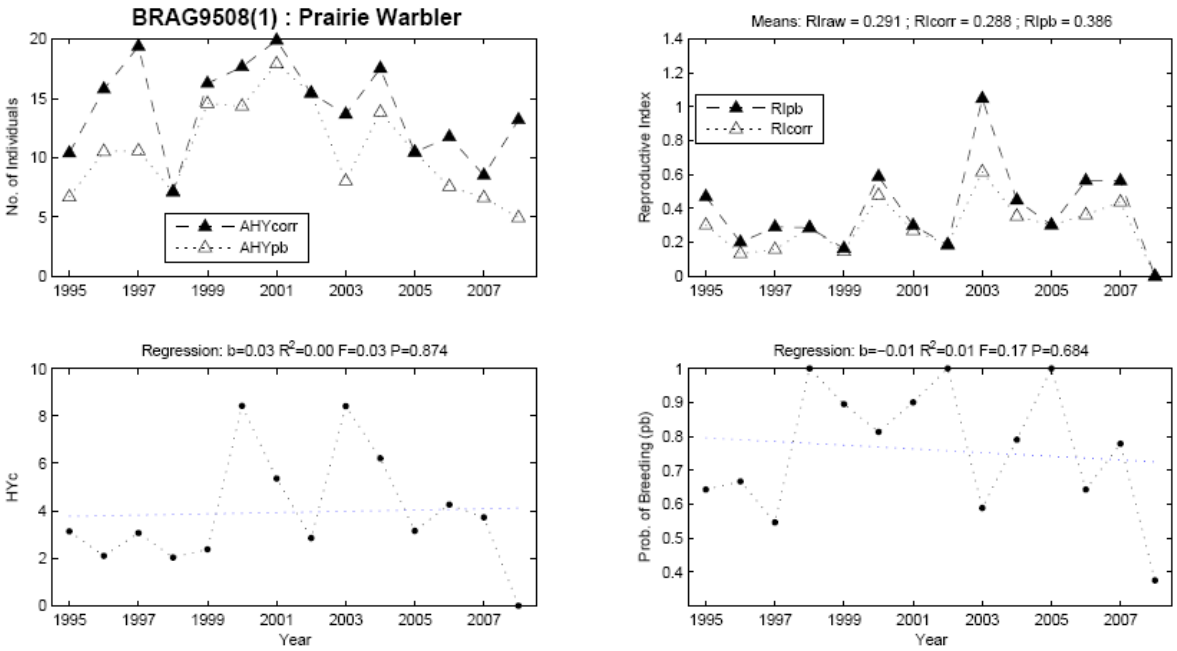
THE 2009 REPORT OF MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM ON FORT BRAGG, NORTH CAROLINA.



Example output from website summarizing Fort Bragg MAPS data
(http://birdpop.org/DoD/brag/dod_brag_viz.htm)

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CONTENTS

SUMMARY

In1995, six Monitoring Avian Productivity and Survivorship (MAPS) stations were established and operated by The Institute for Bird Populations (IBP) at Fort Bragg, North Carolina. We continued to operate these stations during the summers of 1996-2002 by means of funding from Fort Bragg and the DoD Legacy Resource Management Program, and during the summers of 2003-2009 by means of funding from Fort Bragg natural resources program. The objectives of the MAPS Program on Fort Bragg are directed at USFWS-listed species of conservation concern, including Neotropical migrant species, in the context of balancing bird conservation with land management intended to enhance military Readiness and Range Sustainment (R&RS).

The objectives are to a) monitor year to year changes in population dynamics, b) provide landscape-level population management decision-support tools, and c) monitor and subsequently assess the efficacy of specific management actions intended to create or maintain landscapes that support healthy, productive "source" populations. These conservation goals are particularly relevant to the dispersal and recruitment of individuals into adjacent federal or private lands (Nott and Morris 2007). These data have also contributed to the information and management decision-support tools developed in collaboration with other DoD installations that support MAPS monitoring, modeling, and management efforts (Nott 2008). At Fort Bragg, Wood Thrush and Prairie Warbler were identified as management species of concern. Since 2006, however, only one Wood Thrush has been captured at the S112 station (where the majority were previously captured) and Prairie Warblers have declined. Given one objective of Fort Bragg's natural resources program, which is to restore and maintain the pine-dominated communities, we

might have expected this result, however Fort Bragg is also at the southern limit of the Wood Thrush breeding range where the predicted warming trend associated with climate change might be expected to extirpate this species.

Following the recommendations of Nott et al. (2003), the I102 station at Fort Bragg was discontinued in 2003 and replaced by the Sandstone Hill station in a mosaic of upland patchy forest, shrubland, and grasslands that are frequently managed to reduce fire risks. Specifically, Sandstone Hill was established to monitor the effects of a prescribed fire regime upon Prairie Warbler populations, and prior to the 2004 season the area around Sandstone Hill was burned. Thus, 2009 is the sixth year of operation for the Sandstone Hill station following fire management at this station.

The capture rate of adult landbirds at Fort Bragg, an index of adult population size, was 37.7 birds per 600 net-hours in 2009, substantially lower than the 44.9 birds/600 net-hours recorded in 2008 and the 47.0 adults per 600 net-hours recorded in 2007. Reproductive index (number of young birds per adult) was 0.70 in 2009, substantially higher than the 0.28 value in 2008, the 0.52 value in 2007, and the 0.55 value in 2006, indicating very high productivity at Fort Bragg in 2009. This reflects generally increased productivity observed throughout the southeastern United States in 2009, perhaps due to poor reproductive success in this region in 2008, resulting in lower adult populations and fewer inexperienced, first-time breeding birds in 2009. Carolina Wren was the most frequently captured species at the six stations in 2009, followed by Northern Cardinal, Common Yellowthroat, Pine Warbler, Prairie Warbler, Carolina Chickadee, Eastern Towhee, and Bachman's Sparrow.

In order to assess species emigration and recruitment dynamics at Fort Bragg, we undertook a new analysis, scoring our annual status codes against year for 38 species at each of the five long-running stations with sufficient residency data. We classified each species at each station as Resident, Intermittent, Establishing, or Vacating based on the plot over the 15 years in which these stations have operated. Of 146 assessments, 71 species were considered as resident, 46 as intermittent, 12 as establishing, and 17 as vacating, indicating a substantial amount of species with intermittent status as compared with other MAPS locations in the Southeast, and more emigration from than recruitment into the Fort Bragg station areas. Among stations, the most intermittency and emigration appeared to be occurring at S114 and S112, whereas the station with the least amount of intermittency and emigration appeared to be I104. These data, showing a high proportion of intermittent species and a greater number of species vacating than establishing stations at Fort Bragg, indicate that habitats may generally be declining for breeding landbirds around these five stations.

Using 15 years of data (1995-2009) from all seven stations ever operated on Fort Bragg, estimates of adult survival and recapture probabilities were obtained for 19 target species. Survival-rate estimates for all 19 species showed variable precision, with a mean CV of 29.9%., comparable to the mean CV of 29.7% following the 2008 season for the same 19 species, Annual adult survival rates for these 19 species in 2009 ranged from a low of 0.234 for Hooded Warbler to a high of 0.592 for Ovenbird, with a mean survival rate of 0.434 for the 19 species.

Survival estimates have been low at Fort Bragg compared to other locations, especially for resident species. In comparing survival values from Fort Bragg (1995-2009) with those of the Southeast Region of the United States (1992-2001), for example, survival at Fort Bragg was lower than that of the Southeast Region for 12 of 18 target species which could be compared with the mean at Fort Bragg for these 18 species (0.435) being 12.3% lower than that of the Southeast Region (0.496). Importantly, survival for the five resident species was substantially lower at Fort Bragg than in the Southeast Region (Nott et al. 2009), perhaps indicating problems with survival of landbirds on the Fort Bragg installation and/or vicinity.

At Fort Bragg, two species, Prairie Warbler and Wood Thrush, emerged as candidates for particular management concern. Since, the numbers of Wood Thrush have declined below acceptable levels and it is no longer considered a target species of management concern. In 2003 the I102 station was replaced by the Sandstone Hill specifically to monitor the effects of a prescribed fire regime upon Prairie Warbler populations. Prior to the 2004 season the area around Sandstone Hill was burned, and in 2005-2007 Prairie Warblers were found in good numbers and showed excellent productivity, but in 2008 and 2009 no adult or young Prairie Warblers were captured there. Thus, it appears that Prairie Warblers can be effectively managed with a control-burn program operating once every 4-5 years, and that Prairie Warblers will occupy potential habitat for 3-4 years following a springtime burn.

To help interpret MAPS data on landbird dynamics we have recently developed and would like to highlight installation-specific resource pages for eight installations including Fort Bragg. Resources at the Fort Bragg page include the up-to-date Breeding Status List, a Spatial Statistics

Database, a page interpreting and highlighting MAPS reports from Fort Bragg, and up to 36 Data Visualizations for 16 species at FLW. Data visualizations have been completed for the target species, Prairie Warbler, and an additional species-management-account page for this species is being developed. For the 2010 report we will have completed development of these pages, and will incorporate them more fully into the annual report.

The overall goal of this work is to evaluate the efficiency of on-going management practices (or cessation thereof) aimed at reversing declining populations and maintaining stable or increasing populations of target landbird species; and to modify those management practices in an adaptive management framework. The results of the first five years of this effort at Fort Bragg and other DoD installations indicate that we are well on our way to achieving success in this endeavor.

A more comprehensive analysis of historical MAPS monitoring on Fort Bragg is provided by a section of IBP's website (www.birdpop.org/dod/dod_ibp.htm), the development of which was mainly funded by the DoD Legacy Resource Management Office.

INTRODUCTION

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) Program, a cooperative effort among public and private agencies and individual bird banders in North America, to operate a continent-wide network of over 1000 constant-effort mist-netting and banding stations. MAPS was designed to provide information on the vital rates (productivity or birth rate, and survivorship or death rate) of landbirds that is critically needed for efforts to identify demographic causes that may be affecting 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, 2001a, 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). A recent study (Saracco et al. 2008) analytical methods to a) show that both MAPS and the North American Breeding Bird Survey (BBS) provide similar estimates of population trends for 36 species of wood warblers, and b) show that adult survival, rather than productivity, is the primary demographic parameter driving regional population changes in Yellow Warbler. Unpublished results suggest that the annual survival rates of Neotropical migrants is strongly affected by stressors acting on migrating and overwintering individuals.

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) Partners-in-Flight strategy. Moreover, because birds are excellent indicators of the health of ecological systems, they can serve as sensitive barometers of the overall

effectiveness of efforts to maintain the biodiversity and ecological integrity of military installations. The MAPS program was therefore initiated on select military installations beginning in 1992 and soon became a focal project of the DoD Partners-in-Flight 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.

Accordingly, in 1995, six MAPS stations were established and operated on Fort Bragg. The operation of these stations during the summers of 1995 and 1996 and the subsequent analyses of data from those years were accomplished through funding from U.S. Army Fort Bragg. Operation of these six MAPS station and associated data analyses during the three years 1997-1999 was accomplished by means of funding from the DoD Legacy Resource Management Program. The operation of the six stations was continued during the summers of 2000 through 2009 by means of funding from Fort Bragg, while the comprehensive analyses of data from 1995-2002 was funded by the DoD Legacy Resource Management Program.

The initial objective of the MAPS Program on DoD installations such as Fort Bragg has been to identify generalized management guidelines and formulate specific management actions that could be implemented on military installations 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 was to be achieved 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. The 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 suspected to be driving the population decline).

The Legacy Resource Management Program allowed us to undertake these analyses and formulate management strategies. These analyses were completed in 2003 and management guidelines were formulated for ten bird species of conservation concern that breed in the southeastern United States (Nott et al. 2003). With additional funding from the Legacy Resource Management Program, we are currently implementing these guidelines through management actions on eight military installations (including Fort Bragg) 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.

At Fort Bragg, Wood Thrush and Prairie Warbler were identified as management species of concern. Following the recommendations of Nott et al. (2003), the I102 station was discontinued in 2003 to reduce the probability of capturing endangered Red-cockaded Woodpeckers that breed within the boundaries of that station. The I102 station was replaced by the Sandstone Hill station

in a mosaic of upland patchy forest, shrubland, and grasslands that are frequently managed to reduce fire risks. Specifically, Sandstone Hill was established to monitor the effects of a prescribed fire regime upon Prairie Warbler populations, and prior to the 2004 season the area around Sandstone Hill was burned. Thus, 2009 is the sixth year of operation for the Sandstone Hill station following fire management at this station.

A complete summary of the results of the MAPS Program on Fort Bragg from 1993-1999, as well as on 12 other installations or groups of nearby installations in the eastern United States, was presented by DeSante et al. (2001b), and summaries of 2000-2008 results from Fort Bragg were presented by DeSante et al. (2002, 2004, 2005), Pyle et al. (2006), and Nott et al. (2007, 2008, 2009). We have also developed installation-specific resource pages for eight installations including Fort Bragg. This report briefly updates these earlier reports and documents the operation of the six MAPS stations on Fort Bragg during the 2009 breeding season. In so doing, we have also performed a new analysis looking at species-specific emigration and recruitment rates at the five long-running stations at Fort Bragg, and we highlight some of the new information available at the resource page mentioned above.

METHODS

Six MAPS stations were operated in 2009, in the same locations where they were first established in 1995 (five stations) or 2003 (Sandstone Hill station). Each of these six MAPS stations was operated in accordance with the highly standardized banding protocols established by The Institute for Bird Populations for use by the MAPS Program throughout North America and spelled out in detail in the MAPS Manual (DeSante et al. 2009). 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-netting sites within the interior eight hectares of each 20 hectare station. These ten nets at each station were operated for six morning hours per day (beginning at local sunrise), and for one day in each of 6-8 consecutive 10-day periods between May 13 and August 4 (Table 1). The operation of stations was initially carried out by IBP field biologist interns Nolan Lancaster and Mark Frantz, who were trained by IBP biologist James Saracco at the Howell Woods Learning Center, Four Oaks, North Carolina.

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. 2009):

(1) capture code (newly banded, recaptured, band changed, unbanded);

(2) band number;

(3) species;

(4) age and how aged;

(5) sex (if possible) and how sexed (if applicable);

(6) extent of skull pneumaticization;

(7) breeding condition of adults (i.e., extent of cloacal protuberance or brood patch);

(8) extent of juvenal plumage in young birds;

(9) extent of body and flight-feather molt;

(10) extent of primary-feather wear;

(11) presence of molt limits and plumage characteristics;

(12) wing chord;

(13) fat class and body mass;

(14) date and time of capture (net-run time);

(15) station and net site where captured; and

(16) any pertinent notes.

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

The computer entry, proofing, and verification of all banding, effort, and breeding status data were completed by IBP biologists using specially designed data entry, verification, and editing programs. The critical data for each banding record (capture code, band number, species,

age, sex, date, capture time, station, and net number) were proofed by hand against the raw data and any computer-entry errors were corrected. All banding data were then run through a series of verification programs as follows:

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

(2) Cross-check programs to compare station, date, and net fields from the banding data with those from the effort and breeding status data;

(3) Cross-check programs to compare species, age, and sex determinations against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), extent of juvenal plumage, extent of body and flight-feather molt, extent of primary-feather wear, and presence of molt limits and plumage characteristics;

(4) Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species; and

(5) Verification programs to screen banding and recapture data from all years of operation for inconsistent species, age, or sex determinations for each band number.

Any discrepancies or suspicious data identified by any of these programs were examined manually and corrected if necessary. Wing chord, body mass, fat content, date and station of capture, and any pertinent notes were used as supplementary information for the correct determination of species, age, and sex in all of these verification processes. The proofed, verified, and corrected banding data from each year were then run through a series of analysis

programs that calculated for each species and for all species pooled at each station and for all stations pooled on each forest:

(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 each year) for individual adult and young birds; and

(3) the proportion of young in the catch.

Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach et al. 1996), the number of adult birds captured was used as an index of adult population size. For our estimate 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.

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 (see Appendix I). We used these data to classify each species at each station according to three residency categories for the station over the period of study: breeder, migrant, or transient (Appendix I). In order to assess species emigration and recruitment dynamics at Fort Bragg, we scored our annual status codes (1.0 = breeder, 0.5 = likely breeder, and 0.0 = non-breeder) for 38 species against year for each of the five long-running stations. We classified each species at each

station as Resident, Intermittent, Establishing, Vacating based on the plot over the 15 years in which these stations have operated.

Survival of target species was estimated using Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al. 1992) on 15 years (1995-2009) of capture histories of adult birds from all seven stations operated at this location. 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 seven stations pooled, at which the species was a breeder during more than half of the years the station was operated. Using the computer program TMSURVIV (White 1983, Hines et al. 2003), we calculated, for each target species, maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability, adult recapture probability, and the proportion of residents among newly captured adults using a time-constant, between- and within-year transient model (Pradel et al. 1997, Nott and DeSante 2002, Hines et al. 2003). The use of the transient model 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 AND DISCUSSION

We operated six MAPS stations on Fort Bragg during the summer of 2009 (Table 1). A total of 3107.0 net-hours were accumulated at all six stations pooled, representing 95.9% of the maximum possible effort (3240 net-hours) at the six stations. Of these net hours, only 1783.0 can be compared with those of 2007 in a constant-effort manner, due to various problems affecting operation in 2008 (Nott et al. 2009). The details of the operation of these six stations during 2009 are presented in Table 1.

For each individual species and for all species pooled, the numbers of birds newly banded, captured and released unbanded, and recaptured are presented for each station in Table 2 and, for all stations combined, in Table 4. A total of 455 captures of 45 species occurred at Fort Bragg during the summer of 2009 (Table 4). Newly banded birds comprised 67.0% of the total captures. The greatest number of total captures (98) was recorded at the I113 station and the smallest number of total captures (57) was recorded at the S114 station. The highest species richness occurred at Station I104 (27 species) and the lowest species richness occurred at S114 (10 species).

The capture rates (per 600 net-hours) of individual adult and young birds and the proportion of young in the catch are presented for each species and for all species pooled at each station in Table 3 and, for all stations combined, in Table 4. We present capture rates (captures per 600 net-hours) of adults and young in these tables so that the data can be compared among stations which, because of the vagaries of weather, accidental net damage, and/or other events, can differ from one another in effort expended (Table 1). Adult population size (for all species pooled) was highest at Station S104 (63.2 adults/600 net hours; Table 3), followed by Station

I113 (43.4), Station S112 (35.2), Station S110 (34.4), Sandstone Hill (27.8), and Station S114 (22.4). These values were generally lower than those recorded in 2008, varying from being 43% lower in 2009 than in 2008 (Sandstone Hill) to being 5.4% higher than in 2008 (S112). Overall (all stations combined), the adult capture rate was 37.7 birds/600 net-hours in 2009, lower (by 16%) than the 44.9 adults per 600 net-hours recorded in 2008.

Among individual species, Carolina Wren was the most frequently captured species at the six stations in 2009, followed by Northern Cardinal, Common Yellowthroat, Pine Warbler, Prairie Warbler, Carolina Chickadee, Eastern Towhee, and Bachman's Sparrow (Table 4). The most abundant breeding species, having a capture rate of at least 2.0 adults per 600 net-hours, in decreasing order, were Northern Cardinal, Common Yellowthroat, Great Crested Flycatcher, Pine Warbler, and Prairie Warbler (Table 4). The most abundant breeding species at each station, having a capture rate of at least 3.0 birds per 600 net-hours in 2009 are as follows (species of concern, as noted above, in italics):

Sandstone Hill
Pine Warbler*
Chipping Sparrow
Bachman's Sparrow*
Brown-headed Nuthatch†
Eastern Bluebird†
Prairie Warbler†
Blue Grosbeak†

S110
Prairie Warbler
Common Yellowthroat
White-eyed Vireo†
Tufted Titmouse†
Eastern Towhee†
Pine Warbler†
Northern Cardinal†

I 104
Great Crested Flycatcher
Gray Catbird*
Common Yellowthroat
Northern Cardinal*
Blue-gray Gnatcatcher*
Pine Warbler
*Prairie Warbler**
American Goldfinch †
Eastern Bluebird†
Eastern Wood-Pewee†

S114
Hooded Warbler
Northern Cardinal
Carolina Chickadee†
Tufted Titmouse†

I113
Great Crested Flycatcher
Northern Cardinal
Common Yellowthroat*
Eastern Towhee*
Bachman's Sparrow*
Blue-gray Gnatcatcher†
Prairie Warbler†

S112
Northern Cardinal
Summer Tanager
Red-eyed Vireo†
Carolina Wren†
Tufted Titmouse†

* At least 3.0 adults per 600 net hours in 2009 but not in 2007.
† At least 3.0 adults per 600 net hours in 2007 but not in 2009.

As can be seen from the number and position of marked species (* and †), there was again considerable turnover between 2008 and 2009, as happened between 2007 and 2008 (Nott et al. 2009). One species, Bachman's Sparrow, showed increases at more than one station (Sandstone Hill and I113), whereas three species showed decreases at more than one station, Tufted Titmouse (S110, S114, and S112), Eastern Bluebird (Sandstone Hill and I104), and Prairie Warbler (Sandstone Hill and I113, but also increasing at I104).

Examples of longer-range emigration and recruitment plots for species at the five long-running stations are shown in Figure 1 and these data are summarized for 38 species at these stations (all but Sandstone Hill) in Table 5. Of 146 assessments, 71 species were considered as resident, 46 as intermittent, 12 as establishing, and 17 as vacating, indicating a substantial

amount of species with intermittent status as compared with other MAPS locations in the Southeast, and more emigration from than recruitment into the Fort Bragg station areas. Four species were considered vacating at more than one station, Gray Catbird (at I113 and S110), Brown Thrasher (at I104 and S110), Ovenbird (at S114 and S112), Hooded Warbler (at I113 and S112) and one species, Wood Thrush, was vacating the only station in which it occurred with sufficient frequency (S112); whereas three species were considered establishing at more than one stations, Pileated Woodpecker (at I113 and S114), Eastern Bluebird (at I113, S110, and S114), and Chipping Sparrow (at I104 and I113). Among stations, the most intermittency and emigration appeared to be occurring at S114 (8 resident, 14 intermittent, one establishing, and one vacating) and S112 (15 resident, 5 intermittent, no establishing, and six vacating), whereas the station with the least amount of intermittency and emigration appeared to be I104 (17 resident, 7 intermittent, 5 establishing, and one vacating).

These data, showing a high proportion of intermittent species and a greater number of species vacating than establishing stations at Fort Bragg, indicate that habitats may generally be declining for breeding landbirds around these five stations. To further help interpret these sorts of dynamics at DoD installations we have recently developed installation-specific resource pages for eight installations including Fort Bragg. Links for up to 36 visualizations per species, for eight species at Fort Bragg, can be found in Table 5. We believe that these resource pages and visualizations will greatly help interpret population dynamics of landbirds at Fort Bragg, as well as responses of target species to habitat-management activities on the installation.

Reproductive index (number of young birds per adult) showed a different pattern, being highest at Sandstone Hill (1.67), followed by Station S110 (0.90), Station S112 (0.72), Station

I113 (0.64), Station S114 (0.50), and Station I104 (0.28). Except for Station S114, where reproductive success dropped (by 5%) from that of 2008, all other stations showed substantial increases, from +45% at Station I113 to +595% at Sandstone Hill. The overall reproductive index was 0.70 in 2009, substantially higher (by 150%) than the 0.28 value recorded in 2008, indicating very high productivity at Bragg in 2009.

Using 15 years of data (1995-2009) from all seven stations ever operated on Fort Bragg, estimates of adult survival and recapture probabilities were obtained for 19 target species. Maximum-likelihood estimates of annual adult survival probability, recapture probability, and proportion of residents among newly captured adults from the time-constant transient model are presented in Table 6 for these 19 species. Survival-rate estimates for all 19 species showed variable precision (CVs between 9% and 77%) with a mean CV of 29.9%. This compares with a mean CV of 29.7% following the 2008 season for the same 19 species, indicating comparable precision with the addition of an 15th year at Fort Bragg. Annual adult survival rates for these 19 species in 2009 ranged from a low of 0.234 for Hooded Warbler to a high of 0.592 for Ovenbird, with a mean survival rate of 0.434 for the 19 species.

Survival estimates have been low at Fort Bragg compared to other locations, especially for resident species. In comparing survival values from Fort Bragg (1995-2009) with those of the Southeast Region of the United States (1992-2001), for example, survival at Fort Bragg was lower than that of the Southeast Region for 12 of 18 target species which could be compared (all but Blue-gray Gnatcatcher), with the mean at Fort Bragg for these 18 species (0.435) being 12.3% lower than that of the Southeast Region (0.496). Importantly, survival for the five resident species was substantially lower at Fort Bragg than in the Southeast Region (Nott et al.

2009), perhaps indicating problems with survival of landbirds on the Fort Bragg installation and/or vicinity. The survival rates of the two Neotropical migrants, Prairie Warbler (0.368) and Common Yellowthroat (0.349), were also lower than those for Southeast region (0.421 and 0.420, respectively). Breeding Bird Survey trend data (1980-2007; Sauer et al. 2007) showed more-or-less stable populations for these five resident and two Neotropical species in North Carolina.

These results provide a strong suggestion that over-winter survival of individuals wintering on Fort Bragg may be poor (DeSante et al. 2004, 2005a). The Institute for Bird Populations undertook the Monitoring Avian Wintering Survival (MAWS) Program in 2002-2007 to assess habitat-specific overwintering survival rates in the southern parts of the United States. Six of the 24 MAWS stations were established on Fort Bragg through funding from the Legacy Resources Management Program. No significant declines or increases in survival rates were detected in MAWS data between the winters of 2003-2004 and 2006-2007. The MAWS Program if it can be re-established, in conjunction with MAPS, should lead to the formulation of management strategies and guidelines to enhance overwintering survival, especially for declining species of conservation concern that overwinter in the United States. We believe this will be especially important in order to monitor the effects of increasingly extreme weather on overwintering populations.

As mentioned earlier, analyses aimed at identifying and describing relationships between four demographic parameters (adult population size, population trends, numbers of young, and productivity) and landscape-level habitat characteristics have been completed for 13 military installations including Fort Bragg (Nott et al. 2003, Nott and Michel 2005). These analyses were

funded by Legacy Resource Management Program Project #103. At Fort Bragg, two species, Prairie Warbler and Wood Thrush, emerged as candidates for particular management concern. Since, the numbers of Wood Thrush have declined below acceptable levels and it is no longer considered a target species of management concern.

In 2003 the I102 station was replaced by the Sandstone Hill station in a mosaic of upland patchy forest, shrubland, and grasslands that are frequently managed to reduce risk of wildfire. This station was established to specifically monitor the effects of a prescribed fire regime upon Prairie Warbler populations. Prior to the 2004 season the area around Sandstone Hill was burned, and in 2004 a single Prairie Warbler was captured. In 2005-2007 the capture rates of adult and young (per 600 net-hours) Prairie Warblers increased to 15.5 and 4.8 in 2005, 14.3 and 0.0 in 2006, and 12.5 and 1.8 in 2007, but in 2008 and 2009 no adult or young Prairie Warblers were captured at Sandstone Hill (Nott et al. 2009; Table 3). This indicates that the management actions at Sandstone Hill successfully resulted in increased populations of Prairie Warblers for three years, but that post-burn habitat succession resulted in no Prairie Warblers in 2008. Thus, it appears that Prairie Warblers can be effectively managed with a control-burn program operating once every 4-5 years. Since 2002, Wood Thrush captures and recaptures recorded at S112 have declined and they were not captured at all at Fort Bragg in 2007 or 2008. A single adult was captured at S112 in 2009 (Table 2).

In summary, our data suggest that Prairie Warblers will occupy potential habitat for 3-4 years following a springtime burn. As this fire-managed "disclimax" community succeeds towards forest, we predicted that continued effectiveness monitoring of these populations will detect the onset of a decline in reproductive success or population size, and this appears to have been the case in 2008 at Sandstone Hill. We thus recommend adjusting prescribed fire frequency to once every

4-5 years, to maximize mean annual productivity of Prairie Warbler populations (and perhaps Bachman's Sparrows, which showed increases in 2009, and other species; *cf.* Nott et al. 2008) while meeting the management goals associated with Readiness and Range Sustainment. Through such adaptive management cycles, we are confident that we can achieve the long-term goal of reversing declining populations and maintaining stable or increasing source populations of target landbird species at Fort Bragg and other military installations.

Adult capture rates of all species pooled at Fort Bragg have declined alarmingly since 1995 (Nott et al. 2009). Captures of young birds varied between 50 in the drought year of 1999 to over 300 in 2004 which featured an extremely wet summer. The reasons for the decline in adults are unknown. Although observed poor survival rates may be a big factor further investigation is required to identify which species are declining, where they overwinter, and the conditions that prevailed in the over wintering regions. Interestingly, similar declines were experienced at other east coast DoD installations so the reasons may be environmental and regionally-scaled. Many Neotropical migrant species that breed at these stations overwinter in the Caribbean and eastern slopes of Mexico and Central America where they experience stress through habitat loss and unfavorable weather conditions (e.g. El-Nino events cause drier winters in the Caribbean). The relatively poor survival rates reported might also suggest high mortality during the winter and/or migration, or emigration to other breeding areas. It appears that high productivity in 1995, 2000, and 2004 may have increased adult capture rates the following year. Interestingly, those three years are also associated with extreme summer rainfall. More formal species-specific analyses will be required to investigate the proximate cause(s) of this declining trend.

To help interpret MAPS data on landbird dynamics we have recently developed and would like to highlight installation-specific resource pages for eight installations including Fort Bragg. Resources at the Fort Bragg page include the up-to-date Breeding Status List, a Spatial Statistics Database, a page interpreting and highlighting MAPS reports from Fort Bragg, and up to 36 Data Visualizations for 16 species at FLW. Data visualizations have been completed for the target species, Prairie Warbler, and an additional species-management-account page for this species is being developed. For the 2010 report we will have completed development of these pages, and will incorporate them more fully into the annual report.

The overall goal of this work is to evaluate the efficiency of on-going management practices (or cessation thereof) aimed at reversing declining populations and maintaining stable or increasing populations of target landbird species; and to modify those management practices in an adaptive management framework. The results of the first five years of this effort at Fort Bragg and other DoD installations indicate that we are well on our way to achieving success in this endeavor.

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Table 1. Summary of the 2009 MAPS program on U.S. Army Fort Bragg.

Station						2009 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours[1]	No. of periods	Inclusive dates
Sandstone Hill	SAHI	16706	Controlled burn pine savanna, mixed scrub oak woodland	35°03'05"N,79°19'31"W	141	518.5 (288.3)	9	5/13 – 7/31
I 104	I104	16657	Controlled burn pine savanna, riparian fields and scrub	35°06'58"N,79°19'11"W	88	512.3 (271.8)	9	5/16 – 8/03
I 113	I113	16658	Controlled burn riparian, savanna and pine-oak woodland	35°05'34"N,79°19'25"W	107	539.3 (312.0)	9	5/14 – 8/01
S 110	S110	16659	Riparian woodland, pine savanna and pine-oak woodland	35°07'08"N,79°20'11"W	94	505.7 (268.5)	9	5/17 – 8/04
S 114	S114	16661	Pine-oak and riparian woodland bordering grain fields	35°02'56"N,79°16'15"W	81	536.7 (343.0)	9	5/11 – 7/30
S 112	S112	16660	Pine-oak mixed with riparian woodland	35°06'44"N,79°21'46"W	121	494.5 (299.3)	9	5/15 – 8/02
ALL STATIONS COMBINED						3107.0(1783.0)	9	5/11 - 8/04

[1] Total net-hours in 2009. Net-hours in 2009 that could be compared in a constant-effort manner to 2008 are shown in parentheses.

Table 2. Capture summary for the six individual MAPS stations operated on U.S. Army Fort Bragg in 2009. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Sandstone Hill			I 104			I 113			S 110			S 114			S 112		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Northern Bobwhite		2									1							
Mourning Dove					1						1							
Ruby-throated Hummingbird					2						4			1			4	
Belted Kingfisher					1													
Red-headed Woodpecker	2			1		2												
Downy Woodpecker	2			2														
Hairy Woodpecker							1									1		
Red-cockaded Woodpecker		4																
Eastern Wood-Pewee	1		1			2	1											
Acadian Flycatcher																1		
Great Crested Flycatcher	1			4		1	6			1						1		
Eastern Kingbird				1														
White-eyed Vireo										3		1	2					
Blue-headed Vireo							1											
Red-eyed Vireo							2									1		
Blue Jay										1								
Carolina Chickadee				3		1	4		2	1						5		
Tufted Titmouse							2		2	3	1	1				2		1
Brown-headed Nuthatch	2			2														
Carolina Wren				4		1	8		14	8	1	9	9	1	9	11		5
Blue-gray Gnatcatcher				4			4									1		
Eastern Bluebird	11			2														
Wood Thrush																1		
American Robin	1																	
Gray Catbird				5			1											
Brown Thrasher	1			1						1								
Yellow-throated Warbler				1														
Pine Warbler	27		2	4		1	2			1						3		

Table 2. (cont.) Capture summary for the six individual MAPS stations operated on U.S. Army Fort Bragg in 2009. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Sandstone Hill			I 104			I 113			S 110			S 114			S 112		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Prairie Warbler				3		2	2		1	6		6						
Black-and-white Warbler																1		
Prothonotary Warbler				1														
Worm-eating Warbler																1		
Northern Waterthrush													1					
Common Yellowthroat				5		1	6	2	6	11		6	2			2		
Hooded Warbler													4		9			
Summer Tanager	3			2			2			2						3		
Eastern Towhee				2			2		2	2		2	1	1	1	2		
Bachman's Sparrow	5	1	1	3			3			2								
Chipping Sparrow	5		1				2											
Northern Cardinal				7			8		8	6		3	5		9	6		7
Blue Grosbeak	1						1			1			1					
Indigo Bunting				1			2						1			2		2
Common Grackle				2														
Brown-headed Cowbird																1		
American Goldfinch				1			1			1								
ALL SPECIES POOLED	62	7	5	61	4	11	61	2	35	50	8	28	26	3	28	45	4	15
Total Number of Captures		74			76			98			86			57			64	
Number of Species	13	3	4	23	3	8	21	1	7	16	5	7	9	3	4	18	1	4
Total Number of Species		15			27			21			19			10			19	

Table 3. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated on U.S. Army Fort Bragg in 2009.

	Sandstone Hill			I 104			I 113			S 110			S 114			S 112		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Red-headed Woodpecker	1.2	1.2	1.00	2.3	0.0	0.00												
Downy Woodpecker	2.3	0.0	0.00	2.3	0.0	0.00												
Hairy Woodpecker							1.1	0.0	0.00							1.2	0.0	0.00
Eastern Wood-Pewee	1.2	0.0	0.00	2.3	0.0	0.00	1.1	0.0	0.00									
Acadian Flycatcher																1.2	0.0	0.00
Great Crested Flycatcher	1.2	0.0	0.00	5.9	0.0	0.00	6.7	0.0	0.00	1.2	0.0	0.00				1.2	0.0	0.00
Eastern Kingbird				1.2	0.0	0.00												
White-eyed Vireo										2.4	1.2	0.50	2.2	0.0	0.00			
Red-eyed Vireo							2.2	0.0	0.00							1.2	0.0	0.00
Blue Jay										1.2	0.0	0.00						
Carolina Chickadee				2.3	1.2	0.50	0.0	4.5	und.	0.0	1.2	und.				1.2	4.9	4.00
Tufted Titmouse							2.2	0.0	0.00	2.4	2.4	1.00				2.4	1.2	0.50
Brown-headed Nuthatch	0.0	2.3	und.	1.2	1.2	1.00												
Carolina Wren				1.2	4.7	4.00	2.2	8.9	4.00	0.0	9.5	und.	2.2	8.9	4.00	2.4	12.1	5.00
Blue-gray Gnatcatcher				4.7	0.0	0.00	2.2	2.2	1.00							1.2	0.0	0.00
Eastern Bluebird	0.0	12.7	und.	2.3	0.0	0.00												
Wood Thrush																1.2	0.0	0.00
American Robin	1.2	0.0	0.00															
Gray Catbird				5.9	0.0	0.00	1.1	0.0	0.00									
Brown Thrasher	1.2	0.0	0.00	1.2	0.0	0.00				1.2	0.0	0.00						
Yellow-throated Warbler				1.2	0.0	0.00												
Pine Warbler	6.9	24.3	3.50	4.7	1.2	0.25	1.1	1.1	1.00	1.2	0.0	0.00				1.2	2.4	2.00
Prairie Warbler				4.7	0.0	0.00	1.1	1.1	1.00	9.5	1.2	0.13						
Black-and-white Warbler																1.2	0.0	0.00
Prothonotary Warbler				1.2	0.0	0.00												
Worm-eating Warbler																0.0	1.2	und.

Table 3. (cont.) Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated on U.S. Army Fort Bragg in 2009.

	Sandstone Hill			I 104			I 113			S 110			S 114			S 112		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Common Yellowthroat				5.9	1.2	0.20	3.3	3.3	1.00	5.9	8.3	1.40	2.2	0.0	0.00	2.4	0.0	0.00
Hooded Warbler													6.7	0.0	0.00			
Summer Tanager	1.2	2.3	2.00	1.2	1.2	1.00	1.1	1.1	1.00	2.4	0.0	0.00				3.6	0.0	0.00
Eastern Towhee				0.0	2.3	und.	3.3	0.0	0.00	2.4	0.0	0.00	2.2	0.0	0.00	2.4	0.0	0.00
Bachman's Sparrow	3.5	3.5	1.00	1.2	2.3	2.00	3.3	0.0	0.00	1.2	1.2	1.00						
Chipping Sparrow	6.9	0.0	0.00				2.2	0.0	0.00									
Northern Cardinal				5.9	2.3	0.40	4.5	5.6	1.25	1.2	5.9	5.00	4.5	2.2	0.50	7.3	3.6	0.50
Blue Grosbeak	1.2	0.0	0.00				1.1	0.0	0.00	1.2	0.0	0.00	1.1	0.0	0.00			
Indigo Bunting				1.2	0.0	0.00	2.2	0.0	0.00				1.1	0.0	0.00	2.4	0.0	0.00
Common Grackle				2.3	0.0	0.00												
Brown-headed Cowbird																1.2	0.0	0.00
American Goldfinch				1.2	0.0	0.00	1.1	0.0	0.00	1.2	0.0	0.00						
ALL SPECIES POOLED	27.8	46.3	1.67	63.2	17.6	0.28	43.4	27.8	0.64	34.4	30.9	0.90	22.4	11.2	0.50	35.2	25.5	0.72
Number of Species	11	6		23	9		19	8		14	8		8	2		17	6	
Total Number of Species		13			24			20			16			8			18	

Table 4. Summary of results for all six U.S. Army Fort Bragg MAPS stations combined in 2009.

Species	Birds captured			Birds/600 nethours		Prop. Young
	Newly banded	Un-banded	Recap-tured	Adults	Young	
Northern Bobwhite		3				
Mourning Dove		2				
Ruby-throated Hummingbird		11				
Belted Kingfisher		1				
Red-headed Woodpecker	3		2	0.6	0.2	0.33
Downy Woodpecker	4			0.8	0.0	0.00
Hairy Woodpecker	2			0.4	0.0	0.00
Red-cockaded Woodpecker		4				
Eastern Wood-Pewee	2		3	0.8	0.0	0.00
Acadian Flycatcher	1			0.2	0.0	0.00
Great Crested Flycatcher	13		1	2.7	0.0	0.00
Eastern Kingbird	1			0.2	0.0	0.00
White-eyed Vireo	5		1	0.8	0.2	0.25
Blue-headed Vireo	1					
Red-eyed Vireo	3			0.6	0.0	0.00
Blue Jay	1			0.2	0.0	0.00
Carolina Chickadee	13		3	0.6	1.9	3.33
Tufted Titmouse	7	1	4	1.2	0.6	0.50
Brown-headed Nuthatch	4			0.2	0.6	3.00
Carolina Wren	40	2	38	1.4	7.3	5.43
Blue-gray Gnatcatcher	9			1.4	0.4	0.29
Eastern Bluebird	13			0.4	2.1	5.50
Wood Thrush	1			0.2	0.0	0.00
American Robin	1			0.2	0.0	0.00
Gray Catbird	6			1.2	0.0	0.00
Brown Thrasher	3			0.6	0.0	0.00
Yellow-throated Warbler	1			0.2	0.0	0.00
Pine Warbler	37		3	2.5	4.8	1.92
Prairie Warbler	11		9	2.5	0.4	0.15
Black-and-white Warbler	1			0.2	0.0	0.00
Prothonotary Warbler	1			0.2	0.0	0.00
Worm-eating Warbler	1			0.0	0.2	und.
Northern Waterthrush	1					
Common Yellowthroat	26	2	13	3.3	2.1	0.65
Hooded Warbler	4		9	1.2	0.0	0.00
Summer Tanager	12			1.5	0.8	0.50
Eastern Towhee	9	1	5	1.7	0.4	0.22
Bachman's Sparrow	13	1	1	1.5	1.2	0.75
Chipping Sparrow	7		1	1.5	0.0	0.00
Northern Cardinal	32		27	3.9	3.3	0.85
Blue Grosbeak	4			0.8	0.0	0.00

Table 4. (cont.) Summary of results for all six U.S. Army Fort Bragg MAPS stations combined in 2009.

Species	Birds captured			Birds/600 nethours		Prop. Young
	Newly banded	Un-banded	Recap-tured	Adults	Young	
Indigo Bunting	6		2	1.2	0.0	0.00
Common Grackle	2			0.4	0.0	0.00
Brown-headed Cowbird	1			0.2	0.0	0.00
American Goldfinch	3			0.6	0.0	0.00
ALL SPECIES POOLED	305	28	122	37.7	26.5	0.70
Total Number of Captures		455				
Number of Species	40	10	16	37	16	
Total Number of Species		45			38	

Table 5. Residency patterns for 38 species at the five long-running stations at Fort Bragg. See Figure 5 for examples of patterns reported here[1]. Links to visualization data from Fort Bragg are provided for eight species.

Species	I104	I113	S110	S114	S112
Mourning Dove	Resident	Resident	Resident	Intermittent	Resident
Yellow-billed Cuckoo	Intermittent	Intermittent	Vacating	Intermittent	Intermittent
Ruby-thr. Hummingbird	Intermittent	Intermittent	Establishing		Intermittent
Red-bellied Woodpecker	Resident	Resident	Intermittent	Intermittent	Resident
Red-headed Woodpecker	Intermittent	Intermittent		Intermittent	
Downy Woodpecker	Intermittent	Intermittent	Intermittent		Resident
Red-cockaded Woodpecker		Intermittent	Resident	Intermittent	
Yellow-shafted Flicker	Intermittent	Intermittent	Establishing	Intermittent	Intermittent
Pileated Woodpecker		Establishing		Establishing	Intermittent
Eastern Wood-Pewee	Resident	Resident	Vacating		
Great Crested Flycatcher	Resident	Resident	Resident	Resident	Resident
White-eyed Vireo	Vacating		Intermittent	Intermittent	
Red-eyed Vireo		Intermittent	Intermittent	Intermittent	Resident
Blue Jay	Intermittent	Intermittent	Intermittent	Intermittent	Establishing
Carolina Chickadee	Resident	Resident	Resident	Resident	Resident
Tufted Titmouse	Resident	Resident	Resident	Resident	Resident
White-breasted Nuthatch	Vacating		Intermittent	Intermittent	
Brown-headed Nuthatch	Resident	Intermittent	Resident		
Carolina Wren	Resident	Resident	Resident	Resident	Resident
Blue-gray Gnatcatcher	Resident	Resident	Resident	Resident	Resident
Eastern Bluebird		Establishing	Establishing	Establishing	
Wood Thrush					Vacating
Gray Catbird	Resident	Vacating	Vacating		
Brown Thrasher	Vacating		Vacating		
Prairie Warbler	Resident	Resident	Resident		
Pine Warbler	Resident	Resident	Resident	Intermittent	Vacating
Black-and-white Warbler			Intermittent		Vacating
Ovenbird				Vacating	Vacating
Common Yellowthroat	Resident	Resident	Resident	Intermittent	Vacating
Hooded Warbler		Vacating	Intermittent	Resident	Vacating
Summer Tanager	Resident	Resident	Resident	Intermittent	Resident
Eastern Towhee	Resident	Resident	Resident	Resident	Resident
Chipping Sparrow	Establishing	Establishing	Resident		
Bachman's Sparrow	Establishing	Resident	Intermittent		
Northern Cardinal	Resident	Resident	Resident	Resident	Resident
Indigo Bunting	Establishing	Intermittent	Resident	Intermittent	Resident
Brown-headed Cowbird			Intermittent		Vacating
American Goldfinch	Resident	Intermittent	Resident	Intermittent	Resident

[1] See Figure 1 for examples of plots used for the above assessments.

Table 6. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using a time-constant model for 19 species breeding at the seven MAPS stations ever operated on U.S. Army Fort Bragg obtained from 15 years[1] (1995-2009) of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.[5]	Survival probability[6]	Surv. C.V.[7]	Recapture probability[8]	Proportion of residents[9]
Great Crested Flycatcher*	6	140	156	9	0.256 (0.129)	50.4	0.264 (0.242)	0.786 (0.799)
Red-eyed Vireo	4	64	73	5	0.555 (0.169)	30.4	0.160 (0.156)	0.430 (0.444)
Carolina Chickadee	6	102	137	12	0.517 (0.108)	20.9	0.243 (0.115)	0.416 (0.224)
Tufted Titmouse	6	136	219	25	0.431 (0.075)	17.4	0.521 (0.127)	0.398 (0.145)
Carolina Wren	5	173	390	43	0.355 (0.053)	14.9	0.693 (0.108)	0.554 (0.157)
Blue-gray Gnatcatcher*	5	71	80	3	0.421 (0.202)	48.0	0.393 (0.316)	0.080 (0.094)
Wood Thrush	1	59	86	6	0.476 (0.149)	31.4	0.147 (0.117)	0.724 (0.593)
Gray Catbird	2	111	169	9	0.445 (0.120)	27.0	0.186 (0.110)	0.478 (0.304)
Brown Thrasher	2	51	67	5	0.491 (0.150)	30.6	0.415 (0.228)	0.088 (0.094)
Pine Warbler	6	138	153	8	0.430 (0.151)	35.2	0.146 (0.140)	0.619 (0.630)
Prairie Warbler	4	250	379	39	0.368 (0.060)	16.4	0.420 (0.103)	0.614 (0.183)
Ovenbird+	1	33	42	6	0.592 (0.144)	24.3	0.129 (0.114)	1.000 (0.923)
Common Yellowthroat	5	384	863	54	0.349 (0.044)	12.7	0.667 (0.095)	0.214 (0.063)
Hooded Warbler	4	76	128	8	0.234 (0.116)	49.8	0.499 (0.298)	0.704 (0.483)
Summer Tanager	6	94	111	8	0.549 (0.136)	24.8	0.160 (0.114)	0.492 (0.372)
Eastern Towhee	6	127	221	33	0.398 (0.065)	16.4	0.780 (0.108)	0.451 (0.141)
Northern Cardinal	5	194	444	60	0.512 (0.047)	9.1	0.565 (0.075)	0.367 (0.101)
Indigo Bunting	5	78	92	7	0.471 (0.155)	32.8	0.323 (0.207)	0.342 (0.259)
American Goldfinch*+	4	57	61	2	0.399 (0.304)	76.3	0.059 (0.179)	1.000 (3.021)

[1] Analysis of all stations pooled include data from 1995-2009 from the I 104, I 113, S 110, and S112, from 1995-2002 from the S 102 station and 2003-2009 from the Sandstone Hill station which replaced the S 102 station. Only data from 2003-2009 is included from the S114 station.

[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.

Table 6. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using a time-constant model for 19 species breeding at the seven MAPS stations ever operated on U.S. Army Fort Bragg obtained from 15 years[1] (1995-2009) of mark-recapture data.

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[6] Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate).
[7] The coefficient of variation for survival probability, CV(φ).
[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).
† The estimate for recapture probability (and possibly survival probability as well) may be biased low because the estimate for τ was 1.000.
* The estimate for survival probability should be viewed with caution because it is based on fewer than five between-year recaptures or the estimate is very imprecise (SE(φ)≥0.200 or CV(φ)≥50.0%)

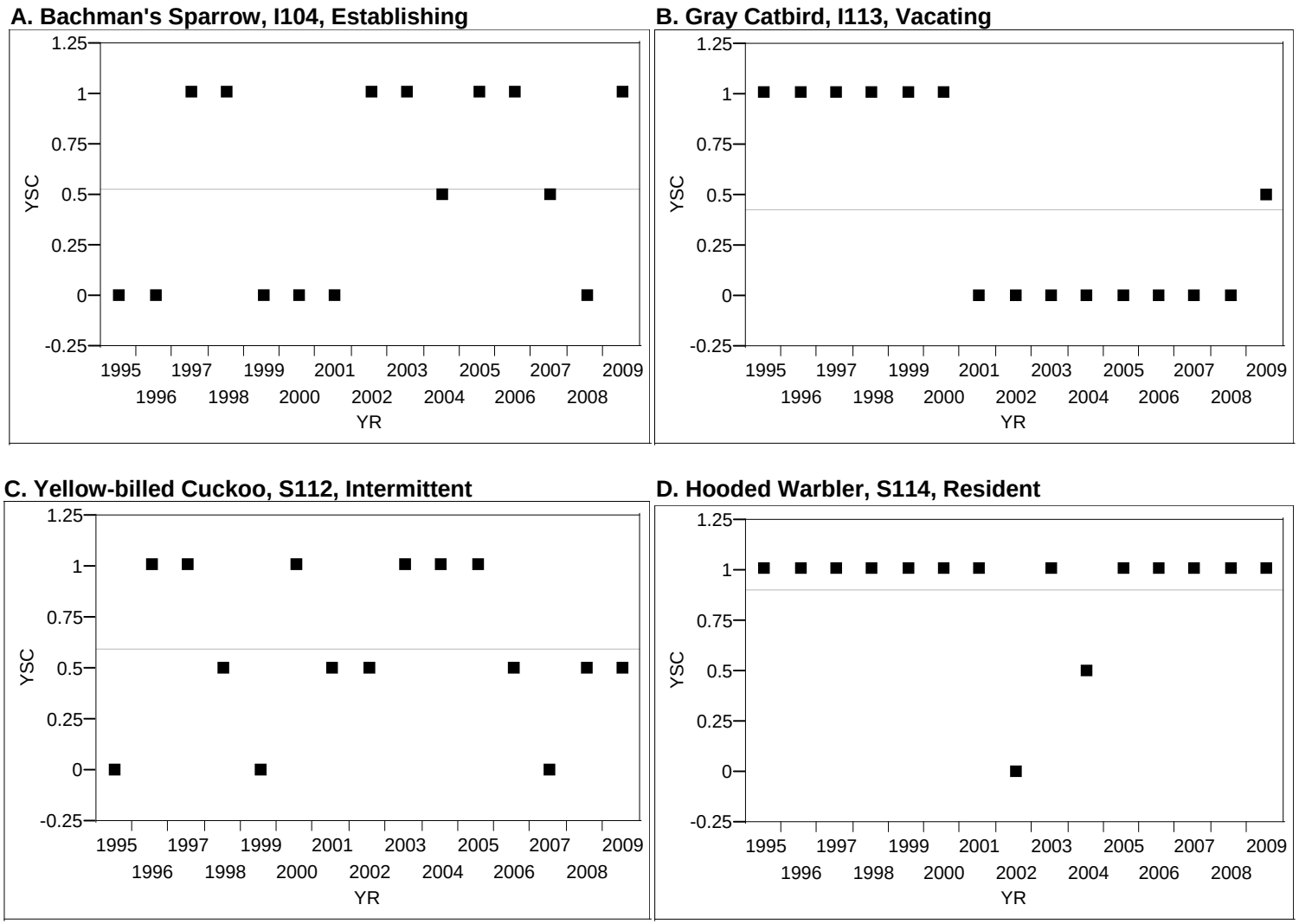

Figure 1. Examples of occurrence patterns at stations based on annual breeding status assessments (YSC) during the15-year (1995-2009) period of the study at the five long-running stations at Fort Bragg. Confirmed breeding was scored as 1.0, probable or possible breeding was scored as 0.5, and transient or migrant status was scored as 0.0 for each species annually. Overall patterns for a species at a station were scored as Establishing (Example **A**), Vacating (Example **B**), Intermittent (Example **C**), or Resident (Example **D**). See Table 5 for species assessments at each station.

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 15 years, 1995-2009, of the MAPS Program on the seven stations operated on U.S. Army Fort Bragg.

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	Sandstone Hill (SAHI)	I 104 (I104)	I 113 (I113)	S 110 (S110)	S 114 (S114)	S 112 (S112)	I 102 (I102)
00860	DCCO	Double-crested Cormorant		T					
00950	AMBI	American Bittern		T					
01010	GBHE	Great Blue Heron	T	O	T	T		T	T
01040	GREG	Great Egret						T	
01130	GRHE	Green Heron		T					
01290	BLVU	Black Vulture		T		T			
01300	TUVU	Turkey Vulture	T	T	T	T	T	O	T
01460	CANG	Canada Goose		T	T	T		T	
01570	WODU	Wood Duck		U	T	T	T	T	T
01630	MALL	Mallard		T					
02200	SSHA	Sharp-shinned Hawk		M		M			
02210	COHA	Cooper's Hawk				T	T		T
02380	RSHA	Red-shouldered Hawk		T	T	T	O	O	
02400	BWHA	Broad-winged Hawk		T	T	T	T	T	
02460	RTHA	Red-tailed Hawk		T	T	T	T	O	T
02630	AMKE	American Kestrel	O	O	O	T	T	T	U
03040	WITU	Wild Turkey	T		T		T		
03160	NOBO	Northern Bobwhite	U	U	U	U	U	U	B
04490	AMWO	American Woodcock		T	T	T			
05570	MODO	Mourning Dove	B	U	B	B	U	B	B
06410	YBCU	Yellow-billed Cuckoo	O	U	U	U	U	U	O
06680	EASO	Eastern Screech-Owl		T	O	T	T	T	T
06800	GHOW	Great Horned Owl		T	T				
06950	BADO	Barred Owl					T		
07080	CONI	Common Nighthawk	U	U	U	O	O	O	U
07170	CWWI	Chuck-will's-widow	T	O		O	O	O	
07230	WPWI	Whip-poor-will		T	O	O		T	
07400	CHSW	Chimney Swift	T	O	T	T	T	O	T
08630	RTHU	Ruby-throated Hummingbird	O	O	O	U	O	U	O
09110	BEKI	Belted Kingfisher	T	O	T		T	T	T
09420	RHWO	Red-headed Woodpecker	O	U	U	O	O	O	U
09550	RBWO	Red-bellied Woodpecker	O	B	U	U	U	U	B
09650	DOWO	Downy Woodpecker	O	U	U	U	U	U	O

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	SAHI	I104	I113	S110	S114	S112	I102
09660	HAWO	Hairy Woodpecker		O	T	T	O	U	O
09680	RCWO	Red-cockaded Woodpecker	U	O	U	O	T	T	B
09800	YSFL	Yellow-shafted Flicker	B	U	U	U	U	U	B
09860	PIWO	Pileated Woodpecker	O	O	O	O	U	U	U
11390	EAWP	Eastern Wood-Pewee	U	B	B	U	O	O	B
11460	ACFL	Acadian Flycatcher		T	T	T	O	O	T
11595	UEFL	Unidentified Empidonax Flycatcher				?			
11610	EAPH	Eastern Phoebe		T					T
11760	GCFL	Great Crested Flycatcher	B	B	B	B	U	B	B
12030	EAKI	Eastern Kingbird	O	O	T	O	T	T	
12520	LOSH	Loggerhead Shrike	T						
12550	WEVI	White-eyed Vireo	T	U	O	U	O	O	O
12690	YTVI	Yellow-throated Vireo	T	O	O	O	O	O	
12720	BHVI	Blue-headed Vireo			M	M		M	M
12790	REVI	Red-eyed Vireo	O	O	U	U	U	B	T
12930	BLJA	Blue Jay	B	U	U	U	U	B	B
13190	AMCR	American Crow	U	O	O	O	O	U	O
13270	FICR	Fish Crow	B	U	O	O	O	T	O
13340	PUMA	Purple Martin	T	T	T	T	T	T	T
13410	TRES	Tree Swallow	M				M	M	M
13490	NRWS	Northern Rough-winged Swallow			T				
13540	BARS	Barn Swallow	T		T	T	T	T	T
13560	CACH	Carolina Chickadee	U	B	B	B	B	B	B
13660	TUTI	Tufted Titmouse	B	B	B	B	B	B	B
13700	WBNU	White-breasted Nuthatch	U	U	U	O	U	U	U
13720	BHNU	Brown-headed Nuthatch	B	U	U	U	T	O	U
14000	CARW	Carolina Wren	O	B	B	B	B	B	B
14350	BGGN	Blue-gray Gnatcatcher	O	B	U	B	U	B	U
14560	EABL	Eastern Bluebird	U	U	O	O	O	O	U
14780	VEER	Veery				M		M	M
14790	GCTH	Gray-cheeked Thrush		M		M	M		
14810	SWTH	Swainson's Thrush		M		M		M	M
14830	WOTH	Wood Thrush	T	T	T	T	O	U	
15000	AMRO	American Robin	O	O	O	O	O	O	U
15130	GRCA	Gray Catbird		U	O	O	O	O	U
15150	NOMO	Northern Mockingbird	T	T	T				
15200	BRTH	Brown Thrasher	O	U	O	U	O	O	U
15550	CEDW	Cedar Waxwing	M	M		M			
15630	BWWA	Blue-winged Warbler		M					
15730	NOPA	Northern Parula		T	T	T	T	T	T
15750	YWAR	Yellow Warbler			M			M	
15770	MAWA	Magnolia Warbler		M		M	M	M	M

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	SAHI	I104	I113	S110	S114	S112	I102
15790	BTBW	Black-throated Blue Warbler		M	M	M	M	M	M
15830	BTNW	Black-throated Green Warbler		M				M	
15870	YTWA	Yellow-throated Warbler	T	O	T	O	O	O	T
15910	PIWA	Pine Warbler	B	B	B	B	U	U	B
15930	PRAW	Prairie Warbler	U	B	U	B	O	O	B
15970	BLPW	Blackpoll Warbler		M				M	M
16030	BAWW	Black-and-white Warbler		T	O	O	O	U	
16040	AMRE	American Redstart		O	T	T	T	T	T
16050	PROW	Prothonotary Warbler		T	T		O	T	T
16060	WEWA	Worm-eating Warbler			T			T	
16080	OVEN	Ovenbird	T	O	O	O	U	U	T
16090	NOWA	Northern Waterthrush		M	M		M	M	
16100	LOWA	Louisiana Waterthrush		T		O	T	T	
16110	KEWA	Kentucky Warbler				T	U	O	T
16150	COYE	Common Yellowthroat	T	B	B	B	U	U	B
16280	HOWA	Hooded Warbler		O	O	U	B	U	U
16290	WIWA	Wilson's Warbler		M					
16300	CAWA	Canada Warbler					M		
16460	YBCH	Yellow-breasted Chat		O	O	T	T	T	T
16820	SUTA	Summer Tanager	B	B	B	B	U	B	U
17820	EATO	Eastern Towhee	B	B	B	B	U	B	B
17930	BACS	Bachman's Sparrow	B	U	U	U		O	U
18020	CHSP	Chipping Sparrow	U	U	U	U	O	T	U
18050	FISP	Field Sparrow	O	O	T	O			T
18080	VESP	Vesper Sparrow		T					
18270	WTSP	White-throated Sparrow		M					M
18560	NOCA	Northern Cardinal	O	B	B	B	B	B	B
18600	RBGR	Rose-breasted Grosbeak					M		
18640	BLGR	Blue Grosbeak	U	O	O	O	O	O	T
18670	INBU	Indigo Bunting	O	U	U	B	U	B	U
18730	RWBL	Red-winged Blackbird		O					
18800	EAME	Eastern Meadowlark			T				
18870	COGR	Common Grackle	T	O	T	O		T	T
18960	BHCO	Brown-headed Cowbird	O	O	O	U	O	U	U
19040	OROR	Orchard Oriole			T		T		T
19160	BAOR	Baltimore Oriole						M	
19370	HOFI	House Finch	T			T		O	
19510	AMGO	American Goldfinch	O	B	U	U	U	B	U
19920	HOSP	House Sparrow				T	T		