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Landscape Analysis for Grassland Bird Conservation in the Eastern US

Integrating Habitat Management for Grassland Birds with Land Needs for Military Training

Mr. William G. Minser
Dr. David A. Buehler
Dr. James J. Giocomo

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MANAGEMENT OF GRASSLAND, SAVANNAH, AND BARREN HABITATS AT FORT CAMPBELL, KENTUCKY/TENNESSEE

INTEGRATING HABITAT MANAGEMENT FOR GRASSLAND BIRDS WITH LAND NEEDS FOR MILITARY TRAINING

Mr. William G. Minser
Dr. David A. Buehler
Dr. James J. Giocomo

Department of Forestry, Wildlife and Fisheries
The University of Tennessee

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EXECUTIVE SUMMARY

A study of grassland, savannah, and barren habitats was conducted at Fort Campbell Kentucky/Tennessee to provide information necessary for management to meet the military mission and simultaneously provide habitat for grassland birds. Fort Campbell has one of the largest remaining native grasslands east of the Mississippi River. Grasslands are critical to airmobile training operations and are also critical habitat for one of the nation's most threatened group of wildlife, grassland birds.

Native grasslands are recognized by many as one of the most imperiled ecosystems in North America. Unique grassland bird communities are also in danger; grassland birds have shown the steepest decline of any other guild in North America. Grassland habitat management at Fort Campbell and bird use of those habitats were studied from 1999 through 2003. Well over 100 species of birds use grasslands at Fort Campbell for breeding, in winter, and as migration stopover habitat. Since 1938 about 70% (48,000 acres) of Fort Campbell's grassland has reverted to forest; about 13,000 acres were planted to pine and 35,000 acres reverted to forest through natural plant succession. Controlled fire is an effective and inexpensive tool for maintaining native grasslands. However, managed fires have not been frequent enough and/or intense enough to prevent fields from succeeding to forests. Clearing fields of trees with heavy equipment is costing Fort Campbell up to $700/ acre compared to ~$1.00/ acre every 1-3 years to maintain fields with fire. Options for recovery of native grasslands and expansion of field size for military use and improvement of habitat for grassland birds are presented.

The need for open grassland areas for airmobile training is compatible with the habitat needs of most grassland birds. Management to recover and improve native grasslands at Fort Campbell will improve habitat for native birds and simultaneously increase military training capacity and training options in grassland cover. Key ideas for grassland recovery and management include:

- Revise burning schedules of fields and forests to be more flexible. In general, burning has been too infrequent and/or too ineffective to control woody plant invasion, resulting in overgrown fields. Fields need to be burned on a 2-year rotation and forests that are in the burning program on a 2-3 year rotation. Additional burning may be needed until desired habitat conditions are restored. Burning conditions may need to be liberalized to include hotter and drier conditions to make burning more effective at controlling woody invasion.
- Use August and September prescribed burns in fields with extensive when weather and fuel conditions allow, to more effectively control plant succession.
- Convert existing pine plantations and selected oak stands to savannahs through thinning and periodic fires. Savannahs will be more usable for training and provide valuable wildlife habitat to grassland wildlife. Timber sales from thinning could be used to support forestry programs. Additional pine stands could be harvested and converted to native warm season grass (NWSG) fields.
- Convert exotic fescue fields, now about 3000 acres, to native warm season grasses (NWSG) that are less expensive to maintain and much more valuable to wildlife.
- Convert agricultural-lease fields, currently in row-crops and not contributing to the military mission, into NWSG fields.

- Expand the size and number of NWSG fields by combining or expanding smaller fields. This will expand options for airmobile operations, reduce concentrated wear on existing fields and improve habitat for grassland birds.
- Where possible, large-scale land management should be avoided between the beginning of May and the end of August to avoid the critical breeding season of the grassland birds. If mowed field conditions are required for training purposes, mowing operations should start in April and continue every one to two weeks through August to deter birds from using these fields for nesting habitat. Mowing/haying date could be stipulated in Agricultural-lease contracts.
- Command and Control: Insure that there is a clearer understanding of the military mission and land management needs among managing units of the Natural Resources branch: agricultural leasing, forestry, and wildlife management divisions. Controversy on this point at times has apparently led to inefficiency in land management.

PREFACE

A study of grassland, savannah, and barren bird habitats and management at Fort Campbell Kentucky/Tennessee was carried out 1999-2003 with funding from the Department of Defense, the Legacy Program and with support from Fort Campbell and the University of Tennessee. The purpose of this report is to give information to military trainers and land managers to provide landscapes that are optimum for carrying out the military mission and simultaneously provide high quality habitat for grassland wildlife, especially grassland birds.

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INTRODUCTION

Grasslands on military reservations, particularly in the eastern United States, provide important training ground for Department of Defense (DOD) personnel. Grasslands in otherwise forested landscapes are used for drop zones for troops and equipment, helicopter landing zones, and firing ranges. Grassy woodlands, or savannahs, provide excellent landscapes for maneuvering troops and mechanized equipment and for field command posts and encampments during training exercises. Without proper management, however, grasslands become brushy and revert to forests within a few years as a result of natural plant succession (Abrams and Gibson 1990, DeSelm and Clebsch 1990).

Native grasslands include several grasses that grow only in warm weather and are referred to as native warm season grasses (NWSG). The most common of these grasses are little bluestem, big bluestem, indiangrass, switchgrass and broomsedge and are the dominant grasses that comprise remnant native prairies in the Southeast (Scientific names for flora and fauna in this report are in the appendix). On average, the native prairie grass barrens of Fort Campbell are populated by 145 different plant species (Chester et al. 1997).

When European explorers first traversed the area that is now Kentucky and Tennessee, they found a landscape that was mixed hardwood forest and native grassland, and occasionally vast prairies with scattered trees (Baily 1856). Much of the woodlands were open and park-like with grassy understories as a result of frequent fires set by American Indians, a common practice throughout the Southeast (Bartram 1791, DeVivo 1990, Belue 1996). Common reasons cited for their extensive use of fire were: to improve hunting by making movement through field and forest easier, to attract game to green-up areas after fire, to drive game during hunts (fire-hunting), to reduce pest insects, to kill forests and create field openings for agriculture, and for defensive purposes to expose raiding enemies (DeVivo 1990, Goudsblom 1994, Belue 1996).

The effect of persistent burning of the landscape for centuries by American Indians was creation of extensive prairies and pine and oak savannahs. Prairies in Tennessee were described at May Prairie near Tullahoma (DeSelm (1986), in Crab Orchard and Grassy Cove in Cumberland County (Ramsey 1853), and near Nashville. From Nashville, northwest to near Paducah, Kentucky, was an extensive prairie of about 3 million acres known as the Big Barrens or just the Barrens, which includes the land that is now Fort Campbell (Ramsey 1853, Shull 1921, Chester 1988, Belue 1996). Early explorers believed the grasslands were barren of trees because the soil was too poor (Belue 1996). Without the Indians and the fires they set, the grasslands of the Southeast would have been forests instead. Most native grassland in Kentucky and Tennessee were converted to agriculture or reverted to forests when burning the landscape was curtailed after settlement in the 1800s.

North America once contained about 1.4 million square miles of native prairie habitat (Ryan 1986), but native grassland is now one of the most threatened habitats in the U.S. More than 99% of tallgrass prairies east of the Mississippi River have disappeared as a result of agriculture and development (Noss et al. 1995).

Historically, native grasslands of Kentucky and Tennessee supported an interesting array of wildlife including bison, elk, and prairie chickens that were once part of the Barrens landscape (Wilson 1811, Ramsey 1853, Williams 1927, Belue 1996), but have since disappeared. Accompanying the decline of native prairies has been the decline of grassland birds, which have decreased more than any other group of birds from 1966 to 1999 (Peterjohn and Sauer 1999). Grassland songbirds have decreased as much a 14% per year (Askins 1993). Bobwhite quail have declined by nearly 78% since 1966 with projections of an additional loss of an additional 54% of the remaining population in the next 2 decades (Dimmick et al. 2002). In fact, most disturbance-dependent birds have undergone population declines since the 1800s, likely in response to fire suppression in grassland and forest habitats (Hunter et al. 2001). Many state and federal wildlife agencies now list grasslands and grassland management as a top priority (Pruitt 1966, Hunter 1998).

Military reservations such as Fort Campbell with more than 24,000 acres of NWSG have some of the largest patches of native grassland remaining in the eastern U.S. (Fig. 1). Because of the rarity of native prairies in the East, these tracts provide important habitat to a number of songbird species experiencing serious population declines. How these grasslands are managed affect these species.

The goal of this report is to identify management opportunities for improving military training in grassland habitats that simultaneously provide quality habitat for wildlife. In this report we describe the different types of grassland habitats at Fort Campbell, how they are used in military training, how they are currently being managed, the value to grassland birds and management opportunities for improving those habitats for training and bird use.

Figure 1. Example of a large native warm season grass field in drop zone, Fort Campbell, Tennessee, Kentucky. (Photo D. Moss)

MILITARY TRAINING IN GRASSLANDS
MANAGEMENT, PROBLEMS, AND OPPORTUNITIES FOR IMPROVEMENT

General Status of Grassland Habitats at Fort Campbell

The area of grassland available for training continues to decrease as a result of gradual encroachment by trees and shrubs. Approximately 70% (48,000acres) of grasslands on Fort Campbell have reverted to forests during the past 60 years (Fig. 2). While 13,000 acres were planted to pine plantations (Fig. 3) during the 1950's to 1970's, much of the loss of fields has been due to natural plant succession that has occurred because of too infrequent use of fire or fire too low in intensity to control hardwoods or both (Fig. 4, Table 1).

Covertypes Used for Military Training

To develop a grassland management strategy that is compatible with the military mission, training needs for grasslands must be defined. Use of grasslands for military training at Fort Campbell was determined by interviewing training personnel and land managers. We present general land requirements for various types of training in grasslands, problems in managing those lands, value of these sites for wildlife and opportunities for site improvement.

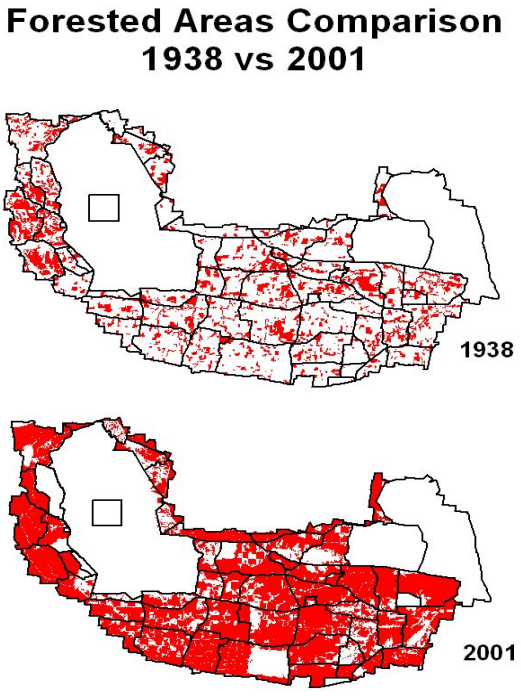

Figure 2. Forested areas (red) in the major training areas at Fort Campbell indicate a 70% loss (48,000 acres) of fields from 1938-2001. The large white area to the west is an impact zone and the two areas in the east are the small arm impact zone and the cantonment area not included in this analysis.

Figure 3. Pine plantations replaced 13,000 acres of fields at Fort Campbell.

Table 1. Area (acres) by cover type class, Fort Campbell, KY-TN.

Covertype Class	Acres
Open Areas	**35662**
NonImpact Zones	17546
Impact Zones	18115
Grass Types	
Cool Season Grasses	2931
Native Grasses/Mixed	32730
Ag Leases	5543
Forested Areas	**57590**
Pine	11426
Hardwood	38150
Forested Impact Zone	8014
Human Developed	**12212**
Cantonment	9301
Old Clarksville Base	2157
Ammunition Supply	420
Demo Area 11	134
Landfill	200
Total	**105464**

Figure 4. Old crop fields are taken over by woody thickets where fire was used too infrequently or ineffectively.

Small Arms Ranges/Impact Areas

Small arms ranges and impact areas are used for munitions ranging from small arms to ground artillery and aerial rocket artillery require tracts from 500 to 20,000 acres. These areas are generally kept free of forests, however, scattered trees and shrubs are acceptable. The small arm impact area totals about 4490 acres. The impact areas for heavy ordinance totals about 21,693 acres (Table 2).

Management and problems: Portions of the impact areas are burned annually, sometimes more often because of incendiary devices or through prescribed burning. Because of frequent fires, few vegetation control problems exist for military training on these sites.

Avian use: Some of the best and largest native grasslands on Fort Campbell are in the impact areas. Most have never been planted to exotic grasses (e.g., fescue), so represent perhaps some of the best native grasslands left in the eastern U.S. Habitat of impact zones is beneficial to several grassland bird species because of the large size of the areas and frequent use of fire. During the breeding season, avian species diversity is the greatest in the largest and the smallest field sizes fields and in those burned annually; bird abundance is also greatest in fields burned annually at Fort Campbell (Moss 2001). Species of concern that seem to benefit most by large, frequently burned fields typified by impact areas include: dickcissel, Henslow's sparrow, Bachman's sparrow, northern bobwhite (quail), and grasshopper sparrow (Moss 2001).

Management recommendations: No management changes are recommended for the impact zones at this time.

Table 2. Area (acres) contained within different classes of training lands, Fort Campbell, KY-TN.

Land Class	Acres
Drop Zones	**3729**
Bastogne	574
Carentan	353
Charlie	102
Corregidor	352
Golden Eagle	479
India	75
November	101
Suckchon	1428
Veghel	265
Impact Zones	**26129**
Small Arms	4490
Large Impact Zone	21639
Training Areas	**65962**
Total	**95820**

Parachute Drop Zones

Drop zones require large grassland tracts with shrubby vegetation kept to 21 inches or less. There are 9 major drop zones on Fort Campbell ranging in size from 75 to 1428 acres (mean = 414 acres) and total 3729 acres (Table 2).

Management and problems: Most drop zones on Fort Campbell are vegetated by cool-season grasses, mostly fescue hayfields. Buffer fields on the periphery of the drop zones are also mostly fescue hayfields. These fields are leased to farmers and cut for hay in May-July. Problems from a land management standpoint include encroachment of trees and shrubs in drainages and borders causing a hazard to airborne troops and equipment (Fig. 5). Fires in border areas may not be frequent enough or intense enough to control woody vegetation. Drop zone buffer fields receive lighter military use and are often in rougher terrain. These fields are sometimes mowed or burned sporadically and as a result, woody plant invasion is sometimes a problem (Fig. 4). Controlled fires in drop zone buffer fields may not be intensive or frequent enough to prevent woody encroachment. Also, rougher portions of some buffer fields may not be mowed for hay every year allowing woody plants to invade.

Figure 5. Woody encroachment in the edge of drop zones is a hazard to paratroopers who may land outside the target area.

Avian use: Hayfield drop zones provide habitat for a limited number of bird species for nesting. Grasshopper sparrows, a species of special concern, show a preference for large fields with low grass height and use fescue drop zones for nesting (Moss 2001). A diversity of songbirds were found to use unmowed fescue fields during the breeding season in Kentucky but Larkin (1997) concluded that unless fescue fields are left unmowed during the breeding season, the use of fescue fields by breeding songbirds would not be significant. And, because at Fort Campbell most fescue hayfields are mowed during the breeding season (May-July) to maximize hay nutrition, fescue drop zones may never provide significant nesting habitat for most bird species.

Drop zone buffer fields, which often are a mix of fescue and NWSG with some low shrubs, are more valuable habitat for a wider diversity of birds than mowed drop zones. Drop zone buffer fields could include most of the grassland bird species nesting on Fort Campbell (Table 3).

Management recommendations: Management of drop zones in cool-season grasses, maintained by haying operations provides for adequate landing sites for airborne and airmobile operations. Quality of bird habitat is considered low in fescue zones although they do receive some use.

- Convert drop zones from cool-season grasses to NWSG. Conversion could be accomplished with a herbicide, such as Plateau, at a cost of about $50/acre and annual burning.
- NWSG would not have to be planted but would reestablish through seeds in the soil-bank.
- Management by fire could be carried out more quickly than mowing and haying equipment would not be in the way of military training. Resulting NWSG fields would support a wider diversity and larger numbers of grassland birds and other wildlife.
- Manage buffer fields with prescribed fires every 1-2 year in February and March or during the growing season in August and September, where woody encroachment is a problem.

Helicopter Landing Zones

Landing zones (LZs) require fields ranging in size from 50-500 acres for landing aircraft and equipment. LZs must be free of trees and should be clear of shrubs taller than 20 inches. There are approximately 81 fields that meet these criteria at Fort Campbell.

Management and problems: The largest of the LZ fields are in cool-season grasses managed as hayfields that are harvested in May-June. The smaller fields are vegetated in NWSG and associated old-field vegetation and managed by prescribed fire (January through March) on a 3-year burning rotation. The most serious management problem for LZs is invasion by shrubs and trees, especially around the field borders. Fields often shrink in size over the years as woody growth invades sometimes to the point that fields become unusable for aircraft. Re-growth of trees, shrubs, and briars in LZs is a continual problem that threatens the safety of airmobile operations (Fig. 6). It appears that fires are not frequent enough or intense enough to exclude woody growth.

Figure 6. Woody encroachment in helicopter landing zones threatens safety of men and aircraft.

Avian Use: Avian use of helicopter landing zones is diverse and depends on field size, and habitat condition, which is a reflection of recent management action. Vegetation height, vegetation density, time since last fire and field size are all factors that affect which bird species use these fields. Small shrubby fields, burned 2-3 years ago, typically are used by prairie warbler, yellow-breasted chat, indigo bunting, northern bobwhite (quail), and wild turkey, whereas large fields with short grass, burned less than 1 year ago, are more likely to be used by field sparrow, eastern meadowlark, and grasshopper sparrow. Henslow's sparrow, white-eyed vireo, and prairie warbler were found in 2-year-old burned fields, which have taller clumps of old, dead NWSG (Moss 2001).

Northern bobwhite (quail) usually prefer to nest in NWSG fields that are 2-years old or older since the last burn (Stoddard 1939, Dimmick 1972).

Management Recommendations: In general, a customized approach to grassland management is recommended with enough flexibility in the program to treat each field as needed to prevent woody vegetation from replacing grassland. A burning rotation of 1 to 3 years, depending on field conditions, should maintain grassland habitat. The 1-3 year burning rotations will assure habitat diversity for the widest diversity of early succession birds. The following approach to management is suggested:

- Revise prescribed fire guidelines so that hotter burns may be preformed. This may mean burning on warmer, less humid, and windier days than regulations now allow. Liberalizing regulations for weather conditions in which burning may be done will increase the number of days available to successfully carry out the burning program and will improve burning effectiveness in controlling woody vegetation.
- Allow for occasional growing-season (August and September) burns to control serious encroachment problems by woody vegetation (Watkins 2002).
- Inspect fields annually for woody vegetation control; carry out corrective management actions as needed.
- Burn most fields on a 2-year rotation. Annual burning may be required for a few years in fields where woody vegetation is a problem. Fields where there is good control of woody vegetation may be burned on a 3-year rotation. Be flexible; burn as necessary.
- Use mechanical and herbicide control of woody vegetation as needed; the need for herbicides or mechanical control will be reduced with a more aggressive burning program.
- Expand the size of individual fields, or combine smaller fields where feasible. Field size is being reduced by encroachment of woody vegetation. Several bird species of special concern need large (>250 ac) fields. Concentrated troop training activities during bird breeding season can have a negative effect on reproductive success. As numbers and size of grassland fields decline, options for military training are reduced forcing training on a smaller number of remaining fields. Larger fields will improve military training options and recover more prairie-like conditions for grassland bird species that have suffered serious population declines.

Small Fields for Gun Emplacements and Troop Movements:

Fields of 1-50 acres are useful for artillery or mortar emplacements, and other training and provide habitat for grassland birds.

Management and problems: Small fields are managed by burning (January through March) on a 3-year rotation and by mowing when needed. Woody growth often shrinks field size as the wood-line invades the field. Often entire fields are overtaken by shrubs and trees, especially if it has been more than 3 years since a field has been burned, mowed, or been under agricultural manipulation. Once trees grow to 3-5 inches in diameter, they can no longer be controlled by fire or mowing. Use of fire may be too

infrequent or not intense enough to control invasion by woody vegetation. Then, chainsaws, chemicals and/or bulldozers are necessary to remove the trees (Fig. 7), which may cost up to $700/acre per acre. During field reclamation, trees are pushed into large piles and sometimes left in the field (Fig. 8). These “dozer piles” are a hazard to airmobile traffic. As dozer piles decompose over the years, shrubs and trees grow in them and within 10-15 years islands of trees develop where the tree piles once were (Fig. 9). This creates new hazards for helicopters and other equipment. It is likely that small fields have been the most vulnerable to being completely lost to plant succession over the years and have had the greatest impact on the cumulative loss of 35,000 acres of grassland since 1938.

Figure 7. Dozer work to reclaim fields may cost $700 or more per acre.

Figure 8 a and b. Dozer debris piles left in fields cause a hazard to airmobile operations and eventually grow into islands of trees (right).

Avian Use: Eighty-four breeding bird species were found in and around fields at Fort Campbell (Table 3 and Appendix 1). Bird species diversity was greatest in the smallest (12-38 acres) and largest (more than 130 acres) field sizes at Fort Campbell with lesser numbers found in medium size fields. Small fields were preferred by indigo bunting, yellow- breasted chat, and prairie warbler and were used by 34 other species.

Management Recommendations:

Controlling Plant Succession

- See Recommendations above. More aggressive and timely use of prescribed fire in combination with other techniques would be the most efficient and economical method for controlling woody plant succession
- To recover or enlarge size of fields, remove competing woody vegetation larger than 2-3 inches in diameter by mechanical or chemical means. Prescribed burn these fields annually as long as necessary until woody vegetation is under control. Burning during the growing season (August and September) may be necessary to control woody encroachment. Then use a 2-3 year burning rotation when satisfactory control is obtained.
- Combine 2 or more fields to obtain desired field size.
- Contracts for field reclamation projects should specify that all woody debris piles must be pushed out of the field into field borders or burned onsite (Fig.9).

Figure 9. Woody debris piles make good cover for wildlife but should be pushed to the forest edge of LZs to reduce damage risk to helicopters.

Woodlands for Maneuvers of Troops and Equipment

Woodlands comprise about 70% (48,000 acres) of the training area of Fort Campbell and provide areas for troop training and wildlife habitat. Fort Campbell's woodlands are about 75% natural hardwood forests and about 25% (11,000) acres are loblolly pine plantations, 20-40 years old.

Management and Problems: Hardwoods are generally not prescribed burned and are harvested by clearcut and selective harvest techniques. Most pine stands have been thinned and burned once within the past 5 years. Some pine stands have been clearcut and converted to other habitats. Woodlands managed in an open, grassy condition are known as savannahs (Fig. 10) and facilitate use by troops and vehicles. Savannahs are the result of frequent burning of the forest usually associated with forest thinning. Some oak savannahs exist at Fort Campbell, particularly in the impact area where fires are

frequent. Those savannahs were apparently not the result of planned management to create them but the unintended result of burning practices. Nevertheless, these savannahs are important for training purposes and especially important for wildlife. Portions of other hardwood stands have the potential to be managed as oak savannahs, which could improve usefulness for certain types of training. Pine plantations are currently not being managed with the intention of creating savannahs.

Figure 10. Pine savannahs are created by forest thinning and prescribed fire every 1-2 years and provide good conditions for military training and wildlife habitat.

Most existing pine and hardwood stands are too thick for maneuver of troops and equipment (Figs. 11 and 12), thus lands in this condition are greatly underutilized for training purposes. Although pine-thinning operations are underway, better control of understory vegetation would improve usability for training. Most thinned pine stands are still too dense to allow access to vehicles and too brushy to allow for reasonable troop movement or development of a grassland understory (Figure 13). The number of years between burns is too great and/or fires are not intense, and the stocking rate is still too high to control woody vegetation in the understory and promote a savannah type condition in thinned pine stands (Fig. 14).

Figure 11. Hardwood stand with narrow tree spacing making movement of vehicles and equipment difficult.

Figure 12. A pine stand too thick with brushy understory to allow adequate movement of troops and equipment.

Figure 13. Pine stand thinned through a commercial sale and burned 4 months ago. Woody plant re-growth will result in dense, woody understory in 3 years without fire; grass cover will not develop.

Figure 14. Pine stand thinned and burned 3 years ago. Tree spacing is too dense and woody growth too thick for optimum troop and vehicle movement or grassland development.

Creation and management of savannahs has not been set forth as a management objective although some savannahs do already exist by default. Pine plantations (11,000 acres) offer tremendous potential for improved cover for training and grassland habitat if managed toward savannah conditions.

Avian Use: Although oak forests and oak savannahs undoubtedly provide important wildlife habitat, we have not evaluated avian use of these habitats as part of this study at Fort Campbell. Studies by others showed that thinned and burned mixed pine-hardwood stands provide useful habitat to a mix of forest and grassland birds in other parts of the Southeast. Woodpecker and flycatcher species, Bachman's sparrow, prairie warbler, and northern bobwhite and others benefited from pine-grassland management in Arkansas (Wilson et al. 1995).

Management recommendations:
Pine Forests- Pine plantations present opportunities for improvement in terms of military training and for birds favoring grassland habitats. Two options include creating pine savannahs through thinning/burning or creating NWGS grasslands through clearcutting/burning.
Pine Savannahs: In hot weather savannahs would provide shaded conditions for troops in training and reduced heat stress (Fig. 15).

- Thin the pine stands during summer or fall to a basal area of ~20-30 square feet/acre.
- Remove or slash down all hardwoods; leave scattered dogwoods and other soft mast producing hardwoods.
- One year after thinning, apply a herbicide, such as Arsenal™, to the re-sprouting hardwoods where hardwood invasion is significant. Avoid spraying the soft mast-producing hardwoods (Fig. 16).
- Begin an annual burning program in late winter to control woody vegetation and remove slash. NWSG will begin establishing naturally; annual burning may be required for 5 or more years to control woody growth (Fig 17.).
- Use additional herbicide treatments to control woody growth where necessary. A 1-3 year burning rotation may suffice once hardwood competition is controlled.
- When pine stands have regrown to a basal area of 70 square feet/acre, thin again back to ~20-30 square feet/acre and repeat burning cycle.

Figure 15. Thinning a pine stand to ~20-30 square feet/acre and slashing down all hardwoods is the first step to creating a pine savannah. Timber sold will pay for the operation and should result in net revenue gain.

Figure 16. Herbicides and/or annual fire (August and September) may be needed in understories where hardwood competition is intense. This stand was burned 3 years ago. Additional thinning and annual fire will be needed to create a pine savannah.

Figure 17. Annual prescribed fires may be necessary to establish and maintain grassy understories in savannahs. Once native warm season grasses are established, controlled burns every 2-3 years suffice.

Pine Conversion to Grassland: Pine stands can be converted to open, native grasslands by clearcutting.

- Clearcut in late summer or fall. Slash down all unmerchantable trees.
- Chip on site or otherwise remove all felled, unmerchantable trees greater than 2 inches in diameter.
- One year later, apply a herbicide, such as Arsenal™, to control re-sprouting hardwoods.
- Burn with a hot fire in late winter after herbicide application.
- Burn as often as necessary (annually at first, every 2 years thereafter) to control hardwoods and maintain NWSG.

Hardwood Forests: The amount of closed-canopy hardwood forest and open-canopy hardwood forest (savannah) needs to be set in objectives that integrate military and natural resource (forestry and wildlife) considerations. Because hardwood savannahs are potentially important for military training and are very important for wildlife, conversion of some portion of closed-canopy hardwood forests to savannahs is desirable (Fig. 18).
Hardwood Savannahs: For those stands that are targeted for creation of hardwood savannah conditions, the following is recommended:

- Thin stand to ~20-30 square feet/acre basal area; leave mature oaks and hickories.
- Apply herbicide, such as Garlon™, to resprouting hardwoods the following August.
- Prescribe burn in late winter; low intensity burns (sometimes in August and September) may be required annually over 5-10 years to control hardwoods (DeSelm and Clebsch 1990, Waldrop and Lloyd 1990).
- Burn on a 2-3 year rotation after hardwood sprouting is controlled.
- NWSG will occupy the understory as a result of natural succession and fire; planting NWSG should not be necessary at Fort Campbell.

Figure 18. Oak savannahs can provide shade that is useful for troop training and important wildlife habitat. Establish by thinning hardwood stands to ~20-30 square feet/acre and maintain with low intensity fires. Sale of the timber should pay for the thinning operation.

Agricultural Leases and Other Grasslands

Agricultural leases (ag-lease) provide open field conditions while giving economic opportunities to local farmers. Agricultural lands are typically leased for hay, soybean and corn production and cover about 5500 acres on Fort Campbell. Most drop zones are managed through a hay lease program. When carried out successfully, land management is done with reduced cost to DOD. Since 1938, about 35,000 acres of fields were withdrawn from the ag-lease program and were allowed to revert to forest conditions. As a result, training areas requiring open field conditions were greatly reduced.

Figure 19. Abandoned ag lease field returning to forest conditions; ~35,000 acres of fields have reverted to oak-hickory forests since 1938.

Management and problems: Ag-leases are managed in row crops (corn and soybeans) or hay (fescue). Although hay fields provide appropriate conditions for training, it is becoming increasingly difficult to attract area farmers to manage these fields, especially in fields heavily used for training. In addition, hay fields are of limited value to wildlife. Row crops may be more useful to some wildlife as a food source but are of very limited value for training. In balance, then, it could be argued that lands devoted to the ag-lease program could be reduced, based on the demand for leased acreage by area farmers and the relative values for military training. These lands could be converted to NWSG fields at minimal expense for conversion of management.

Avian use: Field size, vegetative density and composition, and management actions impact field use by wildlife (Moss 2001) (see section below of avian use of grassland habitats). Most NWSG fields are managed by controlled fire. The number of years since the last fire affect grass density, height and presence of shrubs and hence, avian use (Figs. 20-21). Generally, annual fires result in mostly grass cover. The more years since the last fire, the more woody vegetation will invade (DeSelm and Clebsch 1990, Waldrop

and Lloyd 1990) (Fig. 22). By 3 years after a fire, patches of woody vegetation 3-10 feet high are common and by 5-7 years, shrubs and trees dominate the field.

Management recommendations:

- Return abandoned agricultural fields to NWSG. Seeds of NWSG exist in the soil throughout Fort Campbell and will naturally re-vegetate the land if competing vegetation is controlled.
- Annual burning of abandoned agricultural fields until woody vegetation is controlled may be necessary for 5-10 years to restore NWSG. A burning rotation of 2-3 years may then be employed.
- Cool season grass fields, primarily fescue, that are no longer leased should be returned to NWSG.
    - Burning the field in winter to reduce thatch;
    - Kill fescue with a herbicide, such as Plateau™ and Roundup™.
    - Burn annually for 2-5 years allowing NWSG to re-vegetate naturally from the seed-bank in the soil.
    - Burn on a 2-3 year rotation once NWSG is established.

Figure 20. Grasshopper sparrows and eastern meadowlarks will use short grass (average = 10-20 inches).

Figure 21. Henslow's sparrows, and northern bobwhites prefer grass with residual stems from the previous growing season for nesting habitat. This field was burned 2 years ago. Henslow's sparrows, dickcissels, and grasshopper sparrows prefer large (>250 acres) fields.

Figure 22. Brushy fields burned 3-4 years ago are good nesting cover for prairie warbler, yellow-breasted chat, and wild turkey. Prairie warbler, common yellow-throat, and white-eyed vireo prefer smaller fields.

GRASSLANDS AS AVIAN HABITAT

Bird habitat use and nesting success was evaluated at Fort Campbell from 1999-2003 in an effort to document what species were using the reservation and under what conditions Fort Campbell was providing source habitats. Bird species were identified by song and sight using point count methods during the breeding season (Moss 2001). A greater diversity of grassland birds use Fort Campbell than at any other place in Tennessee or Kentucky or perhaps the entire eastern United States. Coincidentally, these grasslands are also important for military training (Fig. 23). Military training and avian use of these grasslands are compatible; <1% of the nest loss documented in this study was attributed to military training. In contrast, significant nest loss can be attributed to land management activities (e.g., farming operations).

Of the species of birds nesting in grasslands (Table 2), 9 are of regional concern (Henslow's sparrow, grasshopper sparrow, dickcissel, yellow-breasted chat, eastern meadowlark, prairie warbler, indigo bunting, Bachman's sparrow, and field sparrow; Pashley et al. 2000). Henslow's sparrow and grasshopper sparrow have been found nesting in few other places in Tennessee. Other birds of special concern found at Fort Campbell include northern harrier, Bell's vireo, bobolink, and lark sparrow. In all, over 100 bird species were found associated with grass-dominated habitats at Fort Campbell, an impressive number in part due to the extensive grasslands (Appendix 1).

Field habitat is also cover for other wildlife. Native prairies are important to gamebirds such as bobwhite quail and wild turkeys for nesting, travel, and feeding. Grasslands provide habitat for a variety of small mammals such as mice, voles, moles, and shrews, which form the prey-base in a food-chain for foxes, coyotes, bobcats and birds of prey.

White-tailed deer use native grasslands for bedding, feeding, and fawning. Also, many reptiles and amphibians include grasslands as part of their homerange.

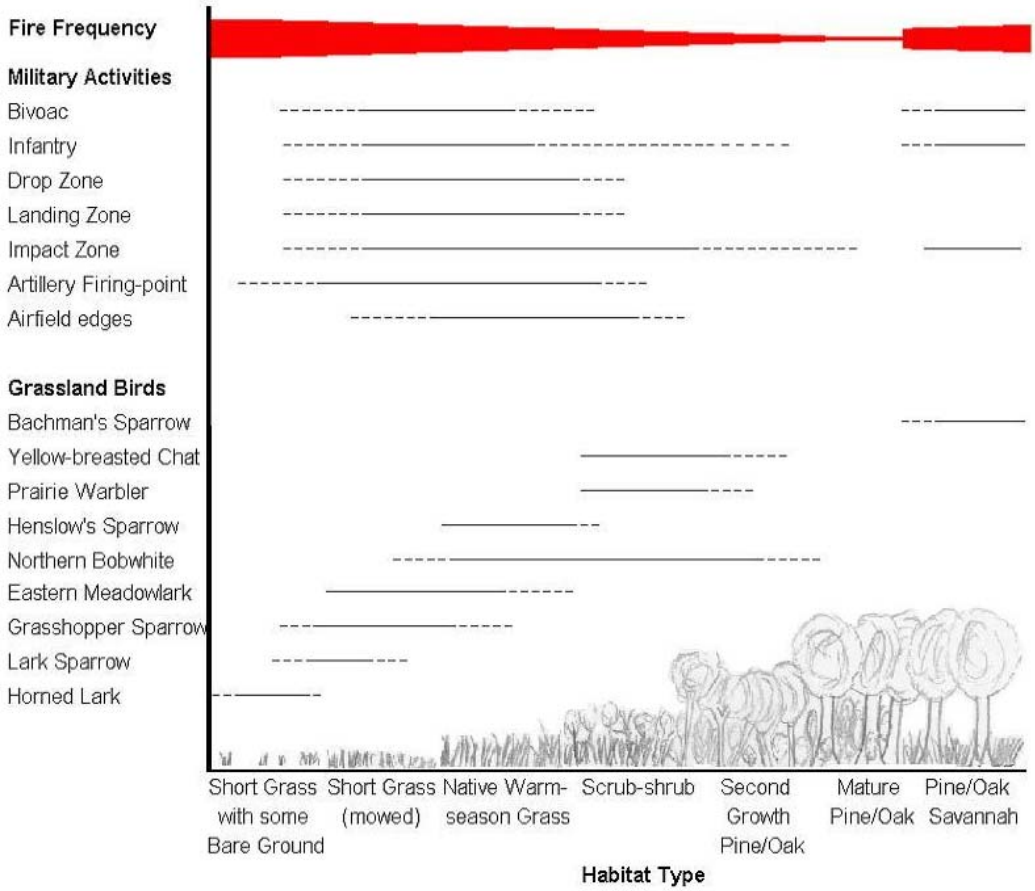

Figure 23. Ideal habitats used for military training and grassland breeding birds.

Table 3. Grassland birds observed on Fort Campbell Military Reservation, Kentucky-Tennessee, 1999-2003.

Habitat	Species	Population Trend[1]	Breeding[2]	Winter	Migration
Grassland	Upland Sandpiper	+		c	C
Grassland	Sedge Wren	+	pr		C
Grassland	Henslow's Sparrow	-	c		
Grassland	Grasshopper Sparrow	-	c	p	
Grassland	Short-eared Owl	-		c	
Grassland	Eastern Meadowlark	-	c	c	
Grassland	Horned Lark	-	c		
Grassland	Bobolink	-			C
Grassland	Dickcissel	-	c		
Grassland	Northern Harrier	-	c	c	
Grassland	Vesper Sparrow	-		p	C
Grassland	Western Meadowlark	-	po	p	
Grassland	Savannah Sparrow	-		c	
Grassland	Barn Owl	0	pr	p	
Grassland	Le Conte's Sparrow	0		p	
Shrub	Yellow Warbler	+	c		
Shrub	Carolina Wren	+	c		
Shrub	House Wren	+	c		
Shrub	Blue Grosbeak	+	c		
Shrub	Nashville Warbler	+			C
Shrub	Lincoln's Sparrow	+		p	C
Shrub	Palm Warbler	+		p	C
Shrub	Field Sparrow	-	c	c	
Shrub	Northern Bobwhite	-	c	c	
Shrub	Lark Sparrow	-	c		
Shrub	Bell's Vireo	-	pr		C
Shrub	Golden-winged Warbler	-			P
Shrub	Prairie Warbler	-	C		
Shrub	Eastern Towhee	-	C	c	
Shrub	White-crowned Sparrow	-		c	
Shrub	Orange-crowned Warbler	-			P
Shrub	Brown Thrasher	-	C		C
Shrub	Wilson's Warbler	-			C
Shrub	Clay-colored Sparrow	-			P
Shrub	Mourning Warbler	-			C
Shrub	White-throated Sparrow	-		c	
Shrub	Indigo Bunting	-	C		
Shrub	Chestnut-sided Warbler	-	C		
Shrub	Song Sparrow	-	C	c	
Shrub	Common Yellowthroat	-	C		
Shrub	Connecticut Warbler	0			P
Shrub	Blue-winged Warbler	0	c		
Shrub	Bewick's Wren	0	po		
Shrub	Gray Catbird	0	c		
Shrub	American Goldfinch	0	c		
Shrub	Willow/Alder Flycatcher	0	c		
Shrub	Yellow-breasted Chat	0	c		
Shrub	American Woodcock	0	c		
Shrub	Northern Cardinal	0	c		
Shrub	White-eyed Vireo	0	c		
Shrub	Fox Sparrow	0		c	P

1-- Breeding Bird Survey population trend for 1966-2002 "+" = increasing trend, "-" = negative trend, "0"= no trend.

2-- c = confirmed breeding on Fort Campbell, pr = probable breeder, observed during breeding season, po = possible.

Grassland Bird Management

It is important when making management decisions to recognize the significance of the Fort Campbell natural resources from a wildlife perspective. Grassland birds at Fort Campbell use a wide range of grassland conditions; some species prefer tall grass, others nest in short grass, and others use fields being invaded by woody vegetation (Fig. 23). Grassland birds also use a wide range of field sizes, with some found exclusively in the largest fields (i.e., >250 acres), whereas others actually prefer the smallest fields (i.e., < 1 acre). The challenge in managing for grassland birds at Fort Campbell is to provide a diversity of grassland habitats in as many training areas as possible. To do this, it is necessary to manage for a diversity of field sizes, field age classes (years since last burn) and savannahs in each 1000-2000 acre training area. Ideally, about one half of each training area could be dedicated to grassland habitats. Concentrating the majority of fields towards one side of a training area would tend to favor species needing more unbroken prairie habitats.

Henslow's sparrow

Grasshopper sparrow

The number of large fields (>250 acres) as well as the combined acreage of all fields (more than 24,000 acres) creates a landscape level grassland effect that is likely responsible for attracting many species of grassland birds to Fort Campbell. Given the rarity of native grassland habitat in the eastern U.S. and the accompanying decline of grassland birds, the loss of significant areas of native grassland is detrimental to several birds that are already considered as being in need of management. In addition, gamebirds, such as bobwhite quail and wild turkey, will likely decrease as grasslands acreage declines.

Cool season grass fields, predominantly fescue hayfields, cover several large fields at Fort Campbell. Use of fescue fields by songbirds and other wildlife is generally lower than for native grasslands (Cooper 1997, Larkin 1997) and reproduction in these fields is often compromised by the haying schedule. The timing of management activities during the breeding season could have serious negative effects on the productivity of grassland birds (Giocomo 2004, Fig. 24). Approximately 3000 acres of cool season hayfields exist at Fort Campbell, which generally reduce habitat quality for wildlife.

Dickcissel

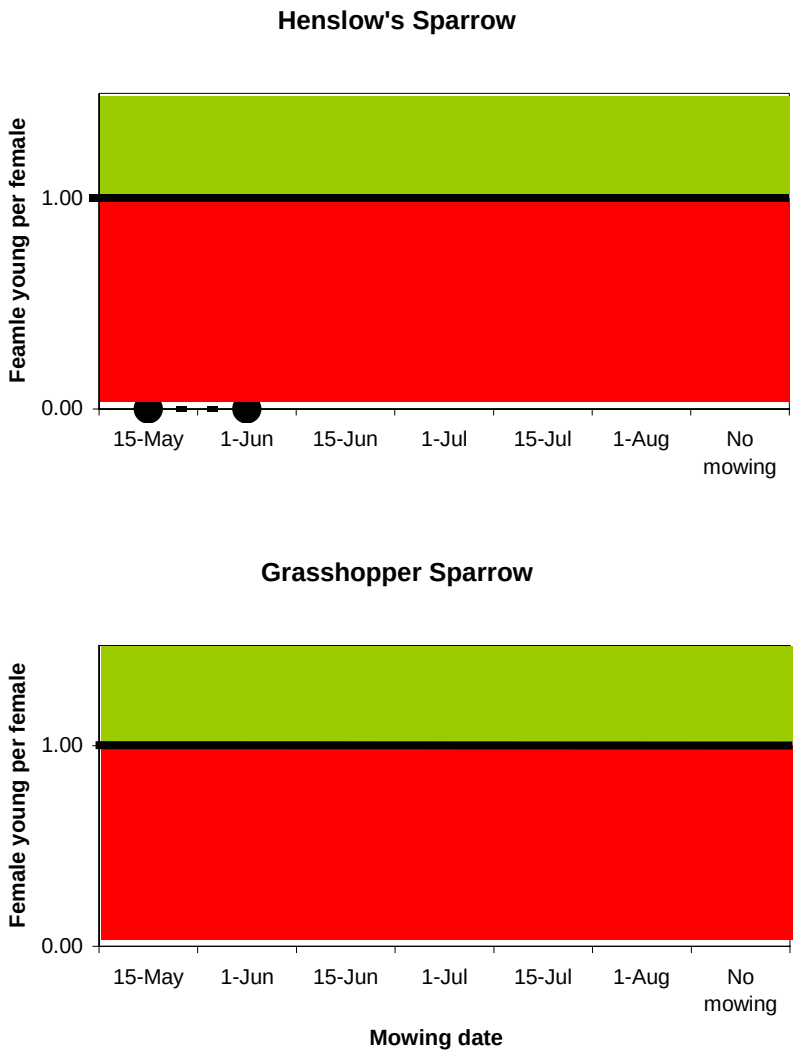

Figure 24. Estimated average annual productivity of Henslow's sparrows and grasshopper sparrows at Fort Campbell (assuming adult survival = 0.5, juvenile survival = 0.25, and birds can fledge up to 3 successful broods within one breeding season). Points below 1 female young per female indicate decreasing populations (red area) and points above 1 indicate increasing populations (green area) for each mowing date and for no mowing within the breeding season. Henslow's sparrows do not re-nest in the same field after mowing, but grasshopper sparrows season will nest in mowed fields with reduced success (75% of average nest success).

Management recommendations:
Field Size: Fields of 25-100 acres are decreasing in size and number. Woody vegetation encroachment has diminished field size to the point that some fields are no longer large enough to accommodate desired military training and are of reduced value for grassland birds (Fig. 25).

- Use timber harvest and other means to restore/create larger (>250 acres) NWSG fields and field complexes. This will improve training options and enable trainers to "rest" some fields and reduce wear on soil, vegetation and reduce negative impacts on wildlife.
- Increase total acreage in NWSG fields of all size classes at Fort Campbell. Considering that 70% of the landscape was in open habitats in 1938 and only 30% still remains in open conditions, a goal of 50% open lands would enhance military training opportunities greatly and also wildlife habitat values significantly.
- Burn restored fields annually (August and September) until woody succession problems are under control.
- Use herbicides as needed to address problem areas with woody encroachment.

Figure 25. Reclaiming large fields or combining 2 or more smaller fields to NWSG would provide additional landing zones and habitat for songbirds, game birds and other wildlife. These fields can be inexpensively maintained with periodic fire.

Timing of management activities: The timing of management activities could be altered to allow nesting birds to produce sustainable populations. Because the primary mission of Fort Campbell is military training, harvesting of hay may be conducted after the breeding season in August, as long as troop training and safety are not impacted.

- Habitat management (mowing and haying) during the breeding season (15 April – 15 August) should be restricted to after August 15 to avoid the bulk of the nesting season.

- If mowing is necessary, mowing before the nesting season begins (early April) and continuously mowing every two to three weeks would help to prevent individual birds from attempting to nest in a population sink area.
- The timing of management could be stipulated in the agricultural lease between the farmers and Fort Campbell.

If hay production is still desirable, converting fields from non-native, cool-season grasses back to native, warm-season grasses would allow haying in August while avoiding the main portion of the nesting season (Fig. 26). For example, Bastogne and Corregidor drop zones could be converted to NWSG, so mowing for hay management would not need to occur in the middle of the breeding season.

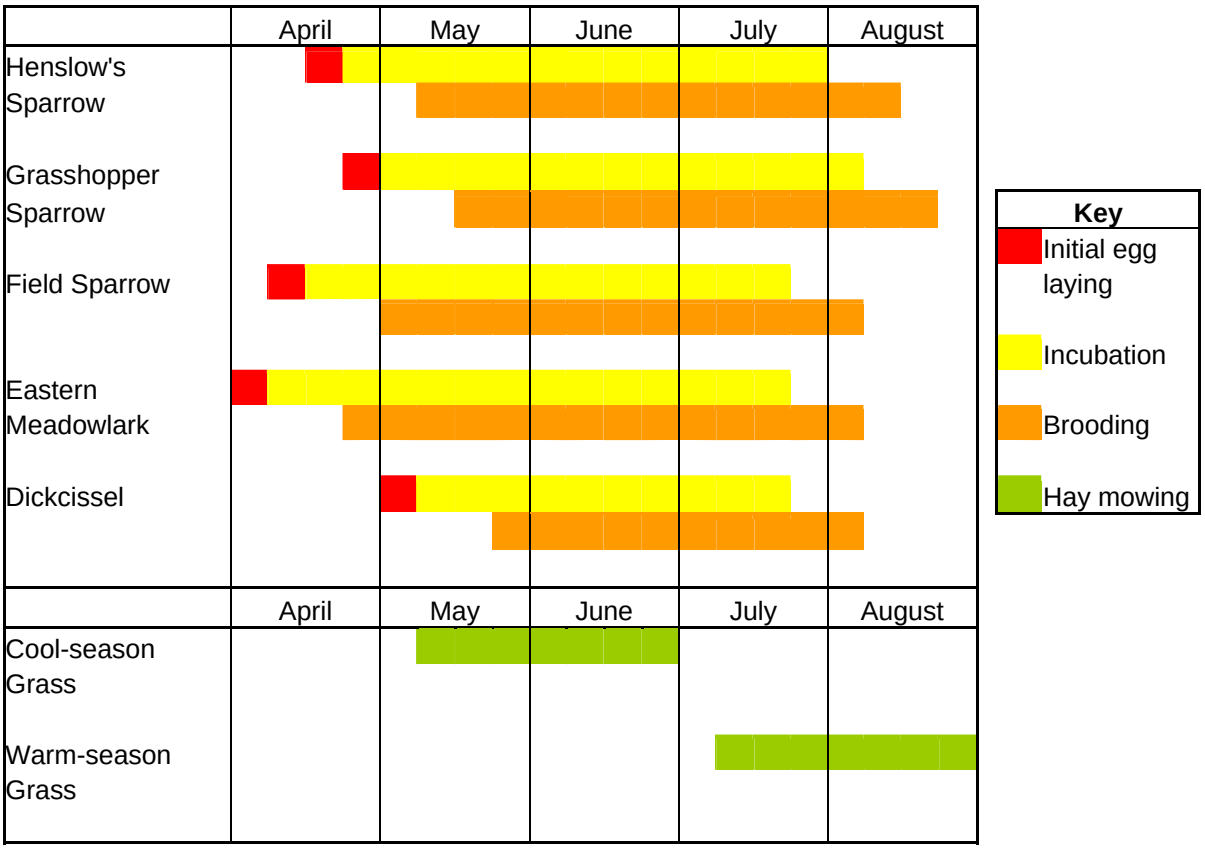

Figure 26. The breeding season starts between early April and early May for grassland breeding species at Fort Campbell. Mowing activities for hay management of non-native, cool-season grass fields start in the second week of May and continue into June and sometimes July. Converting fields back to native warm-season grasses would push the necessary mowing date into late July or August, which coincides with the end of the breeding season for grassland birds.

COMMAND AND CONTROL

Conflicting management objectives sometimes exists between divisions (forestry, agricultural leasing, and wildlife management) within the Natural Resources Branch at Fort Campbell. Without complete coordination and cooperation among groups and a clear understanding of the military mission and habitat requirements needed on the land to accomplish that mission, achievement of desired landscape conditions is problematic. To prevent confusion and improve cooperation among managing units, communications along the chain of command clarifying land management objectives would be useful in more successfully meeting those objectives.

A description of what the landscape in each of the major training areas should look like and what percentage of the landscape should be in each cover type would be a "roadmap" to success in accomplishing management goals. This could be done for the entire post and by training area. Information could include density of forest cover, forest type, forest understory condition, grass cover types and height in drop zones and landing zones, etc., and management techniques to achieve desired results. These objectives could be determined through a team approach to include command, training, and Natural Resources Branch personnel. A resulting document could then be a permanent guide available to new commanders and Natural Resources Branch personnel so that management decisions would not have to be rethought and designed as personnel change.

CONCLUSION

Thousands of acres of native grassland, previously available for military training and wildlife habitat at Fort Campbell, have succeeded to brushy and forested cover, are of low value for military training, and limited value to wildlife of regional management concern. This report presents management options for restoring these lands conditions that would more closely meet the needs of DOD for training and simultaneously provide critical habitat for wildlife in need of management.

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APPENDIX

Appendix 1. Common name and scientific name of bird species found at Fort Campbell, TN/KY, during the breeding season and non-breeding season and their associated habitats (G= grassland, S=successional or shrub, W=grass-dominated wetland).

Species	Scientific Name	Breeding	Non-breeding	Habitat
Common Loon	*Gavia immer*		X	
Pied-billed Grebe	*Podilymbus podiceps*		X	
Double-crested Cormorant	*Phalacrocorax auritus*		X	
American Bittern	*Botaurus lentiginosus*		X	W
Great Blue Heron	*Ardea herodias*	X		W
Little Blue Heron	*Egretta caerulea*		X	W
Cattle Egret	*Bubulcus ibis*		X	W
Green Heron	*Butorides virescens*	X		W
Black-crowned Night-Heron	*Nycticorax nycticorax*		X	W
Black Vulture	*Coragyps atratus*	X		
Turkey Vulture	*Cathartes aura*	X		
Snow Goose	*Chen caerulescens*		X	W
Canada Goose	*Branta canadensis*	X		W
Wood Duck	*Aix sponsa*	X		W
Gadwall	*Anas strepera*		X	W
American Wigeon	*Anas americana*		X	W
American Black Duck	*Anas rubripes*		X	W
Mallard	*Anas platyrhynchos*	X		W
Blue-winged Teal	*Anas discors*		X	W
Northern Shoveler	*Anas clypeata*		X	W
Northern Pintail	*Anas acuta*		X	W
Green-winged Teal	*Anas crecca*		X	W
Canvasback	*Aythya valisineria*		X	W
Redhead	*Aythya americana*		X	W
Ring-necked Duck	*Aythya collaris*		X	W
Greater Scaup	*Aythya marila*		X	W
Lesser Scaup	*Aythya affinis*		X	W
Bufflehead	*Bucephala albeola*		X	
Hooded Merganser	*Lophodytes cucullatus*		X	W
Red-breasted Merganser	*Mergus serrator*		X	W
Ruddy Duck	*Oxyura jamaicensis*		X	W
Mississippi Kite	*Ictinia mississippiensis*		X	S
Bald Eagle	*Haliaeetus leucocephalus*		X	
Northern Harrier	*Circus cyaneus*	X		G
Sharp-shinned Hawk	*Accipiter striatus*	X		
Cooper's Hawk	*Accipiter cooperii*	X		
Red-shouldered Hawk	*Buteo lineatus*	X		
Broad-winged Hawk	*Buteo platypterus*	X		
Red-tailed Hawk	*Buteo jamaicensis*	X		S
Rough-legged Hawk	*Buteo lagopus*		X	

Appendix 1 (Cont.)

Species	*Scientific Name*	**Breeding**	**Non-breeding**	**Habitat**
American Kestrel	*Falco sparverius*	X		S
Merlin	*Falco columbarius*		X	
Peregrine Falcon	*Falco peregrinus*		X	
Wild Turkey	*Meleagris gallopavo*	X		S
Northern Bobwhite	*Colinus virginianus*	X		S
Sora	*Porzana carolina*		X	W
American Coot	*Fulica americana*		X	W
Sandhill Crane	*Grus canadensis*		X	W
American Golden-Plover	*Pluvialis dominica*		X	
Killdeer	*Charadrius vociferus*	X		G
Solitary Sandpiper	*Tringa solitaria*		X	W
Upland Sandpiper	*Bartramia longicauda*		X	G
Common Snipe	*Gallinago gallinago*		X	W
American Woodcock	*Scolopax minor*	X		S
Common Tern	*Sterna hirundo*		X	
Rock Dove	*Columba livia*	X		
Eurasian Collared-Dove	*Streptopelia decaocto*		X	
Mourning Dove	*Zenaida macroura*	X		S
Black-billed Cuckoo	*Coccyzus erythropthalmus*		X	
Yellow-billed Cuckoo	*Coccyzus americanus*	X		
Barn Owl	*Tyto alba*	P		
Eastern Screech-Owl	*Otus asio*	X		
Great Horned Owl	*Bubo virginianus*	X		
Barred Owl	*Strix varia*	X		
Long-eared Owl	*Asio otus*		P	G
Short-eared Owl	*Asio flammeus*		X	G
Common Nighthawk	*Chordeiles minor*	X		G
Chuck-will's-widow	*Caprimulgus carolinensis*	X		
Whip-poor-will	*Caprimulgus vociferus*	X		
Chimney Swift	*Chaetura pelagica*	X		
Ruby-throated Hummingbird	*Archilochus colubris*	X		
Belted Kingfisher	*Ceryle alcyon*	X		
Red-headed Woodpecker	*Melanerpes erythrocephalus*	X		
Red-bellied Woodpecker	*Melanerpes carolinus*	X		
Yellow-bellied Sapsucker	*Sphyrapicus varius*		X	
Downy Woodpecker	*Picoides pubescens*	X		
Hairy Woodpecker	*Picoides villosus*	X		
Northern Flicker	*Colaptes auratus*	X		
Pileated Woodpecker	*Dryocopus pileatus*	X		
Olive-sided Flycatcher	*Contopus cooperi*		X	
Eastern Wood-Pewee	*Contopus virens*	X		
Acadian Flycatcher	*Empidonax virescens*	X		
Willow Flycatcher	*Empidonax traillii*	X		S
Eastern Phoebe	*Sayornis phoebe*	X		

Appendix 1 (cont.)

Species	Scientific Name	Breeding	Non-breeding	Habitat
Great Crested Flycatcher	*Myiarchus crinitus*	X		
Eastern Kingbird	*Tyrannus tyrannus*	X		S
Scissor-tailed Flycatcher	*Tyrannus forficatus*		X	S
Loggerhead Shrike	*Lanius ludovicianus*	X		S
White-eyed Vireo	*Vireo griseus*	X		S
Bell's Vireo	*Vireo bellii*		X	S
Yellow-throated Vireo	*Vireo flavifrons*	X		
Blue-headed Vireo	*Vireo solitarius*		X	
Warbling Vireo	*Vireo gilvus*	X		
Philadelphia Vireo	*Vireo philadelphicus*		P	
Red-eyed Vireo	*Vireo olivaceus*	X		
Blue Jay	*Cyanocitta cristata*	X		
American Crow	*Corvus brachyrhynchos*	X		
Horned Lark	*Eremophila alpestris*	X		G
Purple Martin	*Progne subis*	X		
Tree Swallow	*Tachycineta bicolor*	X		
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	X		
Cliff Swallow	*Petrochelidon pyrrhonota*	X		
Barn Swallow	*Hirundo rustica*	X		
Carolina Chickadee	*Poecile carolinensis*	X		
Tufted Titmouse	*Baeolophus bicolor*	X		
Red-breasted Nuthatch	*Sitta canadensis*		X	
White-breasted Nuthatch	*Sitta carolinensis*	X		
Brown Creeper	*Certhia americana*		X	
Carolina Wren	*Thryothorus ludovicianus*	X		
Bewick's Wren	*Thryomanes bewickii*	P	P	S
House Wren	*Troglodytes aedon*	X		
Winter Wren	*Troglodytes troglodytes*		X	
Sedge Wren	*Cistothorus platensis*		X	S
Marsh Wren	*Cistothorus palustris*		X	W
Golden-crowned Kinglet	*Regulus satrapa*		X	
Ruby-crowned Kinglet	*Regulus calendula*		X	
Blue-gray Gnatcatcher	*Polioptila caerulea*	X		
Eastern Bluebird	*Sialia sialis*	X		S
Swainson's Thrush	*Catharus ustulatus*		X	
Hermit Thrush	*Catharus guttatus*		X	
Wood Thrush	*Hylocichla mustelina*	X		
American Robin	*Turdus migratorius*	X		
Gray Catbird	*Dumetella carolinensis*	X		
Northern Mockingbird	*Mimus polyglottos*	X		S
Brown Thrasher	*Toxostoma rufum*	X		S
European Starling	*Sturnus vulgaris*	X		
American Pipit	*Anthus rubescens*		X	G
Cedar Waxwing	*Bombycilla cedrorum*	X		
Blue-winged Warbler	*Vermivora pinus*	X		

Appendix 1 (Cont.)

Species	Scientific Name	Breeding	Non-breeding	Habitat
Tennessee Warbler	*Vermivora peregrina*		X	
Orange-crowned Warbler	*Vermivora celata*		P	S
Nashville Warbler	*Vermivora ruficapilla*		X	
Northern Parula	*Parula americana*	X		
Yellow Warbler	*Dendroica petechia*	X		S
Chestnut-sided Warbler	*Dendroica pensylvanica*		X	
Magnolia Warbler	*Dendroica magnolia*		X	
Yellow-rumped Warbler	*Dendroica coronata*		X	
Black-throated Green Warbler	*Dendroica virens*		X	
Blackburnian Warbler	*Dendroica fusca*		X	
Yellow-throated Warbler	*Dendroica dominica*	X		
Pine Warbler	*Dendroica pinus*	X		
Prairie Warbler	*Dendroica discolor*	X		S
Palm Warbler	*Dendroica palmarum*		X	
Bay-breasted Warbler	*Dendroica castanea*		X	
Cerulean Warbler	*Dendroica cerulea*		X	
Black-and-white Warbler	*Mniotilta varia*		X	
American Redstart	*Setophaga ruticilla*		X	
Prothonotary Warbler	*Protonotaria citrea*	X		
Worm-eating Warbler	*Helmitheros vermivorus*	X		
Swainson's Warbler	*Limnothlypis swainsonii*		P	
Ovenbird	*Seiurus aurocapillus*	X		
Louisiana Waterthrush	*Seiurus motacilla*	X		
Kentucky Warbler	*Oporornis formosus*	X		
Mourning Warbler	*Oporornis philadelphia*		X	
Common Yellowthroat	*Geothlypis trichas*	X		S
Hooded Warbler	*Wilsonia citrina*	X		
Wilson's Warbler	*Wilsonia pusilla*		X	
Yellow-breasted Chat	*Icteria virens*	X		S
Summer Tanager	*Piranga rubra*	X		
Scarlet Tanager	*Piranga olivacea*	X		
Eastern Towhee	*Pipilo erythrophthalmus*	X		S
Bachman's Sparrow	*Aimophila aestivalis*	X		S
American Tree Sparrow	*Spizella arborea*		X	
Chipping Sparrow	*Spizella passerina*	X		S
Clay-colored Sparrow	*Spizella pallida*		P	G
Field Sparrow	*Spizella pusilla*	X		G
Vesper Sparrow	*Pooecetes gramineus*		X	S
Lark Sparrow	*Chondestes grammacus*	X		G
Savannah Sparrow	*Passerculus sandwichensis*		X	S
Grasshopper Sparrow	*Ammodramus savannarum*	X		G
Henslow's Sparrow	*Ammodramus henslowii*	X		G
Le Conte's Sparrow	*Ammodramus leconteii*		P	G
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*		P	G
Fox Sparrow	*Passerella iliaca*		X	S

Appendix 1 (Cont.)

Species	Scientific Name	Breeding	Non-breeding	Habitat
Song Sparrow	*Melospiza melodia*	X	X	
Lincoln's Sparrow	*Melospiza lincolnii*		X	S
Swamp Sparrow	*Melospiza georgiana*		X	S
White-throated Sparrow	*Zonotrichia albicollis*		X	S
White-crowned Sparrow	*Zonotrichia leucophrys*		X	S
Dark-eyed Junco	*Junco hyemalis*		X	
Northern Cardinal	*Cardinalis cardinalis*	X		S
Blue Grosbeak	*Passerina caerulea*	X		S
Indigo Bunting	*Passerina cyanea*	X		S
Dickcissel	*Spiza americana*	X		G
Bobolink	*Dolichonyx oryzivorus*		X	G
Red-winged Blackbird	*Agelaius phoeniceus*	X		W
Eastern Meadowlark	*Sturnella magna*	X		G
Rusty Blackbird	*Euphagus carolinus*		X	
Brewer's Blackbird	*Euphagus cyanocephalus*		P	
Common Grackle	*Quiscalus quiscula*	X		
Brown-headed Cowbird	*Molothrus ater*	X		S
Orchard Oriole	*Icterus spurius*	X		
Baltimore Oriole	*Icterus galbula*		X	
Purple Finch	*Carpodacus purpureus*		P	
House Finch	*Carpodacus mexicanus*	X		
Pine Siskin	*Carduelis pinus*		P	S
American Goldfinch	*Carduelis tristis*	X		S
House Sparrow	*Passer domesticus*	X		

Appendix 2. Plant and mammal species mentioned in report.

Species	Scientific Name
Native Grasses	
Little Bluestem	*Schizachyrium scoparium*
Big Bluestem	*Andropogon gerardii*
Broomsedge	*Andropogon virginicus*
Switchgrass	*Panicum virgatum*
Indian Grass	*Sorghastrum nutans*
Non-native grasses	
Fescue	*Festuca spp.*
Trees	
Hickory	*Carya spp.*
Oak	*Quercus spp.*
Mammals	
Bison	*Bison bison*
Elk	*Cervus elaphus*
Mice	*Peromyscus spp.*
Voles	*Microtus spp.*
Shrews	*Sorex spp.*
Bobcat	*Lynx rufus*
Fox	*Vulpes spp.*
Coyote	*Canis latrans*
White-tailed Deer	*Odocoileus virginianus*