THE 2005 REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM ON FORT LEONARD WOOD

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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 500 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 of the severe and sometimes accelerating population declines documented (Robbins et al. 1989, Terborgh 1989, Peterjohn et al.1995) for many species of North American landbirds (DeSante 1992, DeSante et al. 1995, 1999, 2001a). 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).

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 a sensitive barometer of the overall effectiveness of efforts to maintain the biodiversity and ecological integrity of military installations. Accordingly, the MAPS program was initiated on select military installations beginning in 1992 and soon became one of the focus projects of the DoD 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. The operation of these stations was continued during the summers of 1994-2002 by means of funding from the DoD Legacy Resource Management Program. The operation of the six stations on Fort Leonard Wood was continued during the summers of 2003-2005 by means of funding from Fort Leonard Wood, in conjunction with studies of Cerulean Warblers on the installation.

The ultimate objective of the MAPS Program on DoD installations such as Fort Leonard Wood 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 Fort Leonard Wood) 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. 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 occurred during the spring of 2004. Thus, 2005 is the second year of operation for the Tilley Bottoms and Bradford Cemetery stations.

A complete summary of the results of the MAPS Program on Fort Leonard Wood 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 earlier report and previous reports (DeSante et al. 2004, 2005a), and documents the operation of the six MAPS stations on Fort Leonard Wood during the 2005 breeding season.

Methods

Six MAPS stations were operated in 2005, at the same locations where they were operated in 2003-2004. 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. 2005b). 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 Dawn Marks and Terry Hams, who were trained by IBP field biologists Amy Finfera and Eric Miller and were supervised throughout the season by Amy Finfera.

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. 2005b):

(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 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 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 22 target species using Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) on 13 years (1993-2005) of capture histories of adult birds from the six long-running (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 (*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 Leonard Wood during the summer of 2005 for a total of 2374.7 net-hours. 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, captured and 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 983 captures of 50 species occurred at Fort Leonard Wood during the summer of 2005 (Table 4). Newly banded birds comprised 67.1% of the total captures. The greatest number of total captures (242) was recorded at the Miller Pond station and the smallest number of total captures (67) was recorded at the Macedonia station. The highest species richness also occurred at Miller Pond (36 species) and the lowest species richness occurred at Big Piney (21 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 (258.0 adults/600 net hours; Table 3), followed by Tilley Bottoms (194.1), Bradford Cemetery (188.4), Laughlin Bottoms (166.1), Big Piney (131.1), and Macedonia (55.3).

Among individual species, Yellow-breasted Chat was the most frequently captured species at the six stations in 2005, followed by Indigo Bunting, Blue-winged Warbler, Field Sparrow, White-eyed Vireo, Kentucky Warbler, Common Yellowthroat, Prairie Warbler, Carolina Wren, and Northern Cardinal (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 Yellow-breasted Chat, Indigo Bunting, Blue-winged Warbler, Kentucky Warbler, Field Sparrow, Common

Yellowthroat, White-eyed Vireo, Red-eyed Vireo, Prairie Warbler, and Northern Cardinal (Table 4). 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):

Big Piney
Kentucky Warbler
Indigo Bunting
American Redstart
Red-eyed Vireo
White-eyed Vireo
Blue-winged Warbler
Northern Cardinal

Bradford Cemetery
Field Sparrow
Yellow-breasted Chat
Prairie Warbler
Blue-winged Warbler
Black-and-white Warbler
White-eyed Vireo
Blue-gray Gnatcatcher
Kentucky Warbler
Northern Cardinal
Indigo Bunting

Laughlin Bottoms
Kentucky Warbler
Yellow-breasted Chat
Indigo Bunting
Common Yellowthroat
Blue-winged Warbler
White-eyed Vireo
Field Sparrow
Prairie Warbler
Northern Cardinal

Tilley Bottoms
Yellow-breasted Chat
Common Yellowthroat
Blue-winged Warbler
Indigo Bunting
White-eyed Vireo
Northern Cardinal
Ovenbird
Carolina Chickadee
Blue-gray Gnatcatcher
Kentucky Warbler

Miller Pond
Yellow-breasted Chat
Indigo Bunting
Blue-winged Warbler
Prairie Warbler
Common Yellowthroat
Red-eyed Vireo
Field Sparrow
American Goldfinch
White-eyed Vireo
Blue-gray Gnatcatcher
Northern Cardinal

Macedonia
Ovenbird
Red-eyed Vireo

Reproductive index (the number of young per adult captured) showed a different pattern over the six stations than adult population size, being highest at Miller Pond and Macedonia (0.38 each), followed by Tilley Bottoms (0.26), Big Piney (0.23), Laughlin Bottoms (0.21), and Bradford Cemetery (0.15). The overall reproductive index for the six stations in 2005 was 0.26. Mean reproductive index for all species pooled at Fort Leonard Wood during the seven years 1993-1999 was 0.209 (see DeSante et al. 2001b), less than the 2005 value. Although productivity at the two newly established stations was higher than at the stations they replaced (DeSante et al. 2001b), it still appears that the generally higher productivity in 2005 than in other years was not due solely to the new stations, and that 2005 was likely a reasonably good year for productivity at Fort Leonard Wood. Productivity in 2005 was similar to that observed in 2004, when the overall mean reproductive index was 0.265.

Using 13 years of data from the six long-running stations combined, estimates of adult survival and recapture probabilities were obtained for 22 target species breeding at Fort Leonard Wood. 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 0.348 for Louisiana Waterthrush to a high of 0.683 for American Redstart, with a mean of

0.524 for the 22 species. Furthermore, the C.V.s for the 22 species at Fort Leonard Wood were low (16 of the 22 species < 30%, 14 species < 20%, and 6 species < 10%) indicating quite precise estimates. Moreover, we found that the mean C.V. for 21 species for which survival rate estimates were obtained from both 12 years (1993-2004) and 13 years (1993-2005) of data improved from 19.3% to 18.8% with the addition of the 13th year of data, indicating that survival estimates may continue to become more precise, even after 13 years of data have been collected. In summary, survival of landbirds at Fort Leonard Wood appears to be quite high, 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 Fort Leonard Wood 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 Fort Leonard Wood is very important to landbird populations in the region.

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 Fort Leonard Wood (Nott et al. 2003, Nott and Michel 2005). At Fort Leonard Wood, 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 Fort Leonard Wood 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 4-year period 2001-2004. Interestingly, breeding populations declined in each case during the following two-year period, including 2005 (Table 3), suggesting that the positive effects of burn management on Field Sparrow populations last only 2-3 years. Field Sparrow productivity appeared to be fairly stable at the burn-management stations since the burns took place.

Increased breeding populations often reflect higher recruitment of first-time breeders into an area, which might also be expected to show decreased productivity. Thus, relatively stable productivity in the face of increased population sizes may be interpreted as a relative increase in production of young. At the very least, increased breeding populations without a concomitant decrease in productivity means that, overall, more young are being produced and are available to be recruited in the local breeding populations.

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 is an adequate area of primary breeding habitat. 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 Fort Leonard Wood, 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 (Table 3). Excellent capture rates of two other target species (with increasing populations), Blue-winged and Prairie warblers, were also obtained at the two new stations. Yellow-breasted Chats were also commonly captured. Unfortunately, we expect the numbers and reproductive success of both of 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 target species of management concern at Fort Leonard Wood.

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 two years of this effort indicates that we are well on our to achieving success in this endeavor.

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Table 1. Summary of the 2005 MAPS program on Fort Leonard Wood.

Station					Avg	2005 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Elev. (m)	Total number of net-hours[1]	No. of periods	Inclusive dates
Big Piney	BIPO	14422	Bottomland riparian forest, open fields, scrublands	37°44'33"N,92°02'34"W	235	466.7 (439.7)	8	5/21-8/02
Laughlin Bottoms	LABO	14423	Oldfield complex, walnut plantation, deciduous forest, mature riparian forest	37°46'44"N,92°10'47"W	300	404.7 (390.7)	8	5/24-8/03
Tilley Bottoms	TIBO	14495	Black walnut plantation, mesic lowland	37°46'26"N,92°12'03"W	250	392.7 (390.8)	8	5/28-8/04
Bradford Cemetery	BRCE	14494	Oldfield complex burned every three years, oak forest, pond	37°42'18"N,92°07'00"W	317	344.0 (313.3)	8	5/26-7/31
Miller Pond	MIPO	14424	Old field complex, deciduous forest of varying ages, ponds, mowed firebreaks	37°41'40"N,92°06'40"W	326	332.5 (324.2)	8	6/02-8/01
Macedonia	MACE	14425	Oldfield complex, cedar brakes, secondary woodland	37°36'40"N,92°14'10"W	360	434.2 (384.8)	8	5/27-7/30
ALL STATIONS COMBINED						2374.7(2243.5)	8	5/21 - 8/04

[1] Total net-hours in 2005. Net-hours in 2005 that could be compared in a constant-effort manner to 2004 are shown in parentheses.

Table 2. Capture summary for the six individual MAPS stations operated on Fort Leonard Wood in 2005.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Red-shouldered Hawk					1													
Ruby-throated Hummingbird					7			12			3			4			1	
Unidentified Hummingbird					1													
Red-bellied Woodpecker				1														
Downy Woodpecker				4		2	2						4		1	2		
Hairy Woodpecker		1														2		
Eastern Wood-Pewee													2					
Acadian Flycatcher	3		2	2		1	1			1			1					
Traill's Flycatcher													1					
Least Flycatcher													1					
Eastern Phoebe	1			2						2			8		1			
White-eyed Vireo	5		3	7		3	10	1	8	4		5	8		7			
Red-eyed Vireo	5		6	4		1	1			3			11		1	4		2
Blue Jay													1	1		2		
Carolina Chickadee	2			5			7			5			6		1	2		
Carolina X Black-c. Hybrid										1			1					
Black-capped Chickadee													1		1			
Unident. Poecile Chickadee								3						1				
Tufted Titmouse	1		1	3		1				3			4		1	4		1
White-breasted Nuthatch																1		
Carolina Wren	12		5	8		2	7	2		3			5			1		1
House Wren														1				
Blue-gray Gnatcatcher				2	2	2	10	1		6	2		7				1	
Eastern Bluebird													1					
Wood Thrush	1			1												1		

Table 2. (cont.) Capture summary for the six individual MAPS stations operated on Fort Leonard Wood in 2005.
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
American Robin							1											
Brown Thrasher				1			3			1								
Cedar Waxwing				1														
Blue-winged Warbler	11		1	5	1	6	6	1	8	9		4	15		5			
Northern Parula				1			1			3			7		1	2	1	
Yellow-throated Warbler				1														
Prairie Warbler				4		1	4	1	2	5		9	14	1	4			
Black-and-white Warbler	1		1	5		1	5			7			1			2		
American Redstart	14	3	2															
Prothonotary Warbler	1																	
Worm-eating Warbler	3		1				3						1			1		
Ovenbird	1			4			8			1			2			9	1	10
Northern Waterthrush				1														
Louisiana Waterthrush	2		1			1							1			1		
Kentucky Warbler	17		14	13		4	5			4			2			1		
Common Yellowthroat				8	1	2	10	1	11	2			10		10			
Yellow-breasted Chat	2			8		4	17		13	11		9	18		17			
Summer Tanager				1						1		1	1			1		
Scarlet Tanager				1														
Eastern Towhee				1			1	1		1						2		
Field Sparrow				6		3	4			19		10	13		4	3		1
Northern Cardinal	8	1		5		1	10		5	2		2	3		2	3		
Blue Grosbeak													1					
Indigo Bunting	14		6	8	1	10	9		5	3		1	10		9	3		1
Brown-headed Cowbird	1						1											

Table 2. (cont.) Capture summary for the six individual MAPS stations operated on Fort Leonard Wood in 2005.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Orchard Oriole													1					
American Goldfinch				1			1			3			5		2			
ALL SPECIES POOLED	105	5	43	114	14	45	127	23	52	100	5	41	167	8	67	47	4	16
Total Number of Captures		153			173			202			146			242			67	
Number of Species	20	3	12	30	7	17	24	9	7	24	2	8	33	5	16	20	4	6
Total Number of Species		21			34			26			25			36			22	

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 2005.

	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Red-bellied Woodpecker				0.0	1.5	und.[1]												
Downy Woodpecker				5.9	3.0	0.50	0.0	3.1	und.[1]				0.0	7.2	und.[1]	1.4	1.4	1.00
Hairy Woodpecker																0.0	2.8	und.[1]
Eastern Wood-Pewee													3.6	0.0	0.00			
Acadian Flycatcher	5.1	0.0	0.00	1.5	1.5	1.00	1.5	0.0	0.00	1.7	0.0	0.00	0.0	1.8	und.			
Traill's Flycatcher													1.8	0.0	0.00			
Eastern Phoebe	1.3	0.0	0.00	1.5	1.5	1.00				0.0	3.5	und.[1]	0.0	14.4	und.			
White-eyed Vireo	7.7	0.0	0.00	10.4	1.5	0.14	15.3	7.6	0.50	10.5	1.7	0.17	9.0	7.2	0.80			
Red-eyed Vireo	12.9	0.0	0.00	5.9	0.0	0.00	1.5	0.0	0.00	5.2	0.0	0.00	18.0	3.6	0.20	8.3	0.0	0.00
Blue Jay													1.8	0.0	0.00	2.8	0.0	0.00
Carolina Chickadee	1.3	1.3	1.00	1.5	5.9	4.00	7.6	3.1	0.40	5.2	3.5	0.67	3.6	9.0	2.50	1.4	1.4	1.00
Carolina X Black-c. Hybrid										1.7	0.0	0.00	1.8	0.0	0.00			
Black-capped Chickadee													0.0	1.8	und.			
Tufted Titmouse	2.6	0.0	0.00	3.0	1.5	0.50				3.5	1.7	0.50	0.0	7.2	und.	4.1	2.8	0.67
White-breasted Nuthatch																0.0	1.4	und.
Carolina Wren	5.1	11.6	2.25	5.9	5.9	1.00	1.5	7.6	5.00	0.0	5.2	und.	1.8	5.4	3.00	1.4	0.0	0.00
Blue-gray Gnatcatcher				3.0	0.0	0.00	7.6	7.6	1.00	10.5	0.0	0.00	9.0	3.6	0.40			
Eastern Bluebird													0.0	1.8	und.			
Wood Thrush	1.3	0.0	0.00	1.5	0.0	0.00										1.4	0.0	0.00
American Robin							0.0	1.5	und.									
Brown Thrasher				1.5	0.0	0.00	4.6	0.0	0.00	1.7	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 2005.

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
Cedar Waxwing				1.5	0.0	0.00												
Blue-winged Warbler	7.7	6.4	0.83	11.9	1.5	0.13	18.3	1.5	0.08	17.4	1.7	0.10	27.1	3.6	0.13			
Northern Parula				1.5	0.0	0.00	1.5	0.0	0.00	5.2	0.0	0.00	5.4	7.2	1.33	0.0	2.8	und.
Yellow-throated Warbler				1.5	0.0	0.00												
Prairie Warbler				7.4	0.0	0.00	4.6	3.1	0.67	19.2	0.0	0.00	25.3	3.6	0.14			
Black-and-white Warbler	2.6	0.0	0.00	5.9	1.5	0.25	1.5	6.1	4.00	12.2	0.0	0.00	0.0	1.8	und.	1.4	1.4	1.00
American Redstart	19.3	1.3	0.07															
Prothonotary Warbler	1.3	0.0	0.00															
Worm-eating Warbler	5.1	0.0	0.00				4.6	0.0	0.00				1.8	0.0	0.00	1.4	0.0	0.00
Ovenbird	0.0	1.3	und.[1]	4.4	1.5	0.33	10.7	1.5	0.14	1.7	0.0	0.00	3.6	0.0	0.00	15.2	1.4	0.09
Louisiana Waterthrush	1.3	1.3	1.00	1.5	0.0	0.00							1.8	0.0	0.00	1.4	0.0	0.00
Kentucky Warbler	24.4	2.6	0.11	19.3	4.4	0.23	7.6	0.0	0.00	7.0	0.0	0.00	3.6	0.0	0.00	0.0	1.4	und.
Common Yellowthroat				13.3	0.0	0.00	24.4	0.0	0.00	3.5	0.0	0.00	19.9	7.2	0.36			
Yellow-breasted Chat	2.6	0.0	0.00	17.8	0.0	0.00	36.7	3.1	0.08	26.2	3.5	0.13	45.1	3.6	0.08			
Summer Tanager				1.5	0.0	0.00				3.5	0.0	0.00	1.8	0.0	0.00	1.4	0.0	0.00
Scarlet Tanager				0.0	1.5	und.												
Eastern Towhee				1.5	0.0	0.00	3.1	0.0	0.00	1.7	0.0	0.00				1.4	1.4	1.00
Field Sparrow				8.9	0.0	0.00	4.6	1.5	0.33	31.4	7.0	0.22	18.0	7.2	0.40	2.8	2.8	1.00
Northern Cardinal	7.7	3.9	0.50	7.4	1.5	0.20	15.3	3.1	0.20	7.0	0.0	0.00	9.0	0.0	0.00	4.1	0.0	0.00
Blue Grosbeak													1.8	0.0	0.00			
Indigo Bunting	20.6	0.0	0.00	17.8	0.0	0.00	18.3	0.0	0.00	7.0	0.0	0.00	28.9	0.0	0.00	5.5	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 2005.

	Big Piney			Laughlin Bottoms			Tilley Bottoms			Bradford Cemetery			Miller Pond			Macedonia		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Brown-headed Cowbird	1.3	0.0	0.00				1.5	0.0	0.00									
Orchard Oriole													1.8	0.0	0.00			
American Goldfinch				1.5	0.0	0.00	1.5	0.0	0.00	5.2	0.0	0.00	12.6	0.0	0.00			
ALL SPECIES POOLED	131.1	29.6	0.23	166.1	34.1	0.21	194.1	50.4	0.26	188.4	27.9	0.15	258.0	97.4	0.38	55.3	20.7	0.38
Number of Species	19	8		28	14		22	13		22	8		25	18		16	11	
Total Number of Species		20			30			24			24			32			20	

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

Table 4. Summary of results for all six Fort Leonard Wood MAPS stations combined in 2005.

Species	Birds captured			Birds/600 nethours		Reprod. Index
	Newly banded	Un-banded	Recap-tured	Adults	Young	
Red-shouldered Hawk		1				
Ruby-throated Hummingbird		27				
Unidentified Hummingbird		1				
Red-bellied Woodpecker	1			0.0	0.3	und.[1]
Downy Woodpecker	12		3	1.3	2.3	1.80
Hairy Woodpecker	2	1		0.0	0.5	und.
Eastern Wood-Pewee	2			0.5	0.0	0.00
Acadian Flycatcher	8		3	1.8	0.5	0.29
Traill's Flycatcher	1			0.3	0.0	0.00
Least Flycatcher	1					
Eastern Phoebe	13		1	0.5	2.8	5.50
White-eyed Vireo	34	1	26	8.6	2.8	0.32
Red-eyed Vireo	28		10	8.6	0.5	0.06
Blue Jay	3	1		0.8	0.0	0.00
Carolina Chickadee	27		1	3.3	3.8	1.15
Carolina X Black-cap. Hybrid	2			0.5	0.0	0.00
Black-capped Chickadee	1		1	0.0	0.3	und.
Unidentified Poecile Chickadee		4				
Tufted Titmouse	15		4	2.3	2.0	0.89
White-breasted Nuthatch	1			0.0	0.3	und.
Carolina Wren	36	2	8	2.8	6.1	2.18
House Wren		1				
Blue-gray Gnatcatcher	25	6	2	4.5	1.8	0.39
Eastern Bluebird	1			0.0	0.3	und.
Wood Thrush	3			0.8	0.0	0.00
American Robin	1			0.0	0.3	und.
Brown Thrasher	5			1.3	0.0	0.00
Cedar Waxwing	1			0.3	0.0	0.00
Blue-winged Warbler	46	2	24	12.9	2.5	0.20
Northern Parula	14	1	1	2.0	1.5	0.75
Yellow-throated Warbler	1			0.3	0.0	0.00
Prairie Warbler	27	2	16	8.3	1.0	0.12
Black-and-white Warbler	21		2	3.8	1.8	0.47
American Redstart	14	3	2	3.8	0.3	0.07

Table 4. (cont.) Summary of results for all six Fort Leonard Wood MAPS stations combined in 2005.

Species	Birds captured			Birds/600 nethours		Reprod. Index
	Newly banded	Un-banded	Recap-tured	Adults	Young	
Prothonotary Warbler	1			0.3	0.0	
Worm-eating Warbler	8		1	2.3	0.0	0.00
Ovenbird	25	1	10	6.1	1.0	0.17
Northern Waterthrush	1					
Louisiana Waterthrush	4		2	1.0	0.3	0.25
Kentucky Warbler	42		18	10.9	1.5	0.14
Common Yellowthroat	30	2	23	9.6	1.0	0.11
Yellow-breasted Chat	56		43	19.7	1.5	0.08
Summer Tanager	4		1	1.3	0.0	0.00
Scarlet Tanager	1			0.0	0.3	und.
Eastern Towhee	5	1		1.3	0.3	0.20
Field Sparrow	45		18	9.9	2.8	0.28
Northern Cardinal	31	1	10	8.3	1.5	0.18
Blue Grosbeak	1			0.3	0.0	0.00
Indigo Bunting	47	1	32	16.2	0.0	0.00
Brown-headed Cowbird	2			0.5	0.0	0.00
Orchard Oriole	1			0.3	0.0	0.00
American Goldfinch	10		2	2.8	0.0	0.00
ALL SPECIES POOLED	660	59	264	159.4	41.4	0.26
Total Number of Captures		983				
Number of Species	47	17	26	38	29	
Total Number of Species		50			45	

[1] 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 both temporally variable and time-constant models for 22 species breeding at MAPS stations on Fort Leonard Wood obtained from 13 years (1993-2005) of mark-recapture data from the six long-running stations.

Species	Num. sta2.[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	Survival probability[5]	Surv. C.V.[6]	Recapture probability[7]	Proportion of residents[8]
Downy Woodpecker	6	90	105	11	0.641 (0.113)	17.6	0.304 (0.131)	0.255 (0.138)
Acadian Flycatcher	5	169	284	49	0.615 (0.052)	8.5	0.413 (0.069)	0.401 (0.101)
White-eyed Vireo	5	181	344	48	0.571 (0.055)	9.6	0.466 (0.077)	0.356 (0.097)
Red-eyed Vireo	6	244	307	39	0.495 (0.067)	13.5	0.261 (0.079)	0.774 (0.265)
Carolina Chickadee †	6	120	148	17	0.524 (0.105)	20.1	0.161 (0.088)	1.000 (0.586)
Blue-gray Gnatcatcher ‡†	6	92	101	3	0.567 (0.224)	39.6	0.031 (0.073)	1.000 (2.345)
Blue-winged Warbler	4	324	481	68	0.541 (0.048)	8.9	0.534 (0.070)	0.306 (0.066)
Northern Parula †	5	63	72	5	0.537 (0.182)	33.9	0.083 (0.106)	1.000 (1.318)
Prairie Warbler	3	194	256	27	0.548 (0.080)	14.6	0.198 (0.071)	0.692 (0.267)
Black-and-white Warbler ‡	5	90	100	4	0.570 (0.217)	38.1	0.576 (0.289)	0.058 (0.051)
American Redstart	1	92	115	15	0.683 (0.095)	14.0	0.232 (0.093)	0.421 (0.194)
Worm-eating Warbler	2	83	108	11	0.560 (0.120)	21.4	0.611 (0.173)	0.131 (0.074)
Ovenbird	4	97	143	17	0.553 (0.092)	16.7	0.440 (0.130)	0.331 (0.142)
Louisiana Waterthrush	1	56	98	12	0.348 (0.108)	31.1	0.757 (0.200)	0.459 (0.235)
Kentucky Warbler	5	298	521	97	0.611 (0.039)	6.4	0.500 (0.054)	0.421 (0.074)
Common Yellowthroat	3	206	388	56	0.500 (0.052)	10.5	0.612 (0.081)	0.378 (0.093)
Yellow-breasted Chat	3	360	636	118	0.612 (0.035)	5.7	0.382 (0.044)	0.573 (0.091)
Summer Tanager ‡	3	40	47	4	0.453 (0.197)	43.6	0.244 (0.234)	0.527 (0.562)
Field Sparrow	3	323	470	66	0.473 (0.049)	10.3	0.336 (0.064)	0.705 (0.160)
Northern Cardinal	6	174	241	34	0.596 (0.070)	11.7	0.179 (0.057)	0.963 (0.325)
Indigo Bunting	6	629	985	149	0.480 (0.033)	7.0	0.380 (0.046)	0.744 (0.110)
American Goldfinch †	3	169	201	10	0.351 (0.128)	36.4	0.120 (0.106)	1.000 (0.884)

[1] Number of stations where the species was a regular or usual breeder and at which adults of the species were captured. Stations within one km of each other were combined into a single super-station to prevent individuals whose home ranges included portions of two or more stations from being counted as multiple individuals.
[2] Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).
[3] Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.

Table 5. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 22 species breeding at MAPS stations on Fort Leonard Wood obtained from 13 years (1993-2005) of mark-recapture data from the six long-running stations.

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[4] Total number of returns. A return is the first recapture in a given year of a bird originally banded at the same station in a previous year.
[5] Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate).
[6] The coefficient of variation for survival probability, CV(φ).
[7] Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate).
[8] The proportion of residents among newly captured adults (τ) presented as the maximum likelihood estimate (standard error of the estimate).

‡ The estimate for survival probability should be viewed with caution because it is based on fewer than five between-year recaptures, or the estimate is very imprecise (SE(φ)>0.200 or CV(φ)>50.0%).
† The estimate for recapture probability (and possibly survival probability as well) may be biased low because the estimate for τ was 1.000.