the North American Breeding Bird Survey (BBS), as well as from the MAPS program, suggest that many populations of migratory songbirds are declining. Yet, knowledge of declines is not enough to effectively design management and conservation action capable of reversing these declines and maintaining healthy populations. Demographic data from MAPS can help to focus conservation efforts by providing information on proximate causes of observed population trends. We illustrated how demographic data from MAPS can provide unique insights into drivers of population trend in a recent analysis of 12 years (1992-2003) of MAPS data for Yellow Warbler published in the November 2008 issue of the *Journal of Wildlife Management* ([Saracco *et al.* 2008](#)).
- Brunswick and Redington MAPS data were included in an analysis reported in *Journal of Wildlife Management* paper, we reported results of similar analyses for an additional 38 species of migratory bird in a report that we recently submitted to the National Fish and Wildlife Foundation ([Saracco and DeSante 2008](#)). These results indicate that (1) enhancing survival, especially of first-year birds, may be the most important conservation strategy for slowing declines and achieving stable populations of many migratory songbird species, (2) enhancing productivity may be necessary to recover populations whose declines have been arrested, and (3) relationships between landbird vital rates and winter weather and habitat characteristics must be identified and described.
- A number of large military installations in North Carolina, Indiana, Kentucky, Missouri, and Texas have been monitored since 1994 by IBP under an agreement with the DoD Legacy Resources Management Office. Performance measures of population demographics and landscape showed that, in general, the installations managed large tracts of forest which represented a higher percentage of the land compared to the percentage of forested land within a 20km radius of the installations' boundaries. These forests also featured large "core areas" known to be beneficial to forest species. Consequently, the survival rate estimates and productivity indices of forest bird populations were higher than those of the surrounding MAPS or North American Bird Conservation Initiative's (NABCI) Bird Conservation Regions ([Nott](#)

[and Morris 2007](#)).

- A report submitted to the Virginia Division of Natural Resources documented landbird demographics for 23 species of greatest conservation need within Virginia and 150km of the Virginia border ([Nott et al. 2008a](#)).
- Analyses describing relationships between four demographic parameters (adult population size, population trend, number of young, and productivity) and landscape-level habitat characteristics for bird species of conservation concern have been completed for 13 military installations in south-central and southeastern United States. From these relationships we have formulated conservation management strategies that are currently being validated by follow-up monitoring or “effectiveness monitoring” ([Nott et al. 2003a](#)).
- Productivity of landbirds breeding in Pacific Northwest national forests is affected by global climate cycles including the El Niño Southern Oscillation and the North Atlantic Oscillation, in such a manner that productivity of Neotropical migratory species is determined more by late winter and early spring weather conditions on their wintering grounds than by late spring and summer weather conditions on their breeding grounds ([Nott et al. 2002](#)).
- Modeling spatial variation in MAPS productivity indices and survival-rate estimates as a function of spatial variation in population trends provides a successful means for identifying the proximate demographic cause(s) of population change at multiple spatial scales ([DeSante et al. 2001](#)).
- Patterns of productivity from MAPS at two large spatial scales (eastern North America and the Sierra Nevada) not only agreed with those found by direct nest monitoring and those predicted from theoretical considerations, but were in general agreement with current life-history theory and were robust with respect to both time and space ([DeSante 2000](#)).
- Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales ([DeSante et al. 1999](#)).
- Age ratios obtained during late summer banding provided a good index to actual productivity in the Kirtland's Warbler ([Bart et al. 1999](#)).

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

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

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

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

More recently, the MAPS program was established on Naval Air Station Brunswick (hereafter ("Brunswick")) and Redington Training Facility (hereafter ("Redington")) in 2003. It is expected that information from the MAPS program will be capable of aiding research and management efforts at Brunswick and Redington to protect and enhance the installations avifauna and ecological integrity, while helping it fulfill its military mission in an optimal manner.

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

The Legacy Resource Management Program funded IBP to undertake these analyses and formulate management strategies. These analyses were completed in 2003 and management guidelines were formulated for ten bird species of conservation concern that breed in the southeastern United States ([Nott et al. 2003a](#)). With additional funding from the Legacy Resource Management Program, we are currently implementing these guidelines through management actions on eight military installations in conjunction with efforts to increase

military Readiness and Range Sustainment ([Nott and Michel 2005](#)). The strategy for implementing these guidelines includes the establishment of new MAPS stations to monitor the effectiveness of such proposed or on-going management, the discontinuance of an equal number of old stations, and the continued operation of others of the old stations to serve as controls for the new management stations. In this way, the total number of stations operated will remain the same.

Because the MAPS program has only been operated for six years at Brunswick and Redington, we are not yet ready to formulate management strategies specific to these installations. However, with the addition of a sixth year of data we are better able to estimate survival and population trends for up to 15 species breeding at Brunswick and Redington. Because of their northerly location within the MAPS program and occurrence in boreal deciduous forests, many of these species are captured at higher rates at Brunswick and Redington than at any other MAPS stations within the program.

We are pleased to report continuing improvement in the number and scope of analyses made possible by the accumulated size of the dataset. In our report of three years ago ([Pyle *et al.* 2006](#)) we use multivariate ANOVAs and logistic regression analyses to show that adult population sizes and productivity at Brunswick and Redington were higher at stations with low-saturation (drier) soil than at stations with high-saturation (wetter) soil, suggesting that drier habitats are more diverse or healthier than those of wetter soils. Two years ago, we obtained estimates of adult survival and recapture probabilities using temporally variable, time-constant models, for 12 species breeding at Brunswick and Redington, and we compared survival values at Brunswick and Redington to values estimated from MAPS stations operated in 1992-2003 within [Bird Conservation Region \(BCR\) 14](#), the Atlantic Northern Forest Region, in which Brunswick and Redington are located. Survival at the two installations during 2003-2006 was much higher than that recorded in BCR 14 during 1992-2003, with eleven of twelve species showing higher survival at the installations whereas only one species, indicating excellent survival for target species breeding at Brunswick and Redington ([Nott *et al.* 2007](#)). Last year, we expanded the assessment to establishing the relationships between a) survival and bird mass, and b) productivity and bird mass for 11 species across the entire MAPS dataset ([Nott *et al.* 2008](#)). This comparison confirmed the fact that survivorship was healthy at Brunswick and Redington and indicated that low productivity may have been driving population trends (including declines) at the installations. This year we have enough data to obtain survival estimates and consider factors driving population trends for an additional four species of landbirds at Brunswick and Redington.

METHODS

Six MAPS stations were re-established and operated in 2008 on Brunswick (two stations), near the coast at Brunswick, Maine, and Redington (four stations), in a montane region near Rangeley, Maine, in the exact same locations in which they were originally established in 2003 and operated in 2004-2007. These stations were originally selected in three different habitat types, deciduous, mixed, and coniferous forests, and along an elevational gradient such that species diversity on each installation could be inventoried and differences in species composition and productivity between habitat types and elevation could be examined ([Pyle et al. 2006](#)).

At Brunswick the two stations are: 1) Golf Course (GOCO) in mixed (primarily balsam fir/eastern hemlock canopy with deciduous understory) habitat at 13 m elevation at the southwestern end on the installation near the golf course, and 2) Chimney Rock (CHRO) in deciduous (primarily northern red oak) habitat at 18 m elevation on the southeastern edge of the installation. At Redington, stations were selected, in careful consideration of Survival, Evasion, Resistance, and Escape (SERE) training exercises, at: 3) Potato Nubble (PONU) in mixed (primarily maple and birch with fir/spruce subdominant) habitat at 488 m elevation near the entrance road at the west end of the installation, 4) Redington Pond (REPO) in deciduous (primarily birch and maple) habitat at 507 m elevation on the east end of Redington Pond, 5) Blueline Trail (BLUE) in lowland coniferous (primarily balsam fir and Eastern hemlock) habitat at 515 m elevation in the central region of the installation near the head of Blueline Trail, and 6) Highland (HGHL) in upland coniferous (primarily balsam fir and red spruce) habitat at 724 m elevation in the north-central region of the installation just south of the High Road. A summary of the major habitats represented at each of the six stations is presented in Table 1. Additional details on the habitat composition, degree of drainage, and history of habitat disturbance to the stations are presented in Table 2 of Pyle et al. ([2006](#)).

The six stations were re-established for operation by IBP biologist Leslie Latt and biologist-interns Dan Allen and Angela Fojtik during June 12-18 2008. The two biologist-interns received intensive training by experienced bander Leslie Latt *in situ*. 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 5 (beginning June 10) and Period 10 (beginning July 29). The operation of all stations occurred on schedule during each of the six 10-day periods, in coordination with personnel at Redington and to avoid conflict with SERE exercises.

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

Collection of MAPS Data

All MAPS stations were operated in accordance with the highly standardized banding protocols established by The Institute for Bird Populations for use by the MAPS Program throughout North America (see MAPS Manual [DeSante et al. 2008](#)). On each day of operation each year,

one 12-m long, 30-mm mesh, 4-tier nylon mist net was erected at each of ten fixed mist-net sites within the interior eight ha of each 20-ha station. With few exceptions, all birds captured during the course of the study were identified to species, age, and sex and, if unbanded, were banded with USGS/BRD numbered aluminum bands. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety would be compromised. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms ([DeSante et al. 2008](#)):

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

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

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

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

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

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

Data Analysis

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

Population-Size and Productivity Analyses

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

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

(3) the reproductive index.

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

For each station, we calculated percent changes between 2007 and 2008 in the numbers of adult and young birds captured, and actual changes in the reproductive index. These between-year comparisons were made in a "constant-effort" manner by means of a specially designed analysis program that used actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by-period basis to exclude captures that occurred in a given net in a given period in one year during the time when that net was not operated in that period in the other year.

We determined the statistical significance of between-year changes in the indices of adult population size and post-fledging productivity according to methods developed by the BTO in their CES scheme (Peach *et al.* 1996), by using confidence intervals derived from the standard errors of the mean percentage changes of all six stations. The statistical significance of the overall change at a given station was inferred from a one-sided binomial test on the proportion of species at that station that increased (or decreased). Throughout this report, we use an alpha level of 0.05 for statistical significance, and we use the term ‘near-significant’ or ‘nearly significant’ for differences for which $0.05 < P < 0.10$.

For each of the four stations and for each location combined we calculated six-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.

Analyses of trends in adult population size and productivity

For all six stations combined we examined six-year (2003-2008) trends in indices of adult population size and productivity, for each target species for which we recorded an average of at least 2.5 individual adults per year at the two stations combined, at stations at which the species was a regular (B) or usual (U) breeder. For trends in adult population size, we first calculated adult population indices for each species in each of the eight years based on an arbitrary starting index of 1.0 in 2001. Constant-effort changes (as defined above) were used to calculate these “chain” indices in each subsequent year by multiplying the proportional change between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

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

where PSI_i is the population size index for year i and d_i is the percentage change in constant-effort numbers from year i to year $i+1$. A regression analysis was then run to determine the slope of these indices over the eight years (PT). Because the indices for adult population size

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

$$(\text{slope of the regression line} / \text{predicted value for the first year}) * 100$$

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

Trends in productivity, *PrT*, were calculated in an analogous manner by starting with actual reproductive index values in 2003 and calculating each successive year's value based on the constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r*), and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends.

Estimates of Survivorship

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

RESULTS

In 2008, IBP completed the sixth year of operating MAPS stations at Naval Air Station Brunswick and Redington Training Facility, Maine, in three different habitat types, deciduous, mixed, and coniferous forests, and along an elevational gradient, such that species diversity on each installation could be inventoried and differences in species composition and productivity between habitat types and elevation could be examined.

We achieved a total of 1681.7 net-hours at the six MAPS stations in 2008 (Table 1). Of these, 1681.7 hrs, 1303.2 net-hours (77.5%) could be compared with 2007 data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

The 2008 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 six stations in Table 2 and for all stations combined in Table 4. A total of 415 captures of 42 species were recorded at the six stations combined (Table 4). Newly banded birds represented 67.2% of the total captures. The greatest number of captures occurred at Redington Pond (127), followed by Blueline Trail (83), Highland (64), Potato Nubble (58), Golf Course (46), and Chimney Rock (37). Species richness followed a very similar order, being greatest at Redington Pond (26 species) and Blueline Trail (25), and lowest at and Chimney Rock (13) and Golf Course (11). Overall, the most abundantly captured species at the six stations, in descending order, were Swainson's Thrush, Magnolia Warbler, White-throated Sparrow, Black-throated Blue Warbler, Ovenbird, Hermit Thrush, Common Yellowthroat, and Trail's Flycatcher (Table 4).

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 the reproductive index (young captured per adult), for each species and for all species pooled at each station in Table 3 and for all stations combined in Table 4. These capture indices suggest that the total adult population size in 2008 was greatest at Redington Pond (160.2 adults/600 net-hours), followed Blueline Trail (119.0), Potato Nubble (89.5), Highland (62.4), Golf Course (60.7), and Chimney Rock (49.1).

Overall, the most abundant breeding species at the six Brunswick and Redington MAPS stations in 2008, as determined by adults captured per 600 net-hrs, was Swainson's Thrush, followed in descending order by Magnolia Warbler, Ovenbird, White-throated Sparrow, Hermit Thrush, Black-throated Blue Warbler, Common Yellowthroat, Traill's Flycatcher, Least Flycatcher, and Red-eyed Vireo (Table 4). The following is a list of the common breeding species (captured at a rate of at least 4.0 adults per 600 net-hours), in decreasing order, at each station in 2008 (see Table 3):

Golf Course

Common Yellowthroat
Black-capped Chickadee*
Hermit Thrush
Veery*
Ovenbird*
Magnolia Warbler*
Black-throated Green Warbler†

Chimney Rock

Ovenbird
Hermit Thrush
Black-throated Green Warbler†

Potato Nubble

Swainson's Thrush
Black-throated Blue Warbler
Magnolia Warbler
Hermit Thrush
Ovenbird
White-throated Sparrow†
Philadelphia Vireo†
Veery†
Black-throated. Green Warbler†

Redington Pond

Swainson's Thrush
Magnolia Warbler
Least Flycatcher
Black-throated Blue Warbler
Ovenbird
Red-eyed Vireo
American Robin*
American Redstart
Hermit Thrush*
Canada Warbler*

Redington Pond (cont.)

Philadelphia Vireo*
Yellow-rumped Warbler
White-throated Sparrow
Purple Finch*
Bicknell's Thrush†
Common Yellowthroat†

Blueline Trail

Magnolia Warbler
White-throated Sparrow
Traill's Flycatcher
Swainson's Thrush*
Nashville Warbler*
Black-throated Blue Warbler*
Blackburnian Warbler*
Pine Siskin*
Downy Woodpecker*
Northern Waterthrush
Common Yellowthroat
Ruby-crowned Kinglet†
Hermit Thrush†
American Robin†
Acadian Flycatcher†
Red-eyed Vireo†
Black-throated Green Warbler†
Black-and-white Warbler†

Highland

Swainson's Thrush
White-throated Sparrow
Blackpoll Warbler
Dark-eyed Junco†
Veery†
Magnolia Warbler†

* Did not exceed 4.0 adults per 600 net hours in 2007

† Exceeded 4.0 adults per 600 net hours in 2007 but not in 2008.

Captures of young of all species pooled (Table 3) varied substantially, being highest at Redington Pond (63.7 young birds/600 net hours), followed by Blueline Trail (49.1), Potato Nubble (19.4), Chimney Rock (9.8), Highland (7.3), and Golf Course (6.1). The reproductive index, as determined by the number of young per adult, also varied, being highest at Blueline Trail (0.41), followed by Redington Pond (0.40), Potato Nubble (0.22), Chimney Rock (0.20), Highland (0.12), and Golf Course (0.10).

Comparisons between 2007 and 2008

Constant-effort comparisons between 2007 and 2008 were undertaken at all six Brunswick and Redington stations, for numbers of adult birds captured (index of adult population size; Table 5), numbers of young birds captured (Table 6), and number of young per adult (reproductive index; Table 7).

Adult population size, for all species pooled and at all six stations combined, decreased moderately but non-significantly between 2007 and 2008, by -10.6% (Table 5). Decreases were recorded for 21 of 46 species (0.46), a proportion not significantly greater than the proportion expected by chance (0.50). The number of adults captured of all species pooled decreased at three stations, by amounts ranging from -13.9% at Potato Nubble to -38.3% at Redington Pond, and it increased at three stations, ranging from +6.7% at Highland to +38.1% at Golf Course. The proportion of decreasing or increasing species was not significantly greater than 0.50 at any station. American Robin and Black-throated Green Warbler showed significant decreases across stations between 2007 and 2008 whereas no species showed near-significant or significant increases across stations.

The number of young birds captured, of all species pooled and for all six stations combined, decreased by a highly significant -69.6% between 2007 and 2008 (Table 6). Decreases between 2007 and 2008 were recorded for 26 of 35 species (0.74), a proportion significantly greater than 0.50. Young captured for all species pooled decreased at the four Redington Stations, by amounts ranging from -56.3% at Potato Nubble to -80.0% at Redington Pond and Highland, whereas it increased at the two Brunswick stations, by +200% at Golf Course and +150% at Chimney Rock. The proportion of decreasing species was significantly greater than 0.50 at Redington Pond and Blueline Trail. White-throated Sparrow and Dark-eyed Junco showed significant declines in young captured across stations, whereas no species showed near-significant or significant increases.

Reproductive index (the number of young per adult) showed a substantial absolute decrease of -0.356, from 0.539 in 2007 to 0.183 in 2008 for all species pooled and both stations combined, a near-significant change (Table 7). Decreases in productivity were recorded for 18 of 28 species (0.64), a proportion near-significantly greater than 0.50. Reproductive index decreased at the four Redington stations by amounts ranging from -0.219 at Potato Nubble to -0.858 at Blueline Trail, whereas it increased at the two Brunswick stations, by +0.056 at Golf Course and +0.100 at Chimney Rock. The proportion of increasing or decreasing species was not significantly greater than 0.50 at any station, and only one species (White-throated Sparrow) showed a near-significant decrease across stations.

Thus, in general, all three parameters showed decreases between 2007 and 2008, with those of adult breeding populations not as severe as those of young captured or reproductive success. Very similar decreases (but less severe) were also recorded between 2006 and 2007, indicating a concerning second straight year of declining dynamics at Brunswick and Redington. However, these changes were not region wide, with the decreases adult captures being found at only three of the six stations, and the decreases in young captured and productivity being found at the Redington stations but not at the Brunswick stations. This compares to increasing dynamics between 2005 and 2006, when breeding populations increased fairly substantially, young increased substantially and significantly, and reproductive success increased substantially and near-significantly. We often observe alternating changes in opposite directions at MAPS stations, perhaps reflecting density dependent effects, but this does not appear to be occurring at Brunswick and Redington, perhaps reflecting a more important influence of climatic variables on bird dynamics here.

Six-year mean population size and productivity values in relation to the Northeast Region

Mean numbers of individual adults (an index of adult population size) and young captured per 600 net-hours, and reproductive index (a measure of productivity), averaged over the six-year period 2003-2008, are presented in Table 8, for each station and for all six stations combined. Examination of values for all species pooled indicates that the highest breeding populations have been recorded at Redington Pond and Blueline Trail, and that the lowest breeding populations have been recorded at Golf Course and Chimney Rock. Productivity values have been high at Potato Nubble and Blueline Trail, and much lower at Golf Course and Chimney Rock. Highland showed population size and reproductive index values that were closer to average.

According to [NBII/IBP Demographics Query Interface](#), the overall reproductive index at Brunswick/Redington of 0.34 is fairly low compared with the mean value of 0.43 calculated for all species pooled in the Northeast MAPS Region, during the 12-year period 1992-2003. Of nine target species for which productivity values could be compared, four (Red-eyed Vireo, Hermit Thrush, American Robin, and Common Yellowthroat) showed substantially (> 50%) lower productivity; three (American Redstart, Ovenbird, and White-throated Sparrow) showed slightly (< 50%) lower productivity; one (Magnolia Warbler) showed slightly (< 50%) higher productivity; and one (Black-capped Chickadee) showed substantially (> 50%) higher productivity at Brunswick/Redington than in the Northeast Region. This indicates that productivity may be lower than it should be for many species at Brunswick and Redington, at least during the six-year period 2003-2008. It should be noted, however, that productivity is much lower at the two Brunswick stations (Golf Course and Chimney Rock; mean productivity index 0.085) than at the four Redington stations (mean 0.423), the latter index comparable to that of the Northeast Region as a whole.

Six-year trends in adult population size and productivity

"Chain" indices of adult population size and productivity, at the six Brunswick and Redington stations combined, for 22 target species and for all species pooled, are presented in Figures 1 and 2, respectively. 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 1.

The population trend for all species pooled was non-substantially ($r < 0.5$) and non-significantly ($P = 0.385$) positive during the six-year period 2003-2008 (Fig. 1), showing an annual increase of 1.4%. This trend was characterized by a three-year increase between 2003 and 2006, followed by a two-year decline between 2006 and 2008. Substantial six-year increases were recorded for seven of the 22 species, the positive trends being significant or near-significant for Swainson's Thrush and Ovenbird, and being non-significant for Blue-headed Vireo, Red-eyed Vireo, Black-throated Blue Warbler, White-throated Sparrow, and Dark-eyed Junco. By contrast, substantial declines were recorded for only two species, Yellow-bellied Flycatcher and Nashville Warbler, in both cases the negative trends being significant or near-significant. The remaining 13 species showed non-substantial population trends (absolute $r < 0.5$), with eight trends being negative and five being positive.

The six-year trend in productivity for all species pooled increased slightly and non-significantly between 2003 and 2008 (Fig. 2), showing an annual increase of 0.6%. Three of the target species (Yellow-bellied and Traill's flycatchers and Cedar Waxwing) had no young captured during the six-year period, preventing the calculation of meaningful trends. Of the remaining 19 species, six showed substantial increases, with that of Nashville Warbler being near-significant, and those of Red-eyed Vireo, Black-capped Chickadee, Veery, American Redstart, and Canada Warbler being non-significant; and four showed substantial decreases, with those of Swainson's Thrush and White-throated Sparrow being significant or near-significant, and those of Blue-headed Vireo and Hermit Thrush being non-significant. The remaining nine species showed non-substantial trends, with five being positive and four being negative (Fig. 2).

Estimates of Adult Survivorship

Using six years of data (2003-2008) from all six stations, we were able to obtain estimates of adult survival and recapture probabilities using temporally variable, time-constant models, for 15 species breeding at Brunswick and Redington (Table 9). This represents two additional species, Yellow-bellied Flycatcher and American Robin, than we were able to obtain estimates for with five years of data.

Estimates of annual adult survival rate ranged from a low of 0.351 for Hermit Thrush to a high of 0.713 for Red-eyed Vireo, with a mean of 0.508. Recapture probability varied from a low of 0.100 for Red-eyed Vireo to a high of 0.748 for Blackpoll Warbler, with a mean of 0.396. Proportion of residents varied from a low of 0.000 for Yellow-bellied Flycatcher to a high of 1.000 for Veery, American Robin, and Black-throated Green Warbler, and averaged 0.549. The precision of these survival estimates, as estimated by mean C.V., was 35.4%, which is as expected for survivorship analyses on six years of data. A comparison of C.V.s with those of estimates from four years (2003-2007) of data, for the 13 species for which estimates could be obtained in both years, revealed substantial improvement in precision, of 31.5% after six years of data had been collected vs. 37.4% after five years of data had been collected. Nine of 13 species showed improvement in precision after the additional year of data, with five species (Red-eyed Vireo, Veery, Blackpoll Warbler, Ovenbird, and White-throated Sparrow) showing substantial improvement, as indicated by a drop in C.V. of >25%. Data collected during the MAPS

program as a whole reveals that precision of our estimates will invariably improve as more years of data are collected at Brunswick and Redington, up to 12 years of data or more.

To see how the survival values compare to those of surrounding areas, we have presented the values estimated from MAPS stations operated in 1992-2003 within Bird Conservation Region (BCR) 14, the Atlantic Northern Forest Region, in which Brunswick and Redington are located (Table 9). These values were derived for 14 of the 15 target species from IBP's [NBII/IBP Demographics Query Interface](#); not enough data was available to estimate survival for Yellow-bellied Flycatcher in BCR 14.

Survival estimates for nine of 14 species was higher at Brunswick/Redington during 2003-2008 than in the Region during 1992-2003, by amounts ranging from +3.0% (Magnolia Warbler) to +70.8% (American Redstart). By contrast only five species showed lower survival at Brunswick, by amounts ranging from -10.8% (Traill's Flycatcher) to -31.8% (Black-capped Chickadee). Although some of these differences may relate to the different time frames for data analysis, these results indicate relatively good survival for most target species breeding at Brunswick and Redington. Of possible concern, however, is that the one resident or near-resident species, Black-capped Chickadee, showed the lowest value compared to the region, indicating possible negative over-winter effects at Brunswick.

Productivity and Survival as a Function of Body Mass

It has previously been shown that both productivity and survival of birds vary with body mass: on average, the larger the bird the lower the productivity and the higher the survival. Thus, in order to assess whether or not productivity or survival in a given species is higher or lower than expected, body mass needs to be accounted for. Figure 3 shows mean productivity indices and time-constant annual adult survival rate estimates recorded at Brunswick and Redington as a function of mean body mass (log transformed) for 15 target species for which both productivity indices (Table 8) and survival estimates (Table 9) could be obtained. The purpose of this analysis was to determine which species at Brunswick and Redington showed higher or lower productivity or survival than might be expected given their body mass. Two regression lines are presented on each graph, one (solid) based on the 15 target species using data from Brunswick and Redington, and one (dashed) using data from 210 (productivity) and 89 (survival) species for which these parameters could be estimated from MAPS data collected from stations distributed across the entire North American continent.

For productivity (Fig. 3A), the regression line based on data from the 15 species at Brunswick and Redington shows the same (parallel) relationship between productivity and mass, but is below that based on data from North America as a whole, confirming our earlier supposition that productivity is low at Brunswick/Redington. For survival (Fig. 3B), the regression line based on data from Brunswick/Redington is above that based on data from North America as a whole (for the most part), also confirming our earlier supposition that survival is healthy at Brunswick.

Three of the species shown in Figure 3 (species alpha codes in bold uppercase letters) showed population declines (Fig. 1; $r < - 3.0$). Two of these species, Yellow-bellied Flycatcher (YBFL) and Blackpoll Warbler (BLPW) showed lower-than expected productivity but expected to

higher-than-expected survival, indicating that low productivity at Brunswick and Redington may be the cause of the declines. The third species, Black-capped Chickadee (BCCH), showed slightly higher-than-expected productivity and slightly-lower than expected survival, indicating that poor survival might be causing the declines at Brunswick, as noted above for this species. For Yellow-bellied Flycatcher and Black-capped Chickadee productivity and survival values roughly counterbalanced each other with respect to their relationship with body mass, which may reflect normal population dynamics for these species. It is possible in such cases that another factor, such as low first-year survival or recruitment, may be causing the population decline at Brunswick.

Seven of the 15 species shown in Figure 3 (in regular-font uppercase letters) showed population increases (Fig. 1; $r > 0.3$). Five of these species showed roughly expected and/or counterbalanced productivity and survival values, with slightly elevated productivity perhaps contributing to the increases of Hermit Thrush (HETH) and White-throated Sparrow (WTSP) and slightly elevated survival perhaps contributing to the increases in Red-eyed Vireo (REVI), Black-throated Green Warbler (BTNW), and Ovenbird (OVEN). Other factors, as mentioned above, may also be contributing to the increases of these species. For Swainson's Thrush (SWTH), productivity was close-to-expected but survival was higher-than-expected, and for Common Yellowthroat (COYE) survival was close-to-expected but productivity was lower-than-expected. For both of these species the evidence also points toward good survival as a leading cause for the population increases.

The remaining five species (in lower-case letters) showed no population trend (Fig. 1; absolute $r < 0.3$). Two of these species, American Robin (amro) and Magnolia Warbler (mawa), showed roughly expected survival and productivity values suggesting balanced population dynamics. Two species, Traill's Flycatcher (trfl) and Veery (veer), showed lower-than-expected productivity values but close-to-expected survival values, and the fifth species, American Redstart (amre) showed higher-than-expected productivity and survival estimates. For these three species, it appears that other factors such as high (trfl, veer) or low (amre) juvenal survival or recruitment may be maintaining stable population sizes despite unbalanced dynamics. Calculation of intrinsic population growth rates (λ), recruitment values, and juvenal survival using advanced mark-recapture analyses could help us answer these questions.

In summary, lower-than-expected productivity may be driving population dynamics in up to eight species (two declining, four increasing, and two stable), whereas lower-than-expected survival may be influencing the dynamics of two species (one increasing and one declining). These results reinforce others presented above, indicating that productivity is lower (especially at NAS Brunswick) and survival higher at Brunswick and Redington than is indicated for the region and the continent.

DISCUSSION

Despite the fact that the Brunswick and Redington MAPS stations have been run for only six years, important and interesting data have been gathered on breeding populations and

productivity for many summer resident landbird species on the installations. Notably, the species composition at these stations shows a strong boreal-forest component that is not sampled adequately by MAPS locations elsewhere. Among MAPS stations operated by the Institute for Bird Populations, for example, seven target species at Brunswick and Redington (Yellow-bellied Flycatcher; Magnolia, Black-throated Blue, Black-throated Green, Blackpoll, and Canada warblers; and White-throated Sparrow) have not been captured in sufficient numbers to be monitored effectively at any other location. This underscores the importance of the Brunswick and Redington stations to understanding the population dynamics of this important group of landbirds.

In previous year's reports ([Pyle *et al.* 2006](#), [Nott *et al.* 2007](#), [Nott *et al.* 2008](#)), we use multivariate ANOVAs and logistic regression analyses to show that adult population sizes and productivity at Brunswick and Redington were higher at stations with low-saturation (drier) soil than at stations with high-saturation (wetter) soil, and we obtained preliminary estimates of adult survival and recapture probabilities and established relationships between a) survival and bird mass, and b) productivity and bird mass for up to 11 species across the entire MAPS dataset. For this report we had accumulated enough data to expand these analyses to an additional four species of landbirds at Brunswick and Redington. Data from all six MAPS stations at Brunswick and Redington have been pooled to provide indices of breeding population size and productivity, and we have been able to examine six-year trends in breeding population sizes and productivity for 22 target species and to obtain survival estimates for 15 target species.

Recent demographic patterns

Adult breeding populations, numbers of young birds captured, and overall reproductive success all showed decreases between 2007 and 2008 for the second straight year, with those of adult breeding populations not as severe as those of young captured or reproductive success. However, these changes were not region wide and they follow increasing trends in these three population parameters between 2003 and 2006.

MAPS data often show an alternating cycle different from that observed at Brunswick and Redington, whereby low productivity one year resulted in low populations the next year, which have higher breeding success resulting in higher populations the following year, etc. The synchrony of these parameters documented here is of interest and perhaps of potential concern. It could indicate that normal processes are being disrupted, perhaps by global climate change. It may also indicate that dynamics in the Northeast are driven by cyclic climate phenomena such as the North Atlantic Oscillation, which influences the magnitude of storms in the Northeast. It will be very interesting to see if this pattern continues at Brunswick and Redington in the future.

In this regard, it is interesting to note that these MAPS stations are on the southern edge of the geographic breeding range of many species and these species might be expected to decline under the current continental warming trend.

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

observed population trends to 15 target species.

The overall reproductive index at Brunswick/Redington during 2003-2008 is fairly low compared with the mean value calculated for all species pooled in the Northeast MAPS Region, during the 12-year period 1992-2003. Seven of nine target species showed lower productivity whereas only two species showed higher productivity at Brunswick/Redington than in the Northeast Region. However, productivity is much lower at the two Brunswick stations than at the four Redington stations, where it is comparable to that of the Northeast Region as a whole. By contrast, survival of landbirds at Brunswick and Redington appears to be good, being higher than that of the Northeast MAPS Region as a whole for nine of 14 target species. Lower-than-expected productivity (in comparison with body mass) also appears to be driving population dynamics in up to eight species (two declining, four increasing, and two stable) whereas lower-than-expected survival may be influencing the dynamics of two species (one increasing and one declining), reinforcing our conclusion that productivity is lower (especially at NAS Brunswick) and survival higher at Brunswick and Redington than is indicated for the region and the continent. Calculation of intrinsic population growth rates (λ), recruitment values, and juvenal survival using advanced mark-recapture analyses could help us refine our understanding of the causes for population decline at Brunswick and Redington.

Species-specific summaries of 2003-2008 analyses

We summarize the demographic performance (2003-2008) of 13 species with sufficient data (a mean of >2.5 adults captured per year) or that are species of particular concern in the area. We compare population trend data with that reported by the Breeding Bird Survey (BBS) for the state of Maine for 1966-2007 and 2003-2007 ([Sauer et al. 2008](#)).

Red-eyed Vireo - breeds at all six stations, although only occasionally (< 50% of years) at Highland. Populations have shown a substantial 5-year increase (particularly marked between 2004 and 2006) according to MAPS data, with 2.5 adults captured per 600 net hours in 2008. This coincides with significant ($P < 0.01$) increases in Maine for both 1966-2007 (2.15% per year) and 2003-2007 (2.88% per year) according to BBS data. Productivity showed a steady but small increase between 2003 and 2007, followed by a decline to 2006 levels in 2008.

Black-capped Chickadee - breeds at all six stations, although in most but not all years at Golf Course. Populations according to MAPS data have shown a general and non-significant decline between 2003 and 2008 (to 1.8 adults captured per 600 net hours in 2008) while productivity showed a general increase of similar magnitude (0.8 young per adults in 2008). BBS data indicated a near-significant ($P < 0.10$) decline during 2003-2008 in Maine, whereas longer-term (1966-2007) BBS data indicated a significant ($P < 0.05$) increase of 0.87% per year.

Veery - breeds commonly at Brunswick but less commonly at Redington, where breeding was only confirmed at Potato Nubble (< 50% of years) and Blueline Trail (most but not all years). Population size fluctuated widely between 2003 and 2008 but showed little trend according to MAPS data (1.8 adults captured per 600 net hours in 2008); this compares with significant declines recorded in Maine with BBS data for both 1966-2007 ($P < 0.001$; -2.89% per year) and 2003-2007 ($P < 0.05$, -6.40% per year). At MAPS stations young were captured in only one

year, 2007.

Swainson's Thrush - breeds at all six stations, although only occasionally (< 50% of years) at the two Brunswick stations. Populations showed a near-significant increase (to 11.1 adults captured per 600 net hours in 2008) according to MAPS data whereas productivity showed a near-significant decrease (to 0.2 young per adult in 2008). BBS data indicate no trend in Maine for either 1966-2007 or 2003-2007.

Hermit Thrush - breeds at all six stations, although only occasionally at Potato Nubble and Highland (< 50% of years). The 5-year population trend at MAPS stations showed a slight but non-significant increase (most notably during 2005-2007), with 6.1 adults captured per 600 net hours in 2008; BBS trends in Maine were also non-significantly positive. Productivity showed a slight but consistent decline through the period according to MAPS data (no young captured in 2008).

Nashville Warbler - breeds at Golf Course and all four Redington Stations, in most years only at Potato Nubble and Redington Pond. Populations showed a near-significant increase (to 1.4 adults captured per 600 net hours in 2008) according to the MAPS data whereas productivity showed a near-significant decrease (to 1.5 young per adults in 2008). BBS data indicate no trend in Maine for either 1966-2007 or 2003-2007.

Magnolia Warbler - breeds at all four Redington stations and occasionally (< 50% of years) at Golf Course station at Brunswick. Populations were fairly stable during 2003-2008 according to MAPS data, with 8.6 adults captured per 600 net hours in 2008. This coincides with BBS data during 2003-2008, which also showed no trend in Maine (BBS trend was significantly positive for 1966-2007, with populations increasing at 3.46% per year). Productivity at MAPS stations increased linearly between 2003 to 2007, after which it decreased substantially in 2008 (0.33 young per adults), to below the 2003 level.

Black-throated Blue Warbler - breeds at all four Redington stations, although in most years only at Blueline Trail and only occasionally (< 50% of years) at Highland. Both population size and productivity were highly variable at MAPS stations, with population sizes showing a non-significant increasing trend (most noticeably between 2005 and 2007) and productivity showing little discernable trend. BBS data showed near-significant ($P < 0.10$) positive trends in Maine for both 1966-2007 (4.07% increase per year) and 2003-2008 (13.43% increase per year). A total of 6.1 adults were captured per 600 net hours and 0.4 young per adult in 2008.

Black-throated Green Warbler - breeds regularly at all six stations. Populations fluctuated widely between 2003 and 2008 according to MAPS data, slightly increasing overall but then declined dramatically between 2007 and 2008 (1.4 adults captured per 600 net hours). BBS data indicated no trend in 1966-2007 but a significantly ($P < 0.05$) positive trend of 6.50% per year in Maine for 2003-2008. Productivity according to MAPS data declined between 2003 and 2005, after which it increased through 2008, to slightly higher levels than in 2003 (0.5 young per adult in 2008).

Ovenbird - breeds at all six stations, although only occasionally (< 50% of years) at Blueline Trail and Highland. Populations increased significantly between 2003 and 2008 (to 7.5 adults captured per 600 net hours in 2008) at MAPS stations whereas productivity remained relatively stable (0.1 young per adult in 2008). BBS data indicated no trend in 1966-2007 but a significantly ($P < 0.05$) positive trend of 4.78% per year in Maine for 2003-2008.

Common Yellowthroat - breeds at all six stations, although in most but not all years at Highland and only occasionally (< 50% of years) at Redington Pond. Population size was stable during the 5-year period at MAPS stations (3.9 adults captured per 600 net hours in 2008), and productivity slight increased (to 0.2 young per adult in 2008). BBS data also indicated a stable population during 2003-2008 in Maine (but showed a highly significant decline of -1.02% per year for 1966-2008).

Canada Warbler - breeds only at Potato Nubble (most but not all years) and at Highland (< 50% of years). Population size at MAPS stations fluctuated widely during the 5-year period, with an apparent peak in 2005 and dropping to a low of 1.1 adults captured per 600 net hours in 2008. BBS data indicate a near-significant ($P < 0.10$) declining trend (-2.72 per year) for 1966-2007 but a non-significant positive trend for 2003-2008 in Maine. Productivity increased steadily between 2003 and 2007 at MAPS stations, after which it decreased substantially in 2008, to slightly above the 2003 level (0.3 young per adult).

White-throated Sparrow - breeds at all four Redington stations and occasionally (< 50% of years) at Golf Course. Populations showed a general increase between 2003 and 2008 (although dropping between 2007 and 2008, to 6.8 adults captured per 600 net hours in 2008) whereas productivity showed a highly significant 5-year decline, to a low of 0.7 young per adult in 2008. This decline is concerning although BBS data for 2003-2008 indicate no trend in Maine; longer-term data (1966-2007) indicated a significant ($P < 0.01$) decline of 2.69% per year.

Management considerations

Management could be applied to increase the productivity of landbirds at the two locations, particularly Brunswick. Target species for which attention may be especially important according to our data include Yellow-bellied Flycatcher, Red-eyed Vireo, Hermit Thrush, American Robin, Blackpoll Warbler, American Redstart, Ovenbird, Common Yellowthroat, and White-throated Sparrow. Management actions designed to increase nesting opportunities by ensuring the availability of dense understory in open edge woodland may increase local productivity and lead to higher rates of recruitment. Such habitat is common to regenerating forest gaps and the edges of cut areas. The availability of understory vegetation can be seriously depleted by foraging white-tailed deer that are overpopulated across the northeastern United States, and deer exclusion may allow more dense foliage to develop.

Overall, it appears that high survival at Brunswick and Redington may be counterbalancing the low productivity, resulting in stable or increasing six-year population trends for many species. While on the surface this may appear to be a favorable situation, it is opposite to results from other MAPS stations across the continent, generally indicating that low survival, particularly for Neotropical migrants, is the primary factor driving population declines. Thus, should survival of

the populations at NAS Brunswick decline, we will likely be facing some severe population declines at this installation. Low productivity combined with increasing populations may also indicate that NAS Brunswick may be harboring a sink population that is being supported primarily by higher productivity from surrounding regions. One of the goals of the MAPS program is to identify such populations, such that management actions can be taken to increase productivity. Once causal factors for population declines or low productivity have been confirmed with an adequate time-series of data (six or more years), we will be prepared to make more specific management recommendations to increase productivity and/or survival of landbirds at Brunswick and Redington and to assess the results of management actions.

Future monitoring and research with a regional perspective

The long-term goal for the Brunswick and Redington MAPS program is to provide critical information to clarify the ecological processes leading from environmental stressors to landbird population responses. We will accomplish this by including Brunswick and Redington data in analyses of data from other MAPS stations in the Northeast, 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 Northeastern MAPS region.

In addition, MAPS data from NIOC Brunswick and Redington will provide an important contribution to the determination of accurate indices of adult population size and productivity and precise estimates of adult survival rates on the still larger region-wide scale (e.g., northeastern North America) for many landbird species. Recently we undertook an analysis of the entire MAPS program in the Northeastern Region for the Northeast Coordinated Bird Monitoring Partnership ([DeSante et al. 2008](#)). In our report it was recommended that the MAPS program be increased by about 50% throughout the Northeastern United States. Five of the six stations at Brunswick and Redington (all but Chimney Rock) were recommended to be continued as contributing adequately to our understanding of population dynamics for species of concern within Bird Conservation Region 14 the Atlantic Northern Forest, receiving a mean priority score of 54.1, compared with a mean score of 28.0 for all MAPS stations in the region; thus, the recommendation of the report was that these five stations were of significant contribution to the MAPS Program in the Northeast Region and in BCR 14 and that all five stations should be continued. The priority score for Chimney Rock station, however, was 30.0, and it was recommended that this station be discontinued and preferably relocated to another more productive area on the Brunswick installation. We strongly recommend the continuation of all four stations at Redington, and that the two stations at Brunswick be re-evaluated and possibly relocated.

As more years of data accumulate we will be able to make better assessments of population trends as well as inferences about the effects of weather on productivity and the effect of changes in productivity on population size. The precision of our survival estimates will improve

substantially as more data is collected, up to and even beyond 12 years of data collection (Rosenberg 1996). Pooling data at this level will further allow comparison between Brunswick/Redington and other military installations, parks, other protected areas along the Atlantic seaboard that participate in the MAPS program, and unprotected areas along the Atlantic coast. Finally, MAPS data from Brunswick and Redington can be pooled with other MAPS data to provide large-scale regional (or even continental) indices and estimates of (and longer-term trends in) these key demographic parameters, as we have provided in this report regarding productivity in the Northeastern MAPS region and adult survival in Bird Conservation Region 14. We conclude that the MAPS protocol is well-suited to provide an integral component of Brunswick and Redington's long-term ecological monitoring effort, and we recommend the continued operation of the Brunswick and Redington MAPS stations well into the future.

ACKNOWLEDGMENTS

All data collected for the MAPS Program at Naval Air Station Brunswick and Redington Training Facility in 2008 were gathered primarily by Dan Allen and Angela Fojtik (field biologist interns of The Institute for Bird Populations), as supervised by IBP Biologist Leslie Latt. We thank these biologists for their excellent work in operating the Brunswick/Redington MAPS stations. We also thank the on-duty personnel of SERE exercises for logistical help. We especially thank Natural Resource Managers Charles Webster, and Greg Apraham for invaluable assistance in selecting and setting up the stations and for assistance with logistics and equipment, and Chief of SERE Operations Merle Wagg for assistance in working in conjunction with SERE exercises. Financial support for the MAPS Program and housing for the field biologist interns, for which we are very grateful, were provided by Naval Air Station Brunswick and Redington through a Cooperative Agreement between NAVFACENCOM, Atlantic Division, and The Institute for Bird Populations. This is Contribution Number 374 of IBP.

LITERATURE CITED

Links to PDF versions or web pages are provided for relevant publications.

- 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. 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. 1999. Patterns of productivity and survivorship from the MAPS program. In: Bonney, Rick, David N. Pashley, Robert J. Cooper, and Larry Niles, eds. *Strategies for Bird Conservation: The Partners in Flight Planning Process*. Cornell Lab of Ornithology. [HTML](#)
- 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., 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.
- 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. 2008. MAPS Manual: 2008 Protocol. Contribution No. 127 of The Institute for Bird Populations. [PDF \(1219KB\)](#)
- DeSante, D.F., M.P. Nott, and D.R. O'Grady. 2001. Identifying the Proximate Demographic Cause(s) of Population Change by Modeling Spatial Variation in Productivity, Survivorship, and Population Trends. *ARDEA* 89:185-208. [PDF \(1.3MB\)](#)
- 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., P. Pyle, and D. Kaschube. 2004. The 2003 annual and final report of the Monitoring Avian Productivity and Survivorship (MAPS) Program on Cape Cod National Seashore. The Institute for Bird Populations, Point Reyes Station, California. 48 pp.
- DeSante, D.F., J.F. Saracco, P. Pyle, D.R. Kaschube, and M.K. Chambers. 2008. Integrating the MAPS Program into Coordinated Bird Monitoring in the Northeast (U.S. Fish and Wildlife Service Region 5). The Institute for Bird Populations, Point Reyes Station, California. 99 pp. [\(PDF\)](#)
- 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.
- Michel, N., D. F. DeSante, D. R. Kaschube, and M. P. Nott, 2006. The Monitoring Avian Productivity and Survivorship (MAPS) Program Annual Reports, 1989-2003. NBII/MAPS Avian Demographics Query Interface. Web-based database of continental and regional demographics. for USGS/NBII Washington, D.C.
<http://www.birdpop.org/nbii/NBIIHome.asp>
- Nott, M.P. 2000. Identifying Management Actions on DoD Installations to Reverse Declines in Neotropical Birds. (Tech. report to U.S. Army Corps of Engineers, Contribution No. 133 of The Institute for Bird Populations, 21 p) *This report documents the results of a landscape analysis of National Landcover Data surrounding MAPS stations located on Big Oaks NWR (formerly Jefferson Proving Ground). Importantly, this study quantifies forest patch size threshold values of maximum reproductive success for four forest-interior landbird species.* [PDF \(200KB\)](#)
- Nott, M.P. 2002. Weather and landscape effects on landbird survival and reproductive success in Texas. (Tech. report to the Texas Army National Guard Command: Adjutant General's Department and U.S. Department of Defense Legacy Resources Management Program, Contribution No. 163 of The Institute for Bird Populations.) [PDF \(10MB\)](#)
- 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 (eds.), *Predicting Species Occurrences: Issues of Scale and Accuracy*. Island Press, NY.
- Nott, M. P., K. Gordon, D. R. Kaschube, and T. Morris. 2008a. Landbird Monitoring in Virginia: An Analysis of Historical MAPS data in Virginia and Surrounding Region. A Report to the State of Virginia, Dept. of Game and Inland Fisheries, Richmond, VA. Contribution No.294 of The Institute for Bird Populations, Point Reyes Station, CA. [\(PDF\)](#)
- Nott, M. P. and N. Michel. 2005. Management strategies for reversing declines in landbirds of conservation concern on military installations: Predictive modeling of landbird populations on military installations. The Institute for Bird Populations, Pt. Reyes Station, CA. *A report to the Legacy Resources Management Office, Washington. D.C.* [PDF \(641KB\)](#)
- Nott, M. P. and T. Morris. 2007. Performance Measure Analysis: Examples of Comparing and Contrasting Installation-specific Demographics with Regional Demographics and Landscape Characteristics. (Tech. report to the U.S. Department of Defense Legacy Resources Management Program, Contribution No.324 of The Institute for Bird Populations, Point Reyes Station, CA.) [PDF \(7MB\)](#)
- 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.
- 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. *A report to the Legacy Resources Management Office, Washington. D.C.* [Executive Summary, PDF \(332KB\)](#)

- Nott, M.P., DeSante, D.F., Siegel, R.B., 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. [PDF \(411KB\)](#)
Read more about this [study of climate and birds](#)
- Nott, M.P., P. Pyle, and D. Kaschube. 2007. The 2006 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) Program at Naval Air Station Brunswick and Redington Training Facility. The Institute for Bird Populations, Point Reyes, CA. [\(PDF\)](#)
- Nott, M.P., P. Pyle, and D. Kaschube. 2008b. The 2007 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) Program at Naval Air Station Brunswick and Redington Training Facility. The Institute for Bird Populations, Point Reyes, CA. [\(PDF\)](#)
- 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, pp. 60-72.
- Pyle, P., D. Kaschube, and P. Nott. 2006. The 2006 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) Program at Naval Air Station Brunswick and Redington Training Facility. The Institute for Bird Populations, Point Reyes, CA. [\(PDF\)](#)
- 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.
- Rosenberg, D.K. (1996) Evaluation of the statistical properties of the Monitoring Avian Productivity and Survivorship (MAPS) program. The Institute for Bird Populations Pt. Reyes Station, CA.
- Saracco, J. F., and D. F. DeSante. 2008. Identifying proximate causes of population trends in migratory birds. Submitted to the National Fish and Wildlife Foundation. The Institute for Bird Populations, Pt. Reyes Station, CA. [\(PDF\)](#)
- Saracco, J. F., D. F. DeSante, and D. R. Kaschube. 2008. Assessing landbird monitoring programs and demographic causes of population trends. *Journal of Wildlife Management* 72:1665-1673. [\(PDF\)](#)
- Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2006. Version 5.15.2008. [USGS Patuxent Wildlife Research Center](#), Laurel, MD.
- Siegel, R. B., M. P. Nott and D. F. DeSante. 2001. Using point counts to establish conservation priorities: how many visits are optimal? *Journal of Field Ornithology*. 72:228-235.
- 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

.

Table 1. Summary of the 2007 MAPS program on Naval Air Station Brunswick and Redington Training Facility.

Station			Major Habitat Type	Latitude-longitude	Avg Elev. (m)	2007 operation		
Name	Code	No.				Total number of net-hours ¹	No. of periods	Inclusive dates
Naval Air Station Brunswick								
Golf Course	GOCO	15654	Mixed balsam fir and maple forest with boggy areas, golf course	43°52'08"N,-69°56'20"W	13	336.7 (318.8)	6	6/14 - 7/31
Chimney Rock	CHRO	15655	Northern red oak and maple forest, shrubs and small firs along seasonal streams	43°52'24"N,-69°55'05"W	18	333.0 (332.5)	6	6/15 - 8/05
Redington Training Facility								
Potato Nubble	PONU	15657	Mixed forest of maple/birch deciduous and fir/spruce coniferous components	44°59'30"N,-70°30'33"W	488	246.7 (212.0)	5	6/21 - 8/02
Redington Pond	REPO	15656	Primarily birch/maple forest with scattered balsam fir, pond, alder thicket	44°58'57"N,-70°24'53"W	507	174.7 (159.3)	5	6/23 - 8/01
Blueline Trail	BLUE	15658	Boggy balsam fir and Eastern hemlock forest, alder thicket	44°59'20"N,-70°26'12"W	515	186.0 (176.0)	4	7/04 - 8/03
Highland	HGHL	15659	Stunted red spruce and balsam fir forest, beaver ponds, very boggy areas	45°00'31"N,-70°27'10"W	724	266.5 (262.2)	5	6/20 - 8/04
ALL STATIONS COMBINED						1543.5(1460.8)	6	6/14 - 8/05

¹ Total net-hours in 2007. Net-hours in 2007 that could be compared in a constant-effort manner to 2006 are shown in parentheses.

Table 2. Capture summary for the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility in 2007. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Cooper's Hawk								1										
Ruffed Grouse		1																
Ruby-throated Hummingbird								1				1						
Yellow-bellied Sapsucker							1											
Downy Woodpecker												7						
Hairy Woodpecker																	1	
Black-backed Woodpecker																	1	
Yellow-bellied Flycatcher																		1
Acadian Flycatcher										1			4					
Traill's Flycatcher										1			3					
Least Flycatcher										4			6					
Blue-headed Vireo										1							1	
Philadelphia Vireo							2		1									
Red-eyed Vireo							1			11			2					
Gray Jay																	1	
Blue Jay	1																	
Black-capped Chickadee	3			2			1						5				1	
Boreal Chickadee																	1	
Brown Creeper							2			1				1			1	
Winter Wren													2					
Golden-crowned Kinglet																	5	
Ruby-crowned Kinglet	1												3					
Veery	1						2			1			1				2	
Gray-cheeked Thrush							1										1	
Swainson's Thrush	1									12		9	1				5	8
Hermit Thrush	5		2	4	2	10		1		1			2		2			
American Robin				2	1	1				7		2	3	1				
Cedar Waxwing	1									1			1					

Table 2. (cont.) Capture summary for the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility in 2007. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Nashville Warbler	1												1			1		
Northern Parula								1										
Chestnut-sided Warbler							1			3			3					
Magnolia Warbler							3			4			18		1	2		
Black-throated Blue Warbler							16	2	4	9		1	5		2			
Yellow-rumped Warbler				1			1		1	2			4					
Black-throated Green Warb.	5		1	4		4	2						6					
Pine Warbler													1		1			
Blackpoll Warbler													2					5
Black-and-white Warbler	2									1			3	2				
American Redstart							1			3								
Ovenbird			1	5		4	8		1	3		1	1					
Northern Waterthrush													3		2			
Common Yellowthroat	4		3				3			3			4		1			
Canada Warbler										2			1					
Song Sparrow				1									3					
Lincoln's Sparrow							1											
White-throated Sparrow				1		1	5	1	2	5		1	10	2	5	6	2	
Dark-eyed Junco							2			1			1			10	1	
Northern Cardinal				1														
Rose-breasted Grosbeak													3					
Common Grackle				1									1					
Purple Finch										1						1		
ALL SPECIES POOLED	25	1	7	22	0	12	64	6	10	78	0	14	110	7	14	40	3	14
Total Number of Captures		33		34			80			92			131			57		
Number of Species	11	1	4	10	0	5	20	5	6	23	0	5	31	5	7	16	2	3
Total Number of Species		13		10			23			23			33			18		

Table 3. Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility in 2007.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Yellow-bellied Sapsucker							2.4	0.0	0.00									
Downy Woodpecker													3.2	19.4	6.00			
Hairy Woodpecker																2.3	0.0	0.00
Black-backed Woodpecker																0.0	2.3	und. ¹
Yellow-bellied Flycatcher																2.3	0.0	0.00
Acadian Flycatcher										0.0	3.4	und. ¹	6.5	3.2	0.50			
Traill's Flycatcher										3.4	0.0	0.00	9.7	0.0	0.00			
Least Flycatcher										13.7	0.0	0.00	3.2	9.7	3.00			
Blue-headed Vireo										3.4	0.0	0.00				2.3	0.0	0.00
Philadelphia Vireo							4.9	0.0	0.00									
Red-eyed Vireo							2.4	0.0	0.00	24.0	13.7	0.57	6.5	0.0	0.00			
Gray Jay																0.0	2.3	und.
Blue Jay	1.8	0.0	0.00															
Black-capped Chickadee	3.6	1.8	0.50	3.6	0.0	0.00	2.4	0.0	0.00				3.2	12.9	4.00	0.0	2.3	und.
Boreal Chickadee																0.0	2.3	und.
Brown Creeper							0.0	4.9	und. ¹	0.0	3.4	und.				0.0	2.3	und.
Winter Wren													0.0	6.5	und. ¹			
Golden-crowned Kinglet																0.0	11.3	und.
Ruby-crowned Kinglet	1.8	0.0	0.00										9.7	0.0	0.00			
Veery	1.8	0.0	0.00				4.9	0.0	0.00	3.4	0.0	0.00	0.0	3.2	und.	4.5	0.0	0.00
Gray-cheeked Thrush							2.4	0.0	0.00							2.3	0.0	0.00

Table 3. (cont.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility in 2007.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Swainson's Thrush	1.8	0.0	0.00							55.0	6.9	0.13	3.2	0.0	0.00	22.5	0.0	0.00
Hermit Thrush	10.7	0.0	0.00	7.2	1.8	0.25	14.6	9.7	0.67	0.0	3.4	und.	9.7	0.0	0.00			
American Robin				3.6	0.0	0.00	2.4	0.0	0.00	20.6	6.9	0.33	9.7	0.0	0.00			
Cedar Waxwing	1.8	0.0	0.00							3.4	0.0	0.00	3.2	0.0	0.00			
Nashville Warbler	1.8	0.0	0.00										0.0	3.2	und.	2.3	0.0	0.00
Chestnut-sided Warbler							0.0	2.4	und.	3.4	6.9	2.00	0.0	6.5	und.			
Magnolia Warbler							4.9	2.4	0.50	6.9	6.9	1.00	19.4	38.7	2.00	4.5	0.0	0.00
Black-throated Blue Warbler							31.6	9.7	0.31	17.2	17.2	1.00	3.2	12.9	4.00			
Yellow-rumped Warbler				1.8	0.0	0.00	2.4	2.4	1.00	6.9	0.0	0.00	3.2	9.7	3.00			
Black-throated Green Warbler	8.9	0.0	0.00	10.8	0.0	0.00	4.9	0.0	0.00				6.5	12.9	2.00			
Pine Warbler													3.2	0.0	0.00			
Blackpoll Warbler													0.0	6.5	und.	6.8	0.0	0.00
Black-and-white Warbler	3.6	0.0	0.00							0.0	3.4	und.	6.5	3.2	0.50			
American Redstart							0.0	2.4	und.	3.4	6.9	2.00						
Ovenbird	1.8	0.0	0.00	12.6	0.0	0.00	17.0	4.9	0.29	13.7	0.0	0.00	3.2	0.0	0.00			
Northern Waterthrush													9.7	3.2	0.33			
Common Yellowthroat	5.3	3.6	0.67				2.4	2.4	1.00	10.3	0.0	0.00	16.1	0.0	0.00			
Canada Warbler										3.4	3.4	1.00	0.0	3.2	und.			
Song Sparrow				0.0	1.8	und. ¹							3.2	6.5	2.00			
Lincoln's Sparrow							2.4	0.0	0.00									
White-throated Sparrow				1.8	0.0	0.00	9.7	2.4	0.25	13.7	3.4	0.25	35.5	9.7	0.27	11.3	4.5	0.40

Table 3. (cont.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility in 2007.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Dark-eyed Junco							2.4	2.4	1.00	3.4	0.0	0.00	0.0	3.2	und.	6.8	18.0	2.67
Northern Cardinal				1.8	0.0	0.00												
Rose-breasted Grosbeak													0.0	9.7	und.			
Common Grackle				1.8	0.0	0.00							3.2	0.0	0.00			
Purple Finch										3.4	0.0	0.00				2.3	0.0	0.00
ALL SPECIES POOLED	44.6	5.3	0.12	45.0	3.6	0.08	114.3	46.2	0.40	213.0	85.9	0.40	180.6	183.9	1.02	69.8	45.0	0.65
Number of Species	12	2		9	2		17	11		19	13		23	20		12	8	
Total Number of Species		12			10			20			23			31			18	

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

Table 4. Summary of results for all six Naval Air Station Brunswick and Redington Training Facility MAPS stations combined in 2007.

Species	Birds captured			Birds/600 nethours		Reprod. Index
	Newly banded	Un-banded	Recap-tured	Adults	Young	
Cooper's Hawk		1				
Ruffed Grouse		1				
Ruby-throated Hummingbird		2				
Yellow-bellied Sapsucker	1			0.4	0.0	0.00
Downy Woodpecker	7			0.4	2.3	6.00
Hairy Woodpecker	1			0.4	0.0	0.00
Black-backed Woodpecker	1			0.0	0.4	und. ¹
Yellow-bellied Flycatcher			1	0.4	0.0	0.00
Acadian Flycatcher	5			0.8	0.8	1.00
Traill's Flycatcher	4			1.6	0.0	0.00
Least Flycatcher	10			1.9	1.2	0.60
Blue-headed Vireo	2			0.8	0.0	0.00
Philadelphia Vireo	2		1	0.8	0.0	0.00
Red-eyed Vireo	14			3.9	1.6	0.40
Gray Jay	1			0.0	0.4	und.
Blue Jay	1			0.4	0.0	0.00
Black-capped Chickadee	12			2.3	2.3	1.00
Boreal Chickadee	1			0.0	0.4	und.
Brown Creeper	4	1		0.0	1.6	und.
Winter Wren	2			0.0	0.8	und.
Golden-crowned Kinglet	5			0.0	1.9	und.
Ruby-crowned Kinglet	4			1.6	0.0	0.00
Veery	7			2.3	0.4	0.17
Gray-cheeked Thrush	2			0.8	0.0	0.00
Swainson's Thrush	19		17	10.9	0.8	0.07
Hermit Thrush	22		7	7.4	2.3	0.32
American Robin	13	1	3	4.7	0.8	0.17
Cedar Waxwing	3			1.2	0.0	0.00
Nashville Warbler	3			0.8	0.4	0.50
Northern Parula		1				
Chestnut-sided Warbler	7			0.4	1.9	5.00
Magnolia Warbler	27		1	4.7	5.8	1.25

Table 4. (cont.) Summary of results for all six Naval Air Station Brunswick and Redington Training Facility MAPS stations combined in 2007.

Species	Birds captured			Birds/600 nethours		Reprod. Index
	Newly banded	Un-banded	Recap-tured	Adults	Young	
Black-throated Blue Warbler	30	2	7	7.4	5.1	0.68
Yellow-rumped Warbler	8		1	1.9	1.6	0.80
Black-throated Green Warbler	17		5	5.8	1.6	0.27
Pine Warbler	1		1	0.4	0.0	0.00
Blackpoll Warbler	2		5	1.2	0.8	0.67
Black-and-white Warbler	6	2		1.6	0.8	0.50
American Redstart	4			0.4	1.2	3.00
Ovenbird	17		7	7.8	0.8	0.10
Northern Waterthrush	3		2	1.2	0.4	0.33
Common Yellowthroat	14		4	4.7	1.2	0.25
Canada Warbler	3			0.4	0.8	2.00
Song Sparrow	4			0.4	1.2	3.00
Lincoln's Sparrow	1			0.4	0.0	0.00
White-throated Sparrow	27	5	9	9.7	2.7	0.28
Dark-eyed Junco	14	1		1.9	3.9	2.00
Northern Cardinal	1			0.4	0.0	0.00
Rose-breasted Grosbeak	3			0.0	1.2	und.
Common Grackle	2			0.8	0.0	0.00
Purple Finch	2			0.8	0.0	0.00
ALL SPECIES POOLED	339	17	71	95.6	49.0	0.51
Total Number of Captures		427				
Number of Species	46	10	15	40	32	
Total Number of Species		51			47	

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

Table 5. Percentage changes between 2006 and 2007 in the numbers of individual ADULT birds captured at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species								All six stations combined				
	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	Number of adults		Percent change	SE ²	
								2006	2007			
Yellow-bellied Sapsucker			++++ ³				1	0	1	++++ ³		
Downy Woodpecker	-100.0				0.0		2	2	1	-50.0	50.0	
Hairy Woodpecker		-100.0	-100.0			++++ ³	3	2	1	-50.0	75.0	
Black-backed Woodpecker							0	0	0			
Yellow-bellied Flycatcher				-100.0	-100.0	-66.7	3	6	1	-83.3	12.7	**
Acadian Flycatcher					++++ ³		1	0	2	++++		
Traill's Flycatcher				-50.0	50.0		2	4	4	0.0	50.0	
Least Flycatcher				-33.3	++++		2	3	3	0.0	66.7	
Blue-headed Vireo	-100.0	-100.0		++++ ³		++++	4	2	2	0.0	115.5	
Philadelphia Vireo			++++	-100.0			2	1	2	100.0	400.0	
Red-eyed Vireo		-100.0	-66.7	150.0	100.0		4	8	8	0.0	61.2	
Gray Jay							0	0	0			
Blue Jay	++++ ³	-100.0					2	1	1	0.0	200.0	
Black-capped Chickadee	-33.3	0.0	++++		++++		4	5	6	20.0	50.2	
Boreal Chickadee						-100.0	1	2	0	-100.0		
Red-breasted Nuthatch					-100.0		1	1	0	-100.0		
Brown Creeper	-100.0		-100.0				2	4	0	-100.0	88.9	
Winter Wren							0	0	0			
Golden-crowned Kinglet							0	0	0			
Ruby-crowned Kinglet	++++				++++		2	0	4	++++		
Veery	-100.0	-100.0	++++	++++		++++	5	5	5	0.0	104.9	
Gray-cheeked Thrush			++++			++++	2	0	2	++++		
Swainson's Thrush	++++		-100.0	160.0	-66.7	0.0	5	22	25	13.6	46.3	
Hermit Thrush	50.0	-20.0	300.0		200.0		4	11	17	54.5	49.3	
American Robin		100.0	++++	400.0	200.0		4	3	11	266.7	94.3	*

Table 5. (cont.) Percentage changes between 2006 and 2007 in the numbers of individual ADULT birds captured at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined				
								Number of adults		Percent change	SE ²	
								2006	2007			
Cedar Waxwing	++++			0.0	-75.0		3	5	3	-40.0	43.3	
Tennessee Warbler					-100.0		1	4	0	-100.0		
Nashville Warbler	0.0		-100.0		-100.0	-80.0	4	10	2	-80.0	11.3	***
Northern Parula							0	0	0			
Chestnut-sided Warbler				-50.0			1	2	1	-50.0		
Magnolia Warbler			-71.4	0.0	200.0	0.0	4	12	11	-8.3	58.5	
Black-throated Blue Warb.			140.0	-16.7	0.0		3	12	18	50.0	61.7	
Yellow-rumped Warbler		0.0	-75.0	100.0	++++	-100.0	5	10	5	-50.0	32.6	
Black-throated Green Warb.	150.0	0.0	++++	-100.0	++++		5	10	15	50.0	61.2	
Blackburnian Warbler	-100.0						1	1	0	-100.0		
Pine Warbler					++++		1	0	1	++++		
Bay-breasted Warbler						-100.0	1	2	0	-100.0		
Blackpoll Warbler						-50.0	1	6	3	-50.0		
Black-and-white Warbler	-50.0	-100.0					2	4	1	-75.0	25.0	
American Redstart			-100.0	-85.7			2	10	1	-90.0	6.0	
Ovenbird	-83.3	-30.0	0.0	++++	++++		5	23	20	-13.0	30.2	
Northern Waterthrush					200.0		1	1	3	200.0		
Common Yellowthroat	-57.1	-100.0	++++	50.0	66.7		5	14	12	-14.3	36.1	
Canada Warbler			-100.0	0.0			2	3	1	-66.7	44.4	
Scarlet Tanager		-100.0					1	1	0	-100.0		
Song Sparrow				-100.0	++++		2	1	1	0.0	200.0	
Lincoln's Sparrow			++++				1	0	1	++++		
Swamp Sparrow							0	0	0			
White-throated Sparrow	-100.0	0.0	0.0	200.0	120.0	25.0	6	15	23	53.3	32.4	
Dark-eyed Junco			0.0	0.0		50.0	3	4	5	25.0	18.8	

Table 5. (cont.) Percentage changes between 2006 and 2007 in the numbers of individual ADULT birds captured at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined			
								Number of adults		Percent change	SE ²
								2006	2007		
Northern Cardinal	-100.0	++++ ³					2	1	1	0.0	200.0
Rose-breasted Grosbeak							0	0	0		
Common Grackle		++++			++++		2	0	2	++++	
Purple Finch				-100.0		++++	2	2	1	-50.0	100.0
American Goldfinch	-100.0	-100.0					2	3	0	-100.0	88.9
ALL SPECIES POOLED	-37.8	-37.5	-2.3	18.6	58.8	-22.5	6	238	227	-4.6	14.1
No. species that increased ⁴	6(4)	3 (2)	11(9)	9(3)	18(10)	7(5)				17(7)	
No. species that decreased ⁵	12(8)	11(9)	9(6)	10 (5)	6(4)	6(3)				23(8)	
No. species remained same	1	4	3	4	2	2				8	
Total Number of Species	19	18	23	23	26	15				48	
Proportion of increasing (decreasing) species	(0.632)	(0.611)	(0.391)	0.391	0.692	(0.400)				(0.479)	
Sig. of increase (decrease) ⁶	(0.180)	(0.240)	(0.895)	0.895	0.038	(0.849)				(0.667)	
					**						

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 2006.

⁴ No. of species for which adults were captured in 2007 but not in 2006 are in parentheses.

⁵ No. of species for which adults were captured in 2006 but not in 2007 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. Percentage changes between 2006 and 2007 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined			
								Number of young		Percent change	SE ²
								2006	2007		
Yellow-bellied Sapsucker							0	0	0		
Downy Woodpecker					++++ ³		1	0	6	++++ ³	
Hairy Woodpecker							0	0	0		
Black-backed Woodpecker						++++ ³	1	0	1	++++	
Yellow-bellied Flycatcher					-100.0		1	1	0	-100.0	
Acadian Flycatcher				++++ ³	++++		2	0	2	++++	
Trail's Flycatcher							0	0	0		
Least Flycatcher				-100.0	-50.0		2	8	3	-62.5	18.8
Blue-headed Vireo					-100.0		1	1	0	-100.0	
Philadelphia Vireo							0	0	0		
Red-eyed Vireo				0.0			1	1	1	0.0	
Gray Jay						++++	1	0	1	++++	
Blue Jay							0	0	0		
Black-capped Chickadee	-50.0				33.3	-50.0	3	7	6	-14.3	30.6
Boreal Chickadee						++++	1	0	1	++++	
Red-breasted Nuthatch							0	0	0		
Brown Creeper		-100.0	0.0	++++		++++	4	4	4	0.0	70.7
Winter Wren					++++		1	0	2	++++	
Golden-crowned Kinglet					-100.0	25.0	2	5	5	0.0	40.0
Ruby-crowned Kinglet							0	0	0		
Veery					++++		1	0	1	++++	
Gray-cheeked Thrush							0	0	0		
Swainson's Thrush			-100.0	-50.0	-100.0	-100.0	4	20	2	-90.0	11.7 ***
Hermit Thrush		0.0	300.0	0.0	-100.0		4	5	6	20.0	85.4
American Robin		-100.0		100.0			2	2	2	0.0	100.0

Table 6. (cont.) Percentage changes between 2006 and 2007 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined				
								Number of young		Percent change	SE ²	
								2006	2007			
Cedar Waxwing							0	0	0			
Tennessee Warbler							0	0	0			
Nashville Warbler				-100.0	0.0	-100.0	3	4	1	-75.0	28.6	
Northern Parula							1	1	0	-100.0		
Chestnut-sided Warbler				++++	-50.0		2	4	4	0.0	100.0	
Magnolia Warbler			-66.7	++++	500.0	-100.0	4	11	15	36.4	135.4	
Black-throated Blue Warb.			-72.7	-28.6	100.0	-100.0	4	21	12	-42.9	24.8	
Yellow-rumped Warbler			-50.0	-100.0	50.0	-100.0	4	6	4	-33.3	37.4	
Black-throated Green Warb.				-100.0	0.0		2	5	4	-20.0	32.0	
Blackburnian Warbler				-100.0	-100.0		2	3	0	-100.0	88.9	
Pine Warbler							0	0	0			
Bay-breasted Warbler						-100.0	1	1	0	-100.0		
Blackpoll Warbler					100.0	-100.0	2	2	2	0.0	100.0	
Black-and-white Warbler				++++	0.0		2	1	2	100.0	200.0	
American Redstart			++++ ³	-81.8	-100.0		3	13	3	-76.9	11.6	**
Ovenbird		-100.0	-80.0	-100.0			3	9	1	-88.9	7.4	***
Northern Waterthrush		-100.0			0.0		2	2	1	-50.0	50.0	
Common Yellowthroat	++++ ³		0.0				2	1	3	200.0	400.0	
Canada Warbler				-100.0	++++		2	1	1	0.0	200.0	
Scarlet Tanager							0	0	0			
Song Sparrow		++++ ³			++++		2	0	3	++++		
Lincoln's Sparrow							0	0	0			
Swamp Sparrow				-100.0	-100.0		2	3	0	-100.0	88.9	
White-throated Sparrow			-100.0	0.0	0.0	100.0	4	5	5	0.0	32.7	
Dark-eyed Junco			++++		++++	700.0	3	1	10	900.0	300.0	*

Table 6. (cont.) Percentage changes between 2006 and 2007 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined			
								Number of young		Percent change	SE ²
								2006	2007		
Northern Cardinal							0	0	0		
Rose-breasted Grosbeak					++++	-100.0	2	1	3	200.0	600.0
Common Grackle							0	0	0		
Purple Finch						-100.0	1	1	0	-100.0	
American Goldfinch							0	0	0		
ALL SPECIES POOLED	50.0	-71.4	-48.3	-43.2	36.6	-41.2	6	150	117	-22.0	20.0
No. species that increased ⁴	1(1)	1 (1)	3(2)	6(5)	13(8)	7(4)				14(8)	
No. species that decreased ⁵	1(0)	4 (4)	6(2)	11 (8)	11(9)	10(9)				17(7)	
No. species remained same	0	1	2	3	5	0				8	
Total Number of Species	2	6	11	20	29	17				39	
Proportion of increasing (decreasing) species	0.500	(0.667)	(0.545)	(0.550)	0.448	(0.588)				(0.436)	
Sig. of increase (decrease) ⁶	0.750	(0.344)	(0.500)	(0.412)	0.771	(0.315)				(0.832)	

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 2006.

⁴ No. of species for which young birds were captured in 2007 but not in 2006 are in parentheses.

⁵ No. of species for which young birds were captured in 2006 but not in 2007 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 7. Changes between 2006 and 2007 in the REPRODUCTIVE INDEX (young/adult) at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species								All six stations combined			
	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	Reproductive Index			
								2006	2007	Change	SE ²
Yellow-bellied Sapsucker			nc. ³				1	und. ⁴	0.000	nc. ³	
Downy Woodpecker	nc. ³				6.000		2	0.000	6.000	6.000	0.000
Hairy Woodpecker		nc. ³	nc.			nc. ³	3	0.000	0.000	0.000	0.000
Black-backed Woodpecker						nc.	1	und.	und. ⁴	nc.	
Yellow-bellied Flycatcher				nc. ³	nc. ³	0.000	3	0.167	0.000	-0.167	0.173
Acadian Flycatcher				nc.	nc.		2	und.	1.000	nc.	
Trill's Flycatcher				0.000	0.000		2	0.000	0.000	0.000	0.000
Least Flycatcher				-0.667	nc.		2	2.667	1.000	-1.667	4.216
Blue-headed Vireo	nc.	nc.		nc.	nc.	nc.	5	0.500	0.000	-0.500	0.685
Philadelphia Vireo			nc.	nc.			2	0.000	0.000	0.000	0.000
Red-eyed Vireo		nc.	0.000	-0.300	0.000		4	0.125	0.125	0.000	0.144
Gray Jay						nc.	1	und.	und.	nc.	
Blue Jay	nc.	nc.					2	0.000	0.000	0.000	0.000
Black-capped Chickadee	-0.167	0.000	nc.		nc.	nc.	5	1.400	1.000	-0.400	1.356
Boreal Chickadee						nc.	1	0.000	und.	nc.	
Red-breasted Nuthatch					nc.		1	0.000	und.	nc.	
Brown Creeper	nc.	nc.	nc.	nc.		nc.	5	1.000	und.	nc.	
Winter Wren					nc.		1	und.	und.	nc.	
Golden-crowned Kinglet					nc.	nc.	2	und.	und.	nc.	
Ruby-crowned Kinglet	nc.				nc.		2	und.	0.000	nc.	
Veery	nc.	nc.	nc.	nc.	nc.	nc.	6	0.000	0.200	0.200	0.255
Gray-cheeked Thrush			nc.			nc.	2	und.	0.000	nc.	
Swainson's Thrush	nc.		nc.	-0.646	-0.333	-1.200	5	0.909	0.080	-0.829	0.186 **
Hermit Thrush	0.000	0.050	0.000	nc.	-2.000		5	0.455	0.353	-0.102	0.384
American Robin		-1.000	nc.	-0.600	0.000		4	0.667	0.182	-0.485	0.342

Table 7. (cont.) Changes between 2006 and 2007 in the REPRODUCTIVE INDEX (young/adult) at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined			
								Reproductive Index			
								2006	2007	Change	SE ²
Cedar Waxwing	nc.			0.000	0.000		3	0.000	0.000	0.000	0.000
Tennessee Warbler					nc.		1	0.000	und.	nc.	
Nashville Warbler	0.000		nc.	nc.	nc.	-0.400	5	0.400	0.500	0.100	0.701
Northern Parula					nc.		1	und.	und.	nc.	
Chestnut-sided Warbler				2.000	nc.		2	2.000	4.000	2.000	5.657
Magnolia Warbler			0.071	2.000	1.000	-3.000	4	0.917	1.364	0.447	0.746
Black-throated Blue Warb.			-1.950	-0.167	2.000	nc.	4	1.750	0.667	-1.083	0.575
Yellow-rumped Warbler		0.000	0.500	-1.000	nc.	nc.	5	0.600	0.800	0.200	0.698
Black-throated Green Warb.	0.000	0.000	nc.	nc.	nc.		5	0.500	0.267	-0.233	0.646
Blackburnian Warbler	nc.			nc.	nc.		3	3.000	und.	nc.	
Pine Warbler					nc.		1	und.	0.000	nc.	
Bay-breasted Warbler						nc.	1	0.500	und.	nc.	
Blackpoll Warbler					nc.	-0.167	2	0.333	0.667	0.333	1.374
Black-and-white Warbler	0.000	nc.		nc.	nc.		4	0.250	2.000	1.750	2.850
American Redstart			nc.	0.429	nc.		3	1.300	3.000	1.700	1.828
Ovenbird	0.000	-0.200	-0.571	nc.	nc.		5	0.391	0.050	-0.341	0.212
Northern Waterthrush		nc.			-0.667		2	2.000	0.333	-1.667	
Common Yellowthroat	0.667	nc.	nc.	0.000	0.000		5	0.071	0.250	0.179	0.213
Canada Warbler			nc.	-1.000	nc.		3	0.333	1.000	0.667	1.774
Scarlet Tanager		nc.					1	0.000	und.	nc.	
Song Sparrow		nc.		nc.	nc.		3	0.000	3.000	3.000	1.732
Lincoln's Sparrow			nc.				1	und.	0.000	nc.	
Swamp Sparrow				nc.	nc.		2	und.	und.	nc.	
White-throated Sparrow	nc.	0.000	-0.333	-0.667	-0.218	0.150	6	0.333	0.217	-0.116	0.091
Dark-eyed Junco			1.000	0.000	nc.	2.167	4	0.250	2.000	1.750	0.751

Table 7. (cont.) Changes between 2006 and 2007 in the REPRODUCTIVE INDEX (young/adult) at six constant-effort MAPS stations on Naval Air Station Brunswick and Redington Training Facility.

Species	Golf Course	Chimney Rock	Potato Nubble	Redingt. Pond	Blueline Trail	Highland	n ¹	All six stations combined			
								Reproductive Index			
								2006	2007	Change	SE ²
Northern Cardinal	nc.	nc.					2	0.000	0.000	0.000	0.000
Rose-breasted Grosbeak					nc.	nc.	2	und.	und.	nc.	
Common Grackle		nc.			nc.		2	und.	0.000	nc.	
Purple Finch				nc.		nc.	2	0.500	0.000	-0.500	1.000
American Goldfinch	nc.	nc.					2	0.000	und.	nc.	
ALL SPECIES POOLED	0.076	-0.095	-0.310	-0.449	-0.169	-0.205	6	0.630	0.515	-0.115	0.232
No. species that increased	1	1	3	3	3	2				13	
No. species that decreased	1	2	3	8	4	4				13	
No. species remained same	5	4	2	4	5	1				7	
Total Number of Species ⁵	7	7	8	15	12	7				33	
Proportion of increasing (decreasing) species	0.143	(0.286)	(0.375)	(0.533)	(0.333)	(0.571)				(0.394)	
Sig. of increase (decrease) ⁶	0.992	(0.938)	(0.855)	(0.500)	(0.927)	(0.500)				(0.919)	

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 non-calculable at this station because no adult individual of the species was captured in one of the two years.

⁴ Reproductive index undefined because no adult individual of the species was captured in the year shown.

⁵ Species for which the change in the reproductive index is undefined are not included.

⁶ Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.

*** $P < 0.01$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$

Table 8. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility averaged over the five years, 2003-2007. Data for each species are included only from stations that lie within the breeding range of the species.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland			All stations pooled		
	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹
Yellow-bellied Sapsucker							0.8	0.0	0.00				1.2	0.0	0.00				0.3	0.0	0.00
Downy Woodpecker	0.3	0.0	0.00	0.3	0.0	0.00	0.3	0.6	0.00	0.9	0.0	0.00	1.9	4.5	2.11				0.6	0.7	1.88
Hairy Woodpecker	0.9	0.3	0.50	0.3	0.0	0.00	0.3	0.3	0.00				1.8	0.0	0.00	0.5	0.0	0.00	0.6	0.1	0.20
Black-backed Woodpecker																0.0	0.5	und. ³	0.0	0.1	und. ³
Eastern Wood-Pewee				0.3	0.0	0.00													0.1	0.0	0.00
Yellow-bellied Flycatcher										0.6	0.0	0.00	5.3	0.3	0.08	3.2	0.0	0.00	1.5	0.1	0.03
Acadian Flycatcher										0.0	0.7	und. ³	1.3	0.6	0.50				0.2	0.2	1.00
Trail's Flycatcher										6.9	0.0	0.00	6.5	0.0	0.00	0.3	0.0	0.00	2.1	0.0	0.00
Least Flycatcher										4.6	2.5	0.81	1.5	4.1	1.00	0.3	0.0	0.00	0.9	1.0	1.14
Eastern Phoebe													0.6	0.0	0.00				0.1	0.0	0.00
Blue-headed Vireo	2.2	0.0	0.00	0.3	0.0	0.00	0.6	0.3	0.50	1.6	0.0	0.00	0.6	0.6	0.50	0.5	0.0	0.00	0.9	0.2	0.13
Philadelphia Vireo							1.0	0.0	0.00	3.5	0.9	0.33							0.7	0.1	0.27
Red-eyed Vireo	0.6	0.0	0.00	3.8	0.0	0.00	1.8	0.0	0.00	10.8	3.1	0.14	2.6	0.0	0.00				2.9	0.4	0.09
Gray Jay																0.3	0.8	1.00	0.1	0.1	1.00
Blue Jay	1.6	0.0	0.00	0.6	0.0	0.00	0.7	0.0	0.00	0.3	0.0	0.00	0.6	0.0	0.00				0.6	0.0	0.00
Black-capped Chickadee	4.4	1.0	0.29	3.1	0.0	0.00	2.6	0.0	0.00	3.1	0.6	0.28	5.7	4.7	1.20	1.8	1.3	0.33	3.4	1.2	0.43
Boreal Chickadee																3.6	0.5	0.00	0.6	0.1	0.00
Tufted Titmouse				0.6	0.0	0.00													0.1	0.0	0.00
Red-breasted Nuthatch	0.3	0.0	0.00	0.3	0.0	0.00	1.2	0.0	0.00	0.0	0.3	und.	1.2	0.0	0.00				0.5	0.1	0.25
Brown Creeper	1.3	0.0	0.00	0.3	1.1	2.00	0.3	1.6	2.00	1.3	1.0	0.33				0.0	0.5	und.	0.5	0.7	0.77
Winter Wren							0.0	0.3	und. ³	1.2	0.0	0.00	0.0	1.3	und. ³				0.2	0.2	0.50
Golden-crowned Kinglet							0.3	0.3	0.00	0.0	0.6	und.	1.2	0.9	0.50	0.0	4.0	und.	0.3	1.0	1.83
Ruby-crowned Kinglet	0.4	0.0	0.00										2.6	0.0	0.00				0.4	0.0	0.00
Veery	3.5	0.0	0.00	2.6	0.0	0.00	1.0	0.0	0.00	1.0	0.0	0.00	1.5	0.6	0.00	0.9	0.0	0.00	1.7	0.1	0.03
Gray-cheeked Thrush							0.5	0.0	0.00							0.5	0.0	0.00	0.2	0.0	0.00
Swainson's Thrush	0.7	0.0	0.00	0.3	0.0	0.00	7.4	5.0	0.73	25.6	6.7	0.33	6.8	0.6	0.07	19.9	6.3	0.31	9.5	3.0	0.32
Hermit Thrush	10.1	0.0	0.00	6.4	1.2	0.16	4.7	5.9	1.02	0.0	2.0	und.	4.4	0.9	0.33				4.3	1.6	0.41
American Robin	0.7	0.0	0.00	1.9	0.3	0.13	2.4	0.0	0.00	7.3	2.3	0.23	3.5	1.3	0.58				2.3	0.6	0.25

Table 8. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility averaged over the five years, 2003-2007. Data for each species are included only from stations that lie within the breeding range of the species.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland			All stations pooled		
	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹
Gray Catbird	0.0	0.3	und. ³							0.3	0.0	0.00	0.3	0.0	0.00				0.1	0.1	0.00
Cedar Waxwing	0.6	0.0	0.00							3.5	0.0	0.00	3.4	0.0	0.00				1.2	0.0	0.00
Tennessee Warbler										0.3	0.0	0.00	2.1	0.0	0.00				0.4	0.0	0.00
Nashville Warbler	3.4	0.3	0.05				1.5	0.3	0.17	0.6	1.8	2.00	4.4	2.2	0.27	7.3	0.9	0.07	2.9	0.9	0.32
Northern Parula													0.7	0.6	0.50				0.1	0.1	0.50
Chestnut-sided Warbler	0.3	0.0	0.00				0.0	0.8	und.	1.6	2.0	1.00	0.0	2.5	und.				0.3	0.7	2.67
Magnolia Warbler							7.8	2.9	0.33	9.4	3.2	0.36	7.9	11.1	1.20	10.3	1.8	0.60	5.6	2.7	0.51
Black-throated Blue Warbler							12.0	8.6	0.92	10.8	8.1	0.64	1.2	4.4	3.00	0.6	0.6	0.00	3.8	3.2	0.83
Yellow-rumped Warbler				0.9	0.0	0.00	2.7	1.4	0.63	4.5	0.9	0.40	3.1	3.1	0.94	3.3	0.6	0.13	2.3	0.9	0.39
Black-throated Gn. Warb.	5.7	0.0	0.00	7.5	0.0	0.00	2.5	0.0	0.00	1.8	0.3	0.08	2.2	5.3	2.25	0.6	0.0	0.00	3.5	0.8	0.23
Blackburnian Warbler	0.3	0.0	0.00				0.6	0.0	0.00	0.3	1.2	2.00	3.0	2.5	1.17				0.7	0.6	1.21
Pine Warbler													0.6	0.0	0.00				0.1	0.0	0.00
Bay-breasted Warbler													0.3	0.0	0.00	1.8	0.3	0.13	0.4	0.1	0.13
Blackpoll Warbler													0.0	1.9	und.	11.0	0.3	0.03	1.9	0.3	0.22
Black-and-white Warbler	3.2	0.0	0.00	0.6	0.0	0.00				0.0	0.7	und.	1.3	1.2	0.50				0.8	0.3	0.24
American Redstart							1.3	0.5	0.00	10.7	6.3	0.77	1.2	1.2	0.50	0.0	0.3	und.	2.1	1.3	0.96
Ovenbird	5.9	0.0	0.00	9.5	1.4	0.14	9.6	4.4	0.42	6.5	1.8	0.88	1.6	0.3	0.00	0.3	0.0	0.00	5.5	1.3	0.22
Northern Waterthrush	0.3	0.0	0.00	0.3	0.3	0.00	0.3	0.3	1.00	0.6	0.0	0.00	5.0	1.3	0.23	0.9	0.0	0.00	1.2	0.3	0.32
Mourning Warbler										0.3	0.3	1.00							0.0	0.0	1.00
Common Yellowthroat	9.1	1.0	0.17	3.9	0.0	0.00	1.8	0.8	0.33	5.1	0.9	0.21	8.4	0.6	0.10	0.9	0.0	0.00	4.7	0.6	0.13
Wilson's Warbler													0.3	0.0	0.00				0.1	0.0	0.00
Canada Warbler	0.9	0.0	0.00	0.6	0.0	0.00	1.3	0.0	0.00	6.6	1.3	0.29	0.6	1.3	0.50	0.3	0.3	1.00	1.7	0.4	0.55
Scarlet Tanager	0.3	0.0	0.00	0.9	0.0	0.00													0.2	0.0	0.00
Chipping Sparrow	0.3	0.0	0.00																0.0	0.0	0.00
Song Sparrow	0.3	0.0	0.00	0.0	0.4	und. ³				1.2	0.0	0.00	0.9	1.3	1.00	0.0	0.3	und.	0.4	0.3	0.67
Lincoln's Sparrow	0.3	0.0	0.00				0.5	0.0	0.00										0.1	0.0	0.00
Swamp Sparrow										0.0	0.6	und.	1.5	1.2	1.00				0.2	0.3	1.33
White-throated Sparrow	1.9	0.0	0.00	0.6	0.0	0.00	5.9	2.6	0.63	9.3	4.4	0.53	19.6	4.1	0.19	7.7	3.9	0.44	7.0	2.4	0.35

Table 8. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the six individual MAPS stations operated on Naval Air Station Brunswick and Redington Training Facility averaged over the five years, 2003-2007. Data for each species are included only from stations that lie within the breeding range of the species.

Species	Golf Course			Chimney Rock			Potato Nubble			Redington Pond			Blueline Trail			Highland			All stations pooled		
	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹	Ad.	Yg.	Repr. Ind. ¹
Dark-eyed Junco							1.4	1.5	0.67	2.5	0.0	0.00	0.0	1.3	und.	4.1	4.8	0.83	1.3	1.2	0.84
Northern Cardinal	0.3	0.0	0.00	0.7	0.0	0.00													0.2	0.0	0.00
Rose-breasted Grosbeak													0.0	1.9	und.	0.0	0.3	und.	0.0	0.3	und.
Common Grackle				0.7	0.0	0.00							0.6	0.0	0.00				0.2	0.0	0.00
Baltimore Oriole	0.3	0.0	0.00																0.1	0.0	0.00
Purple Finch				0.3	0.0	0.00				3.5	0.9	0.30				0.5	0.3	0.00	0.7	0.2	0.33
American Goldfinch	0.9	0.0	0.00	0.6	0.0	0.00													0.3	0.0	0.00
ALL SPECIES POOLED	61.5	3.0	0.05	48.0	4.7	0.09	75.0	38.6	0.52	148.4	55.5	0.37	121.4	69.9	0.51	81.1	28.4	0.37	85.9	30.7	0.35
Number of Species	31	5		27	6		30	19		34	27		42	32		25	20		59	43	
Total Number of Species		32			28			32			40			47			31			61	

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 9. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 13 species breeding at MAPS stations on Naval Air Station Brunswick and Redington Training Facility obtained from five¹ years (2003-2007) of mark-recapture data.

Species	Num. sta ²	Num. ind. ³	Num. caps. ⁴	Num. ret. ⁵	Survival probability ⁶	Surv. C.V. ⁷	Recapture probability ⁸	Proportion of residents ⁹	Survival prob. Atlantic Northern Forest 1992-2003 ¹⁰
Traill's Flycatcher*	2	30	40	5	0.532 (0.222)	41.8	0.617 (0.306)	0.392 (0.297)	0.460 (0.070)
Red-eyed Vireo*	5	40	49	3	0.527 (0.335)	63.5	0.235 (0.275)	0.429 (0.482)	0.555 (0.076)
Black-capped Chickadee*	6	59	72	4	0.432 (0.240)	55.6	0.370 (0.310)	0.216 (0.202)	0.551 (0.052)
Veery*†	3	21	34	4	0.483 (0.311)	64.5	0.302 (0.276)	1.000 (0.972)	0.543 (0.045)
Swainson's Thrush	4	119	206	32	0.697 (0.093)	13.3	0.544 (0.108)	0.371 (0.107)	0.608 (0.062)
Hermit Thrush	4	62	93	10	0.425 (0.129)	30.4	0.716 (0.224)	0.278 (0.175)	0.463 (0.042)
Magnolia Warbler	4	82	144	14	0.442 (0.121)	27.5	0.593 (0.196)	0.347 (0.168)	0.400 (0.046)
Black-throated Green Warbler*†	6	55	73	5	0.535 (0.295)	55.2	0.153 (0.165)	1.000 (0.997)	0.403 (0.046)
Blackpoll Warbler	1	25	50	10	0.416 (0.140)	33.8	0.723 (0.231)	0.887 (0.466)	0.338 (0.128)
American Redstart	2	27	58	9	0.764 (0.124)	16.2	0.850 (0.136)	0.098 (0.096)	0.412 (0.045)
Ovenbird	4	77	123	12	0.493 (0.151)	30.7	0.534 (0.208)	0.365 (0.187)	0.501 (0.050)
Common Yellowthroat	6	63	101	14	0.593 (0.134)	22.7	0.557 (0.171)	0.367 (0.165)	0.446 (0.046)
White-throated Sparrow	4	88	152	14	0.317 (0.104)	32.8	0.738 (0.210)	0.623 (0.298)	0.282 (0.043)

¹ Analysis of all stations pooled include data from 2003-2007 from the Golf Course, Chimney Rock, Potato Nubble, and Highland stations and from 2003-2006 from the Redington Pond and Blueline Trail stations. These latter two stations did not operate enough periods in 2007 to be usable in survivorship analyses.

² 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.

³ Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).

⁴ Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.

⁵ Total number of returns. A return is the first recapture in a given year of a bird originally banded at the same station in a previous year.

⁶ Survival probability (ϕ) presented as the maximum likelihood estimate (standard error of the estimate).

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 13 species breeding at MAPS stations on Naval Air Station Brunswick and Redington Training Facility obtained from five¹ years (2003-2007) of mark-recapture data.

⁷ The coefficient of variation for survival probability, $CV(\varphi)$.

⁸ Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate).

⁹ The proportion of residents among newly captured adults (τ) presented as the maximum likelihood estimate (standard error of the estimate).

¹⁰ Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate) for the Bird Conservation Region the Atlantic Northern Forest over the 12 years 1992-2003.

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

† The estimate for survival probability, recapture probability, or both may be biased low because the estimate for τ was 1.00.

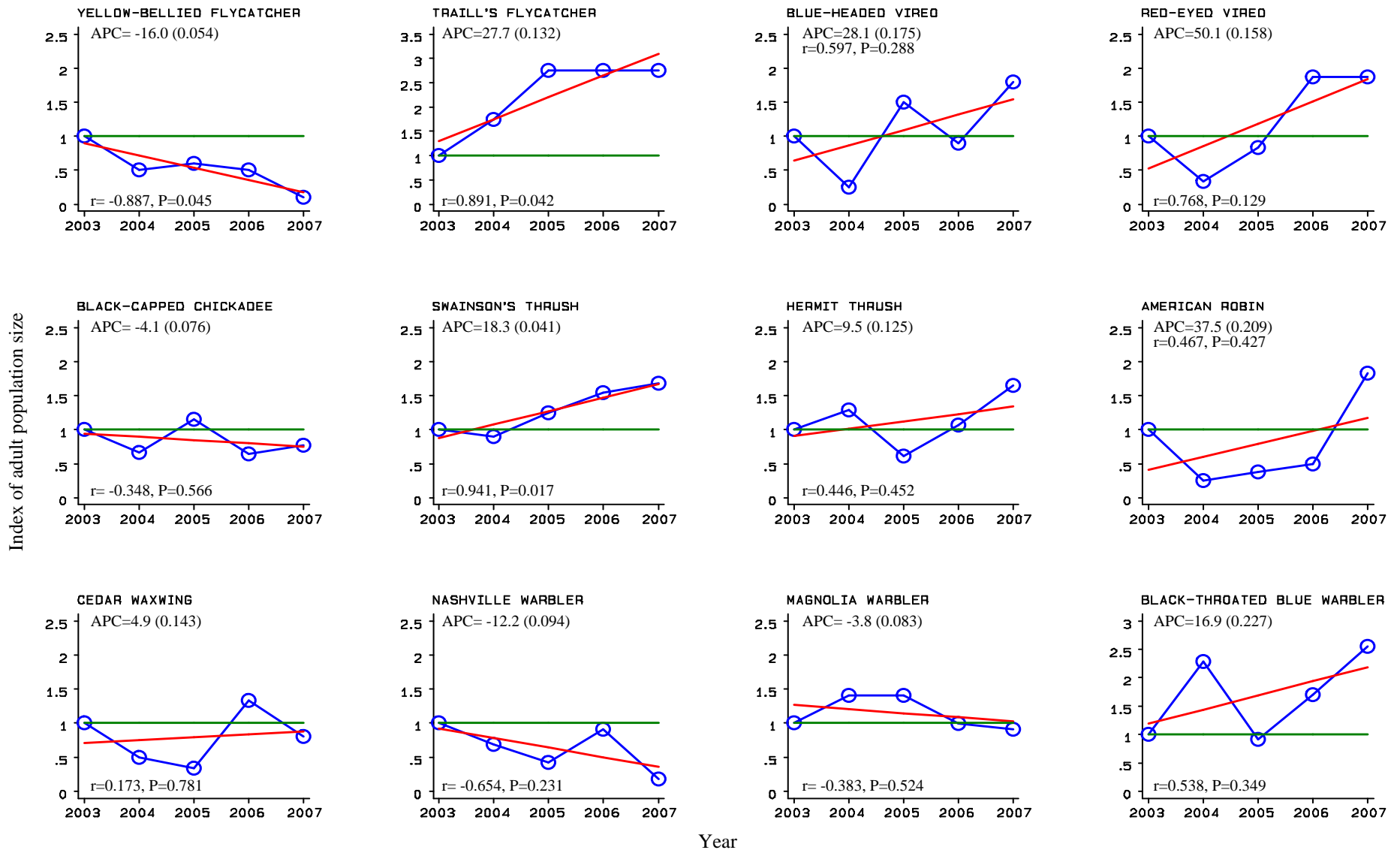


Figure 1. Population trends for 21 species and all species pooled on Naval Air Station Brunswick and Redington Training Facility over the five years 2003-2007. The index of population size was arbitrarily defined as 1.0 in 2003. Indices for subsequent years were determined from constant-effort between-year 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.

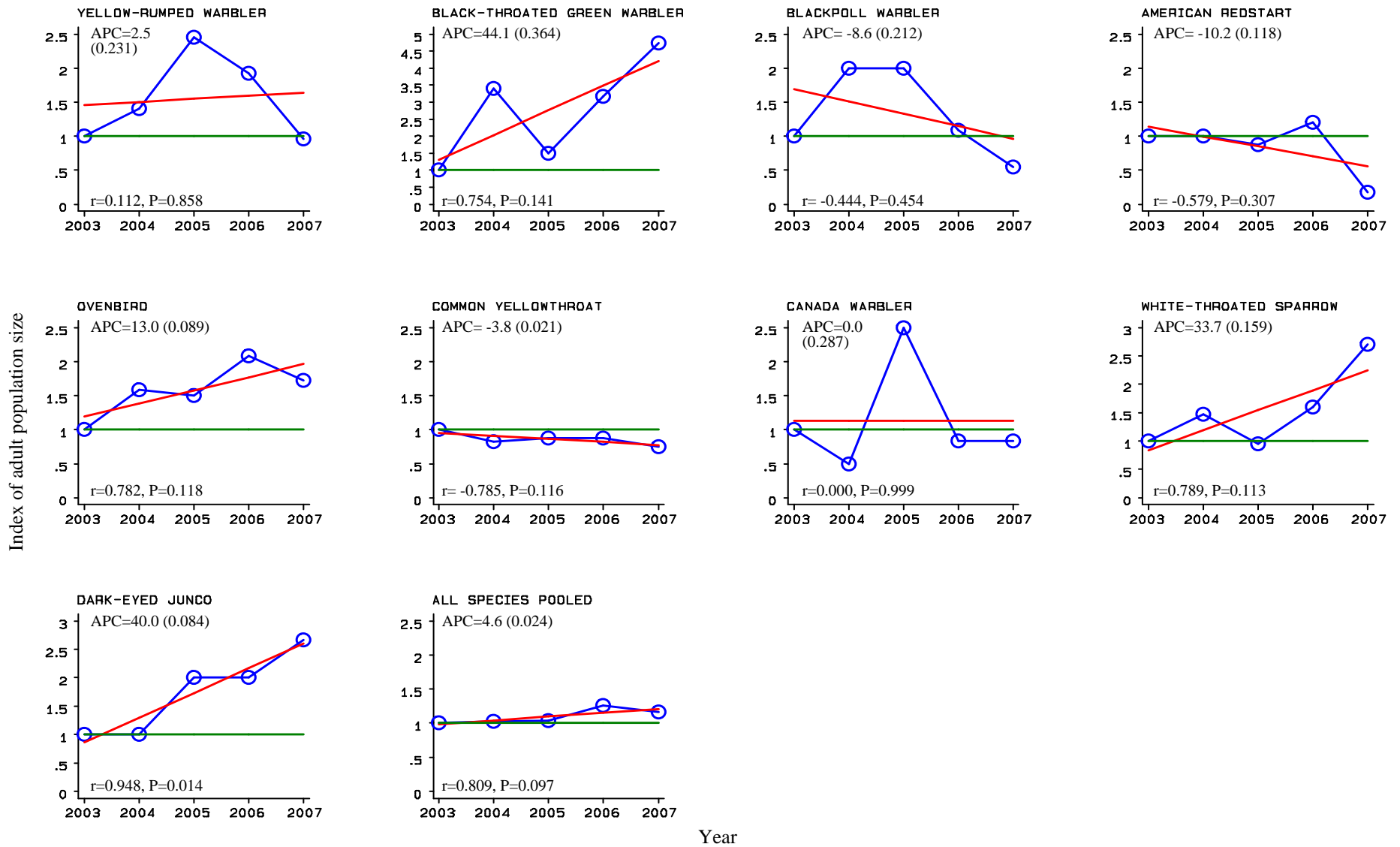


Figure 1. (cont.) Population trends for 21 species and all species pooled on Naval Air Station Brunswick and Redington Training Facility over the five years 2003-2007. The index of population size was arbitrarily defined as 1.0 in 2003. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

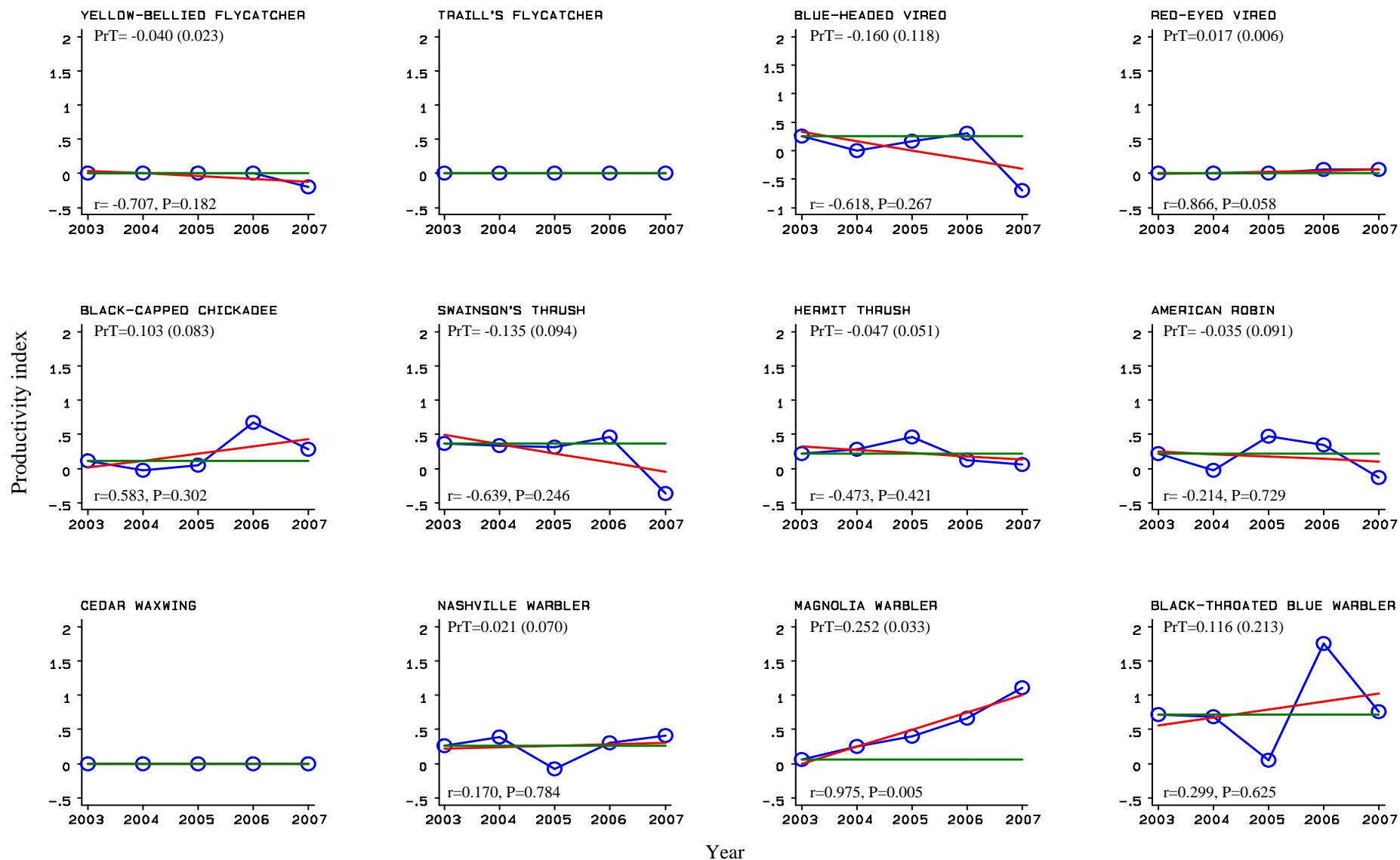


Figure 2. Trend in productivity for 21 species and all species pooled on Naval Air Station Brunswick and Redington Training Facility over the five years 2003-2007. The productivity index was defined as the actual productivity value in 2003. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

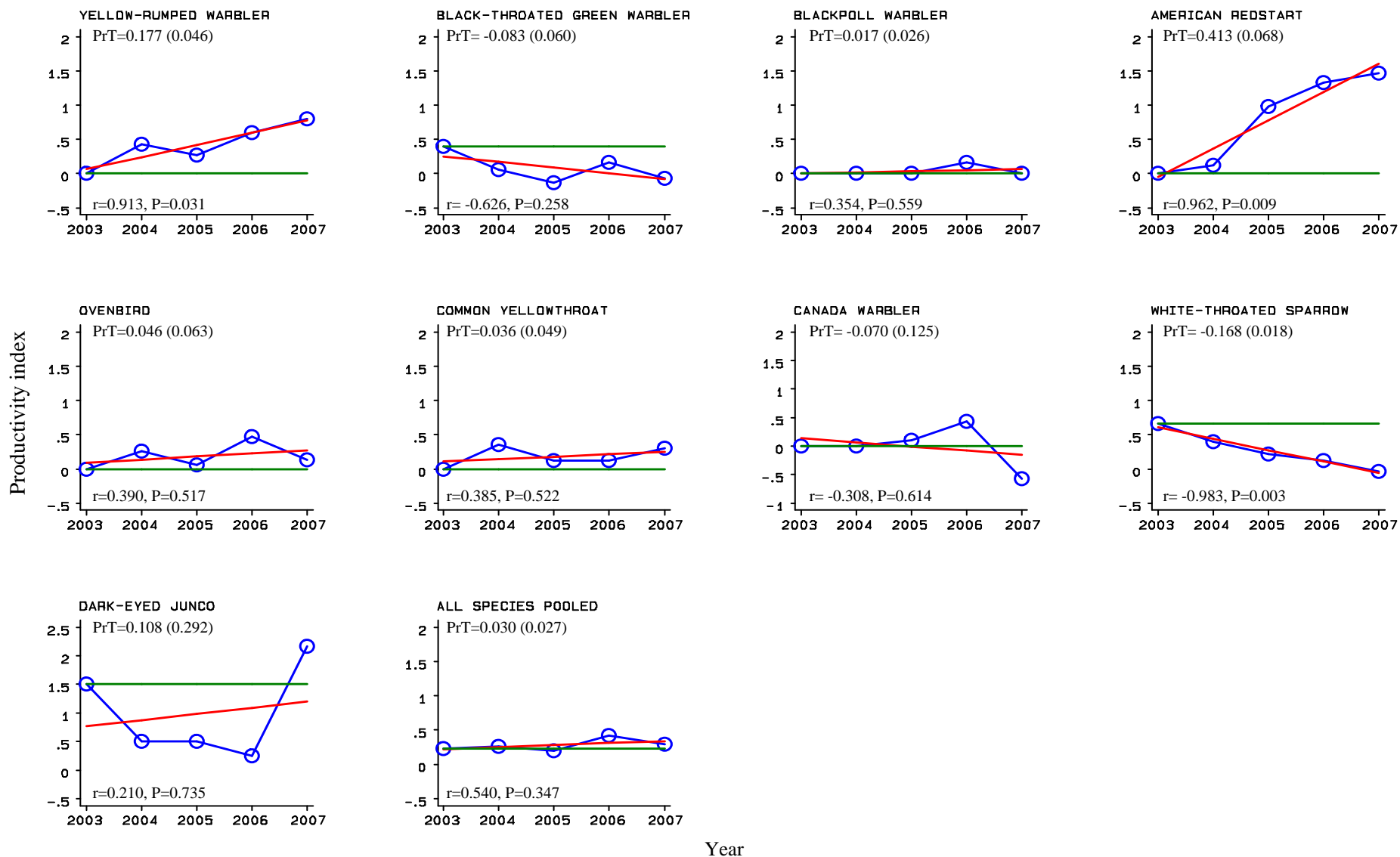


Figure 2. (cont.) Trend in productivity for 21 species and all species pooled on Naval Air Station Brunswick and Redington Training Facility over the five years 2003-2007. The productivity index was defined as the actual productivity value in 2003. Indices for subsequent years were determined from constant-effort 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.

Appendix I. Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the six years, 2003-2008, of the MAPS Program on the six stations on Naval Air Station Brunswick and Redington Training Facility.

Cumulative breeding status for all years in which each station was operated are also included (B = Regular Breeder (all years); U = Usual Breeder (>½, not all, years); O = Occasional Breeder (<½ years); T = Transient; M = Migrant; A= Altitudinal Disperser; ? = Uncertain Species ID

NUMB	SPEC	SPECIES NAME	Golf Course (GOCO)	Chimney Rock (CHRO)	Potato Nubble (PONU)	Redington Pond (REPO)	Blueline Trail (BLUE)	Highland (HGHL)
00100	COLO	Common Loon	T	T			T	T
00860	DCCO	Double-crested Cormorant	T					
01010	GBHE	Great Blue Heron	T	T	T	T	T	T
01300	TUVU	Turkey Vulture	T			T		
01460	CANG	Canada Goose	T			T		
01570	WODU	Wood Duck	T					
01620	ABDU	American Black Duck				T	T	U
01630	MALL	Mallard				T	T	
01680	BWTE	Blue-winged Teal					T	
01980	COME	Common Merganser			T	T	T	T
02020	OSPR	Osprey	O	O				
02130	BAEA	Bald Eagle		T				
02200	SSHA	Sharp-shinned Hawk			T	T	T	
02210	COHA	Cooper's Hawk	T		T			
02400	BWHA	Broad-winged Hawk	O	O	O	O	T	O
02460	RTHA	Red-tailed Hawk		T	T	T		
02640	MERL	Merlin				T		
02940	RUGR	Ruffed Grouse	O	O	O	U	B	
03040	WITU	Wild Turkey	T	T		T	T	T
03780	KILL	Killdeer	T					
03910	LEYE	Lesser Yellowlegs	M					
03970	SOSA	Solitary Sandpiper						M
04020	SPSA	Spotted Sandpiper				O		T
04490	AMWO	American Woodcock		O	O	T	T	
04690	RBGU	Ring-billed Gull	M					
04710	HERG	Herring Gull	O	T				
04940	COTE	Common Tern		T				
05570	MODO	Mourning Dove	U	U				
06400	BBCU	Black-billed Cuckoo	O	O		T	T	
06410	YBCU	Yellow-billed Cuckoo		O				
06950	BADO	Barred Owl	T				T	
08630	RTHU	Ruby-throated Hummingbird	T	T	U	O	O	O
09110	BEKI	Belted Kingfisher		T	O	T	T	O

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	GOCO	CHRO	PONU	REPO	BLUE	HGHL
09580	YBSA	Yellow-bellied Sapsucker	T		O	T	T	T
09650	DOWO	Downy Woodpecker	O	O	O	O	B	U
09660	HAWO	Hairy Woodpecker	U	O	U	T	U	O
09710	BBWO	Black-backed Woodpecker						O
09800	YSFL	Yellow-shafted Flicker	T	T	T	T	O	T
09860	PIWO	Pileated Woodpecker	T	O	O	T	T	
11390	EAWP	Eastern Wood-Pewee	U	B	T		T	T
11450	YBFL	Yellow-bellied Flycatcher		T	O	O	U	B
11460	ACFL	Acadian Flycatcher				T	T	
11475	ALFL	Alder Flycatcher	O			U	U	T
11475	TRFL	Traill's Flycatcher	O		T	U	B	T
11475	WIFL	Willow Flycatcher				U		
11500	LEFL	Least Flycatcher	T	O		U	O	O
11595	UEFL	Unidentified Empidonax Flycatcher					?	
11610	EAPH	Eastern Phoebe	O	O	T		T	T
11760	GCFL	Great Crested Flycatcher	O	T	T			
12030	EAKI	Eastern Kingbird	O	T		T		T
12720	BHVI	Blue-headed Vireo	U	O	U	U	U	U
12760	WAVI	Warbling Vireo		T				
12780	PHVI	Philadelphia Vireo			T	U		
12790	REVI	Red-eyed Vireo	O	B	B	B	B	O
12910	GRAJ	Gray Jay			T			O
12930	BLJA	Blue Jay	U	U	U	O	U	O
13190	AMCR	American Crow	U	U	O	O	O	O
13300	CORA	Common Raven	T	T	T	O	O	O
13410	TRES	Tree Swallow	O	T		T	T	O
13540	BARS	Barn Swallow	O	T				
13570	BCCH	Black-capped Chickadee	U	B	U	U	U	U
13610	BOCH	Boreal Chickadee	T		U		O	B
13660	TUTI	Tufted Titmouse	O	U				
13690	RBNU	Red-breasted Nuthatch	U	O	U	O	U	U
13700	WBNU	White-breasted Nuthatch	O	T	T			O
13730	BRCR	Brown Creeper	U	O	T	O	O	T
14110	WIWR	Winter Wren			U	U	B	U
14240	GCKI	Golden-crowned Kinglet	O		U	O	U	O
14250	RCKI	Ruby-crowned Kinglet	T			T	O	O
14560	EABL	Eastern Bluebird	T	T				
14780	VEER	Veery	B	U	T	O	U	O
14790	GCTH	Gray-cheeked Thrush			T			T
14810	SWTH	Swainson's Thrush	O	O	U	B	B	B
14820	HETH	Hermit Thrush	B	B	B	O	U	O
14835	UNTH	Unidentified Thrush			?	?		
15000	AMRO	American Robin	U	B	B	B	B	O

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	GOCO	CHRO	PONU	REPO	BLUE	HGHL
15130	GRCA	Gray Catbird	O	T		T	T	
15370	EUST	European Starling	T	T				
15550	CEDW	Cedar Waxwing	U	U	U	U	U	U
15650	TEWA	Tennessee Warbler				T	O	
15670	NAWA	Nashville Warbler	U		O	O	B	U
15730	NOPA	Northern Parula	O	O	O	O	U	
15760	CSWA	Chestnut-sided Warbler	O		T	O	O	T
15770	MAWA	Magnolia Warbler	O	T	B	B	B	B
15780	CMWA	Cape May Warbler					T	T
15790	BTBW	Black-throated Blue Warbler		T	B	B	U	O
15800	MYWA	Myrtle Warbler	O	O	U	B	U	U
15830	BTNW	Black-throated Green Warbler	B	B	B	B	U	U
15860	BLBW	Blackburnian Warbler	O	T	O	O	U	
15910	PIWA	Pine Warbler	T				O	
15960	BBWA	Bay-breasted Warbler			O	T	O	U
15970	BLPW	Blackpoll Warbler	T				O	B
16030	BAWW	Black-and-white Warbler	B	O	T	O	O	O
16040	AMRE	American Redstart	O	T	O	B	O	T
16080	OVEN	Ovenbird	B	B	B	B	O	O
16090	NOWA	Northern Waterthrush	T	T	O	O	B	O
16130	MOWA	Mourning Warbler				T	T	
16150	COYE	Common Yellowthroat	B	U	O	B	B	U
16290	WIWA	Wilson's Warbler					T	
16300	CAWA	Canada Warbler	T	T	T	U	T	O
16495	UNWA	Unidentified Warbler					?	?
16830	SCTA	Scarlet Tanager	O	U	T			T
18020	CHSP	Chipping Sparrow	U	O	T		T	O
18230	SOSP	Song Sparrow	O	T		U	O	T
18240	LISP	Lincoln's Sparrow	T		T	T		O
18250	SWSP	Swamp Sparrow		T		O	U	O
18270	WTSP	White-throated Sparrow	O	O	B	B	B	B
18320	SCJU	Slate-colored Junco			B	O	O	B
18335	UNSP	Unidentified Sparrow					?	
18560	NOCA	Northern Cardinal	O	O				
18600	RBGR	Rose-breasted Grosbeak	T	T		T	O	T
18720	BOBO	Bobolink	T	T				
18730	RWBL	Red-winged Blackbird	T	O	T	T	T	
18850	RUBL	Rusty Blackbird				O	O	T
18870	COGR	Common Grackle	T	O	T	T	T	O
18960	BHCO	Brown-headed Cowbird	O	O	T			T
19160	BAOR	Baltimore Oriole	O	O				
19350	PUFI	Purple Finch	U	O	O	U	T	O
19370	HOFI	House Finch	T					

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	GOCO	CHRO	PONU	REPO	BLUE	HGHL
19390	WWCR	White-winged Crossbill					T	T
19430	PISI	Pine Siskin			T	T	T	T
19510	AMGO	American Goldfinch	U	U	T	T	O	T
19580	EVGR	Evening Grosbeak			T		T	O
20085	UNBI	Unidentified Bird	?					