

**THE 2008 REPORT OF THE  
MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP  
(MAPS) PROGRAM ON FORT LEONARD WOOD**

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## SUMMARY

Six Monitoring Avian Productivity and Survivorship (MAPS) stations were established and operated by The Institute for Bird Populations (IBP) in 1993 on Fort Leonard Wood (FLW), Missouri. We continued to operate these stations during the summers of 1994-2002 by means of funding from the DoD Legacy Resource Management Program, and during the summers of 2003-2008 by means of funding from FLW natural resources program, which also supports studies of Cerulean Warblers on the installation. The objectives of the MAPS Program on FLW 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](#)).

Following the recommendations of Nott et al. ([2003](#)), the Smith Ridge and Miller Ridge stations at FLW were discontinued in 2003 due to low capture rates and because they were located in dry, upland, mature, closed canopy forest where management results are less

achievable. The two stations were replaced by the Tilley Bottoms station in a moist bottomland forest, and the Bradford Cemetery station to monitor the effects of cessation of fire management on species of conservation concern. Thus, 2008 is the fifth year of operation for the Tilley Bottoms and Bradford Cemetery stations, and the fifth year following management actions at Miller Pond and Macedonia. Fire management of open scrubby habitat around the Miller Pond and Macedonia stations also occurred during the spring of 2004.

Adult capture rates at the six stations generally decreased by small amounts (except at Bradford Cemetery) from those of 2007, suggesting slightly smaller breeding populations at FLW in 2008. Adults captured at all stations pooled (131.5) decreased by 12.2% over the value of 147.5 recorded in 2007. Indigo Bunting was the most frequently captured species at the six stations in 2008, followed by Yellow-breasted Chat, White-eyed Vireo, Kentucky Warbler, Ruby-throated Hummingbird, Prairie Warbler, Red-eyed Vireo, Blue-winged Warbler, Common Yellowthroat, and Field Sparrow.

The overall reproductive index for the six stations in 2008 was 0.19, compared to 0.27 in 2007 and 2006, and 0.26 in 2005, suggesting a substantial drop in productivity compared with the consistent values of the past three years. The reproductive index in 2008 was lower than in 2007 (by 11-91%) at all individual stations except Bradford Cemetery, where it increased by almost 50%. This reflects generally decreased productivity observed throughout the southeastern United States in 2008, perhaps due to good reproductive success in this region in 2007, resulting in more inexperienced, first-time breeding birds in 2008.

Using 16 years of data from the six long-running stations combined, estimates of adult survival and recapture probabilities were obtained for 24 target species breeding at FLW. These ranged from a low of 0.361 for Carolina Wren to a high of 0.645 for Ovenbird, with a mean of 0.529 for the 24 species. The coefficients of variation about these estimates indicated that the precision of these estimates have improved with a mean of 18.0%, compared with 18.6% following the 2007 season, and 19.8% following the 2006 season. Furthermore, we expect that survival estimates may continue to become more precise in future years. Survival and productivity of landbirds at FLW appears to be higher than that at other MAPS stations in the South-central MAPS Region (Nott and Morris 2007). We suggest that the large patches of forested habitat and their adjacency to forested tracts of Mark Twain National Forest create high quality breeding habitat for many species. These large patches should be maintained and micro-managed to ensure the availability of good quality breeding habitat for target species of concern.

Analyses of DoD MAPS data have described strong relationships between demographic parameters and landscape-level habitat characteristics for ten bird species of conservation concern on 13 military installations in the south-central and southeastern United States ([Nott et al. 2003](#), [Nott and Michel 2005](#)). Of these ten species, five species with declining or stable populations at FLW were selected as species of local management concern: Acadian Flycatcher, Worm-eating Warbler, Louisiana Waterthrush, Kentucky Warbler, and Field Sparrow.

Nott et al. ([2003](#)) predicted that fire management practices, implemented in the vicinity of certain stations, should result in increased populations and productivity among Field Sparrows at those stations. Examination of Field Sparrow data since fire management at FLW indicate that

adult populations peaked during the year or two following that of the managed burns. From 2004-2007 Field Sparrow productivity was fairly stable at the burn-management stations but declined between 2007 and 2008, perhaps reflecting post-burn succession of the habitat.

Nott et al. ([2003](#)) also predicted that the establishment of the two new stations, Tilley Bottoms and Bradford Cemetery, should shed further light on landbird population dynamics at FLW. During the 2006, 2007, and 2008 seasons, we recorded high capture rates of two target species, Kentucky Warbler, and Acadian Flycatcher. Two species of regional conservation concern with increasing FLW adult population sizes, Blue-winged Warbler and Prairie Warbler, also exhibited high capture rates. We might expect the numbers and reproductive success of both these species to decline in coming years, as Bradford Cemetery is managed to allow succession towards the pine forest community currently surrounding it. Thus, the addition of these two stations will help us resolve the driving forces behind the population dynamics of target species of management concern at FLW.

Concerning the remaining two target species, Louisiana Waterthrush has always been captured at low rates at FLW, and changes of stations and management actions have had no impact on this species. Worm-eating Warbler captures continue to decline at FLW (see Nott et al. 2008) indicating an overall decline of this species and indicating that changes at FLW have not been beneficial to this species. Further consideration should be given to management actions that might result in increased success of Louisiana Waterthrush and Worm-eating Warbler at FLW.

The overall goal of this work is to assess the efficacy of on-going management practices (or cessation thereof) aimed at 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 indicate success in predicting post-management demographic changes with three of five target species.

The FLW MAPS data contribute to a demographic monitoring dataset collected at numerous DoD installations since 1992. These data have also contributed to the development of management decision-support tools designed to predict the effects of proposed management on a suite of species of concern (Nott 2008).



## 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) used novel 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. Hence, as Nott et al. (in prep.) suggested, annual survival rate of Neotropical migrants is strongly affected by stressors act 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. Accordingly, the MAPS program was 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 1993, six MAPS stations were established and operated on Fort Leonard Wood, Missouri (FLW). The operation of these stations was continued during the summers of 1994-2002 by means of funding from the DoD Legacy Resource Management Program, and during the summers of 2003-2008 by means of funding from FLW, which also supports studies of Cerulean Warblers on the installation.

The ultimate objective of the MAPS Program on DoD installations such as FLW is to identify generalized management guidelines and formulate specific management actions that can 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 is 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. Our goal is to identify relationships between productivity (and survivorship for permanent resident species) and these habitat and weather variables. These management strategies involve efforts to modify habitat characteristics from those associated with low productivity to those associated with high productivity, for species for which low productivity is driving a population decline.

The Legacy Resource Management Program allowed us to undertake these analyses and formulate management strategies. These analyses have now been completed ([Nott et al. 2003](#)) and management guidelines have been formulated for ten bird species of conservation concern that breed in the southeastern United States. With additional funding from the Legacy Resource Management Program, we are currently implementing these guidelines and actions on eight military installations (including FLW) 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 their effectiveness, 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 has remained the same.

At FLW, following the recommendations of Nott et al. ([2003](#)), the Smith Ridge and Miller Ridge stations were discontinued in 2003 due to low capture rates and because they were located in mature forest where management results are less achievable. They were replaced by the Tilley Bottoms station (to act as a replicate for the Big Piney station) and the Bradford Cemetery station, a grassland area that is presently undergoing secondary succession and should be monitored. The Big Piney and Laughlin Bottoms stations were maintained as controls. Fire management of open scrubby habitat around the Miller Pond and Macedonia stations also occurred during the spring of 2004. Thus, 2008 is the fifth year of operation for the Tilley Bottoms and Bradford Cemetery stations, and the fifth year following management actions at Miller Pond and Macedonia.

A complete summary of the results of the MAPS Program on FLW from 1993-1999, as well as on 12 other installations or groups of nearby installations in eastern United States, was presented by DeSante et al. (2001b). This report briefly updates that earliest report and previous reports (DeSante et al. 2004, 2005; Pyle et al. 2006; Nott and Morris 2007, Nott et al. 2006, 2008), and documents the operation of the six MAPS stations on FLW during the 2008 breeding season.

## METHODS

Six MAPS stations were operated in 2008, at the same locations where they were operated in 2003-2006. 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. 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-netting sites within the interior eight ha of each 20-ha 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 eight consecutive 10-day periods between May 21 and August 5 (Table 1). The operation of stations occurred on schedule in each of the ten-day periods and was carried out by IBP field biologist interns Elly Knight and Chantal Villeneuve, who were trained by IBP field biologists Melissa Wolfe and Mary Chambers, and were supervised by Melissa Wolfe throughout the season.

With few exceptions, all birds captured during the course of the study were identified to species, age, and sex and, if unbanded, were banded with USGS/BRD numbered aluminum bands. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety would be comprised. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms ([DeSante et al. 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.

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, weight, 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 combined, 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 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. 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.

Survival was estimated for 24 target species using Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) on 16 years (1993-2008) of capture histories of adult birds from all eight stations at FLW (including the discontinued Smith Ridge and Miller Ridge stations). 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 up to all six stations pooled at which the species was a breeder during more than half of the years the station was operated. Using the computer program TMSURVIV (White 1983, Hines et al. 2003), we calculated, for each target species, maximum-likelihood estimates and standard errors (*SEs*) for adult survival probability, adult recapture probability, and the proportion of residents among newly captured adults using 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 FLW during the summer of 2008 for a total of 2624.0 net-hours. This represents 91.1% of the maximum expected effort. Details of the operation of these six stations are presented in Table 1.

For each individual species and for all species pooled, the numbers of individual birds newly banded, released unbanded (including hummingbirds, which we are not licensed to band), and recaptured, are presented for each station in Table 2 and for all stations combined in Table 4. A total of 958 captures of 51 species occurred at FLW during the summer of 2008 (Table 4). Newly banded birds comprised 61.1% of the total captures.

The greatest number of total captures (208) was recorded at the Miller Pond Station and the smallest number of total captures (47) was recorded at the Macedonia station. The highest species richness occurred at Miller Pond (34 species) and the lowest species richness occurred at Macedonia (15 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 and accidental net damage, can differ from one another in effort expended (Table 1). Adult population size (for all species pooled) was

highest at Miller Pond (175.5 adults/600 net hours; Table 3), followed by, Tilley Bottoms (161.7), Laughlin Bottoms (135.3), Big Piney (132.8), Bradford Cemetery (130.7), and Macedonia (48.1). These adult capture rates generally decreased by small amounts (by a larger amount at Bradford Cemetery) from those of 2007 indicating generally smaller breeding populations at Leonard Wood in 2008. Adults captured at all stations pooled (131.5; Table 4) decreased by 12.2% over the value of 147.5 recorded in 2007.

Among individual species, Indigo Bunting was the most frequently captured species at the six stations in 2008, followed by Yellow-breasted Chat, White-eyed Vireo and Kentucky Warbler, Ruby-throated Hummingbird, Prairie Warbler, Red-eyed Vireo, Blue-winged Warbler, Common Yellowthroat, and Field Sparrow (Table 4). The most abundant breeding species, having a capture rate of at least 6.0 adults per 600 net-hours, in decreasing order, were Indigo Bunting, Yellow-breasted Chat, White-eyed Vireo, Kentucky Warbler, Red-eyed Vireo, and Blue-winged Warbler (Table 4); we could not calculate this value for Ruby-throated Hummingbird since birds were not banded. The most abundant breeding species at each installation, having a capture rate of at least 6.0 adults per 600 net-hours were as follows (Table 3; species of concern, as noted below, in *italics*):

**Big Piney**

American Redstart  
 Indigo Bunting  
*Kentucky Warbler*  
 Red-eyed Vireo  
*Louisiana Waterthrush*  
 White-eyed Vireo\*  
 Carolina Wren\*  
*Acadian Flycatcher*<sup>†</sup>

Blue-winged Warbler<sup>†</sup>  
 Wood Thrush<sup>†</sup>  
*Worm-eating Warbler*<sup>†</sup>  
 Northern Cardinal<sup>†</sup>

**Laughlin Bottoms**

Indigo Bunting  
*Kentucky Warbler*  
 Yellow-breasted Chat

Northern Cardinal\*  
 Blue-winged Warbler  
 White-eyed Vireo  
 Blue-gray Gnatcatcher\*  
 Common Yellowthroat\*  
 Ovenbird<sup>†</sup>

**Bradford Cemetery**

Yellow-breasted Chat  
 Indigo Bunting  
 White-eyed Vireo  
 Prairie Warbler  
*Acadian Flycatcher*\*  
*Field Sparrow*  
 Blue-winged Warbler<sup>†</sup>  
 Red-eyed Vireo<sup>†</sup>  
 Black-and White Warbler<sup>†</sup>  
*Kentucky Warbler*<sup>†</sup>  
 Northern Cardinal<sup>†</sup>  
 American Goldfinch<sup>†</sup>  
 Blue-gray Gnatcatcher<sup>†</sup>

**Tilley Bottoms**

Yellow-breasted Chat  
 Indigo Bunting  
 White-eyed Vireo  
*Kentucky Warbler*\*  
 Blue-winged Warbler  
 Common Yellowthroat  
 Blue-gray Gnatcatcher\*  
 American Redstart<sup>†</sup>

**Miller Pond**

Yellow-breasted Chat  
*Field Sparrow*  
 Indigo Bunting  
 Prairie Warbler\*  
 American Goldfinch  
 White-eyed Vireo  
 Blue-winged Warbler  
 Common Yellowthroat  
 Red-eyed Vireo\*  
 Northern Cardinal<sup>†</sup>  
 Cedar Waxwing<sup>†</sup>  
 Carolina Chickadee<sup>†</sup>

**Macedonia**

Indigo Bunting  
 Red-eyed Vireo\*  
 Ovenbird<sup>†</sup>  
 Summer Tanager<sup>†</sup>

\* At least 6.0 adults per 600 net hours in 2008 but not in 2007.

<sup>†</sup> At least 6.0 adults per 600 net hours in 2007 but not in 2008.

Reproductive index (the number of young per adult captured pooled across six stations) showed a different pattern than adult population size (Table 3), being highest at Laughlin Bottoms (0.23), followed by Bradford Cemetery (0.22), Miller Pond (0.21), Tilley Bottoms (0.19), Big Piney (0.14), and Macedonia (0.03). Productivity was lower than in 2007 (by 11-91%) at all stations except Bradford Cemetery, where it increased by almost 50%. The overall reproductive index for the six stations in 2008 was 0.19 (Table 4), compared to 0.27 in 2007 and 2006, and 0.26 in 2005, suggesting a substantial drop in productivity compared with the

consistent values of the past three years. Thus, the mean reproductive index for all species pooled at FLW in 2008 was similar to the 0.209 recorded during the seven years 1993-1999 (see DeSante et al. 2001b, albeit with two different stations). This reflects generally decreased productivity observed throughout the southeastern United States in 2008, perhaps due to good reproductive success in this region in 2007, resulting in more inexperienced, first-time breeding birds in 2008.

Using 16 years of data from the six long-running stations combined, estimates of adult survival and recapture probabilities were obtained for 24 target species breeding at FLW. 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 5. Annual adult survival-rate estimates ranged from a low of 0.361 for Carolina Wren to a high of 0.645 for Ovenbird, with a mean of 0.529 for the 24 species. Furthermore, the C.V.s for the 24 species at FLW were low (20 of the 24 species < 30%, 14 species < 20%, and 10 species < 10%) indicating quite precise estimates. The mean C.V. for these 24 species was 18.0%, compared with 18.6% following the 2007 season (with 15 years of data) and 19.8% following the 2006 season (with 14 years of data), indicating that survival estimates may continue to become more precise, even after 16 years of data have been collected.

Furthermore, survival of landbirds at FLW appears to be quite good, better than that at other MAPS stations in the South-central MAPS Region (DeSante et al. 2004). We suggest that the populations of landbirds breeding at FLW consist of high-quality individuals that are attracted to and able to hold territories in the pristine habitats at the Fort and that, on average,

display better survival than birds that breed over the South-central Region as a whole. This suggests that FLW is very important to landbird populations.

As mentioned earlier, analyses aimed at identifying and describing relationships between four demographic parameters (adult population size, population trend, number of young, and productivity) and landscape-level habitat characteristics for ten bird species of conservation concern have been completed for 13 military installations in south-central and southeastern United States, including FLW ([Nott et al. 2003](#), [Nott and Michel 2005](#)). At FLW, five species with declining or stable populations emerged as candidates for particular management concern: Acadian Flycatcher, Worm-eating Warbler, Louisiana Waterthrush, Kentucky Warbler, and Field Sparrow.

Nott et al. ([2003](#)) predicted that fire management practices, implemented in the vicinity of certain stations, should result in increased populations and productivity among Field Sparrows at those stations. Fire management has occurred at FLW at various times: during spring 2000 at Laughlin Bottoms, spring 2002 at Miller Pond and Bradford Cemetery, and spring 2003 at Macedonia; no fire management has occurred at the remaining two stations, Big Piney and Tilley Bottoms. Examination of Field Sparrow data indicate that adult populations at each of the four stations having fire management showed increases which peaked during the year or two following that of the managed burns: 2002 at Laughlin Bottoms (10.2 adults/600 net hours), 2003 at Miller Pond (29.3), 2003 at Bradford Cemetery (36.0), and 2004 at Macedonia (4.3). In each case, these totals were the highest recorded during the eight-year period 2001-2008. Interestingly, breeding populations declined in each case during the following four-year period,

including 2008 (Table 3), suggesting that the positive effects of burn management on Field Sparrow populations last only 2-3 years. Until 2008, Field Sparrow productivity has appeared fairly stable at the burn-management stations since the burns took place, but it declined between 2007 (mean 0.39 at five stations where young were captured) and 2008 (mean 0.04 at three stations where young were captured). This may reflect a change in post-burn successional habitat, which would appear to disfavor Field Sparrow 4-6 years following a burn, or it may simply reflect the fact that 2008 was a poor overall year for productivity compared to the previous five years.

For successional species, such as Field Sparrow, the conservation goal is to consistently provide enough primary breeding habitat to annually support a target number of territories (dependent on installation or management zone) and level of productivity consistent with that of a source population in which breeding individuals are able to replace their own numbers. This requires maintaining a mosaic of habitat patches in various stages of post-fire succession such that every year there are adequate areas of habitat for recruitment, breeding, and strong reproductive success. The ability to maintain an abundant “source” population might be considered an adequate performance measure by which to evaluate landbird conservation efforts and habitat management techniques.

Nott et al. ([2003](#)) also predicted that the establishment of the two new stations, Tilley Bottoms and Bradford Cemetery, should shed further light on landbird population dynamics at FLW, including those of the other four target species, Acadian Flycatcher, Worm-eating Warbler, Louisiana Waterthrush, and Kentucky Warbler. In 2005 all of these species except the



waterthrush were captured at these two stations, including excellent capture rates of Kentucky Warbler. During 2006-2008, captures of Kentucky Warbler and Acadian Flycatcher have remained fairly consistent whereas those of Worm-eating Warbler have been lower (cf. Table 3). It is possible that some of the decline reflects generally declining capture rates of all species from 2005 to 2008. Excellent capture rates of two other target species (with increasing populations), Blue-winged and Prairie warblers, were also obtained at the two new stations in 2005-2008. We might expect the numbers and reproductive success of both these species to decline in coming years, as Bradford Cemetery is managed for succession of the pine forest community currently surrounding it. Although this will eventually represent a loss of productive Field Sparrow habitat, “disclimax” management on other parts of the installation could replace such habitat. Thus, it appears that the addition of these two stations will help us resolve the population dynamics of these target species of management concern at FLW.

Concerning the remaining two target species, Louisiana Waterthrush has never been captured at monitorable rates at FLW, and changes of stations and management actions have had no impact on this species. Worm-eating Warbler captures continue to decline at FLW (see Nott et al. 2008) indicating an overall decline of this species and indicating that changes at FLW have not been beneficial to this species. Further consideration should be given to management actions that might result in increased success of Louisiana Waterthrush and Worm-eating Warbler at FLW.

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 indicate that we are well on our way to achieving success in this endeavor.

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Table 1. Summary of the 2008 MAPS program on Fort Leonard Wood.

Station					2008 operation			
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours <sup>1</sup>	No. of periods	Inclusive dates
Big Piney	BIPI	14422	Bottomland riparian forest, open fields, scrublands	37°44'16"N,92°02'41"W	263	470.0 (389.7)	8	5/23 - 7/30
Laughlin Bottoms	LABO	14423	Oldfield complex, walnut plantation, deciduous forest, mature riparian forest	37°46'44"N,92°10'33"W	248	461.2 (420.8)	8	5/22 - 8/02
Tilley Bottoms	TIBO	14495	Black walnut plantation, mesic lowland	37°46'26"N,92°12'14"W	257	441.7 (316.5)	8	5/27 - 7/31
Bradford Cemetery	BRCE	14494	Oldfield complex burned every three years, oak forest, pond	37°42'17"N,92°07'01"W	319	417.7 (366.2)	8	5/24 - 8/01
Miller Pond	MIPO	14424	Old field complex, deciduous forest of varying ages, ponds, mowed firebreaks	37°41'44"N,92°06'47"W	333	434.2 (370.5)	8	5/25 - 8/03
Macedonia	MACE	14425	Oldfield complex, cedar brakes, secondary woodland	37°36'43"N,92°14'13"W	361	399.3 (323.7)	8	5/26 - 8/04
ALL STATIONS COMBINED						2624.0(2187.3)	8	5/22 - 8/04

<sup>1</sup> Total net-hours in 2008. Net-hours in 2008 that could be compared in a constant-effort manner to 2007 are shown in parentheses.







Table 2. (cont.) Capture summary for the six individual MAPS stations operated on Fort Leonard Wood in 2008.  
 N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Northern Cardinal	3		1	10		3	3		1	2			2			2		1
Indigo Bunting	9		9	21	1	17	15	1	7	9	1	8	13	1	4	6		8
Brown-headed Cowbird							1		1	1			2					
Orchard Oriole													3		4			
American Goldfinch				1		1	3		1	3			8					
ALL SPECIES POOLED	90	15	59	117	22	45	124	19	50	90	14	58	137	13	58	27	4	16
Total Number of Captures		164			184			193			162		208			47		
Number of Species	22	7	11	29	6	11	29	7	12	25	8	11	33	7	10	14	3	6
Total Number of Species		25			31			31			28		34			15		

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 Fort Leonard Wood in 2008.

Species	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
	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-billed Cuckoo	1.3	0.0	0.00				1.4	0.0	0.00	1.4	0.0	0.00	0.0	0.0	0.00			
Red-bellied Woodpecker							0.0	1.4	und. <sup>1</sup>									
Downy Woodpecker				1.3	0.0	0.00				0.0	1.4	und. <sup>1</sup>						
Eastern Wood-Pewee							0.0	1.4	und.	1.4	0.0	0.00	2.8	2.8	1.00	4.5	0.0	0.00
Acadian Flycatcher	5.1	1.3	0.25	3.9	0.0	0.00	2.7	0.0	0.00	7.2	2.9	0.40	2.8	0.0	0.00	3.0	0.0	0.00
Trail's Flycatcher	1.3	0.0	0.00				2.7	1.4	0.50	5.7	0.0	0.00	4.1	0.0	0.00			
Eastern Phoebe				0.0	1.3	und. <sup>1</sup>				0.0	1.4	und.	2.8	1.4	0.50			
Great Crested Flycatcher													1.4	0.0	0.00			
White-eyed Vireo	7.7	0.0	0.00	6.5	3.9	0.60	20.4	2.7	0.13	14.4	4.3	0.30	9.7	4.1	0.43			
Red-eyed Vireo	11.5	0.0	0.00	5.2	0.0	0.00	1.4	0.0	0.00	7.2	1.4	0.20	6.9	0.0	0.00	6.0	0.0	0.00
Blue Jay																1.5	0.0	0.00
Carolina Chickadee	3.8	0.0	0.00	0.0	1.3	und.							2.8	1.4	0.50			
Tufted Titmouse	5.1	0.0	0.00	2.6	1.3	0.50	1.4	0.0	0.00							1.5	0.0	0.00
Carolina Wren	6.4	0.0	0.00	5.2	0.0	0.00	1.4	0.0	0.00				2.8	1.4	0.50			
Blue-gray Gnatcatcher				6.5	0.0	0.00	6.8	0.0	0.00				4.1	2.8	0.67			
Wood Thrush	3.8	0.0	0.00	0.0	1.3	und.	1.4	0.0	0.00							3.0	0.0	0.00
Gray Catbird							1.4	1.4	1.00	2.9	0.0	0.00	1.4	1.4	1.00			
Brown Thrasher				2.6	0.0	0.00	1.4	0.0	0.00				1.4	0.0	0.00	1.5	0.0	0.00
Blue-winged Warbler	1.3	0.0	0.00	7.8	1.3	0.17	12.2	0.0	0.00	4.3	0.0	0.00	9.7	0.0	0.00	1.5	0.0	0.00
Northern Parula	2.6	0.0	0.00	1.3	1.3	1.00	1.4	0.0	0.00	0.0	2.9	und.	2.8	0.0	0.00			
Yellow Warbler													1.4	0.0	0.00			
Prairie Warbler				3.9	0.0	0.00	2.7	0.0	0.00	10.1	0.0	0.00	16.6	5.5	0.33			
Cerulean Warbler	1.3	0.0	0.00															
Black-and-white Warbler	1.3	1.3	1.00	0.0	1.3	und.	4.1	2.7	0.67	4.3	10.1	2.33	1.4	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 Fort Leonard Wood in 2008.

Species	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
American Redstart	21.7	0.0	0.00	2.6	0.0	0.00	2.7	0.0	0.00									
Worm-eating Warbler	7.7	5.1	0.67	0.0	1.3	und.	1.4	0.0	0.00									
Ovenbird	3.8	2.6	0.67	0.0	3.9	und.	1.4	4.1	3.00	1.4	1.4	1.00				3.0	0.0	0.00
Louisiana Waterthrush	8.9	6.4	0.71	2.6	2.6	1.00										1.5	1.5	1.00
Kentucky Warbler	14.0	2.6	0.18	15.6	3.9	0.25	13.6	8.2	0.60	5.7	1.4	0.25	1.4	1.4	1.00			
Common Yellowthroat				6.5	1.3	0.20	12.2	1.4	0.11				8.3	1.4	0.17			
Yellow-breasted Chat	1.3	0.0	0.00	13.0	1.3	0.10	34.0	4.1	0.12	20.1	0.0	0.00	29.0	6.9	0.24			
Summer Tanager				1.3	0.0	0.00				2.9	0.0	0.00	4.1	0.0	0.00	3.0	0.0	0.00
Scarlet Tanager													1.4	0.0	0.00	1.5	0.0	0.00
Eastern Towhee				1.3	0.0	0.00	1.4	0.0	0.00	4.3	0.0	0.00						
Chipping Sparrow	1.3	0.0	0.00							2.9	0.0	0.00						
Field Sparrow				2.6	0.0	0.00				7.2	0.0	0.00	20.7	2.8	0.13			
Northern Cardinal	3.8	0.0	0.00	9.1	3.9	0.43	4.1	0.0	0.00	2.9	0.0	0.00	1.4	1.4	1.00	4.5	0.0	0.00
Indigo Bunting	17.9	0.0	0.00	31.2	0.0	0.00	21.7	1.4	0.06	18.7	1.4	0.08	18.0	0.0	0.00	12.0	0.0	0.00
Brown-headed Cowbird							2.7	0.0	0.00	1.4	0.0	0.00	2.8	0.0	0.00			
Orchard Oriole													2.8	1.4	0.50			
American Goldfinch				2.6	0.0	0.00	4.1	0.0	0.00	4.3	0.0	0.00	11.1	0.0	0.00			
ALL SPECIES POOLED	132.8	19.1	0.14	135.3	31.2	0.23	161.7	29.9	0.19	130.7	28.7	0.22	175.5	35.9	0.21	48.1	1.5	0.03
Number of Species	22	6		22	15		26	11		21	10		28	14		14	1	
Total Number of Species		22			28			28			24		28				14	

<sup>1</sup> 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 Fort Leonard Wood MAPS stations combined in 2008.

Species	Birds captured			Birds/600 nethours		Reprod. Index
	Newly banded	Un-banded	Recap-tured	Adults	Young	
	Mourning Dove		1			
Yellow-billed Cuckoo	4			0.7	0.0	0.00
Ruby-throated Hummingbird		41				
Red-bellied Woodpecker	1			0.0	0.2	und. <sup>1</sup>
Downy Woodpecker	2			0.2	0.2	1.00
Pileated Woodpecker		2				
Eastern Wood-Pewee	10	1	1	1.4	0.7	0.50
Yellow-bellied Flycatcher	1					
Acadian Flycatcher	20		1	3.9	0.7	0.18
Traill's Flycatcher	11			2.3	0.2	0.10
Least Flycatcher	1					
Unidentified Empidonax Flycat.		1				
Eastern Phoebe	5			0.5	0.7	1.50
Great Crested Flycatcher	1			0.2	0.0	0.00
Unidentified Flycatcher		1				
White-eyed Vireo	45	2	29	9.8	2.5	0.26
Philadelphia Vireo	1					
Red-eyed Vireo	27	2	6	6.4	0.2	0.04
Blue Jay	1			0.2	0.0	0.00
Carolina Chickadee	7	2		1.1	0.5	0.40
Tufted Titmouse	9	1		1.8	0.2	0.13
Carolina Wren	9	4	4	2.7	0.2	0.08
Blue-gray Gnatcatcher	15	2	1	3.0	0.5	0.15
Swainson's Thrush	4					
Wood Thrush	6		4	1.4	0.2	0.17
Gray Catbird	6			0.9	0.5	0.50
Brown Thrasher	5			1.1	0.0	0.00
Blue-winged Warbler	20	1	14	6.2	0.2	0.04
Northern Parula	9			1.4	0.7	0.50
Yellow Warbler	1			0.2	0.0	0.00
Prairie Warbler	24	1	11	5.5	0.9	0.17
Cerulean Warbler	1			0.2	0.0	0.00
Black-and-white Warbler	18		4	1.8	2.5	1.38

Table 4. Summary of results for all six Fort Leonard Wood MAPS stations combined in 2008.

Species	Birds captured			Birds/600 nethours		Reprod. Index
	Newly banded	Un-banded	Recap-tured	Adults	Young	
American Redstart	15	2	8	4.8	0.0	0.00
Worm-eating Warbler	10	1	7	1.6	1.1	0.71
Ovenbird	14	1	4	1.6	2.1	1.29
Louisiana Waterthrush	11	1	11	2.3	1.8	0.80
Kentucky Warbler	42	1	34	8.5	3.0	0.35
Mourning Warbler	1					
Common Yellowthroat	19	1	14	4.6	0.7	0.15
Wilson's Warbler	1					
Canada Warbler	3					
Yellow-breasted Chat	55	6	52	16.2	2.1	0.13
Unidentified Warbler		2				
Summer Tanager	6		2	1.8	0.0	0.00
Scarlet Tanager	2			0.5	0.0	0.00
Eastern Towhee	5	1		1.1	0.0	0.00
Chipping Sparrow	3			0.7	0.0	0.00
Field Sparrow	17	4	13	5.0	0.5	0.09
Unidentified Sparrow		1				
Northern Cardinal	22		6	4.3	0.9	0.21
Indigo Bunting	73	4	53	20.1	0.5	0.02
Brown-headed Cowbird	4		1	1.1	0.0	0.00
Orchard Oriole	3		4	0.5	0.2	0.50
American Goldfinch	15		2	3.7	0.0	0.00
ALL SPECIES POOLED	585	87	286	131.5	24.7	0.19
Total Number of Captures		958				
Number of Species	48	22	24	40	28	
Total Number of Species		51			41	

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

Table 5. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using a time-constant model for 24 species breeding at MAPS stations on Fort Leonard Wood obtained from 16 years<sup>1</sup> (1993-2008) of mark-recapture data. Data is included from all eight MAPS stations that have ever operated on Fort Leonard Wood.

Species	Num. sta <sup>2</sup>	Num. ind. <sup>3</sup>	Num. caps. <sup>4</sup>	Num. ret. <sup>5</sup>	Survival probability <sup>6</sup>	Surv. C.V. <sup>7</sup>	Recapture probability <sup>8</sup>	Proportion of residents <sup>9</sup>
Downy Woodpecker	7	110	127	12	0.604 (0.108)	17.9	0.251 (0.116)	0.285 (0.155)
Acadian Flycatcher	6	196	319	52	0.613 (0.049)	8.0	0.375 (0.063)	0.414 (0.101)
White-eyed Vireo	6	342	654	107	0.553 (0.040)	7.2	0.505 (0.056)	0.531 (0.088)
Red-eyed Vireo	7	318	400	49	0.532 (0.058)	10.9	0.274 (0.066)	0.570 (0.158)
Carolina Chickadee †	7	169	201	19	0.467 (0.096)	20.5	0.141 (0.081)	1.000 (0.587)
Carolina Wren	5	123	164	16	0.361 (0.097)	26.9	0.527 (0.179)	0.412 (0.190)
Blue-gray Gnatcatcher ‡†	7	167	185	4	0.502 (0.213)	42.4	0.029 (0.055)	1.000 (1.856)
Blue-winged Warbler	5	487	749	119	0.584 (0.037)	6.3	0.406 (0.047)	0.427 (0.068)
Northern Parula †	6	98	109	7	0.638 (0.142)	22.2	0.052 (0.061)	1.000 (1.176)
Prairie Warbler	4	283	405	55	0.561 (0.055)	9.8	0.226 (0.053)	0.764 (0.200)
Black-and-white Warbler	6	140	162	9	0.471 (0.153)	32.5	0.363 (0.188)	0.202 (0.131)
American Redstart	1	131	181	30	0.633 (0.078)	12.3	0.317 (0.082)	0.515 (0.166)
Worm-eating Warbler	2	97	129	13	0.540 (0.110)	20.3	0.547 (0.160)	0.189 (0.093)
Ovenbird	6	150	205	23	0.645 (0.075)	11.6	0.263 (0.079)	0.333 (0.123)
Louisiana Waterthrush	1	70	123	18	0.416 (0.101)	24.3	0.536 (0.165)	0.749 (0.325)
Kentucky Warbler	6	410	701	121	0.641 (0.034)	5.3	0.432 (0.045)	0.378 (0.060)
Common Yellowthroat	4	297	561	86	0.460 (0.042)	9.2	0.593 (0.069)	0.524 (0.099)
Yellow-breasted Chat	4	603	1118	231	0.628 (0.026)	4.1	0.389 (0.032)	0.664 (0.073)
Summer Tanager	3	51	60	6	0.436 (0.166)	38.0	0.217 (0.199)	0.837 (0.851)



Table 5. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using a time-constant model for 24 species breeding at MAPS stations on Fort Leonard Wood obtained from 16 years<sup>1</sup> (1993-2008) of mark-recapture data. Data is included from all eight MAPS stations that have ever operated on Fort Leonard Wood.

Species	Num. sta. <sup>2</sup>	Num. ind. <sup>3</sup>	Num. caps. <sup>4</sup>	Num. ret. <sup>5</sup>	Survival probability <sup>6</sup>	Surv. C.V. <sup>7</sup>	Recapture probability <sup>8</sup>	Proportion of residents <sup>9</sup>
Eastern Towhee ‡†	6	58	68	3	0.491 (0.247)	50.3	0.067 (0.100)	1.000 (1.434)
Field Sparrow	4	447	667	90	0.464 (0.042)	9.0	0.293 (0.051)	0.834 (0.166)
Northern Cardinal	7	246	343	51	0.580 (0.056)	9.6	0.230 (0.055)	0.761 (0.200)
Indigo Bunting	7	879	1387	214	0.509 (0.027)	5.4	0.389 (0.037)	0.660 (0.080)
American Goldfinch †	4	237	282	15	0.370 (0.107)	28.9	0.124 (0.089)	1.000 (0.715)

<sup>1</sup> Analysis of all stations pooled include data from 1993-2008 from the Big Piney, Laughlin Bottoms, Miller Pond and Macedonia stations as well as data from 1993-2002 from the Smith Ridge and Miller stations and 2003-2008 from the Tilley Bottoms and Bradford Cemetery stations.

<sup>2</sup> 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.

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

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

<sup>5</sup> 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.

<sup>6</sup> Survival probability ( $\phi$ ) presented as the maximum likelihood estimate (standard error of the estimate).

<sup>7</sup> The coefficient of variation for survival probability,  $CV(\phi)$ .

<sup>8</sup> Recapture probability ( $p$ ) presented as the maximum likelihood estimate (standard error of the estimate).

<sup>9</sup> The proportion of residents among newly captured adults ( $\tau$ ) presented as the maximum likelihood estimate (standard error of the estimate).

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

† The estimate for recapture probability (and possibly survival probability as well) may be biased low because the estimate for  $\tau$  was 1.000.

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 16 years, 1993-2008, of the MAPS Program on the eight stations ever operated on Fort Leonard Wood.

Cumulative breeding status for all years in which each station was operated are also included (B = Regular Breeder (all years); U = Usual Breeder (>1/2, not all, years); O = Occasional Breeder (≤1/2 years); T = Transient; M = Migrant; A= Altitudinal Disperser; ? = Uncertain Species ID

NUMB	SPEC	SPECIES NAME	LAG	TH	BO	W	CO	MS	CH	MA	CF	ML	RS	MR	RD
00130	PBGR	Pied-billed Grebe	T												
00950	AMBI	American Bittern		T											
01010	GBHE	Great Blue Heron	T	T	T	T	T	O	O						
01040	GREG	Great Egret	T												
01130	GRHE	Green Heron	T	T				T	O						
01300	TUVU	Turkey Vulture	O	O	T	T	O	O	O	O					
01460	CANG	Canada Goose	T		T			T	T						
01570	WODU	Wood Duck	T					O	O						
01580	GADW	Gadwall						T	O						
01630	MALL	Mallard						T							
02015	UNDU	Unidentified Duck		?	?			?							
02130	BAEA	Bald Eagle	T												
02200	SSHA	Sharp-shinned Hawk	M			M			M						
02210	COHA	Cooper's Hawk		T			O		T	T					
02380	RSHA	Red-shouldered Hawk	O	O	O	T	O	U	U	O					
02400	BWHA	Broad-winged Hawk		T	T	T	O	T	T	T					
02460	RTHA	Red-tailed Hawk	T	O	O	T	T	T	T						
02545	UNHA	Unidentified Hawk						?	?						
02940	RUGR	Ruffed Grouse				T									
03040	WITU	Wild Turkey	O	O	T	T	U	O	O	O					
03160	NOBO	Northern Bobwhite	U	U	T	T	U	O	O	T					
03550	AMCO	American Coot	T	T											
03780	KILL	Killdeer						O	T						
04490	AMWO	American Woodcock	O	T				T							
05570	MODO	Mourning Dove	U	U	B	U	U	B	O	O					
06400	BBCU	Black-billed Cuckoo	T	T	O			O						T	
06410	YBCU	Yellow-billed Cuckoo	U	B	B	B	B	B	U	U	U				

## Appendix I. Continued.

BIPI LABOTIBO BRCEMIPOMACEMIRI SMRI

NUMB	SPEC	SPECIES NAME								
06680	EASO	Eastern Screech-Owl	T			T				
06800	GHOW	Great Horned Owl				T				
06950	BADO	Barred Owl	O	O	T	T	T	O	O	O
07080	CONI	Common Nighthawk					T			
07170	CWWI	Chuck-will's-widow	T							
07230	WPWI	Whip-poor-will	T	O		T		O		
07400	CHSW	Chimney Swift	T	T	T	T	T	T	T	
08630	RTHU	Ruby-throated Hummingbird	U	U	B	U	U	U	O	O
08640	BCHU	Black-chinned Hummingbird						M		
08775	UNHU	Unidentified Hummingbird	?	?	?	?	?	?	?	
09110	BEKI	Belted Kingfisher	T	O	T		T	T		
09420	RHOW	Red-headed Woodpecker					T			
09550	RBWO	Red-bellied Woodpecker	U	U	O	O	O	U	U	O
09650	DOWO	Downy Woodpecker	U	U	U	U	B	U	U	U
09660	HAWO	Hairy Woodpecker	T	O	T	O	O	O	O	O
09800	YSFL	Yellow-shafted Flicker	O	O	T		T	O	O	
09860	PIWO	Pileated Woodpecker	B	B	B	U	O	U	U	U
09915	UNWO	Unidentified Woodpecker			?					
11340	OSFL	Olive-sided Flycatcher					M			
11390	EAWP	Eastern Wood-Pewee	B	U	O	B	U	U	U	U
11450	YBFL	Yellow-bellied Flycatcher	M	M				M		
11460	ACFL	Acadian Flycatcher	B	B	B	O	O	U	B	U
11475	TRFL	Traill's Flycatcher	O	T	T	T	T	T	O	T
11500	LEFL	Least Flycatcher		M			M			M
11530	DUFL	Dusky Flycatcher					M			
11595	UEFL	Unidentified Empidonax Flycatch.	?	?	?	?	?	?	?	
11610	EAPH	Eastern Phoebe	U	O	O	O	U	O	O	O
11760	GCFL	Great Crested Flycatcher	U	O	T	T	O	T	O	O
12030	EAKI	Eastern Kingbird	T	T			O	O		
12085	UNFL	Unidentified Flycatcher	?	?		?	?	?	?	
12550	WEVI	White-eyed Vireo	B	B	B	B	B	U	U	O
12690	YTVI	Yellow-throated Vireo	U	O	O	O	T	T	U	T
12780	PHVI	Philadelphia Vireo					M			
12790	REVI	Red-eyed Vireo	B	B	B	B	U	B	B	B
12930	BLJA	Blue Jay	U	U	U	U	B	U	U	B

## Appendix I. Continued.

BIPI LABOTIBO BRCEMIPOMACEMIRI SMRI

NUMB	SPEC	SPECIES NAME								
13190	AMCR	American Crow	U	U	B	U	B	B	B	B
13340	PUMA	Purple Martin	T	T	T	T	T	T		
13490	NRWS	Northern Rough-winged Swallow	T	T	T		T	O		
13540	BARS	Barn Swallow	T		T	T	T	T		
13560	CACH	Carolina Chickadee	U	B	B	B	B	B	U	U
13565	CBCC	Carolina X Black-c. Chick. Hybrid				T	T			
13570	BCCH	Black-capped Chickadee	T	O	T		O	O	O	
13575	UPCH	Unidentified Poecile Chickadee	?	?	?	?	?	?		
13660	TUTI	Tufted Titmouse	B	B	B	B	B	B	B	U
13700	WBNU	White-breasted Nuthatch	B	O	T	T	O	O	U	U
14000	CARW	Carolina Wren	B	U	B	O	U	O	U	O
14040	BEWR	Bewick's Wren		T		T	O			T
14070	HOWR	House Wren		T	T		T	O		
14205	UNWR	Unidentified Wren					?			
14350	BGGN	Blue-gray Gnatcatcher	U	B	B	B	B	B	U	U
14560	EABL	Eastern Bluebird	T	T		T	O	O		
14780	VEER	Veery						M	M	M
14790	GCTH	Gray-cheeked Thrush	M	M	M					M
14810	SWTH	Swainson's Thrush	M	M	M	M	M	M		M
14830	WOTH	Wood Thrush	B	O	O	T		U	U	O
15000	AMRO	American Robin	T	O	T	T	O	O		
15130	GRCA	Gray Catbird	T	O	O	O	O	T		T
15150	NOMO	Northern Mockingbird					O			
15200	BRTH	Brown Thrasher	O	O	U	T	O	T		
15370	EUST	European Starling						T		
15550	CEDW	Cedar Waxwing	T	O	T	T	T	T		T
15630	BWWA	Blue-winged Warbler	U	B	B	B	B	U	O	
15640	GWWA	Golden-winged Warbler		T						
15650	TEWA	Tennessee Warbler	M							
15670	NAWA	Nashville Warbler							M	
15730	NOPA	Northern Parula	B	B	B	B	U	O	B	U
15750	YWAR	Yellow Warbler	T	T			T			
15760	CSWA	Chestnut-sided Warbler				M				
15770	MAWA	Magnolia Warbler		M	M	M	M			
15870	YTWA	Yellow-throated Warbler	U	O	O		O			



## Appendix I. Continued.

BIPI LABOTIBO BRCEMIPOMACEMIRI SMRI

NUMB	SPEC	SPECIES NAME							
15910	PIWA	Pine Warbler		T		T	T		T O
15930	PRAW	Prairie Warbler		U	B	B	B	U	
15980	CERW	Cerulean Warbler	U	O	T				O
16030	BAWW	Black-and-white Warbler	U	U	B	B	U	U	U O
16040	AMRE	American Redstart	B	O	O			O O	
16050	PROW	Prothonotary Warbler	O	T					
16060	WEWA	Worm-eating Warbler	B	O	T	T	T	O	U O
16080	OVEN	Ovenbird	U	U	B	O	O	B	B B
16090	NOWA	Northern Waterthrush	M	M			M		
16100	LOWA	Louisiana Waterthrush	B	O			T	O	O
16110	KEWA	Kentucky Warbler	B	B	B	B	U	U	U T
16130	MOWA	Mourning Warbler	M	M	M		M		
16150	COYE	Common Yellowthroat	U	B	B	U	B	O	O T
16280	HOWA	Hooded Warbler					T		
16290	WIWA	Wilson's Warbler		M	M	M	M		
16300	CAWA	Canada Warbler	M	M	M			M	
16460	YBCH	Yellow-breasted Chat	U	B	B	B	B	O	O T
16495	UNWA	Unidentified Warbler	?	?			?		? ?
16820	SUTA	Summer Tanager	O	O	T	B	U	O	U B
16830	SCTA	Scarlet Tanager	T	T	T	T	O	O	O O
17820	EATO	Eastern Towhee	U	B	B	B	B	B	U T
18020	CHSP	Chipping Sparrow	T	O		O	O	O	O
18050	FISP	Field Sparrow	T	B	B	B	B	B	
18090	LASP	Lark Sparrow					T		
18140	GRSP	Grasshopper Sparrow						T	
18160	HESP	Henslow's Sparrow				T			
18240	LISP	Lincoln's Sparrow		M					
18335	UNSP	Unidentified Sparrow		?					
18560	NOCA	Northern Cardinal	B	B	B	B	B	B	B U
18600	RBGR	Rose-breasted Grosbeak		T				T	
18640	BLGR	Blue Grosbeak	T			T	O	T	
18670	INBU	Indigo Bunting	B	B	B	B	B	B	B U
18730	RWBL	Red-winged Blackbird	O			T	O	U	
18800	EAME	Eastern Meadowlark	T	T			T	T	
18870	COGR	Common Grackle		T		T	T	T	

Appendix I. Continued.

BIPI LABOTIBO BRCEMIPOMACEMIRI SMRI

NUMB	SPEC	SPECIES NAME								
18960	BHCO	Brown-headed Cowbird	O	O	U	U	B	U	O	O
19040	OROR	Orchard Oriole	T	O			O			
19160	BAOR	Baltimore Oriole		T			T			
19370	HOFI	House Finch						T		
19510	AMGO	American Goldfinch	O	U	B	B	B	U	O	O
20085	UNBI	Unidentified Bird		?		?	?			?