Modeling Overwintering Survival of Declining Landbirds: the 2004-05 Annual Report of the Monitoring Avian Winter Survival (MAWS) Program on four DoD Installations in Southeastern United States

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Long-term data from the North American Breeding Bird Survey (BBS) indicate that many temperate-wintering landbird species, including many sparrows and other species that prefer early successional stage habitats, are experiencing highly significant continent-wide population declines. Recent results from the Monitoring Avian Productivity and Survivorship (MAPS) Program suggest that low survival, rather than low breeding productivity, may be the proximate demographic cause of population decline for many migratory landbird species. Additional evidence from the scientific literature suggests that habitat loss and degradation on these species' wintering grounds may decrease their overwintering survival rate and/or their physical condition at the end of the winter season, which, in turn, may cause increased mortality on spring migration and lowered productivity on the breeding grounds. Spatially extensive data on habitat- and age-specific overwintering survival rates and late-winter physical condition are urgently needed to formulate, implement, and evaluate effective management plans to enhance and preserve winter habitat so as to reverse the population trends of declining species and maintain stable or increasing populations. The Department of Defense may be able to play an important role in such efforts, because the creation and maintenance of the early successional stage habitat required by many of these declining species may be very compatible with management efforts to enhance military Readiness and Range Sustainment.

Accordingly, The Institute for Bird Populations established and operated six Monitoring Avian Winter Survival (MAWS) stations across a gradient of habitats on each of four military installations in southeastern United States during the winter of 2003-04 in an effort to obtain estimates of monthly apparent survival-rates for declining temperate-wintering migratory landbird species during the winter months. The overall goals of the project are: 1) to operate these 24 MAWS stations for at least four winter seasons; and 2) to model the resulting estimates of apparent overwintering survival and indices of physical body condition as functions of station-specific and landscape-scale habitat characteristics in order to formulate avian management guidelines and strategies aimed at reversing the population declines of a number of temperate-wintering migratory landbird species. Follow-up work will be aimed at integrating these strategies into efforts to enhance military Readiness and Range Sustainment.

The 24 MAWS stations established in 2003-04 were located (six per installation) on Fort Chaffee and Camp Robinson in Arkansas, on Fort Bragg in North Carolina, and on Fort Benning in Georgia. These MAWS stations utilized the MoSI (Monitoreo de Sobrevivencia Invernal) protocol of five monthly (November-March) periods of three consecutive days (pulses) of mist netting and banding using up to 16 nets on a 20-ha study area (the station). Although not all pulses of mist-netting were completed during the first winter season (due to station relocations and inclement weather), data were sufficient following that first winter season to obtain estimates of monthly overwintering survival for eighteen target bird species.

During the winter of 2004-05, we continued operating the 24 MAWS stations established in 2003-04. The principal objective for this second season of field work (in addition to collecting additional banding data) was to begin collecting basic habitat data to be incorporated into mark-recapture models of habitat effects on overwintering monthly survival rates. An additional component of this second year of field work was the color-banding and resighting of six sparrow species in an effort to enhance recapture probabilities (and thus the precision of survival rate estimates) for these species.

A total of 25,036.3 net-hours were accumulated as part of the MAWS program in 2004-05. This effort met or exceeded our effort goals for each installation and yielded a total of 9,576 captures (a 78% increase in captures over 2003-04). Of this total, 6,240 were newly banded, 2,804 were recaptures, and 532 were released unbanded. Despite the overall increase in captures, changes in capture rates (i.e., captures adjusted for net-hours) suggested decreases in bird numbers at the Arkansas installations between the winters of 2003-04 and 2004-05 and increases in bird numbers at Forts Bragg and Benning.

We considered two sets of mark-recapture models to estimate survival rates of birds on the four military installations. In the first set, we modeled survival as functions of year and location (installation), while in the second set, we modeled survival as functions of year and habitat using habitat variables derived from a principal components analysis of habitat data collected in the field. In both sets of analyses, we modeled survival both with and without transient modifications, and we modeled recapture probability as functions of location, year, and month. We used information-based ($QAIC_C$) model selection methods and used model averaging with Program MARK to estimate all parameters.

We estimated survival rates on at least one of the four installations for 25 target species. Of these 25 species, many (about 40%) showed some evidence of transient effects on apparent survival rates (compared to 22% of the species examined after the first field season). The increased amount of data, rather than any substantive changes between years may be the cause of this difference in the (apparent) importance of transients between years, although the difference could also have been partly effected by differences in the numbers of wandering individuals (and thus transients) visiting these installations during the two years (there were marked differences in weather between years and many species that showed both transient and year effects). A number of species (nine in the first set of analyses and seven in the second set) also displayed strong indications of year differences in survival rate; in each of these cases survival rate estimates were lower in 2004-05 than in 2003-04.

Support for location effects on survival was strong for only two species (Tufted Titmouse and White-throated Sparrow; see Appendix for scientific names), one of which (titmouse) also showed fairly strong evidence of habitat effects on survival (which may have explained some of the location effects). Models with habitat effects (for at least one of the two habitat variables included in the model) were supported for eight species. Of these eight, the effects were easily interpretable for only three species. One of these three, Field Sparrow, is experiencing range-wide population declines; our habitat model for this species suggested that it may survive (or persist) best at sites (at least in some winters) with relatively complete ground cover, relatively low but still substantial shrub cover, and few canopy trees. Conversely, Swamp Sparrows seem to tend to survive (or persist) better at sites with more shrub and canopy cover and low ground cover. Carolina Wrens survived (or persisted) best at later successional sites with greater canopy and subcanopy development and lower shrub cover.

We found strong support for temporal (monthly and/or seasonal) variation in recapture probability for eight species. Despite our color-banding and resighting efforts, the proportion of returns provided only by resighting (i.e., banded birds resighted in a period other than which they were banded but never recaptured) was substantial (> 20%) for only one of the color-banded sparrow species (Song Sparrow), and support for higher recapture probabilities in 2004-05 than in 2003-04 was only strong for only two color-banded sparrow species (White-throated Sparrow and Dark-eyed Junco). We recommend continued color-banding and resighting of these three species in 2005-06. Although support for location effects on recapture probability was strong for six species, there were no strong consistencies among species in these location differences.

Military lands represent a crucial network of important habitats for many declining species of both Neotropical- and temperate-wintering migratory birds, which themselves serve as sensitive indicators of the health of habitats and ecosystems. Because wise stewardship of DoD lands can allow mission activities and natural resource conservation to coexist, the DoD has become a major cooperating partner in the Neotropical Migratory Bird Conservation Initiative, Partners in Flight (PIF), and in the North American Bird Conservation Initiative (NABCI). The opportunity to enhance both the military mission and natural resource conservation is especially pronounced with respect to the grassland, shrubland, and edge habitats that are often created and maintained in an early successional stage as part of the training missions of DoD installations.

The critical conservation needs of the many seriously declining, early successional stage landbird species, including many sparrow species that winter on DoD installations in southern United States, have only recently become appreciated. Other critical needs that have only recently been identified are the pressing need to mitigate the adverse impacts of encroachment on DoD lands and the need to enhance military readiness and range sustainment (R&RS) on DoD installations. These needs will result in many new land management actions that will be proposed and implemented over the next several years, actions that, if conducted optimally, have the potential to positively affect many declining species of landbirds that require early successional stage habitats. The coincidence in the timing of these needs, the pressing need for land management on military installations and the conservation needs of early successional stage landbird species, provides a unique opportunity for simultaneously enhancing both the military mission and its R&RS on these installations and the landbird populations that depend on them.

The MAWS Program on DoD installations in southeastern United States will contribute significantly to both of those needs. First, it will provide critical information on the manner in which station-specific and landscape-level habitat conditions that result from land-management decisions, such as the successional stage of the habitat, the amount of shrubland cover and edge, and the degree of fragmentation, affect the overwintering survival and late-winter physical condition of declining landbird species that winter on the installations. Overwintering survival and late-winter physical condition may well be key factors in driving their population declines.

Second, the information provided by this project will facilitate the development of pro-active management plans to reverse the population declines in the target species on the particular military installations studied and, by extension, on other installations with similar habitat types.

Finally, the models and avian management guidelines that will result from this project will also provide important information to assist in the development of Integrated Natural Resources Management Plans (INRMP) for each installation. These are important management tools that aim to ensure that military operations and natural resources conservation are integrated and consistent with stewardship and legal requirements. Integration of the avian management guidelines that will result from this work with the INRMP planning process will enhance the installations' ability to conduct landscape-based natural resource management that is compatible with maintaining the military mission.

INTRODUCTION

Analyses of data from the North American Breeding Bird Survey (BBS) indicate that populations of many species of migratory landbirds, including both neotropical- and temperate-wintering species, have declined over the past three decades (Robbins et al. 1989, Terborgh 1989, Peterjohn and Sauer 1993, Pardiek and Sauer 2000). In response to these declines, major conservation efforts such as the Neotropical Migratory Bird Conservation Initiative, Partners in Flight (PIF); the North American Bird Conservation Initiative (NABCI); and the Neotropical Migratory Bird Conservation Act (NMBCA) were established and funded. Nevertheless, these conservation efforts have been hindered by a lack of information concerning the causes of declines (DeSante 1992, 1995, Peterjohn et al. 1995, DeSante et al. 2001). In lieu of information regarding actual causes of declines, conservation plans and management actions have been developed based on species-habitat relationships, where habitat quality is determined by presence/absence, density, or indices of relative abundance, such as the indices provided by the BBS or other point-count-based survey efforts. Such conservation plans and management actions have not always met with success, however, because the link between habitat quality and abundance can be misleading due to source-sink dynamics (Van Horne 1983, Pulliam 1988, Donovan et al. 1995). Indeed, for 31 significantly declining migratory landbird species that winter primarily in Mexico, Central America, and the Caribbean, BBS trends during the 11 years (1992-2002) subsequent to the creation of PIF were not significantly different from those during the 11 years (1980-1991) prior to the creation of PIF, and tended overall to be slightly more negative (DeSante et al. in prep.).

In contrast to population size or relative abundance, vital rates (productivity, recruitment, survival) respond directly, and usually without substantial time lags, to environmental stressors or management actions (Temple and Wiens 1989, DeSante and George 1994). Thus, estimation of avian vital rates provides critical information to population managers (DeSante and Rosenberg 1998) and should be an integral component of all avian monitoring and management efforts (DeSante et al. in press a). In the case of migratory birds, estimates of avian vital rates can be used to help determine whether population declines are related to low productivity on the breeding grounds, high mortality during migration or winter, or both (Sherry and Holmes 1995). More generally, these estimates can be incorporated into predictive population models to assess potential effects of various land use practices on population viability (Noon and Sauer 1992) or predict effects of global climate change on bird populations (Nott et al. 2002, Parmesan and Yohe 2003).

In order to complement the BBS and lend insight into causes of population trends in migratory birds, The Institute for Bird Populations (IBP) created the Monitoring Avian Productivity and Survivorship (MAPS) Program in 1989 (DeSante et al. 1995). MAPS is a cooperative effort among public agencies, private organizations, and individual bird banders in the U.S. and Canada to operate a network of about 500 standardized, constant-effort mist-netting and banding stations during the breeding season. The principal goals of MAPS are (1) to monitor the vital rates and population dynamics of over 100 species of resident and migratory landbirds (DeSante and O'Grady 2000); (2) to describe temporal and spatial patterns in the vital rates of target species (DeSante 2000), and relationships between those patterns and (a) population trends and ecological characteristics of the target species (DeSante et al. 1999) and (b) habitat and weather variables (Nott 2002); and (3) to use this information to identify the proximate demographic cause(s) of population trends in the target species (DeSante et al. 2001) in order to formulate and evaluate management guidelines and conservation strategies to reverse the population declines (Nott 2000).

Analyses of MAPS data show that low adult survival, rather than low breeding productivity, appears to be the proximate demographic cause of population decline for many migratory landbirds (DeSante et al. 2001, DeSante et al. in prep). Although mortality in landbirds occurs throughout the year, relatively high rates of mortality may often occur toward the end of the winter, when food resources are scarce and intra- and inter-specific competition is high. Habitat loss or degradation in such a competitive environment could result in dramatically lowered survival rates. Moreover, diminished late winter resources could increase mortality during the ensuing spring migration, when birds must cross hostile or unfavorable habitats, often under adverse weather conditions (Sillett and Holmes 2002, Bearhop et al. 2004). Either way, it is likely that low survival during the non-breeding season can be an important factor affecting population declines of migratory birds.

Another important result from MAPS suggests that conditions on the wintering grounds at the end of winter can play a major role in determining avian reproductive success on the breeding grounds (Nott et al. 2002). Again, the extent of this effect likely varies as a function of habitat quality on the wintering grounds. These findings agree with work that suggests that winter habitat quality affects the physical condition and spring departure schedules of American Redstarts, resulting in variable arrival dates and physical condition on temperate breeding grounds that can affect reproductive success (Marra et al. 1998, Norris et al. 2004). These studies provide evidence of an important link between events affecting adult birds on the wintering grounds and subsequent life cycle events, and both suggest that winter habitat may limit populations.

A growing body of evidence thus suggests that populations of many migratory birds may be limited by factors during the non-breeding season. Nevertheless, data on the overwintering ecology of most migratory species is severely limited. A variety of local-scale studies have shown that many neotropical-wintering migrants use a wide array of habitats in the tropics; even species thought to prefer relatively mature or undisturbed primary forest can be found in substantial numbers in secondary forest, forest edge, and other disturbed habitats (e.g., Greenberg 1992). Patterns of winter abundance in different habitats, however, like patterns of abundance in breeding habitats, can be a misleading indicator of habitat quality (Marra and Holmes 2001). Estimates of habitat-specific overwintering survival rates and indices of late winter physical condition may provide better measures of winter habitat quality. Moreover, because older adults and males may actively exclude first winter birds and females, respectively, from preferred habitats, such estimates and indices should also, if possible, be age- and sex-specific. Although habitat-, age-, and sex-specific data on overwintering survival rates and late-winter physical condition have been obtained for a few species on a local scale (e.g., Latta and Faaborg 2002, Siegel et al. 2004), data regarding these parameters are not available for most migratory landbirds. Such data are urgently needed to formulate and evaluate effective management plans to modify and preserve winter habitat so as to reverse the population declines of these species and maintain stable or increasing populations.

With an eye toward generating these urgently needed data, The Institute for Bird Populations (IBP), with financial support from the DoD Legacy Resources Management Program, developed a standardized winter-season mist-netting protocol and, in October 1998, established six prototype monitoring stations in four habitat types on Naval Station Guantanamo Bay, Cuba, which were operated for five winters, 1998-99 through 2002-03. IBP researchers then applied state-of-the-art, modified Cormack-Jolly-Seber (CJS) mark-recapture models to the standardized bird-banding data obtained from these stations and were able to estimate overwintering apparent survival for nine species of migratory wood warblers wintering on the installation (Siegel et al. 2004).

IBP researchers used the protocols developed at Guantanamo Bay to create the MoSI (Monitoreo de Sobrevivencia Invernal) Program, a cooperative, spatially extensive network of standardized mist-netting stations operated by agencies, organizations, and individual bird-banders in Mexico, Central America, and the Caribbean. The immediate objectives of MoSI are to monitor the overwintering survival and late-winter physical condition of Neotropical-wintering migratory birds in order to determine, for a larger suite of species, how these parameters vary as a function of time, space, and habitat (DeSante et al. in press b). The overall goal of the program is then to use these data to formulate winter habitat management and conservation strategies for declining Neotropical-wintering migratory birds. Since its establishment in 2002, MoSI has grown to about 60 stations that were operated during each of the past two winters.

Significant declines in migratory landbirds have not, however, been limited to Neotropical-wintering species. Examination of 37 years of data (1966-2002) from the North American Breeding Bird Survey (BBS; Sauer et al. 2004) indicates that a large number of temperate-wintering landbird species have shown significant declines as well. Many of these declining temperate-wintering species are associated with grassland, shrubland, and other early successional stage habitats. In fact, 26 (0.765) of 34 species of North American sparrows show continent-wide population declines, a proportion highly significantly greater than 0.50 (P=0.00). Moreover, no fewer than 17 of these 26 species exhibit significant (P<0.05) declines ranging from 0.5% per year (Song Sparrow) to 8.4% per year (Henslow's Sparrow). Indeed, the declines for 14 of these 17 species are highly significant (P=0.00). In marked contrast to the 17 significantly declining sparrows, only two of the eight increasing species showed significant (P<0.05) increases. Efforts to estimate overwintering survival rates and late-winter physical condition of these sparrow species, and to model those estimates as functions of habitat characteristics and weather, should be a high priority among avian conservation efforts in the United States.

Importantly, many of these declining species of sparrows are found on military installations in southeastern United States. Because extensive future management efforts to enhance military Readiness and Range Sustainment (R&RS) on these installations will create and modify substantial areas of successional-stage habitat, a unique opportunity will arise to integrate strategies for enhancing wintering habitat for these declining species into the management actions to enhance military R&RS. We suggest that optimal strategies for the conservation and management of avian winter habitat should be based on relationships between overwintering survival and late-winter physical condition and habitat characteristics. In order to obtain critical data to establish these relationships and develop these conservation strategies, The Institute for Bird Populations, with funding again from the DoD Legacy Resources Management Program, implemented the MoSI protocol at six Monitoring Avian Winter Survival (MAWS) stations on each of four DoD installations in southeastern United States during October and November 2003. Although the MoSI protocol was established for estimating the overwintering survival and late-winter physical condition of Neotropical-wintering migratory birds, we believed that it would also be useful for obtaining such information on temperate-wintering migratory birds, especially for species that prefer shrubland, riparian, and forest- or woodland-edge habitats. Obligate grassland species are difficult to capture with passive mist-netting efforts; they will likely require special protocols for monitoring their overwintering survival rates. These 24 MAWS stations have now been operated for two consecutive winters, 2003-04 and 2004-05. This report describes the 2004-05 operation of these stations and documents the results from the first two winters of operation.

METHODS

Re-establishment and Operation of Stations

We re-established 24 MAWS (Monitoring Avian Wintering Survival) stations on four military installations across southeastern U.S. during October 2004, at the exact same locations where they were first established and operated during the winter of 2003-04. Six stations each were located on Fort Chaffee, AR (Table 1a), Camp Joseph T. Robinson, AR (Table 1b), Fort Bragg, NC (Table 1c), and Fort Benning, GA (Table 1d). The MAWS stations on these DoD installations consisted of plots of about 20 ha in size, and were sited on each installation so as to encompass a wide range of the major shrubland and forest- or woodland-edge habitat types available for the most common species of wintering sparrows on the installation. The latitude-longitude, average elevation, and a brief description of the major habitat types present at each station are presented in Table 1.

MAWS stations established and operated in the United States utilize the MoSI (Monitoreo de Sobrevivencia Invernal) protocol (DeSante et al. in press b) which was developed for assessing and monitoring the overwintering survival and late-winter physical condition of Neotropical-wintering migratory birds. The MoSI protocol itself was developed and successfully used during a five-year (1998-99 through 2002-03) study, funded by the Legacy Resources Management Program, on Naval Station Guantanamo Bay, Cuba (Siegel et al. 2004). The MoSI protocol consists of five pulses two or three consecutive days of mist netting and banding, one pulse per month, during the five month overwintering period, November through March. For the purpose of standardization, this five-month overwintering period is broken down into five 30-day periods as follows:

Period 1: November 2-December 1;
Period 2: December 2-31;
Period 3: January 1-30;
Period 4: January 31-March 1; and
Period 5: March 2-31.

To accommodate time off for the Christmas/New Years' Day holidays, stations can be operated within the five-day grace periods before or after the scheduled dates of operation of each period.

An important goal of the MoSI protocol is to maximize the numbers of captures per unit effort expended. This is because increasing either the numbers of individual birds in the sample (number of capture histories), or the recapture probabilities of those birds, increases the precision of survival-rate estimates obtained through mark-recapture modeling. To achieve this goal, we attempted to operate sixteen 12-m-long, 30-mm-mesh mist nets at each station for six morning hours on each of three consecutive days during each of the five 30-day periods. If all 16 mist nets at each of the six stations on a given installation could be operated in this manner for during each of the five periods, a total of 1,728 net-hours could be accumulated on each installation during each of the five periods. It is impossible, however, to operate mist nets during inclement weather, such as that characterized by significant amounts of precipitation (anything more than a slight drizzle or light snow flurries), wind (anything over 15 knots), or extreme heat or cold (less than 23ºF with no wind), without potentially endangering the lives or welfare of the captured birds. Because winter weather in southeastern United States can typically be inclement or unsettled for extended periods, we set a very conservative guideline of one-third of the maximum number of net-hours per installation per period, 576 net-hours, as our goal for the first year of the study, and carefully monitored the welfare and apparent condition of the captured birds. We were pleased to discover, after our first winter of banding, that overall we amassed about 40% of the maximum number of net-hours and that, even then, we likely were being overly conservative regarding the bird safety. Accordingly, we increased our goal during our second winter of banding to 1,037 net-hours per installation per period, 60% of the maximum number of net-hours per installation per period.

Nets were opened each morning at local sunrise or as soon after as possible. The opening of nets was delayed on very cold mornings to up to an hour after local sunrise, when the temperatures began to rise. All nets were opened and closed and, if possible, checked in the same order on each day of operation and on each net check. Although constant-effort operation of nets is not required for mark-recapture analyses, and therefore was not required at MAWS stations, consistency of operation was considered a worthwhile goal, as heterogeneous capture probabilities can complicate mark-recapture modeling.

The operation of all stations during the winter of 2004-05 was accomplished by IBP field biologist interns, who were trained and supervised by IBP biologists Keith Doran, who supervised the Fort Chaffee and Camp Robinson operations, and Ron Taylor, who supervised the Fort Bragg and Fort Benning operations. The 2004 field biologist intern training session was held October 12-20 at Fort Chaffee, AR. In order not to induce net avoidance in any individual birds in this study or interfere with them in any way, we held our training session at two locations well removed from the actual Fort Chaffee MAWS stations. IBP staff biologist Kerry Wilcox ran the intern training session with help from IBP biologists Keith Doran and Ron Taylor. The 2004 training session went very well, with substantial numbers of birds captured, despite a few days of cold, rainy weather. By the end of the ten-day session, the field biologist interns, most of whom had previous banding experience, were well trained in mist-netting, banding, color-banding, and processing birds and in MAWS protocol. Kate Eldridge and Andrea Wuenschel set-up and operated the Fort Chaffee stations. Noel Dodge and Joanna Hubbard set-up and operated the Camp Robinson stations. The Fort Bragg stations were set-up and operated through December by Amber Jonker and Sara Kennedy and operated after December by Daniel Farrar and Amber Jonker. Finally, the Fort Benning stations were set-up and operated by Janet Lapierre and Andrea Lindsay.

Data Collection

All unmarked birds captured during the course of mist netting were banded with a uniquely numbered, USGS/Bird Banding Lab leg band, and the band numbers of all previously banded birds were carefully read. All birds captured were identified to species, age (first winter = hatching-year [before January 1]/second-year [after December 31] versus adult = after-hatching-year [before January 1]/after-second-year [after December 31]), and, if possible for that species, sex (Pyle 1997). Age determinations were based on the presence of molt limits and plumage characteristics and, to a lesser degree and generally only during the early winter, on the extent of skull pneumaticization, the extent, if any, of body and flight-feather molt, and the extent of primary-feather wear. The unflattened wing chord of each bird captured was measured to the nearest mm, the body mass of each individual captured was determined on every capture to 0.1 g using a portable battery-operated electronic balance, and the fat class of each individual was determined. Birds were released immediately upon capture (before being banded and processed) if situations arose where bird safety would be comprised. Such situations involved exceptionally large numbers of birds being captured at once, or the sudden onset of adverse weather conditions such as strong winds or sudden rainfall. Banding data also included the date and time of capture as well as the station and net number at which the bird was captured.

Individuals of six focal sparrow species (Field, Fox, Song, Swamp, and White-throated sparrows and Dark-eyed Junco) were color-banded with a unique combination of two plastic color bands on one leg and one plastic color band and the Bird Banding Lab metal band on the other leg. Variable, but substantial, effort was expended during each period searching for and recording the exact location of color-banded birds. All resightings of color-banded birds were treated as recaptures.

Effort data, i.e., the number and timing of net-hours (recorded to the nearest ten minutes) on each day of operation, were also collected in a standardized manner. All species seen or heard on the study plot during the course of the mist netting effort each day (even if not captured) were recorded by methods similar to those used in bird atlas projects so that the residency status (confirmed resident [from recapture data], probable resident, visitor) of each species could be determined.

Finally, extensive habitat structure assessment (HSA) data were collected at each station during the February period when resources were thought likely to be at a minimum. MAWS HSA data included (1) a detailed station map that identified the major habitats present at the station and delineated their boundaries; (2) quantitative estimates of the % cover and average height, and a listing major plant species present in each of four vegetative layers, canopy, subcanopy, shrub, and ground cover; and (3) a detailed description of each major habitat type that included information on the successional stage and/or age of the habitat, the moisture regime and presence of water, the homogeneity of the vegetative cover, characteristics of the edges between habitat types, and both the natural and human-caused disturbance regime and management history.

Computer Data Entry and Verification

The computer entry of all banding data was completed by John W. Shipman of Zoological Data Processing, Socorro, NM. 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. Computer entry of effort, winter residency, and HSA data was completed by IBP biologists using specially designed data entry programs. All 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 numerical information in all banding, effort, winter residency, and HSA data;

(2) Cross-check programs to compare station, date, and net information in the banding and effort data;
(3) Within-record verification programs to compare species, age, and sex determinations in the banding data against molt limits and plumage characteristics, degree of skull pneumaticization, and extent of body and flight-feather molt and primary-feather wear;
(4) Between-record verification programs to screen banding and recapture data from all days of operation for inconsistent species, age, or sex determinations for each band number; and
(5) Screening programs to identify unusual or duplicate band numbers or unusual band sizes for each species.

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

Data Analysis

Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992), using data from three to five (depending on station) two- or three-day pulses of mist netting (one during each of the five 30-day capture periods defined above) during the winter of 2003-04 and five pulses during the winter of 2004-05 were conducted for each of 25 target species. Target species were defined as those for which, for at least one of the four installations, an average of at least 2.5 individuals per period were captured (i.e., 25 period-unique captures were recorded) during the winter of 2004-05 from all stations pooled on the installation, *and* for which at least three between-period recaptures (returns) were recorded on that installation. A return is defined as the first recapture of a bird at a given station during a given period that was banded at the same station during a previous period.

We used the computer program MARK (White and Burnham 1999) to model mark-recapture data and calculate, for each target species, maximum-likelihood estimates and standard errors (*SE*s) for monthly apparent survival rates (ϕ) and recapture probabilities (p). Apparent survival rate is defined as the probability of a bird marked (banded) at a given station in a given monthly (30-day) period surviving to the next monthly period and remaining at the same station. The complement (lack) of apparent survival thus includes both mortality and emigration, and CJS mark-recapture models cannot distinguish between the two. Recapture probability is defined as the conditional probability of recapturing (or resighting) a bird at a station in a subsequent month that was banded at the station in a previous month, given that it survived and remained at the station at which it was originally banded. A minimum of three capture sessions are required to estimate recapture probability and, because recapture probability must be estimated in order to estimate apparent survival rate, at least three capture sessions are required in order to estimate apparent survival rate. By including two winters of data, each of the six stations on each of the four installations were operated for between eight and ten capture sessions (periods).

The presence of transient individuals (dispersing, floating, and late fall or early spring migrating individuals) in the sample of newly captured birds tends to bias apparent survival rates and/or recapture probabilities low, because they are only captured once and never recaptured. Pradel et al. (1997), Nott and DeSante (2002), and Hines et al. (2004) have developed and discussed the use of both between- and within-year transient models ($\phi p \tau$) that provide survival estimates that are unbiased with respect to transient individuals, and allow for estimation of the proportion of residents among newly captured birds (τ). Extensive analysis of MAPS data (Nott and DeSante 2002) has shown that transient models are usually chosen over non-transient models by information-based (AIC) model-selection techniques (Burnham et al. 1995, Anderson and Burnham 1999), provided that there are sufficient data to allow for the estimation of the added parameters. At the very minimum, at least four capture periods are required to utilize a between-period transient model (Pradel et al. 1997). Again, by including two winters of data, each of the six stations on each of the four installations fulfilled this requirement.

We conducted our analyses to examine the effects of year, location (installation), and habitat characteristics (at the station level) on apparent monthly survival. With only two years of banding data and many potential habitat variables to choose from, we limited our analyses to consideration of just two composite habitat variables. These two variables were created by (1) calculating station-level weighted averages for six of the original habitat variables (weights were the proportions of each major habitat type present at a station), (2) performing a principal components analysis (PCA) on these six habitat variables, and (3) extracting principal components scores for each station along the first two axes of the PCA. The first two PCA axes accounted for 71% of the variation in the original six habitat variables, suggesting that they captured most variation in habitat structure among stations. In addition to reducing the dimensionality of the habitat data, the creation of the two composite habitat variables enabled us to analyze many strongly correlated habitat variables simultaneously (Pearson's correlation coefficients from pairwise correlations among the original variables ranged from 0.15 to 0.71). The original habitat variables and their relative contributions to the two PCA axes are presented in Table 2.

Following Burnham et al. (1987) and Burnham and Anderson (1998), we first created *a priori* sets of CJS models based on our knowledge of avian biology and on limitations inherent in the dataset. Because we have only two years of data, we did not attempt to model survival simultaneously as a function of location (installation) and habitat characteristics (station), but rather conducted two sets of analyses. The *a priori* sets of candidate models for these two analyses are listed in Tables 3 and 4, respectively. In the first, we modeled ϕ as a function of year, location (installation), and location*year. In the second, we modeled ϕ as a function of year, habitat principal component 1, habitat principal component 2, habitat principal component 1*year, and habitat principal component 2*year. Again, because of the limited number of years of data, we did not attempt to model ϕ simultaneously as functions of habitat principal component 1 and habitat principal component 2. Because eight months elapsed between the final capture session (March) of the winter of 2003-04 and the first capture session (November) of the winter of 2004-05, and those eight months included spring migration, the breeding season, the pre-basic molting period, and fall migration, we always modeled apparent survival rate as a function of season, where monthly survival rates between November and March (overwintering survival) were allowed to differ from monthly survival rates between March and November. In addition, in each analyses, we modeled survival both with and without Pradel et al.'s (1997) transient modification.

We modeled recapture probability (p) the same in each analysis. In the most generalized model, we modeled p as a function of location (installation), year, and month. In this model, p was allowed to have a different value for each of the ten capture sessions at each installation, a total of 40 parameter values. Reduced parameter models then included p varying as a function of location only, year only, month only, location*year, location*month, and year*month. In the most reduced parameter model, p was constant over all locations, years, and months. Thus there were always eight model parameterizations for p. There were also eight model parameterizations for ϕ in the first analysis, thus yielding a total of 64 candidate models for each species in the first analysis. There were, however, 12 model parameterizations for ϕ in the second analysis, thus yielding a total of 96 candidate models for each species in the second analysis.

Model selection methods based on Akaike's Information Criterion (AIC) (Burnham & Anderson 1998) were used to assess the evidence for transient, year, and location (installation) effects on apparent monthly survival in the first analysis, and evidence for transient, year, habitat principal component 1, and habitat principal component 2 effects on apparent monthly survival in the second analysis. Models in each candidate set were first ranked by second-order AIC differences (Burnham & Anderson 1998) and adjusted by the "c-hat" obtained from the bootstrap goodness-of-fit test included in Program MARK to insure conservative model selection (Cooch and White 2002). The c-hat adjustment corrects AICs for over-dispersion of data and creates the values of $QAIC_C$ to be used in model selection. The c-hat was calculated by dividing the observed deviance by the mean deviances of the simulated model. Separate analyses of the goodness-of-fit test, and hence c-hat values, were applied to the each of the two analyses, as the data sets were different from each other.

The relative likelihood of each model in each of the candidate sets was estimated with $QAIC_C$ weights (w_i; Burnham & Anderson 1998). A model averaging procedure was used to provide the best estimates of survival and recapture probabilities from all models in a candidate set (e.g., the survival estimate(s) on Fort Bragg). Model averaging is based on w_i values for each model and thus includes model selection uncertainty in the estimate of each parameter and its associated variance (Burnham & Anderson 1998). Statistical support for transient, year, and location effects on survival in the first analysis, and for transient, year, habitat principal component 1, and habitat principal component 2 effects on survival in the second analysis (and for location, year, and month effects in recapture probability) was assessed by summing the w_i for all models in which a parameter of interest occurred. This method of multi-model inference enabled us to use the entire set of candidate models to judge the importance of a parameter to survival rate, rather than basing conclusions on a single best-fit model.

RESULTS

Details of station operation are presented in Table 1a-d for each MAWS station on each of the four military installations in southeastern U.S. on which stations were operated during the winter of 2004-05. The order of presentation of stations on each installation generally proceeds from those characterized by more open habitats to those characterized by more closed habitats. A total of 25,036.3 net-hours was accumulated on the MAWS Program on the four military installations in southeastern United States during the winter of 2004-05, twice the number that were accumulated on these four installation last winter (12,463.4 net-hours). We were pleased to have met or exceeded our goal of 60% of the maximum number of net-hours per period per installation on all four installations: 1,244.6 (72.0%) at Fort Chaffee, 1,275.1 (73.8%) at Camp Robinson, 1,043.8 (60.4%) at Fort Bragg, and 1,443.8 (83.6%) at Fort Benning; 1,251.8 (72.4%) overall. Histograms of the total net-hours by station and intended period are presented for each of the four installations for which data could be used for survivorship analyses in Figure 1. With few exceptions, numbers of net-hours were relatively constant over the five periods at all four installations, the most notable exception being a relatively high number of net-hours at Camp Robinson in November.

The 2004-05 capture summary of the numbers of newly-banded, unbanded, and recaptured birds is presented for each species and all species pooled at each of the six stations and for all stations pooled on each of the four military installations in southeastern United States in Table 5a-d. A total of 1,643 captures of 37 species was recorded at the six MAWS stations operated on *Fort Chaffee* during the winter of 2004-05 (Table 5a), of which 1,027 were newly banded individuals, 529 were recaptures of some of those individuals, and 87 were individuals that were captured but, because of exceptionally large numbers of birds being captured at once or the sudden onset of adverse weather conditions, were released unbanded. This represents a 20.6% decrease in the total number of captures (but a 5.7% increase in the number of species captured) during the winter of 2004-05 as compared to the winter of 2003-04, despite a 38.0% increase in the total number of net-hours accumulated at Fort Chaffee during 2004-05 compared to 2003-04; thus, a 42.5% *decrease* between the two winters in birds captured per 100 net-hours (b/100nh) from 45.9 to26.4.

A total of 2,141 captures of 41 species were recorded at the six MAWS stations operated on *Camp Robinson* during the winter of 2004-05 (Table 5b), of which 1,304 were newly banded individuals, 700 were recaptures of some of those individuals, and 137 were individuals that were captured but released unbanded. Although this represents a 134.8% increase in the total number of captures (and a 32.7% increase in the number of species captured) during the winter of 2004-05, there was a 383.1% increase in the total number of net-hours accumulated at Camp Robinson during 2004-05; thus, there was a 51.4% *decrease* between the two winters in birds captured per 100 net-hours (b/100nh) from 69.1 to33.6.

A total of 2,722 captures of 40 species was recorded at the six MAWS stations on *Fort Bragg* during the winter of 2004-05 (Table 5c), of which 1,797 were newly banded, 661 were recaptures, and 264 were released unbanded. While this represents a 78.6% increase in the total number of captures (but no change in the number of species captured) during the winter of 2004-05, there was also a 60.3% increase in the total number of net-hours accumulated at Fort Bragg during 2004-05. However, because the increase in net-hours was less than the increase in birds captured, Fort Bragg saw an 11.5% *increase* between the two winters in birds captured per 100 net-hours (b/100nh) from 46.8 to 52.2.

A total of 3,070 captures of 56 species was recorded at the six MAWS stations on *Fort Benning* during the winter of 2004-05 (Table 5d), of which 2,112 were newly banded, 914 were recaptures, and 44 were released unbanded. This represents a 205.8% increase in the total number of captures (and a remarkable 69.7% increase in the number of species captured) during the winter of 2004-05. There was also a 113.7% increase in the total number of net-hours accumulated at Fort Benning during 2004-05. Again, however, because the increase in net-hours was less than the increase in birds captured, Fort Benning saw a 43.1% *increase* between the two winters in birds captured per 100 net-hours (b/100nh) from 29.7 to 42.5.

In summary, winter bird populations in Arkansas (as determined by capture rates at the MAWS stations located on the two military installations in Arkansas) appeared to undergo a substantial drop of nearly 50% between the winters of 2003-04 and 2004-05, while winter bird populations farther east tended to increase somewhat between the two winters, especially at the more southerly location of Fort Benning. Altogether, a total of 9,576 captures was recorded during the winter of 2003-04, of which 6,240 were newly banded, 2,804 were recaptures, and 532 were released unbanded. Thus, while there was 73.8% increase in the total number of captures over the entire program during the winter of 2004-05, the 100.9% increase in the total number of net-hours was even greater; thus, overall, there was a 13.5% *decrease* between the two winters in birds captured per 100 net-hours (b/100nh) from 44.2 to 38.3.

We evaluated the effectiveness of color-band-resighting as a means of generating recapture data for our mark-recapture analyses for the six sparrow species color banded during winter 2004-05 (Table 6). Overall, at least one return (the first recapture in a period of an individual originally banded in a previous period) was recorded by means of a recaptured bird for 538 (19.4%) of the 2,777 individuals of these six species that were banded. This percentage varied among the six species from a low of 6.6% for Fox Sparrow to a high of 31.4% for Swamp Sparrow, and averaged 17.8% for the six species. In contrast, at least one return of a color-banded bird that was never recaptured was made by means of a resighted bird for only 72 (4.0%) of the 1,801 individuals of these six species that were color banded. This percentage varied among the six species from lows of 0.0% for Fox Sparrow and 0.8% for Swamp Sparrow to a high of 9.2% for White-throated Sparrow, and averaged 3.3% for the six species. Thus, resighting birds was considerably less efficient than recapturing them as a means of generating returns. Interestingly, however, only 4 of the 76 individuals that were ever resighted were ever recaptured. The remaining 72 resighted individuals were never resighted. Thus, 11.8% of all returns were generated only by resighting. This proportion, however, varied substantially among the six species from lows of 0.0%, 1.7%, and 3.6% for Fox, Swamp, and Field sparrows, respectively, to highs of 15.6%, 15.9%, and 23.8% for White-throated Sparrow, Dark-eyed junco, and Song Sparrow, respectively.

Apparent Survival-Rate Estimates
A total of 25 species met the requirements for survivorship analyses at one or more of the installations (at least 25 period-unique encounters from all stations pooled on the installation and at least three between-period returns recorded on the installation), and were designated as target species. The number of individuals captured (i.e., the number of capture histories), the total number of captures, and the number of returns are presented in Table 7 for each of the 25 target species at the each of the four military installations. As outlined in the Methods, we estimated monthly apparent survival rates for these 25 target species through two different analyses.

A. Analysis 1. We investigated transient effects on apparent survival rate, month effects on recapture probability, and year effects on both survival and recapture probabilities for all 25 target species, and investigated the location (installation) effects on survival and recapture probabilities for the 17 target species that were captured in adequate numbers at more than one installation (Tables 8 and 9). Strong evidence ($w_i > 0.4$) for effects of transients on apparent survival rate was found for 10 of the 25 target species (Table 8), with overwhelmingly strong evidence ($w_i > 0.97$) being found for five species (Ruby-crowned Kinglet, Hermit Thrush, Yellow-rumped Warbler, Common Yellowthroat, and White-throated Sparrow), all of which are migratory. The remaining species for which strong evidence for the effects of transients was found included Carolina Wren, Northern Mockingbird, Field Sparrow, and Swamp Sparrow. Weak evidence ($0.3 \geq w_i > 0.2$) for the effects of transients was found for two species and very weak or essentially no evidence ($0.2 \geq w_i$) was found for the remaining 13 species.

Strong evidence for year effects on survival was found for nine of the 25 target species (Table 8), with very strong evidence ($w_i > 0.87$) being found for five species (Ruby-crowned Kinglet, Hermit Thrush, Common Yellowthroat, White-throated Sparrow, and Dark-eyed Junco). Interestingly, strong evidence for the effects of transients was also obtained for four of these five species. The remaining species for which strong evidence was found for year effects on survival included Eastern Towhee, Field Sparrow, Swamp Sparrow, and Northern Cardinal. Again, strong evidence for the effects of transients was also obtained for two of these four species. Interestingly, model-averaged apparent survival estimates were substantially (or sometimes dramatically) higher during the winter of 2003-04 than during the winter of 2004-05 for all nine of these species at all locations for which survival was estimated except for White-throated Sparrow at Fort Bragg and Eastern Towhee at Fort Benning, for which survival during 2004-05 appeared to be higher than during 2003-04 (Table 10). Moderate evidence ($0.4 \geq w_i > 0.3$) for year effects on survival was obtained for four species, weak evidence was obtained for 11 species, and very weak or essentially no evidence was found for only one species, Yellow-rumped Warbler. Survival during the winter of 2003-04 tended to be higher than during the winter of 2004-05 for seven of these 16 species, the reverse for another seven species, and about equal during the two winters for two species (Table 10).

Strong evidence for location (installation) effects on apparent survival rate was found for only two of the 17 species (Tufted Titmouse and White-throated Sparrow) for which location effects could be modeled, while moderate evidence was found for three additional species (Eastern Towhee, Chipping Sparrow, and Field Sparrow), and weak evidence was found for Song Sparrow (Table 8). Very weak or essentially no evidence for location effects on apparent survival rate was found for the remaining 11 species. Interestingly, patterns of apparent survival among locations were similar for Tufted Titmouse and White-throated Sparrow, the two species with strong evidence for a location effect: apparent survival for both species was highest at Fort Chaffey or Camp Robinson, lower at Fort Bragg, and lowest at Fort Benning (Table 10). A similar pattern was found for Chipping Sparrow, with higher survival at Fort Bragg than Fort Benning, but the opposite pattern was found for Eastern Towhee, Field Sparrow, and Song Sparrow, with higher survival at Fort Bragg and Fort Benning than at Fort Chaffee and Camp Robinson (Table 10).

Model-averaged time-constant overwintering monthly apparent survival rates (Table 10) varied substantially among species. The highest apparent overwintering monthly survival rates ($\phi > 0.9$ during both winters at all installations where survival could be estimated) were found for three permanent resident species, Blue Jay, Carolina Chickadee, and Northern Cardinal, and one partially migratory species, Brown Thrasher. (The high estimates also shown for Eastern Bluebird may not be valid because of the preponderance of estimates of 1.0 with a standard error of 0.0.) Several species, including Eastern Phoebe, Carolina Wren, Hermit Thrush, Common Yellowthroat, Field Sparrow, Song Sparrow, and White-throated Sparrow had overwintering monthly apparent survival rates that averaged from about 0.85 to 0.90. Apparent survival rates for Tufted Titmouse, Ruby-crowned Kinglet, Gray Catbird, Northern Mockingbird, Eastern Towhee, Chipping Sparrow, Swamp Sparrow, and Dark-eyed Junco averaged somewhat lower, generally between about 0.75 and 0.85. Apparent overwintering monthly survival rates for the remaining five species, Golden-crowned Kinglet, Yellow-rumped Warbler, Pine Warbler, Savannah Sparrow, and Fox Sparrow, tended to average below about 0.75. The low apparent survival rates of these last five species may reflect a relative lack of site-persistence during winter. In addition to having low apparent survival-rates, however, estimates for these latter five species had large standard errors (SEs) and coefficients of variation ($CV(\phi) > 20\%$) and, thus, poor precision.

Recapture probabilities for each of the 25 target species is presented as a function of location (installation) and time (month and year) in Figure 2. Strong year effects on recapture probability were found for nine of the 25 target species (Blue Jay, Ruby-crowned Kinglet, Hermit Thrush, Yellow-rumped Warbler, Common Yellowthroat, Eastern Towhee, Field Sparrow, White-throated Sparrow, and Dark-eyed Junco), while moderate year effects were found for four species and weak year effects were found for 11 species (Table 9). The preponderance of year effects on capture probability is perhaps not surprising since the total mist-netting effort per period was nearly twice as high during the winter of 2004-05 as the winter of 2003-04. Nevertheless, higher recapture probabilities among the nine species that showed strong year effects did not always occur during 2004-05. Recapture probabilities for Eastern Towhee and Field Sparrow, for example, seemed to be higher during 2003-04 than during 2004-05 (Fig. 2). Strong month effects on recapture probability were found for only two migratory species, Ruby-crowned Kinglet and Dark-eyed Junco; they showed pronounced but seemingly inconsistent monthly variation in recapture probabilities (Fig. 2). Moderate and weak month effects on recapture probability were shown by one and three species respectively, while the remaining 19 species showed very weak or no monthly effects on recapture probability.

Strong location (installation) effects on recapture probability were found for six (Brown Thrasher, Yellow-rumped Warbler, Eastern Towhee, Chipping Sparrow, Field Sparrow, and White-throated Sparrow) of the 17 species for which location effects could be analyzed, while moderate and weak location effects on recapture probability were shown by two and three species respectively (Table 9). No consistent patterns of variation by location among these species were readily evident (Fig. 2), although recapture probabilities at Fort Chaffee sometimes appeared noticeably higher or lower than at other locations.

Overall, recapture probabilities for the various species were low and relatively consistent among species, averaging about $p = 0.2$ or less (Fig. 2). Eastern Phoebe, Blue Jay, and Eastern Bluebird had particularly low recapture probabilities, perhaps indicating the relative difficulty of capturing them. Chipping Sparrow also showed a very low recapture probability which, however, may better reflect the species low site-persistence and flocking behavior. In contrast, Ruby-crowned Kinglet, Hermit Thrush, and Eastern Towhee at Camp Robinson during 2003-04, and White-throated Sparrow at Fort Bragg and Camp Robinson showed recapture probabilities that were substantially above 0.2. Standard errors of recapture probabilities (Fig. 2) were generally fairly low for Blue Jay, Carolina Chickadee, Tufted Titmouse, Carolina Wren, Eastern Bluebird, Chipping Sparrow, Song Sparrow, Swamp Sparrow, and Northern Cardinal than for the remaining species (Fig. 2).

<u>B. Analysis 2</u>. Based on the second (habitat) set of analyses, we found strong (QAICc weight > 0.4) transient or year effects on survival rates for 11 of the 25 (44%) target species (Table 11). Most species that displayed evidence of transient or year effects on survival in the first (location) set of analyses (70% and 78% respectively; compare Tables 8 and 11) also showed evidence of these effects in the second set of analyses. In addition, two species (Chipping Sparrow and Dark-eyed Junco) showed evidence of transient effects in the second set of analyses, while exhibiting no such evidence of these effects in the first set of analyses.

Strong habitat effects on survival rate were apparent for eight of the target species (Table 11). Summed QAICc weights for models that included principal component (PC) 1 suggested that habitat features associated with this axis were important in affecting the survival of both Carolina Wrens ($w_i = 0.76$) and Dark-eyed Juncos ($w_i = 0.43$). The true nature of this relationship, however, was only clear for Carolina Wrens, for which overwintering survival (both in 2003-04 and 2004-05) tended to be highest at stations with greater canopy and subcanopy cover, lower shrub cover, and in habitats in later successional stages (Fig. 3; refer to Table 2 for PC definitions). Six species showed evidence of effects of habitat features associated with PC 2 on survival. As was the case for PC 1, however, the nature of this relationship was only easily interpretable for the species that showed the strongest evidence of this habitat effect (Fig. 4). In particular, the over-summer 2004 and overwintering 2004-05 survival of Field Sparrow (which had the highest summed QAICc weights for models including PC 2; $w_i = 0.97$) showed a negative relationship with PC 2. That is, individuals of this species survived (or persisted at the site) better at stations with higher ground cover and lower shrub and canopy cover. In contrast, Swamp Sparrows (which had the second highest summed QAICc weights for models including PC 2; w_i = 0.69) tended to survive (or persist) better at sites with greater shrub and canopy cover and low levels of ground cover.

Levels of support for the hypothesis that recapture probability varied among locations were similar between the first and second sets of analyses for most species (compare Tables 9 and 12). Three species, Yellow-rumped Warbler, Eastern Towhee, and White-throated Sparrow showed very strong evidence of a location effect on recapture probability in both cases (all had w_i > 0.69 in both sets of analyses). In each of these three species, location-effects were complex and complicated by strong year effects on recapture probability (Fig. 5). With very few exceptions, support for year and month effects on recapture probability were nearly identical between the first and second sets of analyses. Eight species showed strong year effects, while two species showed strong month effects in both sets of analyses. As was found in the first set of analyses, recapture probability estimates from the second set were generally low for all species (most around 0.2 or lower).

DISCUSSION

Banding effort at MAWS stations was much more consistent and complete across each of the five banding periods in 2004-05 than in 2003-04 as a result of both more consistently mild weather (warmer and drier) and having completed all station relocations during the previous winter. Overall, effort goals (60% of the maximum attainable) were met or exceeded at each of the four military installations in 2004-05. This increased effort paid off by providing sufficient data for very precise estimation of survival rates (as indicated by low coefficients of variation [CVs]; see Table 10) and the consequent detection of location-, time-, or habitat-related variation in survival rates for many species. Our ability to detect such effects and to build more complicated survival models will be enhanced with additional years of study (five additional capture sessions added each year). We anticipate that by the completion of the four-year pilot study, data will be adequate to provide habitat management recommendations that (if implemented) will enhance the overwintering survival (and population health) for a number of species of concern.

Only two species showed strong support for location effects on survival (Tufted Titmouse and White-throated Sparrow); and only one of these, White-throated Sparrow, did not also show strong support for habitat effects (which may likely have explained at least some of the location effects for Tufted Titmouse). The pattern of survival among seasons and locations for White-throated Sparrow was complicated, although it tended to be lower at Forts Bragg and Benning and higher in Arkansas. Many more species showed support for habitat effects than showed location effects on survival.

Of the eight target species showing strong support for habitat effects on survival, Field Sparrow is suffering the most serious population declines. We were pleased that our first efforts at modeling the winter survival of this species as a function of habitat produced very interesting results. This species, which was widely distributed among the 24 MAWS stations, seems to require (at least in some years) primarily early successional habitat to persist at a site through winter (and possibly between winters). The highest station-level estimated survival for this species during winter 2004-05 (and over-summer) was at the Molnar Range station of Fort Benning, which had very few canopy trees (0.89%), relatively low but still substantial (28%) shrub cover, and very high levels of ground cover (88%). Other species for which we found interpretable habitat effects (e.g., Carolina Wren, Swamp Sparrow) are not currently experiencing range-wide population declines and thus would not warrant management or conservation action (at least at this time).

Although modeling survival rates as a function of habitat variables is perhaps the single most important objective of the MAWS program, another important component of our efforts is the tracking of temporal variation in the survival of target species. Seven of our target species showed strong evidence (in at least one of the two sets of survival analyses) of differences in monthly overwintering survival rates between years. Survival rate estimates for each of these species declined between the winters of 2003-04 and 2004-05. This reduction in survival (or site persistence) may reflect winter climatic differences between years (although differences in summer climate and productivity between years could also have played some role). In particular, relatively high levels of precipitation in the Northeast and Midwest in winter 2004-05 (based on National Climate Data Center data; www.ncdc.noaa.gov) may have produced a higher than normal influx of wandering individuals moving to more southerly wintering areas during that year. Because these individuals may have been less likely to be site persistent (as suggested by a greater proportion of species with strong support for transient survival models in 2004-05 than in 2003-04), they may have contributed to lowered apparent survival rate estimates during the winter of 2004-05. Indeed, the hypothesis that there was a large influx birds to wintering areas with milder climate in 2004-05 was also supported by an increase in capture rates at the more southerly or eastern installations (Forts Bragg and Benning) and a decrease in capture rates at the more northerly and interior Arkansas installations.

An important addition to MAWS field work in 2004-05 was the inclusion of color-banding and resighting efforts for six sparrow species. Although numbers of returns of these species (between-pulse recaptures) detected only by resighting (and not recapture) were few for all species except Song Sparrow (which had the highest return rate by resighting only at 9.2%), at least two additional species, White-throated Sparrow and Dark-eyed Junco, showed some evidence of higher recapture rates in 2004-05 than in 2003-04 (see Tables 8 and 12 and Figs. 2 and 5), which may have been due to resightings. Thus, we recommend that color-banding and resighting activities be continued in 2005-06, at least for those three species.

Summary

The 2004-05 MAWS field season was remarkably successful: effort goals were met, substantial numbers of new birds were banded, and many recaptures were recorded. Basic station-level habitat data were also collected, and post-field-season data analyses utilizing simple linear mark-recapture models showed evidence of habitat effects on overwintering apparent survival for a number of target bird species (including at least some species experiencing range-wide population declines [e.g., Field Sparrow]). We plan on collecting additional mark-recapture data during the winters of 2005-06 and 2006-07 and incorporating them into more complex habitat (and perhaps climate) models (which may include landscape-level, as well as station-specific, habitat variables). These models will enable us to meet our goal of formulating management guidelines for reversing declines of the target species. Following the 2006-07 season, we will seek opportunities to incorporate our guidelines into management actions designed to enhance military Readiness and Range Sustainment. In this way, installation managers will be able to simultaneously enhance both the military mission and the natural resources (landbird habitat) of the installations.

Benefits to the Military

DoD military lands represent a crucial network of important habitats for many declining species of both Neotropical- and temperate-wintering migratory birds, which themselves serve as sensitive indicators of the health of habitats and ecosystems. Because wise stewardship of DoD lands can allow mission activities and natural resource conservation to coexist, the DoD has become a major cooperating partner in the Neotropical Migratory Bird Conservation Initiative, Partners in Flight (PIF), and in the North American Bird Conservation Initiative (NABCI).

The opportunity to enhance both the military mission and natural resource conservation is especially pronounced with respect to the grassland, shrubland, and edge habitats that are often created and maintained in an early successional stage as part of the training missions of DoD installations.

Populations of many early successional stage landbird species, including many sparrow species that winter on DoD installations in southern United States, are in serious decline. The critical conservation needs of these species have only recently become appreciated. Other critical needs that have only recently been identified are the pressing need to mitigate the adverse impacts of encroachment on DoD lands and the need to enhance military readiness and range sustainment (R&RS) on DoD installations. These needs will result in many new land management actions that will be proposed and implemented over the next several years, land management actions that, if conducted optimally, have the potential to positively affect many declining species of landbirds that require early successional stage habitats. The coincidence in the timing of these two needs, a pressing need for land management and the conservation needs of early successional stage landbird species, provides a unique opportunity for simultaneously enhancing both the military mission and its R&RS on these installations and the landbird populations that depend on them.

The ultimate goals of the DoD's PIF and NABCI efforts are twofold: 1) to implement research and monitoring projects aimed at determining the causes of population declines in migratory birds and identifying management actions to reverse the declines; and 2) subsequently to use this information to manage its lands in such a manner as to benefit populations of these birds. The MAWS Program on DoD installations in southeastern United States will contribute significantly to both of those goals. First, it will provide critical information on the manner in which landscape-level habitat conditions that result from land-management decisions, such as the successional stage of the habitat, the amount of shrubland cover and edge, and the degree of fragmentation, affect the overwintering survival and late-winter physical condition of declining landbird species that winter on the installations. Overwintering survival and late-winter physical condition appear to be key factors in driving the population declines. Thus, information on relationships between these factors and landscape-level habitat conditions is exactly what is needed to make optimal land-management decisions that can balance the installation's mission activities with natural resource conservation. Moreover, the information provided by this project will facilitate the development of pro-active management plans to reverse the population declines in the target species on the particular military installations studied and, by extension, on other installations with similar habitat types.

The development of landscape-scale models of overwintering survival and physical condition from the MAWS program on DoD installations complements ongoing efforts to implement avian management guidelines on DoD installations based on landscape-level models of productivity, adult population size, and probability of breeding from the MAPS Program. Indeed, the work proposed here fulfills the recent request by researchers and land managers throughout the PIF and NABCI network for work to be initiated on the wintering grounds of migratory birds to complement the work that has been completed or is ongoing on their breeding grounds.

The models and avian management guidelines that will result from this project will also provide important information to assist in the development of Integrated Natural Resources Management Plans (INRMP) for each installation. These are important management tools that aim to ensure that military operations and natural resources conservation are integrated and consistent with stewardship and legal requirements. Integration of the avian management guidelines that will result from this work with the INRMP planning process will enhance the installations' ability to conduct landscape-based natural resource management that is compatible with maintaining the military mission.

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Table 1a. Summary of the 2004-05 MAWS program on Fort Chaffee, AR.

Station					Avg	2004-05 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Elev. (m)	Total number of net-hours	No. of periods	Inclusive dates
Spizella	SPIZ	54403	Open grassland with islands of shrubland bordered by tall deciduous forest	35˚18'46"N,-94˚14'59"W	120	1279.3	5	11/02 - 03/03
Zonotrichia	ZONO	54401	Shrubby grassland bordered by pine forest Old field/shrubland	35˚18'06"N,-94˚15'27"W	130	1067.8	5	11/08 - 03/06
Junco	JUNC	54405	Old field/shrubland bordered by deciduous and juniper forest	35˚15'33"N,-94˚12'22"W	220	817.2	5	10/30 - 02/28
Passerella	PASS	54402	Wet old field/shrubland with pond	35˚16'00"N,-94˚07'46"W	140	1039.7	5	11/05 - 03/10
Pipilo	PIPI	54404	Mixture of old field/shrubland and woodland	35˚11'38"N,-94˚02'38"W	200	1069.8	5	11/15 - 03/18
Melospiza	MELO	54406	Shrubland encircled by deciduous forest with pond	35˚11'08"N,-94˚04'43"W	160	949.0	5	11/11 - 03/14
ALL STATIONS COMBINED						6222.8	5	10/30 - 03/18

Table 1b. Summary of the 2004-05 MAWS program on Camp Joseph T. Robinson, AR.

Station						2004-05 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of periods	Inclusive dates
New Bird	NEWB	54413	Wet grassland with interspersed trees	34˚57'00"N,-92˚22'15"W	85	888.2	5	11/14 - 03/13
POW Camp	POWC	54407	Old field/shrubland with riparian area	34˚51'45"N,-92˚18'15"W	115	1022.8	5	10/28 - 02/27
Mini Forest	MIFO	54408	Old field/shrubland with riparian woodland	34˚54'45"N,-92˚16'15"W	101	1067.2	5	11/01 - 03/02
Siamese	SIAM	54409	Edge between open field and shrubland/immature pine stands	34˚56'30"N,-92˚19'15"W	101	1006.7	5	11/05 - 03/06
PeeDee	PEED	54411	Wet grassland and edge of forest	34˚57'00"N,-92˚20'30"W	96	1155.5	5	11/08 - 03/16
Buck	BUCK	54412	Oak forest with dense understory and riparian areas	34˚55'30"N,-92˚19'15"W	96	1235.3	5	11/11 - 03/08
ALL STATIONS COMBINED						6375.7	5	10/28 - 03/16

Table 1c. Summary of the 2004-05 MAWS program on Fort Bragg, NC.

Station						2004-05 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of periods	Inclusive dates
Golf Course	GCOU	56618	Clear-cut grassy landscape with piles of brush/tree debris	35˚12'58"N,-79˚02'27"W	58	769.7	5	11/11 - 02/27
Dove Field	DOFI	56613	Open grassy fields divided by lines of deciduous trees and surrounded by pine forest	35˚11'46"N,-79˚13'59"W	88	773.7	5	11/20 - 03/11
Deer Pen Lake	DEER	56621	Wet old field/shrubland	35˚14'00"N,-79˚00'00"W	68	689.3	5	11/08 - 03/03
Holland Lake	HOLA	56615	Brushy open pine forest with sparse canopy	35˚10'25"N,-79˚17'38"W	NR[1]	966.0	5	11/29 - 03/15
Wolf Pit Creek	WOCR	56617	Pine forest with somewhat dense understory	35˚06'30"N,-79˚20'50"W	57	1099.0	5	11/05 - 03/14
Wildfire	WIFI	56614	Saturated bottomland hardwood forest	35˚10'00"N,-79˚08'11"W	70	921.3	5	11/02 - 03/12
ALL STATIONS COMBINED						5219.0	5	11/02 - 03/15

[1] Not recorded

Table 1d. Summary of the 2004-05 MAWS program Fort Benning, GA.

Station						2004-05 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of periods	Inclusive dates
Charlie Charlie 2	CC02	56619	Tall grassland with small riparian area, surrounded by deciduous woodland	32˚15'55"N,-84˚50'30"W	85	1291.0	5	11/16 -03/11
Charlie Charlie 3	CC03	56604	Brushy grassland surrounded by mixed bottomland forest.	32˚22'15"N,-85˚02'30"W	73	1125.7	5	11/05 -03/08
Molnar Range	MOLE	56602	Old field/grassland adjacent to mixed woodland with variable understory	32˚17'40"N,-84˚55'50"W	68	1169.7	5	10/28 -02/27
Yankee 2	YANK	56620	Old field/shrubland and decidous woodland with dense understory	32˚18'50"N,-84˚56'50"W	68	1207.7	5	11/09 -03/02
Victor 1	VICK	56603	Powerline corridor and adjacent open pine forest	32˚20'30"N,-84˚58'40"W	104	1375.0	5	10/31 -03/05
X-ray 5	XRAY	56601	Powerline corridor and adjacent open mixed forest	32˚15'35"N,-84˚54'45"W	82	1049.7	5	11/14 -03/14
ALL STATIONS COMBINED						7218.8	5	10/28 -03/14

Table 2. Relative contributions of the six habitat variables to the two principal component (PC) axes used in habitat analyses. PC 1 accounted for 51% of the variation in the original habitat data; PC 2 accounted for an additional 20% of the variation. Successional stage and the percent coverages of the canopy, subcanopy, and shrub layers were strongly correlated with one another and each contributed strongly (eigenvectors $\geq$0.40) to PC 1. PC 2 was most strongly defined by percent ground cover. Shrub and canopy cover variables contributed to PC 2 to a lesser degree.

	Eigenvectors (relative contribution to axes)	
Variable	PC 1	PC 2
Successional stage (ranges from 1 = early succ. to 5 = late succ.)	0.50	0.09
Percent canopy cover	0.44	0.46
Percent subcanopy cover	0.46	0.18
Percent shrub cover	-0.40	0.44
Percent ground cover	0.28	-0.72
No. snags in canopy	0.31	0.17

Table 3. Model parameterization of monthly apparent survival rate (ϕ) and recapture probability (*p*) for candidate models for the first and second seasons (2003-04 and 2004-05) of the Monitoring Avian Wintering Survival (MAWS) Program for the **analysis of the effects of location on survival and recapture probability**. Combinations of these parameterizations provide up to 64 candidate models for each species. Model notation follows Lebreton *et al.* (1992). See Methods for descriptions of variables.

Model parameterization of ϕ	Definition
ϕ_{season}	ϕ constant among locations (installations) and years but allowed to vary between seasons (winter vs spring/summer/fall)
$\phi_{season*location}$	ϕ allowed to vary among locations (installations) and between seasons (winter vs spring/summer/fall) but constant among years
$\phi_{season*year}$	ϕ constant among locations (installations) but allowed to vary among years and between seasons (winter vs spring/summer/fall)
$\phi_{season*location*year}$	ϕ allowed to vary among locations (installations), years, and between seasons (winter vs spring/summer/fall)
$\phi_{transient*season}$	ϕ constant among locations (installations) and years but allowed to vary between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population
$\phi_{transient*season*location}$	ϕ allowed to vary among locations (installations) and between seasons (winter vs spring/summer/fall) but constant among years and allows for transient individuals in the population
$\phi_{transient*season*year}$	ϕ constant among locations (installations) but allowed to vary among years and between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population
$\phi_{transient*season*location*year}$	ϕ allowed to vary among locations (installations), years, and between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population

Model parameterization of *p*	Definition
$p_{.}$	*p* constant among locations (installations), years, and by month
$p_{location}$	*p* allowed to vary among locations (installations) but constant by month and year
p_{year}	*p* constant among locations (installations) and by month but allowed to vary between years
$p_{location*year}$	*p* allowed to vary among locations (installations) and years but constant by month
p_{month}	*p* constant among locations (installations) and years, but allowed to vary by month, e.g. all December's are the same
$p_{location*month}$	*p* allowed to vary among locations (installations) and by month but constant between years, e.g. all December's are the same within a location
$p_{year*month}$	*p* constant among locations (installations) but allowed to vary by month and between years
$p_{location*year*month}$	*p* allowed to vary among locations (installations), by month, and between years

Table 4. Model parameterization of monthly apparent survival rate (ϕ) and recapture probability (*p*) for candidate models for the first and second seasons (2003-04 and 2004-05) of the Monitoring Avian Wintering Survival (MAWS) Program for the **analysis of the effects of habitat principal components on survival**. Combinations of these parameterizations provide up to 96 candidate models for each species. Model notation follows Lebreton *et al.* (1992). See Methods for descriptions of variables.

Model parameterization of ϕ	Definition
ϕ_{season}	ϕ constant among all stations and years but allowed to vary between seasons (winter vs spring/summer/fall)
$\phi_{season\ *\ station\ principle\ compoent\ \#1}$	ϕ is allowed to vary by station principal component #1[1] and between seasons (winter vs spring/summer/fall) but constant among years.
$\phi_{season\ *\ station\ principle\ compoent\ \#2}$	ϕ is allowed to vary by station principal component #2[1] and between seasons (winter vs spring/summer/fall) but constant among years.
$\phi_{season\ *\ year}$	ϕ constant among all stations but allowed to vary among years and between seasons (winter vs spring/summer/fall)
$\phi_{season\ *\ station\ principle\ compoent\ \#1\ *\ year}$	ϕ allowed to vary by station principal component #1[1] , years, and between seasons (winter vs spring/summer/fall)
$\phi_{season*\ station\ principle\ compoent\ \#2\ *\ year}$	ϕ allowed to vary by station principal component #2[1] , years, and between seasons (winter vs spring/summer/fall)
$\phi_{transient\ *\ season}$	ϕ constant among all stations and years but allowed to vary between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population
$\phi_{transient\ *\ season\ *\ station\ principle\ compoent\ \#1}$	ϕ allowed to vary by station principal component #1[1] and between seasons (winter vs spring/summer/fall) but constant among years and allows for transient individuals in the population
$\phi_{transient\ *\ season\ *\ station\ principle\ compoent\ \#2}$	ϕ allowed to vary by station principal component #2[1] and between seasons (winter vs spring/summer/fall) but constant among years and allows for transient individuals in the population
$\phi_{transient\ *\ season\ *\ year}$	ϕ constant among all stations but allowed to vary among years and between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population
$\phi_{transient\ *\ season*\ station\ principle\ compoent\ \#1\ *\ year}$	ϕ allowed to vary by station principal component #1[1] , years, and between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population
$\phi_{transient\ *\ season*\ station\ principle\ compoent\ \#2\ *\ year}$	ϕ allowed to vary by station principal component #2[1] , years, and between seasons (winter vs spring/summer/fall) and allows for transient individuals in the population

Table 4. (cont.) Model parameterization of monthly apparent survival rate (ϕ) and recapture probability (*p*) for candidate models for the first and second seasons (2003-04 and 2004-05) of the Monitoring Avian Wintering Survival (MAWS) Program for the **analysis of the effects of habitat principal components on survival**. Combinations of these parameterizations provide up to 96 candidate models for each species. Model notation follows Lebreton *et al*. (1992). See Methods for descriptions of variables.

Model parameterization of *p*	Definition
$p_{.}$	*p* constant among locations (installations), years, and by month
$p_{location}$	*p* allowed to vary among locations (installations) but constant by month and year
p_{year}	*p* constant among locations (installations) and by month but allowed to vary between years
$p_{location*year}$	*p* allowed to vary among locations (installations) and years but constant by month
p_{month}	*p* constant among locations (installations) and years, but allowed to vary by month, e.g. all December's are the same
$p_{location*month}$	*p* allowed to vary among locations (installations) and by month but constant between years, e.g. all December's are the same within a location
$p_{year*month}$	*p* constant among locations (installations) but allowed to vary by month and between years
$p_{location*year*month}$	*p* allowed to vary among locations (installations), by month, and between years

[1] Station principal component # 1 is a habitat covariate which represents an increase in successional stage, canopy, and subcanopy cover. Station principal component # 2 is a habitat covariate which most strongly correlates with decrease in ground cover but also increased canopy and shrubs.

Table 5a. Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Chaffee during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Spizella			Zonotrichia			Junco			Passerella			Pipilo			Melospiza			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Sharp-shinned Hawk		1			1											1	1		1	3	
Red-bellied Woodpecker	1																		1		
Yellow-bellied Sapsucker				2			1		2	1									4		2
Downy Woodpecker				1		2	1			1			2			1			6		2
Northern Flicker				1															1		
Eastern Phoebe				2												4			6		
Blue Jay	7		1	6			5			7			6		1	3	1	1	34	1	3
Carolina Chickadee	10		11	8		19	7	4	7	11	1	13	13		15	4		9	53	5	74
Tufted Titmouse	3			8		9	5		1	14		13	8		8	19	2	7	57	2	38
Brown Creeper										1						2			3		
Carolina Wren	1			1		1	1	1	2	2	1	6	1		4	2		3	8	2	16
House Wren				2			1			1									4		
Winter Wren	1	1					1		1										2	1	1
Golden-crowned Kinglet	3						1			2		1	2	1		2			10	1	1
Ruby-crowned Kinglet	12		15	11	7	6	7	2	2	5		4	10		7	6		3	51	9	37
Eastern Bluebird	11		1	7		1	3						7		1	7			35		3
Hermit Thrush	11		11	7	1	12	10	1	14	7	1	12	8		13	4		12	47	3	74
American Robin	1			4			4						1						10		
Gray Catbird	1		1																1		1
Northern Mockingbird	8	1	4	5	3	1	1		3	4		5	1			2		1	21	4	14
Brown Thrasher	5	2	1	10	1	6	3		1	7	3	5				2			27	6	13
Orange-crowned Warbler	5						1	1		2	1		1		1	1			10	2	1
Yellow-rumped Warbler	8			5	1								1						14	1	
Eastern Towhee				1	1	1				3	2		1			7			12	3	1
Field Sparrow	19		8	13		3	4		2	12	1	5	2		2	6		1	56	1	21
Fox Sparrow	12	2	2	22	1	1	7		5	19	2	3	16	1	4	5			81	6	15
Song Sparrow	12		7	4	2	1		1	2	13		4	1		2			3	30	3	19
Lincoln's Sparrow	2									2									4		

Table 5a. (cont.) Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Chaffee during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Spizella			Zonotrichia			Junco			Passerella			Pipilo			Melospiza			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Swamp Sparrow	4		4			2		1		5	2	10	2			2			13	3	16
White-throated Sparrow	50		14	66	2	24	16	2	19	49	1	22	28	3	25	46	3	11	255	11	115
White-crowned Sparrow										1									1		
Dark-eyed Junco	16		4	13		10	2		4	11		1	12		2	3			57		21
Northern Cardinal	21	2	10	14	5	9	2	1	6	13	2	2	7		8	5		5	62	10	40
Common Grackle				3															3		
Purple Finch				1															1		
Pine Siskin													1						1		
American Goldfinch	12			15			2			2			14	10	1				45	10	1
ALL SPECIES POOLED	236	9	94	232	25	108	85	14	71	195	17	106	145	15	94	134	7	56	1027	87	529
Total Number of Captures		339			365			170			318			254			197			1643	
Number of Species	25	6	15	26	11	17	22	9	15	25	11	15	23	4	15	22	4	11	37	21	24
Total Number of Species		26			28			24			25			23			23			37	

Table 5b. Capture summary for the six individual MAWS stations, and all stations pooled, operated on Camp Joseph T. Robinson during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	New Bird			POW Camp			Mini Forest			Siamese			Pee Dee			Buck			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Sharp-shinned Hawk					1								1	1					1	2	
American Woodcock											1									1	
Red-bellied Woodpecker	3	1								2			1			2			8	1	
Yellow-bellied Sapsucker	2																		2		
Downy Woodpecker	2		1	1						2						3			8		1
Northern Flicker							2			2						2			6		
Eastern Phoebe	4									1									5		
Blue-headed Vireo							2												2		
Blue Jay	4	1		3		1	8	1		7	1	1	3						25	3	2
Carolina Chickadee	11		6	10	1	6	10	1	7	5	1	4	12	1	9	9	1	4	57	5	36
Tufted Titmouse	22	8	11	8	6	4	34		19	34	4	29	37	4	33	86	5	59	221	27	155
Brown Creeper	1															5		2	6		2
Carolina Wren	7	1	2	4	6	3	7		10	8	2	11	6		5	7	1	6	39	10	37
Bewick's Wren	2		3	2	1	6													4	1	9
House Wren	1	1		2	2							1							3	3	1
Winter Wren	6	1								1				1		1			8	2	
Golden-crowned Kinglet				2			5		4	9	2	6	9	1	1	9		3	34	3	14
Ruby-crowned Kinglet	6	2		36	2	4	24	5	15	11	1	4	12	1	4	16	1	7	105	12	34
Eastern Bluebird	4		1	4			2			8			11						29		1
Hermit Thrush				25	8	16	23		39	12		22	11	1	38	4		14	75	9	129
American Robin				1	2		6			6		2	2			1			16	2	2
Gray Catbird				2			1		1										3		1
Northern Mockingbird				7		6	3	1	2				3		2	1			14	1	10
Brown Thrasher	2			9	5	1	6	3	5	7	2	5	7	1	7	7	2	3	38	13	21
Orange-crowned Warbler				1		1	2			4									7		1
Nashville Warbler				1			1												2		
Yellow-rumped Warbler				1									3						4		
Pine Warbler	7																		7		

Table 5b. (cont.) Capture summary for the six individual MAWS stations, and all stations pooled, operated on Camp Joseph T. Robinson during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	New Bird			POW Camp			Mini Forest			Siamese			Pee Dee			Buck			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Spotted Towhee							1												1		
Eastern Towhee	6	1		12	2		2			5			3			8			36	3	
Chipping Sparrow	1			1															2		
Field Sparrow	29		8	24	2	8	10	1		10		6	10	1		1			84	4	22
Fox Sparrow	2						1			7		1	1	1		1			12	1	1
Song Sparrow	18	2	1	14	4	6	5		5	12	1	2	9		2	1			59	7	16
Swamp Sparrow	22	2	8	2									1						25	2	8
White-throated Sparrow	51	2	8	38	4	12	38	1	15	31	2	32	49		32	43	1	57	250	10	156
Dark-eyed Junco	2			1	1				1	6	1	1	5	2	1	1			15	4	3
Northern Cardinal	3			21	2	5	16	2	5	13	2	4	15		14	2		10	70	6	38
Indigo Bunting				2	1														2	1	
Purple Finch													2						2		
American Goldfinch	4	3					2						6	1		5			17	4	
ALL SPECIES POOLED	222	25	49	234	50	79	211	15	128	203	20	131	219	16	148	215	11	165	1304	137	700
Total Number of Captures		296			363			354			354			383			391			2141	
Number of Species	26	12	10	27	17	14	24	8	13	23	12	16	24	12	12	22	6	10	40	26	24
Total Number of Species		26			28			25			25			25			22			41	

Table 5c. Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Bragg during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Golf Course			Dove Field			Deer Pen Lake			Holland Lake			Wolf Pit Creek			Wildfire			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Red-bellied Woodpecker	1	1																	1	1	
Yellow-bellied Sapsucker	3			1	2		2	1								2			8	3	
Downy Woodpecker	3			1			1									1			6		
Hairy Woodpecker																1			1		
Northern Flicker																1			1		
Eastern Phoebe	3		1	9		2	1						3			3			19		3
Blue-headed Vireo							1									2			3		
Blue Jay				1			3						1			1	1		6	1	
Carolina Chickadee	3		5	2			6		3	9		6	5	1	2	6		7	31	1	23
Tufted Titmouse	1			8	4	9	8	2	1	5		1	10		6	7		6	39	6	23
Red-breasted Nuthatch				1												1			2		
White-breasted Nuthatch										1			1			2			4		
Brown-headed Nuthatch	2									3						2			7		
Brown Creeper				2															2		
Carolina Wren	11		5	5	2	2	3	3	1	3		8	3	2	2	7		5	32	7	23
House Wren	2	1		2		1	1	2		1									6	3	1
Winter Wren	3	1	1							3		2	3		4				9	1	7
Golden-crowned Kinglet	2			9		1	2			16		13	32	3	8	21	2	9	82	5	31
Ruby-crowned Kinglet	19	2	13	12	10	4	29	6	14	59	4	57	80	26	48	67		21	266	48	157
Eastern Bluebird	17	8	5	7	1	1	2			1			1						28	9	6
Hermit Thrush	1			3			7	1	8	13		23	12		13	11	1	10	47	2	54
American Robin	5	10		1									5				27		11	37	
Gray Catbird							1			8		2	4		10	2			15		12
Northern Mockingbird	1			1			1		3							1	2		4	2	3
Brown Thrasher	2			1			4		1	1			1		3				9		4
Yellow-rumped Warbler	2			49	41	2	1	2		2			1			12			67	43	2
Pine Warbler	10		2	13			3	1		2			1			10			39	1	2
Palm Warbler							1												1		

Table 5c. (cont.) Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Bragg during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Golf Course			Dove Field			Deer Pen Lake			Holland Lake			Wolf Pit Creek			Wildfire			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Common Yellowthroat	1											2							1		2
Eastern Towhee	7	1		9	1	1	3			8		4	7	4	1	3	6		37	12	6
Chipping Sparrow	46	1	3	154	38	16	1									29		1	230	39	20
Field Sparrow	75	3	26	25		10	34		17	2						12		2	148	3	55
Fox Sparrow							2												2		
Song Sparrow	43	2	17	24		12	109	1	27	3		3	4		2	11		2	194	3	63
Swamp Sparrow	55	3	19	1			33		26	6		4	1			13	1	8	109	4	57
White-throated Sparrow	12		4	24	1	16	15		1	9		16	9		9	10			79	1	46
Dark-eyed Junco	83		27	62	1	10	5			3		1	15		1	4		2	172	1	41
Unidentified Sparrow					1			1												2	
Northern Cardinal	8	2	3	7	6	2	5	10	1	5	2	6	2	5		7	4	6	34	29	18
House Finch							2												2		
American Goldfinch	11			1			3			18		1				10		1	43		2
ALL SPECIES POOLED	432	35	131	435	108	89	289	30	103	181	6	149	201	41	109	259	44	80	1797	264	661
Total Number of Captures		598			632			422			336			351			383			2722	
Number of Species	29	12	14	28	11	15	30	10	12	23	2	16	22	6	13	29	8	13	40	24	25
Total Number of Species		29			28			30			24			22			30			40	

Table 5d. Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Benning during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Charlie Charlie 2			Charlie Charlie 3			Molnar Range			Yankee 2			Victor 1			X-ray 5			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Sharp-shinned Hawk										1						1			2		
Northern Bobwhite		2																		2	
Mourning Dove				1															1		
Common Ground-Dove							1												1		
Red-headed Woodpecker													5						5		
Red-bellied Woodpecker							1			1			1			2			5		
Yellow-bellied Sapsucker							1						2						3		
Downy Woodpecker				2	1								3						5	1	
Hairy Woodpecker																1			1		
Northern Flicker													1						1		
Eastern Phoebe	4			2			3			3			3			6		2	21		2
White-eyed Vireo													1						1		
Blue-headed Vireo										1									1		
Blue Jay				3			2			3						2			10		
Carolina Chickadee	3		8	11		12	3			4			3		2	3		2	27		24
Tufted Titmouse	6		1	5		5	2			1		1	9			1		1	24		8
White-breasted Nuthatch													1						1		
Brown-headed Nuthatch				2															2		
Carolina Wren	8		9	11	2	9	4		6	7		2	11		15	11		14	52	2	55
House Wren				2			1			1			2			2			8		
Winter Wren													1						1		
Ruby-crowned Kinglet	12		21	35	1	35	8		5	19		10	10		9	20	1	6	104	2	86
Eastern Bluebird	6			1			8		1				5			11			31		1
Hermit Thrush	7		5	7		4	1			4		3	1			10		6	30		18
American Robin							22	2		1	1		1			20			44	3	
Gray Catbird										1									1		
Northern Mockingbird				1			4		2	2		4	1						8		6
Brown Thrasher				2			2		3	4		2	1			1			10		5

Table 5d. (cont.) Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Benning during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Charlie Charlie 2			Charlie Charlie 3			Molnar Range			Yankee 2			Victor 1			X-ray 5			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Cedar Waxwing													1			2			3		
Orange-crowned Warbler				3						6		3				1			10		3
Magnolia Warbler				1			1						4						6		
Yellow-rumped Warbler	29		10	75		18	10			2			3			13	1	1	132	1	29
Black-throated Green Warbler				1															1		
Pine Warbler	6			4		2	17	1	4				14	2	2	4	1	1	45	4	9
Palm Warbler				2		1	5			2			2						11		1
Common Yellowthroat	3		9	2		7	27	1	9	5		4	10		13	8		3	55	1	45
Yellow-breasted Chat							1												1		
Eastern Towhee	14		7	13		7	3			22	2	4	8		6	19	1	4	79	3	28
Bachman's Sparrow										1			1	2		1			3	2	
Chipping Sparrow	3		2	12	1	1	118	2	1	14	1	1	47		2	39			233	4	7
Field Sparrow	5		2	23		30	56	1	56	24	2	12	23	1	12	18		7	149	4	119
Vesper Sparrow							2		1										2		1
Savannah Sparrow							83		42	19		2							102		44
Grasshopper Sparrow										1									1		
Henslow's Sparrow										1			1						2		
Fox Sparrow	10		1	1			1			6		2				5			23		3
Song Sparrow	18	1	19	11		6	63	2	14	50	4	27	20		11	19		6	181	7	83
Lincoln's Sparrow													1						1		
Swamp Sparrow	17		22	10		6	114		71	40	1	34	21		23	6	1	5	208	2	161
White-throated Sparrow	62	1	42	30		15	14	2	3	74	1	46	30		12	48		13	258	4	131
Dark-eyed Junco	36	1	14										17		1	6		1	59	1	16
Northern Cardinal	4		1	15		7	19		3	14		3	9		5	17		4	78		23
Indigo Bunting				1			2						6		2				9		2
Red-winged Blackbird	2	1					2			1									5	1	
Purple Finch										1									1		
American Goldfinch	4			14			5			18		3	10			3		1	54		4

Table 5d. (cont.) Capture summary for the six individual MAWS stations, and all stations pooled, operated on Fort Benning during the 2004-05 season. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Charlie Charlie 2			Charlie Charlie 3			Molnar Range			Yankee 2			Victor 1			X-ray 5			All Stations Pooled		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
ALL SPECIES POOLED	259	6	173	303	5	165	606	11	221	354	12	163	290	5	115	300	5	77	2112	44	914
Total Number of Captures		438			473			838			529			410			382			3070	
Number of Species	21	5	16	31	4	16	34	7	15	34	7	18	38	3	14	30	5	17	55	17	27
Total Number of Species		22			31			34			34			38			30			56	

Table 6. Recapture and resighting information from the 2004-05 MAWS season for the six species that were individually color banded during that season.

Species	Number banded	Number (%) returns from recaptures[1]	Number color banded	Number (%) returns from resightings[2]	Total number (%) returns	% returns from resightings
Field Sparrow	481	107(22.2)	293	4(1.4)	111(23.1)	3.6
Fox Sparrow	122	8(6.6)	103	0(0.0)	8(6.6)	0.0
Song Sparrow	499	77(15.4)	262	24(9.2)	101(20.2)	23.8
Swamp Sparrow	379	119(31.4)	240	2(0.8)	121(31.9)	1.7
White-throated Sparrow	972	190(19.5)	701	35(5.0)	225(23.1)	15.6
Dark-eyed Junco	324	37(11.4)	202	7(3.5)	44(13.6)	15.9
Total	2777	538(19.4)	1801	72 (4.0)	610(22.0)	11.8

1 A return is the first recapture in a given pulse of a bird originally banded in a previous pulse. These returns were obtained by recaptures.

2 These returns were obtained only by resightings; these birds were resighted but not recaptured during that pulse.

Table 7. Numbers of individuals captured, total captures, and returns for 25 target species by location (installation) over the winters of 2003-04 and 2004-05. Data are included only from stations that were operated during both the 2003-04 and 2004-05 seasons[1]. Data from locations where the species was captured, but for which fewer than an average 2.5 individuals per pulse were captured or resighted (i.e., 25 pulse-unique encounters) or fewer than three returns were recorded are presented in italics. Data presented in italics were not included in the mark-recapture models.

	Fort Chaffee			Camp Joseph T. Robinson			Fort Bragg			Fort Benning		
Species	No. Ind.[2]	No. Cap.[3]	No Ret.[4]	No. Ind.[2]	No. Cap.[3]	No Ret.[4]	No. Ind.[2]	No. Cap.[3]	No Ret.[4]	No. Ind.[2]	No. Cap.[3]	No Ret.[4]
Eastern Phoebe	*10*	*10*	*0*	*7*	*7*	*0*	28	32	3	*26*	*28*	*2*
Blue Jay	56	60	3	*31*	*33*	*1*	*7*	*7*	*0*	*11*	*11*	*0*
Carolina Chickadee	118	219	78	99	143	37	48	80	26	46	71	20
Tufted Titmouse	130	190	52	261	423	118	52	79	17	44	58	11
Carolina Wren	23	48	22	53	95	22	54	89	26	84	157	45
Golden-crowned Kinglet	*14*	*15*	*1*	45	60	10	96	127	17			
Ruby-crowned Kinglet	84	132	34	127	176	23	417	665	137	121	211	38
Eastern Bluebird	54	58	4	*32*	*33*	*0*	40	46	5	*37*	*38*	*1*
Hermit Thrush	102	222	80	104	239	77	71	148	48	39	57	13
Gray Catbird	*1*	*2*	*0*	*3*	*4*	*0*	19	33	6	*3*	*3*	*0*
Northern Mockingbird	38	57	15	*16*	*26*	*7*	*4*	*7*	*2*	*14*	*24*	*7*
Brown Thrasher	53	73	15	52	82	17	*14*	*20*	*4*	*14*	*20*	*4*
Yellow-rumped Warbler	*58*	*58*	*0*	*20*	*21*	*0*	161	172	4	178	208	14
Pine Warbler				*9*	*9*	*0*	*52*	*56*	*2*	52	61	6
Common Yellowthroat							*10*	*15*	*4*	80	139	30
Eastern Towhee	*22*	*23*	*1*	58	61	3	*57*	*65*	*2*	105	135	20
Chipping Sparrow				*2*	*2*	*0*	379	407	22	351	360	5
Field Sparrow	213	275	51	109	139	23	224	303	59	236	390	94
Savannah Sparrow	*6*	*6*	*0*							162	225	36
Fox Sparrow	166	203	26	*15*	*17*	*1*	*4*	*4*	*0*	*30*	*33*	*2*
Song Sparrow	174	241	49	140	175	24	276	375	58	251	367	77
Swamp Sparrow	41	62	20	42	53	8	159	237	54	282	472	108
White-throated Sparrow	603	805	155	483	724	166	157	232	45	326	470	95
Dark-eyed Junco	230	284	43	38	46	6	276	334	47	76	94	7
Northern Cardinal	187	250	51	122	170	32	54	84	23	105	129	19

[1] By location, the stations from which data are included in this table are: six stations on Fort Chaffee (SPIZ, ZONO, JUNC, PASS, PIPI, MELO); six stations on Camp Joseph T. Robinson (NEWB, POWC, MIFO, SIAM, PEED, BUCK); six stations on Fort Bragg (GCOU, DOFI, DEEF, HOLA, WOCR, WIFI); and six stations on Fort Benning (CC02, CC03, MOLE, YANK, VICK, XRAY).

[2] Number of individuals (i.e., number of capture histories).

[3] Total number of captures.

[4] Total number of returns. A return is the first recapture (or resighting) in a given period of a bird originally banded at the same station in a previous period.

Table 8. Model selection (QAICc weights, w_i) for transient, location (installation), and year effects on monthly apparent survival-rate (ϕ) for 25 target species (see text) for the two MAWS seasons 2003-04 and 2004-05 for the **analysis of the effect of location on survival and recapture probability**. Strong effects ($w_i > 0.4$) are shown in bold, moderate effects ($0.4 \geq w_i > 0.3$) are underlined, and weak effects ($0.3 \geq w_i > 0.2$) are shown in italics.

	Transient effects on ϕ		Location effects on ϕ		Year effects on ϕ	
Species	Transient effect	No transient effect	Location effect	No location effect	Year effect	No year effect
Eastern Phoebe	0.04195	0.95804			*0.24137*	0.75862
Blue Jay	0.07842	0.92157			*0.23448*	0.76551
Carolina Chickadee	*0.23999*	0.75998	0.00469	0.99528	*0.25162*	0.74835
Tufted Titmouse	0.03735	0.96265	**0.75929**	0.24071	<u>0.32909</u>	0.67091
Carolina Wren	**0.53035**	0.46966	0.00492	0.99509	<u>0.36349</u>	0.63652
Golden-crowned Kinglet	0.18440	0.81561	0.12728	0.87273	<u>0.32600</u>	0.67401
Ruby-crowned Kinglet	**1.00001**	0.00001	0.06339	0.93663	**0.87630**	0.12372
Eastern Bluebird	0.08563	0.91434	0.12861	0.87136	*0.21496*	0.78501
Hermit Thrush	**0.97112**	0.02891	0.00109	0.99894	**0.96138**	0.03865
Gray Catbird	0.04338	0.95661			*0.23516*	0.76483
Northern Mockingbird	**0.45945**	0.54054			*0.24968*	0.75031
Brown Thrasher	0.09243	0.90755	0.15233	0.84765	*0.27025*	0.72973
Yellow-rumped Warbler	**0.98179**	0.01818	0.07081	0.92916	0.12038	0.87959
Pine Warbler	0.07606	0.92395			*0.24417*	0.75584
Common Yellowthroat	**0.98949**	0.01050			**0.99976**	0.00023
Eastern Towhee	0.08286	0.91712	<u>0.35881</u>	0.64117	**0.46196**	0.53802
Chipping Sparrow	0.16446	0.83551	<u>0.39087</u>	0.60910	*0.22700*	0.77297
Field Sparrow	**0.43153**	0.56848	<u>0.33898</u>	0.66103	**0.47619**	0.52382
Savannah Sparrow	0.10794	0.89207			*0.27291*	0.72710
Fox Sparrow	0.10403	0.89596			<u>0.32178</u>	0.67821
Song Sparrow	**0.70964**	0.29039	*0.24117*	0.75886	*0.23612*	0.76391
Swamp Sparrow	**0.41513**	0.58488	0.02246	0.97755	**0.42236**	0.57765
White-throated Sparrow	**1.00000**	0.00000	**0.99521**	0.00479	**0.93107**	0.06893
Dark-eyed Junco	0.07671	0.92327	0.16958	0.83040	**0.96791**	0.03207
Northern Cardinal	*0.21946*	0.78055	0.00495	0.99506	**0.53161**	0.46840

Table 9. Model selection (QAICc weights, w_i) for location (installation), year, and month (pulse) effects on recapture probability (p) for 25 target species (see text) for the two MAWS seasons 2003-04 and 2004-05 for the **analysis of the effect of location on survival and recapture probability**. Strong effects ($w_i > 0.4$) are shown in bold, moderate effects ($0.4 \geq w_i > 0.3$) are underlined, and weak effects ($0.3 \geq w_i > 0.2$) are shown in italics.

Species	Location effects on p		Year effects on p		Month effects on p	
	Location effect	No location effect	Year effect	No year effect	Month effect	No month effect
Eastern Phoebe			<u>0.32428</u>	0.67571	0.04639	0.95360
Blue Jay			**0.42732**	0.57267	0.01349	0.98650
Carolina Chickadee	0.06319	0.93678	*0.26285*	0.73712	0.01353	0.98644
Tufted Titmouse	0.10696	0.89304	*0.26387*	0.73613	*0.24514*	0.75486
Carolina Wren	*0.21533*	0.78468	*0.20800*	0.79201	0.06278	0.93723
Golden-crowned Kinglet	*0.23103*	0.76898	*0.29297*	0.70704	0.01473	0.98528
Ruby-crowned Kinglet	0.01246	0.98756	**0.82769**	0.17233	**0.89224**	0.10778
Eastern Bluebird	<u>0.30954</u>	0.69043	*0.27481*	0.72516	0.07912	0.92085
Hermit Thrush	0.15828	0.84175	**0.60037**	0.39966	0.16874	0.83129
Gray Catbird			*0.29611*	0.70388	0.00130	0.99869
Northern Mockingbird			*0.22322*	0.77677	0.05411	0.94588
Brown Thrasher	**0.40751**	0.59247	0.18860	0.81138	0.12837	0.87161
Yellow-rumped Warbler	**0.69290**	0.30707	**0.58108**	0.41889	0.01953	0.98044
Pine Warbler			*0.25502*	0.74499	0.00839	0.99162
Common Yellowthroat			**0.56384**	0.43615	0.00450	0.99549
Eastern Towhee	**0.87879**	0.12119	**0.77615**	0.22383	0.00162	0.99836
Chipping Sparrow	**0.74782**	0.25215	*0.20624*	0.79373	0.09000	0.90997
Field Sparrow	**0.70629**	0.29372	**0.71851**	0.28150	<u>0.35899</u>	0.64102
Savannah Sparrow			*0.20734*	0.79267	*0.25768*	0.74233
Fox Sparrow			<u>0.39258</u>	0.60741	0.01818	0.98181
Song Sparrow	*0.26348*	0.73655	<u>0.31172</u>	0.68831	0.03065	0.96938
Swamp Sparrow	0.04729	0.95272	<u>0.32613</u>	0.67388	*0.22876*	0.77125
White-throated Sparrow	**0.99818**	0.00182	**0.75019**	0.24981	0.00202	0.99798
Dark-eyed Junco	0.03406	0.96592	**0.93317**	0.06681	**0.99467**	0.00531
Northern Cardinal	<u>0.35616</u>	0.64385	*0.25739*	0.74262	0.07226	0.92775

Table 10. Model-averaged time-constant monthly apparent survival-rate estimates[1] and their standard errors (SEs) and coefficients of variation (CVs) for the overwintering period (November - March) by target species and location (installation).

			Apparent Survival Probability											
			Fort Chaffee			Camp Robinson			Fort Bragg			Fort Benning		
Species	c-hat	Season	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV
Eastern Phoebe	1.127	Winter 1							0.825	0.281	34.0			
		Summer							1.000	0.000	0.0			
		Winter 2							0.899	0.202	22.5			
Blue Jay	1.000	Winter 1	0.971	0.078	8.0									
		Summer	0.940	0.164	17.4									
		Winter 2	0.998	0.077	7.7									
Carolina Chickadee	1.337	Winter 1	0.979	0.042	4.3	0.979	0.042	4.3	0.979	0.042	4.3	0.980	0.042	4.2
		Summer	0.916	0.023	2.6	0.916	0.024	2.6	0.916	0.024	2.6	0.916	0.024	2.6
		Winter 2	0.988	0.040	4.0	0.988	0.040	4.0	0.988	0.040	4.0	0.989	0.039	4.0
Tufted Titmouse	1.000	Winter 1	0.818	0.066	8.0	0.829	0.060	7.2	0.795	0.082	10.3	0.744	0.101	13.6
		Summer	0.900	0.039	4.3	0.991	0.010	1.0	0.991	0.006	0.6	0.977	0.051	5.3
		Winter 2	0.807	0.061	7.5	0.834	0.045	5.4	0.811	0.076	9.4	0.598	0.101	16.9
Carolina Wren	1.010	Winter 1	0.884	0.056	6.3	0.884	0.056	6.3	0.884	0.056	6.3	0.884	0.056	6.3
		Summer	0.973	0.026	2.7	0.972	0.026	2.7	0.972	0.027	2.7	0.972	0.026	2.7
		Winter 2	0.838	0.053	6.3	0.838	0.053	6.3	0.838	0.053	6.3	0.838	0.053	6.3
Golden-crowned Kinglet	1.476	Winter 1				0.685	0.203	29.7	0.656	0.191	29.1			
		Summer				0.862	0.137	15.9	0.763	11.545	1512.2			
		Winter 2				0.781	0.158	20.2	0.761	0.151	19.9			

Table 10. (cont.) Model-averaged time-constant monthly apparent survival-rate estimates[1] and their standard errors (SEs) and coefficients of variation (CVs) for the overwintering period (November - March) by target species and location (installation).

			Apparent Survival Probability											
			Fort Chaffee			Camp Robinson			Fort Bragg			Fort Benning		
Species	c-hat	Season	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV
Ruby-crowned Kinglet	1.466	Winter 1	0.847	0.087	10.3	0.846	0.101	11.9	0.857	0.078	9.1	0.849	0.088	10.4
		Summer	0.956	0.039	4.0	0.950	0.037	3.9	0.957	0.035	3.6	0.959	0.032	3.4
		Winter 2	0.728	0.085	11.7	0.739	0.075	10.2	0.716	0.081	11.3	0.716	0.083	11.6
Eastern Bluebird	1.064	Winter 1	0.978	0.032	3.3				1.000	0.000	0.0			
		Summer	0.995	0.020	2.0				1.000	0.000	0.0			
		Winter 2	0.973	0.035	3.6				1.000	0.000	0.0			
Hermit Thrush	1.364	Winter 1	0.969	0.073	7.5	0.969	0.073	7.5	0.969	0.073	7.5	0.969	0.073	7.6
		Summer	0.958	0.024	2.5	0.958	0.024	2.5	0.958	0.024	2.5	0.958	0.024	2.5
		Winter 2	0.766	0.054	7.1	0.766	0.054	7.1	0.766	0.054	7.1	0.765	0.054	7.1
Gray Catbird	1.743	Winter 1							0.814	0.285	35.1			
		Summer							0.966	0.152	15.7			
		Winter 2							0.723	0.339	46.8			
Northern Mockingbird	1.134	Winter 1	0.804	0.142	17.7									
		Summer	0.965	0.069	7.1									
		Winter 2	0.749	0.141	18.8									
Brown Thrasher	1.000	Winter 1	0.949	0.083	8.8	0.930	0.099	10.7						
		Summer	0.930	0.054	5.8	0.920	0.056	6.1						
		Winter 2	0.920	0.097	10.6	0.901	0.111	12.3						

Table 10. (cont.) Model-averaged time-constant monthly apparent survival-rate estimates[1] and their standard errors (SEs) and coefficients of variation (CVs) for the overwintering period (November - March) by target species and location (installation).

			Apparent Survival Probability											
			Fort Chaffee			Camp Robinson			Fort Bragg			Fort Benning		
Species	c-hat	Season	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV
Yellow-rumped Warbler	1.270	Winter 1							0.728	0.199	27.4	0.738	0.184	25.0
		Summer							0.930	20.391	2191.8	0.996	0.023	2.3
		Winter 2							0.737	1.368	185.5	0.748	0.170	22.8
Pine Warbler	2.173	Winter 1										0.361	7.714	2134.9
		Summer										n/a		
		Winter 2										0.478	0.295	61.8
Common Yellowthroat	1.036	Winter 1										1.000	0.000	0.0
		Summer										0.967	0.038	3.9
		Winter 2										0.824	0.110	13.3
Eastern Towhee	1.000	Winter 1				0.729	0.102	13.9				0.876	0.124	14.2
		Summer				n/a						0.998	0.005	0.5
		Winter 2				0.648	10.673	1648.3				0.963	0.062	6.4
Chipping Sparrow	1.070	Winter 1							0.833	0.149	17.8	0.713	0.166	23.2
		Summer							0.923	0.069	7.5	0.969	0.038	4.0
		Winter 2							0.857	0.142	16.6	0.747	0.162	21.7
Field Sparrow	1.361	Winter 1	0.884	0.074	8.4	0.934	0.048	5.1	0.937	0.046	4.9	0.898	0.070	7.8
		Summer	0.926	0.037	4.0	0.949	0.040	4.2	0.920	0.033	3.6	0.950	0.031	3.3
		Winter 2	0.735	0.075	10.2	0.816	0.074	9.0	0.868	0.069	8.0	0.877	0.067	7.6

Table 10. (cont.) Model-averaged time-constant monthly apparent survival-rate estimates[1] and their standard errors (SEs) and coefficients of variation (CVs) for the overwintering period (November - March) by target species and location (installation).

			Apparent Survival Probability											
			Fort Chaffee			Camp Robinson			Fort Bragg			Fort Benning		
Species	c-hat	Season	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV
Savannah Sparrow	3.131	Winter 1										0.606	0.158	26.1
		Summer										0.998	0.042	4.2
		Winter 2										0.645	0.172	26.7
Fox Sparrow	2.743	Winter 1	0.697	0.187	26.8									
		Summer	0.916	0.116	12.6									
		Winter 2	0.640	0.196	30.6									
Song Sparrow	1.377	Winter 1	0.816	0.065	8.0	0.840	0.076	9.1	0.870	0.070	8.0	0.859	0.064	7.4
		Summer	0.894	0.033	3.7	0.911	0.035	3.8	0.863	0.041	4.8	0.917	0.032	3.4
		Winter 2	0.816	0.061	7.5	0.837	0.072	8.6	0.870	0.066	7.5	0.858	0.059	6.9
Swamp Sparrow	1.667	Winter 1	0.792	0.068	8.6	0.790	0.068	8.7	0.788	0.067	8.5	0.789	0.067	8.5
		Summer	0.936	0.034	3.6	0.932	0.075	8.1	0.936	0.034	3.6	0.935	0.033	3.6
		Winter 2	0.749	0.061	8.1	0.745	0.062	8.3	0.745	0.060	8.0	0.745	0.060	8.0
White-throated Sparrow	1.132	Winter 1	0.981	0.073	7.4	0.981	0.044	4.5	0.687	0.155	22.5	0.848	0.174	20.5
		Summer	0.942	0.030	3.2	0.962	0.026	2.7	0.918	0.062	6.8	0.969	0.041	4.2
		Winter 2	0.861	0.063	7.4	0.778	0.049	6.3	0.999	0.000	0.0	0.680	0.075	10.9
Dark-eyed Junco	1.000	Winter 1	1.000	0.000	0.0	1.000	0.000	0.0	1.000	0.000	0.0	1.000	0.000	0.0
		Summer	0.898	0.037	4.1	0.898	0.037	4.1	0.898	0.037	4.1	0.898	0.037	4.1
		Winter 2	0.573	0.083	14.5	0.573	0.083	14.5	0.573	0.083	14.5	0.573	0.083	14.5

Table 10. (cont.) Model-averaged time-constant monthly apparent survival-rate estimates[1] and their standard errors (SEs) and coefficients of variation (CVs) for the overwintering period (November - March) by target species and location (installation).

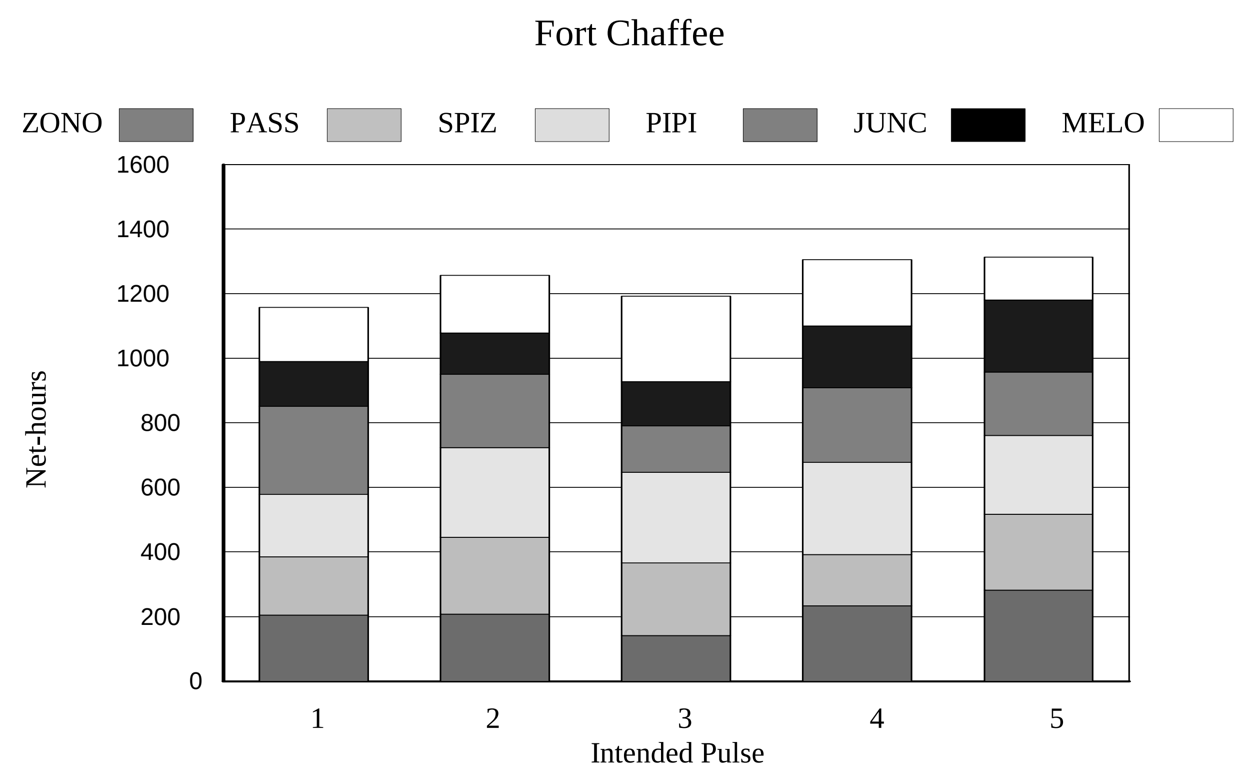
			Apparent Survival Probability											
			Fort Chaffee			Camp Robinson			Fort Bragg			Fort Benning		
Species	c-hat	Season	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV	Est.	SE	CV
Northern Cardinal	1.914	Winter 1	0.981	0.030	3.1	0.980	0.031	3.1	0.981	0.030	3.1	0.980	0.030	3.1
		Summer	0.940	0.032	3.4	0.940	0.032	3.4	0.939	0.032	3.4	0.940	0.031	3.3
		Winter 2	0.903	0.072	8.0	0.903	0.073	8.0	0.903	0.072	8.0	0.903	0.073	8.0

Table 11. Model selection (QAICc weights, w_i) for transient, year, habitat principal component 1, and habitat principal component 2 effects on monthly apparent survival-rate (ϕ) for 25 target species (see text) for the two MAWS seasons 2003-04 and 2004-05 for the **analysis of the effects of habitat principal components on survival**. Strong effects (w_i > 0.4) are shown in bold, moderate effects (0.4 $\geq$ w_i > 0.3) are underlined, and weak effects (0.3 $\geq$ w_i > 0.2) are shown in italics.

	Transient effects on ϕ		Year effects on ϕ		Habitat principal component effects on ϕ		
Species	Transient effect	No transient effect	Year effect	No year effect	Prin. Comp. 1 effect	Prin. Comp. 2 effect	No effect of Prin. Comp. 2
Eastern Phoebe	0.03534	0.96467	*0.21150*	0.78851	0.08587	0.07515	0.83899
Blue Jay	0.04525	0.95474	0.17166	0.82833	*0.22342*	*0.21660*	0.55997
Carolina Chickadee	0.15365	0.84634	0.17574	0.82425	0.15324	<u>0.38928</u>	0.45747
Tufted Titmouse	0.04757	0.95247	<u>0.38498</u>	0.61506	<u>0.36663</u>	**0.56990**	0.06351
Carolina Wren	0.11934	0.88064	*0.22285*	0.77713	**0.76371**	0.01987	0.21640
Golden-crowned Kinglet	0.16499	0.83498	<u>0.35949</u>	0.64048	0.13943	0.10011	0.76043
Ruby-crowned Kinglet	**0.99998**	0.00001	**0.87013**	0.12986	0.00000	0.00000	0.99999
Eastern Bluebird	0.06289	0.93712	0.17887	0.82114	<u>0.35039</u>	0.05348	0.59614
Hermit Thrush	**0.94424**	0.05573	**0.96068**	0.03929	0.02575	0.00491	0.96931
Gray Catbird	0.03957	0.96043	*0.21650*	0.78350	0.04807	0.04047	0.91146
Northern Mockingbird	**0.64698**	0.35299	0.13369	0.86628	0.08579	**0.41815**	0.49603
Brown Thrasher	0.15499	0.84505	*0.27136*	0.72868	0.16721	<u>0.32586</u>	0.50697
Yellow-rumped Warbler	**0.97949**	0.02050	0.12204	0.87795	0.00510	0.00842	0.98647
Pine Warbler	0.06679	0.93321	*0.22097*	0.77903	0.06599	0.07214	0.86187
Common Yellowthroat	**0.98828**	0.01170	**0.99972**	0.00026	0.00064	0.00057	0.99877
Eastern Towhee	0.06017	0.93981	0.19316	0.80682	0.07293	**0.47850**	0.44855
Chipping Sparrow	**0.70188**	0.29812	*0.21659*	0.78341	0.05555	**0.67705**	0.26740
Field Sparrow	0.02168	0.97829	**0.97116**	0.02881	0.00351	**0.97114**	0.02532
Savannah Sparrow	0.08777	0.91223	*0.24010*	0.75990	0.11308	0.11474	0.77221
Fox Sparrow	0.08358	0.91643	*0.27876*	0.72125	0.13974	0.13626	0.72401
Song Sparrow	**0.92358**	0.07639	*0.22059*	0.77938	0.02002	*0.25960*	0.72035
Swamp Sparrow	0.14272	0.85729	<u>0.30434</u>	0.69567	0.02259	**0.68591**	0.29160
White-throated Sparrow	**0.99999**	0.00000	**0.96572**	0.03427	0.00000	0.00000	0.99999
Dark-eyed Junco	**0.52128**	0.47869	**0.74503**	0.25494	**0.43372**	0.19646	0.36979
Northern Cardinal	0.15124	0.84877	**0.54605**	0.45396	0.07856	*0.24558*	0.67587

Table 12. Model selection (QAICc weights, w_i) for location (installation), year, and month (pulse) effects on recapture probability (p) for 25 target species (see text) for the two MAWS seasons 2003-04 and 2004-05 for the **analysis of the effects of habitat principal components on survival**. Strong effects ($w_i > 0.4$) are shown in bold, moderate effects ($0.4 \geq w_i > 0.3$) are underlined, and weak effects ($0.3 \geq w_i > 0.2$) are shown in italics.

	Location effects on *p*		Year effects on *p*		Month effects on *p*	
Species	Location effect	No location effect	Year effect	No year effect	Month effect	No month effect
Eastern Phoebe			<u>0.33411</u>	0.66590	0.04145	0.95856
Blue Jay			**0.46508**	0.53491	0.01108	0.98891
Carolina Chickadee	0.06882	0.93117	*0.26337*	0.73662	0.01324	0.98675
Tufted Titmouse	<u>0.31115</u>	0.68889	*0.23579*	0.76425	0.16387	0.83617
Carolina Wren	<u>0.38078</u>	0.61920	0.16583	0.83415	0.05697	0.94301
Golden-crowned Kinglet	*0.23410*	0.76587	<u>0.30895</u>	0.69102	0.01431	0.98566
Ruby-crowned Kinglet	0.01300	0.98699	**0.82408**	0.17591	**0.88876**	0.11123
Eastern Bluebird	*0.27699*	0.72302	<u>0.30277</u>	0.69724	0.06280	0.93721
Hermit Thrush	0.15653	0.84344	**0.60050**	0.39947	0.16487	0.83510
Gray Catbird			*0.28943*	0.71057	0.00121	0.99879
Northern Mockingbird			*0.20121*	0.79876	0.03859	0.96138
Brown Thrasher	<u>0.37287</u>	0.62717	0.19890	0.80114	0.12062	0.87942
Yellow-rumped Warbler	**0.72067**	0.27932	**0.60056**	0.39943	0.01812	0.98187
Pine Warbler			*0.25340*	0.74660	0.00806	0.99194
Common Yellowthroat			**0.56345**	0.43653	0.00450	0.99548
Eastern Towhee	**0.99528**	0.00470	**0.99102**	0.00896	0.00006	0.99992
Chipping Sparrow	**0.49415**	0.50585	*0.24395*	0.75605	0.10298	0.89702
Field Sparrow	<u>0.39742</u>	0.60256	0.19063	0.90934	<u>0.33305</u>	0.66692
Savannah Sparrow			*0.20830*	0.79170	*0.25304*	0.74696
Fox Sparrow			<u>0.39964</u>	0.60037	0.01748	0.98253
Song Sparrow	0.19288	0.80709	<u>0.30390</u>	0.69607	0.03130	0.96867
Swamp Sparrow	<u>0.32411</u>	0.67590	*0.23722*	0.76279	0.17232	0.82769
White-throated Sparrow	**0.99939**	0.00060	**0.93352**	0.06647	0.00967	0.99032
Dark-eyed Junco	*0.29101*	0.70896	**0.66389**	0.33608	**0.99141**	0.00856
Northern Cardinal	**0.44009**	0.55992	*0.23003*	0.76998	0.06019	0.93982



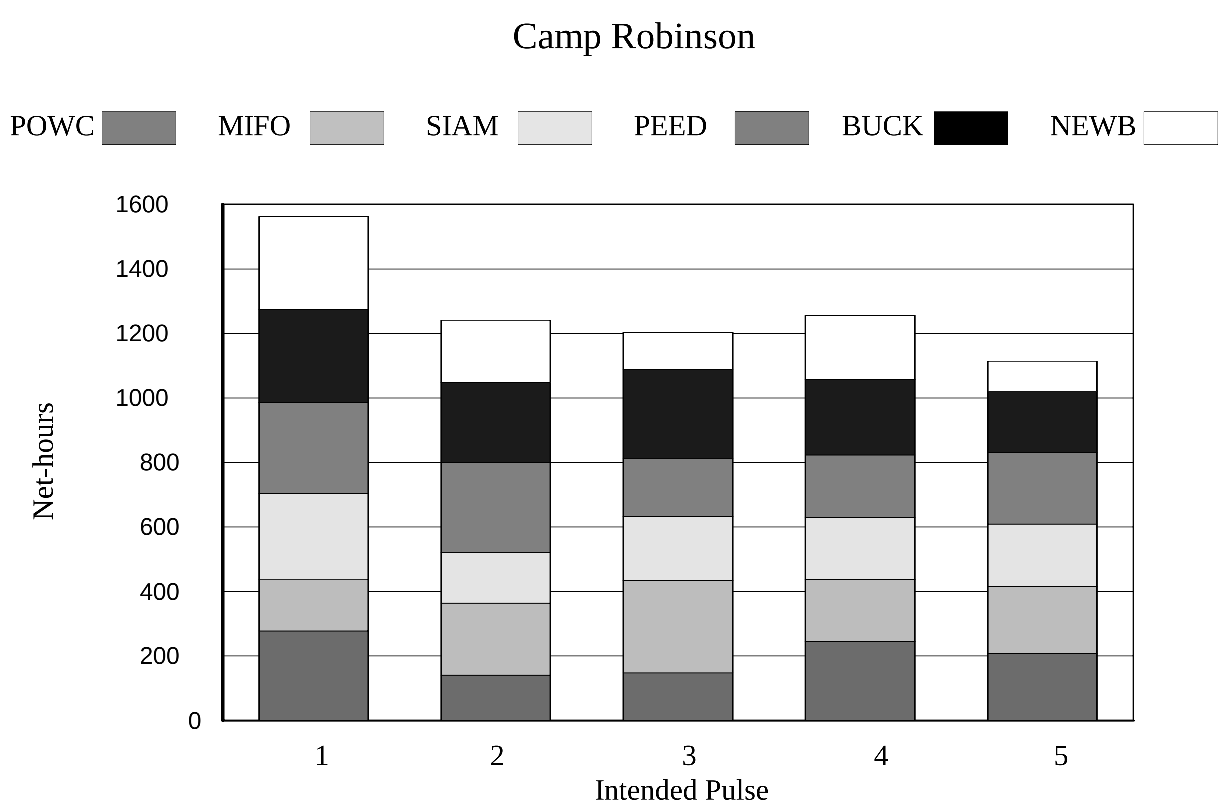
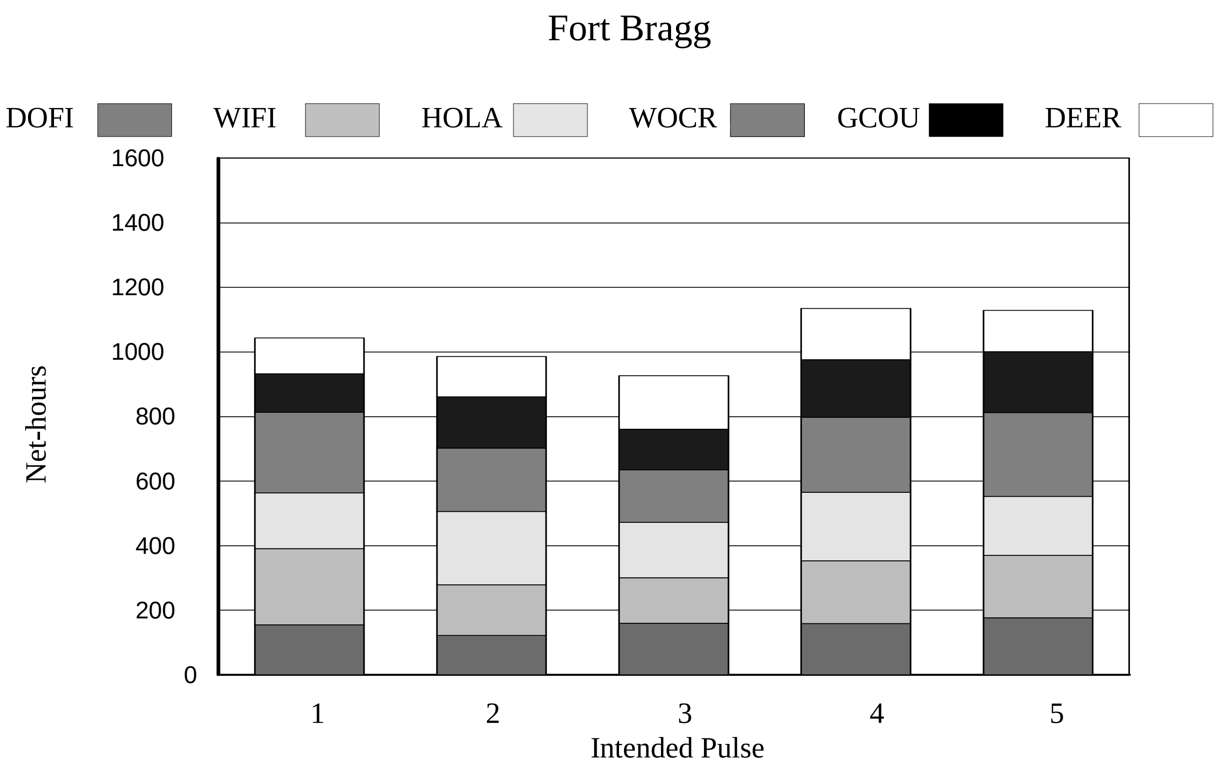


Figure 1. Net-hours by intended period for four MAWS locations (Fort Chaffee, Camp Robinson, Fort Bragg, and Fort Benning) for the 2004-05 MAWS season.



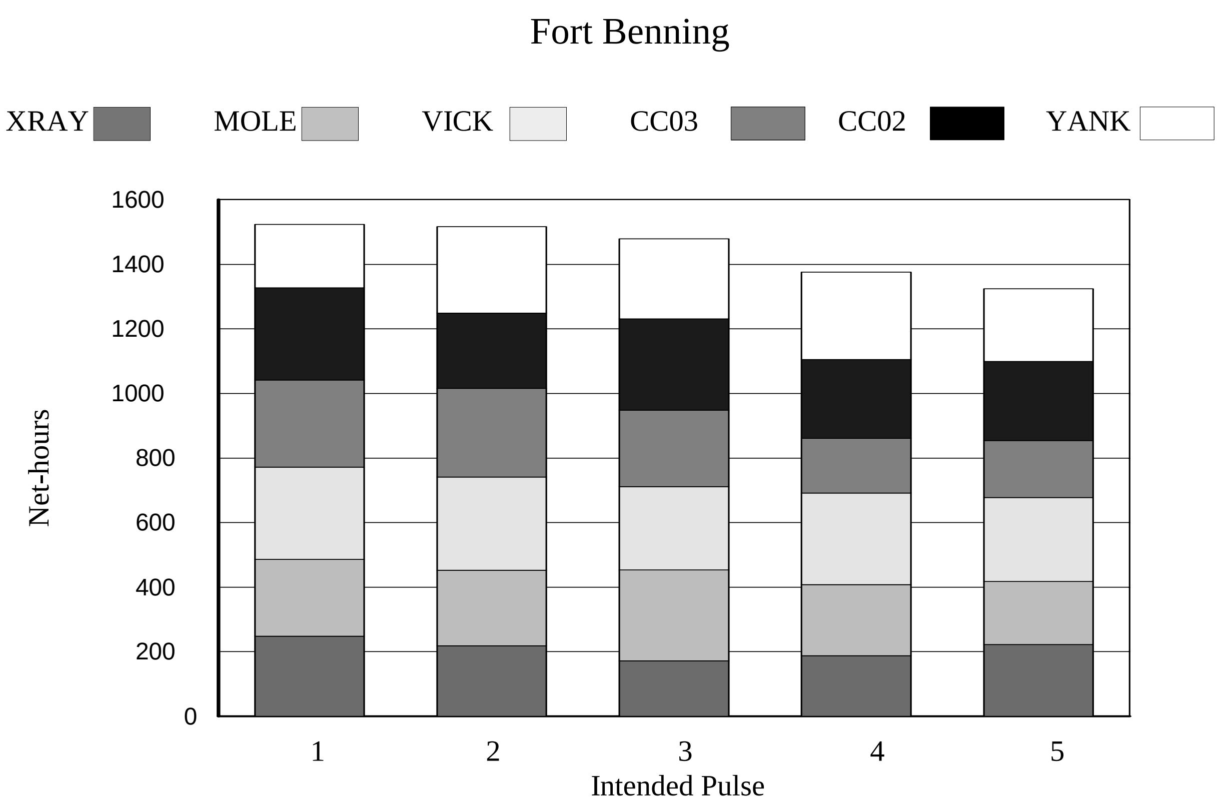


Figure 1 (cont.) Net-hours by intended period for four MAWS locations (Fort Chaffee, Camp Robinson, Fort Bragg, and Fort Benning) for the 2004-05 MAWS season.

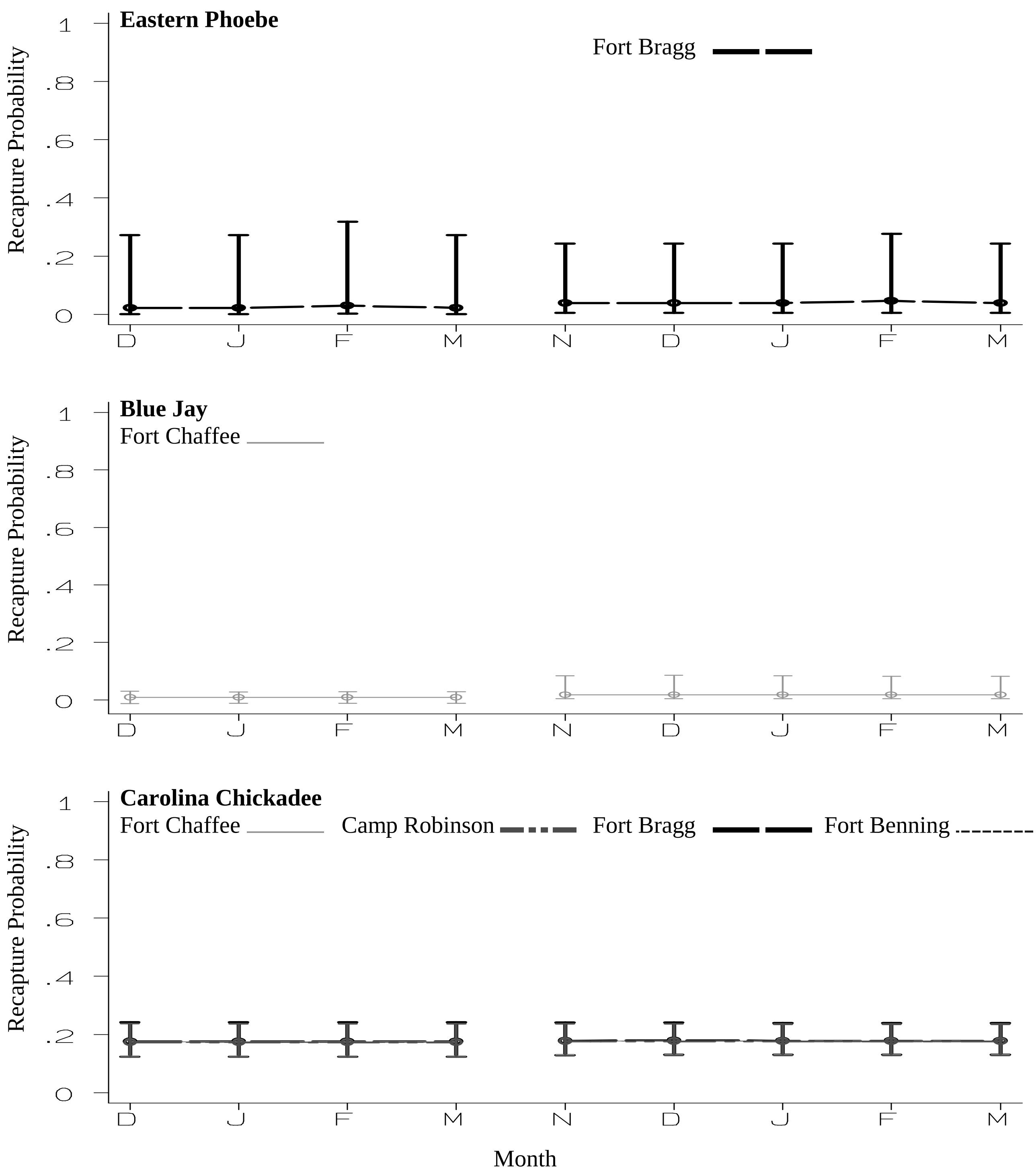


Figure 2. Model-averaged recapture probabilities with 95% confidence limits by location for December 2003 through March 2005. Data was included from the 24 stations operated in the 2004-5 season only from locations at which the species met the minimum data requirements (see text) Recapture probability cannot be computed for the first period, November 2003.

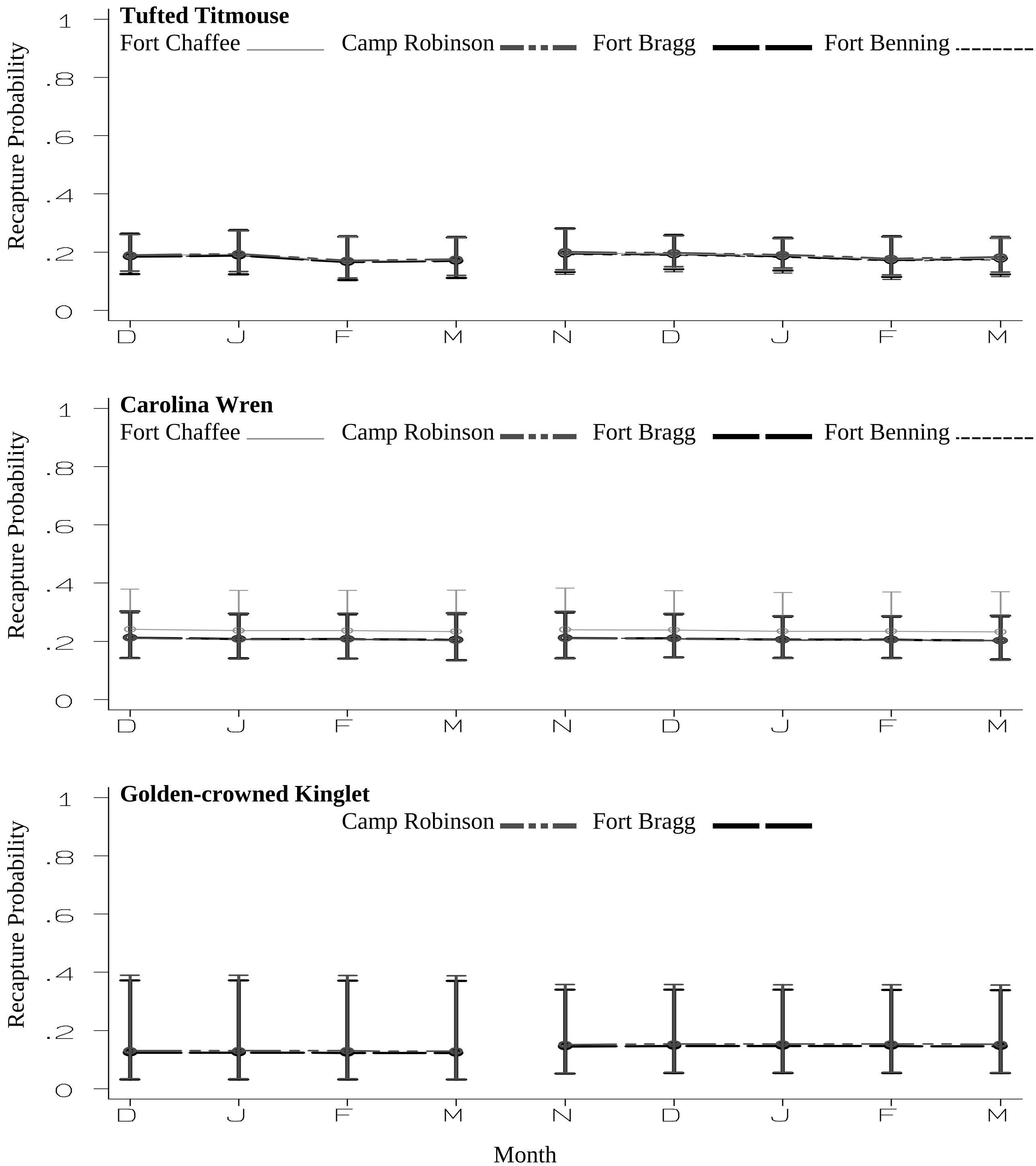


Figure 2. (cont.) Model-averaged recapture probabilities with 95% confidence limits by location for December 2003 through March 2005. Data was included from the 24 stations operated in the 2004-5 season only from locations at which the species met the minimum data requirements (see text) Recapture probability cannot be computed for the first period, November 2003.

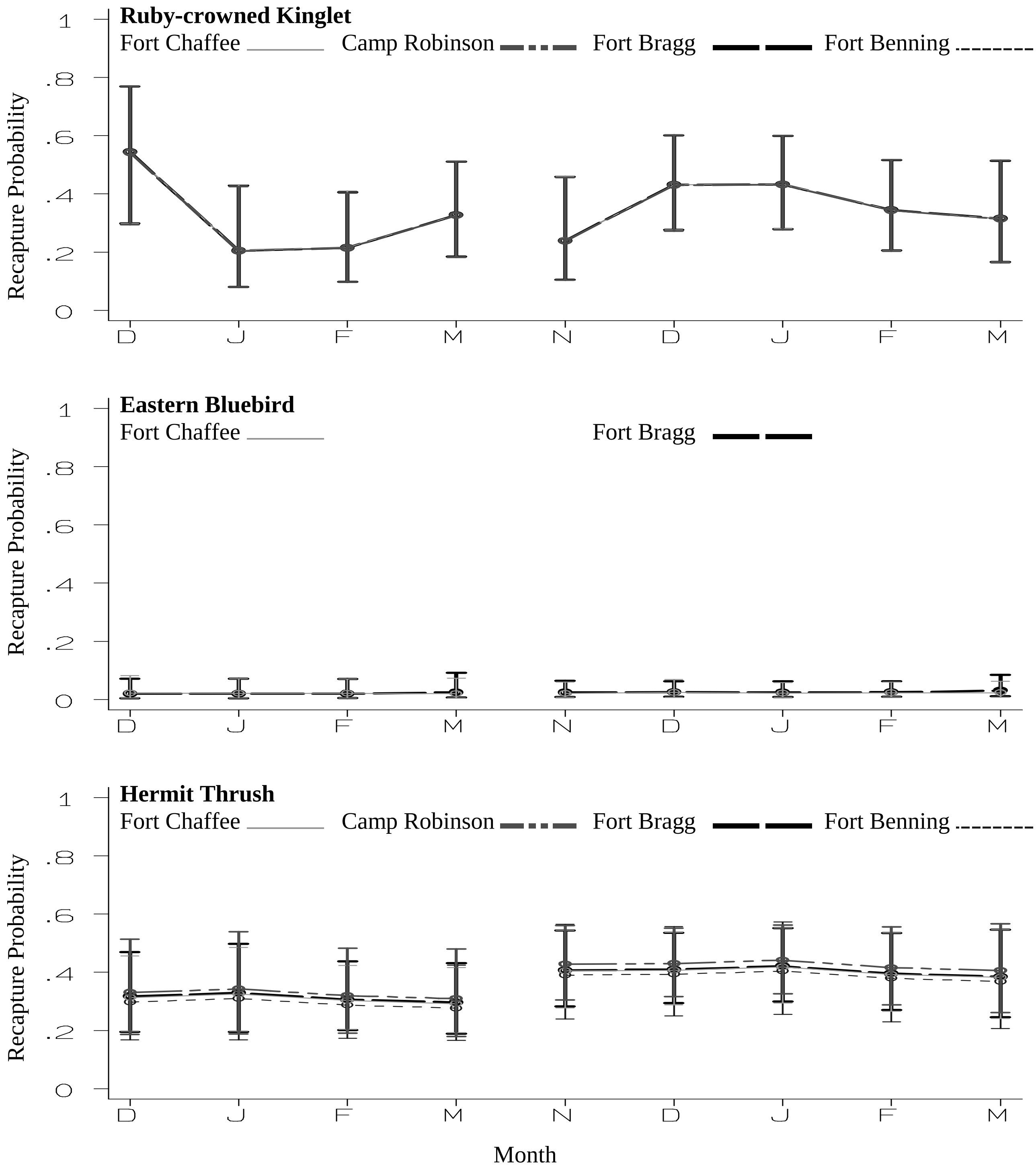
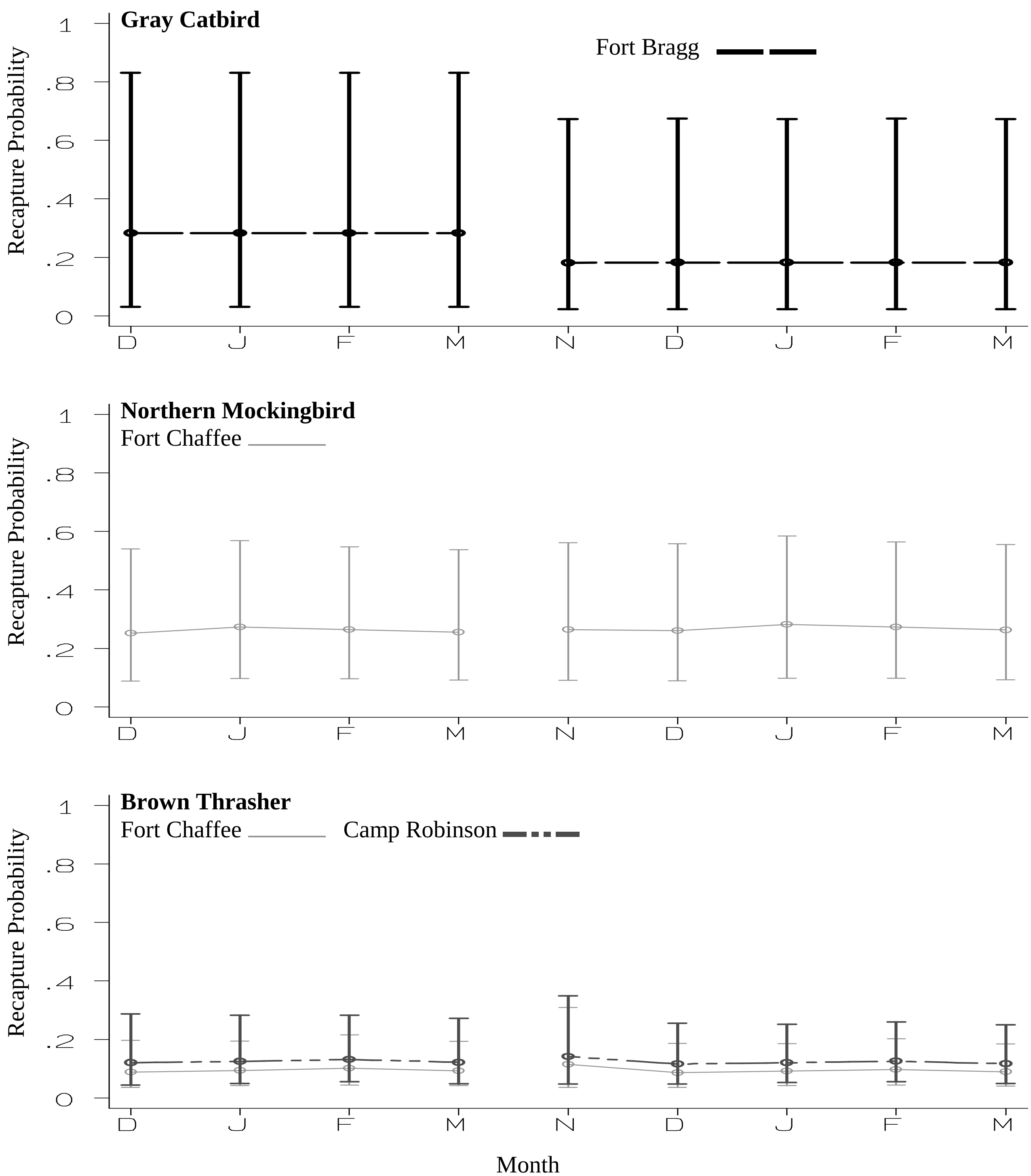


Figure 2. (cont.) Model-averaged recapture probabilities with 95% confidence limits by location for December 2003 through March 2005. Data was included from the 24 stations operated in the 2004-5 season only from locations at which the species met the minimum data requirements (see text) Recapture probability cannot be computed for the first period, November 2003.



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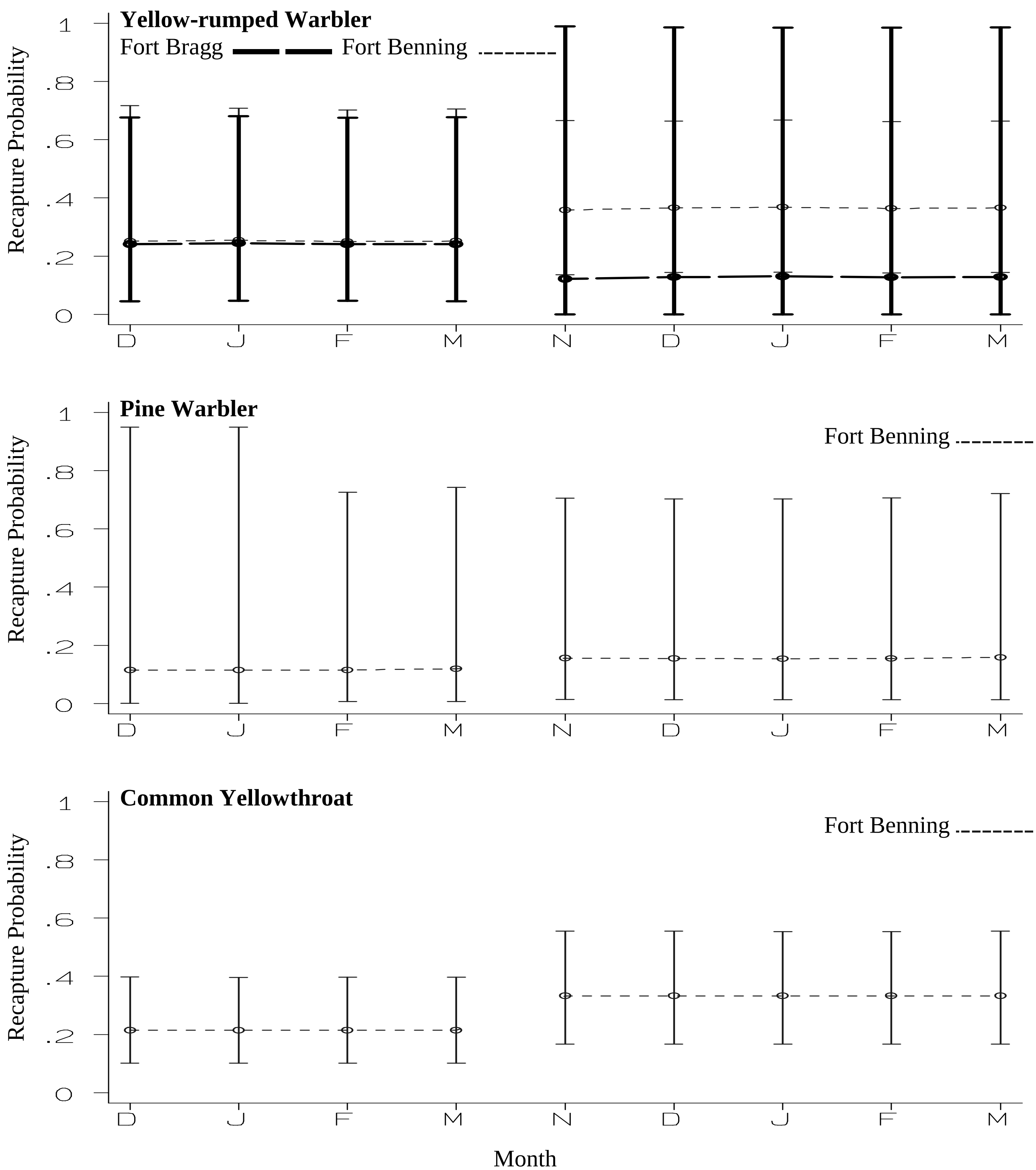

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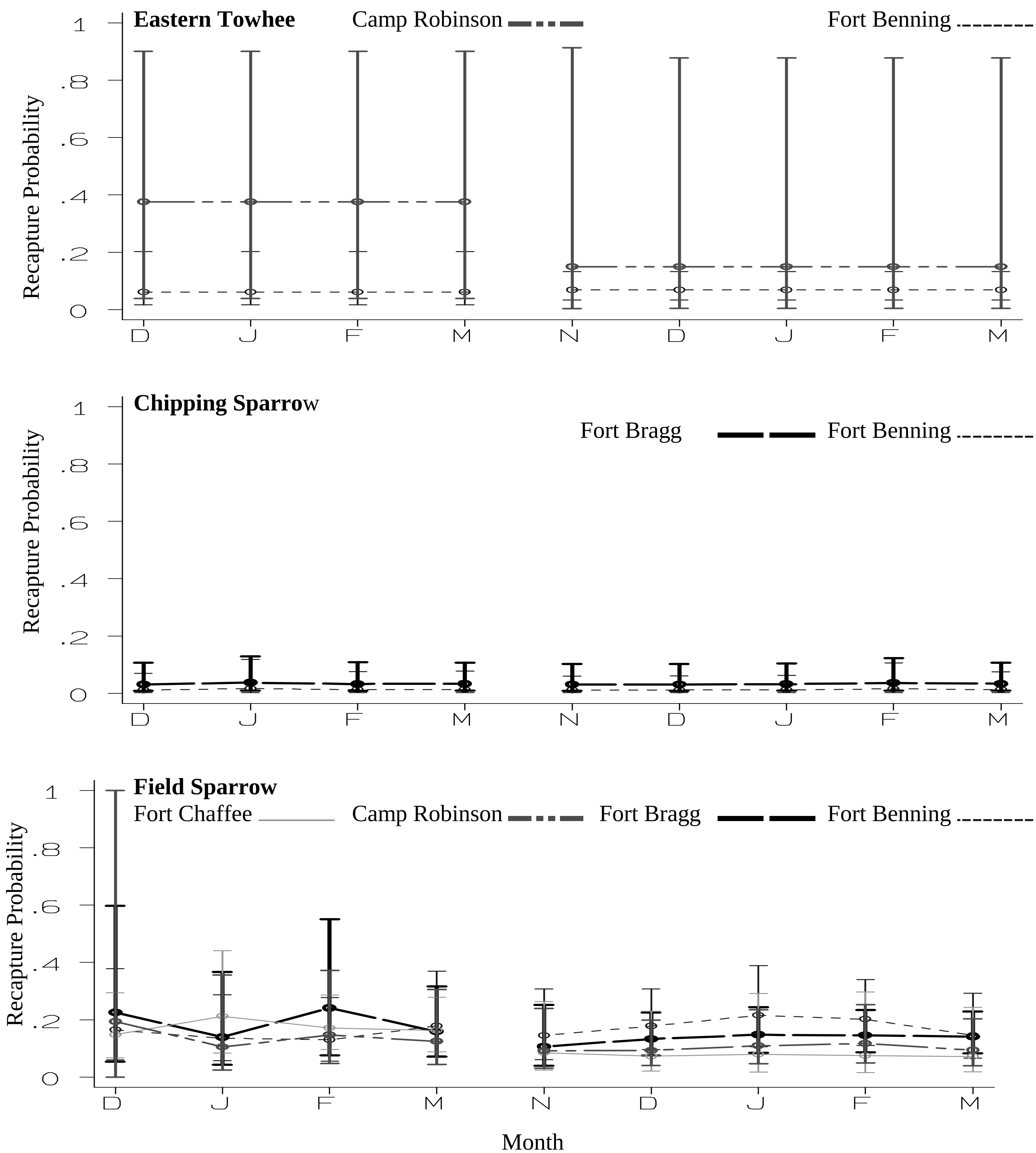

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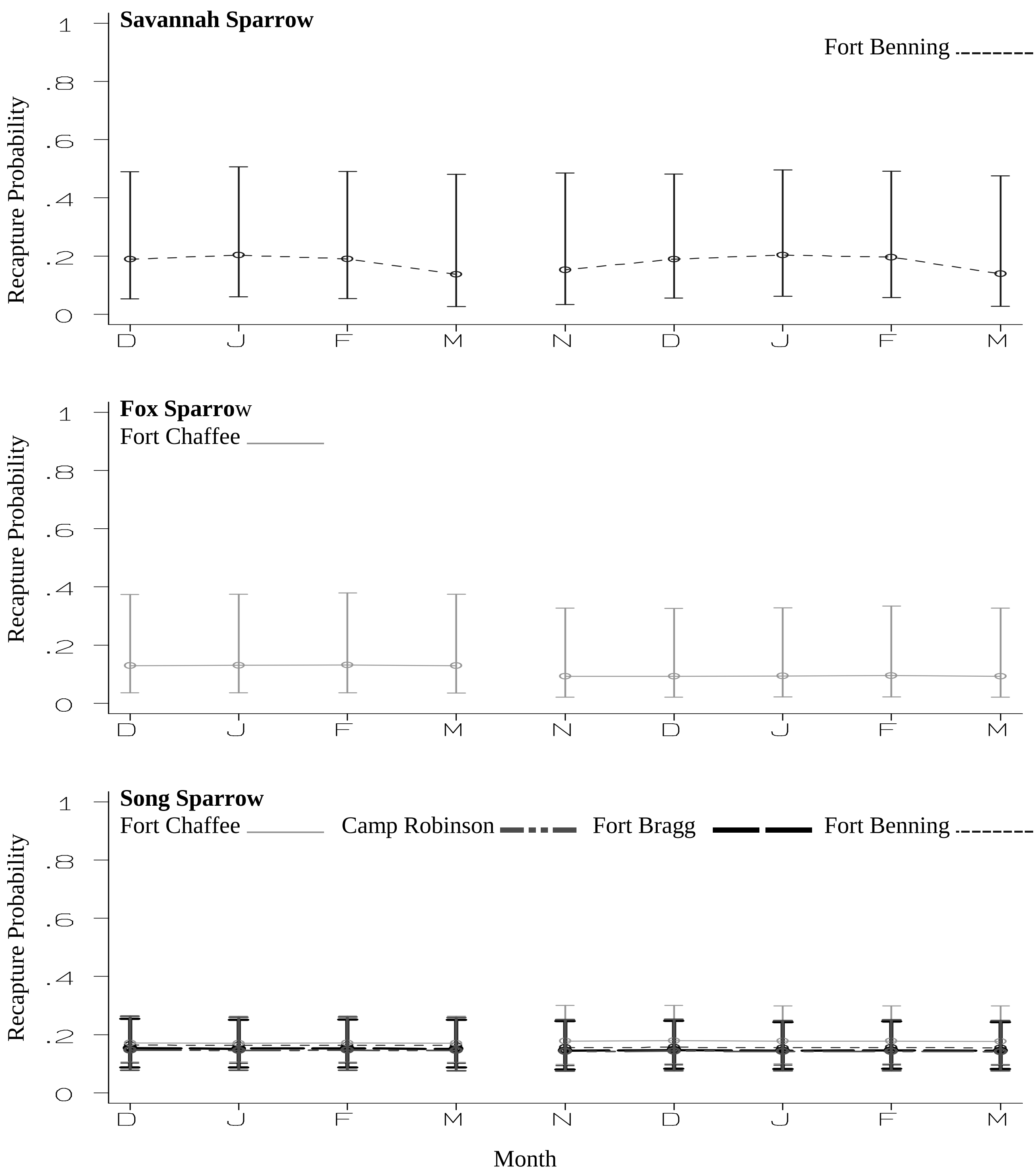

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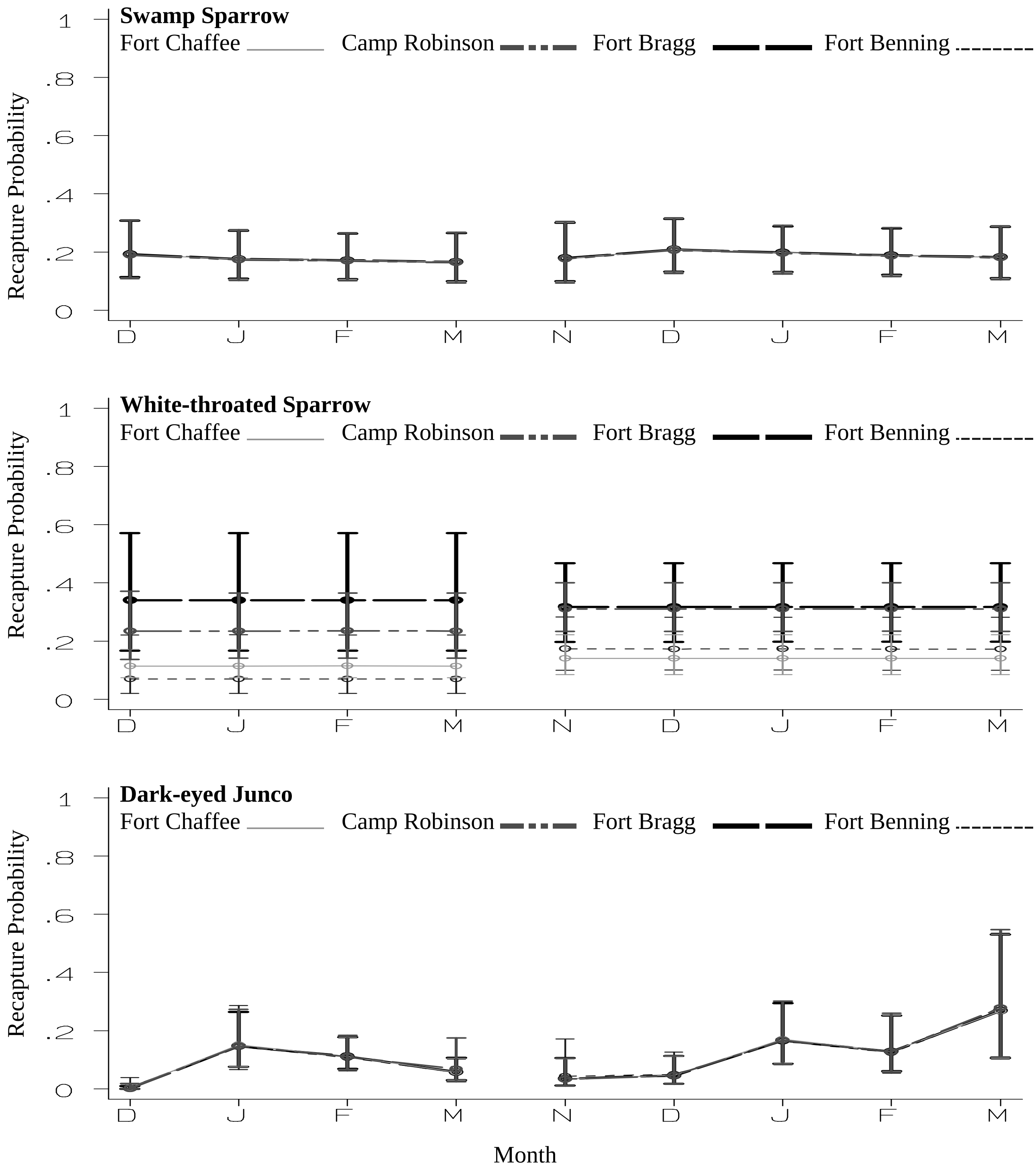

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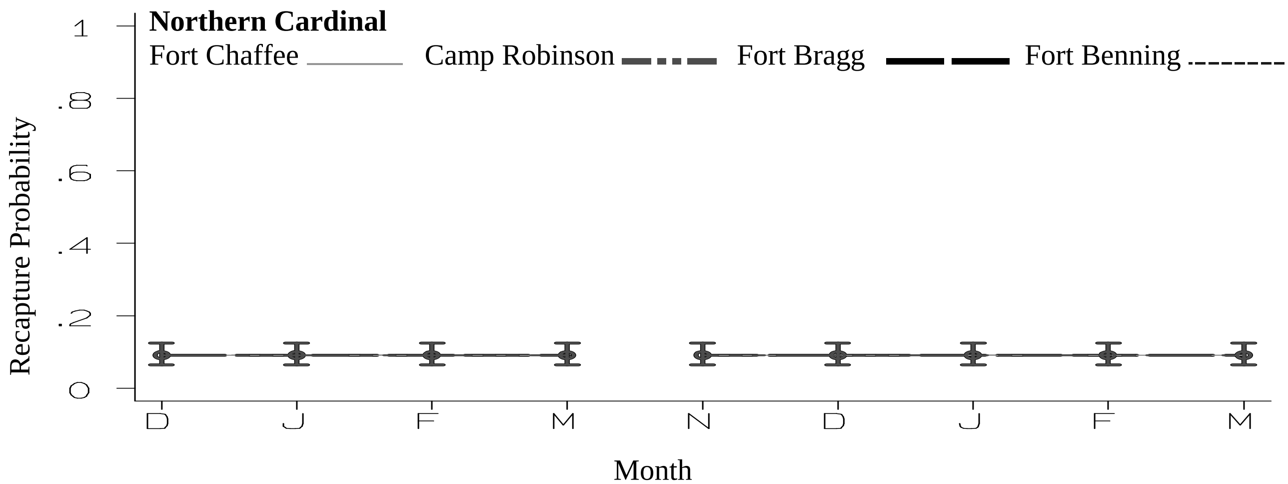

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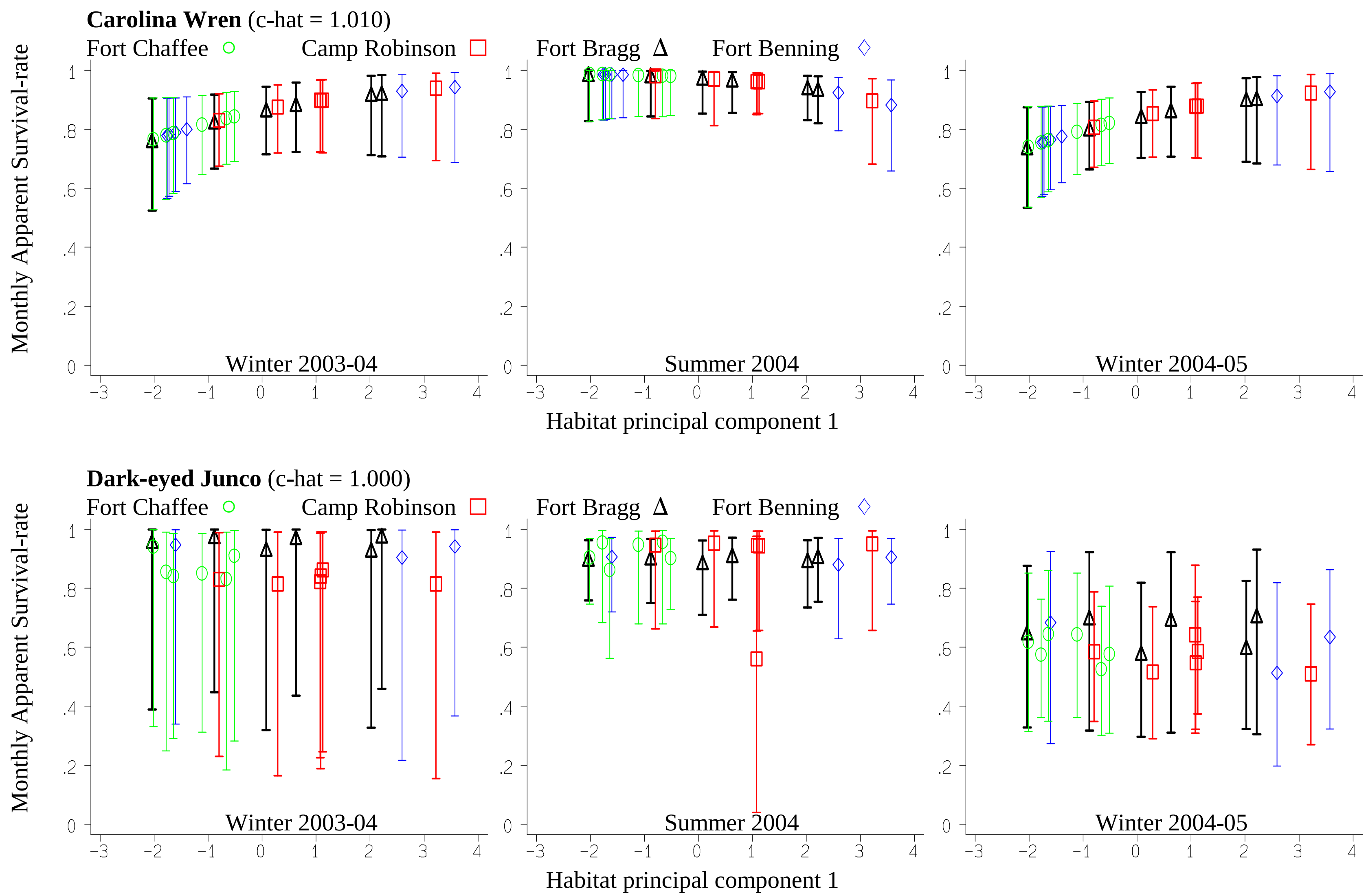


Figure 3. Model-averaged time-constant monthly apparent survival-rate estimates with confidence limits in relation to **habitat principal component 1** (see text for definition) by season (winter 2003-04, summer 2004, and winter 2004-05). Results are presented only for species with strong effects of habitat principal component 1 (w_i>4) on their survival rate (see Table 11). Each value represents a model-averaged survival rate for one MAWS stations at which the species was present at locations that met the minimum data requirements (see text).

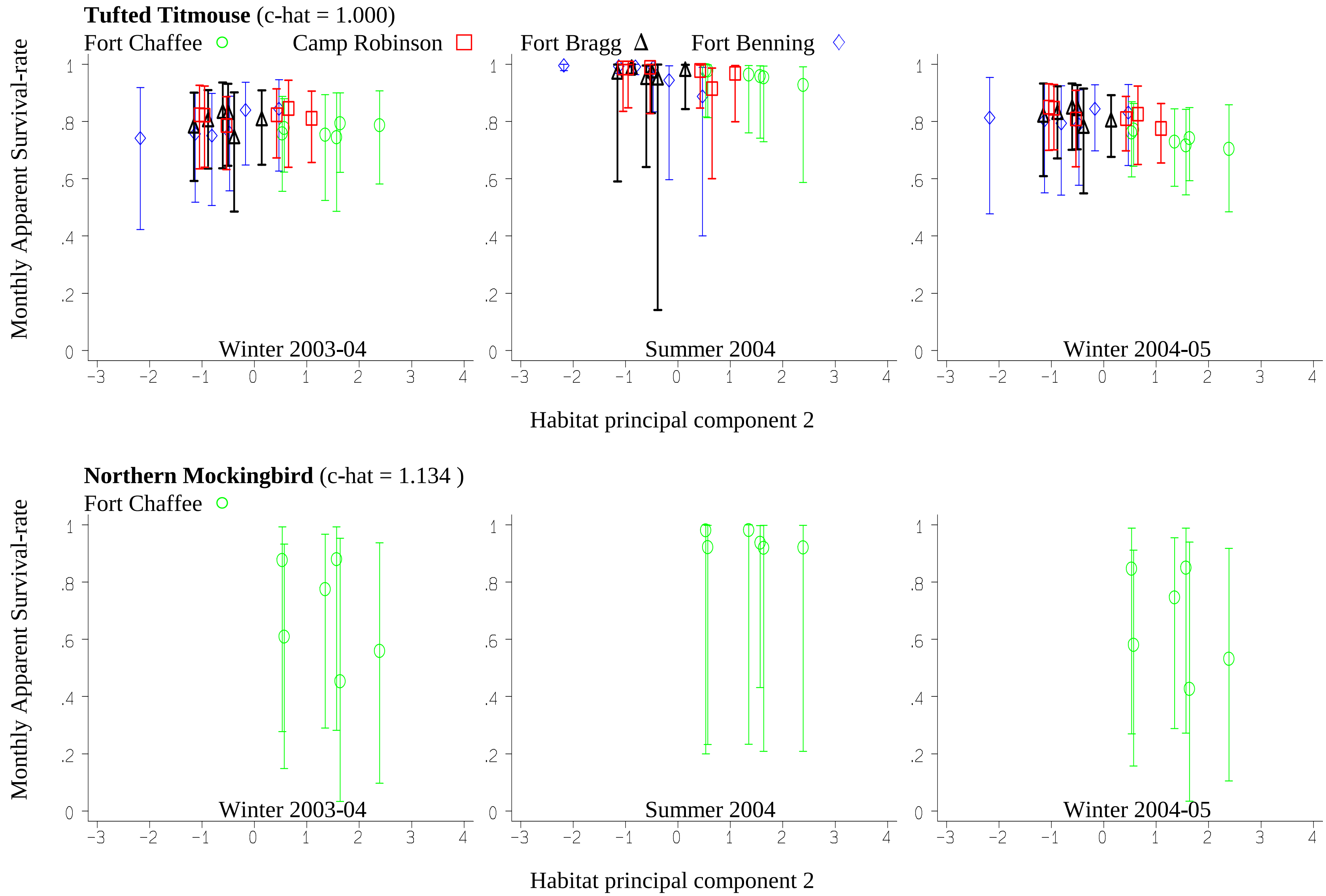


Figure 4. Model-averaged time-constant monthly apparent survival-rate estimates with confidence limits in relation to **habitat principal component 2** (see text for definition) by season (winter 2003-04, summer 2004, and winter 2004-05). Results are presented only for species with strong effects of habitat principal component 2 (w_i>4) on their survival rate (see Table 11). Each value represents a model-averaged survival rate for one MAWS stations at which the species was present at locations that met the minimum data requirements (see text).

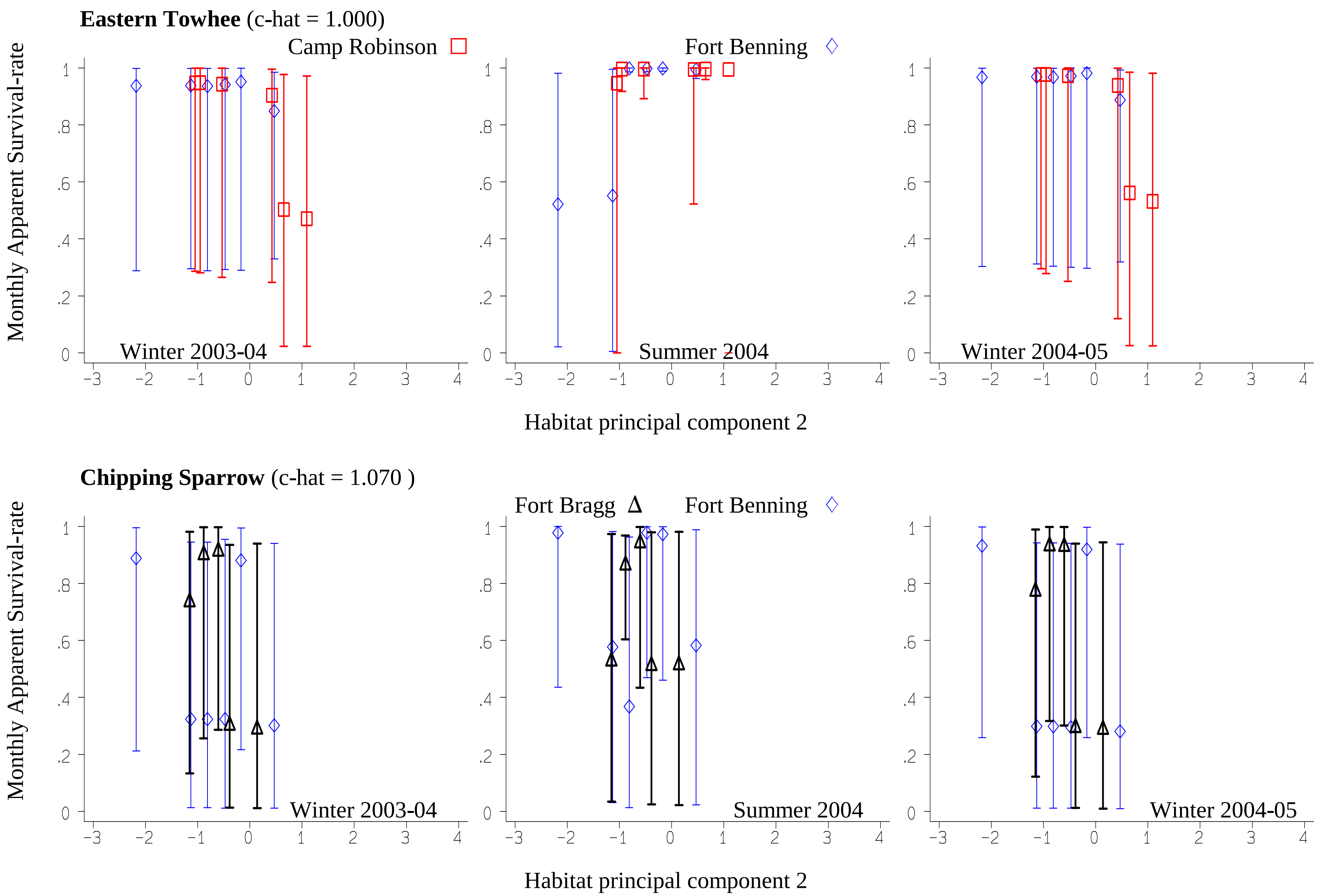


Figure 4. (cont.) Model-averaged time-constant monthly apparent survival-rate estimates with confidence limits in relation to **habitat principal component 2** (see text for definition) by season (winter 2003-04, summer 2004, and winter 2004-05). Results are presented only for species with strong effects of habitat principal component 2 (w_i>4) on their survival rate (see Table 11). Each value represents a model-averaged survival rate for one MAWS stations at which the species was present at locations that met the minimum data requirements (see text).

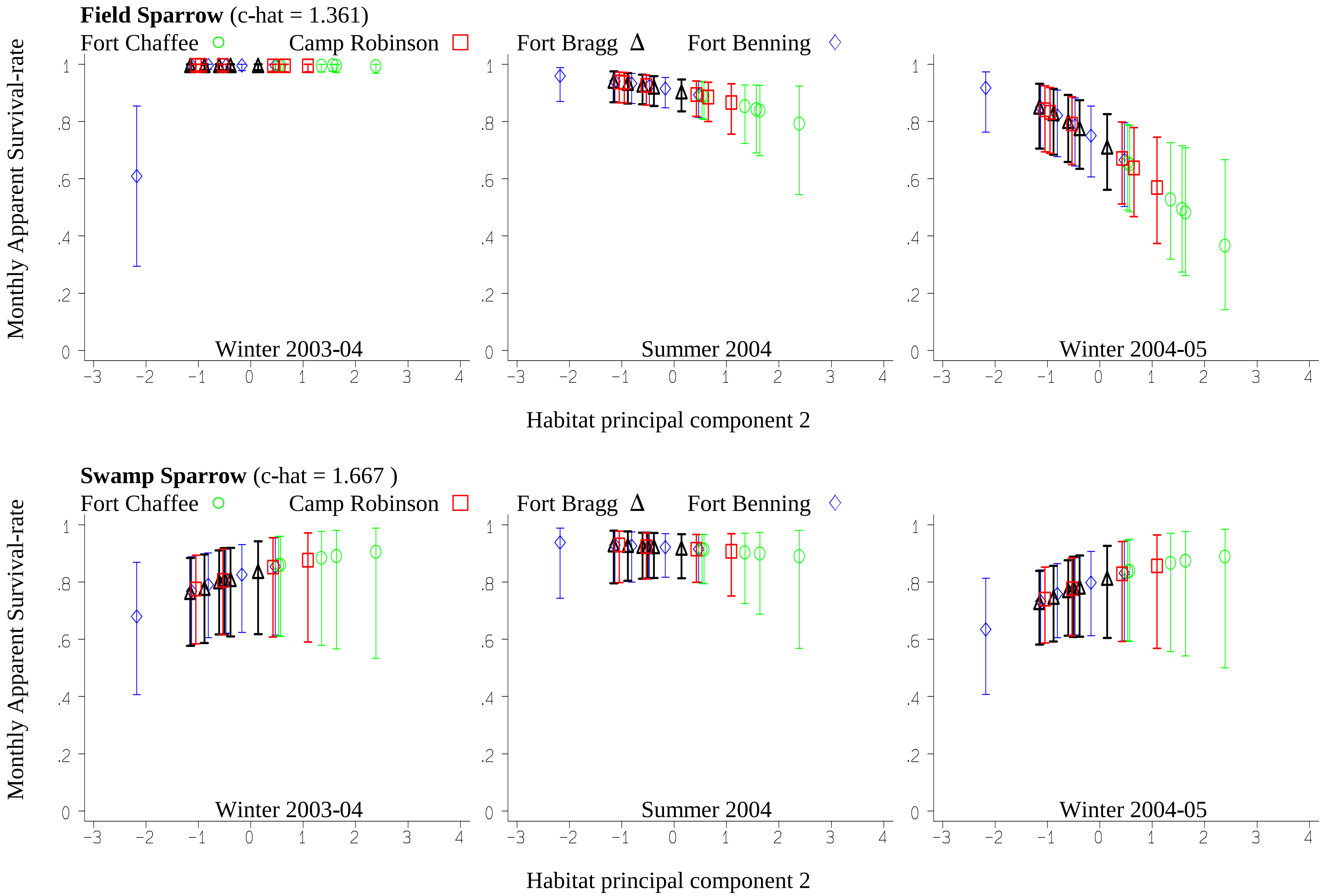


Figure 4. (cont.) Model-averaged time-constant monthly apparent survival-rate estimates with confidence limits in relation to **habitat principal component 2** (see text for definition) by season (winter 2003-04, summer 2004, and winter 2004-05). Results are presented only for species with strong effects of habitat principal component 2 (w_i>4) on their survival rate (see Table 11). Each value represents a model-averaged survival rate for one MAWS stations at which the species was present at locations that met the minimum data requirements (see text).

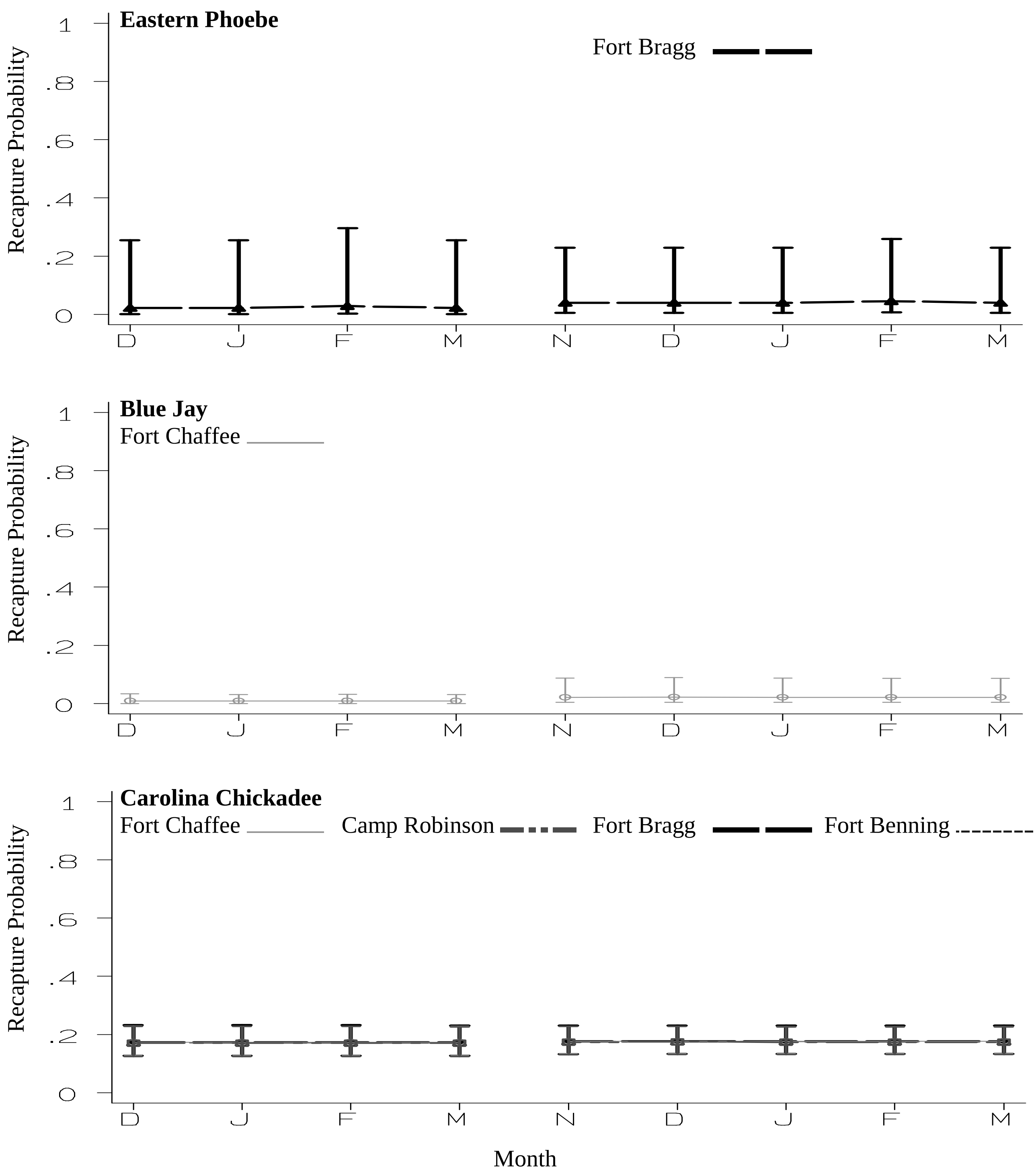
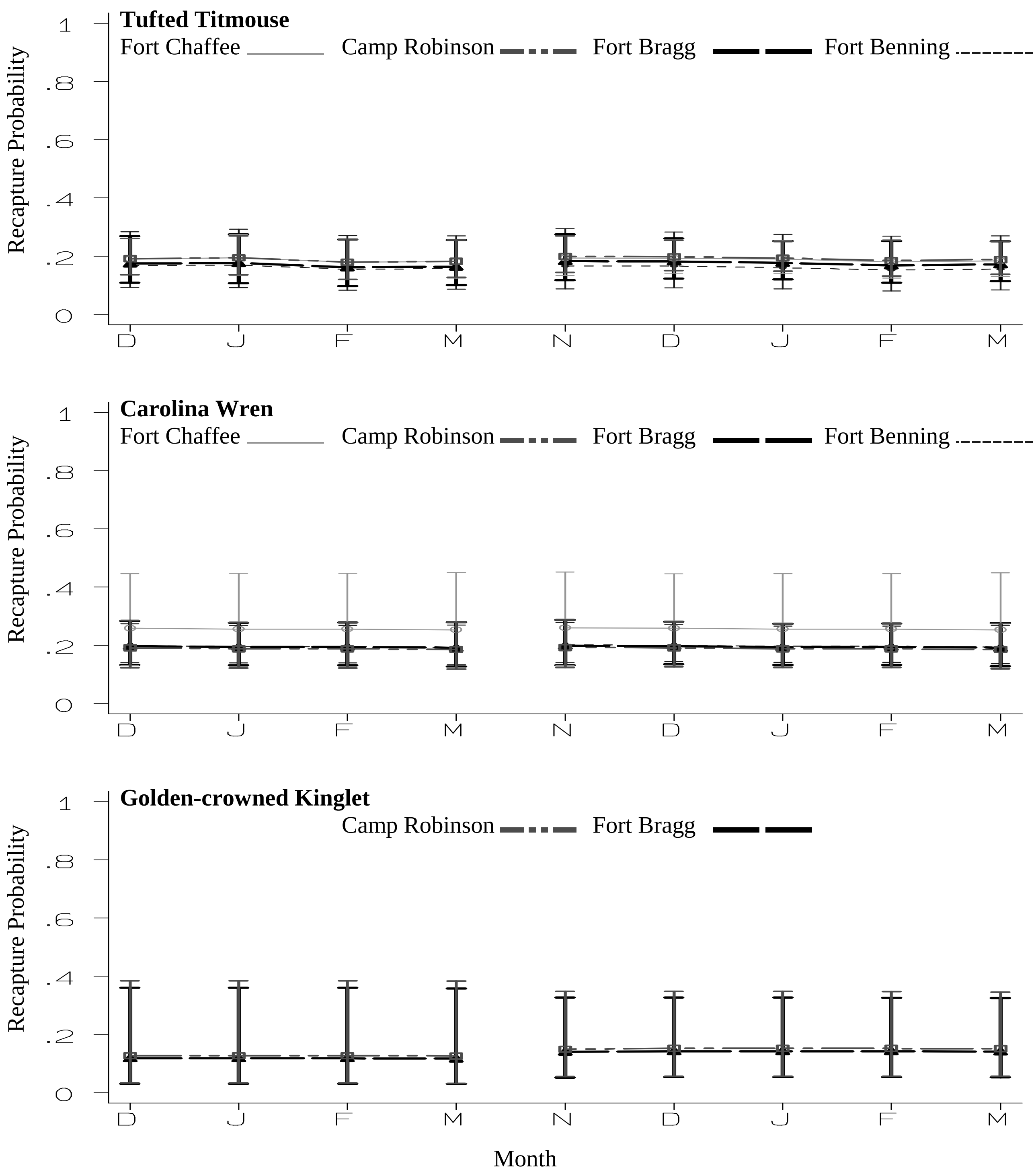


Figure 5. Model-averaged recapture probabilities with 95% confidence limits by location for December 2003 through March 2005 for the **analysis of the effects of principal habitat components on survival**. Data for a species was included only from locations at which the species met the minimum data requirements (see text). Data could be included from the four locations (24 stations) that were operated in the 2004-5 season. Recapture probability cannot be computed for the first period, November 2003.



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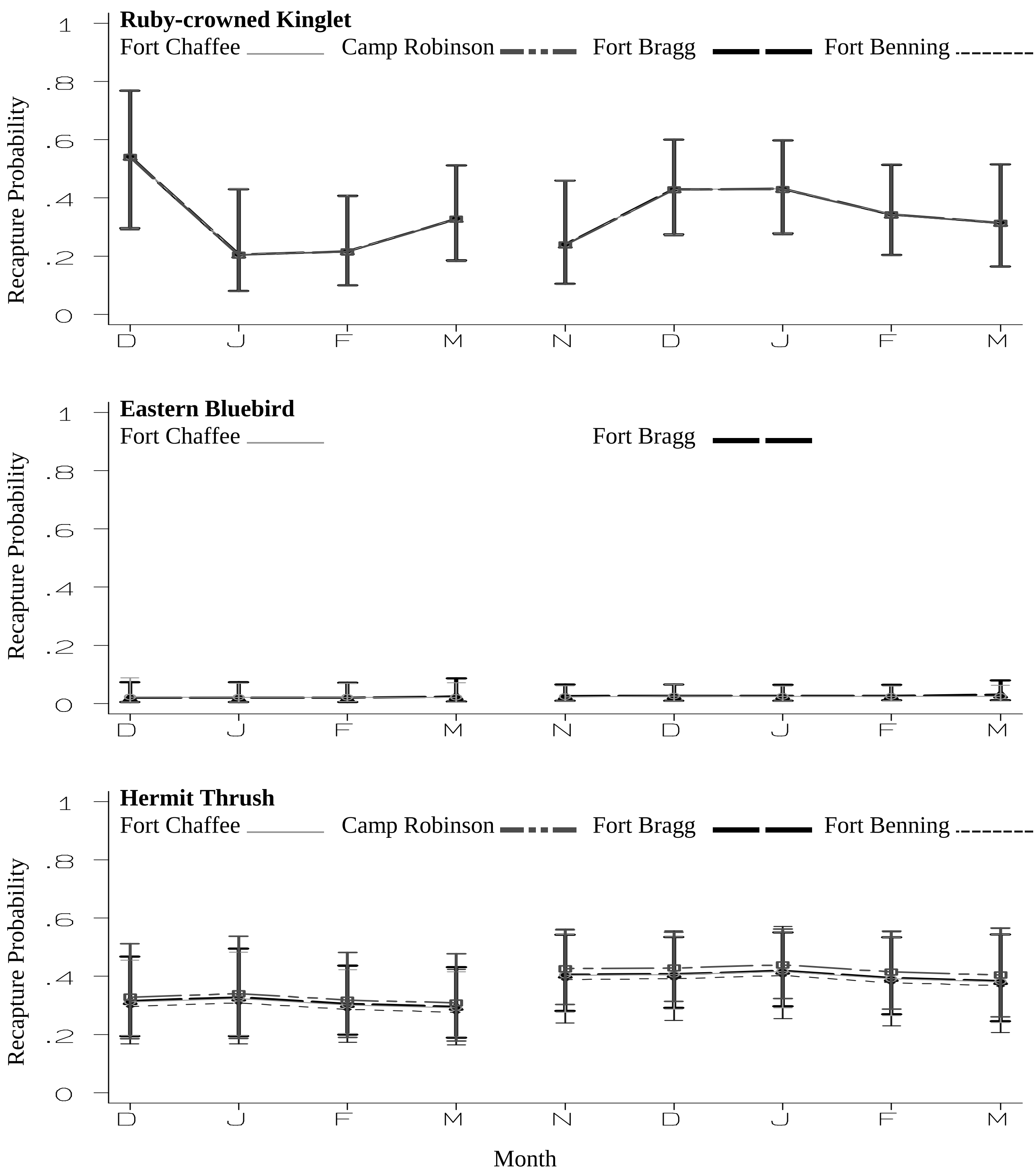

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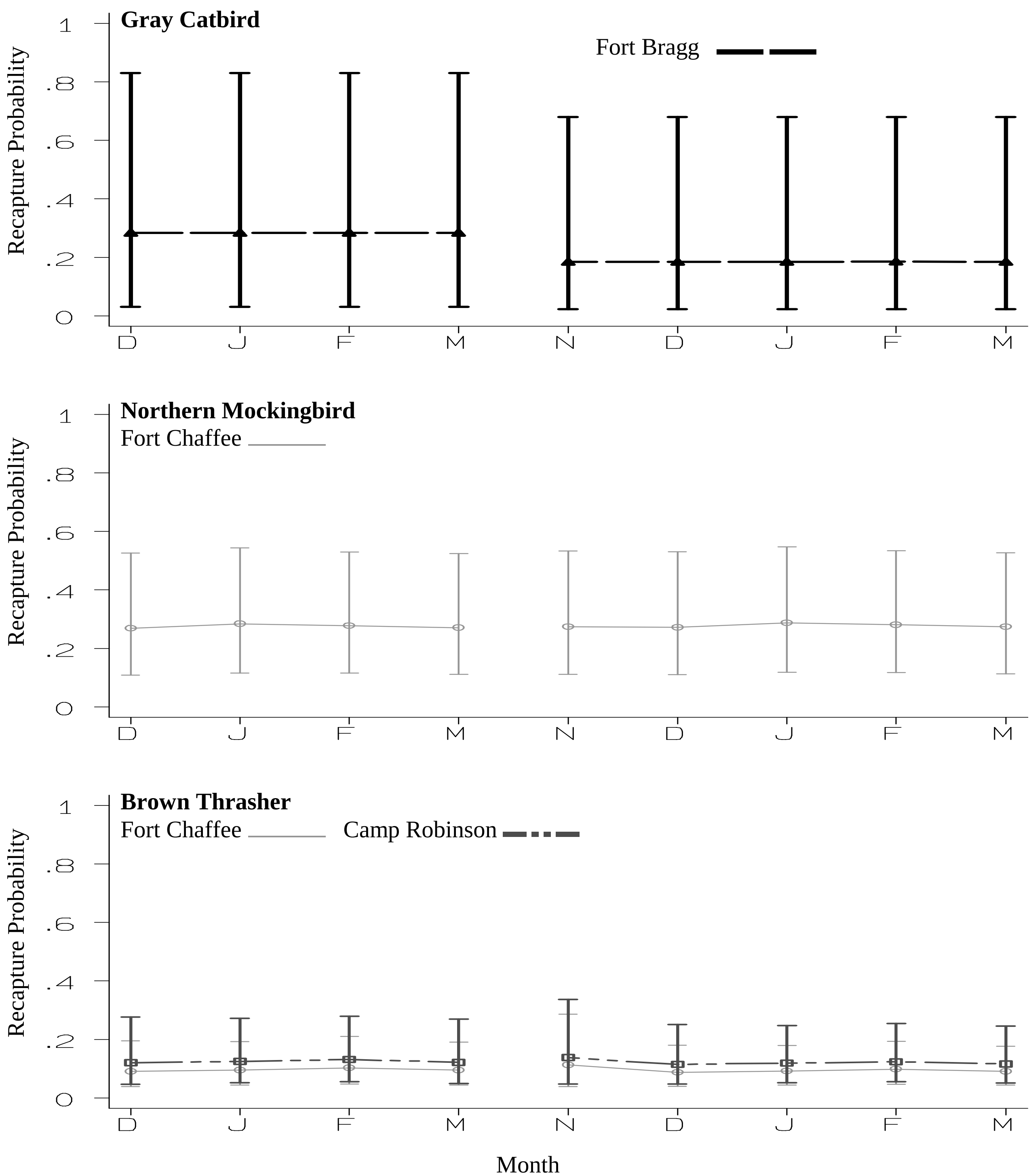

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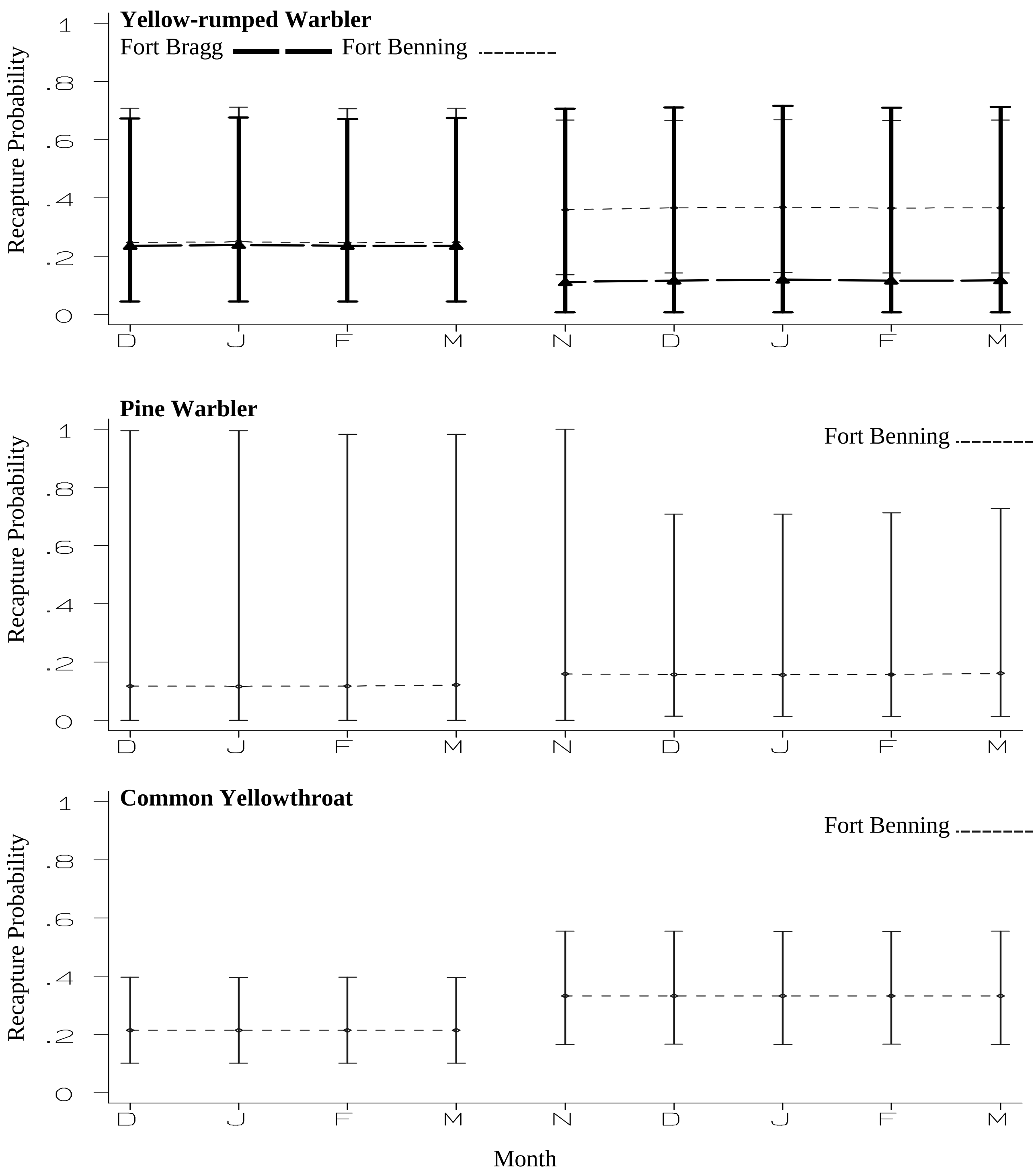

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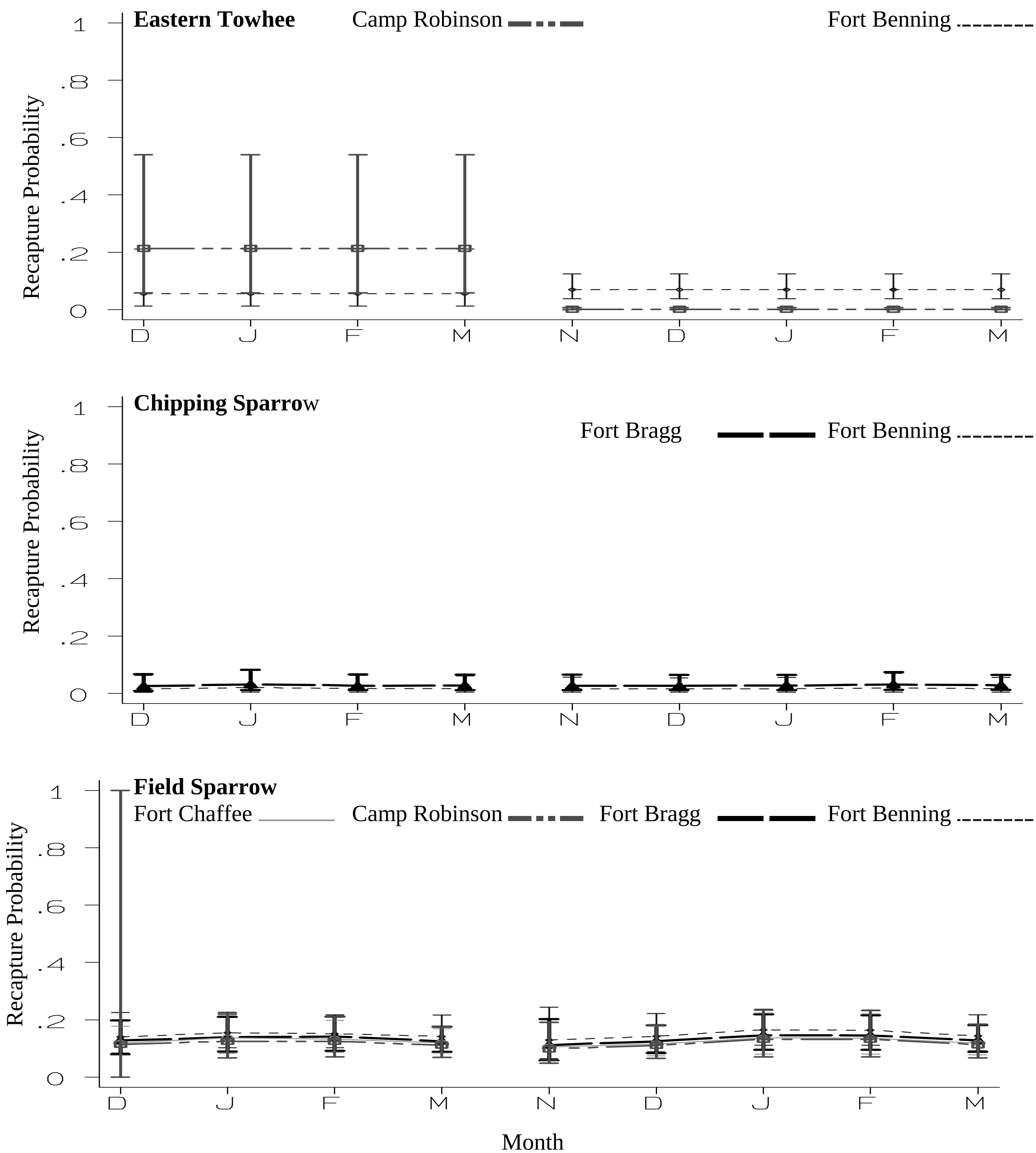

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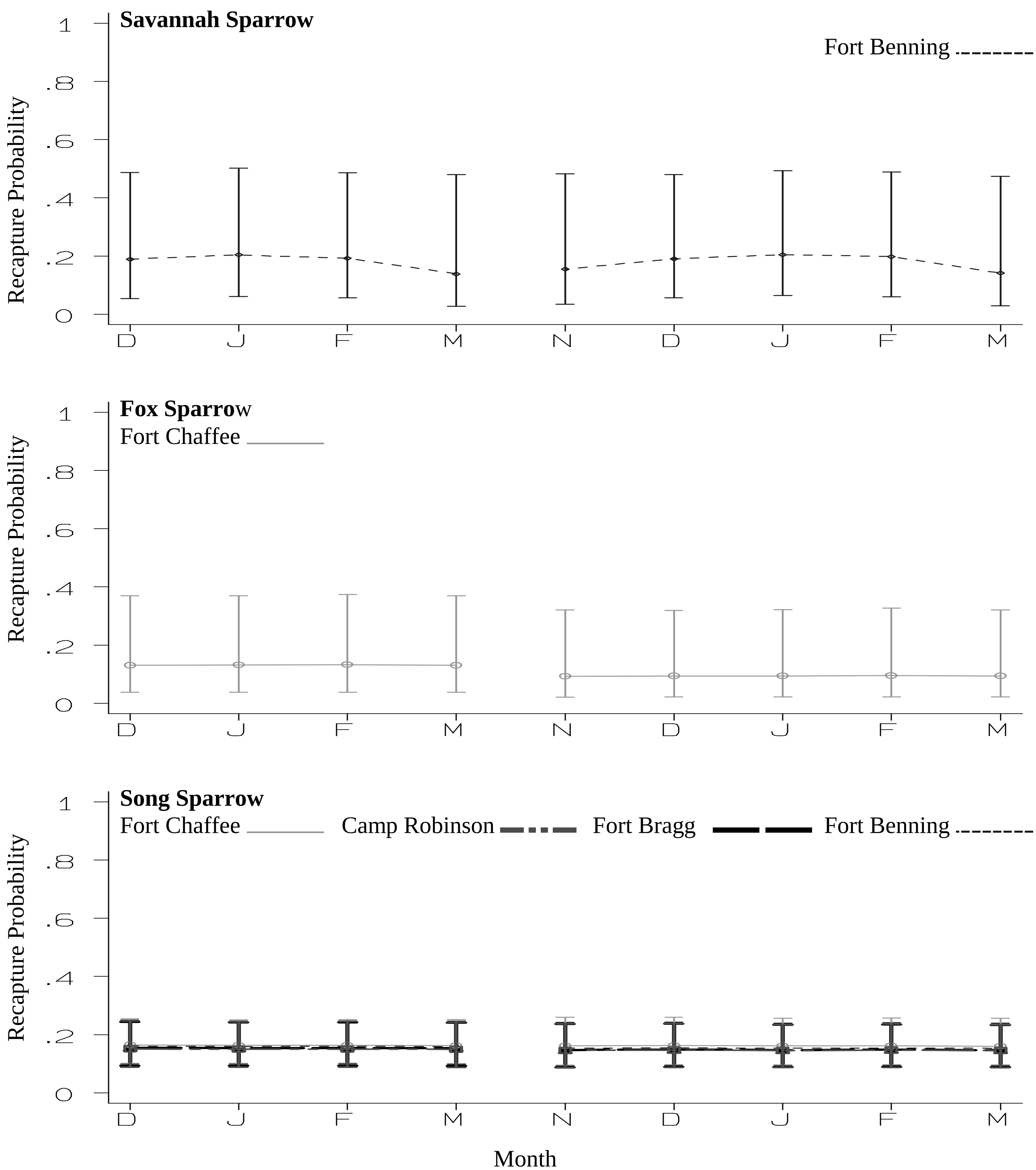

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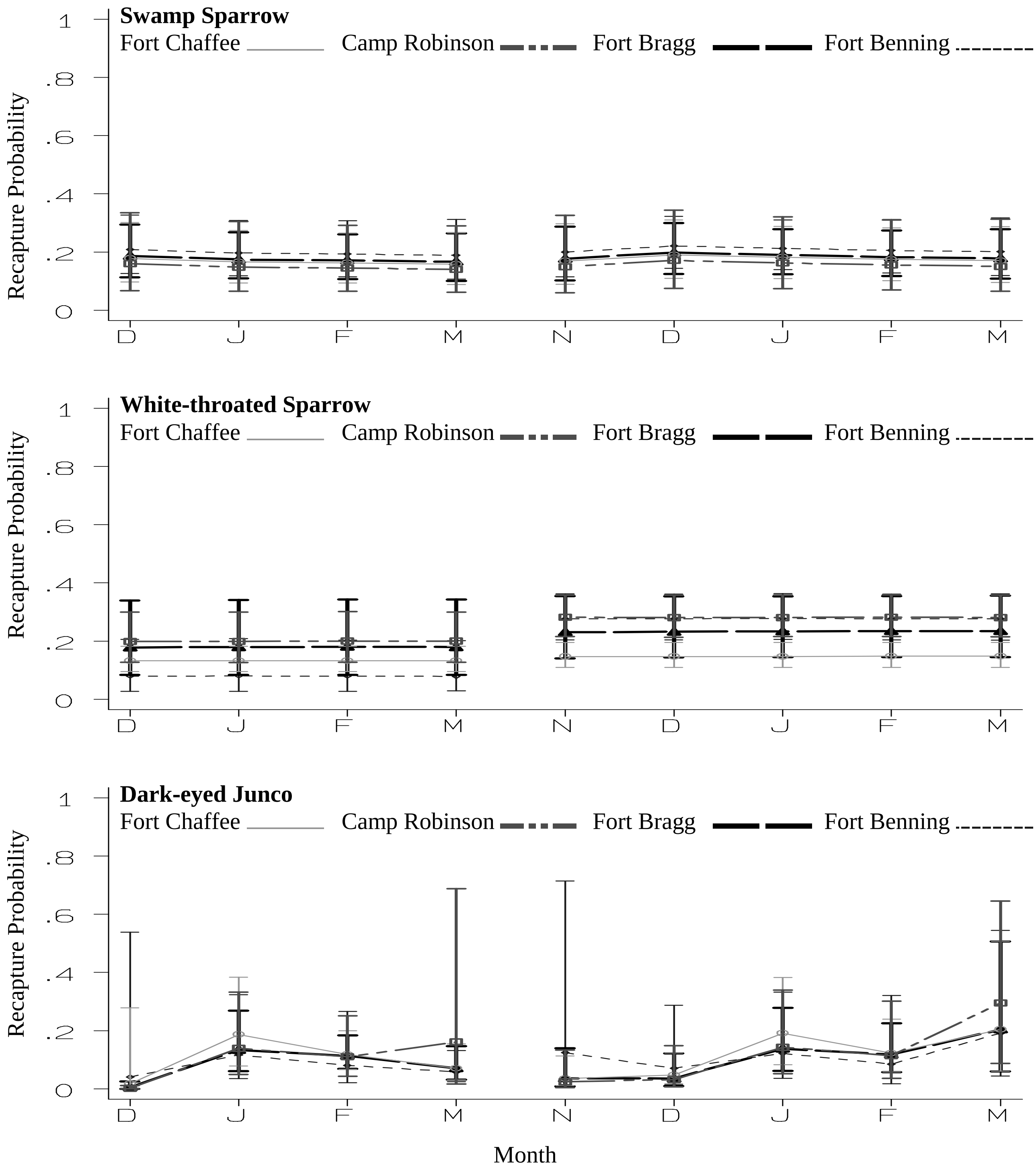

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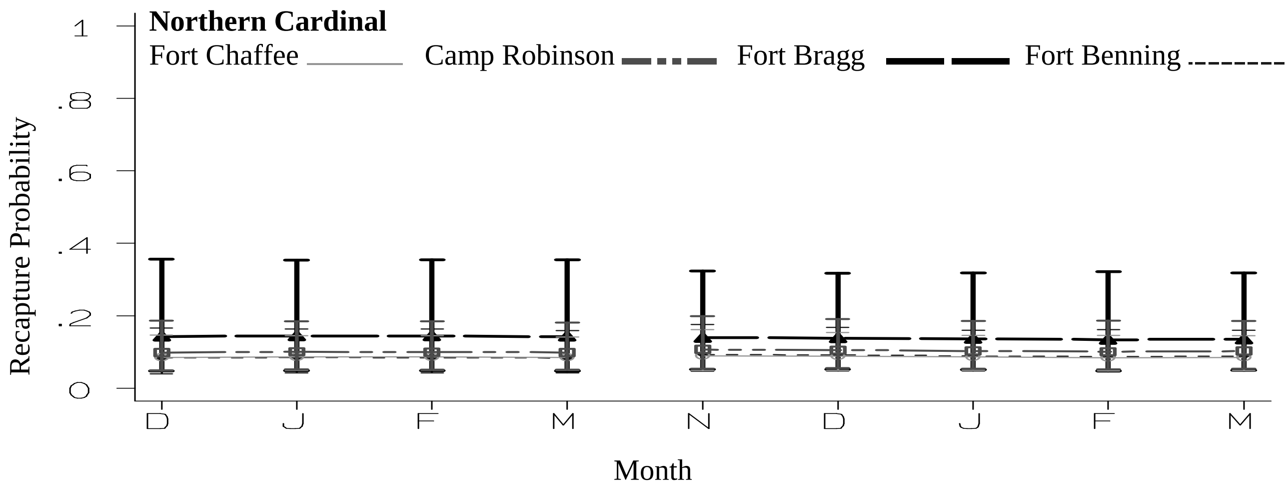

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Appendix. Common and Scientific names of bird species captured at MAWS stations on DoD Installations in the southeastern U.S. in winter 2004-05.

Common name	Scientific name
Sharp-shinned Hawk	*Accipiter striatus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Northern Flicker	*Colaptes auratus*
Eastern Phoebe	*Sayornis phoebe*
Blue Jay	*Cyanocitta cristata*
Carolina Chickadee	*Poecile carolinensis*
Tufted Titmouse	*Baeolophus bicolor*
Brown Creeper	*Certhia americana*
Carolina Wren	*Thryothorus ludovicianus*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Eastern Bluebird	*Sialia sialis*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Brown Thrasher	*Toxostoma rufum*
Orange-crowned Warbler	*Vermivora celata*
Yellow-rumped Warbler	*Dendroica coronata*
Eastern Towhee	*Pipilo erythrophthalmus*
Field Sparrow	*Spizella pusilla*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*

Appendix (continued).

Common name	Scientific name
Swamp Sparrow	*Melospiza georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
Northern Cardinal	*Cardinalis cardinalis*
Common Grackle	*Quiscalus quiscula*
Purple Finch	*Carpodacus purpureus*
Pine Siskin	*Carduelis pinus*