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Survival, Nesting Success, and Habitat Selection of Wild Turkey Populations in the Upper Coastal Plain of South Carolina

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SURVIVAL, NESTING SUCCESS, AND HABITAT SELECTION OF WILD TURKEY POPULATIONS IN THE UPPER COASTAL PLAIN OF SOUTH CAROLINA

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ABSTRACT

Survival, nesting success, and habitat selection of wild turkey (*Meleagris gallopavo*) populations in South Carolina were evaluated. The study was conducted on the Department of Energy's Savannah River Site (SRS) in the Upper Coastal Plain of South Carolina. Portions of the study were conducted on Crackerneck Wildlife Management Area and Ecological Reserve (CWMA) on the western portion of SRS. During January through March of 1998 – 2000, 37 hens and 47 gobblers were captured on SRS, and 19 gobblers were captured on CWMA and fitted with radio transmitters. Survival rates between hunted and unhunted wild turkey gobblers were compared to assess the impact of spring gobbler-only hunts on populations. Hens were monitored to identify nest site characteristics of successful and unsuccessful nests and to determine survival rates and mortality factors of hens. Gobblers and hens on SRS were monitored to determine if they selected for or against available habitat types. Also, the effects of growing and dormant season prescribed burning on plant food species for the eastern wild turkey were compared. Annual survival rates of gobblers on SRS were significantly greater than annual survival rates of gobblers on CWMA. Bobcats (*Lynx rufus*) were the primary confirmed predator of hens and of gobblers on both areas. Woody stem densities immediately surrounding the nest were greater at successful nest sites than those at unsuccessful nest sites, and nest concealment values also were greater at successful nests than unsuccessful ones. At the study-area scale, during fall and winter, habitat use by gobblers and hens was significantly different than habitat availability. Gobblers selected for upland and bottomland hardwoods, while hens selected for upland hardwoods, bottomland hardwoods, and mixed-pine hardwoods, and both gobblers and hens selected against mature pines. Our results indicate that spring gobbler harvests constitute additive mortality to turkey populations. In order to maximize nest success, concealment cover should be provided through management to ensure adequate concealment of wild turkey nests. Overall, few differences were seen in plant food abundance between burning treatments, possibly because of the short length of time that the growing season burn regime has been in place.

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INTRODUCTION

The wild turkey (*Meleagris gallopavo*) has been restored to most areas of the southeastern United States as a result of intensive restocking efforts, protection from illegal harvests, and improved habitat conditions (Kennamer and Kennamer 1990). Since 1970, annual wild turkey harvest has increased dramatically, placing greater demands on turkey populations (Kennamer and Kennamer 1990, Godwin et al. 1991). Many managers and hunters have called for more liberal harvest regulations, including increased use of fall either-sex hunts (Palmer et al. 1993). However, for many game species, including the wild turkey, little is known about the relationships between harvest and natural mortality, which can lead to uncertainty when establishing harvest regulations (Williams et al. 2004).

For many geographic areas, little is known about wild turkey survival rates in hunted populations, and effects of spring gobbler hunting on populations is largely unknown (Kurzejeski et al. 1987, Godwin et al. 1991, Palmer et al. 1993). Survival rates of recently released gobblers in Texas ranged from 0.68-0.71 (Campo et al. 1984, Swank et al. 1985), while the gobbler survival rate in a hunted Alabama population was 0.63 (Everett et al. 1980). In contrast, in a heavily hunted population in Iowa, juvenile and gobbler survival rates were 0.38 and 0.33, respectively (Vangilder 1992).

It has long been assumed that spring-only hunting constituted an additive mortality factor (Vangilder 1992). However, it was also assumed that natural gobbler mortality was low, meaning that spring harvests had minimal effects on annual survival rates. Several wild turkey population models have been developed that simulate effects of hunting on turkey populations (Lobdell et al. 1972, Suchy et al. 1990, Alpizar-Jara et al. 2001), and all hypothesize that spring-only gobbler harvests have little effect on annual survival rates of gobblers. Several studies have examined gobbler survival rates before and after the implementation of spring-only hunting, primarily on areas with recently established populations. However, previous studies have never examined the survival rates of gobblers in an unhunted population that had been established for more than 5 years (Vangilder 1992), nor compared survival rates in a control population with a similar hunted population.

Although populations of wild turkeys in most eastern states are currently higher than they have been since before European colonization (National Wild Turkey Federation 1986), some southeastern populations are experiencing declines (Palmer et al. 1993, Thogmartin and Johnson 1999). Nesting success is the factor that usually has the largest influence on population growth in wild turkeys (Vangilder 1992, Roberts and Porter 1996). Managing areas to increase the availability of quality nesting habitat could help increase population success (Hillestead and Speake 1970).

Wild turkey hens previously have been documented as nesting in a wide range of dissimilar habitat types, including fields, rights-of-way, pine plantations, mature pines, and bottomland hardwoods (Everett et al. 1985, Lazarus and Porter 1985, Sisson et al. 1990, Porter 1992). Several shared microhabitat characteristics, such as dense shrub and herbaceous cover, of various turkey nest sites have been previously reported (Seiss et al. 1990, Still and Baumann 1990, Badyaev 1995). Concealment of nests by vegetation is critical with ground-nesting birds since nest predation can be detrimental to reproductive success (Keppie and Herzog 1978, Bowman and Harris 1980, Badyaev 1995). Hen survival rates are also critically linked to reproductive success. Low hen survival resulting from any mortality factor can reduce population growth (Alpizar-Jara et al. 2001).

During the late 1800's and early 1900's, wild turkey populations declined sharply because of a combination of unregulated hunting and habitat loss (Kennamer et al. 1992). Many areas in the Southeast have recently been undergoing large-scale habitat changes due to increased development, as well as many agricultural fields being converted to even-aged pine stands. As these habitats are altered, updated information on the important habitats for wild turkeys is needed for effective population management. Although wild turkeys use a wide variety of habitats (Hurst and Dickson 1992), the availability of certain habitat types may be critical in ensuring adequate population growth. For example, the importance of grassy brood-rearing habitat for healthy turkey populations has been well-documented (Metzler and Speake 1985, Porter 1992).

Previous studies have shown the importance in the availability of forests with a hardwood component for wild turkeys. New York turkey populations began using hardwoods with high amounts of available mast during the fall (Healy 1992). Turkeys in Missouri also exhibited a similar shift in habitat use (Kurzejeski and Lewis 1990) in the fall to hardwoods. Several other studies in the Southeast have demonstrated that preferred winter habitat for turkeys were areas dominated by hardwoods (Everett et al. 1979, Kennamer et al. 1980, Everett et al. 1985, Sisson et al. 1990, Smith and Teitelbaum 1986, Hurst and Dickson 1992). In Louisiana, turkeys also avoided mature pines and openings during the fall and winter (Hurst and Dickson 1992).

Previous turkey habitat selection studies in the Southeast also demonstrated the importance of pastures, meadows, and agricultural fields, which were heavily used by turkeys during the spring and summer (Hyde and Newsome 1973, Speake et al. 1975, Everett et al. 1985, Hurst and Dickson 1992). These habitats are also considered by many to be essential for hens and poults as bugging areas (Hurst 1978, Hurst and Owen 1980, Metzler and Speake 1985, Porter 1992). Gobblers in other southeastern studies also frequently used pastures and field edges during the spring and summer (Hurst and Dickson 1992). The importance of hardwood habitats and pastures and fields demonstrated by previous studies draws attention to the lack of information on wild turkey habitat selection in Coastal Plain areas dominated by mature forests.

Turkey populations on the U.S. Department of Energy's Savannah River Site (SRS), an 802 km^2 facility in the Upper Coastal Plain of South Carolina, are unique in several ways. First, SRS has been closed to hunting since 1951, prior to re-establishment of wild turkeys in the region (Moore et al. 2005). In the early 1970's, the South Carolina Department of Natural Resources (SCDNR) reintroduced wild turkeys on SRS to establish a source population for future restocking efforts within and outside of the state. Therefore, the SRS turkey population constitutes a long-established population that has never been hunted. Second, since public access is restricted for security concerns, the threat of poaching of turkeys is minimal. Third, SRS is 85% forested, which is unique in the Coastal Plain where most habitats are either developed, maintained for agricultural use, or managed for grazing lands. Therefore, SRS offers a distinctive research opportunity on wild turkey populations.

The objectives of this study were as follows: (1) To compare survival rates and causes of mortality of wild turkey gobblers between long-established unhunted and hunted populations, (2) To identify nesting success, nest site characteristics, and causes of mortality of wild turkey hens, (3) To determine home-range size and habitat selection of wild turkeys in a forest-dominated landscape, and (4) To determine the effects of season of burn on plant food availability for the eastern wild turkey.

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CHAPTER 2

EFFECTS OF SPRING-ONLY HUNTING ON WILD TURKEY GOBBLER SURVIVAL IN SOUTH CAROLINA

Moore, W.M., J.C. Kilgo, D.C. Guynn Jr., and J.R. Davis. To be submitted to the Journal of Wildlife Management

ABSTRACT. We compared survival rates between hunted and unhunted wild turkey (*Meleagris gallopavo*) gobblers in the upper coastal plain of South Carolina to assess the impact of spring gobbler-only hunts on populations. Gobblers were captured on the Savannah River Site (SRS), which contains long-established populations that have never been hunted, and on Crackerneck Wildlife Management Area and Ecological reserve (CWMA), which has held spring hunts since 1983. In January-March of 1998-2000, 47 gobblers were captured on SRS and 19 were captured on CWMA. Each turkey was fitted with a backpack radio transmitter and monitored 3 times per week. Annual survival rates of gobblers on SRS (0.71) were significantly greater ($\chi^2 = 5.11$; df = 1; p = 0.02) than annual survival rates of gobblers on CWMA (0.54). Bobcats (*Lynx rufus*) were the primary confirmed predator on both areas. Our results indicate that spring gobbler harvests constitute additive mortality to turkey populations. However, even in years when reproductive rates were relatively low, a spring-only gobbler harvest rate of 25% appeared to have a minimal effect on turkey populations. Due to the polygynous behavior of wild turkeys, the timing of spring-only harvests could be more important than the level of harvest that occurs during the hunts.

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INTRODUCTION

The effect of regulated hunting on wildlife populations has been a concern of wildlife managers for decades (Burger et al. 1994). For many game species, little is known about the relationships between harvest and natural mortality, which can lead to uncertainty when establishing harvest regulations (Williams et al. 2004). Hunting has often been viewed as a compensatory mortality factor for many wildlife populations (Caughley 1983), meaning that the harvest reduces natural mortality rates in populations following the hunt. In many northern bobwhite (*Colinus virginianus*) populations, hunting appears to have a partial compensatory effect on mortality rates in some areas (Roseberry 1979, Williams et al. 2004). However, Pollock et al. (1989a) reported an additive effect of hunting on mortality rates in a Georgia bobwhite population. Hunting also acted as an additive mortality component in a population of ruffed grouse (*Bonasa umbellus*) (Small et al. 1991).

For many geographic areas, little is known about wild turkey (*Meleagris gallopavo*) survival rates in hunted populations, and effects of spring gobbler hunting on populations is largely unknown (Kurzejeski et al. 1987, Godwin et al. 1991, Palmer et al. 1993). Survival rates of recently released gobblers in Texas ranged from 0.68-0.71 (Campo et al. 1984, Swank et al. 1985), while the gobbler survival rate in a hunted Alabama population was 0.63 (Everett et al. 1980). In contrast, in a heavily hunted population in Iowa, juvenile and gobbler survival rates were 0.38 and 0.33, respectively (Vangilder 1992).

It has long been assumed that spring-only hunting constituted an additive mortality factor (Vangilder 1992). However, it was also assumed that natural gobbler mortality was low, meaning that spring harvests had minimal effects on annual survival rates. Several wild turkey population models have been developed that simulate the effects of hunting on turkey populations (Lobdell et al. 1972, Suchy et al. 1990, Alpizar-Jara et al. 2001), and all hypothesize that spring-only gobbler harvests have little effect on annual survival rates of gobblers. Several studies have examined gobbler survival rates before and after the implementation of spring-only hunting, primarily on areas with recently established populations. However, previous studies have never examined the survival rates of gobblers in an unhunted population that had been established for more than 5 years (Vangilder 1992), nor compared survival rates in a control population with a similar hunted population. The objective of this study was to compare survival rates and causes of mortality of wild turkey gobblers between long-established unhunted and hunted populations in the Coastal Plain of South Carolina.

STUDY AREA

We conducted our study on the Savannah River Site (SRS), which comprises approximately 802 km^2 of the upper coastal plain of South Carolina. The SRS has been closed to hunting since 1951, prior to re-establishment of wild turkeys in the region (Moore et al. 2005). In the early 1970's, South Carolina Department of Natural Resources (SCDNR) reintroduced wild turkeys on SRS to establish a source population for future restocking efforts within and outside of the state. Therefore, the SRS turkey population has been established for > 30 years and has never been hunted. Since public access is restricted for security concerns, the threat of human-induced mortality is minimal.

Crackerneck Wildlife Management Area and Ecological Reserve (CWMA), which initiated gobbler hunting in 1983, encompasses approximately 4400 ha of the western portion of SRS (Moore et al. 2005). Dominant habitat types on both areas include forest stands dominated by longleaf pine (*Pinus palustris*), loblolly pine (*P.*

taeda), mixed pine-hardwood, upland hardwood, and bottomland hardwood. Detailed descriptions of habitats in the study areas were presented by Imm and McLeod (2005).

METHODS

Wild turkeys were captured during January – March of 1998-2000 using 9 X 18 m rocket nets (Bailey et al. 1980). Each turkey was fitted with a numbered aluminum leg band and a "backpack" harness containing an 80g radio transmitter equipped with a mortality signal (Telonics, Mesa Arizona). Capture and handling techniques were approved by the Clemson University Research Committee (Animal Use Protocol Number 01-003). Turkeys were monitored 3 times a week using triangulation (Cochran and Lord 1963) with a handheld Yagi antenna and portable receiver (Telonics, Mesa, Arizona) until the birds died or the transmitter ceased to function. When mortality was suspected, birds were located and attempts were made to determine the cause of death based on evidence at the mortality site, such as hair, tracks, and bite marks. Birds not surviving 14 days post-instrumentation were excluded from analyses because of potential capture injury or stress.

Annual survival rates for 1998-2000 were calculated for gobblers on both areas using the Kaplan-Meier procedure to allow for staggered entry of newly marked animals (Kaplan and Meier 1958, Pollock et al. 1989b). The log-rank test (Cox and Oakes 1984, Pollock et al. 1989b) was used to test for differences in survival rates between hunted and unhunted populations. Except for hunting mortality on the CWMA population, all other mortality factors should be comparable between the CWMA and SRS populations, since the habitat types and predator populations on both areas should be similar. Therefore, if annual survival rates differ significantly between the two areas, the difference in rates should indicate an additive effect of the spring-only harvests.

RESULTS

From January-March 1998 – 2000, 47 gobblers were trapped on SRS, and 19 gobblers were trapped on CWMA (Appendix A). One gobbler on SRS was excluded from analyses since its death was thought to be capture-related. During the study, bobcats (*Lynx rufus*) were the only confirmed natural predator of gobblers, while hunters accounted for 9 mortalities on CWMA (Table 1). However, 4 of the 9 hunter-killed birds were killed after the transmitters had ceased to function and were excluded from survival analyses. Several mortalities on both areas were classified as unknown since insufficient evidence was present to positively identify the cause of death. On SRS, 2 gobblers were killed by automobiles. Survival rates of gobblers on SRS (0.71) (Figure 1) were significantly greater ($\chi^2 = 5.11$; df = 1; p = 0.02) than survival rates of CWMA gobblers (0.54).

DISCUSSION

During the study, 26% of marked gobblers on CWMA were harvested by hunters, which was similar to results reported in other southeastern states. In Mississippi, 29% (n=189) of marked gobblers were harvested during the first spring after they were marked (Palmer et al. 1990). In Alabama, 44% (n=16) of marked gobblers were killed during spring hunts (Everett et al. 1980). While bobcats were the only confirmed natural predator during the study, coyotes (*Canis latrans*) also may significantly affect gobbler

Table 1. Causes of mortality (number and percent) among monitored gobblers on the Savannah River Site (SRS) and Crackerneck Wildlife management Area and Ecological Reserve (CWMA), New Ellenton, South Carolina, 1998-2000.

Cause	SRS	CWMA
Bobcat	11 (61%)	5 (42%)
Harvest	0 (0%)	5 (42%)
Road kill	2 (11%)	0 (0%)
Unknown predator	5 (28%)	2 (11%)
Total	18	12

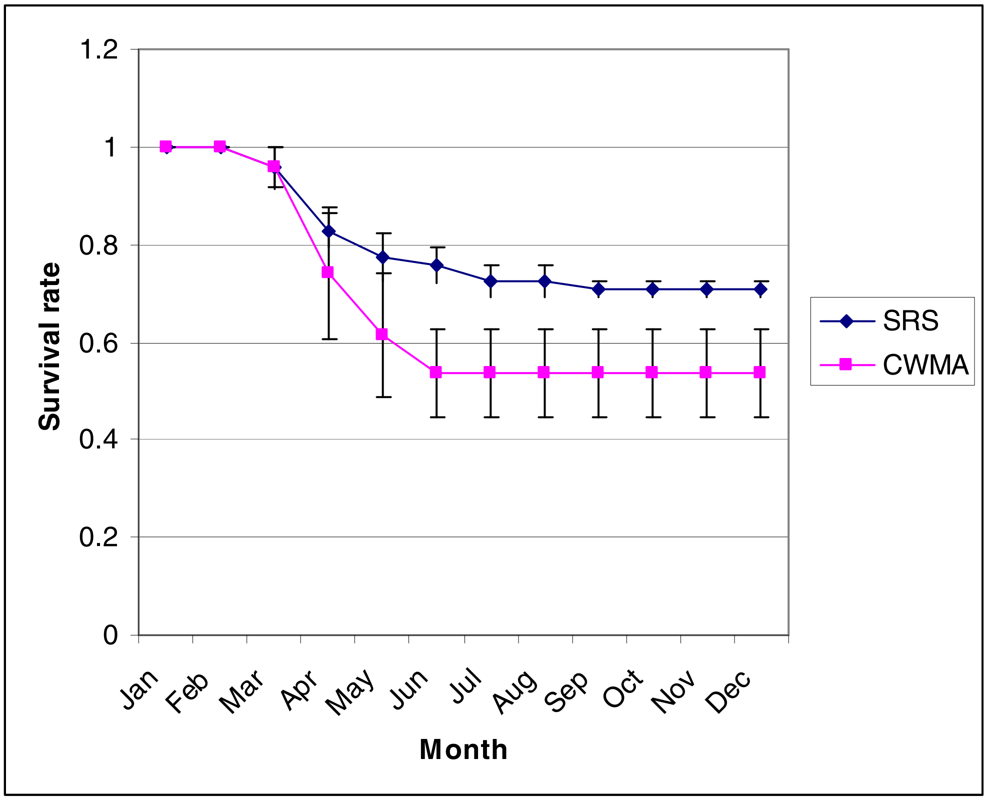

Figure 1. Mean annual survival rates for gobblers on the Savannah River Site (SRS) and Crackerneck Wildlife Management Area and Ecological Reserve (CWMA), New Ellenton, South Carolina, 1998-2000.

populations on SRS and CWMA. Coyote populations have been increasing since 1986 (Mayer et al. 2005), and coyotes have become a major predator of white-tailed deer fawns on SRS (J.C. Kilgo, pers. comm.). Coyotes also have been reported as major wild turkey predators in many other studies (Miller and Leopold 1992). During a SRS hen study from 1998-2000, coyotes were responsible for 2 confirmed hen deaths (Moore et al., unpubl. data). Coyotes may have been responsible for many of the unknown mortalities on SRS and CWMA during the study as well. Most gobbler predation on SRS (73%) and on CWMA (71%) occurred from March – May, which coincides with the spring hunting season. Gobblers apparently are at greater risk to predation during the mating season when their attention is focused on attracting and mating with hens.

Gobbler survival rates (0.71) in the long-established SRS populations were similar to those seen in newly stocked populations in other areas, while CWMA survival rates (0.54) were in the range of survival rates seen with other hunted populations. Reported survival rates of gobblers in hunted populations vary greatly geographically, from 0.63 in Alabama (Everett et al. 1980) to 0.38 in Iowa (Vangilder 1992). In two re-stocked Texas populations, unhunted gobbler populations had annual survival rates of 0.71 (Campo et al. 1984) and 0.68 (Swank et al. 1985).

Our analyses suggest that spring-only gobbler hunting is an additive mortality component for wild turkey populations on CWMA. Since SRS offered a unique opportunity to examine survival rates and causes of mortality in a large, well-established, unhunted wild turkey population, this is the first study to demonstrate that spring-only hunting has a significant additive effect on gobbler survival rates. Previous studies have examined the effect of fall harvest on wild turkey survival rates; however, they only compared the addition of a fall harvest to an existing spring harvest and lacked any control populations that were free of hunting. Little et al. (1990) reported that fall gobbler harvest was an additive mortality component for gobbler populations in Iowa. In contrast, in Virginia and West Virginia populations, fall hunting mortality did not appear to be additive for gobbler populations (Norman et al. 2004). Although our analyses suggest that spring gobbler-only harvests were additive, some degree of compensation may also have occurred in the hunted populations. Bobcat predation on CWMA was 21% lower than bobcat predation on SRS, perhaps because spring harvests reduced the numbers of gobblers available to predators. The degree of compensation may have been similar to that reported by Williams et al. (2004) in northern bobwhite populations, wherein harvest mortality was compensatory until a certain harvest rate was reached, after which the harvest mortality had an additive effect on populations.

Several population models have been developed to examine potential effects of spring and fall harvests on wild turkey populations. Under the model developed by Vangilder and Kulowiec in Missouri (Vangilder 1992), assuming average recruitment rates and that hunting mortality was additive, population growth was relatively unchanged with spring gobbler harvests of ≤ 30%. In our study, 25% of marked gobblers on CWMA were harvested by hunters. Four other gobblers were harvested by hunters during the course of the study but were excluded from analyses since the radio transmitters had ceased functioning. If those males were included in the analyses, harvest mortality would have been 47%, much higher than the threshold hypothesized by the Missouri model. Based on results of a hen nesting success study on SRS and brood surveys conducted by the South Carolina Department of Natural Resources (SCDNR), nesting success and recruitment was relatively high in 1998 but much lower during 1999 and 2000 (Moore et al. 2005). However, based on the numbers of adults observed during SCDNR surveys and the CWMA harvest data for 2000-2002, populations remained relatively unchanged despite the relatively high harvest mortality and apparent low recruitment. Even in years of relatively low reproductive rates, populations were still able to withstand high harvest rates.

MANAGEMENT IMPLICATIONS

Many studies have demonstrated that legal harvest of turkeys can be a major mortality factor in some areas Vangilder (1992). Our results indicate that, in addition to being a significant mortality factor, spring gobbler harvests constitute an additive mortality in wild turkey populations. However, even in years when reproductive rates are relatively low, spring-only gobbler harvest rates of 30 - 40% may have a minimal long-term effect on turkey populations. Due to the polygynous behavior of wild turkeys, the timing of spring-only harvests could be more important than the level of harvest that occurs during the hunts. If high gobbler harvests occur before the peak of the mating season, hunting could cause declines in future populations due to hens laying infertile eggs (Exum et al. 1987, Vangilder 1992).

In populations where spring harvest mortality is additive, as at CWMA, its effect on population growth could be magnified by the implementation of fall turkey seasons. The impact of spring-only gobbler harvests on population growth or maintenance appears to be minimal. Our results indicate that the spring hunting season coincides with the time of year when most natural gobbler mortalities occur. Fall harvests would constitute an additional turkey mortality during a time of year when relatively little natural mortality occurs. Models examining the potential effects of fall hunting seasons on wild turkeys have yielded varied results, primarily due to assumptions regarding the effects of harvest mortality on populations. The Missouri Model, the Suchy Model (Suchy et al. 1990), and the Alpizar-Jara Model (Alpizar-Jara et al. 2001) all assumed that harvest mortality was additive and yielded similar results. Each hypothesized that fall either-sex harvest mortality exceeding 10% of the total population would result in populations declines. Lobdell et al. (1972) assumed hunting mortality was compensatory and theorized that populations could withstand fall either-sex harvest mortalities of 20-35%. Studies on radio-marked turkeys have shown that fall either-sex harvest mortality is additive for turkey populations and have also recommended that fall harvest mortality not exceed 10% of the population (Little et al. 1990, Pack et al. 1999). Based on results from previous radio-telemetry studies and population models, a combined high spring gobbler harvests and moderate fall either-sex harvests could negatively impact population growth. When establishing harvest regulations for wild turkeys, managers should be more concerned with fall harvest regulations and the timing of spring hunts rather than the harvest rates of spring gobbler-only hunts.

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CHAPTER 3

NESTING SUCCESS, NEST SITE CHARACTERISTICS, AND CAUSES OF MORTALITY OF WILD TURKEY HENS IN SOUTH CAROLINA

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ABSTRACT. We captured 37 wild turkey (*Meleagris gallopavo*) hens from 1998-2000 on the U.S. Department of Energy's Savannah River Site (SRS) in South Carolina to identify nest site characteristics of successful and unsuccessful nests and to determine survival rates and mortality factors of hens. Hen nesting success varied greatly among years. Woody stem densities immediately surrounding the nest were greater ($F_{30} = 5.1$; $p = 0.03$) at successful nest sites than those at unsuccessful nest sites, and nest concealment values also were greater ($F_{30} = 4.69$; $p=0.04$) at successful nests than unsuccessful ones. The survival rate for hens on SRS was 0.74, and bobcats were primary predator of marked hens. In order to maximize nest success, concealment cover should be provided through management to ensure adequate concealment of wild turkey nests.

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INTRODUCTION

Populations of wild turkeys (*Meleagris gallopavo*) in most eastern states are currently higher than they have been since before European colonization (National Wild Turkey Federation 1986). However, some populations in the Southeast are experiencing declines (Palmer et al. 1993, Thogmartin and Johnson 1999). Nesting success is the factor that usually has the largest influence on population growth in wild turkeys (Vangilder 1992, Roberts and Porter 1996). Managing areas to increase the availability of quality nesting habitat could help increase population success (Hillestead and Speake 1970).

Wild turkey hens previously have been documented as nesting in a wide range of dissimilar habitat types, including fields, rights-of-way, pine plantations, mature pines, and bottomland hardwoods (Everett et al. 1985, Lazarus and Porter 1985, Sisson et al. 1990, Porter 1992). Several shared microhabitat characteristics, such as dense shrub and herbaceous cover, of various turkey nest sites have been previously reported (Seiss et al. 1990, Still and Baumann 1990, Badyaev 1995). Concealment of nests by vegetation is critical with ground-nesting birds since nest predation can be detrimental to reproductive success (Keppie and Herzog 1978, Bowman and Harris 1980, Badyaev 1995).

Hen survival rates are also critically linked to reproductive success. In areas with fall either-sex turkey harvests, a high hen harvest during the fall season can significantly impact reproduction in the successive breeding season (Vangilder 1992). Low hen survival resulting from any mortality factor can reduce population growth or cause population declines (Alpizar-Jara et al. 2001). Our objectives of this study were to (1) identify nest site characteristics of successful and unsuccessful nests and (2) identify the survival rates and primary mortality factors of hens in a population not subjected to harvest mortality.

STUDY AREA

We conducted our study on the U.S. Department of Energy's Savannah River Site (SRS), an approximately 802-km^2 National Environmental Research Park in the upper coastal plain of South Carolina. When the Site was closed to the public in 1951, the U.S.D.A Forest Service - Savannah River (FSSR) was authorized to manage undeveloped areas on SRS (Imm and McLeod 2005). Currently, approximately 85% of SRS is forested; a stark contrast to conditions in 1951, when an estimated 48% of the area was in forest or heavy vegetation and 52% was agricultural fields and open areas. About 82% of the forested land is actively managed for forest products and wildlife, with managed areas primarily consisting of mixed-pine hardwoods and stands planted with longleaf pine (*Pinus palustris*) and loblolly pine (*P. taeda*). Areas originally planted in slash pine (P. *elliottii*) between 1950 and 1980 are being reforested with longleaf pine. The remainder of the Site consists primarily of upland and bottomland hardwoods, marshes, Carolina bays, old fields, grassy openings, and industrial areas.

Prescribed burning is an important forest management tool on SRS. Almost 60% of prescribed burning on the Site is conducted to improve habitat conditions for various wildlife species, including wild turkey, white-tailed deer (*Odocoileus virginianus*), and the endangered red-cockaded woodpecker (RCW) (*Picoides borealis*) (Shea and Bayle 2005). About 36% of controlled burning on SRS is for fuel reduction. While the majority of prescribed burning occurs in the dormant season, approximately 1000 ha per year are burned in the growing season, mainly for understory control in RCW recovery areas. On most areas, prescribed burning is planned on a 3 – 5 year rotation.

The SRS has been closed to hunting since 1951. Prior to restocking efforts on SRS by the South Carolina Department of Natural Resources (SCDNR) in the early 1970's, wild turkeys were largely absent from the Site, only occasionally sighted in the Savannah River swamp (Moore et al. 2005). In 1973 and 1974, turkeys were released onto SRS and beginning in 1977, SCDNR trapped turkeys on SRS for use in reestablishing populations in other parts of the state. The current SRS turkey population is unique – a relatively large population that has never been exposed to regulated hunting pressure. Also, given the Site's restricted access, the threat of poaching is minimal.

METHODS

Wild turkeys were captured during January – March of 1998-2000 using 9 X 18 m rocket nets (Bailey et al. 1980). Each turkey was fitted with a numbered aluminum leg band and a "backpack" harness containing an 80g radio transmitter equipped with a mortality signal (Telonics, Mesa Arizona). Capture and handling techniques were approved by the Clemson University Research Committee (Animal Use Protocol Number 01-003). Turkeys were monitored 3 times a week using triangulation (Cochran and Lord 1963) with a handheld Yagi antennae and portable receiver (Telonics, Mesa, Arizona). When mortality was suspected, birds were located and attempts were made to determine the cause of death based on evidence at the mortality site, such as hair, tracks, and bite marks. Birds not surviving 14 days post-instrumentation were excluded from analyses because of potential capture injury or stress. Mean annual survival rates were calculated using the Kaplan-Meier procedure to allow for staggered entry of newly marked animals (Kaplan and Meier 1958, Pollock et al. 1989).

From April – July, hens were monitored every 2 days to determine the onset of nesting. Hens that remained stationary for 7 days were presumed to be nesting (Vander Haegen et al. 1988). After the onset of incubation, nests were located to determine clutch size and checked just after hatching to determine apparent nest success. Daily nest survival could not be calculated, since nests were not monitored daily in order to minimize disturbance to the incubating hens. Nest sites were plotted into ARCVIEW® GIS (Environmental Systems Research Institute 2000). To compare nest site characteristics between successful and unsuccessful nests, vegetative characteristics encompassing the nest site were measured in circular plots using the nest as the plot center. Plots were sampled during July of 1998-2000. To determine overstory basal area, a 25 m radius circular plot was used to measure woody stems with a diameter at breast height (dbh) $\geq$ 10.2 cm. A 5m radius circular plot was used to measure percent ground cover (%) using ocular estimation and stem densities (#/m^2) for all woody stems with a dbh of $\leq$ 10.2 cm. A modified (0.4 m^2) density board (Nudds 1977) was used to measure nest concealment (%) by vegetation. The board was placed on the nest bowl and viewed from 4 cardinal directions at ground level from a distance of 10 m. Habitat type was obtained using the FSSR Continuous Inventory of Stand Conditions (CISC) database. Proximity of nests to roads and of random points in stands containing nests to roads was also ascertained. Mean distances between nests and roads and between random points and roads were compared using a two-tailed t-test. Vegetative characteristics between successful and unsuccessful nests were compared using a one-way analysis of variance (ANOVA). Data were analyzed for homogeneity of variance and normal distribution using the Shapiro-Wilk test. Significance was accepted at the $p \leq 0.05$ level.

RESULTS

During January-March of 1998, 1999, and 2000, we captured 15, 7, and 15 hens, respectively (Appendix B). One hen in 2000 was excluded from analyses because her death was thought to be capture-related. Annual nesting success of monitored hens varied greatly so we did not calculate an overall nest survival rate. In 1998, 77% (10) of monitored hens that attempted to nest hatched nests successfully on their first attempt (Table 1). First nests of two other hens were depredated, but they were both successful

Table 1. Nesting success and nest success of monitored hens on the Savannah River Site from 1999-2000, New Ellenton, South Carolina.

	1998	1999	2000
N Hens	15	14	17
Hens Nesting[a]	13	1	13
% Nesting[b]	87	1	77
Hens Successful[c]	12	0	1
% Successful[d]	80	0	6
N Nests	15[e]	1	16[f]
Nests Successful[g]	12	0	1
% Nests Successful[h]	80	0	6
Mean Eggs/Nest – 1st Attempt	11.4	8	10.7
Mean Eggs/Nest - Renest	8.0	--	8.3

a - # of hens that initiated incubation

b - # of hens that initiated incubation/total # of monitored hens

c - # of hens that hatched at least 1 egg

d - hens successful/total # of monitored hens

e - includes 2 renests

f - includes 3 renests

g - # of nests that hatched at least 1 egg

h - # of nests successful/total # of nests on their second attempt. One hen abandoned her first nest because of unfertilized eggs and did not renest. In 1999, the nest of only one out of 15 hens survived to incubation, and it was depredated shortly thereafter. The remaining hens either made no attempt to nest or their nests were destroyed during egg-laying and they did not renest. In 2000, only one nest out of an attempted 16 hatched successfully. Predators, including raccoons, opossums, and rat snakes, destroyed 15 nests, including 3 renests, before they could hatch. In 1998, average clutch sizes of first and second nesting attempts were 11.4 (SE = 0.9) and 8.0 (0.0), respectively. In 2000, average clutch sizes for first and second nesting attempts were 10.7 (SE = 1.1) and 8.3 (1. 5), respectively. Median dates for incubation initiation and hatching during 1998-2000 were 4 May and 7 June, respectively.

Hens nested in many different habitat types, including mature pines, mixed pine-hardwoods, upland hardwoods, bottomland hardwoods, rights-of-way, and young (≤ 15 years) pine plantations. Vegetation surrounding the monitored nests also varied greatly in species composition and stem densities, and there were few similarities among nest sites. Mean distance of nest sites to roads (112.3 m ± 23.2) was significantly less (t_{30} = 2.01; p = 0.02) than the mean distance of random points to roads (195.8 m ± 27.6).

When vegetative characteristics were compared between successful and unsuccessful nests, two significant differences were observed (Table 2). Woody stem densities immediately surrounding the nest were greater (F_{30} = 5.1; p = 0.03) at successful nest sites than at unsuccessful nest sites. Nest concealment values also were greater (F_{30} = 4.69; p=0.04) at successful nests than unsuccessful ones. All other characteristics were similar (p > 0.05) between successful and unsuccessful nests.

Table 2. Vegetative characteristics (means + SE) at successful and unsuccessful wild turkey nest sites on the Savannah River Site (SRS), New Ellenton, SC, 1998-2000. Significant differences ($p \leq 0.05$) are denoted by an asterisk.

	Successful (N=13)	Unsuccessful (N=19)	F_{30}	P-value
Basal area (m^2/ha)	3.57 (0.43)	2.93 (0.33)	1.37	0.24
Woody stems (#/m^2)	10.67 (1.16)	7.62 (0.86)	5.04	0.03*
Ground cover (%)	19.28 (3.59)	17.67 (2.83)	0.13	0.72
Understory species richness	7.50 (1.03)	7.73 (0.83)	0.09	0.86
Nest concealment (%)	57.14 (4.99)	42.33 (4.65)	4.69	0.04*

The survival rate for hens on SRS was 0.74 (Figure 1), with 14 hens dying during the duration of the study. Bobcats were the primary predator and accounted for 64% (9) of mortalities, followed by coyotes (2), roadkills (2), and one unknown mortality. The majority (83%) of hen predation occurred during May – July; 3 died during incubation, 4 died while caring for poults, and 3 died after their nests had failed.

DISCUSSION

Annual nesting success of monitored hens varied greatly during the study, which supports results from many other studies (Beasom and Patte 1980, Vangilder 1992). When the study was continued by Carlisle (2003) in 2001, nesting success of monitored hens on SRS was slightly better than in 1999 and 2000, with 3 of 10 hens nesting successfully. Annual brood surveys conducted by the South Carolina Department of Natural Resources (SCDNR) showed that nesting success of SRS hens was similar to that of monitored hens in 1998 (SCDNR, unpubl. data). During that year, the number of poults observed on SRS was among the highest on record over a 24-year span. In 1999 and 2000, when nesting success of monitored hens was almost zero, the number of poults observed on SRS declined 40%. Such drastic changes in nest success may be due to a variety of factors including changes in predator populations or fluctuations in mast production. Climate factors, such as drought and flooding, can also strongly influence wild turkey nest success (Beasom and Patte 1980). On SRS, a 4-year drought that began in May of 1998 may have negatively impacted reproductive success during the study. Lack of suitable nesting habitat among years should not have been factor in nest success variability, as habitats available on SRS varied little because of consistent management

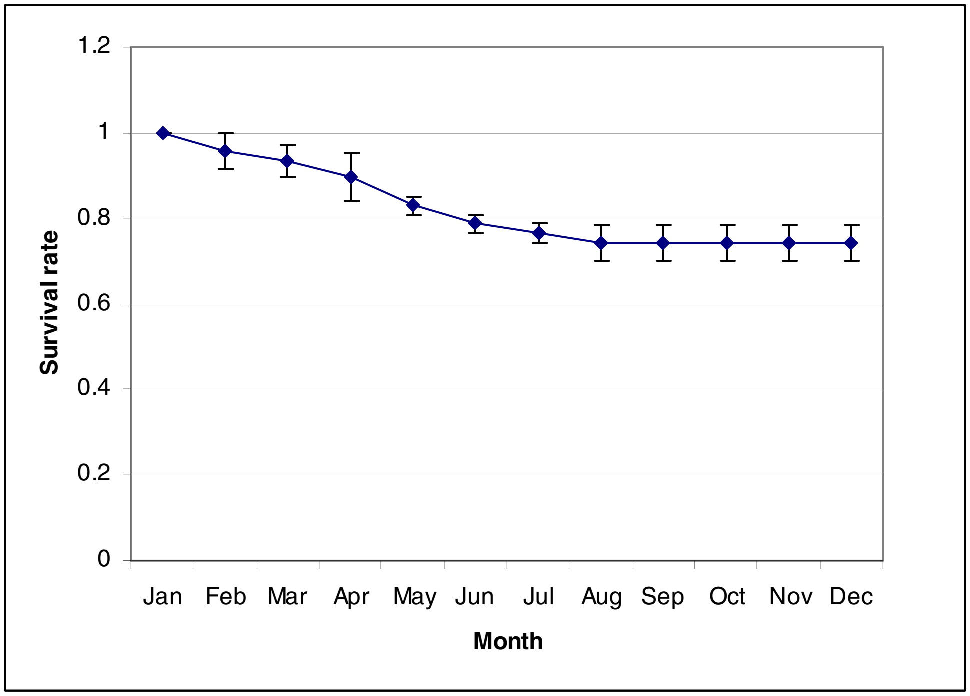

Figure 1. Mean annual survival rate for hens on the Savannah River Site (SRS), New Ellenton, South Carolina, 1998-2000.

practices. Hens nested in many different habitat types. Overstory conditions and percent ground cover did not differ between successful and unsuccessful nests, which was similar to what has been reported elsewhere (Lazarus and Porter 1985, Still and Baumann 1990, Badyaev 1995). However, woody stem densities immediately around the nest and concealment values were significantly greater at successful nest sites, which supports results from previous studies that show the importance of nest concealment (Bowman and Harris 1980, Badyaev 1995). At several monitored nests that were successful in 1998, basal area and stem densities of the overstory and midstory were low, while stem densities immediately at the nest site were high. Even when the hens chose a relatively open stand to nest in, they were still often successful at nesting when sufficient vegetative cover was present immediately surrounding the nest.

Hen survival rates were similar to those reported in other unhunted populations (Ransom et al. 1987, Vander Haegen et al. 1988). Bobcats appear to be the primary predator of both hens and gobblers on SRS (Carlisle 2003, Moore et al. 2005). Hen predation was highest during the spring and summer months while hens were nesting and caring for poults, which has been previously documented (Swank et al. 1985, Vander Haegen et al. 1988, Everett et al. 1980). Most of the monitored hens nested close to roads or firebreaks, possibly to allow easy travel from the nest site to brood habitats after hatching. However, because predators often use roads and firebreaks as travel corridors, higher adult and nest predation may occur when hens nest in close proximity to these areas.

Future red-cockaded woodpecker management activities on SRS could potentially affect wild turkey populations. The Site's RCW management plan established a primary habitat management area (34,831 ha) and a supplemental habitat management area (18,683 ha), which amount to approximately 2/3 of the Site (Johnston 2005). In these areas, forest management activities are aimed at expanding the existing RCW populations, both in numbers and in distribution. In the HMA's, pine stands are now managed on rotations of ≥ 100 years, and the use of growing season burns will increase to control the hardwood midstory. Currently, only a minor portion (< 1000 ha) of available turkey habitat is burned during the growing season, so the effect of the fires on turkey reproduction likely is minimal. Conducted at a larger scale, such burns could destroy turkey nests; in 2001, Carlisle (2003) reported that 2 nests (9%) of monitored hens on SRS were destroyed by growing season fires. Reducing understory woody stem densities could also increase nest predation by decreasing nest concealment. However, since hens nest in a wide range of habitats, even with an expanded growing-season burn regime, the chances of a nest being destroyed by fire likely is low. Growing season burns may also restore pine understories to grassy conditions that favor successful nesting. Thus, whether large-scale growing season fire would result in net positive or negative impacts remains unclear.

MANAGEMENT IMPLICATIONS

Since nesting success can vary greatly from year to year, managers of turkey populations should take great care when establishing harvest regulations, particularly in areas where fall either-sex harvests occur. One season of above-average hen harvests, combined with poor nesting success the following spring, could be detrimental to turkey populations. Because wild turkeys nest in many different habitat types, it is difficult for managers to target specific habitats when seeking to increase nesting success. However, management of understory vegetation in any habitat type , particularly through use of prescribed burning, should promote high densities of woody stems (≤ 10.2 cm dbh) around.

Predation rates were similar to those seen in other successful populations. However, to further reduce predation, especially during spring and summer months, managers should ensure that adequate brood habitat is interspersed throughout the landscape in close proximity to bugging areas for hens with poults. Additional research is needed to evaluate the effects of the distances between nesting areas and brood habitats.

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CHAPTER 4

HABITAT SELECTION IN AN UNHUNTED WILD TURKEY POPULATION IN THE UPPER COASTAL PLAIN OF SOUTH CAROLINA

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ABSTRACT. Although most populations of wild turkey (*Meleagris gallopavo*) are at their highest levels since pre-colonial times, numbers harvested and reproductive rates of turkeys in some areas have been declining. Lack of preferred habitats can limit the growth of some local populations. The U.S. Department of Energy's Savannah River Site (SRS) is an 802 km^2 facility the upper coastal plain of South Carolina that contains a well-established population of wild turkeys that have never been exposed to regulated hunting pressure. Over 85% of SRS is forested, which is unique compared to other managed areas in the southeastern Coastal Plain. During January-March 1998-2000, we captured 47 gobblers and 37 hens on SRS and fitted each with radio transmitters to monitor their habitat use and determine if they selected for or against available habitat types. Gobbler home range sizes (mean = 766 ± 66 ha) were significantly ($F_{60} = 4.36$; $p = 0.04$) larger than those for hens (mean = 526 ± 93 ha). At the study-area scale, during fall and winter, habitat use by gobblers and hens was significantly different than habitat availability ($F_{5,35} = 2.64$; $p = 0.03$ and $F_{5,27} = 2.46$; $p = 0.04$, respectively). Gobblers selected for upland and bottomland hardwoods, while hens selected for upland hardwoods, bottomland hardwoods, and mixed-pine hardwoods ($p \leq 0.05$). Mixed pine-hardwoods, young pines, and openings were used in proportion to their availability by gobblers, and both gobblers and hens selected against mature pines ($p \leq 0.05$). Our results suggest that productive turkey populations can be maintained in areas dominated by mature pine forests, as long as the population's seasonal requirements are met by the remaining habitat types.

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INTRODUCTION

Before European settlement of the southern U.S., eastern wild turkeys (*Meleagris gallopavo sylvestris*) were abundant throughout the region (Hurst and Dickson 1992). Although populations declined severely in the late 1800's because of habitat loss and unregulated harvest, intensive restocking efforts and habitat improvement restored wild turkeys to their native southern ranges by the 1980's (National Wild Turkey Federation 1986).

Wild turkey populations are at all-time highs in many areas of their range (Vangilder 1992); however, some local populations are experiencing population declines (Palmer et al. 1993,Thogmartin and Johnson 1999, Thogmartin 2001). Although wild turkeys use a wide variety of habitats (Hurst and Dickson 1992), the availability of certain habitat types may be critical in ensuring adequate population growth. For example, the importance of grassy brood-rearing habitat for healthy turkey populations has been well-documented (Metzler and Speake 1985, Porter 1992). The objective of our study was to determine home range size and habitat selection by wild turkeys in an area dominated by mature pine forests in South Carolina.

STUDY AREA

We conducted our study on the U.S. Department of Energy's Savannah River Site (SRS), an 802 km^2 facility the upper coastal plain of South Carolina adjacent to the Savannah River. The northernmost portion of the Site (~ 12,000 ha) is characterized by poor, deeply eroded sandy soils, while the majority of the Site has well-drained soils that were historically used for agriculture (White and Gaines 2000). The topography is characterized by gentle rolling ridges with interspersed stream courses.

When the Site was closed to the public in 1951, the U.S.D.A Forest Service - Savannah River (FSSR) was authorized to manage undeveloped areas on SRS therefore planted abandoned farmland in various species of pine (Imm and McLeod 2005). Approximately 85% of SRS is forested, 82% of which is actively managed for forest products and wildlife resources, primarily using long (≥ 100 years) rotation ages with intermediate thinnings. Managed areas primarily consist of mixed-pine hardwoods and stands planted with longleaf pine (*Pinus palustris*) and loblolly pine (*P. taeda*). Areas originally planted in slash pine (*P. elliottii*) between 1950 and 1980 are being reforested with longleaf pine. The remainder of the Site is composed of upland and bottomland hardwoods, marshes, Carolina bays, old fields, industrial areas, and grassy openings.

Forest management practices on SRS have changed dramatically since 1992, largely due to the Site's recovery plan for the red-cockaded woodpecker (RCW) (*Picoides borealis*) (Blake 2005, Shea and Bayle 2005). In order to achieve mandated longer rotation ages in pine forests, clearcutting and planting have become less common, while the importance of stand thinning has grown. Also, most of the Site's current prescribed burning is being done for habitat improvement for RCW and other wildlife species. Before 1991, most controlled burning targeted reduction of fuel loads (Shea and Bayle 2005). Controlled burns on the Site range from 2 – 1,300 ha in size, with an average of 6000-8000 ha being burned each year. Most areas are burned on a 3-5 year rotation. Prescribed burns are conducted in all seasons; however, the total acreage burned during the growing season (< 1000 ha) is relatively small and is primarily restricted to RCW recovery areas.

When the Site was closed to hunting in 1951, wild turkeys were largely absent, only occasionally sighted in the Savannah River swamp (Moore et al. 2005). In 1973 and 1974, turkeys were released onto SRS by the South Carolina Department of Natural Resources (SCDNR) in hopes of establishing a source population for future restocking efforts. The current SRS turkey population is unique – a relatively large population that has never been exposed to regulated hunting pressure. Given the Site's restricted access, the threat of poaching is minimal.

METHODS

Wild turkeys were captured during January – March of 1998-2000 using 9 X 18 m rocket nets (Bailey et al. 1980). Each turkey was fitted with a numbered aluminum leg band and a "backpack" harness containing an 80g radio transmitter equipped with a mortality signal (Telonics, Mesa Arizona). Capture and handling techniques were approved by the Clemson University Research Committee(Animal Use Protocol Number 01-003). Turkeys were monitored 3 times a week using triangulation (Cochran and Lord 1963) with a handheld Yagi antennae and portable receiver (Telonics, Mesa, Arizona). Birds not surviving 14 days post-instrumentation were excluded from analyses because of potential capture injury or stress.

We estimated annual and seasonal home-range size of turkeys using the Animal Movement Program (Hooge et al. 1999), an extension for ARCVIEW® Geographic Information Systems (GIS) (Environmental Research Institute 2000). The fixed kernel method was used to estimate the home ranges of all turkeys with at least 25 locations (Worton 1989, Seaman et al. 1999). Differences in the 95% kernel home-range size between sexes were tested using analysis of variance (ANOVA). Data were analyzed for homogeneity of variance and normal distribution using the Shapiro-Wilk test. Data that did not meet the assumptions of the ANOVA were logarithmically transformed (base 10). Statistical significance was accepted at $p \leq 0.05$.

Habitat types were obtained using the FSSR Continuous Inventory of Stand Conditions (CISC) database. Based on the CISC database and subsequent ground checking, available habitats were grouped into 6 categories: mature pine (MP), upland hardwood (UH), bottomland hardwood (BH), mixed pine-hardwoods (MIX), young pines (YP), and field/openings (OP) (Table 1). Habitat use was assessed by plotting telemetry locations on the existing CISC stand coverages using ARCVIEW® GIS (Environmental Systems Research Institute 2000). Compositional analysis was used to assess habitat selection in relation to habitat type (Aebischer et al. 1993). Log-ratios of used and available habitat were calculated for analysis of habitat use. ANOVA was used to test for nonrandom selection of habitats at each scale. A matrix of t-tests using differences of log-ratios between habitats was constructed to rank habitat preference and determine where ranks differed when nonrandom selection of habitats occurred ($P \leq 0.05$).

Habitat selection was evaluated at both the study-area (second-order selection) and home-range (third-order selection) scales (Johnson 1980). The study-area boundary was generated by establishing a circle around the home range of each bird, with the circle's center being the center of the home range and radius being the maximum linear distance each bird traveled across the center of its home range. Available habitats

Table 1. Availability and description of habitat types at the Savannah River Site, New Ellenton, South Carolina, 1998-2000. (Imm and McLeod 2005)

Habitat type	Vegetative characteristics/description	Habitat availability (ha)
Bottomland hardwoods (BH)	*Quercus michauxii, Q. phellos, Taxodium distichum, Celtis laevigata, Fraxinus spp., Nyssa aquatica, Liquidambar styraciflua*	8412
Upland hardwoods (UH)	*Q. falcata, Q. nigra, Q. incana, Q. laevis, Carya spp., Cornus florida, Liriodendron tulipefera*	7867
Mixed pine-hardwoods (MIX)	Pine (*P. palustris*, *P. taeda*), *Q. nigra, Q. falcata, Q. alba, L. styraciflua, Q. velutina*	6231
Young pines (YP)	Pine (*P. palustris*, *P. taeda*) stands ≤ age 15	11855
Openings/fields (OP)	Old fields, food plots, large roadsides and intersections, grassy areas surrounding industrial areas, powerline rights-of-way	6142
Mature pines (MP)	*P. palustris, P. taeda, P. echinata, P. elliottii*	27663

in the study area were compared to the habitats within the turkey's home range. At the home-range scale, habitat types available in the home range were compared to habitats containing turkey locations. Habitat use among seasons was also compared. For any given habitat type, when use or availability was zero, we replaced zeroes with 0.0001 (Aebischer et al. 1993).

RESULTS

We captured a total of 46 gobblers and 36 hens during January-March 1998-2000 (Table 2) (Appendices A and B). Seven gobblers and 5 hens were excluded from home range and habitat selection analyses because of insufficient numbers of telemetry locations (< 25). In addition, 3 gobblers and 3 hens were excluded from habitat selection analyses because they spent extensive time off the study area where habitat data were not available. Annual home range for each turkey was estimated using an average of 116 radiolocations (range = 25-254, SE = 24). Gobbler home range sizes (mean = 766 ± 66 ha) were significantly larger ($p = 0.04$) than those for hens (mean = 526 ± 93 ha). Home range sizes did not differ significantly among seasons for either gobblers ($p = 0.47$) or hens ($p = 0.34$).

Gobblers and hens used all available habitats throughout the year. At the study-area and home range scales, for both sexes, spring/summer data were pooled and fall/winter data were pooled because there were no differences in habitat selection for those pairs of individual seasons and since cover and food requirements are similar for those seasons (Hurst and Dickson 1992). During spring/summer, gobblers ($F_{5,35} = 0.68$; $p = 0.58$) and hens ($F_{5,27} = 1.17$; $p = 0.32$) used habitats in proportion to their availability

Table 2. Eastern wild turkey captures on the Savannah River Site (SRS), New Ellenton, SC, 1998-2000.

Year	Hens	Gobblers
1998	15	16
1999	7	23
2000	15	26
Total	37	65

at the study-area scale (Figures 1 and 2) . At the same scale, during fall/winter, habitat use and availability were significantly different for gobblers ($F_{5,35} = 2.64$; $p = 0.03$) and for hens ($F_{5,27} = 2.46$; $p = 0.04$). Gobblers selected for upland and bottomland hardwoods (Figure 3), while hens selected for upland hardwoods, bottomland hardwoods, and mixed-pine hardwoods ($p < 0.05$) (Figure 4). Mixed pine-hardwoods, young pines, and openings were used randomly by gobblers, and both gobblers and hens selected against mature pines ($p< 0.05$). At the home-range scale in spring/summer, gobblers ($F_{5,35} = 1.27$; $p = 0.31$) and hens ($F_{5,27} = 1.96$; $p = 0.15$) used habitats in proportion to their availability (Figures 1 and 2). Also, at the home-range scale in fall/winter, gobblers ($F_{5,35} = 1.52$; $p = 0.24$) and hens ($F_{5,27} = 1.02$; $p = 0.37$) used habitats in proportion to their availability (Figures 3 and 4).

DISCUSSION

Home-range sizes of gobblers and hens on SRS were similar to those seen in many other southeastern populations (Healy 1992), which is of interest since all other studied turkey populations are hunted. Hunting pressure on wild turkey populations apparently does not affect average home range size for gobblers or hens. Habitat use during fall and winter by turkeys on SRS was similar to other eastern turkey populations. New York turkey populations used hardwoods with high amounts of available mast during fall (Healy 1992). Turkeys in Missouri also exhibited a similar shift in habitat use (Kurzejeski and Lewis 1990) in fall to hardwoods. Several other studies in the Southeast have demonstrated that preferred winter habitat for turkeys is areas dominated by hardwoods (Everett et al. 1979, Kennamer et al. 1980, Everett et al. 1985, Sisson et al.

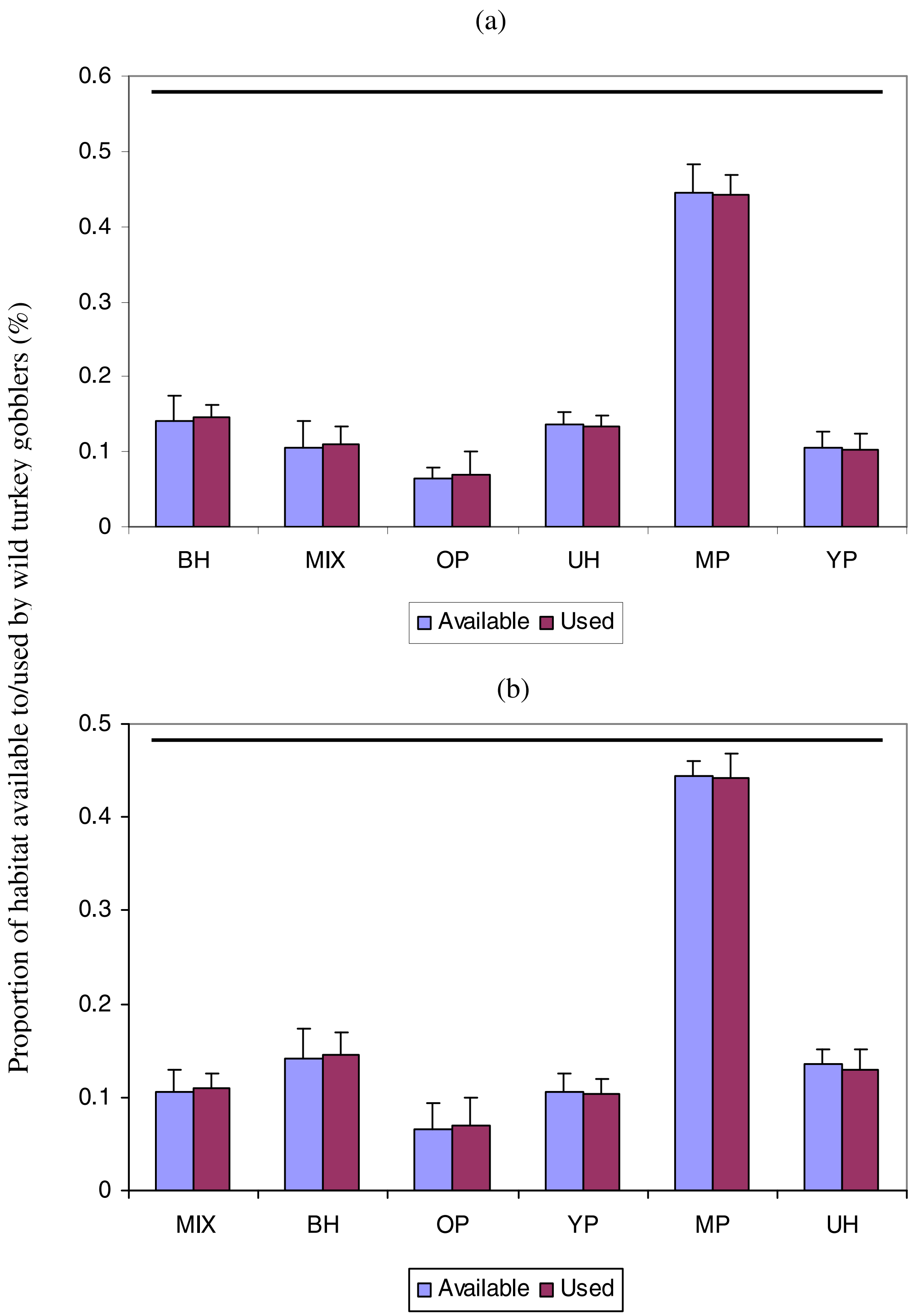

Figure 1. Habitat selection by wild turkey gobblers on the Savannah River Site, South Carolina, during spring/summer of 1998-2000 at (a) the study-area scale (n=36) and (b) the home-range scale (n=36). Habitat types (see Table 1 for definitions of abbreviations) are ranked from left to right in decreasing order of selection. Lines above habitat types indicate no significant difference (compositional analysis, $P \geq 0.05$) in selection among habitat types.

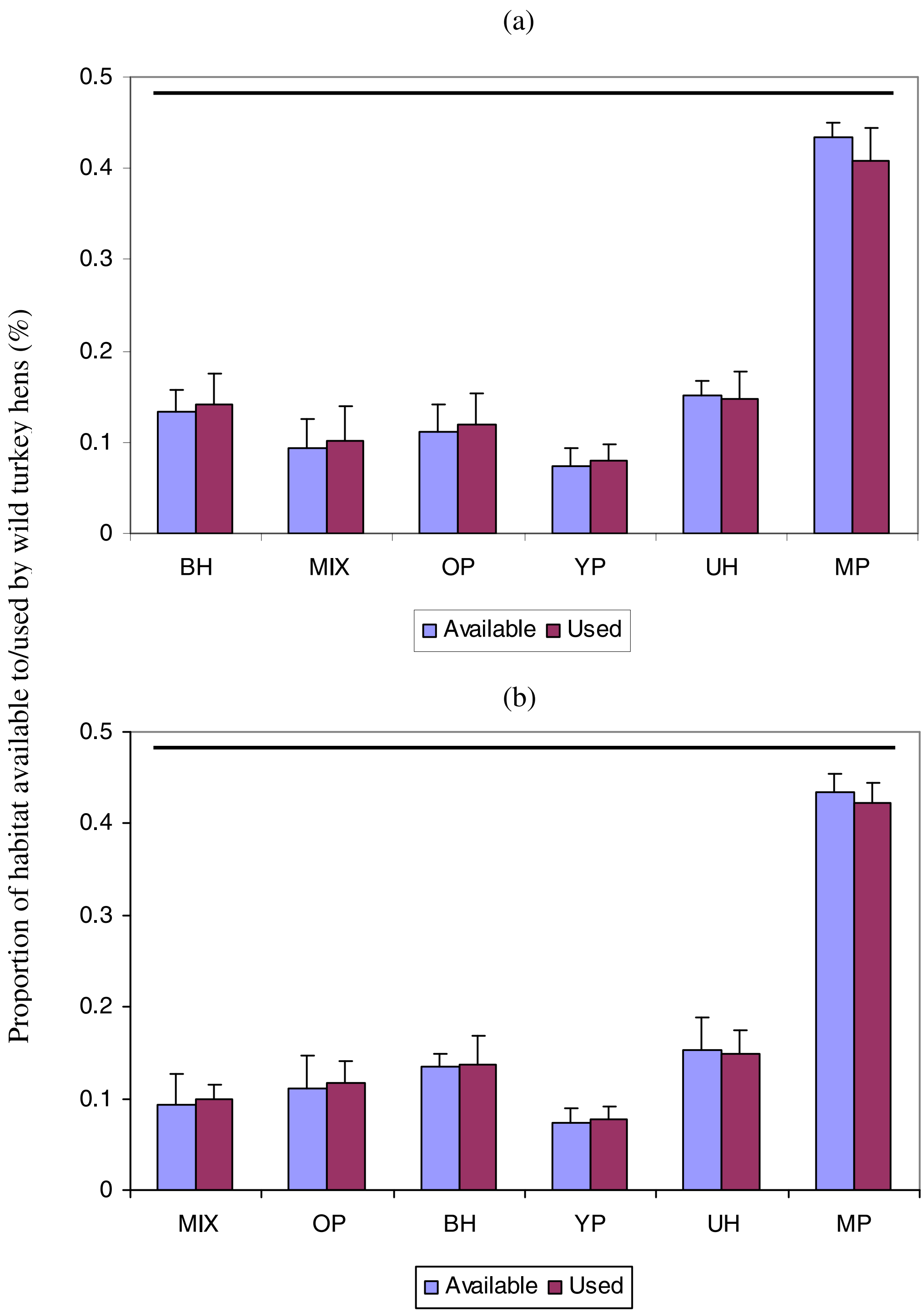

Figure 2. Habitat selection by wild turkey hens on the Savannah River Site, South Carolina, during spring/summer of 1998-2000 at (a) the study-area scale (n=36) and (b) the home-range scale (n=36). Habitat types (see Table 1 for definitions of abbreviations) are ranked from left to right in decreasing order of selection. Lines above habitat types indicate no significant difference (compositional analysis, $P \geq 0.05$) in selection among habitat types.

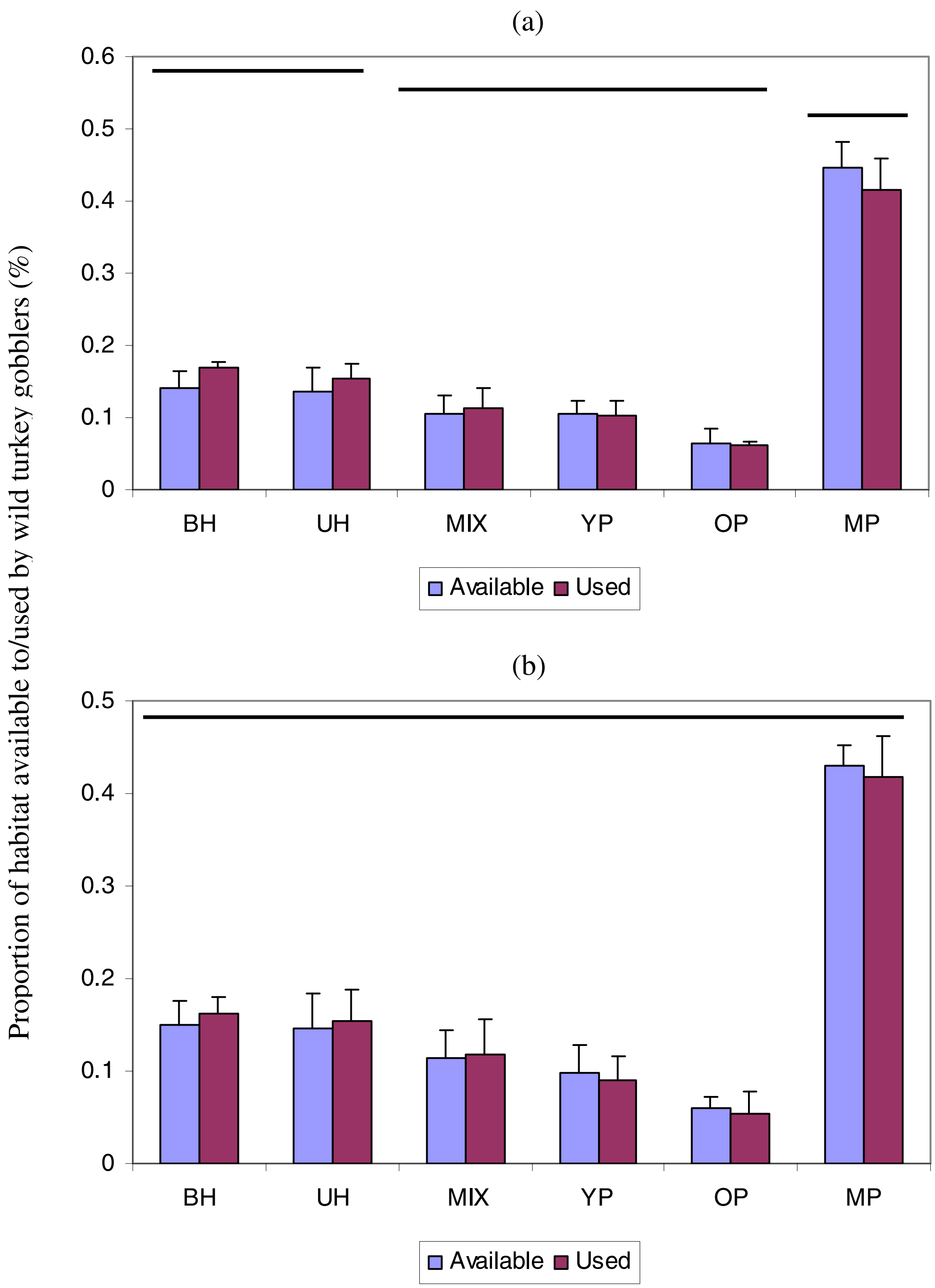

Figure 3. Habitat selection by wild turkey gobblers on the Savannah River Site, South Carolina, during fall/winter of 1998-2000 at (a) the study-area scale (n=36) and (b) the home-range scale (n=36). Habitat types (see Table 1 for definitions of abbreviations) are ranked from left to right in decreasing order of selection. Lines above habitat types indicate no significant difference (compositional analysis, $P \geq 0.05$) in selection among habitat types.

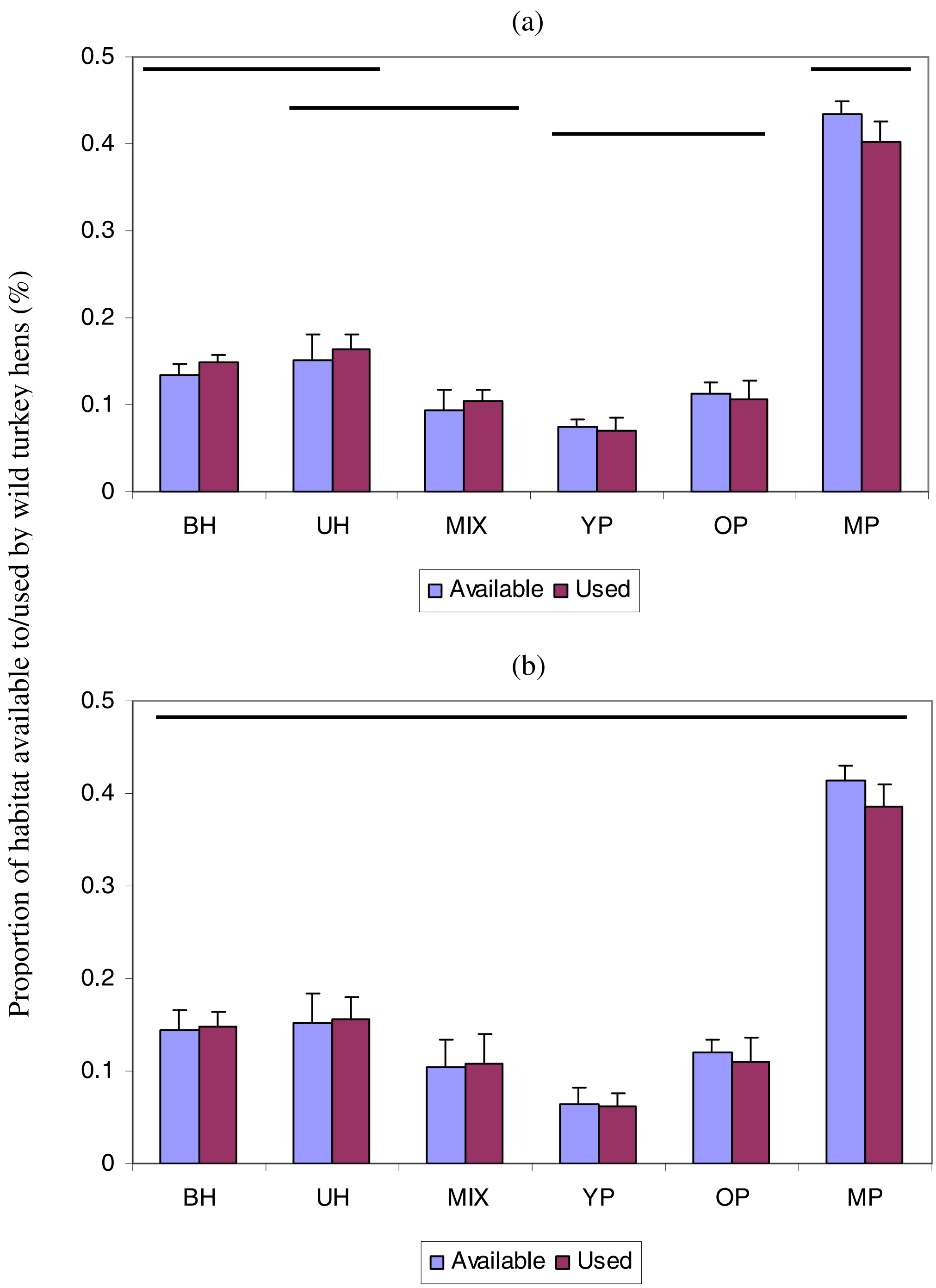

Figure 4. Habitat selection by wild turkey hens on the Savannah River Site, South Carolina, during fall/winter of 1998-2000 at (a) the study-area scale (n=36) and (b) the home-range scale (n=36). Habitat types (see Table 1 for definitions of abbreviations) are ranked from left to right in decreasing order of selection. Lines above habitat types indicate no significant difference (compositional analysis, $P \geq 0.05$) in selection among habitat types.

1990, Smith and Teitelbaum 1986, Hurst and Dickson 1992). In Louisiana, turkeys also avoided mature pines and openings during the fall and winter (Hurst and Dickson 1992).

Previous turkey habitat selection studies in the Southeast have primarily occurred in areas with relatively high amounts of pastures, meadows, and agricultural fields, which were heavily used by turkeys during spring and summer (Hyde and Newsom 1973, Speake et al. 1975, Everett et al. 1985, Hurst and Dickson 1992). These habitats are considered by many to be essential for hens and poults as bugging areas (Hurst 1978, Hurst and Owen 1980, Metzler and Speake 1985, Porter 1992). Gobblers in other southeastern studies also frequently used pastures and field edges during spring and summer (Hurst and Dickson 1992). Because such a high percentage of SRS (85%) is forested, fields and pasture-like conditions are uncommon. However, based on SCDNR trapping records and surveys, the turkey population on SRS has been increasing despite the lack of such habitats (Moore et al. 2005). Our telemetry data indicate that use of such habitats by turkeys during spring and summer was minimal; however, these findings are misleading. Although hens exhibited no habitat selection during the spring/summer periods, hens with and without poults were observed using rights-of-way (ROW) and roadsides (Moore et al. 2005), areas that are dominated by grasses and other early successional plant species (Imm and McLeod 2005) far more during spring/summer than other times of year. Because many of the extremely narrow roadsides and ROW are not in the GIS stands coverage, and since telemetry error was greater than these widths, it was not possible to test whether turkeys selected for these areas. On SRS, such areas may serve as surrogates for agricultural fields, pastures, and other early successional habitats that are commonly found and used by turkeys in other parts of the Coastal Plain.

Future RCW management activities on SRS could potentially affect wild turkey populations. The Site's RCW management plan established a primary habitat management area (HMA) (34,831 ha) and a Supplemental HMA (18,683 ha), which amount to approximately 2/3 of the Site (Johnston 2005). In these areas, forest management activities are aimed at expanding the existing RCW populations both in numbers and in distribution. In the HMA's, pine stands are now managed on rotations of ≥ 100 years, and the use of growing season burns will increase to control the hardwood midstory. Since most future RCW management activities will occur on existing mature pine stands, the effects on wild turkeys is unclear. Mature pine stands are frequently used by turkeys throughout the year, and a change in the burning regime may or may not affect their selection of these habitats. If areas containing mature hardwoods were negatively impacted by harvest or the use of growing season burns, the turkey population could suffer since these areas are so important during the fall and winter.

MANAGEMENT IMPLICATIONS

Gobblers and hens shifted their habitat use to areas dominated by hardwoods in fall and winter, which is common in eastern wild turkey populations. In areas with limited hardwood habitats, or in years of hard mast failure, this reliance on hardwoods may result in increased movements of turkeys, which could result in higher predation rates or greater emigration rates. Most wild turkey studies in the Southeast have stressed the importance of providing a mixture of forested and open field/early successional habitats. Despite the fact that the mature pines were used less than their proportional availability, they were used nevertheless. Combined with the fact that the SRS population has expanded rapidly, our data indicates that a productive wild turkey population can be maintained even in an area dominated by mature pine forests that contains few agricultural fields or pastures.

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CHAPTER 5

EFFECTS OF SEASON OF BURN ON FOOD PLANT ABUNDANCES FOR THE EASTERN WILD TURKEY

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ABSTRACT. The longleaf pine (*Pinus palustris*) ecosystem once occupied over 36 million ha in the southeastern United States, but currently it occurs on less than 3% of its original range. Interests in restoring longleaf pine (LLP) savannas and associated ecosystems have grown in recent years. The endangered red-cockaded woodpecker (RCW) (*Picoides borealis*) is a species that was closely tied to LLP ecosystems. Frequent burning, particularly during the growing season, is an important management technique used in restoring RCW habitats. However, little is known about the effects of growing season burns on plant food production for populations of the eastern wild turkey (*Meleagris gallopavo silvestris*). In 1999 and 2000, we conducted a study on the U.S. Department of Energy's Savannah River Site (SRS), an 802 km^2 facility the upper coastal plain of South Carolina, to compare effects of growing and dormant-season burning on abundance of food plants for wild turkeys. Frequency of occurrence of grasses used by turkeys, which included species such as paspalums (*Paspalum* spp.) and panic grasses (*Panicum* spp.) was significantly greater on growing season-burned areas in 1999, but no differences were seen in 2000. Stem densities of soft mast-producing species were significantly greater on dormant season-burned areas in 1999. Overall, few differences were seen in plant food abundance between burning treatments, possibly because of the short length of time that the growing season burn regime has been in place.

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INTRODUCTION

Interests in restoring longleaf pine (LLP) (*Pinus palustris*) savannas and their associated ecosystems have grown in recent years (Landers et al. 1995, Varner et al.

2000, Barnett 2002). The LLP ecosystem once occupied over 36 million ha in the southeastern United States, but currently it occurs on less than 3% of its original range (Frost 1993). The savanna ecosystems were characterized by an understory which contained a diverse array of herbeacous and grass species and an overstory of scattered, mature longleaf pines (Landers et al. 1995). Prior to European colonization of North America, these ecosystems were maintained by frequent, low-intensity fires which were started by lightning strikes and Native Americans (Komarek 1974, Kush et al. 2000, Robbins and Meyers 1992). Loss of the LLP ecosystems has resulted in population declines of many wildlife species, including many federally listed endangered species, such as the gopher tortoise (*Gopherus polyphemus*) and eastern indigo snake (*Drymarchon corais couperi*).

The red-cockaded woodpecker (RCW) (*Picoides borealis*) is another federally endangered species that was closely tied to LLP ecosystems (Landers et al. 1995, Rudolph et al. 2002). Following European settlement, populations dramatically declined due to habitat loss and exclusion of frequent fire from pine forests, which resulted in a dense understory and midstory dominated by hardwoods and shrubs (Ligon et al. 1986, Streng et al. 1993, Kush et al. 2000, Rudolph et al. 2002). Frequent prescribed burning, particularly growing season burning, is an important management technique used in reducing hardwood midstories in mature pine stands, a critical component of RCW management (Van Balen and Doerr 1978, Conner and Rudolph 1991, Rudolph et al. 2002, Johnston 2005).

While the benefits of such burn regimes are recognized for RCW populations, little is known about the effects of growing season burns on populations of game species such as the eastern wild turkey (*Meleagris gallopavo silvestris*). The benefits of dormant-season fire on wild turkeys are well-documented (Hurst 1978, Buckner and Landers 1979, Porter 1992). However, burning during the growing season has different effects on understory and midstory vegetation (Boyer 1995, Kush et al. 2000), which could affect availability of plant food resources for wild turkeys. The purpose of this study was to compare the effects of growing and dormant season prescribed burning on plant food species for the eastern wild turkey.

STUDY AREA

The study was conducted on the U.S. Department of Energy's Savannah River Site (SRS), an approximately 802-km^2 National Environmental Research Park in the upper coastal plain of South Carolina. When the Site was closed to the public in 1951, the U.S.D.A Forest Service - Savannah River (FSSR) was authorized to manage undeveloped areas on SRS (Imm and McLeod 2005). Currently, approximately 85% of SRS is forested; a stark contrast to conditions in 1951, when an estimated 48% was in forests and 52% was agricultural fields and open areas. About 82% of the forested land is actively managed for forest products and wildlife, with managed areas primarily consisting of mixed-pine hardwoods and stands planted with longleaf pine (*Pinus palustris*) and loblolly pine (*P. taeda*). Areas originally planted in slash pine (*P. elliottii*) are being reforested with longleaf pine. The remainder of the Site consists primarily of upland and bottomland hardwoods, marshes, Carolina bays, old fields, grassy openings, and industrial areas.

Forest management practices on SRS have changed dramatically since 1992, largely due to the Site's recovery plan for the red-cockaded woodpecker (RCW) (*Picoides borealis*) (Blake 2005, Shea and Bayle 2005). In order to achieve the mandated longer rotation ages, clearcutting and planting have become less common, while the importance of stand thinning has grown. Also, most of the Site's current prescribed burning is being done for habitat improvement for RCW and other wildlife species. Before 1991, most controlled burning targeted reduction of fuel loads (Shea and Bayle 2005). Controlled burns on the Site range from 2 – 1300 ha in size, with an average of 6000-8000 ha being burned each year. Most areas are burned on a 3-5 year rotation. Prescribed burns are conducted in all seasons; however, the total acreage burned during the growing season (< 1000 ha) is relatively small and primarily restricted to RCW recovery areas. Forest management activities on much of the Site are aimed at expanding the existing RCW population, both in numbers and distribution. In RCW habitat management areas, pine stands are currently managed on rotations of ≥ 100 years, and use of growing season burns is increasing to control hardwood midstory.

METHODS

The FSSR Continuous Inventory of Stand Conditions (CISC) database was used to denote stands burned during the growing and dormant seasons. On each prescribed burning treatment, 30 points were selected at random to measure several vegetative characteristics, including woody stem density (#/m^2), percent ground cover, species richness, and frequency of occurrence of herbaceous vegetation and vines. Each selected point was used as a plot center on which a 30X100 m grid of subplots was established.

Woody stem density (≥ 0.5 cm dbh) was measured on 30 subplots (1 m^2) established 10 m apart on the grid. Percent ground cover and frequency of occurrence by species of vegetation was measured on 150 subplots (0.25 m^2) established 5 m apart on the grid. Percent canopy closure was measured at the 4 corners of the grid using a spherical densiometer. Vegetation was sampled during July and August of 1999-2000. For each selected point, stand age and time since the previous prescribed burn were determined using the CISC database.

For all vegetative characteristics, analysis of variance (ANOVA) was used to determine differences between burn treatments. Herbaceous vegetation data were normalized with an arcsin transformation (Steele and Torrie 1980) and then compared between treatments based on frequency of occurrence. Woody vegetation data were normalized with a square root transformation and compared between treatments based on the mean number of stems per plot by species. As a measure of species richness, we compared mean number of species per subplot. Statistical significance was accepted at $p \leq 0.05$.

Eastern wild turkey plant food species were grouped and analyzed separately. Wild turkey forage plants were selected according to species lists published in several southeastern food habits studies (Kennamer and Arner 1970, Barwick et al. 1973, Kennamer et al. 1980, McGlincey et al. 1986, Hurst 1992). Stem densities of all soft and hard mast-producing species were compared between treatments. Only oak species with a dbh ≥ 20 cm was considered to be a mast producer (Downs 1944). Botanical nomenclature follows Radford et al. (1968).

RESULTS

Frequency of occurrence of asters was significantly greater ($F_{59} = 4.14$; $p = 0.05$) on growing season-burned areas in 1999 but did not differ between burn treatments in 2000 (Table 1). Frequency of occurrence of grasses was significantly greater on growing season-burned areas in 1999 ($F_{59} = 9.70$; $p = 0.01$) and 2000 ($F_{59} = 10.40$; $p = 0.01$). Occurrence of vines, legumes, and other forbs did not differ between treatments during either year. Percent ground cover also was significantly greater ($F_{59} = 5.66$; $p = 0.02$) on growing season-burned plots in 1999 but did not differ among treatments in 2000. Percent canopy closure was similar between areas during both years. Herbaceous species richness was similar between treatments during both years. Woody stem density was significantly greater ($F_{59} = 4.89$; $p = 0.03$) on dormant season-burned areas in 1999 but was similar on both treatments in 2000. Woody species richness also was similar on both treatments during both years.

Occurrences of several plant species differed significantly between treatments during both years. Broomsedge (*Andropogon virginicum*), little bluestem (*A. scoparius*), wiregrass (*Aristida* spp.), and Indiangrass (*Sorghastrum* spp.) occurred more frequently on growing season-burned areas in both years. Occurrences of beggarweeds (*Desmodium* spp.), spurred butterfly pea (*Centrosema virginiana*), and dollarpea (*Rhynchosia reniformis*) were significantly greater on dormant season- burned areas during both years. Stem densities of sparkleberry (*Vaccinium arboreum*), hawthorne (*Crataegus* spp.), and wax myrtle (*Myrica cerifera*) were greater on growing season-burned areas in both years. Flowering dogwood (*Cornus florida*), southern red oak (*Quercus falcata*), and blackgum (*Nyssa sylvatica*) had higher stem densities on dormant season-burned areas in both

Table 1. Vegetation abundance and % canopy closure in stands burned during the growing and dormant seasons on the Savannah River Site, New Ellenton, SC, in 1999-2000. Values for herbaceous vegetation and vines are means (SE) for frequency of occurrence of species. Woody stem values are mean (SE) stem density per m^2.

	Growing-season Burn	Dormant-season Burn	F_{59}	P
1999				
Woody stem densities (#/m^2)	3.90 (0.52)	5.97 (0.78)	4.89	0.03*
% Canopy closure	67.87 (2.56)	70.57 (2.51)	0.57	0.46
% Ground cover	9.12 (0.41)	7.96 (0.28)	5.66	0.02*
All herbaceous	0.15 (0.01)	0.11 (0.01)	3.53	0.09
Grasses	0.05 (0.01)	0.03 (0.01)	9.70	0.01*
Asters	0.02 (0.01)	0.01 (0.01)	4.14	0.05*
Legumes	0.02 (0.01)	0.03 (0.01)	2.19	0.13
Other forbs	0.03 (0.01)	0.02 (0.01)	1.06	0.34
Vines	0.02 (0.01)	0.02(0.01)	0.47	0.63
2000				
Woody stem densities (#/m^2)	4.77 (0.57)	6.13 (0.78)	1.99	0.16
% Canopy closure	65.87 (2.66)	71.70 (2.13)	2.94	0.90
% Ground cover	9.27 (0.42)	10.28 (0.55)	2.11	0.15
All herbaceous	0.16 (0.01)	0.14 (0.02)	1.49	0.22
Grasses	0.05 (0.01)	0.03 (0.01)	10.40	0.01*
Asters	0.04 (0.01)	0.02 (0.01)	3.62	0.07
Legumes	0.02 (0.01)	0.03 (0.01)	1.78	0.14
Other forbs	0.03 (0.01)	0.03 (0.01)	0.49	0.49
Vines	0.02 (0.01)	0.02 (0.01)	0.57	0.45

* - indicates significance at the $p \leq 0.05$ level

years.

Frequency of occurrence of grasses used by turkeys, which included species such as paspalums (*Paspalum* spp.) and panic grasses (*Panicum* spp.) was significantly greater on growing season-burned areas in 1999 ($F_{59} = 7.18$; $p = 0.01$) and 2000 ($F_{59} = 8.16$; $p = 0.01$) (Table 2). Also, total stem density of soft mast-producing species were significantly greater ($F_{59} = 6.11$; $p = 0.02$) on areas burned during the dormant season in 1999; however stem densities were similar on both treatments in 2000. Common soft-mast producing species included sparkleberry, deerberry (*Vaccinium stamineum*), and flowering dogwood. Stem densities of hard mast-producing species, primarily oaks, were similar on both areas during both years. All other vegetation groups were similar between treatments for both years.

DISCUSSION

We saw more grass food for wild turkeys on summer-burned areas in 1999, indicating that growing season burning could benefit grass seed production for turkeys. Differences in abundance of vegetation between areas burned during the growing and dormant seasons were inconsistent. The occurrence of grasses was significantly different between burning treatments in both years. Frequent growing season burns often result in the development of a grassy herbaceous layer (Conner et al. 2002, Jones et al. 2004), thus improving nesting conditions for wild turkeys (Porter 1992, Conner et al. 2002).

Greater stem densities of soft mast-producing species in 1999 on winter-burned areas were primarily due to the abundance of deerberry and flowering dogwood. Blueberries (*Vaccinium* spp.) of various species were common on both burning

Table 2. Abundance of food plants for wild turkeys in stands burned during the growing and dormant seasons on the Savannah River Site, New Ellenton, SC, in 1999-2000. Values for herbaceous vegetation and vines are means (SE) for frequency of occurrence of species. Woody stem values are mean (SE) stem density per m^2.

	Growing-season Burn	Dormant-season Burn	F_{59}	P
1999				
Woody stem densities				
Soft mast producers	3.02 (0.38)	4.76 (0.59)	6.11	0.02*
Hard mast producers	0.80 (0.03)	1.16 (0.08)	1.58	0.17
All herbaceous	0.09 (0.01)	0.08 (0.01)	2.53	0.10
Grasses	0.03 (0.01)	0.01 (0.01)	7.18	0.01*
Asters	0.02 (0.01)	0.01 (0.01)	3.16	0.09
Legumes	0.01 (0.01)	0.01 (0.01)	0.94	0.38
Other forbs	0.01 (0.01)	0.01 (0.01)	1.17	0.29
Vines	0.02 (0.01)	0.02 (0.01)	0.92	0.38
2000				
Woody stem densities				
Soft mast producers	3.19 (0.40)	4.67 (0.63)	3.88	0.06
Hard mast producers	1.06 (0.05)	1.21 (0.11)	0.63	0.68
All herbaceous	0.10 (0.01)	0.08 (0.02)	2.70	0.09
Grasses	0.03 (0.01)	0.01 (0.01)	8.16	0.01*
Asters	0.02 (0.01)	0.01 (0.01)	0.91	0.39
Legumes	0.01 (0.01)	0.02 (0.01)	1.32	0.30
Other forbs	0.02 (0.01)	0.02 (0.01)	0.79	0.41
Vines	0.01 (0.01)	0.02 (0.01)	0.87	0.41

* - indicates significance at the $p \leq 0.05$ level

treatments in both years and are an important soft mast source for turkeys and other wildlife species. Abundance of hard mast species did not differ between treatments. Both burning treatments had relatively low abundances of oaks capable of producing acorns.

Stem density and percent cover of all turkey food plants were low on both treatment areas. Percent canopy closure of forests on both areas was relatively high, which may have had more influence on plant food abundances than burning treatments. In Arkansas, total soft mast production was greater in shelterwood stands than in unthinned stands with greater canopy closure (Perry et al. 2004) and available herbaceous and woody forage conditions improved following stand thinnings that opened up the forest canopy (Peitz et al. 2001).

Similarities in vegetation between areas also may have been a result of factors other than the burning treatments. An extended drought began on SRS in mid-1998 and continued through 2000, which may have affected vegetation abundance on both areas. Also, many of the areas sampled had only recently come under a growing-season burn regime. Long-term use of growing season burns may restore herbaceous communities of pine stands savanna conditions typical of fire-maintained pine ecosystems but also may reduce the amount of soft mast-producing woody species. However, reduction in woody stem densities may improve light conditions to the forest floor, which could further stimulate herbaceous plant forage.

MANAGEMENT IMPLICATIONS

The long-term effects of growing season burns on wild turkey populations are largely unknown. Most managers are concerned about effects of growing season fire on wild turkey reproduction, either negatively through nest destruction or positively through the increase in preferred nesting habitats. However, managers should not ignore the potential effects that growing season fire may have on plant food production for wild turkeys. These burns may increase abundances of one type of food while eliminating other food resources. Further research is needed to determine what those long-term effects will be.

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APPENDICES

APPENDIX A

CAPTURE DATA, # OF TELEMETRY LOCATIONS, AND FATE OF GOBBLERS CAPTURED ON THE SAVANNAH RIVER SITE AND CRACKERNECK WILDLIFE MANAGEMENT AREA

Table A. Capture data, # of telemetry locations, and fate of gobblers captured on the Savannah River Site (SRS) and Crackerneck Wildlife Management Area (CWMA), New Ellenton, South Carolina, 1998-2000.

Band #	**Radio Frequency**	**Date Captured**	**Location Trapped**	**Age**	**Weight (lbs)**	**Spur Length (in)**	**Beard Length (in)**	**# of Locations**	**Fate**
G2801	150.370	1/29/98	SRS	adult	20	7/8	11	10	roadkill
G2802	150.590	2/15/98	SRS	adult	19	7/8	8	12	lost transmitter
G2803	150.410	2/15/98	SRS	adult	17	¾	9	25	bobcat kill
G2804	150.390	2/25/98	CWMA	adult	17	1 1/8	10	223	signal ceased
G2805	150.760	2/25/98	CWMA	adult	17	1	10 1/4	130	hunter kill
G2806	150.810	2/25/98	CWMA	adult	15	1	9	183	signal ceased
G2807	150.770	2/25/98	CWMA	adult	21	1 ¼	10	14	lost signal
G2809	150.690	2/26/98	CWMA	adult	19	7/8	8	206	signal ceased
G2808	150.460	2/26/98	CWMA	adult	16	1	8	208	signal ceased
G2810	150.440	2/26/98	CWMA	adult	19	1 3/8	10	8	hunter kill
G2811	150.530	2/26/98	CWMA	adult	21	1 ¼	8	7	bobcat kill
G2812	150.430	3/3/98	SRS	adult	18 ½	1 1/8	10	26	bobcat kill
G2813	150.060	3/3/98	SRS	adult	21	1	9	206	signal ceased
G2814	150.380	3/3/98	SRS	adult	17	1	10 1/4	168	bobcat kill
G2815	150.190	3/12/98	SRS	adult	20	1	9 ½	201	signal ceased
Recapture	150.290	2/5/00	SRS		20	1 3/8	9	92	-study ended
G2816	150.230	3/22/98	SRS	adult	15	1	8	195	signal ceased
G2817	150.840	1/19/99	SRS	adult	18 ½	7/8	9 1/2	164	signal ceased
G2818	150.240	1/19/99	SRS	adult	19	1 3/8	11	121	bobcat kill
G2822	150.260	1/28/99	SRS	jake	12	--	3 1/2	27	bobcat kill
G2820	150.550	1/28/99	SRS	jake	12 ½	--	4	175	signal ceased
G2819	150.040	1/28/99	SRS	jake	13	--	4	178	signal ceased
G2821	150.510	1/28/99	SRS	jake	13 ½	--	4 1/2	169	signal ceased
G2826	150.170	2/5/99	SRS	jake	11	--	4 1/2	29	roadkill
G2824	150.070	2/5/99	SRS	jake	11 ½	--	4	36	unknown mort.
G2825	150.210	2/5/99	SRS	jake	10 ½	--	4 1/2	186	signal ceased
G2823	150.500	2/5/99	SRS	jake	10	--	4	196	signal ceased
G2827	150.730	2/14/99	CWMA	adult	20	1 1/4	10	8	hunter kill
G2828	150.020	2/14/99	CWMA	adult	18 ½	1 ¼	9	32	bobcat kill
G2829	150.220	2/14/99	CWMA	adult	19	1 1/8	10 1/2	4	unknown mort.

Table A. continued

Band #	Radio Frequency	Date Captured	Location Trapped	Age	Weight (lbs)	Spur Length (in)	Beard Length (in)	# of Locations	Fate
G2830	150.120	2/14/99	CWMA	adult	18 ½	1 ¼	8	83	bobcat kill
G2831	150.200	2/15/99	SRS	adult	17	1 3/8	10	6	bobcat kill
G2832	151.330	2/15/99	SRS	adult	17 1/2	1 1/8	9	39	bobcat kill
G2833	150.880	2/15/99	SRS	adult	18	1 3/8	10	176	signal ceased
G2834	150.130	2/15/99	SRS	adult	21	1 1/8	11	5	signal ceased
G2835	150.030	2/21/99	SRS	jake	12	--	4	173	signal ceased
G2839	150.940	3/5/99	CWMA	jake	12 1/2	--	3 1/2	15	bobcat kill
G2836	151.130	3/5/99	CWMA	jake	14 1/2	--	4	6	hunter kill
G2838	151.010	3/5/99	CWMA	jake	12 1/2	--	3 1/2	5	hunter kill
G2837	150.300	3/5/99	CWMA	jake	13	--	4 1/2	16	unknown mort.
G2840	150.990	1/22/00	SRS	adult	20	1	9	7	bobcat kill
G2841	150.280	1/22/00	SRS	adult	19	1 1/8	11	103	study ended
G2844	150.160	1/22/00	SRS	adult	20	1	10	7	unknown mort.
G2845	150.050	1/28/00	SRS	jake	13	--	4	98	study ended
G2846	150.530	1/28/00	SRS	jake	14	--	4	98	study ended
G2847	150.910	1/28/00	SRS	adult	16	5/8	8	91	study ended
G2848	150.100	1/28/00	SRS	adult	16	1	9	88	study ended
G2849	150.790	1/28/00	SRS	adult	14	1	9	1	censored
G2850	150.330	1/28/00	SRS	adult	15	7/8	9 1/2	102	study ended
G2851	150.410	1/28/00	SRS	adult	18	1	9	10	bobcat kill
G2852	150.480	2/5/00	SRS	adult	17	5/8	9 1/2	3	radio failed
G2853	150.870	2/5/00	SRS	adult	20	1	10	13	bobcat kill
G2854	150.740	2/5/00	SRS	adult	20	1 1/4	10	6	bobcat kill
G2855	150.320	2/28/00	SRS	adult	20	7/8	10	1	censored
G2858	150.930	3/1/00	SRS	jake	15	--	2 1/2	86	study ended
G2859	150.920	3/8/00	SRS	adult	17	3/4	9 1/2	11	unknown mort.
G2860	150.700	3/14/00	CWMA	jake	13	--	3	103	study ended
G2861	151.300	3/14/00	CWMA	jake	13	--	3	103	study ended
G2862	151.150	3/14/00	CWMA	jake	13	--	2 1/2	103	study ended
G2863	150.310	3/15/00	CWMA	adult	16	7/8	8	9	bobcat kill
G2864	150.430	3/15/00	CWMA	adult	17	1	9	98	study ended

Table A. continued

Band #	Radio Frequency	Date Captured	Location Trapped	Age	Weight (lbs)	Spur Length (in)	Beard Length (in)	# of Locations	Fate
G2865	151.050	4/6/00	SRS	adult	16	1/2	4	75	bobcat kill
G2866	150.110	4/6/00	SRS	jake	11	--	2 1/2	95	study ended

APPENDIX B

CAPTURE DATA, NESTING DATA, # OF TELEMETRY LOCATIONS, AND FATE OF HENS CAPTURED ON THE SAVANNAH RIVER SITE

Table B. Capture data, nesting data, # of telemetry locations and fate of hens captured on the Savannah River Site (SRS), New Ellenton, South Carolina, 1998-2000.

Band #	**Radio Frequency**	**Date Captured**	**Age**	**Weight (lbs)**	**Initiated Incubation? (Y/N) (year)**	**# of eggs**	**Fate of Nest**	**# of Locations**	**Fate of Hen**
TR0515	150.620	2/26/98	adult	10	Y (1998)	13	hatched	206	signal ceased
					Y (1999)	8	depredated		
TR0509	150.820	2/26/98	adult	10	Y (1998)	19	depredated	228	signal ceased
					Renest	8	hatched		
TR0508	150.910	2/26/98	adult	10	N	--	--	12	bobcat kill
TR0516	150.350	2/26/98	adult	10	Y (1998)	10	hatched	184	signal ceased
TR0514	150.470	2/26/98	adult	9	Y (1998)	11	depredated	86	bobcat kill
					Renest	8	hatched		
TR0518	150.650	2/26/98	adult	9	Y (1998)	13	hatched	92	bobcat kill
TR0513	150.860	2/26/98	adult	8	Y (1998)	14	hatched	26	coyote kill
TR0510	150.790	2/26/98	adult	10	Y (1998)	8	abandoned	58	bobcat kill
TR0511	150.570	2/26/98	adult	9	Y (1998)	10	hatched	29	unknown mort.
TR0517	150.600	2/26/98	adult	10	Y (1998)	10	hatched	239	signal ceased
TR0512	150.610	2/26/98	adult	11	Y (1998)	9	hatched	178	signal ceased
TR0519	150.540	3/3/98	adult	11 (4 ½" beard)	Y (1998)	12	hatched	34	roadkill
TR0520	150.630	3/3/98	adult	10	Y (1998)	10	hatched	238	signal ceased
TR0521	150.420	3/3/98	adult	10	N	--	--	18	bobcat kill
TR0522	150.580	3/3/98	adult	10	Y (1998)	9	hatched	156	unknown mort.
TR0525	150.000	2/3/99	adult	9 (7 ½"	N	--	--	208	signal ceased
Recapture	150.890	3/8/00	adult	beard)	Y (2000)	9	depredated	32	bobcat kill
TR0524	150.800	2/3/99	jenny	7	N	--	--	214	signal ceased
Recapture	151.340	3/8/00	adult	8				8	unknown mort.
TR0523	150.780	2/3/99	adult	8 ½ (3" beard)	N	--	--	9	coyote kill
TR0526	150.360	2/21/99	adult	10 ½	N	--	--	197	signal ceased
TR0527	150.670	2/21/99	adult	10 ½	N	--	--	46	bobcat kill
TR0528	150.950	2/21/99	adult	11	N	--	--	58	bobcat kill
TR0529	150.750	2/21/99	adult	8 1/2	N	--	--	209	signal ceased
TR0530	150.450	2/24/00	adult	8	Y (2000)	10	depredated	134	study ended
TR0531	150.270	2/24/00	adult	8	Y (2000)	9	depredated	138	study ended

Table B. Continued

Band #	Radio Frequency	Date Captured	Age	Weight (lbs)	Initiated Incubation? (Y/N) (year)	# of eggs	Fate of Nest	# of Locations	Fate of Hen
TR0532	150.250	2/24/00	adult	10	Y (2000) Renest	14 12	depredated depredated	141	study ended
TR0533	150.850	2/24/00	adult	10	Y	11	depredated	130	study ended
TR0534	150.180	2/24/00	adult	9	Y (2000)	8	depredated	124	study ended
TR0535	150.590	2/28/00	adult	11	Y (2000)	15	abandoned	142	study ended
TR0536	150.640	2/28/00	adult	9	Y (2000)	6	depredated	129	study ended
TR0538	150.340	2/28/00	adult	8	N	--	--	120	study ended
TR0537	150.980	2/28/00	adult	10	N	--	--	1	censored
TR0540	150.710	2/28/00	adult	11	N	--	--	7	bobcat kill
TR0539	150.770	2/28/00	adult	10	Y (2000) Renest	12 8	depredated depredated	137	study ended
0990	150.540	3/1/00	adult	10	Y (2000)	10	depredated	148	study ended
0984	150.860	3/1/00	adult	10	N	--	--	120	study ended
0985	150.150	3/1/00	adult	10	N	--	--	7	roadkill
0972	150.140	3/8/00	adult	11 (7" beard)	N	--	--	126	