

The 2016 Annual Report of the Monitoring Avian Productivity and Survivorship (MAPS) Program on Fort Bragg, North Carolina



Common Yellowthroat (photo by John Flannery)

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Introduction

Fort Bragg, at more than 255 square miles, is one of the largest military installations in the world. In addition to training facilities and housing, the base has a variety of diverse natural habitats, including some of the largest remnants of the endangered longleaf pine ecosystem. Competing demands on this landscape, most importantly training and mission readiness, but also including wildlife and watershed protection, hunting and other types of recreation, and compliance with federal environmental laws such as the Endangered Species and Migratory Bird Treaty Act, mean that base managers must balance a variety of activities for multiple stakeholders and objectives.

The base has an active program of land management that has won several awards for its bird conservation. The Fort Bragg Integrated Natural Resources Management Plan and the Adaptive Ecosystem Management Program Endangered Species Management Component require that migratory birds are considered in natural resource management planning and implementation. Central to these strategies are Fort Bragg's efforts to restore and maintain habitat for the federally-endangered Red-cockaded Woodpecker (*Leuconotopicus borealis*). Current management includes frequent prescribed fires to maintain the open, mature stands of longleaf pine with very little understory in which the species thrives. One of the objectives of base natural resource managers is to understand changes to flora and fauna communities with this and other types of management actions.

Due to their rapid metabolism and high ecological position on most food webs, birds are excellent indicators of habitat quality and environmental change. In addition, their diurnal nature and relative abundance in terrestrial ecosystems make them relatively easy and cost-efficient to monitor and capture. Over the past several decades the creation of monitoring programs such as the Monitoring Avian Productivity and Survivorship (MAPS) Program has aided land managers reach their conservation goals (Rich et al. 2004). With its emphasis on avian vital rates, the Program can provide critical information on which life stage (for example, breeding or non-breeding) is the strongest driver of population change (DeSante et al. 2005). The Program operated at Fort Bragg from 1995-2009, ceased operation for several years due to funding limitations, but resumed in 2015.

The current objectives of the partnership between Fort Bragg and IBP are to:

- monitor year to year changes in avian population dynamics;
- provide landscape-level population management decision-support tools;
- monitor and assess the efficacy of management actions.

Fort Bragg MAPS data have contributed to the management decision-support tools developed in collaboration with other DoD installations that support MAPS monitoring (Nott 2008).

Methods

Establishment and operation of stations

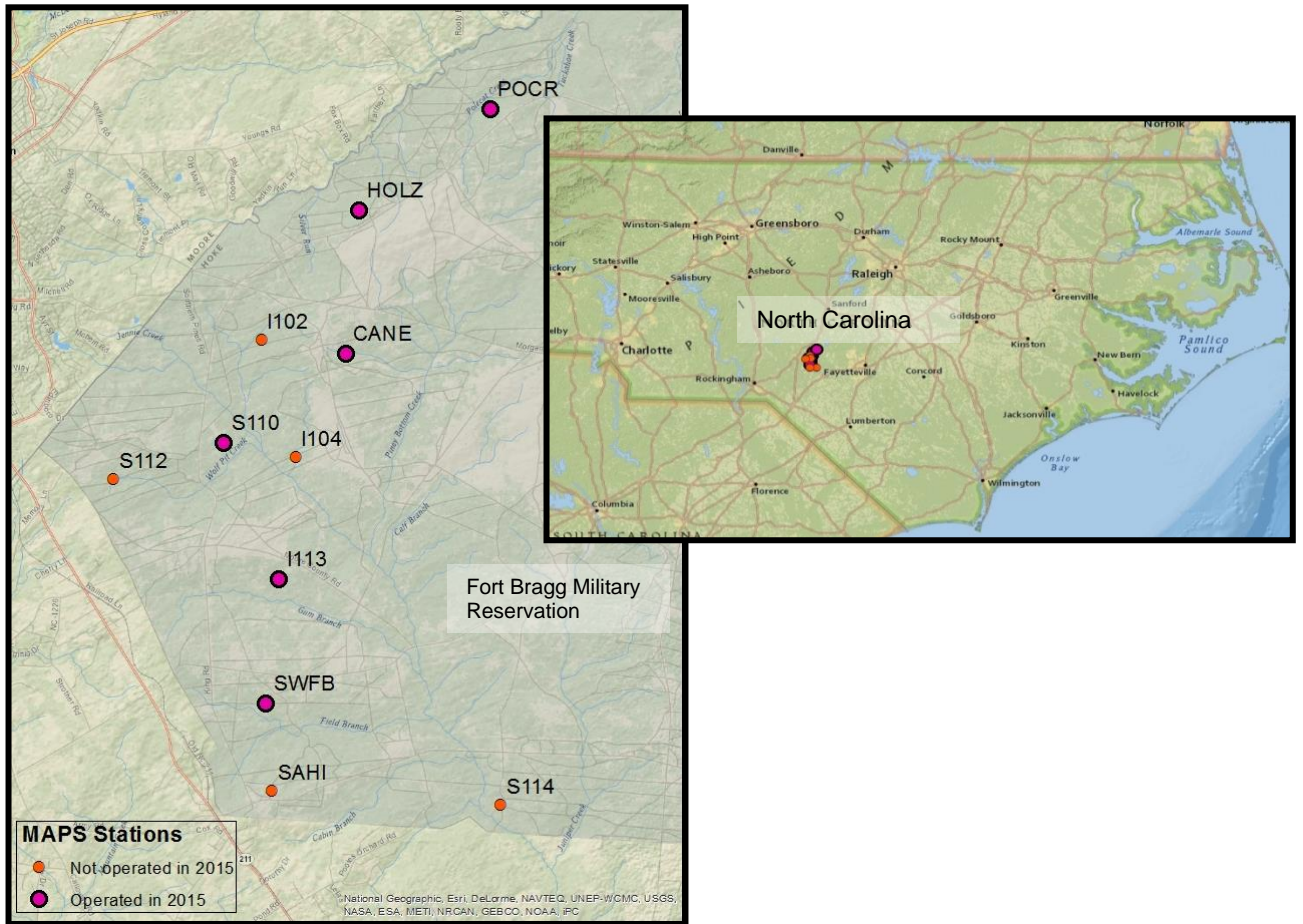
We operated six MAPS stations on Fort Bragg in 2016 (Table 1, Figure 1):

- I-113, located in longleaf pine uplands with clumps of hardwood and drainages of cane and fern and dirt roads through and alongside the station. The site is control-burned every 3 years (last burned 2015).
- S-110, located in longleaf pine upland with a small creek running through the center, surrounded by hardwood, fern, and cane, and dirt roads through and alongside the station. The site is control-burned every 3 years.
- Canebreak (CANE), located in longleaf pine upland with areas of thick cane and other vegetation around nets 01 through 05. The site has undulating terrain and human-made dirt roads. It is burned approximately every three years.
- Holland Landing Zone (HOLZ), located in longleaf pine upland with clumps of hardwoods, and dirt roads through and alongside the station. The site is control-burned every three years, last time being in 2015.
- Polecat Creek (POCR), located in longleaf pine upland with clumps of hardwood and drainages with cane and fern. There are dirt roads through and alongside the station, which is control-burned every three years.
- Southwest Fort Bragg (SWFB), located in longleaf pine upland on top of a hill. There are hardwoods outside the site at the base of the hill on three sides, and dirt roads through and alongside station. The site is control-burned every three years.

Table 1. Summary of the 2016 MAPS stations on Fort Bragg.

Station		No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	2016 (2015) operation metrics		
Name	Code					Total net-hours in 2016 (2015)	No. of periods	Inclusive dates
I-113	I113	16658	Controlled burn riparian, savanna and longleaf pine-oak woodland	35°05'34"N,79°19'25"W	107	417.7 (331.8)	9	5/16 – 8/04
S-110	S110	16659	Riparian woodland, pine savanna and longleaf pine-oak woodland	35°07'08"N,79°20'11"W	94	458.0 (408.2)	9	5/14 – 8/02
Canebreak	CANE	16760	Controlled burn longleaf pine upland, areas of thick cane	35°08'10"N, 079°18'28"W	111	475.7 (417.3)	9	5/12 – 7/31
Holland Landing Zone	HOLZ	16761	Controlled burn longleaf pine-oak upland	35°09'50"N, 079°18'17"W	126	482.0 (414.0)	9	5/15 – 8/03
Polecat Creek	POCR	16762	Controlled burn longleaf pine-oak upland, riparian drainages	35°11'01"N, 079°16'25"W	97	478.2 (412.3)	9	5/13 – 8/01
Southwest Fort Bragg	SWFB	16763	Controlled burn hilltop longleaf pine upland	35°04'06"N, 079°19'36"W	110	503.0 (428.7)	9	5/11 – 8/05
ALL STATIONS COMBINED						2,814.5 (2,412.3)	9	5/11 - 8/05

Figure 1. MAPS stations at Fort Bragg. (Orange dots are stations used during 1995-2009 but not in 2015-16).



Stations were operated in accordance with standard MAPS protocol (DeSante et al. 2015). Each station was operated for six hours per day, beginning at about local sunrise, during one day in each of nine consecutive 10-day periods between May 12 and August 5, for a total of 9 days at each station. At each station, ten 12-meter long, 2.5-meter high, 30-mm mesh nylon mist nets were erected on each day of that station's operation. In addition, to supplement potentially low capture rates, we attempted to capture higher canopy species by erecting a triple-height (6 meters above the ground) net at some locations on some days. Since equipment could not be left at the sites, this involved considerably more effort to set up and take down than standard mist nets, and was only operated when field staff had sufficient time, and the net did not pose a danger to captured birds (e.g. by excessive exposure to the sun).

Data collection

With few exceptions, all birds captured were identified to species, age, and sex. Birds were banded with numbered aluminum bands and the following data were collected:

- capture code (newly banded, recaptured, band changed, unbanded)
- band number
- species
- age and how aged
- sex (if possible) and how sexed (if applicable)
- extent of skull pneumaticization
- breeding condition of adults (i.e., extent of cloacal protuberance or brood patch)
- extent of juvenal plumage in young birds
- extent of body and flight-feather molt
- extent of primary-feather wear
- presence of molt limits and plumage characteristics
- wing chord
- fat class and body mass
- date and time of capture (net-run time)
- station and net site where captured

If a situation arose where bird safety was compromised, such adverse weather, birds were released immediately. The breeding status (confirmed breeder, likely breeder, non-breeder) of each species seen, heard, or captured at each station on each day of operation was also recorded at the end of each day. For each of the six stations, we prepared simple maps indicating the extent and location of major habitats, structures, roads, trails, and streams. We also classified the extent of cover of the upperstory, midstory, understory, and ground cover in each major habitat type into one of twelve pattern types and eleven cover categories according to guidelines in the MAPS Habitat Structure Assessment Protocol (Nott et al. 2003).

Data entry and verification

All data were carefully vetted. We hand-proofed capture code, band number, species, age, sex, date, capture time, station, and net number against raw data and corrected any computer-entry errors. All banding data were then run through a series of verification programs:

- Cross-check program to compare station, date, and net fields from the banding data with those from the summary of mist netting effort data.
- Clean-up programs to check the validity of codes and the ranges of all numerical data.
- Cross-check programs to compare species, age, and sex against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), and extent of body and flight-feather molt, primary-feather wear, and juvenal plumage.
- Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species.

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

Discrepancies were examined and corrected if necessary.

Data analysis

We classified species captured based upon their breeding or summer residency status:

- Regular breeder (B) if there was positive or probable evidence of breeding or summer residency within the boundaries of the station *during all years* the station operated.
- Usual breeder (U) if there was probable evidence of breeding or summer residency within the boundaries of the station *during more than half but not all years* the station operated.
- Occasional breeder (O) if there was probable evidence of breeding or summer residency within the boundaries of the station *during half or fewer of the years* the station operated.
- Transient (T) if the species was *never* a breeder or summer resident at the station, but the station was within the overall breeding range of the species.
- Migrant (M) if the station was not located within the overall breeding range of the species.

Data for a given species from a given station were included in productivity analyses if the station was within the breeding range of the species; that is, data were included from stations where the species was a breeder (B, U, or O), or transient (T), but not where the species was a migrant (M).

Adult population index and productivity analyses

We calculated the following metrics for each species:

- The numbers of newly banded birds, recaptured birds, and birds released unbanded.
- The numbers and capture rates (per 600 net-hours) of first captures (in a given year) of individual adult and young birds.
- The reproductive index.
- Following procedures pioneered by the British Trust for Ornithology in their CES Scheme (Peach et al. 1996), we used the number of adult birds captured as an index of adult population size.
- We calculated a yearly reproductive index as the ratio of the number of young divided by the number of adults.

Results

2016 Indices of Adult Population Size and Post-Fledging Productivity

We present the 2016 numbers of newly-banded, unbanded, and recaptured birds for each species at each of the six stations individually, and for all stations combined in Tables 2-4. A total of 199 (134 new captures) individuals of 32 species were captured in 2016. Newly banded birds comprised 67% of the total. The greatest number of captures (65) was recorded at the I-113 station; the smallest number of captures (12) was recorded at the Southwest Fort Bragg station. The highest species richness occurred at I-113 (16 species) and the lowest species richness occurred at Holland Landing Zone and Southwest Fort Bragg (8 species) (Table 2).

Capture rates and the reproductive index (number of young birds per adult) were pooled at each station and for all stations combined (Tables 3 and 4). Captures per 600 net-hours (rather than absolute numbers) are shown so data can be compared among stations, which may for logistical and weather reasons have had varying degrees of capture effort. Capture indices suggest that the total adult population size in 2016 was greatest at I-113 (43.1 adults/600 net-hours), followed by Polecat Creek (35.1), S-110 (24.9), Canebreak (20.2), Holland Landing Zone (13.7), and Southwest Fort Bragg (9.5). The capture rate of young of all species pooled at each station in 2016 was highest at I-113 (15.8) followed by S-110 (9.2 young/600 net-hours), Holland Landing Zone (8.7), Polecat Creek (5.0), Canebreak (2.5), and Southwest Fort Bragg (0.0) (Table 3). These results were similar to results from 2015.

Reproductive index was greatest at Holland Landing Zone (0.64), followed by S-110 and I-113 (0.37), Polecat Creek (0.14), Canebreak (0.13), and Southwest Fort Bragg (0.00). Mean adult capture rate for the six stations combined was 28.1 per 600 net hours; the overall reproductive index was 0.39.

The most abundant breeding species by capture rate was Common Yellowthroat, followed by Prairie Warbler, Red-headed Woodpecker, Great-crested Flycatcher, and Bachman's Sparrow (Table 4).

Table 2. Captures by station, 2016. N=Newly Banded, U=Unbanded, R=Recaptures of banded birds.

Species	I-113			S-110			Canebreak			Holland Landing Zone			Polecat Creek			Southwest Fort Bragg		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Yellow-billed Cuckoo							1						1					
Ruby-throated Hummingbird								3									1	
Red-headed Woodpecker	1		1							2		1	2		1	1		
Downy Woodpecker													2					
Hairy Woodpecker				1														
Northern Flicker													1					
Pileated Woodpecker					1													
Eastern Wood-Pewee										1			1					
Great Crested Flycatcher				1						3			2			1		
White-eyed Vireo	1																	
Red-eyed Vireo													1			1		
Blue Jay	2			1														
Carolina Chickadee	1			1														
Tufted Titmouse				4						1			3		1			
White-breasted Nuthatch	1									1		1						
Carolina Wren	5		6	2		2	1						1	1				
Blue-gray Gnatcatcher				3	1	1												
Eastern Bluebird										3								
Swainson's Thrush				1														
Brown Thrasher							1											
Common Yellowthroat	6		10	5		2	3						2	1				
Hooded Warbler	2			1									1					
Pine Warbler	1			1			4	1	1	5			4			1		
Prairie Warbler	2	1		2			1	1					4		2	1		
Eastern Towhee	1	1					2						2			1	1	
Bachman's Sparrow	6		1													2		2

Table 2. (Cont.) Captures by station, 2016. N=Newly Banded, U=Unbanded, R=Recaptures of banded birds.

Species	I-113			S-110			Canebreak			Holland Landing Zone			Polecat Creek			Southwest Fort Bragg		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Chipping Sparrow							1											
Summer Tanager				1			1						1		1			
Northern Cardinal		2	2	2	5	4							1					
Blue Grosbeak	3						2			1								
Indigo Bunting	2	1	5				1						1					
Brown-headed Cowbird	1																	
Total Captures by Type	35	5	25	26	7	9	18	5	1	17		2	30	2	5	8	2	2
Total Captures at Station	Total = 65			Total = 42			Total = 24			Total = 19			Total = 37			Total = 12		
# of Species by Capture Type	15	4	6	14	3	4	11	3	1	8	0	2	17	2	4	7	2	1
Total Species at Station	Total = 16			Total = 15			Total = 12			Total = 8			Total = 17			Total = 8		

Table 3. Birds captured per 600 net-hours, and proportion of young at all stations, 2016.

Species	I-113			S-110			Canebreak			Holland Landing Zone			Polecat Creek			Southwest Fort Bragg		
	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Yellow-billed Cuckoo							0.0	1.3	und. ¹				1.3	0.0	0.00			
Red-headed Woodpecker	1.4	0.0	0.00							3.7	0.0	0.00	3.8	0.0	0.00	1.2	0.0	0.00
Downy Woodpecker													2.5	0.0	0.00			
Hairy Woodpecker				1.3	0.0	0.00												
Northern Flicker													1.3	0.0	0.00			
Eastern Wood-Pewee										1.2	0.0	0.00	1.3	0.0	0.00			
Great Crested Flycatcher				1.3	0.0	0.00				3.7	0.0	0.00	2.5	0.0	0.00	1.2	0.0	0.00
White-eyed Vireo	0.0	1.4	und. ¹															
Red-eyed Vireo													1.3	0.0	0.00	1.2	0.0	0.00
Blue Jay	2.9	0.0	0.00	1.3	0.0	0.00												
Carolina Chickadee	0.0	1.4	und.	1.3	0.0	0.00												
Tufted Titmouse				2.6	2.6	1.00				1.2	0.0	0.00	1.3	2.5	2.00			
White-breasted Nuthatch	1.4	0.0	0.00							0.0	1.2	und. ¹						
Carolina Wren	7.2	2.9	0.40	0.0	2.6	und. ¹	0.0	1.3	und.				0.0	1.3	und. ¹			
Blue-gray Gnatcatcher				2.6	1.3	0.50												
Eastern Bluebird										2.5	1.2	0.50						
Brown Thrasher							1.3	0.0	0.00									
Common Yellowthroat	7.2	2.9	0.40	3.9	2.6	0.67	3.8	0.0	0.00				2.5	0.0	0.00			
Hooded Warbler	1.4	1.4	1.00	1.3	0.0	0.00							1.3	0.0	0.00			
Pine Warbler	0.0	0.0	0.00	1.3	0.0	0.00	5.0	0.0	0.00	0.0	6.2	und.	3.8	1.3	0.33	1.2	0.0	0.00
Prairie Warbler	2.9	0.0	0.00	2.6	0.0	0.00	1.3	0.0	0.00				5.0	0.0	0.00	1.2	0.0	0.00
Eastern Towhee	1.4	0.0	0.00				2.5	0.0	0.00				2.5	0.0	0.00	1.2	0.0	0.00
Bachman's Sparrow	7.2	2.9	0.40													2.4	0.0	0.00
Chipping Sparrow							1.3	0.0	0.00									

Table 3. (Cont.) Birds captured per 600 net-hours, and proportion of young at all stations, 2016.

Species	I-113			S-110			Canebreak			Holland Landing Zone			Polecat Creek			Southwest Fort Bragg		
	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Summer Tanager				1.3	0.0	0.00	1.3	0.0	0.00				2.5	0.0	0.00			
Northern Cardinal	1.4	0.0	0.00	3.9	0.0	0.00							1.3	0.0	0.00			
Blue Grosbeak	4.3	0.0	0.00				2.5	0.0	0.00	1.2	0.0	0.00						
Indigo Bunting	4.3	1.4	0.33				1.3	0.0	0.00				1.3	0.0	0.00			
Brown-headed Cowbird	0.0	1.4	und.															
ALL SPECIES POOLED	43.1	15.8	0.37	24.9	9.2	0.37	20.2	2.5	0.13	13.7	8.7	0.64	35.1	5.0	0.14	9.5	0.0	0.00
Number of Species	12	8		12	4		9	2		6	3		16	3		7	0	
Total Species at Station	Total = 15			Total = 13			Total = 11			Total = 8			Total = 17			Total = 7		

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

Table 4. Species captured and reproductive rates for all species at all Fort Bragg MAPS stations, 2016.

Species	Birds captured			Birds/600 net hours		Prop. Young
	Newly banded	Un-Banded	Recap-tured	Adults	Young	
Yellow-billed Cuckoo	2			0.2	0.2	1.00
Ruby-throated Hummingbird		4				
Red-headed Woodpecker	6		3	1.7	0.0	0.00
Downy Woodpecker	2			0.4	0.0	0.00
Hairy Woodpecker	1			0.2	0.0	0.00
Northern Flicker	1			0.2	0.0	0.00
Pileated Woodpecker		1				
Eastern Wood-Pewee	2			0.4	0.0	0.00
Great Crested Flycatcher	7			1.5	0.0	0.00
White-eyed Vireo	1			0.0	0.2	und. ¹
Red-eyed Vireo	2			0.4	0.0	0.00
Blue Jay	3			0.6	0.0	0.00
Carolina Chickadee	2			0.2	0.2	1.00
Tufted Titmouse	8		1	0.9	0.9	1.00
White-breasted Nuthatch	2		1	0.2	0.2	1.00
Carolina Wren	9	1	8	1.1	1.3	1.20
Blue-gray Gnatcatcher	3	1	1	0.4	0.2	0.50
Eastern Bluebird	3			0.4	0.2	0.50
Swainson's Thrush	1					
Brown Thrasher	1			0.2	0.0	0.00
Common Yellowthroat	16	1	12	2.8	0.9	0.31
Hooded Warbler	4			0.6	0.2	0.33
Pine Warbler	16	1	1	1.9	1.3	0.67
Prairie Warbler	10	2	2	2.1	0.0	0.00
Eastern Towhee	6	2		1.3	0.0	0.00
Bachman's Sparrow	8		3	1.5	0.4	0.29
Chipping Sparrow	1			0.2	0.0	0.00
Summer Tanager	3		1	0.9	0.0	0.00
Northern Cardinal	3	7	6	1.1	0.0	0.00
Blue Grosbeak	6			1.3	0.0	0.00
Indigo Bunting	4	1	5	1.1	0.2	0.20
Brown-headed Cowbird	1			0.0	0.2	und.
Total Captures by Type	134	21	44	23.9	6.6	0.28
Total Captures, All Types		199				
Species by Capture Type	30	10	12	27	14	
Total Species, All Types		32			29	

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

Two of the MAPS stations, I-113 and S-110 have been running at the same sites since 1995 and offer some insights for longitudinal comparison between the early portion of the study (1995-2009) and the recent effort (2015-2016, Table 5). For all species pooled, the number of adults captured (37.6 adults per 600 net-hours) and young captured (16.3) were lower than numbers recorded in 1995-2009 (53.2 and 23.7, respectively). Productivity was nearly equal during the two periods (0.43 in 2015-16 vs. a mean of 0.46 for 1995-2009). Capture rates in 2015-16 for the most common species, Great-crested Flycatcher, Carolina Chickadee, Tufted Titmouse, Carolina Wren, Common Yellowthroat, Pine Warbler, Prairie Warbler, and Northern Cardinal, appear similar to the mean for 1995-2009. Several species that were captured in 1995-2009 were not captured in 2015-16, though the effort has obviously been considerably less (14 seasons vs. 2). One species, a Yellow-throated Warbler (young), that was captured in 2016 was not captured in 1995-2009. Productivity for most species was similar between 1995-2009 and 2015-16.

Table 5. Comparison of mean capture rates for two long-running stations, I 113 and S 110 (combined), 2015-2016 and 1995-2009.

Species	Mean 2015-2016 Birds/600 net hours		Prop. of Young	Mean 1995-2009 Birds/600 net hours		Prop. of Young
	Adults	Young		Adults	Young	
Yellow-billed Cuckoo				0.2	0.0	0.00
Red-headed Woodpecker	0.7	0.0	0.00	0.2	0.0	0.00
Red-bellied Woodpecker	0.3	0.0	0.00	0.3	0.0	0.00
Downy Woodpecker				0.0	0.0	1.00
Hairy Woodpecker	0.7	0.0	0.00	0.1	0.0	0.00
Red-cockaded Woodpecker				0.0	0.1	und. ¹
Yellow-shafted Flicker				0.1	0.0	0.50
Eastern Wood-Pewee	0.3	0.0	0.00	0.4	0.0	0.00
Acadian Flycatcher				0.2	0.0	0.20
Great Crested Flycatcher	1.9	0.0	0.00	2.6	0.1	0.11
White-eyed Vireo	0.6	0.7	0.50	1.2	1.0	0.68
Yellow-throated Vireo				0.2	0.0	0.00
Red-eyed Vireo	0.6	0.0	0.00	1.0	0.2	0.17
Blue Jay	1.0	0.0	0.00	0.7	0.2	0.19
American Crow	0.7	1.0	1.50	1.9	1.7	0.94
Fish Crow	1.6	1.3	0.83	2.7	2.5	1.07
Purple Martin	0.7	0.0	0.00	0.1	0.0	0.00
Tree Swallow	0.3	0.0	0.00	0.2	0.3	0.50
Carolina Wren	4.2	4.2	0.96	3.4	5.6	2.67
Blue-gray Gnatcatcher	0.7	0.7	0.50	1.1	0.6	0.49
Wood Thrush				0.1	0.0	0.00
American Robin				0.1	0.0	0.00
Gray Catbird				1.2	0.2	0.17
Brown Thrasher				1.4	0.6	0.39
Yellow-throated Warbler	0.0	0.3	und. ¹			

Table 5. (cont.) Comparison of mean capture rates for two long-running stations, I 113 and S 110 (combined), 2015-2016 and 1995-2009.

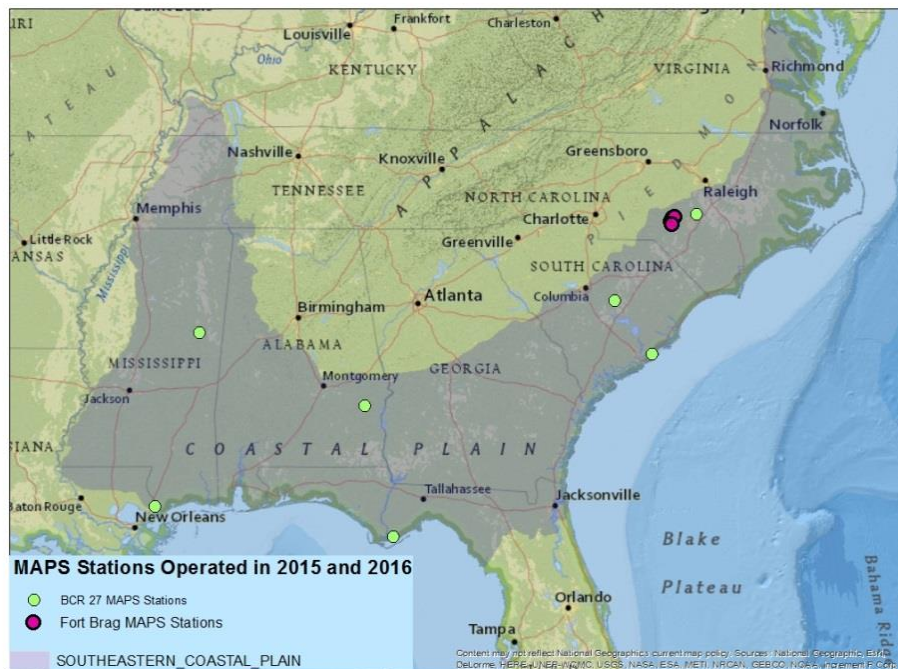
Species	Mean 2015-2016 Birds/600 net hours			Mean 1995-2009 Birds/600 net hours		
	Adults	Young	Prop. of Young	Adults	Young	Prop. of Young
Pine Warbler	1.3	2.5	1.33	2.8	0.8	0.31
Prairie Warbler	3.6	0.0	0.00	6.4	1.4	0.25
Black-and-white Warbler				0.3	0.1	0.00
American Redstart				0.4	0.0	0.00
Worm-eating Warbler				0.1	0.0	0.00
Ovenbird				0.5	0.4	0.75
Louisiana Waterthrush				0.1	0.0	0.50
Kentucky Warbler	0.3	0.0	0.00	0.0	0.1	und. ¹
Common Yellowthroat	5.3	2.9	0.56	6.3	3.0	0.53
Hooded Warbler	1.0	0.3	0.25	1.8	0.2	0.27
Summer Tanager	0.7	0.0	0.00	1.8	0.4	0.21
Eastern Towhee	1.9	0.0	0.00	3.5	0.7	0.20
Bachman's Sparrow	2.0	0.7	0.20	1.0	0.2	0.14
Chipping Sparrow				1.7	0.1	0.11
Northern Cardinal	3.3	0.9	0.25	4.0	2.5	0.69
Blue Grosbeak	1.3	0.0	0.00	0.5	0.1	0.20
Indigo Bunting	2.6	0.3	0.17	1.6	0.2	0.11
Brown-headed Cowbird	0.0	0.3	und. ¹	0.1	0.0	0.00
Orchard Oriole				0.1	0.0	0.00
American Goldfinch				0.9	0.0	0.00
ALL SPECIES POOLED	37.6	16.3	0.43	53.2	23.7	0.46
Number of Species	25	13		41	26	
	Total Species 2015-16 = 27			Total Species 1995-2009 = 43		

Discussion

Several species were captured in 1995-2009 that were not recorded in 2015-16, though the earlier effort covered a much longer period. Still, capture rates in 2015-16 were low compared to other MAPS stations. This is largely due to the habitat types in which the stations were operating, i.e. areas that have been managed to reduce understory for the benefit of Red-cockaded Woodpecker. The attempt to capture more birds using a set of higher nets had mixed success: some birds were captured but they were very few in number, and the nets took considerable time and effort to set up and take down. At all stations pooled, there were 79 species captured from 1995-2009 and 41 captured in the years 2015-2016. From the breeding status list, there were 115 species encountered from 1995-2009 and 99 encountered in the years 2015-2016. We believe there are birds in the upper canopy present that were not captured even by the higher net sets. In coming years, we recommend supplemental methods of bird survey, such as point counts, which can detect species that are not captured by passive netting.

One of the strengths of the MAPS Program is the ability to use its standardized methodologies, and broad geographic and temporal scales to make comparisons between stations or years. Table 6 provides a comparison between the combined Fort Bragg stations to the remaining seven stations operated in the South Eastern Coastal Plain Bird Conservation Region (Bird Conservation Region 27). (We considered comparing results at Fort Bragg with other military installations, but decided that, due to differences in habitats, regions, weather, and other variables, to restrict our analysis to the region of Fort Bragg, Figure 2).

Figure 2. MAPS Stations at Fort Bragg (red dots) and Bird Conservation Region 27, Southeastern Coastal Plain (green dots) that operated over the same period.



Only species for which at least one adult, on average, were captured at Fort Bragg per year are presented in this table. Overall, the BCR 27 stations captured both more adults and young. This is likely due to the open understory at the Fort Bragg stations which inherently leads to lower capture rates.

The MAPS stations on Fort Bragg that were operated in 2015 and 2016 were sited to sample the habitat that comprises most of the base. The productivity for All Species Pooled at Fort Bragg (0.34) is also lower than at the other BCR 27 stations combined (0.41), but for six of the 11 species present in both samples, the productivity is higher. Fort Bragg also captures two species not captured elsewhere in BCR 27 (Red-headed Woodpecker and Bachman's Sparrow), has a higher capture rate of adults for two species (Pine Warbler and Prairie Warbler) which are not well represented in the remainder of the BCR. Caution should be used when interpreting these results because the number of stations and years in the analysis are quite small.

Table 6. Comparison of the mean capture rates, 2015-2016, of the 13 species for which there was at least an average of one adult captured per year at the combined six Fort Bragg stations to the other seven combined stations in BCR 27 for which data were available.

Species	Fort Bragg - Mean 2015-2016 Birds/600 net hours			BCR 27 - Mean 2015-2016 Birds/600 net hours		
	Adults	Young	Prop. of Young	Adults	Young	Prop. of Young
Red-headed Woodpecker	1.4	0.0	0.00			
Great Crested Flycatcher	2.0	0.0	0.00	1.2	0.1	0.06
Tufted Titmouse	1.2	0.7	0.71	1.6	1.0	0.63
Carolina Wren	1.5	1.7	1.16	7.7	7.5	0.97
Common Yellowthroat	2.9	1.1	0.37	4.9	5.2	1.45
Pine Warbler	2.2	2.7	1.13	0.4	0.0	0.00
Prairie Warbler	2.1	0.0	0.00	0.3	0.2	1.00
Eastern Towhee	1.4	0.0	0.00	1.4	0.7	0.70
Bachman's Sparrow	1.0	0.2	0.14			
Summer Tanager	1.6	0.0	0.00	0.5	0.0	0.00
Northern Cardinal	1.3	0.4	0.29	6.9	1.2	0.15
Blue Grosbeak	1.0	0.0	0.00	0.2	0.0	0.00
Indigo Bunting	1.4	0.1	0.10	2.5	0.0	0.00
ALL SPECIES POOLED	26.0	8.8	0.34	71.5	29.5	0.41
Number of Species	33	17		43	29	
Total Number of Species		36			44	

The MAPS Program at Fort Bragg continues to provide station-specific indices of adult population size and post-fledging productivity. As part of a wider network, the station provides data for regional and national comparisons.

Many bird populations continue to decline across North America. Many short-term projects and programs are aimed at tracking population trends, but few offer the depth, breadth, and the ability to look at the proximate causes of population decline as the MAPS Program. However, low capture rates in some habitats at Fort Bragg, especially areas that have been restored for the Red-cockaded Woodpecker and have little understory, provide low capture rates during passive mist-netting, and are not conducive to generating robust statistical analysis. We look forward to continuing our collaboration with the installation and collecting more data in the future to strengthen comparisons, but recommend either using additional habitats where capture rates are higher, supplementing MAPS data with point counts, or even replacing the MAPS protocol with a robust point count project.

With the manifold changes and pressures such as habitat loss, climate change, and disease, it is extremely important that rigorously scientific long-term studies such as these continue. The U.S. Department of Defense, with its large land base, can play a vital role in this effort.

Acknowledgments

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Appendix I. Numerical listing (in AOU 2015 checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the 17 years, 1995-2009 and 2015-2016, of the MAPS Program on the eleven stations ever operated on Fort Bragg.

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

SSN	SPEC	SPECIES NAME	I 113 (I113)	S 110 (S110)	Canebreak (CANE)	Holland Landing Zone (HOLZ)	Polecat Creek (POCR)	Southwest Fort Bragg (SWFB)	I 102 (I102)	I 104 (I104)	S 112 (S112)	S 114 (S114)	Sandstone Hill (SAHI)
350	CANG	Canada Goose	T	T	T	T				T	F		
490	WODU	Wood Duck	T	T					T	U	T	T	
560	MALL	Mallard								F			
1210	NOBO	Northern Bobwhite	U	U	O	B	T	T	B	U	U	U	U
1560	WITU	Wild Turkey	T	T	T							F	F
2610	DCCO	Double-crested Cormorant								T			
2690	AMBI	American Bittern								T			
2760	GBHE	Great Blue Heron	T	T			T	T	T	O	T		T
2810	GREG	Great Egret									T		
2930	GRHE	Green Heron								T			
3080	BLVU	Black Vulture		T		T	T	T		T			
3090	TUVU	Turkey Vulture	T	T	T	T	T	T	T	T	O	T	T
3350	SSHA	Sharp-shinned Hawk		M						M			
3360	COHA	Cooper's Hawk		T		T			T			T	
3560	RSHA	Red-shouldered Hawk	T	T						T	O	O	
3580	BWHA	Broad-winged Hawk	T	T						T	T	T	
3630	RTHA	Red-tailed Hawk	T	T			T	T	T	T	O	T	
4370	KILL	Killdeer				T							
5050	AMWO	American Woodcock	T	T						T			
6490	MODO	Mourning Dove	B	B	B	B	B	B	B	U	B	U	B
6560	YBCU	Yellow-billed Cuckoo	U	U	O	O	O	O	O	U	U	U	O
6810	EASO	Eastern Screech-Owl	O	T					T	T	T	T	
6930	GHOW	Great Horned Owl	T		T					T			
7090	BADO	Barred Owl											T
7240	CONI	Common Nighthawk	U	O	B	B	B	B	U	U	O	O	U
7330	CWWI	Chuck-will's-widow		O						O	O	O	T
7390	EWPW	Eastern Whip-poor-will	O	O	T					T	T		

Appendix I, continued.

SSN	SPEC	SPECIES NAME	I113	S110	CANE	HOLZ	POCR	SWFB	I102	I104	S112	S114	SAHI
7570	CHSW	Chimney Swift	T	T		T		T	T	O	O	T	T
8270	RTHU	Ruby-throated Hummingbird	O	U	O	O	O	T	O	O	U	O	O
9310	BEKI	Belted Kingfisher	T	T					T	O	T	T	T
9620	RHOW	Red-headed Woodpecker	U	O	B	B	B	B	U	U	O	O	O
9750	RBWO	Red-bellied Woodpecker	U	U	B	B	B	B	B	B	U	U	O
9870	DOWO	Downy Woodpecker	U	U	O	O	O	T	O	U	U	U	O
9890	HAWO	Hairy Woodpecker	O	T	T				O	O	U	O	
9920	RCWO	Red-cockaded Woodpecker	U	U	B	T	T	O	B	O	T	T	U
10040	YSFL	Yellow-shafted Flicker	U	U	B	T	B	B	B	U	U	U	B
10120	PIWO	Pileated Woodpecker	U	O	B	B	B	B	U	O	U	U	O
10280	AMKE	American Kestrel	O	T	T	T	T	O	U	O	T	T	O
12440	EAWP	Eastern Wood-Pewee	B	U	B	B	B	B	B	B	O	O	U
12510	ACFL	Acadian Flycatcher	T	T		T	T		T	T	O	O	
12710	EAPH	Eastern Phoebe					T		T	T			
12860	GCFL	Great Crested Flycatcher	B	B	B	B	B	B	B	B	B	U	B
13140	EAKI	Eastern Kingbird	T	O		O				O	T	T	O
13590	LOSH	Loggerhead Shrike											T
13620	WEVI	White-eyed Vireo	O	U	T		T	T	O	U	O	O	T
13770	YTVI	Yellow-throated Vireo	O	O	T					O	O	O	T
13810	BHVI	Blue-headed Vireo	M	M		M		M	M		M		
13880	REVI	Red-eyed Vireo	U	U	O	O	O	O	T	O	B	U	O
14180	BLJA	Blue Jay	U	U	B	B	B	B	B	U	B	U	B
14290	AMCR	American Crow	O	O	B	B	O	B	O	O	U	O	U
14370	FICR	Fish Crow	O	O	B	B	O	B	O	U	T	O	B
14470	PUMA	Purple Martin	T	T	O	O	O	O	T	T	T	T	T
14540	TRES	Tree Swallow							M		M	M	M
14620	NRWS	Northern Rough-winged Swallow	T										
14670	BARS	Barn Swallow	T	T	T	T	T	T	T		T	T	T
14700	CACH	Carolina Chickadee	B	B	B	B	B	B	B	B	B	B	U
14820	TUTI	Tufted Titmouse	B	B	B	B	B	B	B	B	B	B	B
14870	WBNU	White-breasted Nuthatch	U	O	O	O	B	B	U	U	U	U	U
14890	BHNU	Brown-headed Nuthatch	U	U	B	B	B	B	U	U	O	T	B
15090	CARW	Carolina Wren	B	B	B		B	B	B	B	B	B	O
15430	BGGN	Blue-gray Gnatcatcher	U	B	B	T	B	O	U	B	B	U	O
15920	EABL	Eastern Bluebird	O	O	B	O	T		U	U	O	O	U
16150	VEER	Veery		M					M		M		
16160	GCTH	Gray-cheeked Thrush		M						M		M	
16190	SWTH	Swainson's Thrush		M					M	M	M		
16210	WOTH	Wood Thrush	T	T				T		T	U	O	T
16400	AMRO	American Robin	O	O	T	B		T	U	O	O	O	O
16510	GRCA	Gray Catbird	O	O		T		T	U	U	O	O	
16590	BRTH	Brown Thrasher	O	U	T	T	O		U	U	O	O	O

Appendix I, continued.

SSN	SPEC	SPECIES NAME	II13	S110	CANE	HOLZ	POCR	SWFB	II02	II04	S112	S114	SAHI
16710	NOMO	Northern Mockingbird	T		O	T	O			T			T
16880	CEDW	Cedar Waxwing		M	M	M	M	M		M			M
17060	OVEN	Ovenbird	O	O	T			O	T	O	U	U	T
17070	WEWA	Worm-eating Warbler	T								T		
17080	LOWA	Louisiana Waterthrush		O			T			T	T	T	
17090	NOWA	Northern Waterthrush	M							M	M	M	
17120	BWWA	Blue-winged Warbler								M			
17150	BAWW	Black-and-white Warbler	O	O			T			T	U	O	
17160	PROW	Prothonotary Warbler	T						T	T	T	O	
17320	KEWA	Kentucky Warbler	O	O	T		O		T		O	U	
17380	COYE	Common Yellowthroat	B	B	B		B		B	B	U	U	T
17440	HOWA	Hooded Warbler	O	U			T		U	O	U	B	
17450	AMRE	American Redstart	T	T	T				T	O	T	T	
17490	NOPA	Northern Parula	T	T					T	T	T	T	
17520	MAWA	Magnolia Warbler		M					M	M	M	M	
17550	YEWA	Yellow Warbler	M								M		
17580	BLPW	Blackpoll Warbler							M	M	M		
17590	BTBW	Black-throated Blue Warbler	M	M					M	M	M	M	
17640	PIWA	Pine Warbler	B	B	B	B	B	B	B	B	U	U	B
17680	YTWA	Yellow-throated Warbler	T	O					T	O	O	O	T
17710	PRAW	Prairie Warbler	U	B	B		B	O	B	B	O	O	U
17810	BTNW	Black-throated Green Warbler								M	M		
17900	CAWA	Canada Warbler										M	
17910	WIWA	Wilson's Warbler								M			
17990	YBCH	Yellow-breasted Chat	O	T					T	O	T	T	
19120	EATO	Eastern Towhee	B	B	B	B	B	B	B	B	B	U	B
19300	BACS	Bachman's Sparrow	U	U	O	O	T	B	U	U	O		B
19340	CHSP	Chipping Sparrow	U	U	O	O			U	U	T	O	U
19370	FISP	Field Sparrow	T	O					T	O			O
19400	VESP	Vesper Sparrow								T			
19690	WTSP	White-throated Sparrow							M	M			
20050	SUTA	Summer Tanager	B	B	B	B	B	B	U	B	B	U	B
20200	NOCA	Northern Cardinal	B	B	B	T	B	B	B	B	B	B	O
20240	RBGR	Rose-breasted Grosbeak										M	
20310	BLGR	Blue Grosbeak	O	O	O	O		O	T	O	O	O	U
20340	INBU	Indigo Bunting	U	B	O		B	B	U	U	B	U	O
20410	RWBL	Red-winged Blackbird	T		T	T	T			O			
20490	EAME	Eastern Meadowlark	T					T					
20560	COGR	Common Grackle	T	O	T	O		T	T	O	T		T
20650	BHCO	Brown-headed Cowbird	O	U	T	O		T	U	O	U	O	O
20780	OROR	Orchard Oriole	T						T			T	
20920	BAOR	Baltimore Oriole									M		

Appendix I, continued.

SSN	SPEC	SPECIES NAME	I113	S110	CANE	HOLZ	POCR	SWFB	I102	I104	S112	S114	SAHI
21670	HOFI	House Finch	T	T	T			F			O		F
21860	AMGO	American Goldfinch	U	U	T	O	T	T	U	B	B	U	O
21940	HOSP	House Sparrow		T									T