Management Planning and Habitat Modeling for Wild Turkeys (Meleagris Gallopavo Silvestris) in Virginia

Holly N. Morris

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Steve L. McMullin, Committee Co-Chair
James A. Parkhurst, Committee Co-Chair
Dean F. Stauffer
Gary W. Norman

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(ABSTRACT)

The Virginia Department of Game and Inland Fisheries (VDGIF), prior to this study, knew little about stakeholder desires for wild turkeys, and had no modern means to assess turkey habitat. My objectives were to (1) identify stakeholders in management of wild turkeys in Virginia, assess their attitudes and opinions regarding turkey management, and incorporate that knowledge in developing a management plan for wild turkeys in Virginia; during this process, assess how involvement in a management planning process affects stakeholders and agency personnel, and (2) develop a preliminary habitat assessment for wild turkeys in Virginia.

I employed collaborative planning techniques to develop the management plan. I utilized surveys to assess changes in knowledge, attitudes, and opinions by the Stakeholder Advisory Committee (SAC) and VDGIF staff. I performed a review of wild turkey habitat requirements and habitat assessments, and utilized surveys and the Delphi method to select variables and suitability values for the habitat assessment.

The SAC improved their knowledge of wild turkeys, and the SAC and Wild Turkey Technical Committee, and became more accepting of public involvement in decision-making. Wildlife Bureau staff placed more importance on minority stakeholders' values, had more positive views of the agency and wild turkey management, and desired professional opinion in decision-making.

I developed a 2-step comprehensive habitat assessment for wild turkeys. The first step examines habitat at the landscape-level (5,167 acres); the second step applies a rapid habitat appraisal tool that uses aerial imagery and data collected from on-site inspection to assess habitats of <1,000 acres.

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Chapter 1:

Introduction & Literature Review

The eastern wild turkey (*Meleagris gallopavo silvestris*), native throughout the Commonwealth of Virginia, provides recreational benefits to both consumptive and non-consumptive users. In 2006, wild turkey hunters spent $1.5 billion nationwide and almost $88.5 million in Virginia (US Fish and Wildlife Service 2010). During the 2011-2012 season, an estimated 72,975 hunters pursued wild turkeys in Virginia; approximately 41,591 hunted turkeys during the fall season and 56,186 hunted during the spring season (Howell 2012). Non-consumptive users also appreciate wild turkeys, especially when male birds display to attract females during the spring breeding season. In 2011, approximately 2.5 million individuals participated in wildlife viewing and spent approximately $959 million on viewing activities in Virginia (US Department of the Interior et al. 2014). Individuals who enjoy viewing wildlife often enhance such opportunities by providing supplemental food, which tends to congregate wild turkeys.

Hunters in Virginia have had a long tradition of pursing wild turkeys during a fall turkey hunting season (Mosby and Handley 1943). In 1961, the Virginia Department of Game and Inland Fisheries (VDGIF) added a new spring turkey season. VDGIF currently manages wild turkey populations to optimize total harvest from the spring gobbler and fall either sex seasons (Healy and Powell 1999, Norman and Steffen 2003).

In 1995, VDGIF reduced the fall turkey season from 9 to 6 weeks and eliminated turkey hunting concurrent with much of the deer firearms season in many counties, both of which reduced the fall harvest of turkeys significantly. Prior to this change, the fall turkey season overlapped with the deer firearms season, spanned 9 weeks, and approximately 1/3 of the fall turkey harvest came during the first week of the deer firearms season. Managers had suggested adopting these regulatory changes following a joint Virginia and West Virginia study (Pack et al. 1999) that examined the effects of fall hunting on wild turkey populations. That study found that heavy harvests in the fall can be additive and removes birds that otherwise would have survived until the spring hunting season. However, in response to stakeholder demands, VDGIF in 1999 reinstituted the opportunity to harvest a turkey on Thanksgiving Day, which coincides with part of the deer firearms season. Then, in 2011, VDGIF extended the fall turkey season by adding a 2-week open season in January to allow additional hunting opportunities without competition from other big game hunting seasons.

Because of these regulatory changes, the fall harvest of wild turkeys in Virginia has declined dramatically, from 16,593 turkeys harvested in 1990 to 4,432 turkeys during 2012-2013 (VDGIF 2013c) (Figure 1-1). In contrast, the spring harvest of wild turkeys generally has remained stable, but, in 2013, hunters harvested a record 19,265 birds during the spring gobbler season (VDGIF 2013a) (Figure 1-1). The number of hunters participating in the spring turkey season has declined from 61,000 in 2004 to 56,186 in 2012 (Tapley et al. 2011, Howell 2012), and participation in fall turkey hunting has declined, but at a rate slower than the decline in fall harvest; 64,000 hunters participated in 2004, compared to 41,591 hunters in 2011 (Tapley et al. 2011, Howell 2012). Given the apparent influence these regulatory changes have had on both participation and harvest, the agency now faces questions about how best to allocate this resource among hunters and what management goals for the species ought to be. These issues clearly identified the need for a statewide wild turkey management plan.

Personnel from VDGIF and Virginia Tech previously worked together to develop management plans for black bear (*Ursus americanus*) and white-tailed deer (*Odocoileus virginianus*) using collaborative planning techniques (VDGIF 2002, 2007). No such plan previously existed for wild turkey management in Virginia. Collaborative planning involves a variety of methods that allow stakeholders and professionals to work together to formulate a management plan. In the development of previous VDGIF management plans, stakeholders focused on identifying issues and clarifying important values associated with the resource; VDGIF obtained input via focus groups, public meetings, written comments, and participation on stakeholder advisory committees. Concurrently, VDGIF professionals directed their effort toward making technical choices and developing ecologically sound strategies to fulfill stakeholder desires. Ultimately, stakeholders identified management goals and professionals established objectives and designed strategies to achieve the goals. Employing various methods to obtain public input maximizes broad public support. Previous public involvement efforts related to management of wild turkeys in Virginia incorporated information from unsolicited comments, hunter surveys, and public feedback on proposed regulation changes at regional meetings and through the agency's website. However, these methods did not encompass all stakeholders and did not actively include the public in making management decisions.

Development of a management plan using a collaborative approach provides an opportunity for stakeholders to become directly involved in wild turkey management and, when stakeholders believe their voices are being heard by VDGIF, they are more likely to "buy in" to the adoption of the plan. Also, this collaborative approach provides VDGIF staff an opportunity to recognize the values and issues that stakeholders identify and use that information to guide decision-making regarding wild turkey management. During the development of Virginia's first Black Bear Management Plan, Lafon et al. (2004) surveyed stakeholders prior to and post-planning and determined that involvement in the planning process increased stakeholders' knowledge about black bears and their management and also improved both the stakeholders' image of the agency and the agency's acceptance of stakeholders' points of view.

Management planning for the wild turkey in Virginia

Role of management planning and stakeholders

Managers traditionally have been making both value and technical choices, assuming they accurately understand the attitudes and desires of their stakeholders, which heretofore included individuals who paid for access to the resource (i.e., hunters, trappers, and anglers who purchased licenses). More recently, agencies have been taking a broader approach to fish and wildlife management decision-making by including views of all individuals who have an interest in or are affected by management decisions (Decker et al. 1996), and allowing these stakeholders to identify their own values, rather than continuing to have managers make assumptions about them. By integrating the public in the planning process, an agency demonstrates its concern regarding the desires of the public and conveys an interest in better understanding its stakeholders (Vaske et al. 2001). By including all stakeholders in management planning, managers can acknowledge and respond to the values of new user groups, moderate the influence of any one stakeholder group, and work effectively toward achieving the desires of all stakeholders (Decker and Brown 2001). Also, state agency resource managers are entrusted to act in the public interest, and ensure that trustees (elected and appointed officials) understand the public's values and opinions (Smith 2011). The Public Trust Doctrine establishes the government as the responsible party to manage public trust resources, including waterways and fish and wildlife resources, for the benefit of the resource and public enjoyment (Batcheller et al. 2010). If resource managers do not understand public desires, they cannot satisfy the public's desires effectively. Thus, resource managers must identify and understand their stakeholders to manage effectively.

Methods to involve the public

Managers should use a variety of methods and provide multiple opportunities for stakeholder participation in the planning process; maximizing stakeholder participation helps to identify stakeholders' desires properly, but also enhances stakeholder "buy in" to any plan later developed. The quality of opportunities agencies afford stakeholders to comment and participate in the planning process greatly affects their satisfaction with the goals, objectives, and decisions that result from the process (Decker and Chase 1997). To begin a collaborative planning effort, managers must identify stakeholders who should be included and want to participate in plan development. Asking the agency's staff to identify individual stakeholders (e.g., John Doe) or stakeholder groups (e.g., Farm Bureau Federation) works well because staff members frequently interact with stakeholders and know individuals in their area. Stakeholders and organizations also can be solicited directly by asking them to contact the agency if they would like to participate. A combination of approaches works best, as this ensures that the agency provides ample opportunity for all individuals to participate. However, managers should be open to accepting individuals who initially do not accept an offer to participate or are not aware of the planning effort, such that they may join in later.

Focus groups, conducted with stakeholders who have similar interests in a resource (e.g., spring turkey hunters), provide agency managers with valuable information regarding stakeholders' attitudes and opinions toward management of the resource. Focus groups provide an opportunity for managers to listen to stakeholders; they consist of small group interviews, conducted in a setting that encourages participation. Focus groups provide qualitative information about stakeholder-specific values and opinions on the resource. Although focus group-generated qualitative data may be difficult to analyze (Babbie 2010), they help explain the beliefs stakeholders have about issues. Holding numerous focus group meetings allows many opportunities for managers to ask various stakeholders about their satisfaction with current management. Providing stakeholders the opportunity to participate directly increases the probability that issues will be identified and framed correctly rather than having managers predict what stakeholders' issues may be.

A Stakeholder Advisory Committee (SAC) gathers invited representatives of key stakeholders on multiple occasions to establish common goals with all stakeholder interests in mind. Agencies can identify potential participants for the SAC from focus groups, where staff can observe an individual interacting with others to ensure that he/she would be a good 'team player.' SAC members must exhibit open-mindedness and cooperate with other committee members who display different views and opinions to ensure the SAC can function well together and achieve assigned tasks. The SAC must focus on value choices (e.g., desires, broad goals), and leave technical choices (e.g., how to manage) to wildlife professionals. The SAC's primary responsibility includes taking issues identified from previous focus groups and developing goals for inclusion in the management plan that address the desires of all stakeholders fairly. Allowing SAC members to establish goals provides them an opportunity to see first-hand the diversity of interests and issues, and enables them to work together to find common ground.

Public meetings present proposed actions to the public, and offer opportunities to comment on those actions. However, the public forum may intimidate some individuals and prevent them from speaking. Prominent stakeholder groups with long-standing prior relations with the agency (e.g., wild turkey hunters) may overwhelm or intimidate new minority stakeholder groups, thereby reducing the effectiveness of obtaining diverse public input from all stakeholders (Peterson and Messmer 2010). Our management planning process used public meetings as opportunities to receive public comments on the goals developed by the SAC and objectives and strategies generated by VDGIF personnel and discussed by the SAC.

Utilizing a diversity of involvement methods provides a variety of avenues for stakeholders to become and stay involved. Involving stakeholders in the early stages of planning and keeping them active and aware throughout the process increases the likelihood of successfully resolving resource allocation conflicts (McMullin and Nielsen 1991). In collaborative planning, resource managers utilize these methods to allow the public to identify goals for the management plan, which managers use to make the technical decisions. As observed by Lafon et al. (2004), collaborative planning can increase stakeholders' knowledge about the resource and acceptance of science-based management, and also improve both the stakeholders' image of the agency and the agency's acceptance of stakeholders' points of view.

How does management affect the resource?

Management decisions affect not only the public's satisfaction with the resource, but wildlife as well. The results of a management planning effort may indicate the agency needs to change current management strategies to fulfill the goals of the management plan. Agencies manage wild turkey populations primarily by hunting, which, in Virginia, includes spring and fall turkey opportunities. Accommodating aspects of cultural carrying capacity, fairness in harvest allocation, and specific stakeholder desires during the management planning process may lead to changes in existing hunting seasons for wild turkeys. In the next section, I will address how modifications to hunting opportunities (e.g., spring, fall, harvest allocation within the fall season) can affect wild turkey populations (Kurzejeski and Vangilder 1992, Pack et al. 1999).

Spring Turkey Hunting

Spring turkey hunting restricts the harvest to only bearded wild turkeys. The spring gobbler season occurs during the breeding season, unlike hunting seasons for most other game species in Virginia, aside from whitetail deer hunting. Consequently, managers often set seasons to begin after the majority of breeding has taken place, when managers consider males as 'surplus.' Thus, a liberal spring season provides a unique hunting opportunity where a high number of male birds could be harvested (Kurzejeski and Vangilder 1992). However, a high spring harvest can reduce hunter satisfaction, as hunters deplete the population of mature gobblers and hunters ultimately harvest more juveniles or jakes (Vangilder and Kurzejeski 1995).

The spring gobbler season also can affect the population of wild turkey hens. Although the spring season legally restricts hunters to harvest only gobblers, hunters inevitably harvest some hens. Norman et al. (2001b) found that hunters in Virginia harvested (illegally) 6% of the hen population during the spring gobbler season. Norman et al. (2001b) also found that, by delaying the opening of the spring season until after hens begin to lay or incubate eggs, fewer illegal kills of hens, whether intentional or as a result of mistaken identification, will occur.

Fall Either-Sex Turkey Hunting

Hunters also have an opportunity to harvest turkeys of either sex during the fall season. A heavy fall harvest can affect the turkey population; a harvest of >15% of the fall population will result in population decline (Little et al. 1990). Declines in harvest and/or hunter participation during the fall turkey season suggest that the turkey population may be underutilized (D. Steffen, VDGIF, personal communication).

The age (i.e., mature vs. juvenile) of turkeys harvested in the fall varies based on weather and mast production. Persistent cold and wet weather in the spring affects the survival rate of poults, which ultimately will determine yearly production. Hunters typically harvest more adult birds, especially hens, in years of poor reproduction, whereas, in years of good reproduction, the harvest of more juveniles reduces the take on adults (Little et al. 1990, Norman and Steffen 2003).

The number of turkeys harvested in the fall also depends upon the quality of mast production that year. Late spring frosts can damage acorn production, but the effects of that damage vary by species. Norman and Steffen (2003) found that turkey harvest increased during periods of reduced acorn availability; birds moved more frequently in search of food and relied upon a variety of non-mast food resources. This increased movement and frequent visits to forest openings increases vulnerability of turkeys to hunters.

Hunters in the fall turkey season also affect the spring turkey season. Mortality from the fall turkey hunting season is additive; therefore, birds harvested in the fall otherwise might have survived until the spring and been available for harvest or nesting (Little et al. 1990). Steffen and Norman (1996) suggested that, by reducing or eliminating the fall season, spring harvest would be enhanced. However, before making any modification to seasons and/or bag limits, managers must consider the implications of such changes on hunting opportunities and satisfaction and the desires of hunters, whether spring or fall or both.

Allocation of Either-Sex Fall Turkey Harvest

Within the either-sex fall turkey season, hunters have multiple opportunities to harvest a turkey. By modifying the length of the fall turkey season and its overlap with other concurrent seasons, biologists can manipulate hunter effort and harvest. When the open season for turkeys is concurrent with those of other game species (e.g., hunting for deer, squirrel), hunters who are pursuing other species of interest also have an opportunity to harvest a turkey, thereby exerting additional pressure on the resource (Healy and Powell 1999). In addition to issues of overlapping seasons, allocation issues also arise among different types of turkey hunters (e.g., those who hunt with dogs vs. those who do not). Modifying the fall turkey hunting season to accommodate any specific hunter group requires some trade-offs if the population is to be managed sustainably; specific portions of the fall season must be reduced to compensate for methods that are more effective at harvesting turkeys. Therefore, a management plan developed using collaborative techniques ensures that managers consider all stakeholder values when establishing management strategies, particularly in determining who harvests turkeys and when.

Examples of management plans

Management Planning in Virginia

VDGIF adopted the second revision of both the Virginia Black Bear Management Plan in 2012 (VDGIF 2013b) and the Virginia Deer Management Plan in 2007 (VDGIF 2007). Both of these plans recognize “what needs to be done, how it should be done, and when it should be done” (VDGIF 2007; executive summary). Stakeholders identified goals and the agency’s professionals utilized this information to develop technical objectives and strategies to achieve the public’s goals. Both the deer and bear management plans include an overview of the management histories of the species, supply of and demand for the resource, management options, and the goals, objectives, and strategies that resulted from the planning process. The bear plan also discusses black bear life history. The latest bear and deer management plans include accomplishments from the previous plans. These management plans offer benefits, highlight needs and deficiencies of current management, and provide a roadmap to guide future management. The development of the first bear plan increased stakeholder knowledge of the resource and advanced the image of VDGIF (Lafon et al. 2004). VDGIF isn't alone in the endeavor of developing management plans for their game species. Many other state agencies realized the value of management planning, and numerous wild turkey management plans exist throughout the US.

Management Planning for Wild Turkeys - US

A review of existing wild turkey management plans prepared by state agencies revealed that most plans are unique to the area and purposefully represent issues important to stakeholders within the particular state. For example, management plans for New York and California address wild turkey conflicts, such as agricultural damage and aggression by wild turkeys in residential areas, and present strategies to resolve them (Gardner et al. 2004, Sanford et al. 2005). The southeastern Arizona management plan identified the establishment of a viable Gould's wild turkey population as an important management objective (Heffelfinger et al. 2000).

Not every state has developed a wild turkey management plan, or intends to do so. Indiana does not have species-specific plans, except for rare, threatened, or endangered species; instead they have a comprehensive wildlife plan that focuses on identifying species of concern and ways to prevent population degradation (S. Backs, Indiana Department of Natural Resources, personal communication). Ohio focuses on habitat-based management instead of species-specific plans (M. Reynolds, Ohio Division of Wildlife, personal communication).

Maine and West Virginia have wild turkey plans that act as operational plans, discussing how certain criteria must be met to allow hunting (Maine Department of Inland Fisheries and Wildlife 2002; West Virginia Division of Natural Resources, unpublished report). Several comprehensive management plans stand out as exceptions because they focus on all aspects necessary to manage wild turkeys properly. The Pennsylvania plan addresses habitat, populations, and human-turkey conflicts, and takes into consideration the multiple uses of the wild turkey resource (Casalena 2006). The original plan developed by the Arkansas Game and Fish Commission identified the need for a habitat suitability model, which since has been completed and published (Goetz and Porter 2005), and now includes a harvest management plan (Nicholson et al. 2001).

Continuing the methodology already implemented in other species management plans here in Virginia, an effective wild turkey management plan for Virginia should use a holistic and comprehensive approach. Addressing the needs and attitudes of multiple stakeholders and users of the resource, incorporating information about population dynamics and biology of the species, conducting habitat assessment and evaluating potential improvements, addressing human-wildlife conflicts, and meeting education needs are all important aspects of planning and must be considered if wild turkey populations are to prosper in concert with society.

Assessing wild turkey habitat in Virginia

What are critical life requisite requirements?

Food

Wild turkeys consume a variety of vegetation and animal-based foods, but primarily take advantage of whatever foods are available (Glover and Bailey 1949). Gobblers and hens consume emerging green vegetation during spring, then shift to insects, fruits, and other vegetation during summer (Bailey and Rinell 1967). Korschgen's (1973) study of foods consumed by wild turkeys in Missouri indicated that hens and gobblers consumed similar types of foods, but hens consumed more snails than did gobblers. Korschgen (1973) also suggested that management should focus on providing a diversity of habitat types to provide an assortment of available foods. Healy (1985), studying poult feeding behavior, found that poults primarily consumed invertebrates, but, as the poults aged, their diets shifted more to vegetation. In summer, hens seek out and inhabit areas that provide food resources for their broods, focusing on fields and woodland openings with herbaceous plants. Some forests with high site indices, and few understory shrubs and trees can provide an environment for herbaceous plant cover where insects thrive. Poults require high levels of protein in their diet to mature properly, which they easily obtain by consuming insects. Fields and forest openings provide excellent habitat for insects, thus providing a good food source for poults. As poults mature, their food requirements shift from a high protein diet to one similar to the general diet requirements of hens and gobblers.

As summer wanes, turkeys begin to group together in flocks that gradually will grow in size over the coming months. During early fall, they utilize the last available palatable green vegetation and fruits and begin shifting to hard mast resources. Birds occupy forested areas where hard mast, especially acorns, is available and abundant. Wild turkeys rely heavily upon hard mast, particularly that produced by oak trees, but also feed on soft mast producing shrubs and trees, including dogwood (*Cornus spp.*), grape (*Vitis spp*.), sweet-gum (*Liquidambar styraciflua*). Steffen et al. (2002) indicated that acorn abundance may affect movement and behavior, physical condition, mortality rates, and reproductive capability. Wild turkeys reduce the size of their home ranges during years of plentiful acorn production. Scarcity of acorns can result in birds entering the winter season in suboptimal condition and exhibiting smaller body weights. Absence of acorns will not result in the starvation of wild turkeys, given their exceptional adaptability, but populations will experience greater mortality rates during the fall hunting season. Although studies in Virginia have not shown acorn abundance effects reproductive success (Norman et al. 2001a), this relationship likely occurs given on the high nutrition acorns provide turkeys (Steffen et al. 2002).

When winter conditions render other food sources inaccessible, birds move to areas with streams, springs, and seeps that provide macroinvertebrates and late season green vegetation (Bailey and Rinell 1967). Deep (>12”), persistent (lasting >2 weeks) snow will limit the movement of wild turkeys and their access to food, and can result in starvation (Healy 1992b). However, these winter conditions are not typical in Virginia and rarely exert limitations on wild turkey populations here. During a hen survival study in Virginia from 1989-1994, researchers did not observe high mortality during several winter storms where >2’ of snow was present for >2 weeks (G. Norman, VDGIF, personal communication).

Reproduction and nest site selection

During spring, wild turkeys occupy areas that support and enhance mating and reproduction activities. Gobblers prefer areas where other turkeys can hear their gobbling well, such as from ridge tops, and also select areas with open understories and small forest openings that improve viewing opportunities of their courtship displays and thereby increase attraction among hens (Wunz and Pack 1992). Natural mortality of gobblers was highest during spring at 2 study sites in Virginia and West Virginia (VDGIF, unpublished data). At this time of year, gobblers focus most of their activity on gobbling and strutting to attract hens for mating.

Hens begin locating areas suitable for nesting and raising broods, preferably in areas where vegetative cover provides concealment to the hen and her nest from predators (Badyaev 1995). In western Virginia, hens selected nest sites in areas with a high density of tall shrubs (Godfrey and Norman 2001). Hens preferred understory cover that was more dense than typically available in intensively managed pine plantations in the Piedmont region of Virginia (Holbrook et al. 1987). Moore (2006) found that nesting success among hens was correlated with the quality of nest concealment. However, in Connecticut, Spohr (2001) suggested that, in highly fragmented environments, survival of hens and protection of the nest did not depend only on the availability or quality of vegetative cover. Wunz and Pack (1992) believed oak-hickory forests provided sufficient nesting cover throughout. Yet, in northern hardwood forests, hens often sought out regenerating clear cuts and abandoned fields where they would nest along the edges of these dense habitats. In Florida, hens also used habitat ecotones for nesting (Williams et al. 1973). These edge habitats may be selected by hens, but an abundance of predators along these edges will push hens to nest within the dense habitat instead (Thogmartin 1999). Ecotones and disturbed areas allow sunlight to penetrate to the forest floor, encouraging understory vegetation growth that provides better nest concealment.

Brood range

Nest success and poult survival affect annual changes in wild turkey populations, so improvements to nesting and brood habitat should increase the growth of a population (Roberts et al. 1995). Poults experience highest mortality during the first 2 weeks of life (Glidden and Austin 1975, Everett et al. 1980), as they have difficulty navigating terrain, escaping predators, and regulating body temperature. Hens provide shelter from adverse weather for poults living off yolk sacs between 4-6 days old; however, poults between 12-15 days suffer mortalities from cold temperatures and prolonged rain because the hen cannot brood their larger bodies, and poults are not yet able to effectively regulate body temperature (Healy and Nenno 1985). Poults learn to fly at about 8-10 days of age (Pelham and Dickson 1992); however, poults do not use trees for roosting until 2-4 weeks of age (Healy 1992a). During the flightless period when poults roost on the ground, survival improved where the amount of dense vegetation and logs was greater (Spears et al. 2007). Godfrey and Norman (1999) also found understory vegetation influenced poult survival positively. In intensely managed pine forests, Campo et al. (1989) found that broods selected areas with dense herbaceous vegetation and open forest canopies, often the type of conditions found in prescribed burned sites. The hen’s vision should not be obstructed by the height of the vegetation, so she can see predators, but vegetation should be tall enough to conceal the poults from predators (Porter 1992). In contrast, hens without broods in Pennsylvania occupied upland forest sites, where herbaceous understory vegetation was sparse (Ross and Wunz 1990).

In Alabama, researchers found poults and hens using grazed pastures and forests as brood habitat (Hillestrad and Speake 1970). In grazed pastures, cattle removed vegetation that often obstructs travel by poults and also stimulates new plant growth, which provides both a direct food source for turkeys and enhances invertebrate abundance growth. In oak-hickory forests of West Virginia, Pack et al. (1980) recognized the preference for forest openings and pastures by broods; home ranges overlapped for 9 of 17 broods because hens relocated their broods to these areas after hatching, suggesting that brood habitat elsewhere was inadequate. Researchers suggest that managers should mow forest openings only every 1-3 years because frequent mowing decreases invertebrate abundance (Healy and Nenno 1983, Peoples et al. 1995, Backs and Bledsoe 2011). Mowing on a 1-3 year rotation prevents woody stem encroachment and vegetation from becoming too dense to impede poults' movements. These openings provide greater densities of invertebrates compared to intact forest stands.

Escape cover

Young poults that have not yet developed the ability to fly rely heavily upon the availability of high quality escape and roosting cover to increase survival (Spears et al. 2007). However, once birds develop the ability to fly, they begin to utilize trees for roosting and escaping predators. Forest openings that do not restrict the hen's vision, but allow poults to remain concealed, enable hens to identify predators and signal her brood to retreat to cover. Porter (1992) noted that broods, when foraging in openings, will retreat to the closest available cover rather than traveling a great distance to the forest tree line; in one case, the closest available cover was 5' tall cornstalks growing adjacent to the grassy opening. Lima (1993) suggested all birds regularly assess the probability of predation and ways to escape predators; if a situation is too risky, birds will avoid the habitat. Lima (1993) also noted that wild turkeys regularly use woody vegetation as escape cover. Williams et al. (1997) found that hens and poults preferred bottomland hardwoods for foraging during the first 4 weeks after hatching, rather than openings; despite the fact that openings provided more abundant insects, bottomland hardwoods provided sufficient food sources and better overhead forested cover. A study in Mississippi also indicated that wild turkey broods preferred bottomland hardwoods, although an adjacent forest opening near a bottomland hardwood stand received heavy use by one brood; researchers suggested that, for broods to use forest openings, the area must be in close proximity to preferred habitat (Phalen et al. 1986).

Roost sites

In many studies wild turkeys have been found to roost in mature conifers, when available, with streams nearby. Conifers situated on northeastern-facing slopes protect roosting birds from prevailing winds and enable them to regulate body temperature more effectively (Porter 1992). Chamberlain et al. (2000) studied hens in Mississippi and found they preferred to roost in pine and mixed pine-hardwood stands >30 years old, often located near streams. In Rhode Island, wild turkeys primarily used large (>48cm diameter at breast height [DBH]) white pines and some eastern hemlocks positioned near water as roost sites; trees selected as roosts typically were the tallest trees available and featured a layered, horizontal branching pattern (Kilpatrick et al. 1988). Porter (1992) suggests that this horizontal branching pattern 10-30m above the ground is the most important aspect to roost sites. Wild turkeys in Virginia preferred trees with a DBH of 25-50cm for roosts (Hurst and Dickson 1992). Ludwig (2012) found that wild turkeys in Delaware preferred conifers >15" DBH located in areas with an open understory for roosting. In West Virginia, wild turkeys relied upon conifers for roosting during winter months, but, in the absence of conifers, turkeys would use mature deciduous trees instead (Glover 1948). Similarly, researchers in Massachusetts reported that wild turkeys utilized softwood stands for roosting during periods of heavy snow (Vander Haegen et al. 1989). However, Ermer et al. (2005) performed a study on winter roost sites in Minnesota and concluded, as did Haroldson et al. (1998), that researchers should perform additional studies to determine the role conifers actually play in providing necessary roosting habitat for wild turkeys.

Summary of previous habitat models

In Virginia

A review of previously developed habitat models and appraisal tools for wild turkeys allows managers to create new, improved methods without having to go through a lot of trial and error. In Virginia, researchers developed a computer-based wild turkey habitat model using a FORTRAN program for Peters Mountain (Williamson and Koeln 1980). They included mast availability, mast species diversity, competition for food with other species, proximity to permanent water, degree of forest contiguity, proximity to forest openings, and proximity to roost sites as important variables in their habitat model. Williamson and Koeln (1980) developed a linear model, along with a map featuring alphabet letters as symbols to represent habitat scores; darker letters signified better quality habitat. Although they produced a basic model, application of the model did provide a baseline method to determine habitat suitability.

Across the Nation

The US Fish and Wildlife Service produced a habitat suitability index (HSI) model for the wild turkey that focused on seasonal life requirements and also those specific to turkey age (Schroeder 1985). Through a literature review and expert opinion, Schroeder evaluated habitat variables for consideration in the model. Habitat variables focused on summer food and brood habitat, cover, and fall, winter, and spring food components. Variables for the summer food and cover component includes the percent of herbaceous canopy cover, average height of herbaceous canopy, and the distance to a tree/savannah cover type. The fall, winter, and spring food component incorporates the number and average size of hard mast trees >25.4cm DBH, percent canopy cover of soft mast trees, percent shrub crown cover, percent of shrub crown cover comprised of soft mast shrubs, the type of crops and their management, and the distance to a tree dominated cover type. The cover component only included the percent tree canopy cover, the average DBH of overstory trees, and the percent of forest canopy in evergreens. Schroeder never tested or validated the model, but designed the model for use throughout the eastern wild turkey's range as of the 1980s. This model provided the fundamentals and serves as a reference for assessing eastern wild turkey habitat suitability.

Donovan et al. (1987) developed a habitat suitability model using a geographic information system (GIS) and data derived from the Michigan Resource Information System (MIRIS). Researchers wanted to assess the ability of MIRIS to provide data to model the suitability for nesting and brood-rearing habitat for reintroduced eastern wild turkeys. Their model focused on 3 categories: habitat composition (percent hardwoods, wetlands, shrublands, agriculture), spatial arrangement (edge and minimum distance to where all 4 habitats co-occur), and human use (percent used by humans and the distance to the nearest human use areas). They evaluated the model by comparing the HSI values with randomly selected areas and also an area where 9 hens with broods resided; randomly selected areas and ranges of the known wild turkeys differed significantly. Areas that wild turkeys used had higher habitat composition and human use values. Researchers stressed that modeling habitat at large scales using GIS requires generalizing wildlife habitat requirements (e.g., identifying herbaceous areas instead of a warm season grasses).

The Missouri Department of Conservation and USDA Soil Conservation Service (1988) developed a habitat appraisal guide for use in Missouri; this was the only known rapid habitat appraisal tool for the eastern wild turkey designed for application on private lands, with a focus on woodlot size and species, cropping practices, herbaceous areas, and juxtaposition of habitat components. An individual must visit a site of interest and assign a value based on responses to a suite of specific questions. To generate an overall value of the habitat, the user must sum the values and then divide by the total maximum value. Based on the number computed, the user can identify the suitability of the habitat (e.g., excellent, good, fair, poor). This work likely stemmed from the pattern recognition model developed by Kurzejeski and Lewis (1985) that was designed to assess the effects of management options on wild turkey densities in MIssouri.

In Indiana, Gustafson et al. (1994) developed a model that focused on the spatial arrangement of habitat, specifically habitat fragmentation, and how it affects the suitability of habitat for wild turkey populations. They developed the model using image processing software (PC-ERDAS) and Landsat digital data. Researchers established 3 levels of habitat suitability (optimum, suboptimum, poor), focusing on the percent of forest cover, spatial arrangement of forest cover, percent of crop land, and level of human development. They analyzed 9 study sites of 20,100 ha each, with 3 for each habitat suitability level. Researchers determined the proportion of forest cover and patches and, within each patch, calculated area, perimeter, nearest neighbor distance, and proximity indices. Results indicated minimal fragmentation occurred in optimal habitat, compared to poor habitat. Researchers proposed this model would aid managers with the identification of suitable areas for wild turkey introductions.

Rumble and Anderson (1995) tested a habitat model previously developed by Lindzey and Suchy (US Fish and Wildlife Service, unpublished data) and improved the model for the Merriam's wild turkey in the Black Hills. They compared the habitat suitability of radio telemetry-derived locations of hens with broods and adult turkeys vs. randomly selected locations. The Lindzey-Suchy model examined winter food, roost cover, and brood habitat. In revising the model, Rumble and Anderson (1995) identified brood and winter habitats as important, but found the diameter of roost trees was insignificant to wild turkey populations in the Black Hills. Herbaceous vegetation, hard-mast species, and percentage of forested area proved to be important variables for the Merriam's turkey, similar to the eastern wild turkey. The model indicated winter conditions limit the population of wild turkey in the Black Hills.

Glennon and Porter (1999) also used Landsat satellite imagery to assess habitat suitability for wild turkeys in southwestern New York, focusing on cover types, edge, and the spatial arrangement of cover types. Researchers confirmed the classification of habitat by comparisons with aerial photography and ground-truthing. They summarized landscape characteristics at the township-level and compared these characteristics with fall hunter effort and harvest data. They found a positive correlation with turkey abundance and open land, agricultural land, edge density, interspersion and juxtaposition of cover types, and patches; they observed a negative association between wild turkey abundance and contagion. In areas dominated primarily by forest, the addition of open areas and agriculture improved the habitat suitability for wild turkeys. This study proved biologists could employ landscape assessments using land cover data to evaluate turkey habitat and provided knowledge for the development of many other projects and models.

Fleming and Porter (2000) used satellite imagery to develop a landscape-scale habitat suitability model that focused on essential habitat variables for wild turkey reproduction. They incorporated data from previous research in New York on hens with broods to indicate which habitat variables appeared to be important, rather than solely using a literature review to indicate these variables. To study the impacts of weather on brood survival, they also developed a model to assess the effects of rainfall and number of heating degree-days in May and June. Optimal habitat appeared to be in areas where forest dominated the land cover, but also had agriculture land cover interspersed throughout. Heavily forested or highly fragmented areas provided the least suitable habitat. Elevation played a large role in determining suitable temperature regimes for females; higher elevations typically displayed lower temperatures in May, which were better for nesting hens, whereas lower elevations provided temperatures in June better suited to the needs of poults. The Fleming and Porter (2000) model focused on the critical components contributing to wild turkey populations: turkey reproduction and survival. Application of the model identified which regions provided poor turkey reproductive habitat, and may indicate reasons for poor reproductive success.

In Missouri, Larson et al. (2003) developed 12 landscape-level habitat suitability models for various wildlife species, including the wild turkey. Based on information from a literature review, researchers developed a model for the wild turkey using a 102-ha moving window analysis; the model focused on the interspersion of adult habitat and nesting and brood habitat. Forest openings, mature forest, hard mast, and the interspersion of the 3 variables composed the 4 suitability indices. Researchers did not test the model for accuracy.

Baldiviezo (2005) explored possible reasons for Rio Grande wild turkey population decline in Texas by developing a GIS model for female turkeys during the breeding season. The habitat model concentrated on nesting cover, brood-rearing cover, and brood-rearing food, and Baldiviezo tested the model in 4 different study sites; overall, it performed well, but, needed further testing with abundance data to validate the model fully. He used land cover types in the model; disturbance and high levels of woody cover negatively influenced wild turkey populations. Also, he identified changes in the riparian zone arrangement and removal of woody cover limited wild turkey population expansion. Biologists can assess landscape changes with this model to determine how they may affect essential habitat for and populations of Rio Grande turkeys.

Goetz and Porter (2005) developed a habitat model for Arkansas using satellite imagery. Their habitat suitability model valued land cover based on its importance to wild turkeys as food and cover. They used logistic regression to compare the model output at the county-level against wild turkey harvest data. At the statewide scale, the model did not explain variation in turkey harvests well (R^2=0.32); however, models developed for use at the regional scale explained almost 70% of the variation in harvest for one region. The regional approach compensated for differences in topography (i.e., flat vs. mountains) and land use (i.e., commercial forestry vs. large-scale agriculture), thus allowing models to be developed for specific regions; they also hypothesized that each region has different limiting factors for wild turkey populations (i.e., forested area vs. open areas). The variation between the statewide and regional models demonstrates the difficulty in developing an accurate model at such a large scale and across a variety of landscapes. Goetz and Porter (2005) also developed statewide and regional models using logistic regression to identify land cover types associated with low turkey harvest; they found percent of land in row crops ($P<0.002$) and percent of land in commercial-industrial-transportation ($P=0.028$) associated with low turkey harvest at the statewide level.

In Kansas, biologists developed a Rio Grande wild turkey GAP (Gap Analysis Program) model for the state, but the model produced inconsistent results at the state level (Houts et al. 2005). The GAP model performed poorly in specific ecoregions of the state, whereas, in other regions, it performed well. To develop a better assessment of the habitat, researchers developed a habitat suitability model for each ecoregion in Kansas using logistic regression. They identified 7 ecoregions, using land cover variables such as forest, tall grass, mixed grass, short grass, shrub land, wetland, agriculture, urban areas, and water to classify the habitat. They recognized forested, mixed grass, short grass, and shrubs as important land cover types in most of the ecoregions. In comparison to the GAP model, the ecoregion models more consistently predicted habitat correctly; habitat varies across the Kansas, therefore smaller regional models may predict these changes more accurately. Biologists can use this landscape habitat suitability model to assess the habitat suitability of the state and to document wild turkey populations.

In Arizona, Wakeling (2005) developed landscape-level habitat models to assess the year-round requirements for Merriam's wild turkey. He developed the models using forward stepwise regression, focusing on nesting, roosting, winter, and summer habitat use. Wakeling used data from the US Forest Service, Digital Elevation Models, USGS Digital Line Graphs, and Terrestrial Ecosystem Surveys to correlate the telemetry of wild turkey locations with cover types, elevations, vegetation, roads, and other attributes. Greater slope, close proximity to closed (abandoned) and open (active) system roads, close proximity to point water sources, and greater distance from water impoundments positively influenced the selection of roosting habitat. The presence of ponderosa pine and pinyon-juniper vegetation, proximity to timber harvests that had occurred 2 years prior, and proximity to roosting sites and point water sources positively influenced the winter model. Close proximity to open roads, proximity to roosting sites and point water sources, timber harvests that had occurred 1 or 2 years prior, and ponderosa pine and mixed conifer vegetation positively influenced the summer habitat model. The presence of ponderosa pine and mixed conifer vegetation positively influenced the nesting model.

Cathey et al. (2007) developed a habitat appraisal guide for the Rio Grande wild turkey primarily for use in Texas, but also in other states where the Rio Grande subspecies resides. Researchers published this guide in a short report, designed for public and expert consumption. The report identified the crucial habitat requirements for Rio Grande turkeys, and explains how various management tools (e.g., prescribed fire) can be employed to improve wild turkey habitat. Researchers developed a dichotomous key for appraising habitat in Appendix A. Based on the answers the user provides, Appendix B provides suggestions to improve the habitat for Rio Grande turkeys. Additionally, the report provides instructions for applying the appraisal tool. In summary, this appraisal guide provides users with the life history requirements for the Rio Grande subspecies and, after working through the dichotomous key, provides suggestions for improving the habitat.

Dijak et al. (2007) developed the most recent HSI model for the wild turkey. They developed landscape-level habitat suitability software for Windows-based computers and included models for 21 species; researchers also can manipulate this software to create revised models or new HSI models for other species. Researchers designed these HSI models for application across the United States. The software focuses on landscape-scale variables and uses a moving window analysis to compute edge effects, distance to resources, area sensitivity, and habitat types within a home range. The wild turkey HSI model focuses on nesting habitat and adult cover; the suitability indices include values for young trees providing cover, mature trees providing food, equations defining mast production, and a moving window analysis (default set to an area of 19 pixels or 17,100m^2) to determine if all habitat components are available within a turkey's home range. The user must provide the data for use with this software and the developers assumed that users can derive most data from the US Forest Service National Inventory.

Frary et al. (2011) studied the effects of small (<22.9cm DBH) tree thinning and low intensity prescribed burning of ponderosa pine forests to reduce fuel for wildfires on Merriam's turkey roost sites in Arizona. Researchers identified roost sites by monitoring wild turkeys fitted with GPS satellite transmitters and analyzing GIS data. Researchers studied the aspect, elevation, slope, tree basal area, canopy cover, distance from edge, terrain ruggedness, tree density, and canopy height; they also used logistic regression and Akaike's Information Criterion (AIC) to develop models. The models identified terrain ruggedness and elevation as the most important variables in determining roost sites; according to the model, roost sites occurred in areas with rugged terrain at high elevation. The proposed small tree thinning and prescribed burning would pose little harm to the turkeys, as the area supports an abundance of roost sites and the treatments will not directly affect the preferred size of trees in which Merriam's roost.

A model for Gould's wild turkey survival and habitat selection assessed the capability of habitat in southeastern Arizona to sustain a population of turkeys (Wakeling et al. 2001). Researchers collected habitat data from study sites inhabited by wild turkeys fitted with tracking devices and also randomly selected uninhabited sites. Researchers geo-referenced habitat data from on-the-ground habitat classification surveys (pine, oak-juniper, bare ground, etc.) and obtained percent slope, distance to water and roads, and elevation using location data collected from birds fitted with GPS tracking devices. Wakeling et al. (2001) used forward-stepwise logistic regression to develop a model for the Huachuca and Galiuro Mountains study sites. The likelihood of habitat occupation increased in the Huachuca model with the presence of grassland and pines, and in the Galiuro model with the presence of shrubs, pines, and increased elevation. The Huachuca model identified mesquite, bare ground, and distance to springs as factors reducing the likelihood of turkey occupation, whereas the Galiuro model identified proximity to streams and roads as negative factors. Wakeling and Heffelfinger (2011) tested their Galiuro model by applying it to 11 proposed release sites, after which they deemed the model effective in helping determine habitat suitability. Using this model, biologists successfully restored Gould's turkey populations in Arizona.

Phillips et al. (2011) studied the landscape habitat type and arrangement around winter roost sites of Rio Grande turkeys in Texas, as the availability and distribution of these roost sites can limit the spatial growth of these populations. Researchers compared roost and random sites using univariate, correlation, and forward stepwise discriminate function analysis. Variables focused on range, brush, oak, and water cover types; they calculated the percent of the landscape, patch density, largest patch index, edge density, Euclidean nearest neighbor, and aggregation index for each cover type; they also studied relative patch richness, interspersion-juxtaposition index, and Simpson's diversity and evenness indices. Researchers found Rio Grande wild turkeys typically selected roost sites within large oak patches with high amounts of edge and interspersion of habitat types nearby.

Swearingin et al. (2011) studied 32 winter roost sites and 32 random non-roost sites of Rio Grande turkeys in an effort to develop a model for identifying suitable winter roost sites. After assessing a suite of variables that encompassed 3 scales (i.e., individual tree, immediate understory, stand), they found that tree height, tree diameter, stand area, and percentage of litter contributed most to determining suitability of sites for roosting. Managers can use this model to identify sites for conservation and stands that hold potential as future roost sites in Texas.

Habitat variables determined by scale

In the preceding paragraphs, I reviewed the fundamental features of habitat for wild turkeys and previous attempts at assessing habitat. I quickly realized these features or needs span different habitat scales. Concluding that any comprehensive habitat assessment also must span different scales, I developed a 2-step habitat assessment for the wild turkey in Virginia. The first step, discussed in Chapter 3A, employs a landscape-level habitat suitability model, using remote imagery and GIS, based on habitat units (5,167 acres) that approximate a wild turkey's average home range in Virginia (5,189 acres; McDougal 1990); it does not include a field collection of forest stand measurements. I identified datasets (e.g., Forest Inventory and Analysis [FIA]), that provided detailed forest stand information (e.g., stand age), but such datasets are not available for all forested lands; detailed metrics cannot be determined otherwise at the landscape-scale. Therefore, by necessity, I focused on generalized habitat variables (e.g., percent of the area forested) based on the 2006 National Land Cover Dataset (Fry et al. 2011). Using this model and data, I can assess wild turkey habitat uniformly across all of Virginia with easily obtained and inexpensive data, which facilitates use by VDGIF personnel.

The second step in the habitat assessment, discussed in Chapter 3B, includes a rapid habitat appraisal tool that I designed to assess habitat quality of smaller areas of interest (<1,000 acres), using a site visit and aerial imagery of the surrounding area. This habitat appraisal tool requires use of high-quality aerial imagery and physically visiting the site of interest. Free imagery for Virginia is available from the Virginia Base Mapping Program (Virginia Information Technologies Agency, Chester, VA), but information on the more detailed variables (e.g., identification of deciduous tree species) used in this assessment must be collected during site visits. Similar to the Missouri bobwhite quail habitat appraisal guide (White et al. 2005), I designed this appraisal tool to assess habitat components for each life requisite deemed critical to wild turkeys. Application of this tool will provide users with a consistent and quantitative method to assess the quality of small tracts for wild turkeys. This appraisal tool produces an overall habitat suitability score and, ultimately, identifies limiting habitat components.

Benefits of assessing habitat

In addition to having knowledge about the desires and values of stakeholders, sound management decisions also require having reliable information about the resource itself. A comprehensive statewide habitat assessment for wild turkeys would complement the proposed management plan and provide biologists with tools to make informed management decisions (e.g., hunting seasons, habitat management needs). Previous to this research, biologists in Virginia estimated habitat suitability for wild turkeys at the landscape-scale based on estimates of wild turkey abundance (e.g., spring harvest of gobblers per square mile of forested range). Calculation of turkey abundance depends on hunter effort, but hunters obviously do not apply effort equally across Virginia; therefore, wild turkey abundance estimates should be considered somewhat suspect. Also, forested range represents only a portion of available wild turkey habitat. In fact, several counties with smaller amounts of forested range regularly have displayed a high proportion of birds harvested per square mile, which portrays a higher overall turkey abundance compared to similar, but heavily forested, counties. Unlike the former approach, the comprehensive habitat assessment I created identifies habitat variables critical to the wild turkey throughout its life cycle, focusing on particular requirements linked to a turkey's sex, life stage, and seasonal needs. Objectives for the assessment include examining current and past habitat conditions, evaluating the potential of landscapes to support wild turkey populations, and estimating the effects of potential landscape changes on wild turkey populations. Documented habitat differences among broad-scale areas or changes in an area over time will help managers identify landscapes with unique management opportunities. VDGIF personnel need a method to assess current wild turkey habitat and predict the effects of landscape and patch-scale changes on those populations. Thus, the development of a management plan and comprehensive habitat assessment provides VDGIF with a better understanding of their stakeholders and offers management strategies and tools to more effectively manage the wild turkey.

This study had two main objectives:

1. Identify stakeholders in management of wild turkeys in Virginia, assess their attitudes and opinions regarding turkey management, and incorporate that knowledge in developing a

management plan for wild turkeys in Virginia; during this process, assess how involvement in a management planning process affects stakeholders and agency personnel. (Chapter 2)

2. Develop a preliminary habitat assessment for wild turkeys in Virginia. (Chapter 3)

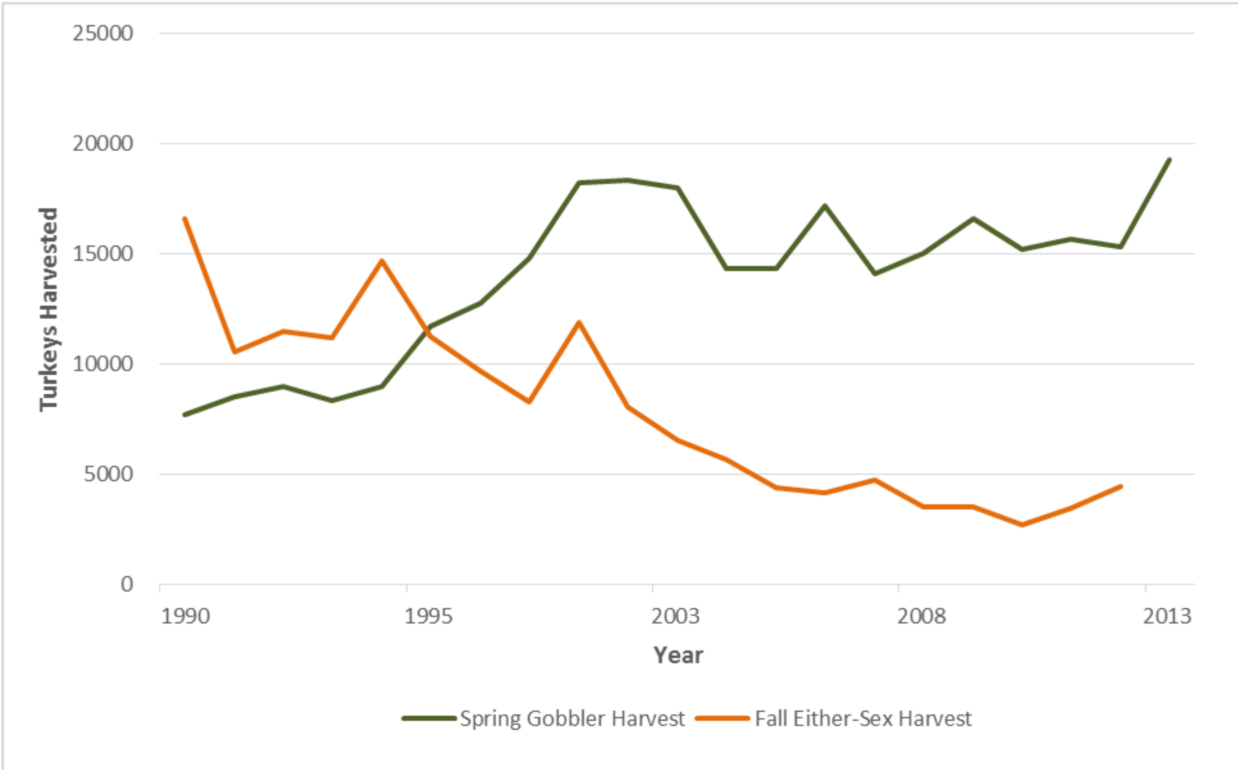

Figure 1-1. Wild turkey harvest from 1990 through Spring 2013 in Virginia based on the Virginia Department of Game and Inland Fisheries (VDGIF) data.

Literature Cited

Babbie, E. 2010. The practice of social research. Wadsworth, Belmont, California, USA.

Backs, S. E., and L. W. Bledsoe. 2011. Invertebrate abundance and vegetative structure in forest openings. Proceedings of the National Wild Turkey Symposium 10:51-63.

Badyaev, A. V. 1995. Nesting habitat and nesting success of eastern wild turkeys in the Arkansas ozark highlands. Condor 97:221-232.

Bailey, R. W. , and K. T. Rinell. 1967. Events in the turkey year. Pages 73-91 *in* O. H. Hewitt, editor. The wild turkey and its management. The Wildlife Society, Washington, D.C., USA.

Baldiviezo, H. L. P. 2005. GIS-based multiple scale study of Rio Grande wild turkey habitat in the Edwards Plateau of Texas. Dissertation, Texas A&M University, College Station, USA.

Batcheller, G. R., M. C. Bambery, L. Bies, T. Decker, S. Dyke, D. Guynn, M. McEnroe, M. O'Brien, J. F. Organ, S. J. Riley, and G. Roehm. 2010. The public trust doctrine: implications for wildlife management and conservation in the United States and Canada. The Wildlife Society, Bethesda, Maryland, USA.

Campo, J. J., W. G. Swank, and C. R. Hopkins. 1989. Brood habitat use by eastern wild turkeys in eastern Texas. Journal of Wildlife Management 53:479-482.

Casalena, M. J. 2006. Management plan for wild turkeys in Pennsylvania 2006-2015. Pennsylvania Game Commission. <www.portal.state.pa.us/portal/server.pt/document/711862/turkey_plan_pdf >. Accessed 16 Dec 2013.

Cathey, J. C., S. Locke, D. Ransom, S. J. DeMaso, T. W. Schwertner, and B. Collier. 2007. Habitat apprasial guide for Rio Grande wild turkey. Texas A&M System AgriLife Extension SP-317.

Chamberlain, M. J., B. D. Leopold, and L. W. Burger. 2000. Characteristics of roost sites of adult wild turkey females. Journal of Wildlife Management 64:1025-1032.

Decker, D. J., and T. L. Brown. 2001. Understanding your stakeholders. Pages 109-132 *in* D. J. Decker, T. L. Brown, and W. F. Siemer, editors. Human dimensions of wildlife management in North America. The Wildlife Society, Bethesda, Maryland, USA.

Decker, D. J., and L. C. Chase. 1997. Human dimensions of living with wildlife: a management challenge for the 21st century. Wildlife Society Bulletin 25:788-795.

Decker, D. J., C. C. Krueger, R. A. Baer, B. A. Knuth, and M. E. Richmond. 1996. From clients to stakeholders: a philosophical shift for fish and wildlife management. Human Dimensions of Wildlife 1:70-82.

Dijak, W. D., C. D. Rittenhouse, M. A. Larson, F. R. Thompson, and J. J. Millspaugh. 2007. Landscape habitat suitability index software. Journal of Wildlife Management 71:668-670.

Donovan, M. L., D. L. Rabe, and C. E. Olson. 1987. Use of geographic information-systems to develop habitat suitability models. Wildlife Society Bulletin 15:574-579.

Ermer, J. R., K. J. Haroldson, R. O. Kimmel, C. D. Dieter, P. D. Evenson, and B. D. Berg. 2005. Characteristics of winter roost and activity sites of wild turkeys in Minnesota. Proceedings of the National Wild Turkey Symposium 9:281-288.

Everett, D. D., D. W. Speake, and W. K. Maddox. 1980. Natality and mortality of a north Alabama wild turkey population. Proceedings of the National Wild Turkey Symposium 4:117-126.

Fleming, K. K., and W. F. Porter. 2000. A habitat suitability approach to evalutating landscape patterns for eastern wild turkey. Proceedings of the National Wild Turkey Symposium 8:157-166.

Frary, V. J., M. F. Ingraldi, S. E. Sesnie, V. Horncastle, and Z. Reichold. 2011. Landscape-scale identification of Merriam's wild turkey roosting habitat in a managed ponderosa pine forest. Proceedings of the National Wild Turkey Symposium 10:293-300.

Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham. 2011. Completion of the 2006 National Land Cover Database for the conterminous United States. Photgrammetric Engineering & Remote Sensing 77:858-864.

Gardner, S., T. Blankinship, and J. Decker. 2004. Strategic plan for wild turkey management. California Department of Fish and Game. <www.dfg.ca.gov/wildlife/hunting/uplandgame/docs/turkplan_04.pdf >. Accessed 13 Sept 2013.

Glennon, M. J., and W. F. Porter. 1999. Using satellite imagery to assess landscape-scale habitat for wild turkeys. Wildlife Society Bulletin 27:646-653.

Glidden, J. W., and D. E. Austin. 1975. Natality and mortality of wild turkey poults in southwestern New York. Proceedings of the National Wild Turkey Symposium 3:48-54.

Glover, F. A. 1948. Winter activities of wild turkey in West Virginia. Journal of Wildlife Management 12:416-427.

Glover, F. A., and R. W. Bailey. 1949. Wild turkey foods in West Virginia. Journal of Wildlife Management 13:255-265.

Godfrey, C. L., and G. W. Norman. 1999. Effect of habitat and movement on wild turkey poult survival. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 53:330-339.

Godfrey, C. L., and G. W. Norman. 2001. Reproductive ecology and nesting habitat of eastern wild turkeys in western Virginia. Proceedings of the National Wild Turkey Symposium 8:203-210.

Goetz, S. L. , and W. F. Porter. 2005. Statewide assessment of wild turkey habitat using satellite imagery in Arkansas. Proceedings of the National Wild Turkey Symposium 9:189-198.

Gustafson, E. J., G. R. Parker, and S. E. Backs. 1994. Evaluating spatial pattern of wildlife habitat: a case-study of the wild turkey (Meleagris gallopavo). American Midland Naturalist 131:24-33.

Haroldson, K. J., M. L. Svihel, R. O. Kimmel, and M. R. Riggs. 1998. Effect of winter temperature on wild turkey metabolism. Journal of Wildlife Management 62:299-305.

Healy, W. M. 1985. Turkey poult feeding activity, invertebrate abundance, and vegetation structure. Journal of Wildlife Management 49:466-472.

Healy, W. M. 1992a. Behavior. Pages 46-65 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Healy, W. M. 1992b. Population influnences: environment. Pages 129-143 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Healy, W. M., and E. S. Nenno. 1983. Minimum maintenance versus intensive management of clearings for wild turkeys. Wildlife Society Bulletin 11:113-120.

Healy, W. M., and E. S. Nenno. 1985. Effect of weather on wild turkey poult survival. Proceedings of the National Wild Turkey Symposium 5:91-101.

Healy, W. M., and S. M. Powell. 1999. Wild turkey harvest management: biology, strategies, and techniques. U.S. Fish and Wildlife Service BTP-R5001-1999.

Heffelfinger, J., B. Wakeling, J. Millican, S. Stone, T. Skinner, M. Fredlake, and M. Adkins. 2000. Southeastern Arizona wild turkey management plan. Arizona Game and Fish Department, Publication FHWA-FLP-96-016. <www.azgfd.gov/pdfs/h_f/management/SoutheasternArizonaWildTurke%20ManagementPlan.pdf >. Accessed 13 Sept 2013.

Hillestrad, H. O., and D. W. Speake. 1970. Activities of wild turkey hens and poults as influenced by habitat. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 24:244-251.

Holbrook, H. T., M. R. Vaughan, and P. T. Bromley. 1987. Wild turkey habitat preferences and recruitment in intensively managed piedmont forests. Journal of Wildlife Management 51:182-187.

Houts, M., B. Houck, and M. Mitchener. 2005. Modeling wild turkey habitat suitability in Kansas. <http://kbs.ku.edu/media/uploads/work/ModelingWildTurkeyHabitat_houts05.pdf >. Accessed 13 Sept 2013.

Howell, J. 2012. Virginia survey of hunter harvest, effort, and attitudes 2011-2012. Department of Game and Inland Fisheries, Richmond, Virginia, USA. (In press).

Hurst, G. A., and J. G. Dickson. 1992. Eastern turkey in southern pine-oak forests. Pages 265-285 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Kilpatrick, H. J., T. P. Husband, and C. A. Pringle. 1988. Winter roost site characteristics of eastern wild turkeys. Journal of Wildlife Management 52:461-463.

Korschgen, L. J. 1973. April foods of wild turkeys in Missouri. Proceedings of the National Wild Turkey Symposium 2:143-150.

Kurzejeski, E. W. , and J. B. Lewis. 1985. Application of PATREC modeling to wild turkey management in Missouri. Proceedings of the National Wild Turkey Symposium 5:269-283.

Kurzejeski, E. W., and L. D. Vangilder. 1992. Population management. Pages 165-184 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole books, Mechanicsburg, Pennsylvania, USA.

Lafon, N. W., S. L. McMullin, D. E. Steffen, and R. S. Schulman. 2004. Improving stakeholder knowledge and agency image through collaborative planning. Wildlife Society Bulletin 32:220-231.

Larson, M. A., W. D. Dijak, F. R. Thompson, and J. J. Millspaugh. 2003. Landscape-level habitat suitability models for twelve wildlife species in southern Missouri. USDA Forest Service, General Technical Report NC-233. <http://nrs.fs.fed.us/pubs/gtr/gtr_nc233.pdf >. Accessed 13 Sept 2013.

Lima, S. L. 1993. Ecological and evolutionary perspectives on escape from predatory attack: a survey of North American birds. Wilson Bulletin 105:1-47.

Little, T. W., J. M. Keinzler, and G. A. Hanson. 1990. Effects of fall either-sex hunting on survival in an Iowa wild turkey population. Proceedings of the National Wild Turkey Symposium 6:119-125.

Ludwig, E. 2012. Reproductive ecology of eastern wild turkey hens in Sussex County Delaware. Thesis, University of Delaware, Newark, USA.

Maine Department of Inland Fisheries and Wildlife. 2002. Wild turkey management system and data base. <www.maine.gov/ifw/pdfs/species_planning/birds/wildturkey/managementsystem.pdf >. Accessed 16 Dec 2013.

McDougal, L. A. 1990. Wild turkey-road interactions on a Virginia national forest. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

McMullin, S. L., and L. A. Nielsen. 1991. Resolution of natural resource allocation conflicts through effective public involvement. Policy Studies Journal 19:553-559.

Missouri Department of Conservation, and USDA Soil Conservation Service. 1988. Wildlife habitat apprasial guide: Missouri. JS-Biol-13(4).

Moore, W. F. 2006. Survival, nesting success, and habitat selection of wild turkey populations in the upper coastal plain of South Carolina. Dissertation, Clemson University, Clemson, South Carolina, USA.

Mosby, H. S., and C. O. Handley. 1943. The wild turkey in Virginia: its status, life history and management. Virginia Commission of Game and Inland Fisheries, Richmond, USA.

Nicholson, D., M. Widner, R. McAnally, J. K. Lynch, D. Henley, L. Moore, B. Carner, M. Hooks, C. Robinette, J. Johnson, and P. Tankersley. 2001. Strategic wild turkey management plan. Arkansas Game and Fish Commission. <http://cdm15021.contentdm.oclc.org/cdm/singleitem/collection/p266101coll7/id/399/rec/33 >. Accessed 13 Sept 2013.

Norman, G. W., J. C. Pack, C. I. Taylor, D. E. Steffen, and K. H. Pollock. 2001a. Reproduction of eastern wild turkeys in Virginia and West Virginia. Journal of Wildlife Management 65:1-9.

Norman, G. W., and D. E. Steffen. 2003. Effects of recruitment, oak mast, and fall-season format on wild turkey harvest rates in Virginia. Wildlife Society Bulletin 31:553-559.

Norman, G. W., D. E. Steffen, C. I. Taylor, J. C. Pack, K. H. Pollock, and K. Tsai. 2001b. Reproductive chronology, spring hunting, and illegal kill of female wild turkeys. Proceedings of the National Wild Turkey Symposium 8:269-280.

Pack, J. C., R. P. Burkert, W. K. Igo, and D. J. Pybus. 1980. Habitat utilized by wild turkey broods within oak-hickory forests of West Virginia. Proceedings of the National Wild Turkey Symposium 4:213-224.

Pack, J. C., G. W. Norman, C. I. Taylor, D. E. Steffen, D. A. Swanson, K. H. Pollock, and R. Alpizar-Jara. 1999. Effects of fall hunting on wild turkey populations in Virginia and West Virginia. Journal of Wildlife Management 63:964-975.

Pelham, P. H., and J. G. Dickson. 1992. Physical characteristics. Pages 32-45 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Peoples, J. C., D. C. Sisson, and D. W. Speake. 1995. Wild turkey brood habitat use and characteristics in coastal plain pine forests. Proceedings of the National Wild Turkey Symposium 7:89-96.

Peterson, C. C., and T. A. Messmer. 2010. Can public meetings accurately reflect public attitudes toward wildlife management? Journal of Wildlife Management 74:1588-1594.

Phalen, P. S., G. A. Hurst, and W. J. Hamrick. 1986. Brood habitat use and preference by wild turkeys in central Mississippi. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 40:397-404.

Phillips, C. E., W. P. Kuvlesky, S. J. DeMaso, L. A. Brennan, and D. G. Hewitt. 2011. Landscape metrics related to Rio Grande wild turkey winter roosts in south Texas. Proceedings of the National Wild Turkey Symposium 10:265-273.

Porter, W. F. 1992. Habitat requirements. Pages 202-213 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Roberts, S. D., J. M. Coffey, and W. F. Porter. 1995. Survival and reproduction of female wild turkeys in New York. Journal of Wildlife Management 59:437-447.

Ross, A. S., and G. A. Wunz. 1990. Habitats used by wild tukey hens during the summer in oak forests in Pennsylvania. Proceedings of the National Wild Turkey Symposium 6:39-43.

Rumble, M. A., and S. H. Anderson. 1995. A test of the habitat suitability model for Merriam's wild turkeys. Proceedings of the National Wild Turkey Symposium 7:165-173.

Sanford, R., K. Armstrong, T. Jurczak, A. Kirsch, K. Parker, G. Batcheller, R. Biss, and D. Rosenblatt. 2005. Wild turkey management plan. New York State Department of Environmental Conservation. <http://www.dec.ny.gov/docs/wildlife_pdf/turkeyplan.pdf >. Accessed 1 Mar 2012.

Schroeder, R. L. 1985. Habitat suitability index models: eastern wild turkey. US Fish and Wildlife Service, Biological Report 82(10.106), Washington, D.C., USA.

Smith, C. A. 2011. The role of state wildlife professionals under the public trust doctrine. Journal of Wildlife Management 75:1539-1543.

Spears, B. L., M. C. Wallace, W. B. Ballard, R. S. Phillips, D. P. Holdstock, J. H. Brunjes, R. Applegate, M. S. Miller, and P. S. Gipson. 2007. Habitat use and survival of preflight wild turkey broods. Journal of Wildlife Management 71:69-81.

Spohr, S. M. 2001. Variables influencing nest success of eastern wild turkeys in Connecticut: nesting habitat, home range-scale fragmentation, and nest attentiveness. Thesis, University of Maine, Orono, USA.

Steffen, D. E., N. W. Lafon, and G. W. Norman. 2002. Turkeys, acorns, and oaks. Pages 241-253 *in* W. J. McShea, and W. M. Healy, editors. Oak forest ecosystems: ecology and management for wildlife. John Hopkins University, Baltimore, Maryland, USA.

Steffen, D. E., and G. W. Norman. 1996. Dynamics between spring and fall harvests of wild turkeys in Virginia. Proceedings of the National Wild Turkey Symposium 7:231-237.

Swearingin, R. M., W. B. Ballard, R. S. Phillips, S. McKenzie-Damron, M. J. Butler, M. C. Wallace, R. N. Walker, and D. C. Ruthven. 2011. Winter roost characteristics of Rio Grande wild turkeys in the rolling plains of Texas. Proceedings of the National Wild Turkey Symposium 10:251-263.

Tapley, J. L., M. A. Hatfield, R. K. Abernethy, and J. E. Kennamer. 2011. Status and distribution of the wild turkey in 2009. Proceedings of the National Wild Turkey Symposium 10:19-30.

Thogmartin, W. E. 1999. Landscape attributes and nest-site selection in wild turkeys. Auk 116:912-923.

US Department of the Interior, US Fish and Wildlife Service, US Department of Commerce, and US Census Bureau. 2014. 2011 national survey of fishing, hunting, and wildlife-associated recreation: Virginia. <www.census.gov/prod/2013pubs/fhw11-va.pdf >. Accessed Jan 30 2014.

US Fish and Wildlife Service. 2010. Turkey hunting in 2006: an analysis of hunter demographics, trends, and economic impacts. <http://library.fws.gov/Pubs/turkey-hunting2006-addendum2010.pdf>. Accessed 26 Mar 2012.

Vander Haegen, W. M. , M. W. Sayre, and W. E. Dodge. 1989. Winter use of agricultural habitats by wild turkeys in Massachusetts. Journal of Wildlife Management 53:30-33.

Vangilder, L. D., and E. W. Kurzejeski. 1995. Population ecology of the eastern wild turkey in northern Missouri. Wildlife Monographs 130:1-50.

Vaske, J. J., D. C. Fulton, and M. J. Manfredo. 2001. Human dimensions considerations in wildlife management planning. Pages 91-108 *in* D. J. Decker, T. L. Brown, and W. F. Siemer, editors. Human dimensions of wildlife management in North America. The Wildlife Society, Bethesda, Maryland, USA.

Virginia Department of Game and Inland Fisheries. 2002. Virginia black bear management plan 2001-2010. <http://www.dgif.virginia.gov/wildlife/bear/blackbearmanagementplan-2001-2010.pdf >. Accessed 13 Sept 2013.

Virginia Department of Game and Inland Fisheries. 2007. Virginia deer management plan 2006-2015. Wildlife Information Publication No. 07-1. Virginia Department of Game and Inland Fisheries, Richmond, USA.

Virginia Department of Game and Inland Fisheries. 2013a. 2013 Spring gobbler harvest summary. <http://www.dgif.virginia.gov/wildlife/turkey/springharvestsummary.asp >. Accessed 9 Sept 2013.

Virginia Department of Game and Inland Fisheries. 2013b. Black bear management plan 2012-2021. <http://www.dgif.virginia.gov/wildlife/bear/blackbearmanagementplan.pdf >. Accessed 13 Sept 2013.

Virginia Department of Game and Inland Fisheries. 2013c. Virginia 2012-2013 fall wild turkey harvest summary. <http://www.dgif.virginia.gov/wildlife/turkey/fallharvestsummary.asp >. Accessed 9 Sept 2013.

Wakeling, B. F. 2005. Landscape-level habitat use by Merriam's turkey in north-central Arizona. Proceedings of the National Wild Turkey Symposium 9:185-188.

Wakeling, B. F. , S. R. Boe, M. A. Koloszar, and T. D. Rogers. 2001. Gould's turkey survival and habitat selection modeling in southeastern Arizona. Proceedings of the National Wild Turkey Symposium 8:101-108.

Wakeling, B. F., and J. R. Heffelfinger. 2011. Habitat suitability model predicts habitat use by translocated Gould's wild turkeys in Arizona. Proceedings of the National Wild Turkey Symposium 10:283-290.

White, B., P. Graham, and R. A. Pierce. 2005. Missouri bobwhite quail habitat apprasial guide. University of Missouri Extension. Publication MP902.

Williams, Jr., L. E., D. H. Austin, T. E. Peoples, and R. W. Phillips. 1973. Movement, behavior, and development of turkey broods. Proceedings of the National Wild Turkey Symposium 2:79-99.

Williams, M. W., D. B. Gibbs, T. H. Roberts, and D. L. Combs. 1997. Habitat use by eastern wild turkey broods in Tennessee. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 51:457-466.

Williamson, J. F., and G. T. Koeln. 1980. A computerized wild turkey habitat evaluation system. Proceedings of the National Wild Turkey Symposium 4:233-239.

Wunz, G. A., and J. C. Pack. 1992. Eastern turkey in eastern oak-hickory and northern hardwood forests. Pages 222-264 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Chapter 2:

Assessing the effects of stakeholder and agency participation in a management planning effort to develop a statewide wild turkey management plan for Virginia

Introduction

Wildlife managers traditionally have made both value choices (e.g., setting broad management goals) and technical choices (e.g., developing and evaluating management strategies) regarding the management of wildlife resources (McMullin and Pert 2010). Wildlife managers made these decisions based on their perceptions of the public interest, assuming they understood and adequately could represent the values of their stakeholders (Magill 1988). However, the values of wildlife professionals and their stakeholders often differ significantly, calling into question the assumption of representing the public interest (Carrozzino-Lyon 2012). Traditionally, state fish and wildlife agency professionals considered individuals who paid for access to the resource, such as hunters and anglers who purchased licenses, important stakeholders and paid less attention to the desires of non-hunting and non-angling stakeholders. More recently, managers have taken a broader approach to management of fish and wildlife to include all individuals who have an interest in or are affected by management decisions (Decker et al. 1996, Jacobson et al. 2010), allowing these stakeholders to identify their own values, rather than assuming them.

The Virginia Department of Game and Inland Fisheries (VDGIF) employs collaborative planning techniques when developing wildlife management plans, and often has partnered with the Department of Fish and Wildlife Conservation at Virginia Tech (VT) to facilitate development of such plans. VT has a long history of providing VDGIF with expertise in conservation planning and public involvement (VDGIF 1999, 2002, 2007, 2011). The collaborative planning approach used by VDGIF and VT demands that stakeholders focus on making value choices, whereas professionals focus on making technical choices (Lafon et al. 2004). This approach also provides stakeholders with multiple opportunities to comment and participate, which greatly affects stakeholders' satisfaction with the goals, objectives, and decisions that result from the process (Decker and Chase 1997). By integrating the public in the planning process, the agency demonstrates its interest in obtaining and understanding stakeholders' desires (Vaske et al.

2001). If resource managers do not understand public desires, they cannot satisfy the public's desires effectively.

A key feature of the planning process employed by VDGIF and VT includes development of a Stakeholder Advisory Committee (SAC) and a Technical Committee with expertise on the species of interest (e.g., wild turkey). The SAC focuses on value choices (e.g., desire to hear more turkeys gobbling) and leaves technical choices (e.g., how to manage hunting seasons to achieve increased gobbling) to the Technical Committee. These committees work together to develop scientifically sound management plans that represent the interests of all citizens of Virginia.

VDGIF has developed management plans for black bear and white-tailed deer (VDGIF 2007, 2013a) and has found these plans useful for guiding management actions and presenting information to the agency's Board. During development of Virginia's first Black Bear Management Plan, Lafon et al. (2004) surveyed stakeholders prior to and post-planning, and determined that involvement in the planning process increased stakeholders' knowledge about black bears and their management; it also improved both the stakeholders' image of the agency and the agency's acceptance of stakeholders' points of view. In a separate study, Halvorsen (2003) also identified that participation in a planning process positively can change attitudes and opinions of involved individuals.

VDGIF identified the need for a wild turkey management plan in 2011, as agency staff expressed concerns about the decline in hunter participation and harvest in the fall turkey season. In 2003, 64,000 hunters participated in fall turkey hunting, but, in 2009, only 50,702 hunters participated (Tapley et al. 2011). The fall harvest of wild turkeys in Virginia declined dramatically from 16,593 turkeys harvested in 1990 to 4,432 turkeys harvested during the 2012-2013 fall season (VDGIF 2013b) (Figure 2-1). In 1995, VDGIF reduced the fall turkey season to 6 weeks and, for 4 consecutive years, eliminated all opportunity to hunt wild turkeys during the general firearms deer season. These changes to the regulated fall turkey season likely caused the decline in the recorded harvest. Concerned about declining harvest and participation trends, VDGIF wanted stakeholders' input on how fall turkey hunting opportunities, and ultimately harvest, should be allocated. In addition, VDGIF biologists also wanted a habitat suitability model that would assess habitat quality for wild turkeys (Morris et al., unpublished report) and the ability of areas to achieve stakeholder-desired population goals. These concerns led to the development of the Virginia Wild Turkey Management Plan.

During development of the Virginia Wild Turkey Management Plan, I initiated surveys to assess changes in knowledge and attitudes toward management among stakeholders and professionals involved in management planning for wild turkeys, similar to what Lafon et al. (2004) and Halvorsen

(2003) conducted. I designed pre- and post-planning surveys to identify the effects of participation in a collaborative planning effort, administered to members of the SAC, the Technical Committee, and VDGIF Wildlife Bureau personnel who did not participate on the Technical Committee. This survey effort had 5 main objectives:

1. Assess stakeholders' knowledge of wild turkey biology and management
2. Assess the importance placed by stakeholders and VDGIF managers on stakeholder groups' values, attitudes, and opinions in wild turkey management
3. Assess the importance stakeholders perceive VDGIF places on the stakeholder groups' values, attitudes, and opinions in wild turkey management
4. Assess stakeholders' and VDGIF managers' opinions of wild turkey management and VDGIF
5. Assess stakeholders' and VDGIF managers' opinion of the public's role in decision-making

Methods

Collaborative Planning Process

The comprehensive planning process used by VT and VDGIF incorporated two main phases: phase 1 included identifying issues related to management of wild turkeys and stakeholders' values, and phase 2 focused on the actual development of the management plan. In the sections below, I discuss the different components of each phase to develop the Virginia Wild Turkey Management Plan (Table 2-1).

Phase I: Identifying stakeholders' values and issues

I began phase 1 by identifying important stakeholder groups for inclusion in the planning process. Staff from VT and VDGIF who led the planning process met and initially identified stakeholder groups for consideration. I then contacted VDGIF staff during the fall of 2011, using an internet-based survey, to identify additional stakeholder groups and solicit names and contact information of potential focus group participants. VDGIF staff members and Law Enforcement personnel not targeted during the initial survey were contacted via email during the winter of 2011-2012 to solicit additional names and contact information.

I then contacted stakeholder groups I believed should have an interest in wild turkey management. I attended the Northern Neck Wild Turkey Association annual banquet and the Virginia Chapter of the National Wild Turkey Federation leadership workshop to network with members and identify potential focus group participants. VT staff and I also contacted representatives of the Virginia vineyard and small fruit production industries, airports, Virginia Cooperative Extension, and US Department of Agriculture - Wildlife Services to identify individuals who experienced conflicts with or received damage from wild turkeys. Finally, I contacted conservation organizations (e.g., Virginia Forest Watch, Virginia Wilderness Committee, Sierra Club of Virginia) via email to assess their interest in participating in the plan development process.

To identify particular hunting stakeholders, (e.g., individuals who harvest a turkey while pursuing other game), I placed press releases in February 2012 to newspapers across the state and in the VDGIF *Outdoor Report* (an electronic newsletter) to solicit names and contact information for potential representatives. I contacted respondents to the prior VDGIF Hunter Surveys who identified themselves as wild turkey hunters to solicit their interest in participating in the planning process and focus groups. Stakeholder groups identified as important to discussions about management of wild turkeys in Virginia included spring turkey hunters, fall turkey hunters, those who experienced damage from or conflicts with turkeys, and individuals who generally are interested in wild turkey conservation. I began planning focus group meetings in the spring of 2012 once I developed an ample number of potential participants.

Next I invited identified stakeholders to a series of focus group discussions as means to highlight specific issues important to stakeholders (e.g., allocation of harvest, hunting participation, damage caused by wild turkeys). I hosted 9, 2-hour focus group meetings on weeknight evenings throughout Virginia in April and May 2012. To afford ample opportunity for stakeholders to convey their input effectively, I held 6 meetings with spring turkey hunters, 2 meetings with fall turkey hunters, and 1 meeting with individuals who experienced conflicts with or damage from wild turkeys. Meeting locations were selected and centralized based on the number of interested participants and where participants would be coming.

At each focus group meeting, participants were asked to respond to a series of broad, open-ended questions specific to the stakeholder group's concern for wild turkey management in Virginia. I developed these questions specifically to identify the issues, opinions, and values associated with each stakeholder group. I audio-recorded meetings, after receiving consent from participants, to ensure I correctly captured all expressed thoughts and opinions (IRB Approval 11-591). Following each focus group meeting, I produced a summary of the discussion and identified the important positions raised.

Due to poor response to my invitation to participate, I surveyed members of two underrepresented stakeholder groups: stakeholders with a primary interest in general wild turkey conservation and stakeholders within the "damage" focus group. I distributed a questionnaire via mail or email that presented the same questions as were discussed at the focus group. I compiled responses and added them to the results from all focus groups to frame a more complete suite of management issues.

I sent an overall executive summary and summaries of the individual focus groups and questionnaires to all stakeholders following the conclusion of phase I. VT and VDGIF staff also developed and distributed an informational flyer explaining the management planning process to all focus group participants and those who could not attend as a means to inform stakeholders regarding the comprehensive management planning process. In addition, VDGIF created a separate webpage on the agency's website dedicated to providing updates and information about the planning process for stakeholders. After framing the issues from the broader public, VT and VDGIF formed the Stakeholder Advisory Committee (SAC) and the Wild Turkey Technical Committee to begin developing the management plan.

Phase II: Management Plan Development

The next phase in the management planning process included developing goals, objectives, strategies, and ultimately a draft and final Virginia Wild Turkey Management Plan.

VDGIF Wild Turkey Technical Committee

VDGIF gathered members of the Wild Turkey Technical Committee (Technical Committee) to initiate plan development. The Technical Committee is a standing committee composed of 13 VDGIF staff members with expertise in turkey management, including 11 Wildlife Biologists, 1 Wildlife Veterinarian, and 1 Conservation Police Officer. The Technical Committee typically focused on regulatory issues; however, during the planning process, the Committee's role also included developing background material and other supporting information regarding the wild turkey in Virginia, and identifying specific objectives and management strategies that fulfill the broader goal statements developed by the SAC (Table 2-2).

The Technical Committee developed a section of the management plan that explained the history, biology, and management of the wild turkey in Virginia. The Technical Committee designed the background material to inform and educate the public as a written part of the plan, and also to educate members of the SAC so they could make well informed decisions regarding the wild turkey resource. This background material serves as a historical record of the wild turkey and its management in Virginia, and biologists can add to this material during future revisions of the Virginia Wild Turkey Management Plan.

In addition, the Technical Committee developed a population model to inform the SAC about the complex tradeoffs VDGIF must consider when making allocation decisions regarding turkey hunting seasons. Members of the SAC used the population model to simulate the effects of different allocation paradigms on harvest of turkeys during all seasons. The model allowed the SAC to modify the balance of spring and fall turkey harvests based on the desired population levels.

After the SAC developed draft management goals, the Technical Committee reviewed the draft goals and offered suggestions for clarification and consistency with VDGIF policies. The Technical Committee then developed draft management objectives and potential strategies to achieve the draft goals. Members of the Technical Committee presented draft objectives and strategies to the SAC, and VT personnel facilitated a discussion among SAC and Technical Committee members to ensure that both groups agreed that draft objectives and strategies effectively addressed desired goals. This framework kept stakeholders focused on value choices, and the professionals focused on technical choices.

Stakeholder Advisory Committee

VDGIF invited 13 representatives from groups deemed important to wild turkey management to participate on a SAC; all individuals accepted the invitation to participate. Stakeholder groups included represented: Virginia Farm Bureau, National Wild Turkey Federation, Virginia Society of Ornithology, US Forest Service, Virginia Vineyard Association, landowners, farmers, members of conservation groups, and turkey hunters (including hunters who hunted primarily in the spring, during the fall, or with dogs). The SAC‘s role in the planning process over the course of several months included reviewing and discussing the findings from the focus group process and establishing broad goals for wild turkey management that fairly represented the desires of all stakeholders (Table 2-3).

Before working on establishing goals, the SAC learned about wild turkey biology, status, and management history in Virginia using the background material developed by the Technical Committee. VDGIF personnel also introduced the SAC to the complex decision-making process in which the agency engages when allocating the wild turkey harvest; SAC members used the population model to see how decisions made relative to fall harvest have significant implications for both spring and fall seasons and participating stakeholders.

The SAC used information produced from focus groups as a starting point for discussion to identify additional public issues and concerns related to wild turkey management in Virginia. The SAC established a draft set of management goals based on stakeholder values and issues. After discussions among the SAC and based on the Technical Committee's feedback, the SAC ultimately approved a set of broad management goals for inclusion in the draft Wild Turkey Management Plan. As previously mentioned, the SAC evaluated the draft objectives and potential strategies created by the Technical Committee. The SAC also offered additional potential strategies for consideration in the plan; the Technical Committee evaluated the additional suggested strategies and included them in the plan if deemed consistent with agency policies.

Draft Plan Review

After the SAC and Technical Committee worked together to develop a draft Virginia Wild Turkey Management Plan, VT and VDGIF released the plan for public review electronically on the agency's website and as hard copies (upon request). During a 30-day public comment period, stakeholders could submit comments electronically or by mail. The VDGIF provided the draft Wild Turkey Management Plan. The VDGIF distributed a press release statewide in newspapers, on the VDGIF Wild Turkey Management Plan web page, and VDGIF's *Outdoor Report* to provide multiple avenues for informing the public about the draft plan and opportunities to comment.

In addition to receiving electronic and written comments, VDGIF and VT hosted 6 public workshop meetings across Virginia to provide additional opportunities for stakeholders to participate in the management planning effort. We designed these public workshops to provide attendees with information about wild turkey biology, history, and management in Virginia, and also to solicit comments on the goals the SAC identified.

Personnel from VDGIF and VT compiled all comments received during the comment period as an appendix to the plan; each comment received a response that justified the inclusion or rejection of the comment in the final plan. Personnel exhibited caution when interpreting the comments to ensure they understood the values behind the statements and were not imposing their own values. Personnel from VDGIF and VT shared the summary and responses with the SAC and Technical Committee via email for their consideration. The SAC identified the need to add and modify several aspects of the plan based on public comments. Technical Committee members applied the suggested revisions and distributed the revised plan for review by the entire Technical Committee. The SAC and the Technical Committee also prioritized objectives prior to producing a final plan. VDGIF staff presented the final Virginia Wild Turkey Management Plan to the Board in January 2014 and Board of Game and Inland Fisheries approved the plan.

Assessing effects of participation in a management planning effort

I developed and distributed pre- and post-planning surveys to the SAC and VDGIF Wildlife Bureau to assess changes in knowledge, attitudes, and opinions after participation in a collaborative management planning effort. To determine differences in active and passive participation, I compared the responses from the Technical Committee with the results of the Wildlife Bureau personnel. In the following sections, I discuss the objectives for each survey and the details of data analysis.

Stakeholder Advisory Committee

I designed and administered surveys to assess how SAC members' knowledge, attitudes, and opinions evolved from their participation in the management planning process, based specifically on the 5 research questions regarding the effects of stakeholder participation:

1. Will the knowledge of SAC members regarding wild turkey biology and management improve after participating in the wild turkey management planning process?

2. Does the importance placed by SAC members on the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

3. Does the perception of SAC members on the importance that VDGIF attaches to the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

4. Do the opinions expressed by SAC members representing disparate interests regarding wild turkey management in Virginia and VDGIF display greater agreement after their participation in the wild turkey management planning process?

5. Do the opinions expressed by SAC members become more accepting of the public's role in decision-making after participating in the wild turkey management planning process?

I also conducted a telephone survey, consisting of 9 open-ended questions, to examine SAC members' satisfaction with and opinions of the planning process. I distributed the questions to members via email approximately 30 minutes prior to performing the interview to provide participants time to formulate their thoughts. During the interview, I took detailed notes of the participant's response to each question.

VDGIF

I distributed a web-based survey to all VDGIF Wildlife Bureau personnel, including Technical Committee members, to assess how their attitudes and opinions evolved throughout the planning process. I designed the survey to focus on 3 main objectives:

1. Assess the importance placed by VDGIF managers on all stakeholder groups' values, attitudes, and opinions in wild turkey management

2. Assess VDGIF managers' opinion of wild turkey management and VDGIF

3. Assess VDGIF managers' opinion of the public's role in decision-making

I developed 3 research questions regarding changes I anticipated from both the Technical Committee and other Wildlife Bureau personnel:

1. Does the importance placed by VDGIF on the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

2. Do the opinions expressed by VDGIF regarding wild turkey management in Virginia and of the agency display greater agreement after participating in the wild turkey management planning process?

3. Do the opinions expressed by VDGIF become more accepting of the public's role in decision-making after participating in the wild turkey management planning process?

Wild Turkey Technical Committee

I distributed the web-based pre-planning survey to 11 of the 13 Technical Committee members in February 2013. I excluded the member representing the Law Enforcement Bureau from this assessment because his role within VDGIF is different than those in the Wildlife Bureau. Also, because the Wildlife Veterinarian joined the Technical Committee late (i.e., during the revision of the draft plan), she did not participate in the pre- or post-planning surveys. In October 2013, I distributed the web-based post-planning survey to the same 11 Technical Committee members to assess how their opinions and attitudes may have changed after the close of the public comment period and during the final revision of the management plan.

Wildlife Bureau Personnel

I distributed the pre- and post-planning surveys to Wildlife Bureau personnel at the same time as I did for the Technical Committee. I distributed the web-based survey to 41 professionals in in February 2013 (pre-planning survey) and again in October 2013 (post-planning survey) to assess how their opinions and attitudes may have changed after the close of the public comment period and during the final revision of the management plan.

Data Analysis

I used JMP 10.0.2 (SAS Institute, Cary, NC) and the non-parametric Wilcoxon signed-rank test to compare the paired pre- and post-survey responses. I analyzed responses only for those respondents who completed both surveys (sample sizes: 11 individuals from the SAC, 7 individuals from the Technical Committee, 20 individuals from the Wildlife Bureau).

Results

Collaborative Planning Process

Phase I: Identifying stakeholders' values and issues

After identifying stakeholders, I invited approximately 230 individuals with interest in wild turkey management to attend a focus group meeting; of those invited, 82 individuals attended a meeting. I received 8 completed surveys from those with an interest in general wild turkey conservation and 4 questionnaires from stakeholders within the "damage" group. During the 2-month period of hosting focus groups, I also received 5 unsolicited comments via mail or email from individuals interested in turkey management, but who could not attend a focus group meeting.

Phase II: Management Plan Development

The SAC developed management plan goals (Table 2-3) and the Technical Committee developed objectives (Table 2-2) to fulfil such goals. During the public comment period, a total of 42 individuals attended the 6 public meetings held across Virginia in July 2013; the number of individuals in attendance ranged from 3 to 19, however, at 1 meeting no one attended. VDGIF received 36 comments on the agency's webpage, 75 comments on flip charts at public meetings, and 12 comments via email, comment cards (handed out at the public meetings), and written letters.

Assessing effects of participation in a management planning effort

Stakeholder Advisory Committee

All 13 SAC members completed a paper survey (100% response rate) in February 2013 prior to the initial SAC meeting, to establish a baseline estimate of their knowledge, attitudes, and opinions regarding wild turkey management in Virginia. In October 2013, the remaining 11 SAC members completed a web-based, post-process survey (100% response rate) identical to the pre-process survey and participated in phone interviews to describe their experiences and thoughts regarding the planning process after the last SAC meeting and during the final revision of the management plan. Two SAC members resigned during the planning process, leaving 11 members on the SAC. After being absent from the first 2 meetings, the representative for the Virginia Society of Ornithology (VSO) resigned and I could not obtain a replacement from the VSO. Shortly after the 3rd SAC meeting, a SAC member representing hunting interests resigned from the committee due to personal time constraints. In addition, I received a 100% response rate for the phone interviews.

Knowledge of wild turkey biology and management

Research Question 1

> Will the knowledge of SAC members regarding wild turkey biology and management improve after participating in the wild turkey management planning process?

The SAC members' knowledge of wild turkey biology and management improved after participating in the wild turkey management planning process ($W=19.5$, $p=0.01$). Eight of 11 individuals improved their score, 1 declined, and 2 remained the same after participating in the process; mean score for the 15 knowledge questions increased from 67% to 77% correct.

Importance placed by stakeholders and the perceived importance placed by DGIF on stakeholder groups' values, attitudes, and opinions in wild turkey management

Research Question 2

> Does the importance placed by SAC members on the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

The importance SAC members placed on the values, attitudes, and opinions of all stakeholder groups did not change throughout the planning process (Table 2-4). The SAC placed the most importance on spring and fall turkey hunters, public landowners, VDGIF, and hunter-advocacy groups, both before and after participation in the planning process (Table 2-4).

Research Question 3

> Does the perception of SAC members on the importance that VDGIF attaches to the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

The perceptions of SAC members regarding the importance VDGIF places on the values, attitudes, and opinions of all stakeholders did not change significantly throughout their participation in the wild turkey management process (Table 2-5). Members of the SAC perceived that VDGIF places the most importance on spring and fall turkey hunters and VDGIF (Table 2-5).

Opinions of wild turkey management, VDGIF, and the role of public opinion in decision-making

Research Question 4

> Do the opinions expressed by SAC members representing disparate interests regarding wild turkey management in Virginia and VDGIF display greater agreement after their participation in the wild turkey management planning process?

Overall, SAC members held favorable opinions of VDGIF and its management of wild turkeys in both the pre- and post-planning surveys (Table 2-6). The opinions of SAC members generally became more favorable toward VDGIF and its management after the planning process, however, I only observed a two large increases in agreement with the statement "I believe VDGIF makes a good effort to obtain input from the public as a whole" (W=10.5, p=0.02) and "I believe that VDGIF makes decisions with public values in mind" (W=7.5, p=0.09; Table 2-7).

Research Question 5

> Do the opinions expressed by SAC members become more accepting of the public's role in decision-making after participating in the wild turkey management planning process?

Comparison of pre- and post-process responses to questions addressing relative roles of stakeholders and professionals in the decision-making process demonstrated a shift in perception of existing and desired roles toward greater importance of stakeholders and lesser importance of professional roles (Table 2-8). Large shifts occurred in the perception of developing strategies (W=-8, p=0.08), the perception of existing stakeholder roles for selecting strategies (W=-7.5, p=0.03), and the perceptions and reality of evaluating progress (W=-6.5, p=0.11; W=-5, p=0.06). Overall, SAC members believed that professional opinions did and should outweigh stakeholder opinions for all types of planning decisions (e.g., setting goals, setting objectives, etc.), both prior to and after participation in the planning process. However, after participation, SAC members perceived that all activities did, and should, incorporate more public opinion than initially (Figure 2-2).

Before participating in the planning process, the SAC exhibited large differences for how management currently is and should be for setting goals, setting management objectives, developing strategies, selecting strategies, and evaluating progress (Table 2-9). However, after the planning process, the SAC displayed smaller differences for how management currently is and should be, with the largest differences only occurring for setting management objectives (W=-5, p=0.06), selecting strategies (W=-5, p=0.06), and evaluating progress (W=-8, p=0.08) (Table 2-9). After participating in the planning process, SAC members approve of the current roles stakeholders and professionals have in decision-making.

Phone interviews

Knowledge of wild turkey biology and management

Two SAC members indicated that they learned little about wild turkey biology and management throughout the management planning process because they were avid hunters or had studied this information previously. One member even disagreed with the findings of VDGIF research that the number of hens harvested increases with earlier spring turkey hunting seasons.

Three members noted they learned about the importance of the fall turkey season to some stakeholders and the various methods (e.g., hunting turkeys with dogs) to harvest turkeys. Three members stated they were unaware that turkeys could pose negative effects for vineyards and other agricultural producers, aside from grain production; one of which expressed how important it would be to wild turkey management to develop a partnership between VDGIF and groups representing private landowners, e.g., the Virginia Farm Bureau.

In addition, three SAC members stated they learned about the association between wild turkey populations and habitat. Four members noted they learned about the potential effects of fall harvest on populations through application of the population dynamics model developed by the VDGIF Technical Committee.

Stakeholder involvement and opinions

All SAC members upheld their roles by sharing information with their constituents. Members shared information with other hunters, friends, conservation groups, and fellow staff members from organizations they represented. Seven of the SAC members thought the right stakeholders participated and no additional groups needed representation; however, some expressed concerns about the individuals representing certain groups due to their lack of participation except for the final stages of the planning process. SAC members thought additional individuals should have participated in the planning process, including the Virginia Department of Forestry, National Park Service, US Fish and Wildlife Service, military representatives, Army Corp of Engineers, Virginia Ornithological Society, urban/suburban county planners, and individuals who only hunted deer. Two members focused on the need for a non-consumptive interest similar to the Virginia Ornithological Society.

Half of the SAC members indicated that participation in the planning process changed their views about other stakeholders interested in management of wild turkeys. Two members specifically indicated they appreciated the opportunity to hear other points of view, including views of stakeholders from other geographic areas. Three members indicated they were not aware that turkeys could damage crops. One stakeholder stated he/she changed his/her opinions of different hunting techniques for wild turkeys (e.g., rifles and dogs), and the ability to hear direct reports of management actions on national forest lands improved his/her opinion of the US Forest Service. Another member indicated that he became less supportive of VDGIF because he did not trust the data the agency used to support its stance on wild turkey depredation. No other SAC members expressed a change in their views of other stakeholders and some indicated they had met individuals on the SAC before.

Ten stakeholders thought that the SAC and VDGIF fairly heard and considered the opinions of all interests in the development of the Wild Turkey Management Plan. However, one individual thought that the SAC and VDGIF did not properly weight agricultural interests. Also, nine SAC members thought that no particular interest had too much influence in the development of the plan. One individual thought turkey hunters had too much influence, even though it was a turkey plan, and another individual thought hunters in general had too much influence. One member suggested that the agricultural representatives tried to exert more influence than necessary, but the other SAC members kept them in check.

Opinions of VDGIF

Ten SAC members said that their opinions of VDGIF did not change; five members stated they already had high praise for the agency and their participation in the effort confirmed their thoughts. One SAC member stated this process improved his/her already-positive views of the agency. Two SAC members indicated they previously participated in the white-tailed deer and black bear management planning efforts, and those interactions already had improved their opinions.

Satisfaction with the planning process and outcome

All SAC members approved of the process that VT and VDGIF used to develop the Virginia Wild Turkey Management Plan. Two SAC members initially expressed concerns about the process, as facilitators kept meetings very structured by adhering to an agenda and establishing rules for participation. Additionally, one member expressed concerns regarding the learning curve for the SAC to participate in a collaborative process. One member thought certain steps of the planning process (i.e., prioritizing objectives) were unnecessary and another member desired to discuss other items (e.g., agency budgets) rather than focusing on the value-oriented tasks. Another members expressed a desire for the plan to take effect by the beginning of 2014, rather than later in 2014 or after the next hunting regulations cycle, depending on the issue at hand.

All SAC members were satisfied with the goals, objectives, and strategies in the Wild Turkey Management Plan; however, 9 members qualified their satisfactions. One member indicated the plan was a good starting point for turkey management and liked the idea that the management plan can evolve as time progresses based on harvest data or changing values. One member specifically stated he had difficulty distinguishing among goals, objectives, and strategies, and another member indirectly expressed confusion with the terms when he referenced an item as a strategy that actually was an objective. One member thought an objective (establishing that 50% of the turkey harvest in the fall would occur during the concurrent muzzleloader and rifle deer seasons) did not represent the SAC's interests and VDGIF established this percentage based on the agency's values; this individual also stressed the importance that the VDGIF Board must understand that some items, such as this objective, did not receive an unanimous vote by the SAC. One SAC member expressed concerns with pending revisions in the management plan addressing habitat on all public lands and another member expressed concerns regarding the scientific data for agricultural depredation; if the revised plan alleviates the concerns, they both would be satisfied with the plan.

SAC members also had additional concerns about things not directly addressed in the management planning effort. One member stated concerns regarding young Conservation Police Officers (CPOs) having an 'us [CPOs] against them [the public]' mentality. Another member thought more focus should have been on wild turkey habitat assistance programs for private landowners, similar to bobwhite quail programs supported by the Natural Resource Conservation Service.

Wild Turkey Technical Committee

Seven of the 11 Technical Committee members completed the survey both pre- and post-planning, resulting in a 64% response rate.

<u>Importance placed by VDGIF personnel on stakeholder groups' values, attitudes, and opinions in wild turkey management</u>

<u>Research Question 1</u>

> Does the importance placed by the Technical Committee on the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

I found no differences in the importance the Technical Committee placed on the values, attitudes, and opinions of all stakeholder groups (Table 2-10). The Technical Committee placed the most importance on spring and fall turkey hunters both before and after participating in the planning process (Table 2-10).

<u>Opinions of wild turkey management, VDGIF, and the role of public opinion in decision-making</u>

<u>Research Question 2</u>

> Do the opinions expressed by Technical Committee members regarding wild turkey management in Virginia and of the agency display greater agreement after participating in the wild turkey management planning process?

In general, opinions of the Technical Committee regarding the agency's management of wild turkeys remained unchanged throughout the planning process (Table 2-11). Members of the Technical Committee agreed with all statements both before and after the planning process (Table 2-12).

<u>Research Question 3</u>

> Do the opinions expressed by Technical Committee members become more accepting of the public's role in decision-making after participating in the wild turkey management planning process?

Most of the Technical Committee's opinion of appropriate roles of stakeholders and professionals in decision-making did not change largely throughout the planning process (Table 2-13). I observed one large change; four Technical Committee members thought that stakeholders should have a greater role in setting management objectives (W=-5, p=0.06) after participating in the planning process.

Members of the Technical Committee believed that stakeholders did, and should have more influence in setting goals and objectives than in developing and selecting strategies and evaluating progress toward achievement of goals (Figure 2-3). The pre-planning comparison of how management currently is and should be revealed large shifts to the public role for setting goals (W=-8.5, p=0.06), developing strategies (W=-5, p=0.06), and evaluating progress (W=-5, p=0.06) (Table 2-14). After participation in the management planning effort, the Technical Committee believed that VDGIF should incorporate more public opinion in setting goals (W=-8, p=0.08) and developing strategies (W=-5, p=0.06).

Comparison of Wild Turkey Technical Committee and Wildlife Bureau Personnel

I received 20 completed paired pre- and post-planning surveys from Wildlife Bureau personnel, producing a 49% response rate.

Importance placed by VDGIF personnel on stakeholder groups' values, attitudes, and opinions in wild turkey management

Research Question 1

> Does the importance placed by the Wildlife Bureau personnel on the values, attitudes, and opinions of all stakeholder groups increase after participating in the wild turkey management planning process?

I found that Wildlife Bureau personnel placed notably more importance on the involvement of agricultural stakeholders (W=18, p=0.02), private urban landowners (W=11, p=0.07) and individuals who enjoy viewing wild turkeys (W=7, p=0.11) after participating in the planning process (Table 2-15). Wildlife Bureau personnel placed the most importance on spring and fall turkey hunters, public landowners, VDGIF, and hunter-advocacy groups after the planning process (Table 2-15).

Wildlife Bureau personnel placed increased importance on private urban landowners, agricultural producers, and individuals who enjoy viewing wild turkeys after participating in the planning process, whereas the Technical Committee did not.

Opinions of wild turkey management, VDGIF, and the role of public opinion in decision-making

Research Question 2

> Do the opinions expressed by Wildlife Bureau personnel regarding wild turkey management in Virginia and of the agency display greater agreement after participating in the wild turkey management planning process?

Wildlife Bureau personnel expressed a notable increase in agreement with the statement "I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys" (W=19.5, p=0.05) and "I believe that VDGIF personnel fairly consider the input they receive from the public" (W=7, p=0.11) after participating in the planning process (Table 2-16). Wildlife Bureau personnel agreed with all statements regarding the agency and its management of wild turkeys both before and after participation in the planning process (Table 2-17).

Research Question 3

> Do the opinions expressed by Wildlife Bureau personnel become more accepting of the public's role in decision-making after participating in the wild turkey management planning process?

Wildlife Bureau personnel did not exhibit large differences in their perceptions regarding the roles of public and professionals in decision-making (Table 2-18). Unlike SAC members and Technical Committee members, Wildlife Bureau personnel shifted toward lesser stakeholder involvement and greater professional involvement in making most planning decisions (Figure 2-4). The pre- and post-planning comparison of how management currently is and should be did not show differences in their opinions (Table 2-19). However, Wildlife Bureau personnel exhibited larger differences in how management currently is and should be after the planning process. The number of individuals expressing a desire for more public opinion in decision-making increased after the planning process.

Both the Technical Committee and Wildlife Bureau personnel agreed that stakeholders should play important roles in setting management goals. However, the Technical Committee believed in a greater role for stakeholders in setting objectives and developing strategies, compared to Wildlife Bureau personnel.

Discussion

Collaborative Planning Process

Phase I: Identifying stakeholders' values and issues

I received little interest from stakeholders interested in wild turkey conservation and the "damage" group; however, I received ample participation from wild turkey hunters, both spring and fall. The lack of participation by stakeholders who experienced damage from or conflicts with wild turkeys may be related to the fact some agricultural producers do experience turkey damage, whereas others do not; I found this to be true when communicating with individual stakeholders during the stakeholder identification stage of the planning process. Minimal information exists on wild turkey damage in Virginia, and what information exists indicates that the species actually depredating (e.g., deer, raccoons, turkeys) and the extent of damage varies across the state (National Wild Turkey Federation, unpublished report).

I believe the lack of participation by wild turkey conservationists may be a result that the wild turkey is a game bird and is relatively plentiful across Virginia. Conservation groups (i.e., The Nature Conservancy) may have more important items of interest (e.g., species of concern like the golden winged-warbler), rather than participating in a game bird management plan. Inclusion of this stakeholder group is important and managers should not overlook this group, even if the majority of stakeholders in this constituent group are not aware of their importance in a management planning effort.

Substantial participation by wild turkey hunters likely stems that they are the traditional stakeholder group and have the most stake in the resource. These individuals may be concerned about the effects the management plan may have on regulations or hunting seasons.

Phase II: Management Plan Development

I believe the lack of participation at the public meetings resulted from stakeholders reviewing the management plan and not having any large disagreements with goals, objectives, and strategies in the plan. During the focus group sessions, facilitators did not identify any substantial issues or major conflicts for the plan to focus on. VDGIF staff presented the issue of fall harvest allocation for discussion, as the agency desired guidance for establishing the appropriate allocation of harvest among the various hunters who pursue turkeys during the fall hunting season.

Assessing effects of participation in a management planning effort

Stakeholder Advisory Committee

Knowledge of wild turkey biology and management

The background material and population dynamics model developed by the Technical Committee appeared to increase SAC member's knowledge about wild turkey biology and management. In addition, SAC members, including individuals who represented hunting interests, indicated during the phone interview that they learned something new about wild turkeys as a result of participating in the management planning process. In a similar VDGIF and VT collaborative planning effort, Lafon et al. (2004) found that stakeholders improved their knowledge of black bear biology and management by participating in the planning process. Involvement in collaborative planning enables stakeholders to learn about the resource and how the agency manages it, which ultimately improves the basis on which stakeholders form their opinions.

Importance placed by stakeholders and the perceived importance placed by DGIF on stakeholder groups' values, attitudes, and opinions in wild turkey management

I believe the SAC placed greatest importance on spring and fall turkey hunters, public landowners, VDGIF, and hunter-advocacy groups because they are most familiar with these stakeholders. The SAC included several members who hunt turkeys and were members of the National Wild Turkey Federation. Some members were familiar with the role of VDGIF in managing wild turkeys and aware of the recreational opportunities the George Washington and Thomas Jefferson National Forests provides for various stakeholders; SAC members that previously did not recognize these relationships became aware through participation in the planning process and working with various stakeholders and VDGIF staff.

The SAC likely placed more importance on hunter-advocacy groups and private urban landowners because of discussions at SAC meetings. This collaborative planning process enabled SAC members to hear the opinions and concerns of all stakeholders, and likely resulted in learning about stakeholder groups not typically considered important. SAC members indicated they positively changed their opinions about different methods of hunting wild turkey (e.g., more accepting of hunters who use dogs and/or rifles) after hearing how SAC members enjoyed using those techniques. In addition, some members noted they now recognized the importance of the fall wild turkey season, when previously they thought the spring season was the most important to all hunters pursuing wild turkeys. Also, I believe information provided in the background material changed the SAC's view of private urban landowners; this material discussed the potential negative effects wild turkeys can pose for agricultural producers and private landowners. Members indicated during meeting discussions and phone interviews that they previously did not recognize turkey depredation as an issue.

Opinions of wild turkey management, VDGIF, and the role of public opinion in decision-making

The large increase in agreement among SAC members with the statement "I believe VDGIF makes a good effort to obtain input from the public as a whole" probably resulted from the SAC members' participation in the collaborative planning process and their awareness of all the opportunities for input made available to the public. Virginia Tech and VDGIF staff facilitating the planning process kept the SAC informed of each step in the process and encouraged SAC members to attend public meetings; eight SAC members participated in focus groups and 3 attended public meetings.

The increase in agreement with the statement "I believe that VDGIF makes decisions with public values in mind" probably resulted from VDGIF asking the SAC to establish goals for the management plan (based on stakeholders' values), rather than VDGIF establishing goals.

The ability to participate in a collaborative planning process changed the SAC's view about current decision-making and how VDGIF should incorporate public opinion in future decision-making. At the end of the process, the SAC perceived that all management activities involved stakeholders more than they previously thought. Nevertheless, SAC members believed the decision-making process should involve stakeholders to an even greater degree. Participation in the planning process appeared to reduce the disparity in perceptions between how management currently is and how it should be, suggesting that SAC members generally approved of the balance between stakeholder opinions and professional expertise in making management decisions.

Phone interviews

Knowledge of wild turkey biology and management

Background materials that explained the history, biology, and management of wild turkeys and the population model provided new information for many SAC members. VDGIF staff played an important role in presenting information to enlighten the SAC regarding harvest allocation, turkey populations, and habitat. Without the efforts put forth by the Technical Committee, many of these improvements in knowledge may not have occurred.

SAC members learned about other stakeholders' points of view and issues during the planning process, which provided them with new insights regarding stakeholder groups previously not considered. The ability for SAC members to share their values and issues with the group clearly made a difference among SAC members' awareness of others.

Stakeholder involvement and opinions

VT and VDGIF facilitators explained to SAC members that their role included disseminating information to individuals they represented, and asked that members bring up concerns from those stakeholders at the SAC meetings. This network of sharing and disseminating information was one avenue of ensuring all stakeholders stayed informed.

After participating in the planning process, SAC members thought additional stakeholders should have been included as members of the SAC to ensure all groups had representation. Suggested additions included public government landowners or others from local governments, as some strategies in the management plan indicated habitat management could be applied to achieve population goals; habitat improvement would require all landowners, public or private, to work together.

Whether SAC members achieved their desired goals largely dictated whether they developed positive or negative opinions of the process. Questions existed regarding the severity and existence of wild turkey depredation on vineyards in Virginia, and due to lack of reliable scientific data in Virginia, the stakeholder representing the vineyard industry thought the SAC did not consider his opinions to the degree necessary. His personal experience with damage from turkeys on his property exacerbated his frustration with the process. Others expressed concerns about the number of hunters participating on the SAC, likely because those SAC members thought hunters did not adequately consider other points of view.

Opinions of VDGIF

Prior experience with VDGIF planning efforts may have led to little change in SAC members' opinions of the agency. Many of the SAC members indicated they volunteered as hunter education instructors and served on SACs for other planning efforts. Also, if these individuals possessed strong negative feelings about the agency, they likely would not have accepted the invitation to participate on the SAC. VDGIF has developed 5 other management plans using collaborative planning processes, and these previous planning efforts may have minimized the opportunity to increase the image of the agency among stakeholders.

Satisfaction with the planning process and outcome

The SAC's satisfaction with the planning process may be linked to the multiple opportunities afforded for stakeholder participation and their belief that VDGIF heard their concerns (Decker and Chase 1997). Satisfaction of SAC members also may be influenced by achievement of their personal goals. For example, one SAC member expressed concerns regarding the fall turkey harvest allocation established during the planning process because he disagreed with final allocation adopted by the group.

Wild Turkey Technical Committee

The 7 individuals that participated in both the pre- and post-planning survey consisted of 1 project leader, a coordinating scientist, a resource manager, and 4 district wildlife biologists. Those that did not complete both surveys included a coordinating scientist, team leader, and 2 district wildlife biologists. The 2 district wildlife biologists likely would have experience with collaborative planning through other wildlife management plans and I am uncertain the experience the team leader and coordinating scientist would possess regarding collaborative planning. Nonetheless, their interest and experience in wild turkey management may have changed the results and outcome of the survey effort.

Importance placed by VDGIF personnel on stakeholder groups' values, attitudes, and opinions in wild turkey management

The members of the Technical Committee that participated in the survey effort have a keen interest in wild turkey management and, particularly district biologists, focus on managing game species for hunters, which likely would cause the Technical Committee to place most importance on spring and fall turkey hunters.

<u>Opinions of wild turkey management, VDGIF, and the role of public opinion in decision-making</u>

I did not observe any large changes in the opinions of the Technical Committee members, which may be a result that members generally approve of VDGIF actions, the Board of Game and Inland Fisheries, and wild turkey management. Prior to the planning effort, this committee also is responsible for establishing regulations and seasons for wild turkey hunting based on scientific information and stakeholder desires; it would make sense for this group to approve of their own actions.

Prior experience of some members of the Technical Committee with previous management planning efforts in Virginia may have resulted in the low number of observations of significant changes in their views of public and professional opinions in decision-making. Technical Committee members may already be familiar with the philosophy of public and professional involvement employed in this collaborative planning process, thus reducing the opportunity for drastic shifts from professional-only opinions to shared opinions among professionals and stakeholders. However, I observed trends and slight shifts when comparing pre- and post-survey results. The overarching trend indicated the Technical Committee had a greater acceptance for the public role in setting goals, but less acceptance for the public role in establishing management objectives, strategies, and evaluating progress. This likely results from the methodology VT and VDGIF employed during this and previous planning processes, which focused the SAC on making values choices (setting goals and evaluating allocation choices). The Technical Committee primarily developed objectives and strategies and selected strategies (technical choices). Over time, VDGIF will be responsible for evaluating their progress achieving goals in the plan, and will be an item of discussion for the next SAC during the revision of the wild turkey plan. Lafon (2002) asked VDGIF staff this same question during the first Black Bear Management Plan planning process, and my results mirror his findings. Apparently, Technical Committee members still desire more public opinion in decision-making, even after participating in the wild turkey management planning process.

Comparison of Wild Turkey Technical Committee and Wildlife Bureau Personnel

The 20 individuals that completed both the pre- and post-planning survey included 2 district wildlife biologists, 6 biologists who focus on non-game topics, 6 project leaders, 3 resource managers, 3 administrators, and 2 specialists. The 6 non-game biologists, 4 administrators, and 2 specialists may not be very familiar with wild turkey management or collaborative planning, which may have skewed the results of the survey effort. Also, depending on the project leaders' role, some of those individuals may not be familiar with collaborative planning.

Three district biologists did not participate in the survey effort, and given their role, they would most likely participated in this type of planning effort previously compared to other professionals in the agency. Their participation may have skewed some of the results to be more favorable of wild turkey management and public involvement. Additionally, 3 administrators and 4 resource managers did not participate; I am uncertain how their participation would have affected the survey results. I assume the administrators would may be less involved with management on the ground and have less of an opportunity to participate in collaborative planning efforts, thus their participation would have negatively affected survey results and shown a desire for less public involvement; I believe the opposite effects would have been observed from the resource managers' participation. Finally, 1 coordinating scientist, 2 team leaders, 1 project leader, and 3 non-game biologists did not participate; given the number of individuals from these groups that did participate in the survey, I do not believe their lack of participation dramatically affected survey results.

Importance placed by VDGIF personnel on stakeholder groups' values, attitudes, and opinions in wild turkey management

Wildlife Bureau personnel placed most importance on spring and fall turkey hunters, probably because they considered these stakeholders to be "paying customers" and therefore the primary stakeholders in management of wild turkeys. In addition, I believe they placed a high importance on public landowners, VDGIF, and hunter-advocacy groups because of the roles these stakeholders play in managing habitat for the resource.

Wildlife Bureau personnel may have placed increased importance on private urban landowners and agricultural producers at the end of the process because initially, they did not recognize the negative effects wild turkeys pose for these stakeholders. Wildlife Bureau personnel likely learned about turkey management issues by reading the background material developed by the Technical Committee. They also may have placed increased importance on individuals who enjoy viewing wild turkeys because they may have gained greater appreciation for the potential for wildlife viewing opportunities; 6 non-game biologists participated in this survey and their roles focusing on wildlife watching and other aesthetic benefits of wildlife may be effecting these results. In addition, during some of the Technical Committee discussions, some members proposed the idea of developing listening stations for stakeholders to hear wild turkeys gobbling. This idea may have been discussed with other VDGIF staff beyond the Technical Committee outside of meetings.

Opinions of wild turkey management, VDGIF, and the role of public opinion in decision-making

The increase in agreement with the statement "I believe that VDGIF personnel fairly consider the input they receive from the public" indicates Wildlife Bureau personnel reviewed the draft management plan and the goals, objectives, and strategies in the plan, and believe the document represents stakeholders' desires. Stakeholders created the goals in the management plan, which represent their values and desires. For example, a goal and objective addresses fall harvest allocation, which is an issue that affects opportunities for stakeholders to participate in hunting wild turkeys. Based on stakeholder input, an allocation of approximately 50% of the fall harvest would occur during the peak deer hunting period (during the first 2 weeks of early muzzleloading deer season and during the first 2 weeks of general firearms deer season), while providing quality turkey hunting opportunities prior to the peak deer hunting periods. In the past, VDGIF personnel made a value choice for stakeholders and decided how the fall harvest should occur.

However, I am uncertain why Wildlife Bureau personnel would significantly increase their agreement with the statement "I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys." I am unable to identify what may have occurred over the period of 9 months that would significantly improve the Wildlife Bureau's opinion of the Board of Game and Inland Fisheries and wild turkey management.

Wildlife Bureau personnel indicated that stakeholders should have less of a role in decision-making than members of the SAC and Technical Committee did. This may indicate that individuals passively involved with the management planning process did not develop the same level of confidence in the planning process or the benefits of stakeholder involvement as members of the Technical Committee. Also, given the different roles Wildlife Bureau personnel have (e.g., administration, non-game management), these individuals may not be familiar or had the opportunity to participate in a collaborative planning effort previously. VDGIF has not developed any collaborative management plans for non-game species, which may be why some of these individuals are not comfortable or familiar with public input. Direct interaction with the SAC and direct involvement in the management planning effort appeared to generate more positive opinions of stakeholder involvement in making management decisions. At the end of the planning process, Wildlife Bureau personnel thought VDGIF based most decisions primarily on professional opinion for most tasks, and that decisions should involve even more professional opinion compared to the pre-survey responses. Clearly these individuals not involved in the Technical Committee do not reap the same benefits of collaborative planning, including failure to understand all the issues or stakeholders, and the steps in the planning process. The agency must try to incorporate these individuals in planning processes so they can observe interactions and participate with stakeholders first hand.

Synthesis

Results from my study concur with those in Lafon et al. (2004) and Halvorsen (2003); active participation in a collaborative planning effort enables stakeholders to improve their knowledge of the resource, perceptions of other stakeholders, and opinions of the agency and its management actions. The SAC's active participation in the management planning effort resulted in positive changes regarding knowledge, opinions, and attitudes. Background material on the history and management of wild turkeys and ability to interact with VDGIF staff gave SAC members insight into wild turkey biology and management. In addition, the SAC also believed VDGIF does a better job obtaining public input and making decisions with public values in mind. Despite the nearly universal desire of stakeholders for agencies to manage resources based on "sound science," (McMullin and Pert 2010), participation in the planning process increased the SAC's desire for more important roles of stakeholders in the decision-making process.

Members of the Technical Committee experienced large changes in the desired roles of professional and public opinion in decision-making. Overall, the Technical Committee developed a desire for stronger roles for stakeholders in setting goals and objectives, but retained a preference for professional opinion when selecting strategies.

Pre- and post-process surveys of Wildlife Bureau personnel suggest that passive involvement in a management planning effort does not yield the same results as active management. Passively involved professionals did not value stakeholders' opinions as highly as Technical Committee members. Their perceived importance of stakeholder involvement increased for agricultural producers, private urban landowners, and individuals who enjoy viewing wild turkeys. Wildlife Bureau professionals thought VDGIF did a better job of considering public input, and thought the Board of Game and Inland Fisheries did a better job balancing stakeholder and scientific information. Also, Wildlife Bureau professionals did not believe that stakeholders should be involved in decision-making to the same degree as SAC members and Technical Committee members. Passively involved professionals expressed a desire for high levels of professional opinion in making management decisions. Overall, I do not believe these passively involved professionals received the same benefits (e.g., knowledge of stakeholder values, acceptance of public opinion) compared to the actively involved SAC and Technical Committee.

This study should concern VDGIF staff, as this is the 6th management planning effort that has used collaborative planning techniques. Clearly, some of these staff members in the Wildlife Bureau are not in positions to actively participate during these efforts and have not been able to see the benefits of collaborative planning. The agency image may be harmed if members of the public ask administrators or biologists questions regarding the process and they cannot provide reasonable responses. All staff members need to understand and support this type of planning.

In the future as staff members retire, the agency may become more understanding or less understanding of collaborative planning, depending on the age structure of staff members that do not accept public opinion. As baby boomers retire and staff turns over, the agency should take advantage of the opportunity to provide new staff members opportunities to participate in collaborative planning and 'sell' the benefits of such to these individuals. In the future, it will be up to the new staff members to understand the planning process and carry on this technique of management planning for the agency.

Recommendations for future planning efforts

I suggest that VDGIF consider a broader group of stakeholders for inclusion on the SAC, based on the feedback received from the SAC during the phone interviews. When asking stakeholders to participate on the SAC, sharing an electronic or hard copy of the Virginia Wild Turkey Management Plan may encourage non-traditional groups (e.g., non-consumptive users) to participate on future advisory committees. This information would give stakeholder groups an idea of the end product and what goals, objectives, and strategies have included previously. VDGIF should explore the possibility of including other public landowners on the SAC, too. VDGIF needs to develop partnerships with all landowners to achieve the desired population goals for wild turkeys.

The SAC and Technical Committee both indicated a desire for stronger stakeholder roles in making most management decisions. Even after multiple planning efforts, VDGIF's desire for increased public involvement in decision-making is very similar to their initial opinions after participating in a bear management planning effort (Lafon 2002); however, the Technical Committee still expresses substantially different desires for public involvement in decision-making than before that effort. Continuing efforts to involve stakeholders actively in making value decisions, while focusing professional involvement on making technical decisions, should further enhance the knowledge of stakeholders and their views of the agency. Those efforts also should generate greater comfort among wildlife professionals that meaningful public involvement can occur without compromising the scientific basis for management.

Also, VDGIF should direct more effort toward keeping all Wildlife Bureau personnel informed of the management planning process. Obviously, these individuals did not understand the comprehensive process nor the effort put forth by facilitators to keep stakeholders informed during the process. Facilitators should develop and disseminate updates regarding management planning efforts to agency staff, in addition to stakeholders. Technical Committee members could share information from technical meetings with other Wildlife Bureau staff from the area they represent, similar to the role SAC members played. Also, these individuals do not seem comfortable including public opinion in decision-making. This should be alarming, as VDGIF has developed 6 total collaborative management plans and the majority of these individuals apparently did not participate in those processes. VDGIF staff facilitating planning efforts should encourage biologists and others not previously involved in collaborative planning (e.g., administrators, non-game biologists) to attend future SAC meetings and public input events (i.e., focus groups, workshops) to gain an understanding of how stakeholders participate and the benefits of stakeholder involvement. Perhaps encouragement from administrators or developing requirements to interact in management planning efforts would increase the number of staff members attending these events. Overall, study results indicate that some members of the agency may not "buy-in," have not been provided the opportunity to see the process, or are not convinced of the benefits of collaborative planning.

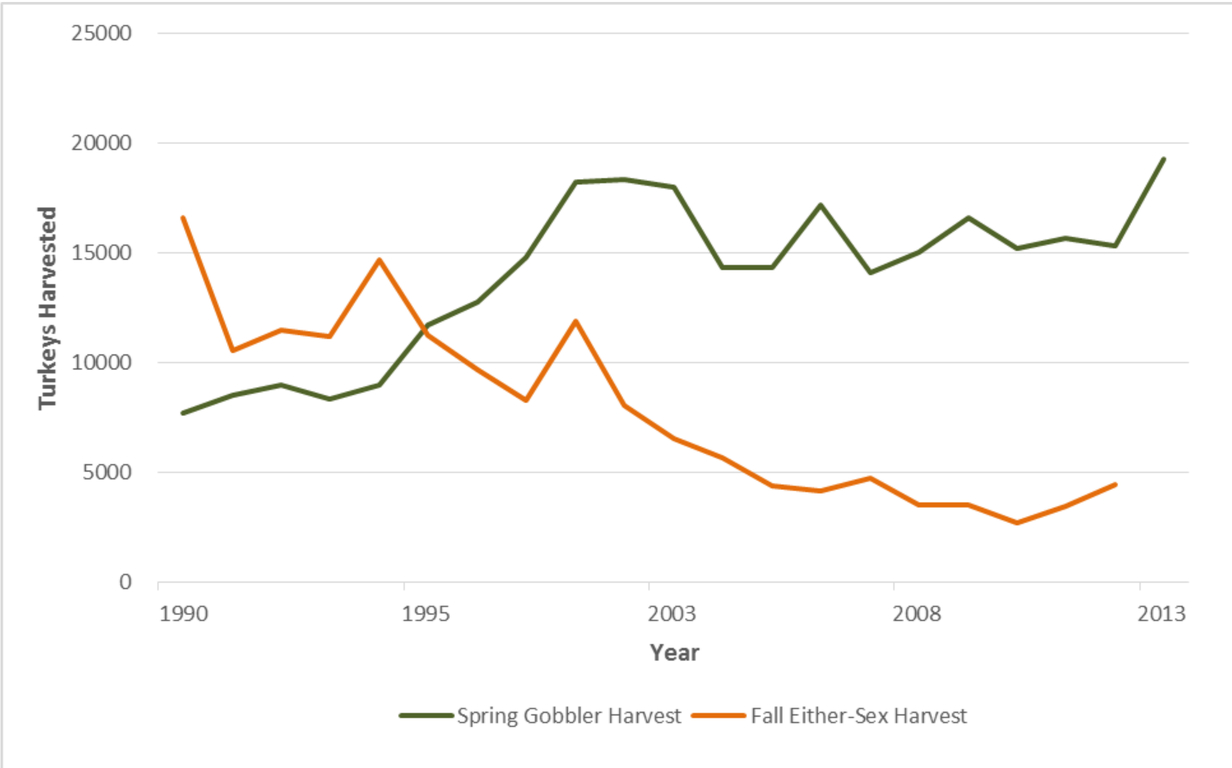

Figure 2-1. Wild turkey harvest from 1990 through Spring 2013 in Virginia based on the Virginia Department of Game and Inland Fisheries (VDGIF) data.

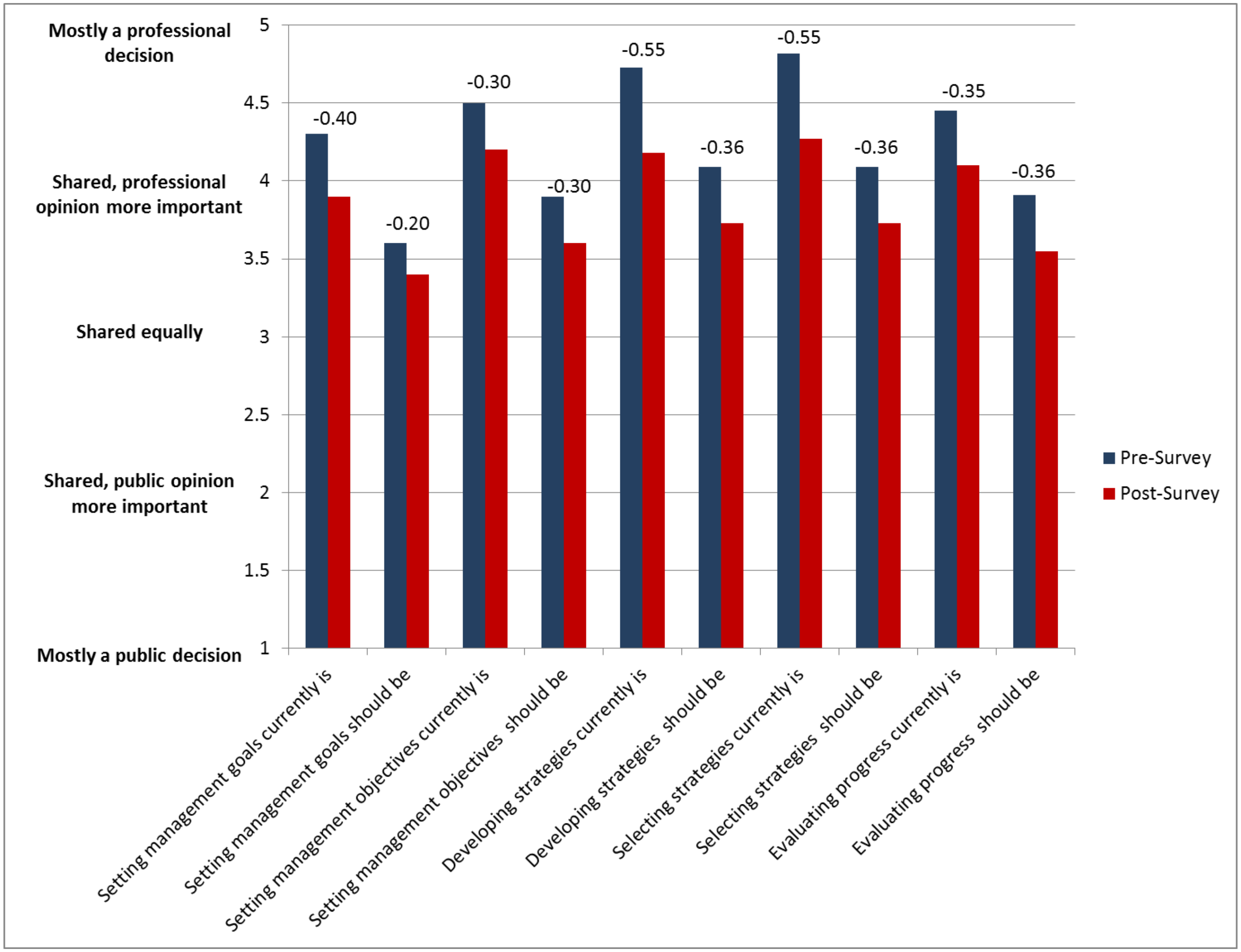

Figure 2-2. Pre- and post-survey opinions of Stakeholder Advisory Committee (SAC) members regarding the current and desired roles of professional and public opinion in decision-making. Data labels indicate the difference in the pre- and post-survey mean responses for each statement.

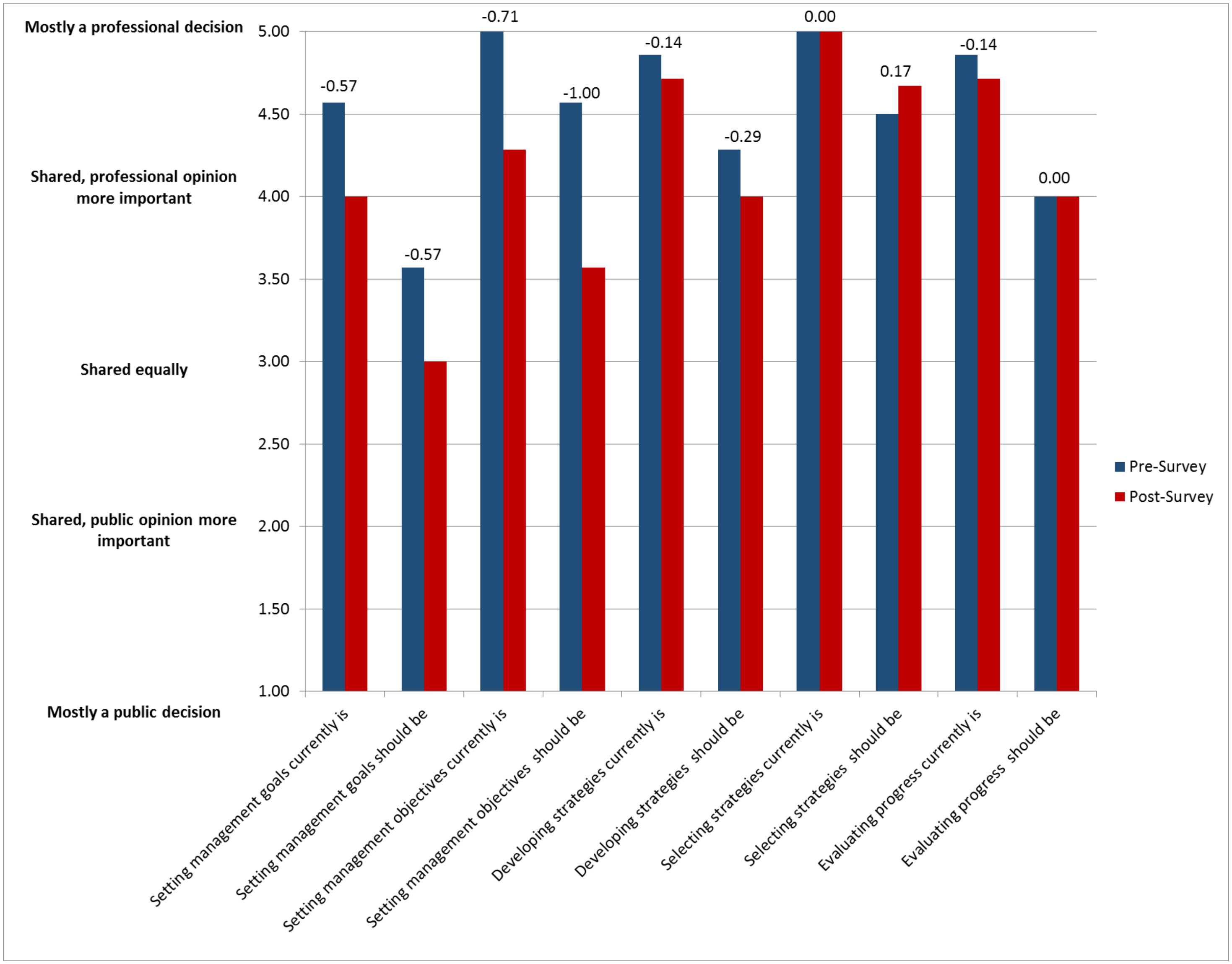

Figure 2-3. Pre- and post-survey opinions of Wild Turkey Technical Committee members regarding the current and desired roles of professional and public opinion in decision-making. Data labels indicate the difference in the pre- and post-survey mean responses for each statement.

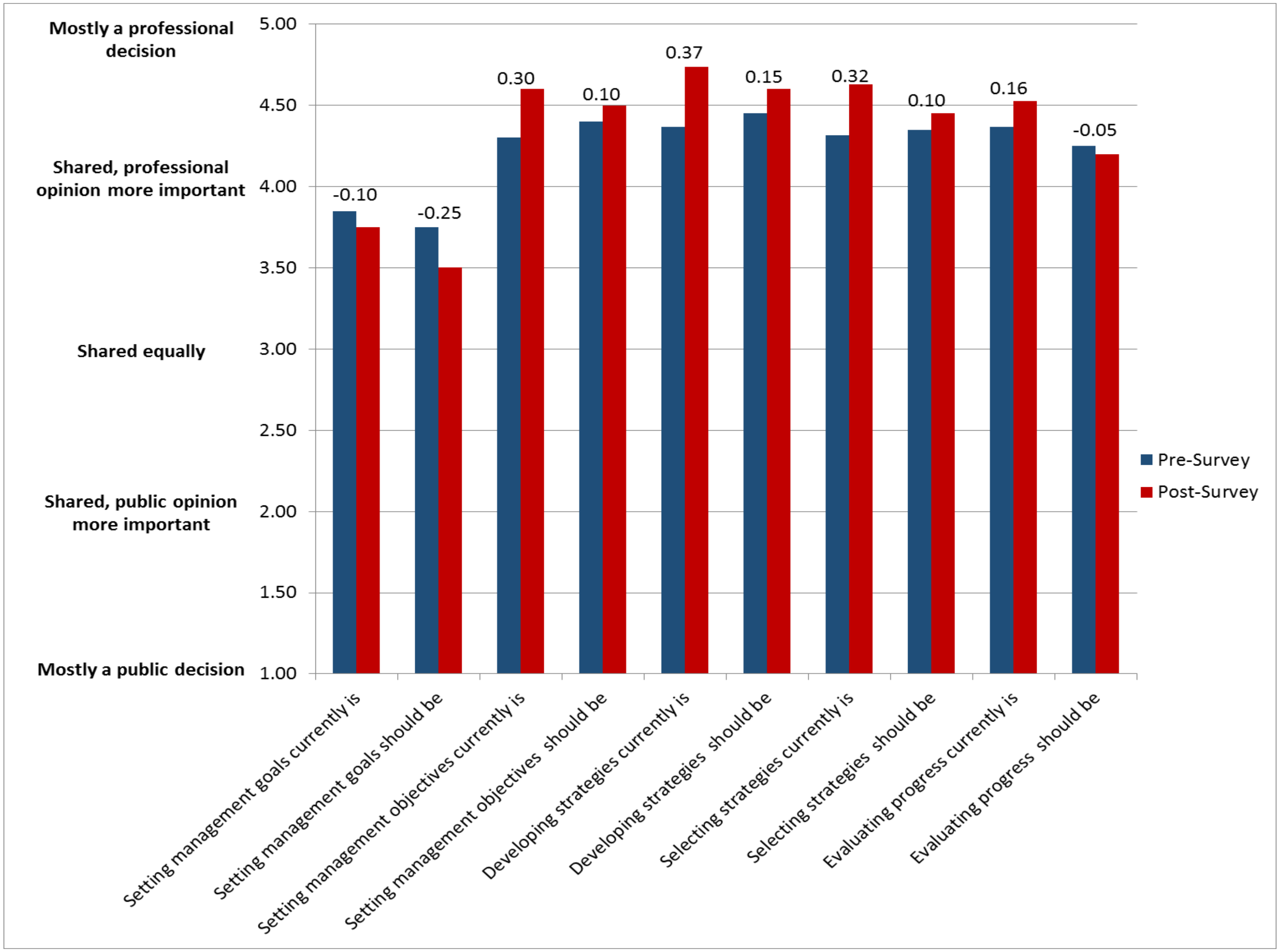

Figure 2-4. Pre- and post-survey opinions of Wildlife Bureau personnel regarding the current and desired roles of professional and public opinion in decision-making. Data labels indicate the difference in the pre- and post-survey mean responses for each statement.

Table 2-1. Timeline identifying major tasks included in the collaborative planning process employed by Virginia Tech and the Virginia Department of Game and Inland Fisheries (VDGIF) to develop the Virginia Wild Turkey Management Plan during the period 2011 through 2014.

Date	Task
	Phase I: Identifying stakeholders' values and issues
Fall 2011-March 2012	Identified stakeholders for participation in the planning process
April & May 2012	Held 9 focus group meetings and distributed questionnaires to frame wild turkey management issues
	Phase II: Management plan development
July 2012	1st Technical Committee meeting: reviewed and discussed background material for inclusion in the plan, reviewed population dynamics model that simulates the effects of different fall turkey season scenarios
Fall 2012	13 stakeholders invited to participate on the SAC
February 2013	1st SAC meeting: informed the SAC of their role in the process, established operational rules for the group, reviewed background material explaining wild turkey biology, history, and management, identified additional issues and concerns related to wild turkey management
March 2013	2nd SAC meeting: introduced the population dynamics model, continued identification of values that drive issues and concerns in wild turkey management, assigned task to develop draft goals between 2nd and 3rd meetings
May 2013	2nd Technical Committee meeting: discussed revisions to the background material, reviewed draft goals developed by the SAC, developed draft management objectives and potential strategies to achieve draft goals
June 2013	3rd SAC meeting: reviewed, discussed, and approved draft management goals, discussed and evaluated draft objectives and potential strategies developed by the Technical Committee
July 12- August 9, 2013	30-day public comment period on draft plan; held 6 public meetings to solicit input
September 2013	4th SAC meeting: discussed public comments and suggested revisions for the management plan
Fall 2013	Technical Committee developed revision of draft plan based on public comments; distributed to SAC for final review
January 2014	Presentation of revised plan to the Board of Game and Inland Fisheries for approval

Table 2-2. Objectives for the Virginia Wild Turkey Management Plan identified by the Wild Turkey Technical Committee (Technical Committee) to fulfil the goals established by the Stakeholder Advisory Committee (SAC).

Topic Area	Objectives
Turkey Populations	1. To meet and maintain turkey population objectives at cultural carrying capacity (CCC) in each county management unit through 12/31/2022 2. To determine factors that may be limiting the attainment of turkey population objectives through 12/31/2022. 3. To biennially assess and update turkey population CCC objectives in each county management unit through 12/31/2022. 4. To annually assess and update turkey population status in each county management unit through 12/31/2022. 5. To develop and/or continue site-specific population management programs within county management units through 12/31/2022. 6. To validate and test sustained yield population models for turkeys and to determine practical methods for identifying maximum sustained yield (MSY) for fall and spring harvests by 12/31/2020.
Turkey-Related Recreation	1. To update knowledge of turkey hunter satisfactions and constraints to hunting participation in Virginia by 1/1/2016. 2. To improve fall and spring turkey hunter satisfactions, as measured by the 2011 hunter survey, by 12/31/2022. 3. To determine non-hunting turkey recreation demands, desires, and satisfactions by 1/1/2017. 4. Establish programs to meet demands and satisfactions for non-hunting recreational opportunities through 2022.
Hunting Tradition	1. To have at least 55,000 fall hunters (i.e., a 30% growth from 2011) and 55,000 spring gobbler hunters (i.e., maintaining 2012 levels) annually participating in turkey hunting by 12/31/2022. 2. To determine limiting factors for participation in fall turkey hunting and make programmatic recommendations to preserve fall turkey hunting traditions and participation by 1/1/2018.
Allocation of Fall Harvest	1. To manage turkey harvests during the peak deer hunting periods (during the first 2 weeks of early muzzleloading deer season and during the first 2 weeks of general firearms deer season) to be approximately 50% (between 40-60%) of the total annual fall turkey harvest through the 2022-23 hunting seasons, while also providing quality turkey hunting opportunity prior to these peak deer hunting periods. 2. To refine appropriate allocation of fall turkey hunting opportunities and harvests by 1/1/2015.

Table 2-3. (Continued)

Topic Area	Objectives
Safety	1. Compared to the 10-year period (2003-12) when 25 spring hunting incidents occurred, reduce turkey hunting-related incidents by 25% (by 6 incidents) for the period 2013- 2022. 2. To annually inform hunters and the general public about open turkey hunting seasons and associated safety considerations through 12/31/2022. 3. To develop and implement a system to annually monitor safety incidents related to fall turkey hunting by 12/31/2015.
Ethics & Compliance with Law	1. To describe ethical principles for turkey hunting by 1/1/2016. 2. To implement strategies that ensure compliance with these standards by 1/1/2018.
Human-Wild Turkey Problems	1. To quantify and assess agricultural and other negative turkey impacts by 1/1/2018. 2. To develop and implement cost-effective response policies/guidelines for managing wild turkey problems by 1/1/2015.

Table 2-3. Goals for the Virginia Wild Turkey Management Plan the Stakeholder Advisory Committee (SAC) developed based on public issues and values.

Topic Area	Goals
Turkey Populations	Manage turkey populations using innovative, flexible, publicly accepted, cost-effective, and technically sound practices that balance the varied needs and expectations of stakeholders statewide and locally (cultural carrying capacity).
Turkey-Related Recreation	Manage wild turkey-related recreation (including hunting and non-hunting recreation) to optimize the multiple factors that determine participants' satisfaction. Turkey-related recreational opportunities should not support activities that prevent attainment of turkey population objectives to meet cultural carrying capacity.
Hunting Tradition	Encourage participation in lawful methods of turkey hunting in both spring and fall in Virginia. Promotion of hunting traditions should not support activities that prevent attainment of turkey population objectives to meet cultural carrying capacity.
Allocation of Fall Harvest	Provide opportunities for all hunters to harvest turkeys, but with primary emphasis on hunters who specifically pursue wild turkeys, including quality fall hunting opportunity prior to significant disruptions from deer hunting activity (primarily muzzleloading and firearms seasons). Fall harvest allocations and hunting opportunity should not prevent attainment of turkey population objectives to meet cultural carrying capacity.
Safety	Promote safety for hunters and non-hunters without diminishing the quality of the hunting experience during both spring and fall.
Ethics & Compliance with Law	Demand a culture of high ethical standards among hunters and develop respect for the interests of non-hunters, other hunters, and landowners, while working to reduce poaching and unethical practices.
Human-Wild Turkey Problems	Reduce the negative consequences upon affected stakeholders from conflicts caused by wild turkeys through shared public/private responsibility and in a manner consistent with population and recreation objectives.

Table 2-4. Changes in the importance placed by Stakeholder Advisory Committee (SAC) members on the values, attitudes, and opinions of all stakeholder groups in the management of wild turkeys in Virginia after participating in the wild turkey management planning process.

Stakeholder Group	Means*		# of Respondents	Increase in Importance	Decrease in Importance	No Change	Wilcoxon signed-rank test results of individual responses
	Pre	Post					
Spring turkey hunters	3.73	3.73	11	1	1	9	W=0, p=0.5
Fall turkey hunters	3.73	3.82	11	1	0	10	W=0.5, p=0.5
Individuals who wish to harvest a turkey while pursuing other game species	2.73	3.09	11	3	1	7	W=3, p=0.25
Individuals who enjoy viewing wild turkeys	3.36	3.45	11	2	1	8	W=1, p=0.5
Agricultural producers	3.45	3.45	11	1	1	9	W=0, p=0.5
Private rural landowners	3.45	3.55	11	2	1	8	W=1, p=0.5
Private urban landowners	2.64	3.00	11	4	1	6	W=5, p=0.16
Public landowners (e.g., US Forest Service)	3.73	3.82	11	1	0	10	W=1, p=0.5
Virginia Dept. of Game and Inland Fisheries	3.82	3.73	11	0	1	10	W=-0.5, p=0.5
Hunter-advocacy groups (e.g., NWTF)	3.45	3.73	11	3	1	7	W=3, p=0.25
Conservation groups (e.g., Audubon)	3.27	3.27	11	1	1	9	W=0, p=0.5

*Mean scores are on a 4-point scale where 1= not at all important and 4= very important

Table 2-5. Changes in the perception of Stakeholder Advisory Committee (SAC) members on the importance that the Virginia Department of Game and Inland Fisheries (VDGIF) attaches to the values, attitudes, and opinions of all stakeholder groups after participating in the wild turkey management planning process.

Stakeholder Group	**Means***		**# of Respondents**	**Increase in Importance**	**Decrease in Importance**	**No Change**	**Wilcoxon signed-rank test results of individual responses**
	Pre	**Post**					
Spring turkey hunters	4.00	3.90	10	0	1	9	W=-0.5, p=0.5
Fall turkey hunters	3.80	3.70	10	1	2	7	W=-1, p=0.5
Individuals who wish to harvest a turkey while pursuing other game species	3.20	3.50	10	4	1	5	W=4.5, p=0.19
Individuals who enjoy viewing wild turkeys	3.40	3.20	10	1	3	6	W=-2.5, p=0.69
Agricultural producers	3.40	3.10	10	2	3	5	W=-3.5, p=0.78
Private rural landowners	3.10	3.20	10	2	1	7	W=1, p=0.5
Private urban landowners	2.60	2.80	10	2	1	7	W=1.5, p=0.38
Public landowners (e.g., US Forest Service)	3.60	3.60	10	0	0	10	W=0, p =0.5
Virginia Dept. of Game and Inland Fisheries	3.89	3.89	9	0	0	9	W=0, p=0.5
Hunter-advocacy groups (e.g., NWTF)	3.70	3.50	10	0	2	8	W=-1.5, p=0.75
Conservation groups (e.g., Audubon)	3.50	3.30	10	0	2	8	W=-1.5, p=0.75

*Mean scores are on a 4-point scale where 1= not at all important and 4= very important

Table 2-6. Mean opinions of Stakeholder Advisory Committee (SAC) members regarding wild turkey management in Virginia and the Virginia Department of Game and Inland Fisheries (VDGIF) before and after participating in the wild turkey management planning process.

Question	Means*	
	Pre	Post
I believe that VDGIF manages wild turkeys well.	6.00	6.09
I believe that VDGIF has a good scientific basis for managing wild turkeys.	5.91	5.91
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	5.00	5.55
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	5.36	5.45
I believe that VDGIF personnel fairly consider the input they receive from the public.	5.27	5.09
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	5.18	5.73
I believe that VDGIF does a good job keeping stakeholders informed about management.	5.27	5.73
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	5.82	5.64
I believe that VDGIF makes decisions with public values in mind.	5.09	5.55
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	5.18	5.09

*Mean scores are on a 7-point Likert scale where 1=strongly disagree with the statement and 7=strongly agree with the statement

Table 2-7. Changes in the opinions expressed by Stakeholder Advisory Committee (SAC) members representing disparate interests regarding wild turkey management in Virginia and the Virginia Department of Game and Inland Fisheries (VDGIF) after participating in the wild turkey management planning process.

Question	# of Respondents	Increase in Agreement	Decrease in Agreement	No Change	Wilcoxon signed-rank test results of individual responses
I believe that VDGIF manages wild turkeys well.	11	3	2	6	W=1.5, p=0.5
I believe that VDGIF has a good scientific basis for managing wild turkeys.	11	5	3	3	W=3, p=0.40
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	11	7	2	2	W=8, p=0.17
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	11	3	3	5	W=1.5, p=0.45
I believe that VDGIF personnel fairly consider the input they receive from the public.	11	4	3	4	W=1, p=0.5
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	11	6	0	5	W=10.5, p=0.02
I believe that VDGIF does a good job keeping stakeholders informed about management.	11	4	1	6	W=4, p=0.19
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	11	5	3	3	W=1, p=0.48
I believe that VDGIF makes decisions with public values in mind.	11	5	1	5	W=7.5, p=0.09
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	11	3	3	5	W=-1.5, p=0.5

Table 2-8. Differences in the opinions expressed by Stakeholder Advisory Committee (SAC) members after participating in the wild turkey management planning process regarding the roles of public and professionals in decision-making.

	Means*		# of Respondents	Shift to Professional Role	Shift to Public Role	No Change	Wilcoxon signed-rank test results of individual responses
	Pre	Post					
Setting management goals currently is	4.3	3.90	10	1	4	5	W=-3.5, p=0.22
Setting management goals should be	3.6	3.40	10	2	4	4	W=-3.5, p=0.34
Setting management objectives currently is	4.5	4.20	10	2	4	4	W=-4.5, p=0.27
Setting management objectives should be	3.9	3.60	10	2	5	3	W=-6, p=0.23
Developing strategies currently is	4.73	4.18	11	1	5	5	W=-8, p=0.08
Developing strategies should be	4.09	3.73	11	1	4	6	W=-5, p=0.16
Selecting strategies currently is	4.82	4.27	11	0	5	6	W=-7.5, p=0.03
Selecting strategies should be	4.09	3.73	11	2	4	5	W=-4.5, p=0.27
Evaluating progress currently is	4.45	4.10	10	2	4	4	W=-6.5, p=0.11
Evaluating progress should be	3.91	3.55	11	0	4	7	W=-5, p=0.06

*Means are on a 5-point scale where 1=mostly a public decision and 5=mostly a professional decision

Table 2-9. Differences in the opinions expressed by Stakeholder Advisory Committee (SAC) members before and after participating in the management planning process regarding the roles of the public and professionals in how management currently is and should be.

	Means*		# of Respondents	Shift to Professional Role	Shift to Public Role	No Change	Wilcoxon signed-rank test results of individual responses
	Currently is	Should be					
Before Participation							
Setting goals currently is/should be	4.30	3.60	10	0	5	5	W=-7.5, p=0.03
Setting management objectives currently is/should be	4.50	3.90	10	1	5	4	W=-8, p=0.08
Developing strategies currently is/should be	4.70	4.00	11	1	6	4	W=-11, p=0.05
Selecting strategies currently is/should be	4.80	4.00	11	0	7	4	W=-14, p=0.01
Evaluating progress currently is/should be	4.60	3.90	10	0	6	4	W=-10.5, p=0.02
After Participation							
Setting goals currently is/should be	3.90	3.40	10	0	3	7	W=-3, p=0.13
Setting management objectives currently is/should be	4.20	3.60	10	0	4	6	W=-5, p=0.06
Developing strategies currently is/should be	4.00	3.78	11	1	4	6	W=-5.5, p=0.13
Selecting strategies currently is/should be	4.11	3.78	11	0	4	7	W=-5, p=0.06
Evaluating progress currently is/should be	3.88	3.50	10	1	5	4	W=-8, p=0.08

*Means are on a 5-point scale where 1=mostly a public decision and 5=mostly a professional decision

Table 2-10. Changes in the importance Technical Committee members placed on the values, attitudes, and opinions of all stakeholder groups in the management of wild turkeys in Virginia after participating in the management planning process.

Stakeholder Group	**Means***		**# of Respondents**	**Increase in Importance**	**Decrease in Importance**	**No Change**	**Wilcoxon signed-rank test results of individual responses**
	Pre	**Post**					
Spring turkey hunters	4.00	4.00	6	0	0	6	W=0, p=0.5
Fall turkey hunters	4.00	4.00	6	0	0	6	W=0, p=0.5
Individuals who wish to harvest a turkey while pursuing other game species	3.00	3.33	6	2	0	4	W=1.5, p=0.25
Individuals who enjoy viewing wild turkeys	3.50	3.50	6	1	1	4	W=0, p=0.5
Agricultural producers	3.00	3.33	6	3	1	2	W=2.5, p=0.31
Private rural landowners	3.17	3.17	6	1	1	4	W=0, p=0.5
Private urban landowners	2.50	2.83	6	4	2	0	W=3.5, p=0.34
Public landowners (e.g., US Forest Service)	3.67	3.50	6	0	1	5	W=-0.5, p=0.5
Virginia Dept. of Game and Inland Fisheries	3.83	3.50	6	0	1	5	W=-0.5, p=0.5
Hunter-advocacy groups (e.g., NWTF)	3.33	3.67	6	1	0	5	W=0.5, p=0.5
Conservation groups (e.g., Audubon)	3.17	3.50	6	1	0	5	W=0.5, p=0.5

*Mean scores are on a 4-point scale where 1= not at all important and 4= very important

Table 2-11. Changes in the opinions expressed by Technical Committee members after participating in the wild turkey management planning process regarding wild turkey management in Virginia and of the agency.

Question	# of Respondents	Increase in Agreement	Decrease in Agreement	No Change	Wilcoxon signed-rank test results of individual responses
I believe that VDGIF manages wild turkeys well.	7	1	4	2	W=-4.5, p=0.81
I believe that VDGIF has a good scientific basis for managing wild turkeys.	7	1	3	3	W=-2.5, p=0.69
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	7	2	2	3	W=1, p=0.5
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	7	3	1	3	W=3, p=0.25
I believe that VDGIF personnel fairly consider the input they receive from the public.	7	3	2	2	W=2.5, p=0.38
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	7	1	2	4	W=-0.5, p=0.5
I believe that VDGIF does a good job keeping stakeholders informed about management.	7	3	0	4	W=3, p=0.13
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	7	2	3	2	W=-1.5, p=0.5
I believe that VDGIF makes decisions with public values in mind.	7	2	0	5	W=1.5, p=0.25
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	7	2	1	4	W=1.5, p=0.38

Table 2-12. Mean opinions of Technical Committee members regarding wild turkey management in Virginia and the Virginia Department of Game and Inland Fisheries (VDGIF) before and after participating in the wild turkey management planning process.

Question	Means*	
	Pre	Post
I believe that VDGIF manages wild turkeys well.	6.57	6.14
I believe that VDGIF has a good scientific basis for managing wild turkeys.	6.71	6.43
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	6.14	6.43
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	6.00	6.43
I believe that VDGIF personnel fairly consider the input they receive from the public.	6.14	6.43
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	5.29	5.00
I believe that VDGIF does a good job keeping stakeholders informed about management.	5.00	5.71
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	6.57	6.43
I believe that VDGIF makes decisions with public values in mind.	6.43	6.71
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	5.57	5.86

*Mean scores are on a 7-point Likert scale where 1=strongly disagree with the statement and 7=strongly agree with the statement.

Table 2-13. Differences in perceptions of Technical Committee members after participating in the wild turkey management planning process regarding the roles of the public and professionals in decision-making.

	Means*		# of Respondents	Shift to Professional Role	Shift to Public Role	No Change	Wilcoxon signed-rank test results of individual responses
	Pre	Post					
Setting management goals currently is	4.57	4.00	7	1	3	3	W=-3, p=0.25
Setting management goals should be	3.57	3.00	7	1	3	3	W=-3, p=0.25
Setting management objectives currently is	5.00	4.29	7	0	2	5	W=-1.5, p=0.25
Setting management objectives should be	4.57	3.57	7	0	4	3	W=-5, p=0.06
Developing strategies currently is	4.86	4.71	7	0	1	6	W=-0.5, p=0.5
Developing strategies should be	4.29	4.00	7	0	2	5	W=-1.5, p=0.25
Selecting strategies currently is	5.00	5.00	7	0	0	7	W=0, p=0.5
Selecting strategies should be	4.50	4.67	6	1	0	5	W=0.5, p=0.5
Evaluating progress currently is	4.86	4.71	7	0	1	6	W=-0.5, p=0.5
Evaluating progress should be	4.00	4.00	7	1	1	5	W=0, p=0.5

*Means are on a 5-point scale where 1=mostly a public decision and 5=mostly a professional decision

Table 2-14. Differences in perceptions of Technical Committee members before and after participating in the wild turkey management planning process regarding the roles of the public and professionals in how management currently is and should be.

	Means*						
	Currently is	Should be	# of Respondents	Shift to Professional Role	Shift to Public Role	No Change	Wilcoxon signed-rank test results of individual responses
Before Participation							
Setting goals currently is/should be	4.57	3.57	7	1	5	1	W=-8.5, p=0.06
Setting management objectives currently is/should be	5.00	4.57	7	0	3	4	W=-3, p=0.13
Developing strategies currently is/should be	4.86	4.29	7	0	4	3	W=-5, p=0.06
Selecting strategies currently is/should be	5.00	4.50	6	0	3	3	W=-3, p=0.13
Evaluating progress currently is/should be	4.86	4.00	7	0	4	3	W=-5, p=0.06
After Participation							
Setting goals currently is/should be	4.33	3.00	7	1	5	1	W=-8, p=0.08
Setting management objectives currently is/should be	4.17	4.00	6	1	2	3	W=-1, p=0.5
Developing strategies currently is/should be	4.67	4.00	6	0	4	2	W=-5, p=0.06
Selecting strategies currently is/should be	5.00	4.60	5	0	2	3	W=-1.5, p=0.25
Evaluating progress currently is/should be	5.00	4.17	6	0	3	3	W=-3, p=0.13

*Means are on a 5-point scale where 1=mostly a public decision and 5=mostly a professional decision

Table 2-15. Changes in the importance Wildlife Bureau personnel placed on the values, attitudes, and opinions of all stakeholder groups in the management of wild turkeys in Virginia after participating in the wild turkey management planning process.

Stakeholder Group	Means*		# of Respondents	Increase in Importance	Decrease in Importance	No Change	Wilcoxon signed-rank test results of individual responses
	Pre	Post					
Spring turkey hunters	4.00	4.00	20	0	0	20	W=0, p=0.5
Fall turkey hunters	3.90	3.95	20	1	0	19	W=0.5, p=0.5
Individuals who wish to harvest a turkey while pursuing other game species	3.35	3.30	20	3	4	13	W=-2, p=0.5
Individuals who enjoy viewing wild turkeys	3.35	3.55	20	5	1	14	W=7, p=0.11
Agricultural producers	2.70	3.10	20	8	1	11	W=18, p=0.02
Private rural landowners	3.10	3.30	20	6	2	12	W=9, p=0.15
Private urban landowners	2.10	2.45	20	7	1	12	W=11, p=0.07
Public landowners (e.g., US Forest Service)	3.89	3.95	20	2	1	17	W=1, p=0.5
Virginia Dept. of Game and Inland Fisheries	3.95	4.00	20	1	0	19	W=0.5, p=0.5
Hunter-advocacy groups (e.g., NWTF)	3.75	3.90	20	4	1	15	W=4.5, p=0.19
Conservation groups (e.g., Audubon)	3.40	3.40	20	4	4	12	W=0, p=0.5

*Mean scores are on a 4-point scale where 1= not at all important and 4= very important

Table 2-16. Changes in the opinions expressed by Wildlife Bureau personnel after participating in the wild turkey management planning process regarding wild turkey management in Virginia and of the agency.

Question	# of Respondents	Increase in Agreement	Decrease in Agreement	No Change	Wilcoxon signed-rank test results of individual responses
I believe that VDGIF manages wild turkeys well.	20	3	4	13	W=-2, p=0.5
I believe that VDGIF has a good scientific basis for managing wild turkeys.	20	3	1	16	W=3, p=0.25
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	20	4	5	11	W=-2.5, p=0.5
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	20	3	2	15	W=2, p=0.41
I believe that VDGIF personnel fairly consider the input they receive from the public.	20	6	1	13	W=7, p=0.11
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	20	5	5	10	W=-2, p=0.56
I believe that VDGIF does a good job keeping stakeholders informed about management.	20	4	7	9	W=-6.5, p=0.69
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	20	6	2	12	W=9, p=0.15
I believe that VDGIF makes decisions with public values in mind.	20	3	4	13	W=-0.5, p=0.5
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	20	8	3	9	W=19.5, p=0.05

Table 2-17. Mean opinions of Wildlife Bureau personnel regarding wild turkey management in Virginia and Virginia Department of Game and Inland Fisheries before and after participating in the wild turkey management planning process.

Question	Means*	
	Pre	Post
I believe that VDGIF manages wild turkeys well.	6.25	6.20
I believe that VDGIF has a good scientific basis for managing wild turkeys.	6.30	6.45
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	6.10	6.05
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	5.65	5.75
I believe that VDGIF personnel fairly consider the input they receive from the public.	5.90	6.15
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	5.95	5.90
I believe that VDGIF does a good job keeping stakeholders informed about management.	5.70	5.50
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	6.05	6.25
I believe that VDGIF makes decisions with public values in mind.	5.95	5.90
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	4.85	5.45

*Mean scores are on a 7-point Likert scale where 1=strongly disagree with the statement and 7=strongly agree with the statement.

Table 2-18. Differences in perceptions of Wildlife Bureau personnel after participating in the wild turkey management planning process regarding the roles of the public and professionals in decision-making.

	Means*		# of Respondents	Shift to Professional Role	Shift to Public Role	No Change	Wilcoxon signed-rank test results of individual responses
	Pre	Post					
Setting management goals currently is	3.85	3.75	20	3	5	12	W=-4.5, p=0.36
Setting management goals should be	3.75	3.50	20	2	6	12	W=-10, p=0.12
Setting management objectives currently is	4.30	4.60	20	4	2	14	W=5.5, p=0.81
Setting management objectives should be	4.40	4.50	20	2	2	16	W=2, p=0.75
Developing strategies currently is	4.37	4.74	19	4	2	13	W=5.5, p=0.83
Developing strategies should be	4.45	4.60	20	5	4	11	W=6.5, p=0.78
Selecting strategies currently is	4.32	4.63	19	4	3	12	W=5.5, p=0.79
Selecting strategies should be	4.35	4.45	20	6	7	7	W=7, p=0.72
Evaluating progress currently is	4.37	4.53	19	6	3	10	W=6, p=0.69
Evaluating progress should be	4.25	4.20	20	6	7	7	W=-2.5, p=0.48

*Means are on a 5-point scale where 1=mostly a public decision and 5=mostly a professional decision

Table 2-19. Differences in perceptions of Wildlife Bureau personnel before and after participating in the wild turkey management planning process regarding the roles of the public and professionals in how management currently is and should be.

	Means*		# of Respondents	Shift to Professional Role	Shift to Public Role	No Change	Wilcoxon signed-rank test results of individual responses
	Currently is	Should be					
Before Participation							
Setting goals currently is/should be	3.85	3.75	20	4	4	12	W=-2, p=0.5
Setting management objectives currently is/should be	4.30	4.40	20	4	4	12	W=4, p=0.72
Developing strategies currently is/should be	4.37	4.42	19	3	4	12	W=2, p=0.66
Selecting strategies currently is/should be	4.32	4.37	19	4	4	11	W=2, p=0.56
Evaluating progress currently is/should be	4.37	4.21	19	1	4	14	W=-4.5, p=0.19
After Participation							
Setting goals currently is/should be	3.75	3.50	20	2	6	12	W=-10, p=0.12
Setting management objectives currently is/should be	4.60	4.50	20	3	5	12	W=-4.5, p=0.36
Developing strategies currently is/should be	4.72	4.56	19	2	5	12	W=-6, p=0.23
Selecting strategies currently is/should be	4.61	4.44	19	2	6	11	W=-9, p=0.14
Evaluating progress currently is/should be	4.50	4.17	19	1	6	12	W=-10.5, p=0.06

*Means are on a 5-point scale where 1=mostly a public decision and 5=mostly a professional decision

Literature Cited

Carrozzino-Lyon, A. L. 2012. Characterization and communicative analysis of wildlife managers and recreational users of Virginia's Wildlife Management Areas. Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Decker, D. J., and L. C. Chase. 1997. Human dimensions of living with wildlife: a management challenge for the 21st century. Wildlife Society Bulletin 25:788-795.

Decker, D. J., C. C. Krueger, R. A. Baer, B. A. Knuth, and M. E. Richmond. 1996. From clients to stakeholders: a philosophical shift for fish and wildlife management. Human Dimensions of Wildlife 1:70-82.

Halvorsen, K. E. 2003. Assessing the effects of public participation. Public Administration Review 63:535-543.

Jacobson, C. A., J. F. Organ, D. J. Decker, G. R. Batcheller, and L. Carpenter. 2010. A conservation institution for the 21st century: implications for state wildlife agencies. Journal of Wildlife Management 74:203-209.

Lafon, N. W. 2002. Evolution of stakeholder knowledge, attitudes, and opinions throughout a participative process to develop a management plan for black bears in Virginia. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Lafon, N. W., S. L. McMullin, D. E. Steffen, and R. S. Schulman. 2004. Improving stakeholder knowledge and agency image through collaborative planning. Wildlife Society Bulletin 32:220-231.

Magill, A. W. 1988. Natural resource professionals: the reluctant public servants. The Environmental Professional 10:295-303.

McMullin, S. L., and E. Pert. 2010. The process of fisheries management. Pages 133-155 *in* W. A. Hubert, and M. C. Quist, editors. Inland fisheries management in North America. Third edition. American Fisheries Society, Bethesda, Maryland, USA.

Tapley, J. L., M. A. Hatfield, R. K. Abernethy, and J. E. Kennamer. 2011. Status and distribution of the wild turkey in 2009. Proceedings of the National Wild Turkey Symposium 10:19-30.

Vaske, J. J., D. C. Fulton, and M. J. Manfredo. 2001. Human dimensions considerations in wildlife management planning. Pages 91-108 *in* D. J. Decker, T. L. Brown, and W. F. Siemer, editors. Human dimensions of wildlife management in North America. The Wildlife Society, Bethesda, Maryland, USA.

Virginia Department of Game and Inland Fisheries. 1999. Virginia deer management plan. Wildlife Information Publication No. 99-1. Virginia Department of Game and Inland Fisheries, Richmond, USA.

Virginia Department of Game and Inland Fisheries. 2002. Virginia black bear management plan 2001-2010. <http://www.dgif.virginia.gov/wildlife/bear/blackbearmanagementplan-2001-2010.pdf >. Accessed 13 Sept 2013.

Virginia Department of Game and Inland Fisheries. 2007. Virginia deer management plan 2006-2015. Wildlife Information Publication No. 07-1. Virginia Department of Game and Inland Fisheries, Richmond, USA.

Virginia Department of Game and Inland Fisheries. 2011. Wildlife management area study: final report. <http://www.dgif.virginia.gov/wmas/study/ >. Accessed 3 Dec 2013.

Virginia Department of Game and Inland Fisheries. 2013a. Black bear management plan 2012-2021. <http://www.dgif.virginia.gov/wildlife/bear/blackbearmanagementplan.pdf >. Accessed 13 Sept 2013.

Virginia Department of Game and Inland Fisheries. 2013b. Virginia 2012-2013 fall wild turkey harvest summary. <http://www.dgif.virginia.gov/wildlife/turkey/fallharvestsummary.asp >. Accessed 9 Sept 2013.

Chapter 3:

Developing a comprehensive habitat assessment for wild turkeys in Virginia

In 2011, the Virginia Department of Game and Inland Fisheries (VDGIF) stated that decision-making and long-term planning relative to wild turkey management in Virginia could be enhanced if biologists were able to more accurately assess wild turkey habitat quality. Further, having that capability nicely would complement the on-going development of a wild turkey management plan in Virginia. Although habitat assessment methodologies currently do exist for the eastern wild turkey (e.g., Schroeder 1985, Missouri Department of Conservation and USDA Soil Conservation Service 1988), many of these approaches do not take advantage of today's newer technologies. To take full advantage of today's technology and meet the desired objectives of the agency, I developed a new approach to wild turkey habitat assessment, one that is easy to use and provides an inexpensive method to compare habitats at multiple scales across Virginia; data from the assessment also can be used to calculate a wild turkey index of abundance. Biologists previously calculated this index using spring turkey harvest/mile^2 of forested habitat, a metric that does not include all habitats potentially suitable for wild turkeys.

Before beginning to develop my habitat assessment method, I performed a thorough literature review to identify the critical habitat resources important to wild turkeys. I paid particular attention to life history attributes when selecting critical habitat resources. In addition, I reviewed other researchers' prior attempts to assess wild turkey habitat, including the variables they used, how they applied the model, and indications of the effectiveness of the assessment.

Meeting the needs of the agency required constructing a 2-step approach to assess wild turkey habitat. The first step, discussed in Chapter 3A, employs a landscape-level habitat suitability model, uses a geographic information system (GIS), and focuses on habitat within a 5,167-acre area that resembles the average home range (5,189 acres; McDougal 1990) of a wild turkey in Virginia. The moving-window analysis assesses variables within an 86 cell radius, which equates to 5,167 acres; I could not obtain an area closer to the average home range without exceeding the desired value. The second step in the habitat assessment, discussed in Chapter 3B, includes a rapid habitat appraisal tool that assesses quality of smaller areas of interest (<1,000 acres), using a site visit and aerial imagery of the surrounding area. To provide a truly comprehensive assessment, the two pieces should be used in concert. The user first should apply the GIS habitat suitability model at the landscape-level to identify areas for further investigation; then, the user should use the rapid habitat appraisal tool to aid in identifying specific factors promoting or limiting the suitability of the area. Overall, this comprehensive habitat assessment provides biologists with valuable tools to assess past and current habitat conditions for wild turkeys, depending on the production date of the data used, and recognize areas where they could focus habitat management efforts to address limiting factors.

Chapter 3A:
A landscape-level habitat suitability model using a geographic information system for the eastern wild turkey in Virginia

Abstract

To manage eastern wild turkey (*Meleagris gallopavo silvestris*) populations effectively, state wildlife management agencies need to make strategic management decisions (e.g., setting hunting season regulations, adopting habitat management practices) that are implemented at the landscape-level. Having a readily available, landscape-level assessment of potential habitat quality would be a valuable aid when making such management decisions. I developed a 2-step, comprehensive habitat suitability assessment protocol that uses available geographic information system (GIS) datasets to evaluate turkey habitat in Virginia. The first step of the assessment examines habitat at the landscape-level, using the average home range (5,189 acres) of a wild turkey in VA to define landscape scale; the second step applies a rapid habitat appraisal tool that uses aerial imagery and data collected from on-site inspection to assess habitats of <1,000 acres. I designed the model using ESRI ArcGIS 10.1 ModelBuilder and used the National Land Cover Database (NLCD) to identify cover types. I selected model parameters and developed habitat suitability curves based on life requisites for turkeys, results from previous research, and a Delphi process involving recognized wild turkey experts. I validated the model using input from the Delphi process and statistical tests of model output and wild turkey demographics. Because many sources of GIS input data are readily available today, biologists can use this model to examine habitat quality over time (historical) and at current conditions. The ability to document changes in habitat quality over time can help managers identify landscapes with unique management needs or opportunities. Model output, based on the most recent NLCD data (2006), suggests that the most suitable habitat for wild turkeys in Virginia occurs in the South Piedmont region and the least suitable occurs in the North Mountain region. In addition, public lands in Virginia generally are of low to moderate suitability compared to private land. I believe this model may have applicability to other wild turkey habitats in the Mid-Atlantic and Appalachian region.

Introduction

In 2011, the Virginia Department of Game and Inland Fisheries (VDGIF) stated that decision-making and long-term planning relative to wild turkey management in Virginia could be enhanced if biologists were able to more accurately assess wild turkey habitat quality. Further, having that capability nicely would complement the on-going development of a wild turkey management plan in

Virginia. Although, habitat assessment methodologies currently do exist for the eastern wild turkey (e.g., Schroeder 1985, Missouri Department of Conservation and USDA Soil Conservation Service 1988), many of these approaches do not take advantage of today's newer technologies. To take full advantage of today's technology and meet the desired objectives of the agency, I developed a new approach to wild turkey habitat assessment, one that is easy to use and provides an inexpensive method to compare habitats at multiple scales across Virginia. Model output also can be used to calculate a wild turkey index of abundance. Biologists previously calculated this index using spring turkey harvest/mile^2 of forested habitat, a metric that does not include all habitats potentially suitable for wild turkeys.

The model I developed has two distinct habitat suitability assessment components. The first model identifies habitat suitability based on how I perceive wild turkeys view terrestrial landscape features; I included every terrestrial landscape feature in the assessment. I then modified that perspective to identify viable wild turkey habitat as the agency perceives it (i.e., excluding areas deemed to be unsuitable [open water, emergent herbaceous wetlands, urban and commercial or industrial areas]). Both assessments employ a landscape-level habitat suitability model, uses a geographic information system (GIS), and focuses on habitat within a 5,167-acre area that resembles the average home range (5,189 acres; McDougal 1990) of a wild turkey in Virginia.

Methods

I followed a protocol suggested by the US Fish and Wildlife Service (1981) for development of habitat suitability index models. This protocol suggests establishing defined objectives, identifying model variables, designing the model, verifying the model, and, throughout the process until completion, documenting your work. As I developed the model, I kept in mind that the model must be relatively easy and inexpensive (e.g., data acquisition) to facilitate adoption by state agency personnel; employees are unlikely to set aside time to learn how to apply a difficult model. In the following paragraphs, I discuss the software and data used in the model and methods I employed to design and validate the model. I then discuss wild turkey life requisites, the variables that fulfill such requisites, and the suitability curves for each variable. Lastly, I explain the aggregation of such variables to calculate suitability values.

Software and Data

I used ArcGIS 10.1 (ESRI, Redlands, CA) to develop the GIS landscape-level model. I designed the habitat model using ModelBuilder, which enabled me to automate the numerous analyses necessary to assess habitat suitability. My assessment protocol uses a moving-window analysis (e.g., Focal Statistics) in ArcGIS to establish the abundance of each defined variable within an area that approximates the average home range (5,189 acres) of a wild turkey in Virginia. To achieve this desired size, my moving-window analysis incorporated an 86-cell radius, which equals 5,167 acres, the closest I could get without exceeding the desired value.

I designed the model to use the 2006 National Land Cover Database (NLCD) (Fry et al. 2011), which is produced by the United States Geological Survey (USGS) and has a spatial resolution of 30 meters. I selected the NLCD because it is cost-free, has additional datasets for 2001 (Homer et al. 2007) and 1992 (Vogelmann et al. 2001), and is likely to be updated in the future; in fact, USGS is expected to release the 2011 NLCD during winter 2014. The NLCD is compiled for the entire United States, which means biologists from states with similar attributes as Virginia could apply the model in its current form, or modify the model for use in different landscapes, but still using NLCD inputs. I eliminated other potential data sources (i.e., US Forest Service Forest Inventory and Analysis data) from consideration because privacy restrictions made obtaining statewide data difficult.

I obtained other data necessary to construct the model, including political and public land boundaries, from a variety of sources (Table 3-1) and, from those, created additional data layers that focused on agency administration units (e.g., regions, districts, counties open to turkey harvest) to provide users the ability to 'extract' tailored output from the model based on their specific interests.

Because the NLCD used different classification matrices in 1992 from those used subsequently (see Figure 3-1), I needed to reconcile disparities between the databases being used. To assure some level of comparabilitity, I regrouped forested and open land classifications used in the model. From the 1992, NLCD database, forested land cover includes deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands categories, whereas open land cover includes orchards/vineyards/others, grassland/herbaceous, pasture/hay, row crops, small grains, and fallow. Habitats deemed unsuitable for wild turkeys includes low intensity residential, high intensity residential, commercial/industrial/transportation, bare rock/sand/clay, quarries/strip mines/gravel pits, transitional, urban/recreational grasses, and emergent herbaceous wetlands. Beginning with the 2001 and subsequent NLCD databases, forested land cover includes deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands categories, whereas open land cover includes grasslands/herbaceous, hay/pasture, and cultivated crop categories. Habitat deemed unsuitable for wild turkeys in these later years includes developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity; barren land; and emergent herbaceous wetlands categories. I ignored the presence of water when calculating habitat suitability, but I generated a layer featuring water bodies for visual reference in all years.

The entity that developed the NLCD has conducted periodic assessments of its accuracy to provide users an estimate of classification data error. Because I reconfigured some of the land use types used in the NLCD to improve consistency in how I was using these data across years, I developed my own error matrices for each available year of the NLCD for wild turkeys (forest, open, unsuitable habitat), I condensed the 16 class error matrices to represent 3 classes (forested, open, and unsuitable) for each year of available data (1992, 2001, 2006) to represent habitat important to wild turkeys. Accuracy estimates for each year of the NLCD, as reclassified, were as follows: 2006 - 92% (Table 3-2), 2001 - 92% (Table 3-3), and 1992 - 74% (Table 3-4).

Reclassifying the NLCD to represent wild turkey habitat classifications (open, forested, unsuitable) increased the accuracy of the data. Researchers from various agencies collaborate to develop accuracy assessments for the NLCD; these assessments of the original NLCD are performed at two levels: Level I provides an estimate for general categories, e.g., forested, and Level II provides an estimate for specific categories, e.g., deciduous forest. The original accuracy of the 2006 NLCD was 78% for Level II (16 classes) and 84% for Level I (8 classes) (Wickham et al. 2013), and when I reclassified the data to represent wild turkey habitat, the accuracy increased to 92%. The accuracy of the 2001 NLCD prior to reclassification was 79% for Level II (16 classes) and 85% for Level I (8 classes) (Wickham et al. 2013), and again improved to 92% when reclassified for wild turkey habitat. The 1992 NLCD had lower accuracy reports, with 43% for Level II (15 classes) and 70% for Level I (6 classes) in the Mid-Atlantic region (Stehman et al. 2003). Accuracy improved slightly to 74% when reclassified for wild turkey habitat. Condensing categories improved accuracy; therefore, unless researchers have interest in a specific land cover type, I suggest that users keep categories as general as possible. The data for use in the habitat model is relatively accurate; therefore, little confusion should exist within the data when differentiating between forest, open, and unsuitable habitats.

Model Development

In addition to reviewing wild turkey habitat requirements and other habitat assessments, I employed the Delphi method to aid in selecting variables and modifying the model to assess wild turkey habitat reasonably. The Delphi method is an excellent tool to use when only expert knowledge is available, e.g., developing an expert opinion habitat suitability model (US Fish and Wildlife Service 1987). The members selected for participation in this study provided valuable feedback during two surveys and a response to an informal email. The first survey focused on the specific requirements of wild turkeys and the second survey asked the experts to evaluate habitat suitability of selected tracts using aerial imagery provided. The last contact with the panel of experts included an informal email soliciting their input to assist with calibrating the habitat suitability curves; because I used this contact as a means to validate the model, I discuss the outcome in the *Results* section.

The first survey asked participants to identify appropriate ratios and percentages of specific cover types for wild turkeys, what they consider are important habitat components, and distances wild turkeys will travel to access these components. This information helped me determine what variables were appropriate to assess (assuming data were available at the landscape-scale), and provided a starting point to establish optimal values for habitat suitability curves.

In the second survey, I asked participants to judge suitability for wild turkey broods, adults, and the overall suitability for all wild turkeys based on imagery and summary habitat data (e.g., % forested) I provided. I selected 12 random areas in Virginia where imagery was available (3 areas in each of the 4 VDGIF administrative regions). To ensure diversity, I used output from the draft habitat suitability model and purposefully selected areas that would have high and low suitability. I compared and contrasted the mean opinions provided by experts on habitat suitability for the selected tracts with output produced by my landscape-level habitat suitability model Table 3-5).

I then correlated mean suitability value identified by the expert panel for wild turkey broods, adults, and the overall suitability for all wild turkeys with the mean habitat suitability based on the draft habitat model (r_s=0.78, p<0.0001; Figure 3-2). Based on the disparity in expert opinion and model output for urban and rural samples, I determined that the draft habitat suitability model was over-emphasizing the quality of habitat. I modified the classification of cover types to adjust the calculated suitability value, and correlated the mean habitat suitability identified by the expert panel with the revised habitat suitability model output (r_s=0.85, p<0.0001; Figure 3-3). Initially, a first draft of the habitat suitability model included 'developed – low intensity' as a forested cover type and 'developed – open' as an open cover type; I reclassified both of these cover types to unsuitable habitat for wild turkeys. My final NLCD classification restricted forested cover to include deciduous forest, evergreen forest, mixed forest, shrub/scrub, and woody wetlands, and open cover only includes hay/pasture, grassland/herbaceous, and cultivated crops.

Model Validation

Model validation is essential to ensure users can draw appropriate assumptions from the model output. I used the Delphi method (as previously mentioned) and a comparison of model output with other demographic data for wild turkeys as a means to validate the model.

I compared the model's mean overall habitat suitability output with an index of wild turkey abundance, derived from spring harvest estimates and the number of square miles of habitat (using forested habitat and total suitable habitat) for each county in Virginia. VDGIF and other state fish and wildlife agencies use wild turkey harvest data based on the square miles of forested habitat to provide a measure of abundance, however this likely does not represent true turkey habitat. Therefore, I also used wild turkey harvest data and the total square miles of suitable habitat, produced by the model, to calculate turkey abundance. I used both forested habitat and total suitable habitat to calculate independent indices of abundance; even though forested habitat may not be the best representation of true turkey habitat, an index of abundance calculated with suitable habitat should correlate to some degree with mean HSI values based on suitable habitat. I hypothesized that significant correlation existed between this index of abundance (harvest/sq mi of habitat) and habitat suitability. Because the data are non-parametric, I used Spearman's rank correlation to compare these variables. I used JMP 10.0.2 (SAS Institute, Cary, NC) to perform statistical tests. I also used Blossom statistical software 2008.04.02 (Fort Collins Science Center, US Geological Survey, Fort Collins, CO) to perform a quantile regression to explore the data further.

In reality, though, other factors (e.g., predation, disease, hunting) may be influencing turkey abundance aside from habitat suitability alone. Further, studies have shown that harvest rates can be a reliable index of the population (Lint et al. 1995, Healy and Powell 1999), and other researchers testing habitat models have used this metric to identify suitable habitat types (Glennon and Porter 1999, Goetz and Porter 2005). However, harvest rates are dependent on hunter effort, which is not consistent over time or across the landscape.

Therefore, as suggested by VanHorne (1983), I incorporated production data along with an index of abundance. Unfortunately, based on current available data, I can investigate abundance and production, but not survival. Brood surveys and gobbling counts provide productivity and abundance data (Healy and Powell 1999). I hypothesized that a significant relationship existed between production and habitat suitability for reproduction and recruitment. To do so, I examined the relationship between habitat suitability obtained from the reproduction and recruitment life requisite with VDGIF's wild turkey production index, which is derived from the total number of juvenile turkeys harvested compared to total number of adult hen wild turkeys harvested in the fall. Specifically, I used Spearman's rank correlation to compare the 5-year production average for 1992 (1990-1994), 2001 (1999-2003), and 2006 (2004-2008) for each physiographic region (Figure 3-4) with the model's output for mean habitat suitability for the reproduction and recruitment life requisite of each physiographic region in Virginia.

To address turkey abundance, I compared the habitat suitability values for each physiographic region in 2001 and 2006 using 3-year mean number of wild turkey observations for each physiographic region for 2001 (2000, 2001, 2002) and 2006 (2005, 2006, 2007) with data generated from VDGIF's annual bowhunter survey. This voluntary survey asks bowhunters to record the number of turkeys observed while hunting during the archery deer season. Data prior to 2000 are not unavailable, so I excluded them from analysis. I used Spearman's rank correlation to assess the relationship between variables. I hypothesized a significant relationship existed between turkey observations and overall habitat suitability.

Another method of estimating turkey abundance includes using gobbler count data (gobbles heard per hour) obtained from VDGIF's Spring Gobbler Survey. This survey asks spring gobbler turkey hunters to record the total number of turkeys heard gobbling each day they hunt. I compared the 5-year average, where applicable, of the number of gobblers heard per hour hunting for each region for 1992 (1991-1994), 2001 (1999-2003), and 2006 (2004-2008) with the HSI data for each physiographic region in 1992, 2001, and 2006. I could not obtain data prior to 1991. I used Spearman's rank correlation to assess the relationship between gobbles heard per hour and overall habitat suitability. I hypothesized that a significant relationship existed between habitat suitability and the number of turkeys heard gobbling. There are issues here, though – turkey hunters typically do not hunt in areas where turkeys are low in abundance. However, I believe analysis of this data aggregated at a regional scale is appropriate.

As a final means to validate the model, I explored the relationship between hunter success and habitat suitability. VDGIF obtains this data from the Hunter Survey and, for this survey, VDGIF defines hunter success as the percentage of hunters that harvest a turkey during the spring gobbler season. VDGIF strives to distribute a Hunter Survey annually, but due to lapses in funding, the actual years VDGIF distributed the survey varies. Using this data, I compared the mean percent of successful spring turkey hunters for each physiographic region for 1992 (1993-1994), 2001 (1999-2001), and 2006 (2005-2007) with the habitat suitability for each region in 1992, 2001, and 2006. Similar to other comparisons, I also used Spearman's rank correlation to observe the relationship between hunter success and habitat suitability. I hypothesized that a significant relationship existed between habitat suitability and hunter success.

Wild Turkey Life Requisites

To be an effective model, it must be based on essential habitat requirements relevant to the animal in question (e.g., food, water, shelter, and special needs [Leopold 1986]). I examined, evaluated, and incorporated food, shelter, and special needs requisites of eastern wild turkeys in the habitat suitability model I constructed. I excluded water from my Virginia assessment model, based on research that suggests that wild turkeys fulfill their necessary water requirements primarily from their food resources they consume, but I recognize that water may be an important requisite in other geographic areas, especially those that experience extremely dry conditions (Hurst 1992, Wunz and Pack 1992).

Based on my review of turkey life requisites, wild turkeys have different needs as broods than as adults. Therefore, I determined I should address adult food and cover needs separate from habitat requirements for successful turkey reproduction and recruitment of broods (Figure 3-5). In the next section, I discuss life requisites of wild turkeys, variables that satisfy those requisites, and the suitability curves of such variables.

Adult Food and Cover Life Requisite

Food

Wild turkeys feed opportunistically on a variety of items, but their main source of food is hard mast produced by deciduous trees; therefore, the abundance of mature hard mast producing trees is important. However, the species of trees also are important. Wild turkeys prefer the acorns of northern red (*Quercus rubra*) and white oaks (*Q. alba*) over those produced by other oaks and the mast produced by other hardwood species (e.g., mockernut hickory [*Carya tomentosa*], black walnut [*Juglans nigra]*) (Minser et al. 1995). Also, having a variety of red and white oak species present adds habitat value. Late spring frosts can damage acorn production, but the effects of that damage vary by species. Because white oak acorns require only one year to mature, the effect of frost damage will be observed in the year damage occurs. With red oaks, where mast develops over a 2-year period, there can be a delayed carry-over effect from frost damage that results in pronounced mast shortages in areas where only red oak species are present (Dickson 1990). However, in mixed species stands, if white oaks fail to produce an acorn crop, red oaks may produce at least some mast due to their 2-year cycle.

Soft mast also represents an important food resource for wild turkeys. Important soft mast species include dogwood (*Cornus spp.*), grape (*Vitus spp.*), blueberry (*Vaccinium spp.*), and pokeweed

(*Phytolacca* spp.). Korschgen (1967) noted that the fruits of dogwoods were the second most commonly occurring food item found in turkey crops, after acorns. Soft mast items may attract wild turkeys to an area, particularly if hard mast is scarce.

Wild turkeys also are attracted to agricultural areas due to the potential food resource benefits they realize there, either from the agricultural products being grown or the insect communities associated with crop production (for brood "bugging" purposes). Wild turkeys will feed directly upon grain crops (i.e., corn, wheat, oats), scavenge for spilled grains left in a field after harvesting, and pluck undigested corn kernels from cattle manure. In winter, wild turkeys use agricultural areas (e.g., harvested fields, dairy farms) as sources of supplemental food, especially where hard mast crops are poor or unattainable (hard packed snow). During difficult times, wild turkeys often stay in areas where residual grain is available.

Cover

Wild turkeys select roost sites based on a variety of factors, including tree species, structure, aspect, and proximity to water. Generally, wild turkeys require mature trees, particularly conifers, for roosting. Conifers situated on northeastern-facing slopes protect roosting birds from prevailing winds and enable them to regulate body temperature more effectively (Porter 1992). Without suitable roost habitat available, wild turkeys will move to other places to roost and feed, particularly during harsh winter weather.

Adult Food and Cover Variables

Modeling the suitability of herbaceous vegetation, agricultural crops, and hard and soft mast resources available to wild turkeys at the landscape-scale on both public and private lands is difficult. Direct estimates of the abundance of herbaceous vegetation are not available, so I used surrogate metrics. Also, details on the specific types of agricultural crops being grown, field condition (i.e., fallow, tilled, abandoned), and identity of soft mast resources present cannot be discerned easily from available remote sensing data. Currently, it is impossible to quantify directly the abundance of hard mast producing trees across Virginia because forest stand data (including age and specific species) provided in the Forest Inventory and Analysis database is available publically for only US Forest Service and other public lands; no other datasets exist that characterize tree age and species statewide. Given these limitations, I relied on land use cover type data from the NLCD to model adult food resources.

I used forested cover types from the NLCD to serve as a surrogate for hard and soft mast presence. I identified the presence of forested cover using the NLCD in variable 1, which represents the

% of area in forested cover types (V_f). Forested cover types include deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands. Habitat deemed as "excellent" for wild turkeys would exhibit 70-80% of the area in these forested cover types (Figure 3-6). I believe that 0% of the area in forested cover would represent no value to wild turkeys, however, the suitability increases by 0.01 until reaching 10% of the area in forested cover. After 10%, the presence of forested cover provides more value for wild turkeys and increases at a more rapid rate until reaching the optimal value. I also assumed that areas consisting of 100% forested cover would provide a suitability value of only 0.5 (on a scale of 0-1) for wild turkeys, as open cover is not present and habitat to support all needs of wild turkeys (e.g., poults, other adult food sources, nesting habitat) does not exist.

Variable 1 also is used to evaluate roost habitat quality for wild turkeys (Figure 3-6). As noted earlier, data on tree age are not available for much of Virginia's public and private lands; therefore, one's inability to accuracy assess tree age statewide impedes the evaluation of habitat suitability related to roosting requirements of wild turkeys. Currently available databases only allow identification of stand composition by predominant tree species based on the type of forest (deciduous, mixed, or evergreen), as reflected in land cover types from NLCD. Aggregating all forested cover types together represents a useful metric of potential roost habitat because areas classified as deciduous forest likely contain some conifer trees, but an amount insufficient to be classified in the NLCD as coniferous forest.

I also used herbaceous cover types from the NLCD to serve as substitutes in identifying other wild turkey foods, including soft mast, seeds, agricultural crops, and insects. I identified the abundance of herbaceous cover types in variable 2, the % of area in open cover types (V_o). These open cover types include grasslands/herbaceous, hay/pasture, and cultivated crops. Turkey habitat considered "excellent" would have 20-30% of the area in these open cover types (Figure 3-7). This suitability curve is the inverse of the curve for V_f. I assigned areas providing no open cover a suitability value of 0.5, as these areas do not provide habitat necessary to support all of the activities of wild turkeys. Areas consisting of ≥90% open cover provide less value for turkeys because ample amounts of forest then are not available. Ninety percent of a wild turkey's home range in this open condition would constitute approximately 4,650 acres in open cover and approximately 517 acres in forested cover.

Reproduction and Recruitment Life Requisite

<u>Nesting Habitat</u>

Wild turkeys select nesting sites in areas where vegetation obstructs the horizontal line-of-sight exposure of hens to potential predators. Although wild turkeys may attempt to nest in a variety of habitats, those characterized by dense herbaceous edges provide high quality cover. Potential nesting habitat includes herbaceous patches along disturbed forested habitats, such as the edges of a clearcut, an open field, gated roads, and utility right-of-ways. Hens also use areas of dense woody regeneration (i.e., 2-5 year old clearcuts). Nesting areas are important because, without quality nesting habitat, population growth will be limited and the likelihood of predation and nest abandonment may be high.

The height of vegetation cannot be determined reliably from satellite or remote sensed data and other sources of this data in GIS format do not exist for Virginia. However, I can assess nesting cover by locating and measuring ecotones along forest openings. In New York, researchers used estimates of edge created along forest and field interfaces as a surrogate for nesting cover in a landscape-scale turkey habitat model (Glennon and Porter 1999). This edge metric identifies areas where sunlight may penetrate to the forest floor, stimulating understory growth. Within forest stands, thin spots or gaps in the forest canopy also allow sunlight to reach the forest floor, stimulating new understory development. However, the NLCD tree canopy database does not identify thin spots in the canopy at the landscape-scale.

I quantified potential nesting habitat using NLCD data to identify areas where forested (i.e., deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands) and open cover (i.e., grassland/herbaceous, hay/pasture, and cultivated crops) types are adjacent. From this, I created a new variable 3, which is the % of area in edge (V_e). Habitat deemed “excellent” for nesting would exhibit >20% of the area in edge (Figure 3-8). I estimated at least 20% in edge would provide sufficient edge habitat for wild turkeys (approximately 1,000 acres). I do not believe there is a maximum amount or too much edge for nesting purposes. However, even if edge is not present (0% of area in edge), the area still can provide some suitable habitat for nesting (suitability value of 0.1); wild turkeys do not require edge habitat, but the availability of edge can provide better quality nesting habitat. Using this approach, I recognize that certain habitats known to be used by turkeys (e.g., gated woods roads) may not be assessed well by use of the NLCD; however, this variable, as measured, provides an appropriate index of potential nesting habitat.

Brood Range

Brood range provides critical protection and food for poults. The main components of brood range include areas of persistent understory vegetation and early succession openings, which support insect populations required for poult survival and growth. Understory vegetation provides cover for young poults that have not yet developed the ability to fly; however, vegetation in the understory or in openings must not obstruct the hen's vision. Forest openings, hay fields, and grazing pastures provide herbaceous vegetation, which supports a greater abundance of insects when compared to most herbaceous vegetation under a forest canopy. In addition, high quality brood range must have forested cover in close proximity to openings because wild turkeys use woody cover as refuge from predators. Hens with broods that feed in openings will retreat to forested cover if they feel threatened. Turkeys rarely use openings that are situated far from forested cover. Evaluating the availability of understory vegetation and openings, and the juxtaposition of forest cover to these components, is critical for quantifying brood range in habitat assessment.

I identified herbaceous areas using the NLCD to identify open cover types, but, unlike variable 2, the focus here was to identify areas that also provide useful cover in close proximity (within 150m of forested cover). Variable 4, the % of area in open cover types useful to a brood (open cover <150m from forested cover) (V_b), is obtained by examining the juxtaposition of and distance of separation between open cover types (grasslands/herbaceous, hay/pasture, and cultivated crops) and forested cover types (deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands). Areas classified as "excellent" brood habitat would exhibit 20-30% of the area in open cover and close proximity to brood cover (Figure 3-9). Areas with 0% open cover for broods still possess value (0.5) because broods obtain protein from insects found in forested cover. Areas consisting of ≥90% receive less value because these areas do not provide more than enough openings for brood range.

An assessment of brood habitat suitability also should measure the <u>potential</u> of an area to provide brood habitat (i.e., the abundance of useful brood cover [open cover <150m from forested cover] compared to the overall abundance of openings). I estimated this potential as variable 5, the % of <u>open cover</u> that is useful to a brood (open cover <150m from forested cover) (V_{ob}). This variable identifies areas that currently serve as a food source for broods and the potential of an area to provide food for broods if biologists created forested cover nearby. I used the same cover types in this variable to identify forest and open cover as in V_b (the % of area in open cover types useful to a brood). Habitat deemed as "excellent" would have >90% of the open cover providing habitat for broods (Figure 3-10), which means ≥90% of the openings already provide brood habitat. Areas where none of the openings provide brood habitat (0%) would exist where unsuitable habitat surrounds openings, yet this still would provide some value (0.4). Although broods use these areas, the lack of forested cover may increase the likelihood of predation. I assumed that, at 50% of the area in open cover useful for a brood, the suitability should represent 0.8 because this is twice as much value as an area with 0% open cover and half of the openings provide habitat for broods. At ≥90%, the suitability value should be 100% because almost all openings at this caliber provide habitat for broods.

Habitat Arrangement

Habitats that provide both nesting cover and brood range within close proximity to each other are essential to poult survival. The farther poults must travel, the more susceptible they are to predation and accidental death, which leads to lower survival and lower population growth. During the first few days after hatching, poults rely on the residual yolk for sustenance, but, after poults fully use the yolk, they must consume insects or perish.

I believe assessing the juxtaposition of all 5 variables in this habitat suitability model is not necessary because evaluation is being made on an area the size of an average home range of a wild turkey in Virginia. If all variables are present within an area, I assume wild turkeys can access these resources. However, if one or more of the variables is not present within the home range, the area will have a lower overall habitat suitability.

Aggregation of Individual Variables

To generate an overall habitat suitability value, individual suitability values for each variable must be aggregated. I combined variables based on the life requisites they satisfy adult food and cover, and reproduction and recruitment. Specifically, I combined V_f and V_o to generate a suitability value for adult food and cover (Figure 3-5). I combined V_e, V_b, and V_{ob} together because they represent requirements necessary for wild turkeys to successfully reproduce and recruit juvenile birds into the population. I used a geometric mean when aggregating all variables and life requisite suitability indices to generate the overall habitat suitability index. When using the geometric mean, the suitability value is more sensitive to low suitability index values than when using an arithmetic mean, providing a more conservative estimate.

Adult Food and Cover

The adult food and cover life requisite includes 2 distinct variables: the V_f and the V_o variables. I weighted the V_f variable more than the V_o variable, based on the fact that without forests, wild turkeys do not have access to their primary food source (hard mast) and don't have appropriate cover to escape from predation and harsh weather.

Adult Food and Cover Life Requisite Suitability Index ($LRSI_A$) = $(V_f^2 * V_o)^{1/3}$

Where:

V_f = % of area in forested cover types (deciduous forest, evergreen forest, mixed forest, shrub/scrub, and woody wetlands)

V_o = % of area in open cover types (hay/pasture, grassland/herbaceous, and cultivated crops)

Reproduction and Recruitment

The reproduction and recruitment life requisite focuses on conditions necessary for a nesting hen and her brood, so I included the V_e, the V_b, and the V_{ob} variables.

Reproduction and Recruitment Life Requisite Suitability Index ($LRSI_B$) = $(V_e*(V_b*V_{ob})^{1/2})^{1/2}$

Where:

V_e = % of area in edge habitat

V_b = % of area in open cover types that are <150m from forested cover types

V_{ob} = % of open cover types that is <150m from forest cover types

Overall HSI

Calculation of overall habitat suitability for wild turkeys in Virginia requires input on each of the 5 variables (V_f, V_o, V_e, V_b, V_{ob}). I weighted the $LRSI_B$ variable more than the $LRSI_A$ component because I believe reproduction and recruitment needs are more important to wild turkeys in Virginia. These parameters assess conditions essential to population establishment and growth.

HSI = $(LRSI_A * LRSI_B^2)^{1/3}$

Where:

$LRSI_A$ = Adult Food and Cover Life Requisite Suitability

$LRSI_B$ = Reproduction and Recruitment Life Requisite Suitability

Results

Model Validation

Delphi Method

My expert panel offered few useful comments on the draft habitat suitability curves, other than suggesting a wide range of optimal values (e.g., V_f of 50-80% would be optimal); suitability curves with wide ranges are not helpful identifying habitat for wild turkeys in Virginia, as most of the range would be considered optimal, leading to inflated characterization of optimal habitat. The purpose of this habitat suitability model is to identify areas displaying true optimal habitat, not simply areas where turkeys can survive. For this reason, I did not apply any changes.

Harvest and Demographic Data

I found correlation between turkey density and habitat suitability, but, the correlations using only forested habitat ($r_s(97)=0.34$, $p=0.0005$) and all suitable habitat ($r_s(97)=0.32$, $p=0.0016$) were weak using both density estimates (Figure 3-11). The 95% and 90% quantile regressions indicate that there are many unmeasured factors limiting wild turkey abundance (spring harvest/sq mi of suitable habitat) (Figure 3-12).

When analyzing the brood:hen ratio data, I did not observe a relationship between the reproduction and recruitment life requisite habitat suitability and wild turkey production ($r_s(14)=-0.10$, $p=0.74$; Figure 3-13).

I found a significant relationship supporting the hypothesis that association exists between wild turkey observations based on the VDGIF bowhunter survey and overall habitat suitability ($r_s(9)=0.78$, $p=0.008$; Figure 3-14).

I did not observe correlation between the number of turkeys heard gobbling per hour of hunting using data from the VDGIF Spring Gobbler Survey and overall habitat suitability ($r_s(14)=0.04$, $p=0.88$; Figure 3-15).

In my last analysis, I found relationship between the percentage of successful spring turkey hunters based on the VDGIF Hunter Survey and overall habitat suitability ($r_s(14)=0.44$, $p=0.10$; Figure 3-16).

Complete Model Output

Although users can generate various outputs from the habitat suitability model, my primary interest was to produce a map of habitat suitability statewide for each year of the NLCD (2006, 2001, and 1992) (Figure 3-17). Using the 2006 NLCD, the model found that habitat was most suitable for wild turkeys in the South Piedmont region (HSI=0.89) of Virginia (Table 3-6); habitat was least suitable in the North Mountain region (HSI=0.64).

Model results indicate slight changes in habitat suitability have occurred between the 2001 and 2006 NCLD data (Table 3-6). I did not observe notable changes in habitat suitability. The comparison of model results with the 1992 NLCD and 2006 NLCD showed mentionable changes in habitat suitability. The overall habitat suitability declined by 0.05 for both the Tidewater and North Mountain regions, and by 0.08 for the North Piedmont region. The South Piedmont region consistently exhibited the best habitat in Virginia from 1992-2006, staying stable at 0.89.

The 2006 NLCD model output for the adult food and cover life requisite habitat suitability resulted in similar findings as the overall habitat suitability; the most suitable habitat for adult food cover was in the South Piedmont (HSI=0.87) and the least suitable habitat was found in the North Mountain region (HSI=0.64) (Figure 3-18; Table 3-6).

I found minimal differences between the 2001 NLCD and the 2006 NLCD in the adult food and cover life requisite habitat suitability (Figure 3-18; Table 3-6). Also, I did not observe substantial changes in suitability when comparing the 1992 NCLD with the 2006 NLCD.

According to model output, the reproduction and recruitment life requisite habitat suitability was most suitable in the South Piedmont region (HSI=0.91) and least suitable in the North Mountain region (HSI=0.67) (Figure 3-19; Table 3-6). Other regions had suitability values in the upper 70s and low- to mid-80s for this life requisite.

Similar to other comparisons of the 2001 NLCD with the 2006 NLCD, I noticed minor changes in habitat suitability for the reproduction and recruitment life requisite (Figure 3-19; Table 3-6). Model output indicated a notable decline in suitability for the North Piedmont region (0.09), Tidewater region (0.08), and North Mountain region (0.07) from 1992 to 2006.

Reduced Model Output

Excluding areas classified as unsuitable wild turkey habitat from the suitability assessment produced slightly different output (Figure 3-20). This model eliminated much of the low suitability habitat observed in the highly developed urban areas (e.g., northern Virginia, Richmond metro area, and Hampton Roads area), as these areas are considered unsuitable habitat for wild turkeys. However, low suitability habitat still exists near the Hampton Roads area (the Great Dismal Swamp) and in the mountainous areas along and west of the Blue Ridge Mountains.

Using the 3 NLCD databases, I estimated the total amount (in square miles) of suitable habitat (suitable habitat is forested and open cover types based on the wild turkey classifications) available and I used these data to provide improved density calculations for wild turkeys: 2006 - 35,167 square miles of suitable habitat (89% of terrestrial habitat); 2001 - 35,301 square miles of suitable habitat (90% of terrestrial habitat); 1992 - 36,761 square miles of suitable habitat (93% of terrestrial habitat in Virginia). Overall, it appears that 1,594 square miles of suitable turkey habitat (4% of terrestrial habitat) has been lost since 1992. Wild turkey population status based on suitable habitat in lieu of forested habitat has provided more representative estimates of wild turkey abundance (spring turkey harvest/square miles of suitable habitat) (Figure 3-21).

Additional Model Uses

My habitat suitability model can produce other outputs. For example, output data on mean habitat suitability and wild turkey estimates of abundance (spring turkey harvest/square miles of suitable habitat) can be used to formulate population management objectives for each county, as employed by VDGIF and VT during the development of a statewide Wild Turkey Management Plan for Virginia (Figure 3-22). Counties designated for population increase had low or very low wild turkey populations based on spring harvest/square mile of suitable habitat and very low to very high habitat suitability. Counties designated as 'stabilize +' included counties where VDGIF was not striving to actively increase the population, but where populations could increase naturally; counties with this objective had moderate to high wild turkey populations and moderate to very high habitat suitability.

Biologists also can use the model to assess suitability of specific areas. For example, I assessed the suitability of the George Washington and Jefferson National Forests using the 2006 NLCD, and then compared those suitability outputs with values obtained for areas beyond the national forest boundaries; pixels on national forest lands had a mean suitability value of 0.51, whereas pixels outside the forest boundary had a mean suitability of 0.82. I also assessed the suitability of all public lands compared to private lands using the 2006 NLCD; pixels on public lands had a mean suitability value of 0.53 and pixels on private lands had a mean suitability of 0.85.

Discussion

Model Validation

Delphi method

Members of the expert panel participated with enthusiasm initially, but, as the process progressed, it appeared interest waned. The final survey I distributed had very low participation (n=3); this could have been a result of distributing the survey in the summer or the complexity involved in assessing habitat suitability curves. The feedback on the last survey also indicated that some confusion existed with the suitability modeling methodology and application of GIS technology. Given today's rate of developing new technology (e.g., data sources, new versions of GIS software), it may be difficult for busy wildlife professionals to keep up. When selecting an expert panel, researchers should consider not only the member's expertise regarding the resource of interest, but also his or her familiarity with the procedures and methods used.

Harvest and demographic data

When comparing the two different indices of turkey abundance based on spring harvest with habitat suitability, I observed a slightly stronger correlation when using forested than using suitable habitat (Figure 3-11). Further, the quantile regression indicates that other factors are at play when determining wild turkey abundance, aside from habitat suitability (Figure 3-12). I believe other factors may be affecting wild turkey abundance (i.e., predation and density dependence) and exerting influences on this relationship. Also, I am skeptical of the reliability of an index of abundance based on spring turkey harvest. The spring turkey harvest depends on hunter effort, which is not consistent across the state. Even when turkeys are present, hunters may not harvest birds if difficult terrain requires hunters to exert more energy, if access is limited (e.g., gated roads, private property), or a combination of factors occurs (e.g., as in some national forest areas). Hunting culture also may not be as prevalent in some areas of the state as others. For these reasons, this index of turkey abundance may best be suited for comparison only for long-term trends, rather than as a 'snapshot' of current turkey populations. I recommend VDGIF biologists calculate abundance using suitable habitat to ensure that all turkey habitat is considered, even though this approach did not display a strong correlation.

The lack of relationship between turkey production and the reproduction and recruitment habitat suitability (Figure 3-13) may indicate other factors are limiting production, such as density dependence or predation. In addition, factors may be affecting turkey production at a scale smaller than the regions I used. Production appears to be declining even in areas with relatively good habitat for reproduction and recruitment, which supports the notion that there may be some density-dependence occurring in wild turkey populations in Virginia (McGhee et al. 2008). Biologists should focus research to explore the limiting factors of wild turkey reproduction to determine if this correlation between production and habitat suitability indicates the model is inaccurate or if and what other factors affect wild turkey production. Future application of this metric will not be possible because VDGIF now collects production data only during an August brood survey; the agency abolished the fall feather collection due to mandated electronic checking of harvests. However, comparison of brood survey data with habitat suitability should display similar results to the comparison with feather samples.

The correlation between turkey abundance, as identified from bowhunter surveys, and habitat suitability may suggest that bowhunters are spending more time/effort in better habitats, which may confirm that other factors are influencing the comparison of turkey abundance (harvest/square mile of suitable habitat) and production. I believe it is critical for state wildlife agencies to continue administering bowhunter surveys, as they provide turkey hunter-independent data which appear to be representative of habitat suitability.

The lack of relationship between habitat suitability and the number of turkeys heard gobbling suggests other factors may influence the number of gobblers hunters hear, and the number of gobbles heard is more a function of hunter effort (Lint et al. 1995). Typically, biologists perform these call count estimates, and data are not derived from hunter surveys (i.e., VDGIF Spring Gobbler Survey); even when biologists collect the data, the data are not accurate representations of the population because a variety of factors can affect gobbling (e.g., weather, presence of hens, individual gobbler behavior) (Miller et al. 1997). Overall, I suggest state wildlife agencies should focus their efforts on collection of turkey hunter (i.e., bowhunter surveys) and hunter independent data (i.e., brood surveys administered by VDGIF staff) for accurate indices of the population.

The relationship between the percentage of successful spring turkey hunters and overall habitat suitability suggest that hunters have a better chance of harvesting a turkey in areas where better habitat exists and turkeys may be more plentiful. I am skeptical of this analysis because the mean percent of successful hunters ideally should be comprised of a 3-year average, at least, to compensate for population variation (i.e., poor hatches, low recruitment); I only used one year of data to calculate the 1992 estimate of hunter success due lapses in survey distribution. Other years, (e.g., 2006) have 3 years' worth of survey data to provide a mean estimate of hunter success. Because of these differences, I may be over or underestimating hunter success for 1992.

Complete Model Output

Overall statewide habitat suitability values produced by the model provide reasonable estimates of habitat quality for wild turkeys. Based on conversations with VDGIF biologists, the high habitat suitability for wild turkeys predicted by the model for the South Piedmont region reflects the diversity of forest and open cover types found in those areas; during 2006, this region has the most hay/pasture and herbaceous cover types (Table 3-6) in Virginia. Conversely, contiguous forest with few openings and minimal edge habitat in the George Washington National Forest and other mountainous areas are characteristic in the North Mountain region; based on Table 3-6, this region has approximately 3,683 sq. mi. of forested cover (deciduous, mixed, evergreen forest) and 1,372 sq. mi. of open cover (cultivated crops, herbaceous, hay/pasture). My observation of Figure 3-17 leads me to believe that areas with low habitat diversity in the Blue Ridge Mountains, US Forest Service properties, other mountainous areas west of the Blue Ridge, and areas with minimal forest and open cover (i.e., highly developed urban areas [northern Virginia, Richmond metro area, and Hampton Roads] are driving many of the low habitat suitability values.

Since 1992, the South Piedmont region has remained the best habitat in Virginia for wild turkeys, likely as a result of the tradition of agriculture and moderate development in the region. Declines in overall habitat suitability from 1992 to 2006 in the Tidewater and North Piedmont regions may be a result of urban sprawl, as many of Virginia's major urban areas reside in these regions. These regions have the highest amount of developed land cover types in Virginia (Table 3-7). Succession of farmland and openings to forested habitat could be driving the decline in suitability for the North Mountain region, which is supported by the -162.30 sq. mi. of hay/pasture lost since 1992 and an increase of 106.39 sq. mi. of evergreen forest and 261.32 sq. mi. of deciduous forest (Table 3-7). Much of the area in the North Mountain region also is George Washington National Forest, and forest stands that recently were harvested in 1992 would be >20 year old stands in 2006 and no longer classified as openings.

I also believe the adult food and cover life requisite component of the model appropriately assessed habitat across Virginia. The presence of good diversity in forest and open cover is responsible for the high suitability in the South Piedmont region, whereas the expansive forest (e.g., George Washington National Forest) or openings (e.g., Interstate 81 corridor, Shenandoah Valley) produces low suitability values for the North Mountain region. Across Virginia, highly developed urban areas also display low suitability values for this life requisite (Figure 3-18).

The model reasonably assessed reproduction and brood needs in Virginia. For reasons previously mentioned, the South Piedmont region exhibited the best habitat, whereas the North Mountain region exhibited the least suitable habitat. I believe the lack of open and edge habitat in urban areas, the Blue Ridge Mountains, George Washington and Jefferson National Forest, and other mountainous areas west of the Blue Ridge caused the low reproduction and recruitment suitability of the habitat (Figure 3-19).

The comparison of habitat suitability for the reproduction and recruitment life requisite leads me to believe that the decline in suitability from 1992 to 2006 is a result of urban expansion and reduction of open habitat in the North Piedmont, Tidewater, and North Mountain regions, based on data previously mentioned from Table 3-7. Expansion of urban areas negatively affects wild turkey habitat as habitat changes from forested or open to unsuitable habitat for wild turkeys. Based on conversations with VDGIF biologists, wild turkey populations in the central North Piedmont are having difficulty prospering, which based on model output, could be a result of declining reproduction and recruitment habitat suitability.

Reduced Model Output

The modified version of the habitat model enables biologists to calculate habitat suitability independent of the effects of unsuitable habitat. This provides biologists with an estimate of habitat suitability for areas where the agency actually can employ management actions and provide hunting opportunities; turkey hunting is prohibited in most cities in Virginia. Areas with expansive tracts of unsuitable habitat will display large differences in the habitat suitability as calculated by the complete model and reduced model; the negative effects of unsuitable habitat in an area will not be considered in calculating the suitability using the reduced model, thus these areas will display a higher suitability value when assessed with the reduced model.

The ability to calculate an improved density estimate for wild turkeys is important because biologists previously limited classifying suitable habitat only to forested areas, which is not representative of all turkey habitat. Using the 2006 NLCD, I identified approximately 25,978 square miles of forested cover (66% of terrestrial habitat), but estimated approximately 35,167 square miles (89% of terrestrial habitat) as suitable habitat (both open and forested cover). Using only forested cover clearly underestimates turkey habitat, and when applied with total number of turkeys harvested, does not provide an accurate index of turkey abundance. Using this broader estimate of suitable turkey habitat, I estimated that Virginia has lost 1,594 square miles of suitable turkey habitat (4% of terrestrial habitat) since 1992. VDGIF biologists should continue to apply the habitat model with new NLCD to monitor habitat loss. VDGIF also should conduct further research to identify specific areas and causes of habitat loss.

Additional Model Uses

The ability to produce population objectives as part of the planning process used to develop and update the Virginia Wild Turkey Management Plan gives the VDGIF credibility, and shows stakeholders that objectives are not being based on politics or value judgments of the agency. Agency staff can defend population objectives with scientific data, thereby strengthening discussions of objectives with stakeholders or agency board members.

Further application of the model to areas of specific interest can aid managers in achieving such population objectives by identifying poor habitats and targeting areas for habitat improvement. For example, based on model output, one could argue that habitat improvement practices on public lands should be a primary focus for management action (using 2006 data, all public land HSI = 0.54, private land HSI = 0.83).

Appropriate Model Use

Users must apply the habitat model correctly to produce accurate and meaningful results. Appropriate use of the model includes applying it only to large areas. Wild turkey home range data should be used to guide the size of the area to assess; however, this area should not be <1,000 acres. Assessing areas that do not represent wild turkey home ranges (i.e., 50 acre farm) with the model can result in misinterpretations of the output, as the model will not calculate variables at the appropriate scale. I suggest that users apply this model at the statewide scale first, and then extract suitability information relevant to administrative regions and districts, or other areas of interest. This should ensure appropriate assessments of variables across the landscape.

Users also should properly identify their specific objectives; if users desire to assess habitat on a small tract (<1,000 acres), he or she should refrain from using this habitat suitability model and instead use a rapid habitat appraisal tool to assess wild turkey habitat (Morris et al., unpublished report). A rapid habitat appraisal tool requires a physical site visit to the area of interest and an evaluation of the land surrounding the area of interest using aerial imagery. Ideally, these two steps should be used in conjunction; first the landscape-level model should be applied to identify the areas requiring further investigation, and second, the rapid appraisal tool should be applied at the patch scale to identify what the factors are limiting or promoting the habitat suitability. The rapid appraisal tool would be particularly useful for assessing the habitat suitability of areas for potential purchase by the agency and for private landowners with an interest in wild turkey habitat management.

Synthesis

The model suggests that the best wild turkey habitat in Virginia exists in the South Piedmont region and in areas with a diversity of forest and open cover types. Poor wild turkey habitat occurs in the North Mountain region, and other mountainous and urban areas. Public lands also exhibit low quality habitat compared to private lands. Using this information and focusing on adult and brood life requisites, wildlife managers can prescribe management strategies to address limiting factors. Additionally, managers should investigate these areas further by applying the rapid habitat appraisal tool to aid in identifying site-specific habitat limitations.

I also observed a decline in habitat suitability over time in the North Piedmont, Tidewater, and North Mountain regions and surrounding urban areas. I recommend that VDGIF identify factors driving these habitat suitability changes. Identification of these factors also will provide insight into habitat loss, which is the prime focus of all wildlife managers, regardless of the species.

I believe the habitat suitability model reasonably assesses habitat for wild turkeys, but I believe biologists should continue to test model output with turkey population indices. State agencies should continue to collect turkey hunter independent data (e.g., turkey abundance from bowhunter survey) and hunter independent data (e.g., brood surveys administered by VDGIF staff) to apply with model output, as these data provide valuable indices of production and populations.

In conclusion, the development and application of this model provides biologists a valuable tool to assess the quality of habitat for wild turkey at the landscape-scale in Virginia. Biologists can identify changes in habitat and potential factors (e.g., brood habitat) that may be limiting or promoting wild turkey populations in the state. I believe this model also has value outside of Virginia, particularly areas in the Mid-Atlantic and Appalachian region.

Chapter 3B:
A rapid habitat appraisal tool for the eastern wild turkey in Virginia

Abstract

To provide a standardized method of assessing wild turkey habitat, I developed a 2-step, geographic information system (GIS)-based habitat suitability assessment that uses available GIS datasets to assess eastern wild turkey habitat (*Meleagris gallopavo silvestris*) in Virginia. The first level of assessment examines habitat at the landscape-level, using the average home range (5,189 acres) of a wild turkey in VA to define landscape scale; the second level applies a rapid habitat appraisal tool that uses aerial imagery and data from a site visit to assess habitats of <1,000 acres. I designed this rapid appraisal with the intent that it would be applied on the area of interest via a site visit, and also beyond the area of interest using aerial imagery. I developed the rapid appraisal to function with high quality, (1:15,000 scale) imagery for assessment of parameters that users cannot observe during a site visit. I formed the rapid habitat appraisal tool based on life requisites for wild turkeys, previous research, and a Delphi process involving recognized wild turkey experts. I validated the tool by applying it on 12 sites across different physiographic regions of Virginia and comparing the results with the suitability indices generated from the landscape-level habitat model. This tool enables biologists to assess habitat quantitatively and provides a standardized means of assessing habitat over time. Biologists can monitor areas and determine if the habitat management successfully has improved suitability for wild turkeys. In addition to Virginia, this rapid habitat assessment may have applicability to other wild turkey habitats in the Mid-Atlantic and Appalachian regions.

Introduction

Biologists must consider the effects of habitat quality when assessing wildlife populations and selecting management strategies. The ability to quantify habitat quality enables biologists to identify limiting habitat factors or, if optimal habitat exists, eliminate habitat quality as a factor negatively affecting the population. In 2011, the Virginia Department of Game and Inland Fisheries (VDGIF) identified a need to assess wild turkey habitat in Virginia. Specifically, the VDGIF desired a tool to assess wild turkey habitat with a more specific focus on areas the agency typically can practice management activities (e.g., areas excluding urban development). Although habitat assessment methodology existed for the eastern wild turkey (Schroeder 1985, Missouri Department of Conservation and USDA Soil Conservation Service 1988), I developed a new version of eastern wild turkey habitat assessment to take advantage of today's technology and to meet the desired objectives of the agency. I determined an appropriate assessment of habitat for wild turkeys must consider habitat requirements at two different scales. I developed a two-step comprehensive habitat assessment: the first step includes a landscape-level habitat suitability model for the wild turkey (Morris et al., unpublished report), and the second step focuses on a patch-scale rapid habitat appraisal tool.

Prior to the development of this tool, biologists often assessed habitat for wild turkeys based on undefined criteria and personal opinion without a clear scientific foundation. This rapid habitat appraisal tool enables biologists to quantitatively assess relatively small tracts of land (<1,000 acres) and provide a standardized method to assess habitat. For example, the habitat suitability indices will be comparable if a biologist assesses an area of interest using the appraisal tool in 2013, and if a different biologist assesses the same site with the appraisal tool in 2020. In addition to assessing habitat and identifying limiting factors, I also provided suggestions to improve habitat for wild turkeys in the assessment.

In the next section, I first address the techniques for developing and requirements for applying the habitat appraisal tool. Then, I discuss habitat requirements of wild turkeys and the appraisal tool variables that evaluate them.

Methods

I performed a literature review of wild turkey habitat requirements, looked at other wild turkey habitat assessments, and obtained assistance from an expert panel to develop this habitat appraisal tool. I produced this tool in conjunction with the development of a landscape-level habitat suitability model for the wild turkey in Virginia, therefore I utilized the Delphi method (the same process used in the landscape-level model) to establish variables for the rapid appraisal tool. The Delphi method is an iterative process of obtaining input from a group of individuals and providing them with complied information generated from the group's original responses (US Fish and Wildlife Service 1987). I initially contacted 7 individuals with expertise in wild turkey biology to obtain general information about wild turkey habitat and to identify appropriate variables at the landscape-level. Variables considered as inappropriate at the landscape-level (e.g., data unavailable, too detailed to measure at such scale) were considered potential variables for inclusion in the rapid appraisal tool. My final contact with the panel solicited their feedback on optimal values for the variables, specifically the habitat suitability curves in the landscape-level habitat suitability model. I included some of the variables (e.g., percent of the area in open cover types) in both the landscape and patch level assessments.

Scale

I developed the habitat appraisal to be applied on the area of interest (AOI) (i.e., wildlife management area, private land) and also on the area encompassed by a 1-mile radius from the center of the AOI. This allows the biologist to assess the AOI, and also consider the habitat surrounding the AOI. The average home range of a wild turkey in Virginia is 5,189 acres (McDougal 1990); therefore, I included an assessment of habitat quality beyond the AOI. In Virginia, the average size of a farm is 171 acres (USDA National Agricultural Statistics Service 2009) and 89% of forested land parcels owned by private owners is <50 acres (Rose 2009). Therefore, it is essential that the appraisal includes not only the AOI, which has a high probably of being a small tract compared to a turkey's home range, but also the surrounding land.

Software and Data

Recent, high quality aerial imagery (suggested scale 1:15,000) is required to perform the appraisal, with a preference for leaf-off imagery. I obtained imagery for Virginia from the Virginia Base Mapping Program (VBMP) (Virginia Information Technologies Agency, Chester, VA). The VBMP imagery is free and accessible through multiple servers. I used ArcGIS 10.1 (ESRI, Redlands, CA) to view the imagery. Biologists also can use Google Earth (Google Inc., Mountain View, CA) software to view the imagery, however I advise them to use ArcGIS. ArcGIS enables the user to create a grid (e.g., Create Fishnet) to assist in calculating the abundance of specific variables and to perform other functions (e.g., place waypoints, overlay other layers). Google Earth does not provide information regarding the scale nor provide options to perform tasks previously mentioned.

Wild Turkey Habitat Requirements and Variables

When selecting variables for the assessment, I kept the original intent of the appraisal in mind: rapid use and items that can be assessed using imagery or during a site visit. Within the AOI, variables can be determined accurately with a site visit. However, access to all adjoining land within a 1-mi radius from the center of the AOI may be limited; therefore, the assessment beyond the AOI only will utilize aerial imagery. With this in mind, I ensured that assessment of variables beyond the AOI would focus on things that can be observed with confidence from the imagery.

Adult Food

Wild turkeys feed opportunistically on a variety of items, including >300 plants species and >75 animal species (Korschgen 1967), but their main source of food is hard mast produced by deciduous trees; therefore, the abundance of mature hard mast producing trees is important. Users could assess the maturity of trees by measuring the DBH of numerous trees and obtaining an average, but this would be too time consuming. Rather than assessing the size of each tree, biologists can estimate the number of mature mast producing trees in the area. Most biologists should have a general idea what a mature tree is, but if not, information presented in the user's guide for this appraisal tool outlines the specifications. For example, Healy and McShea (2002) suggest a minimum of 30cm DBH for mast producing stands.

Question #1 of the protocol asks users to estimate the percentage of mature mast producing trees in the area. I weighted this question (maximum of 6 points) more than others in the food components and beyond because of the importance of mast for wild turkeys (Figure 3-23). I classified an area as "excellent" habitat if 70-100% of the area contained mature hard mast producing deciduous trees. If no hard mast deciduous trees are present within the AOI, users can supplement the suitability by assessing the presence of deciduous trees within a 1-mi radius from the center of the AOI. This provides an estimate of the potential of mature mast producing trees, and potential food, in the surrounding area.

Wild turkeys also exhibit preferences for different types of hard mast species. Wild turkeys prefer the acorns of northern red (*Quercus rubra*) and white oaks (*Q. alba*) over those produced by other oaks and the mast produced by other hardwood species (e.g., mockernut hickory [*Carya tomentosa*], black walnut [*Juglans nigra]*) (Minser et al. 1995). Also, having a variety of red and white oak species present in the AOI adds habitat value. Late spring frosts can damage acorn production, but the effects of that damage vary by species. Because white oak acorns require only one year to mature, the effect of frost damage will be observed in the year damage occurs. With red oaks, where mast develops over a 2-year period, there can be a delayed carry-over effect from frost damage that results in pronounced mast shortages in areas where only red oak species are present (Dickson 1990). However, in mixed species stands, if white oaks fail to produce an acorn crop, red oaks may produce at least some mast due to their 2-year cycle. Ideally, the user should identify the percentage of the deciduous stand in white and red oak groups, but estimating this requires a substantial effort. Also, white and red oak species may grow in the same area, making estimating percentages difficult. Instead, the user can estimate the variety of mast species present on the property, with a focus on white and red oak groups, while walking through the property assessing other variables.

Question #2 asks users to assess the variety of mast producing trees (Figure 3-23). Users identify the number of mast producing species present: ≥2 species, one of each being from the red oak group and white oak group (one of which must be [*Quercus alba]*), ≥2 species, one of each being from the red oak group and white oak group, 1 species from either the red or white oak groups, or no oaks are present. An excellent area has >2 oak species present, including white oak (*Quercus alba)* and a species from the red oak group. I weighted this question moderately (maximum of 3 points). A method to identify oak species with confidence using aerial imagery is not available, therefore the user cannot assess the suitability of areas beyond the AOI using aerial imagery to supplement this suitability value. Assessing the variety of oaks or the abundance of mast producing deciduous species cannot be performed using aerial imagery because, at this level, trees can be distinguished only as deciduous vs. coniferous.

Soft mast also represents an important food resource for wild turkeys. Important soft mast species include dogwood (*Cornus spp.*), grape (*Vitus spp.*), blueberry (*Vaccinium spp.*), and pokeweed (*Phytolacca* spp.*)*. Korschgen (1967) noted that the fruits of dogwoods were the second most commonly occurring food item found in turkey crops, after acorns. Soft mast items may attract wild turkeys to an area, particularly if hard mast is scarce. Any metric of measuring abundance may be difficult, as certain species may not be noticeable during the winter months (e.g., American pokeweed); therefore, I only focused on assessing the presence or absence of soft mast.

Question #3 addresses the presence of soft mast in the area (Figure 3-23). I weighted question #3 moderately (maximum of 3 points). Excellent habitat would have soft mast present. Soft mast species cannot successfully be identified using aerial imagery, therefore no method exists to supplement the suitability value if soft mast isn’t present within the AOI. These assessments require field verification and, like question #2, users cannot identify resources outside the AOI to supplement a poor rating within the AOI due to limitations on field verification.

Wild turkeys also are attracted to agricultural areas due to the potential food resource benefits they realize there, either from the agricultural products being grown or the insect communities associated with crop production (for brood “bugging” purposes). Wild turkeys will consume grain crops (i.e., corn, wheat, oats), scavenge for spilled grains left in a field after harvesting, damage round bales, and pluck undigested corn kernels from cattle manure. In winter, wild turkeys use agricultural areas as sources of supplemental food, especially where hard mast crops are poor or unattainable (hard packed snow). Only identifying the abundance of all agricultural areas inadvertently includes agricultural products that turkeys may not readily consume (e.g., tobacco). However, identifying the presence of grain crops represents the agricultural food sources turkeys will consume. Even if these areas currently are not established, the owner of the property would be able to provide information on future plans or past land use.

Question #4 assesses the presence of grain crops for adult consumption (Figure 3-23). I rated this question as least important (maximum of 2 points) of all questions, even though cropland would provide excellent wild turkey habitat. If the AOI does not have grain crops present, there is no means to identify grain crops outside of the AOI using imagery and supplement the suitability value. These croplands would resemble herbaceous openings using imagery; therefore it is best to address only the presence of herbaceous openings within the AOI.

Brood Range

Poults require sufficient protein in the diet to grow properly and mature into adults, and they derive most of their protein needs from insects they consume. Insects thrive in herbaceous openings, including managed hay fields, cattle grazing areas, abandoned fields, utility right-of-ways, young clear cuts, recently burned areas, and grasslands. Adult turkeys also frequent these early succession areas to feed on the abundant insects, seeds, and soft mast that often occur there. These different types of openings may provide different values for turkeys, but analysis at that scale will not provide a rapid assessment. Herbaceous areas are best assessed by their abundance, rather than calculating the abundance for specific types (e.g., old fields vs. grazing fields). Therefore, I determined it is most appropriate to calculate the abundance of all herbaceous areas, regardless of type.

I designed question #5 to assess the abundance of herbaceous openings within the AOI, which can be performed by a site visit or by using aerial imagery (Figure 3-23). I weighted this question heavily (maximum of 6 points) due to the importance of openings for food for poults and adults. Excellent wild turkey habitat would have 20-30% of the area in herbaceous openings. Because users may be calculating the percent in herbaceous openings with aerial imagery (as suggested), instead of raster land cover data, creating a dot grid using GIS may prove helpful for the user to estimate the percentage of herbaceous openings in the AOI. Users should keep in mind that forested areas with herbaceous understories that provide excellent brood habitat may not be observable using imagery and, if present during a site visit, will need to be included in the suitability. If the suitability of the AOI is poor for question #5, users can supplement the suitability rating by assessing the presence of herbaceous openings within a 1-mi radius from the center of the AOI, as determined from aerial imagery.

Nesting Habitat

Wild turkeys select nesting sites in areas where vegetation obstructs the horizontal line-of-sight exposure of hens to potential predators. Although wild turkeys attempt to nest in a variety of habitats, habitats characterized by dense herbaceous edges provide high quality cover. Potential nesting habitat includes herbaceous patches along disturbed forested habitats, such as the edges of a clearcut, an open field, gated roads, and utility right-of-ways. Hens also use areas of dense woody regeneration (i.e., 2-5 year old clearcuts). Nesting areas are important because, without quality nesting habitat, population growth will be limited and the likelihood of predation and nest abandonment may be high. Initially, the idea of counting the number of potential nesting areas sounded appealing, but this could be very time consuming and differences of opinion by various users may confound results. Also, using field techniques and measuring the height and density of herbaceous vegetation would identify potential nest sites, but is not practical for a rapid ground assessment on a potentially large tract. I propose the best method to calculate abundance of nest sites is to develop an interspersion index value.

Question #6 leads the user through calculation of an index of interspersion to assess the abundance of potential nesting areas (Figure 3-23). The calculation uses aerial imagery and two 1-mile long, perpendicular intersecting diagonal lines centered on the AOI (thereby creating four one-half mile long radiating transects used to standardize the assessment); these transects may extend beyond the boundary of the AOI. I measured interspersion by counting the number of distinct habitat types encountered as one moves along each line within the AOI; I then summed these unique habitat shifts to calculate a total interspersion index for the AOI. To be tabulated, a habitat must be >50 ft. in width at the point where the transect crosses. I propose excellent habitat would display ≥7 changes in habitat. I weighted this variable moderately (maximum of 3 points). If suitability within the AOI is poor, the rating can be supplemented by calculating an index value for surrounding lands using only the portion of each transect that extends beyond the outer boundary of the AOI; the sum of unique habitat types encountered on each transect line beyond the AOI boundary provides the interspersion value.

Roosting Habitat

Wild turkeys require mature trees, particularly conifers, for roosting. Conifers situated on northeastern-facing slopes protect roosting birds from prevailing winds and enable them to regulate body temperature more effectively (Porter 1992). Without suitable roost habitat available, wild turkeys will move to other places to roost and feed, particularly during harsh winter weather.

Question #7 evaluates the presence, species, and the aspect of trees on the landscape that provide roosting habitat for turkeys (Figure 3-23). I weighted this question as least important (maximum of 2 points), as turkeys typically are not limited by roost availability. A user must address this question by a site visit, as the size of trees cannot be assessed accurately using only aerial imagery. The region (e.g., mountainous, piedmont, coastal plain) in which the AOI is located also determines what factors (e.g., NE slope) should be considered when assessing roost suitability because some of Virginia does not have mountainous terrain. In the mountains, excellent habitat would have conifer trees present on northeast facing slopes, and piedmont and coastal plain areas would have conifer trees present with no concern regarding the slope, elevation change is minimal the further east in Virginia one travels. The user of this tool must take tree size into consideration, but also use professional judgment to determine whether each tree truly can support a roosting turkey. Many estimates for suitable roost trees have been provided (Mosby and Handley 1943, Hurst and Dickson 1992, Ludwig 2012), and it appears a tree ≥10" DBH is most appropriate. To supplement an AOI's poor suitability rating, the user can use imagery to identify the presence of conifer trees, as no method exists to estimate DBH or height using imagery, within a 1-mi radius from the center of the AOI. This will provide an estimate of potential roost sites surrounding the AOI.

Habitat Arrangement

Habitats that provide both nesting cover and brood range within close proximity to each other are essential to poult survival. The farther poults must travel, the more susceptible they are to predation and accidental death, which leads to lower survival and lower population growth. During the first few days after hatching, poults rely on the residual yolk for sustenance, but, after poults consume the yolk, they must consume insects or perish.

Habitat components must be within a turkey's range to be valuable, therefore, I assessed the distance between nesting habitat and brood range in question #8 (Figure 3-23). The assessment of this metric requires the use of aerial imagery to identify and measure the distance between potential nesting habitat and brood range. To determine suitability in question #8, the user must measure the distance from the change, or edge habitat, to the closest area that provides brood habitat. If multiple possibilities exist, the configuration with the shortest distance is used. I previously identified nest habitat in question #6 and brood habitat (i.e., herbaceous openings) in question #5. I weighted this question heavily (maximum of 6 points) because without nesting habitat nearby, broods will not be present to take advantage of brood range, or if nesting habitat is available, but brood range is inaccessible, newly hatched poults may have difficulty obtaining the protein they require. I propose excellent habitat would have nest habitat adjacent to brood range and the brood range patch would be ≥5 acres. If both nest habitat and brood habitat do not exist within the AOI, the user can supplement this poor suitability rating by including brood range and nest habitat that exists within ¼ mi of the outer boundary of the AOI.

Determining Habitat Suitability

This appraisal tool includes several variables, each with specific weightings depending on their importance for a wild turkey. As mentioned previously, the first part of each question focuses on the variables within the AOI, and if the suitability within the AOI is poor, the second part of the question assesses the area within a 1-mi radius of the center of the AOI. The final suitability value is derived by summing the individual suitability ratings for each question. Poor suitability values range from 0-7, fair from 8-15, good from 16-23, and excellent from 24-31. To create this range, I summed the maximum number of points possible (31) and divided by 4 (the number of desired suitability categories), and rounded the number (7.75) down (7) to establish how many points should be included in each category; I placed the leftover points (because 31 does not evenly divide by 4) in the excellent category.

Additional Items for Consideration

In addition to the previously described variables, I added a few questions to the appraisal tool to help identify features that may affect the value of the property for wild turkeys, although not calculated in the suitability value (Figure 3-23). I included a question that addresses the presence or absence of springs or seeps on the property. Springs and seeps can provide high quality feeding areas when other food sources are inaccessible and snow is present. However, depending on the time of year, the user may not be able to identify seeps on the property, which is why I excluded it from the calculated variables.

Also, users must keep in mind the ownership of surrounding properties when assessing habitat and suggesting habitat improvement techniques. For this reason, I included a series of checkboxes at the end of the appraisal tool to identify what types of landowners are nearby (e.g., private citizen owned, private corporation owned, state owned public land, federal owned public land) (Figure 3-23). If known, the user should identify the specific name of the property owner (e.g., US Forest Service) to help identify potential partnership opportunities or land intentions.

Tool Validation

I evaluated habitat at 12 sites in 4 different regions of Virginia in an attempt to validate the habitat appraisal tool (Figure 3-24). I selected 4 different regions of Virginia for sampling to ensure the tool functions appropriately in various habitat types, ranging from deciduous forested habitat of the western mountains, to piedmont pine forests, to the southern piedmont agricultural region, and areas in the northern piedmont near urban development. I compared the suitability values I obtained using the field sampling of the rapid appraisal tool with the suitability values generated from the landscape-level habitat suitability model. Although I stress users should not directly compare these suitability indices, my objective was to identify notable discrepancies in the values and identify factors, if any, that would contribute to such differences. For example, if the landscape-level model indicated the area should be optimal habitat and the rapid appraisal tool indicated the area suitability was very poor (or vice versa), it would appear one of the habitat assessment methods was inaccurate. Assuming both assessments function correctly, both habitat suitability indices should be relatively similar.

I also correlated the mean habitat suitability for each county based on where the sample sites were located with the spring wild turkey harvest/sq. mi. of suitable habitat for each county the sample sites exist in. I hypothesized counties with higher habitat suitability exhibit higher spring harvest/sq. mi. of suitable habitat.

Results

The sites I sampled using the rapid appraisal tool produced reasonable suitability values given the location of the site and my knowledge of wild turkey needs (Table 3-8). The most suitable sites included the Chancellorsville Battlefield (27-excellent), Jefferson National Forest site 3 (23 - good), White Oak Mountain WMA site 2 (24 – good) and 3 (25 - excellent), and C. F. Phelps WMA site 2 (24 - good). The least suitable habitat occurred at the Jefferson National Forest sites 2 (16 - fair) and site 3 (15 - fair) and Big Woods WMA site 1 (12 - fair) and site 2 (13 - fair).

I observed some substantial differences between the rapid appraisal tool suitability indices and the landscape-level habitat model suitability indices (Table 3-8); I noted large difference for all sites in the Jefferson National Forest, White Oak Mountain WMA Site 1, C.F. Phelps WMA site 1, and Chancellorsville Battlefield. The rapid appraisal suitability values of the field sampling locations ranged from 13 (fair) – 27 (excellent) (for this version of the appraisal tool, 32 was the maximum possible suitability value). On the Jefferson National Forest, site 1 displayed good suitability (23) based on the rapid appraisal tool, but exhibited a less suitable value (HSI=0.43) when assessed with the GIS model.

Conversely, the other 2 sample sites displayed much higher GIS suitability indices (site 2: HSI=0.51, site 3: HSI=0.74) and fair suitability values (site 2: 16, site 3: 15) generated by the rapid appraisal tool. Site 1 on the White Oak Mountain WMA ranked as fair (16) based on the rapid habitat appraisal tool, but when assessed with the GIS model, the site rated nearly optimal (HSI=0.99). Similarly, the C. F. Phelps WMA site 1 was rated as good habitat (18) using the rapid assessment, but was classified as much more suitable habitat using the GIS model (HSI=0.90). When assessing the Chancellorsville Battlefield site, I observed excellent habitat (27) with the rapid tool, however the GIS model ranked the area much less than excellent (0.66).

In addition to comparing the rapid appraisal tool's suitability values with the landscape-level HSI model's values, I also identified some discrepancies between the suitability tool and the appraisal in the field. Areas in the Big Woods Wildlife Management Area appeared to be forested habitat based on aerial imagery, but when inspecting the area I identified excellent herbaceous brood habitat under the forest canopy. Additionally, I identified a need to modify the roosting cover component based on the field validation. I previously included the northeast facing slope requirement for all suitable roosting habitat, regardless of the site's location in Virginia. I believe this resulted in penalizing areas that have relatively flat terrain, as a northeast facing slope may not be attainable in the area. Therefore, I modified the question to first identify the location of the area in Virginia (e.g., mountainous or piedmont) and then assess the habitat based on specific criteria for that region.

The correlation of the mean habitat suitability for each county with the spring wild turkey harvest/sq. mi. of suitable habitat for each county did not show positive relationship (r_s=-0.80, p=0.10; Figure 3-25). As observed in Table 3-9, the spring turkey harvest/sq. mi. of suitable habitat declines as mean habitat suitability increases.

Discussion

Using the field sampling to validate the tool, I believe the habitat appraisal tool reasonably assesses habitat based on a wild turkey's needs. None of the sites I assessed ranked as very poor habitat, which I expected because established turkey populations exist across Virginia. The sites with a diversity of habitat (e.g., both open and forested cover types) ranked as the most suitable habitat; conversely, the least suitable sites typically exhibited only forested cover. Sites from the Big Woods WMA primarily were pine stands with few openings and had suitability values in the good-fair range. Sites in northern Virginia at the Phelps WMA and Chancellorsville Battlefield exhibited a good combination of open and forested cover types, and ranged from excellent-good suitability. As expected, I observed lower suitability values in the western mountains of the Virginia where the landscape predominately is contiguous forest or has expansive openings; the sample sites on the Jefferson National Forest ranged from fair to good, due to the limited number of openings. White Oak Mountain WMA in the southern piedmont of Virginia had excellent – good suitability; this WMA exhibits some of the best turkey habitat of all sample sites. VDGIF manages for small game on White Oak Mountain WMA, which includes planting fields, prescribed burning, and strip disking. The assessment results from field validation accurately depict what I anticipated for habitat quality.

When comparing the rapid appraisal tool suitability indices with the landscape-level GIS model, I observed why this comparison should be taken with caution. Site 1 on the Jefferson National Forest displayed excellent suitability using the rapid appraisal tool because the site contained open cover, whereas beyond the AOI, contiguous forest dominated the area resulting in a lower habitat suitability based on the GIS model. Site 2 and 3 on the Jefferson National Forest had a lower suitability when assessed with the rapid appraisal tool compared to the GIS model because the AOI did not contain open cover, whereas beyond the AOI fields were present; for similar reasons, the White Oak Mountain WMA site 1 and C. F. Phelps WMA site 1 both ranked lower in suitability with the rapid appraisal tool than with the GIS model. The Chancellorsville Battlefield site ranked as more suitable using the rapid tool than the GIS model because the habitat within the battlefield contained a variety of cover types, and beyond the AOI, urban development dominated. Clearly, the landscape-level model incorporates a much larger area when assessing habitat (5,167 acres), than the small tracts I assessed (approximately 35 – 200 acres).

Other factors are influencing the wild turkey abundance index (spring turkey harvest/sq. mi. of suitable habitat), in addition to the mean habitat suitability determined by the rapid habitat appraisal tool. I anticipated that high abundance would be related to high suitability; however, the counties with the lowest abundance have the highest suitability. This may be related to the fact that harvest is influenced by hunter effort, and other factors (e.g., predation, disease, hunting) may be influencing turkey abundance aside from habitat suitability alone. The spring turkey harvest depends on hunter effort, which is not consistent across the state. Even when turkeys are present, hunters may not harvest birds if difficult terrain requires hunters to exert more energy, if access is limited (e.g., gated roads, private property), or a combination of factors occurs (e.g., as in some national forest areas). Hunting culture also may not be as prevalent in some areas of the state as others. For these reasons, this index of turkey abundance may best be suited for comparison only for long-term trends, rather than as a 'snapshot' of current turkey populations.

Continued application of the model in Virginia will identify other factors that should be modified (e.g., roost habitat component) or require special consideration when applying the tool. I encourage users to thoroughly inspect the area of interest during the site visit and rely on that information, rather than solely on imagery. As I discovered during field validation, habitat management (e.g., timber harvest) may have occurred since the agency collected the imagery or important habitat features resulting from management actions (e.g., prescribed burns) on the ground may not be observable with imagery.

This model not only provides state wildlife biologists in Virginia a standardized and quantitative tool to assess wild turkey habitat, but also biologists in other state agencies, particularly in the mid-Atlantic and Appalachian region. Additionally, non-governmental organizations (NGOs) (e.g., the National Wild Turkey Federation) may find this appraisal tool useful for their members. Partnerships between state wildlife agencies and NGOs and the application of this tool can help the agency meet habitat objectives, and if habitat management occurs on a large enough scale, biologists can use this tool to monitor changes over time that may even affect wild turkey populations.

Limitations and Appropriate Application

Appropriate application of the habitat appraisal ensures that users will obtain reasonable suitability estimates, and therefore select correct habitat management strategies. The habitat appraisal tool should be applied on areas that are relatively small in size (<1,000 acres); however, application on larger or irregular size (e.g., long, narrow ridge) tracts can be performed by dividing the tract into regions and applying the tool on each section. In this case, users should treat each region of the property as an individual unit and prescribe habitat management focusing only on that tract. When performing this method, users should not sum the suitability values from all regions to generate an overall suitability of the tract; doing so will dilute the limiting factors specific to each region.

Users also should properly identify their specific objectives; if users desire to assess habitat across a large area (e.g., county-scale or larger), he or she should refrain from using this appraisal tool and instead use a landscape-level habitat suitability model to assess wild turkey habitat (Morris et al., unpublished report). Extracting the results for small tracts from the landscape-level model will provide false estimates of habitat suitability. Ideally, these two steps should be used in conjunction; first the landscape-level model should be applied to identify the areas requiring further investigation, and second, the rapid appraisal tool should be applied at the patch scale to identify what the factors are limiting or promoting the habitat suitability. The rapid appraisal tool is particularly useful for assessing the habitat suitability of areas <1,000 acres in size for private landowners and other small tracts.

I also strongly recommend that professional biologists or land managers with scientific knowledge of wild turkeys apply this tool. Those with a hobby interest in providing wild turkey habitat should seek professional help to apply this tool for various reasons. Most individuals will not have access to aerial imagery or GIS software, they do not fully understand the scientific needs of wild turkeys, or possess the knowledge to determine which habitat modifications are appropriate for their property. It is essential that biologists apply the tool to ensure that accurate results are produced and appropriate habitat improvements are recommended.

Synthesis

I believe this rapid habitat appraisal tool reasonably assesses the suitability of habitat for wild turkeys based on the field validation and comparison with the landscape-level habitat suitability indices. This provides not only state agency biologists, but also NGOs, a tool to use in assessing wild turkey habitat. In Virginia, landowners previously had no means to assess their property for turkey habitat, and now with the development of this tool, biologists have a repeatable, quantitative method to can help landowners identify deficiencies. Biologists also can provide management suggestions based on the limiting factors identified by the application of this rapid appraisal tool.

I also believe this rapid appraisal tool may be applicable to areas outside of Virginia. In neighboring states, i.e., West Virginia and Maryland, where similar mid-Appalachian habitat exists, the appraisal tool should be directly applicable; however, application in areas outside of the Appalachian region may require modifications of the variables. Continued application of the tool will identify components of the tool requiring improvement, as I identified when applying the tool in various physiographic provinces in Virginia.

I suggest that VDGIF and others interested in wild turkey habitat conduct additional research including investigating areas with low suitability, applying habitat modifications as suggested in the appendix of the tool's user's manual, and observing the effects of habitat management on habitat suitability. Even if the habitat is high quality, or biologists have applied management strategies to improve suitability, other extraneous factors may be limiting the wild turkey population. Other factors (i.e., disease) may limit a population even in high quality habitat.

Chapter Synthesis

This comprehensive habitat assessment provides tools for VDGIF biologists to assess habitat for the wild turkey in Virginia. Prior to the development of this assessment, VDGIF biologists did not employ technology or modeling tools to assess habitat for wild turkeys, but instead often relied on personal opinion. Now, quantitative and repeatable methodology enables biologists to assess habitat over time. Applying the landscape-level habitat model enables agency staff to identify areas worthy of further investigation, and the rapid appraisal tool will help identify factors that limit or promote habitat suitability.

The model suggests that the best wild turkey habitat in Virginia exists in the South Piedmont region and in areas with a diversity of forest and open cover. Poor wild turkey habitat occurs in the North Mountain region, and other mountainous and urban areas. Public lands also exhibit low quality habitat compared to private lands. Using this information and focusing on adult and brood life requisites, wildlife managers can prescribe management strategies to address opportunities and limitations. Additionally, managers should investigate these areas further by applying the rapid habitat appraisal tool to help identify site-specific habitat limitations.

Habitat suitability declined over time in the North Mountain, North Piedmont, and Tidewater region and near urban centers. I recommend that VDGIF identify factors driving these habitat suitability changes. Identification of these factors also will provide insight into changes in habitat use and habitat loss, which is a prime focus of wildlife managers.

Although the habitat suitability model reasonably assesses habitat for wild turkeys, biologists should continue to test model output with turkey population indices, especially turkey hunter independent data (e.g., turkey abundance from bowhunter survey) and hunter independent data (e.g., brood surveys administered by VDGIF staff), as these data provide valuable indices of production and populations.

The rapid habitat appraisal tool appears to reasonably assess habitat suitability for wild turkeys based on field validation and comparison with landscape-level habitat suitability indices. This tool provides biologists and others (e.g., NGOs) with a means to consistently assess wild turkey habitat. Landowners previously had no effective means to evaluate their property for turkey habitat; now, biologists have a standardized, quantitative method to can help landowners identify opportunities and deficiencies. In addition, biologists can provide management suggestions based on limiting factors identified by the application of this rapid appraisal tool.

This comprehensive assessment likely is applicable to areas beyond Virginia, with a focus on Mid-Atlantic States and the Appalachian region. In neighboring states where similar habitat exists (i.e., West Virginia and Maryland), assessment should be directly applicable; however, application in areas outside of Appalachian region (e.g., South Carolina, Florida) may require modifications to the variables. Continued application of both components will identify model and appraisal tool factors requiring improvement.

I suggest that VDGIF and others interested in wild turkey habitat should investigate sites with low suitability, apply habitat modifications as suggested in the appendix of the rapid habitat appraisal tool user's manual, and observe changes. Even if the habitat is high quality, or biologists have applied management strategies to improve suitability, other extraneous factors (i.e., disease, poaching, fall harvest mortality) may be limiting the wild turkey population.

In conclusion, the development this comprehensive habitat assessment provides biologists valuable tools to assess the quality of habitat for wild turkey at multiple scales. Appropriate use of this assessment enables biologists to improve their knowledge of wild turkey habitat quality in their area of interest and helps them to manage the wild turkey more effectively.

Future Application and Improvements

Landscape-Level Habitat Suitability Model

Future application of the landscape-level habitat suitably model should include running the model with the 2011 National Land Cover Database (NLCD), anticipated in early 2014. This new data will provide the most recent assessment of wild turkey habitat in Virginia. Also, managers should use the output produced with the 2011 NLCD in conjunction with prior years' output to provide a larger sample size to correlate with wild turkey indices of abundance and harvest to validate the model. The initial validation techniques used only had a maximum of 3 years of NLCD data (1992, 2001, 2006).

In addition to assessing habitat, managers could use the data derived from the habitat suitability model to establish turkey management units. To determine the appropriate grouping, I suggest that managers perform a cluster analysis of wild turkey density estimates for each county. Managers should use their best judgment in grouping counties; a turkey management unit of 4 or 5 counties would provide a meaningful management area, whereas one or two counties would not be realistic to impose landscape-level habitat management and hunting regulations. Managers can re-evaluate turkey management units every 5 years when the Multi-Resolution Land Characterization consortium releases new NLCD data. This approach would make the turkey management units adaptable to changes in habitat and harvest rates.

Wild turkey research in Virginia should focus on obtaining updated home range estimates for wild turkeys. Recent and localized home range data would improve model output, as some areas may be including unnecessary acreage. As habitat quality declines, turkeys will increase their home ranges to fulfill their needs, and in high quality habitat, home ranges will be smaller. I believe the actual mean home range is smaller in higher quality habitat found in the South Piedmont region of Virginia compared to the mean home range of 5,189 acres (McDougal 1990) in the relatively lower quality habitat in the western mountains of Virginia. This large home range estimate may affect model validity to some degree, as the areas identified as poor quality habitat likely would still be poor quality in a smaller home range, whereas fair and good quality areas may decline in suitability if the home range were smaller.

New Sources of Data

Since the completion of my research, a conglomerate of state agency and non-governmental organization personnel developed a new habitat classification system, the Northeast Terrestrial Wildlife Habitat Classification System (NETWHCS) and a guide for its application in the Northeast (Anderson et al. 2013, Wildlife Management Institute 2013). This classification system identifies fine habitat characteristics, unlike the coarse classification of the NLCD. The NETWHCS identifies habitat features (e.g., Central Appalachian Pine-Oak Rocky Woodland) and habitat macrogroups (e.g., Central Oak-Pine). This detailed approach to mapping habitat would enable managers to distinguish between higher quality oak mast producing stands and less desirable northern hardwood stands. I suggest that VDGIF personnel modify the current habitat suitability model to use the NETWHCS data, but only use the NETWHCS data for identifying fine-scale habitat where necessary (i.e., differentiating between deciduous forest types for food sources). To improve the V_f variable of the model, managers could incorporate a ranking system to place more value on high quality oak forest habitat and place less value on northern hardwoods. However, I encourage managers to continue to use the NLCD data, in addition to the NETWHCS. The Multi-Resolution Land Characterization consortium has produced the NLCD since 1992 and managers can use the data to compare current habitat with past conditions, unlike the NETWHCS data that exists for only one year. In addition, the new iterations of the NLCD will be produced every 5 years, and managers can use the data for assessing long term trends.

Additional variables

With the inclusion of additional variables, biologists can assess the full potential of wild turkey populations at the landscape-scale. The current model only accounts for habitat features, but other variables such as weather, fall hunting season length, disease, mast availability, and soil type also can effect wild turkey populations.

Diseases, such as lymphoproliferative disease virus (LPDV), could affect survival or reproduction of wild turkeys. Currently, biologists know little about LPDV and its effects on wild turkey populations; other diseases, such as avian pox, are not found regularly in wild turkey populations and thus pose little threat. VDGIF should continue to collect annual samples and identify where LPDV currently exists in Virginia. This turkey leg collection from spring or fall harvested turkeys would provide a sample to that could be sent to a laboratory for LPDV testing and also could be used to collect age and sex data from harvested birds (Healy and Nenno 1980, Steffen et al. 1990), similar to the previous feather samples collected at check stations. Coloration of the leg samples also can be used to distinguish between juvenile and adult turkeys (Latham 1976). Biologists could summarize this data for each county and a GIS dataset indicating detection or non-detection could be created and incorporated in the model.

Mast production often dictates where turkeys will be found and can pose implications for fall harvest. Hunters harvest more wild turkeys during years of poor mast production because turkeys are more visible to hunters, often visiting open areas and traveling for food (Norman and Steffen 2003). VDGIF, in conjunction with the Virginia Department of Forestry, conducts a statewide mast survey annually indicating the relative abundance of mast (low, moderate, high) (Virginia Department of Forestry, unpublished report). Biologists could compile this information for each VDGIF region, if data are not available for every county, and incorporate the data in the model (3=high, 2=mod., 1=low) to indicate the potential for wild turkey harvest in the fall.

Further, poor quality soils often hamper management improvement efforts. Information on soils could help managers determine appropriate management actions needed to produce more desirable vegetation for wild turkeys. The US General Soil Map (STATSGO2) can be used to identify soil types and could provide sufficient detail necessary for these purposes (USDA Natural Resources Conservation Service 2013b). I suggest incorporating a weighting system based on the habitat type, where the higher quality soil types receive larger values, similar to the approach suggested for establishing values for various deciduous forest types.

Rapid Habitat Appraisal Tool

Individuals revising this appraisal tool should add a section addressing soil type and quality. Because this assessment is designed for use on small areas, users should use the more detailed Soil Survey Geographic (SSURGO) database (USDA Natural Resources Conservation Service 2013a). Depending on the habitat components that need improvement, biologists can use the soil data to identify where landowners should create fields, based on the locations of favorable soils. Biologists also can identify appropriate vegetation that landowners should plant based on the soil types present. Oftentimes, vegetation exhibits a preference for well drained or moist soil; planting ladino white clover or other plants needing fertile soils with appropriate soil pH on a dry, infertile Appalachian ridge will result in a poor growth and little use for wild turkeys. Further, if the landowner or biologist submitted a soil sample for testing, the results from the analysis could enable the biologist to make additional suggestions regarding the vegetation to be planted and fertilizer and lime application rates. Using this information enables biologists to make the best suggestions for improving habitat for wild turkeys and ensuring limited resources (e.g., money) are well spent.

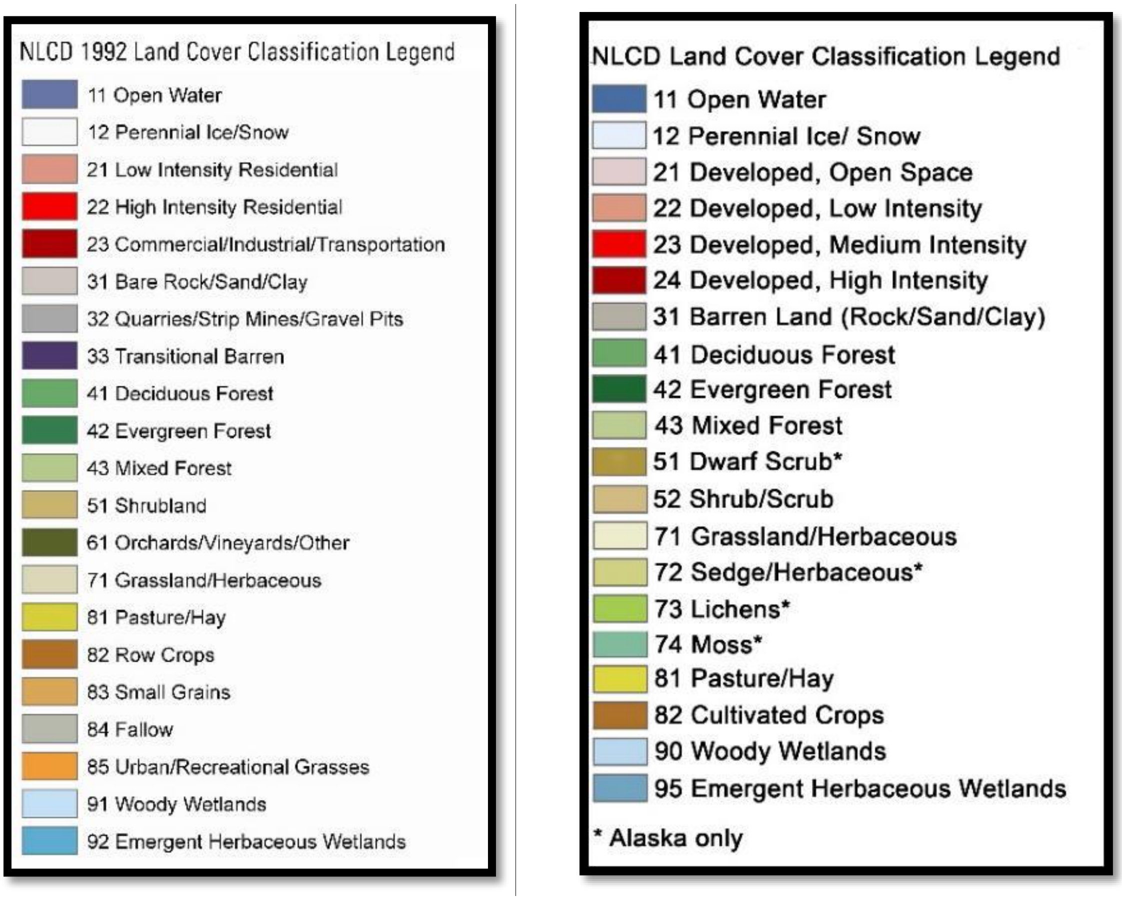

Figure 3-1. Original National Land Cover Database (NLCD) Classification Legends for 1992 (left image) and 2001 and 2006 (right image).

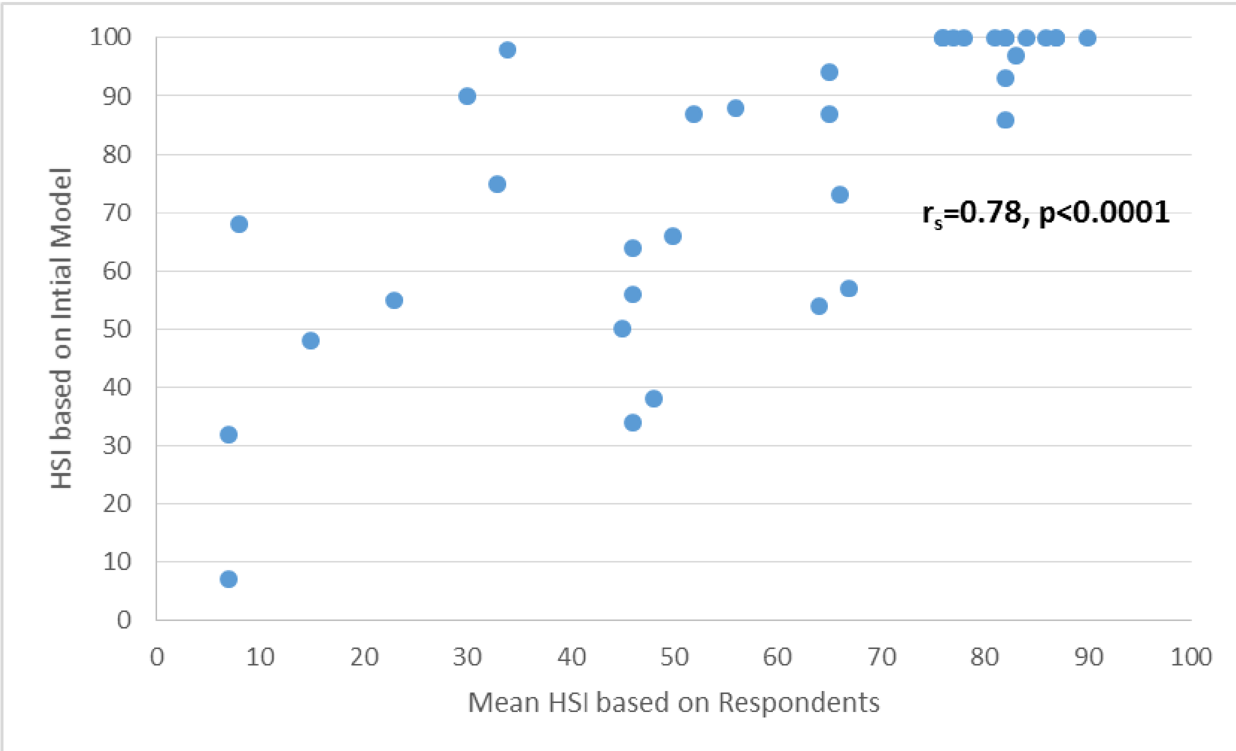

Figure 3-2. Correlation of the draft habitat suitability model values (n=36) with the mean habitat suitability value for each site (n=12) and life requisite (adult, brood, overall) based on the expert panel input.

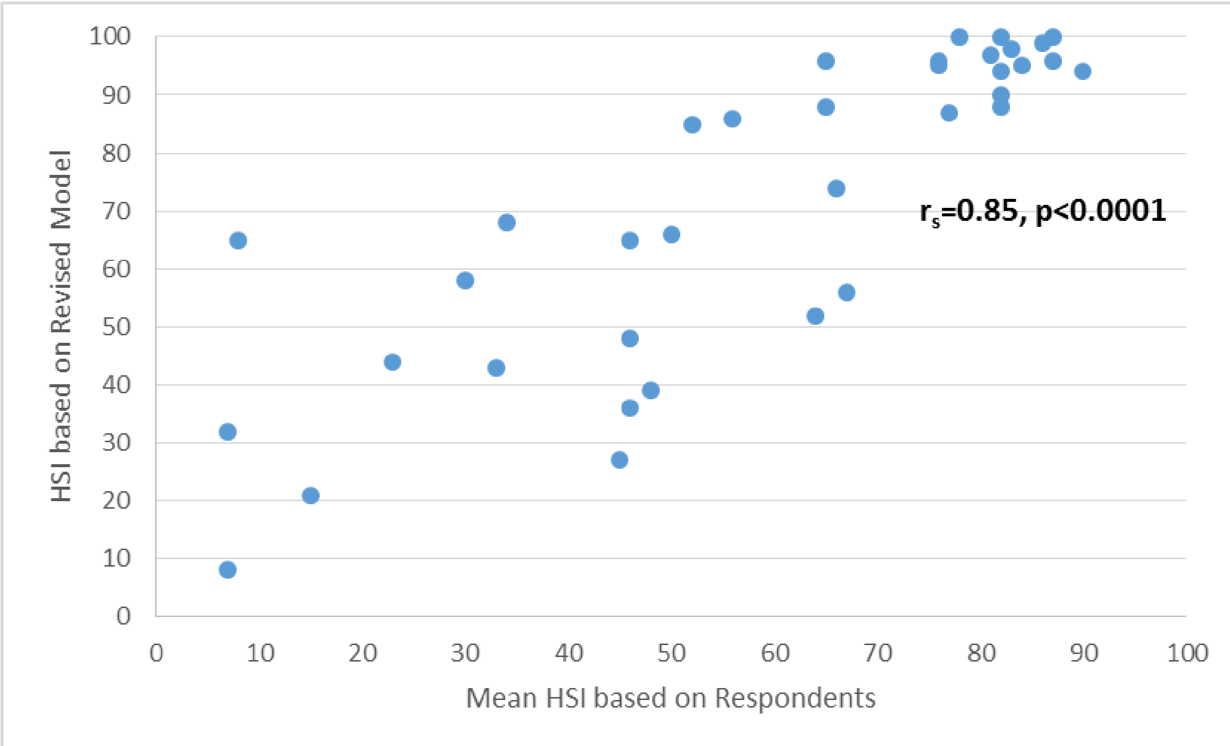

Figure 3-3. Correlation of the revised habitat suitability model values (n=36) with the mean habitat suitability value for each site (n=12) and life requisite (adult, brood, overall) based on the expert panel input.

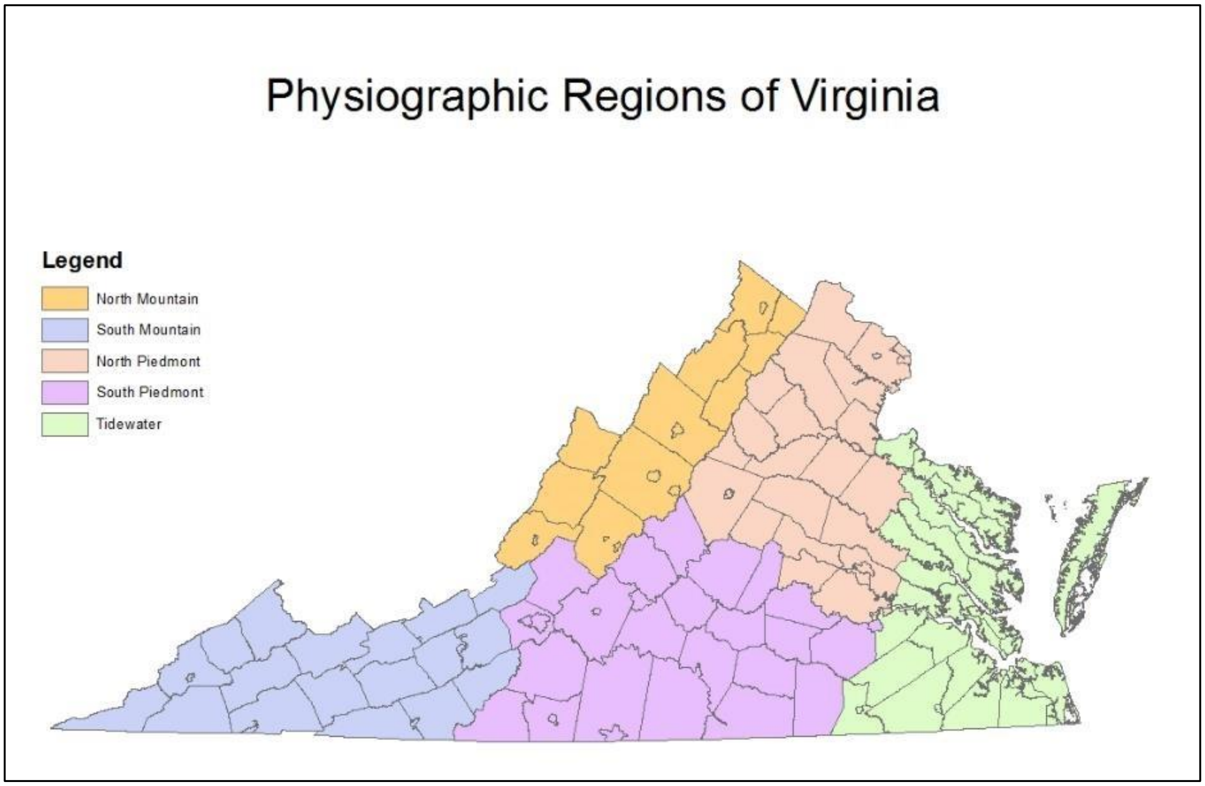

Figure 3-4. The 5 physiographic regions of Virginia.

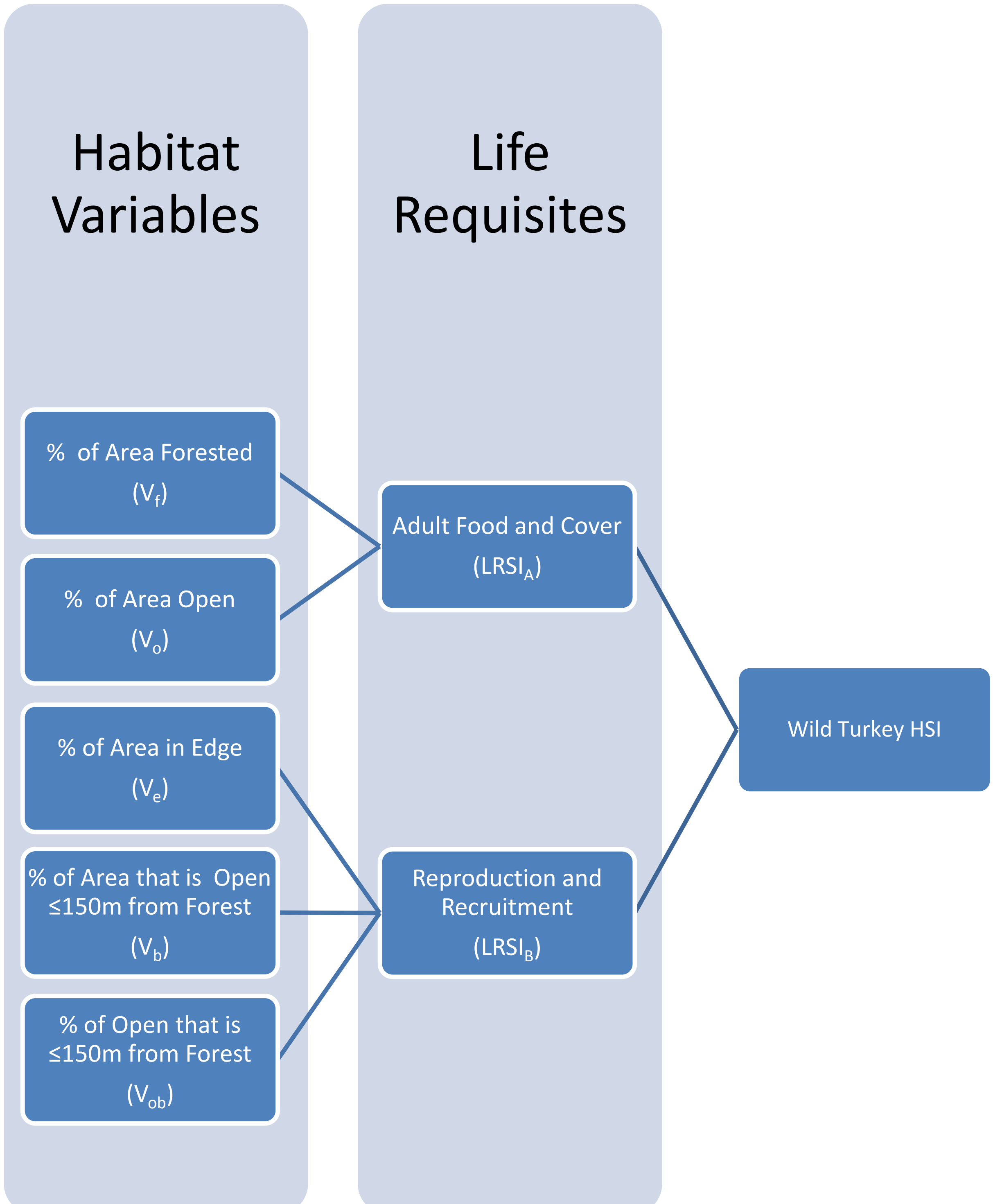

Figure 3-5. Variables and the life requisites they satisfy in the habitat suitability model for the eastern wild turkey in Virginia.

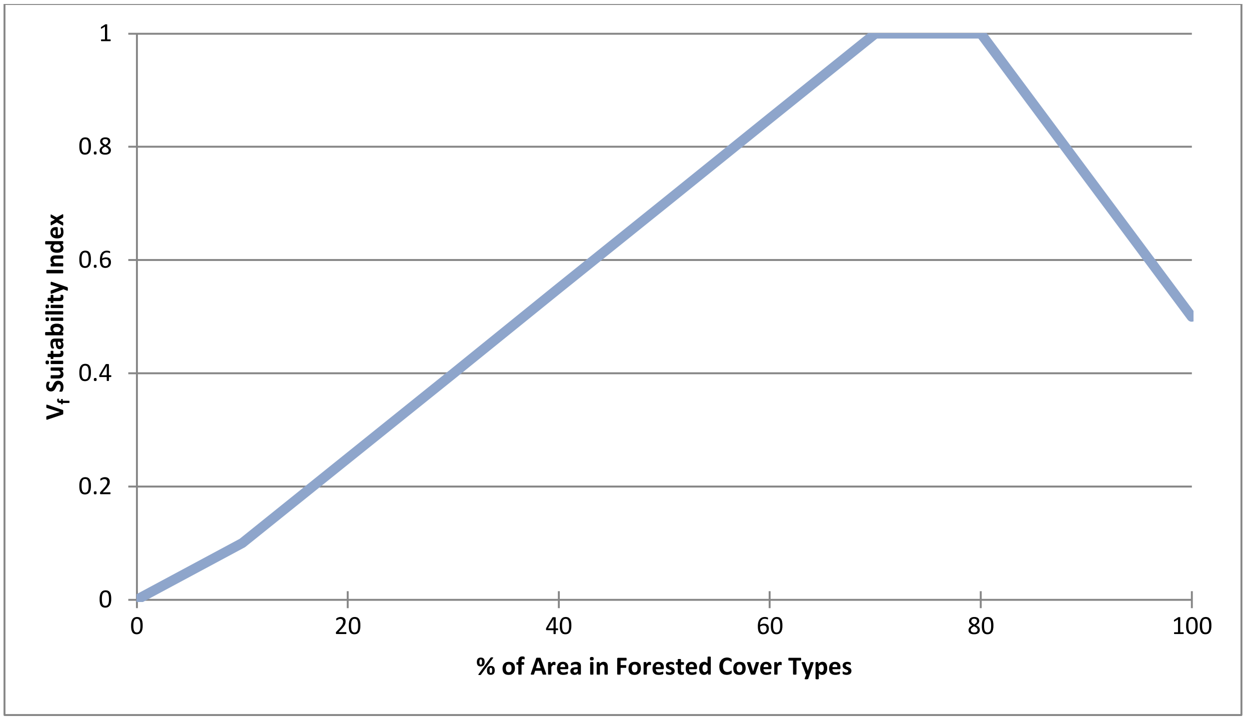

Figure 3-6. Suitability curve representing the percent of area in forested cover types (V_f). Forested cover types include mixed forest, deciduous forest, evergreen forest, shrub/scrub, and woody wetlands.

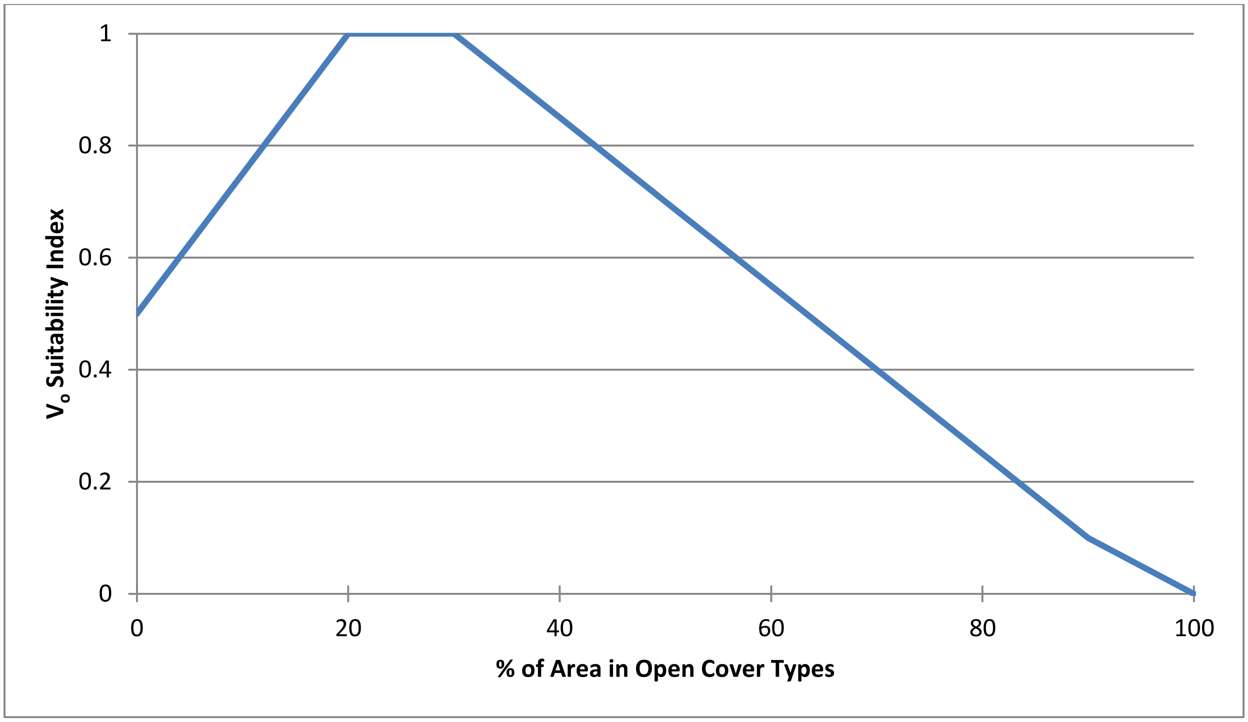

Figure 3-7. Suitability curve representing the percent of area in open cover types (V_o). Open cover types include grassland/herbaceous, hay/pasture, and cultivated crops.

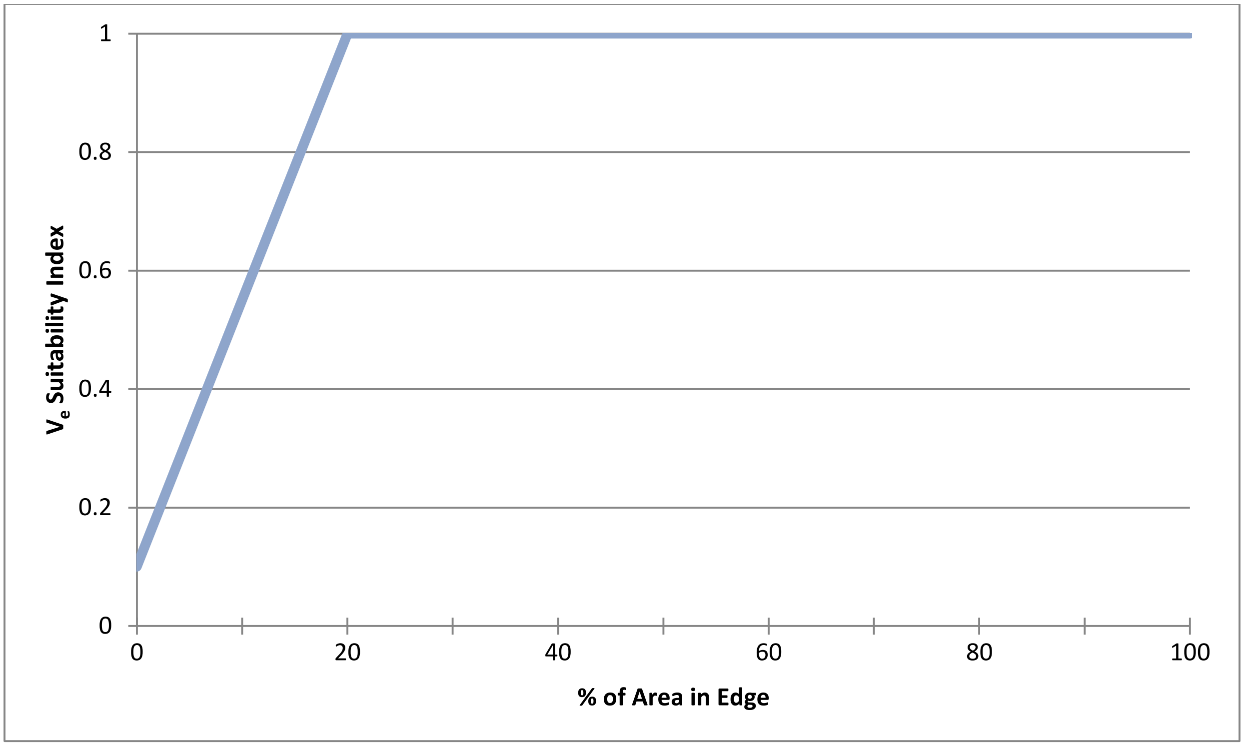

Figure 3-8. Suitability curve representing the percent of area in edge (V_e). Edge is identified as areas where forest and open cover types are adjacent.

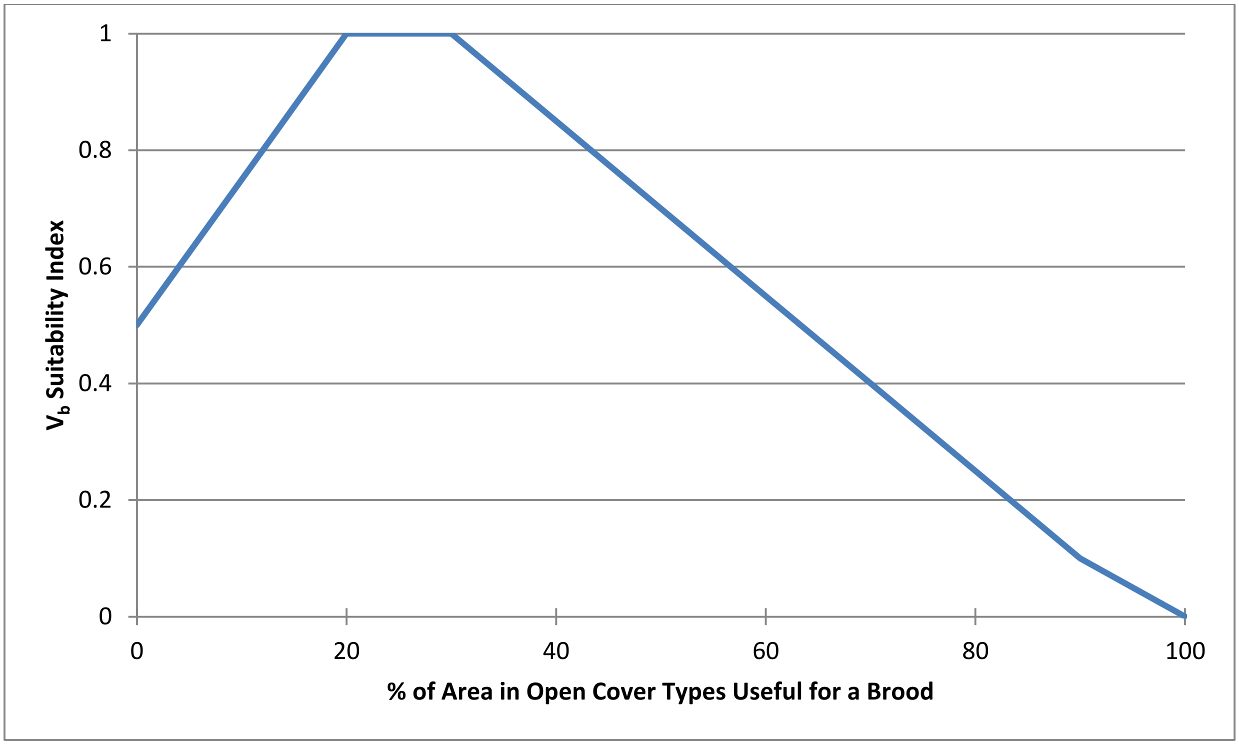

Figure 3-9. Suitability curve representing the percent of area in open cover types that is useful for a brood (V_b). Open cover types include grassland/herbaceous, hay/pasture, and cultivated crops, and must be <150m from forest cover.

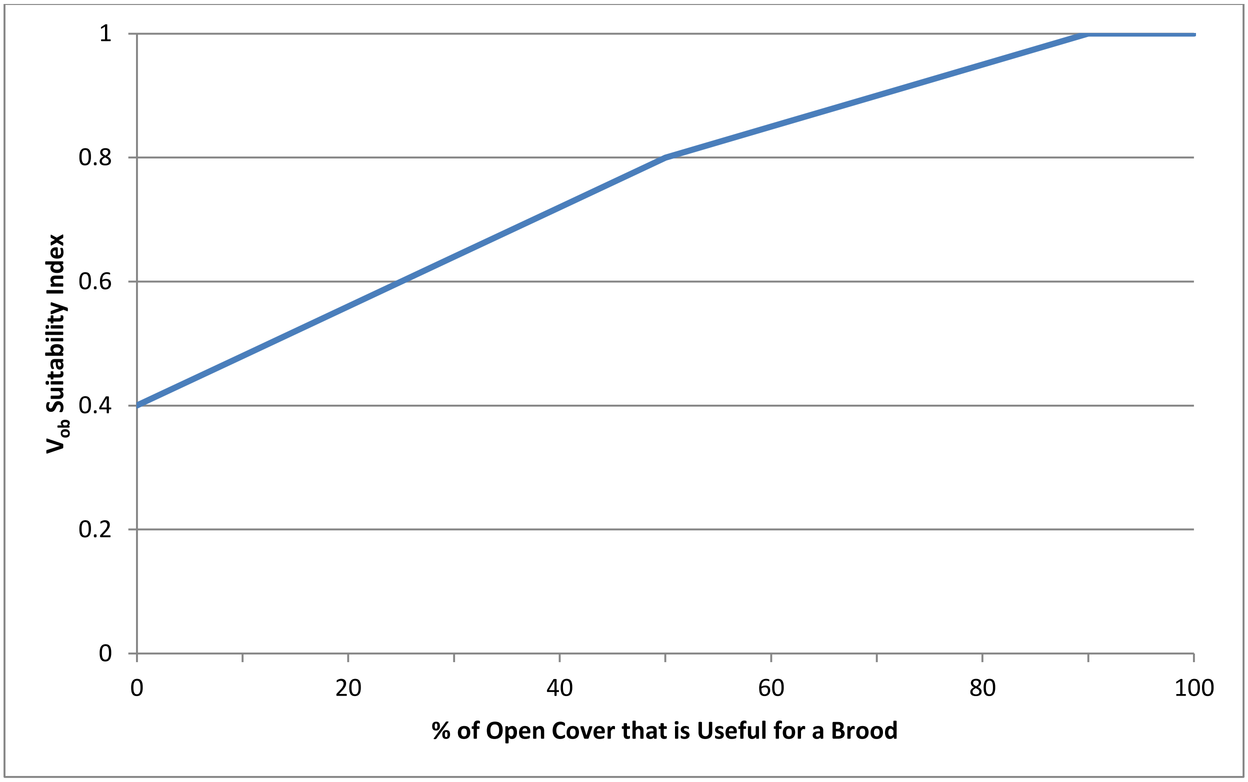

Figure 3-10. Suitability curve representing the percent of open cover that is useful for a brood (V_{ob}). Open cover types include grassland/herbaceous, hay/pasture, and cultivated crops, and must be <150m from forest cover.

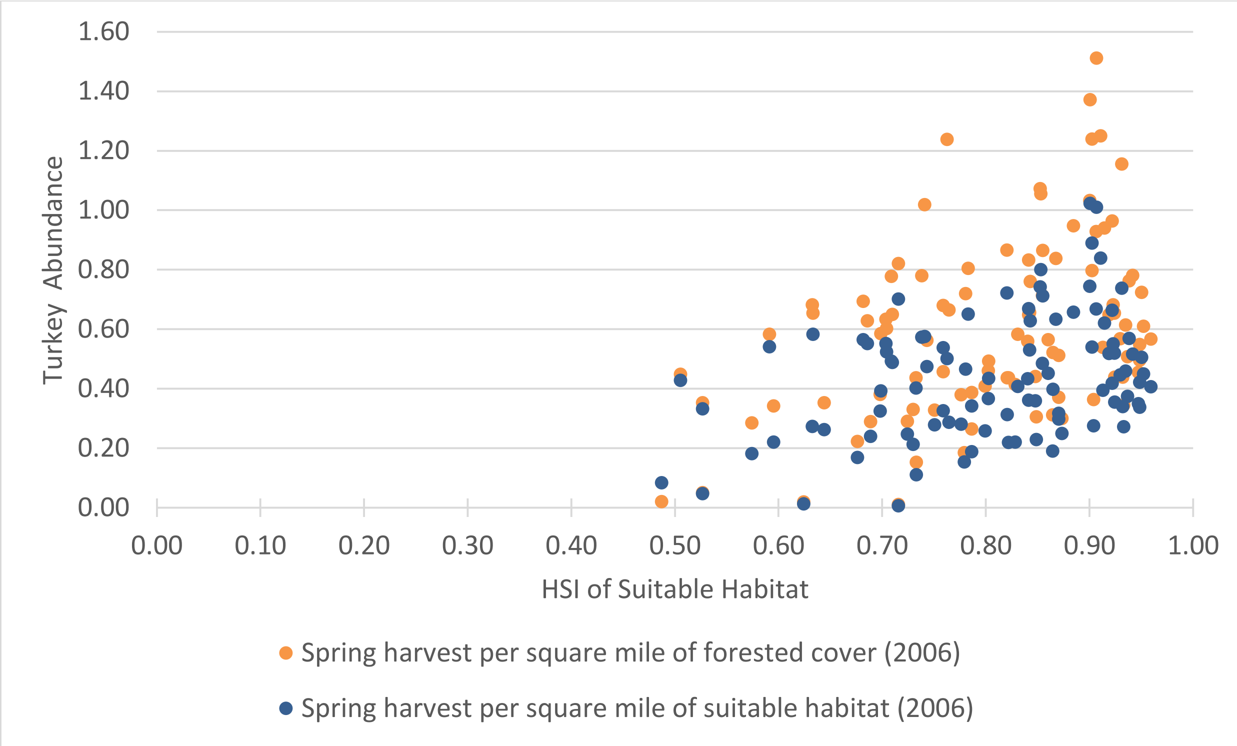

Figure 3-11. Wild turkey indices of abundance (2 indices; each n=98) correlated with overall habitat suitability based on only suitable habitat (modified habitat suitability model). The harvest per square mile of forested cover is based only on forested cover and the harvest per square mile of suitable habitat includes both open and forest habitat.

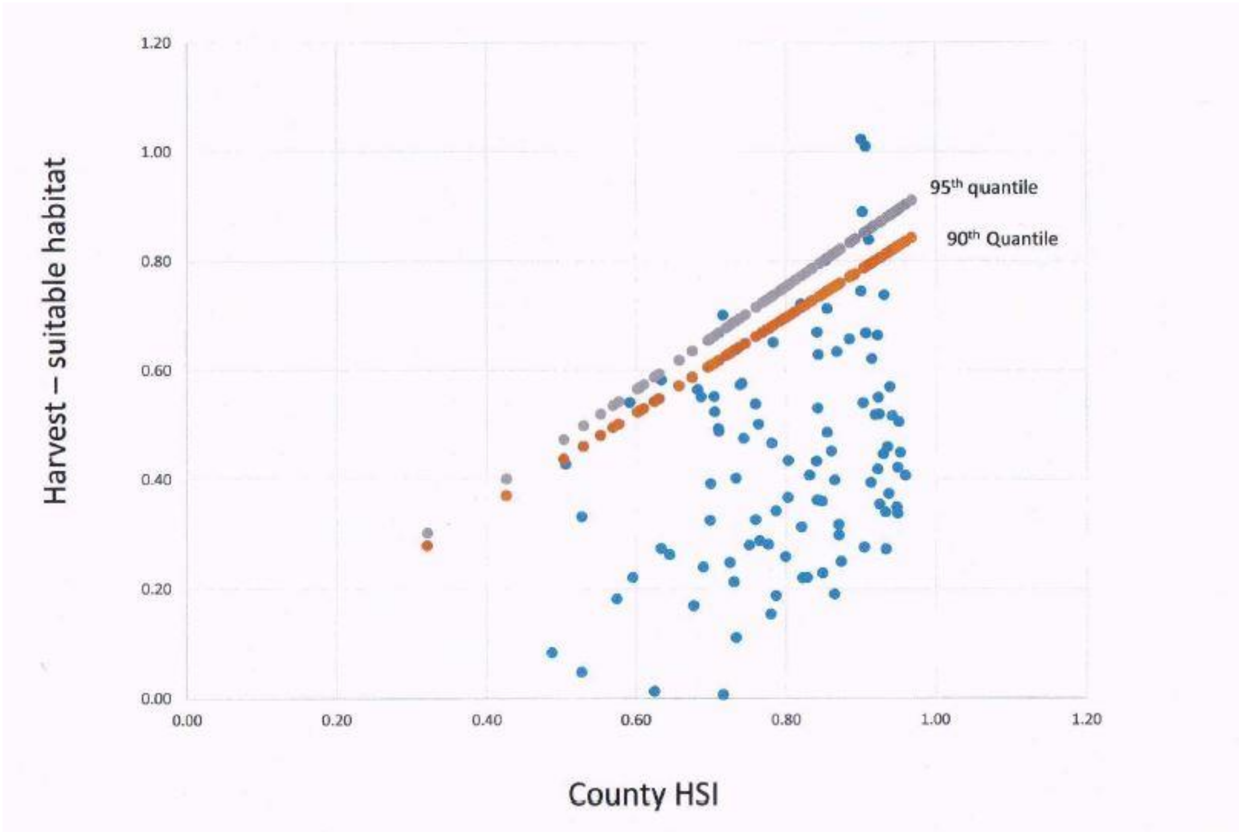

Figure 3-12. 95th and 90th quantile regressions of wild turkey index of abundance (spring harvest/square mile of suitable habitat) and overall habitat suitability based on only suitable habitat (modified habitat suitability model) (n=98).

Figure 3-13. Correlation of the 5-year mean wild turkey production ratios (n=15) for each physiographic region of Virginia with the reproduction and recruitment life requisite habitat suitability for wild turkeys in each physiographic region for 3 samples of National Land Cover Database (NLCD) data (1992, 2001, 2006).

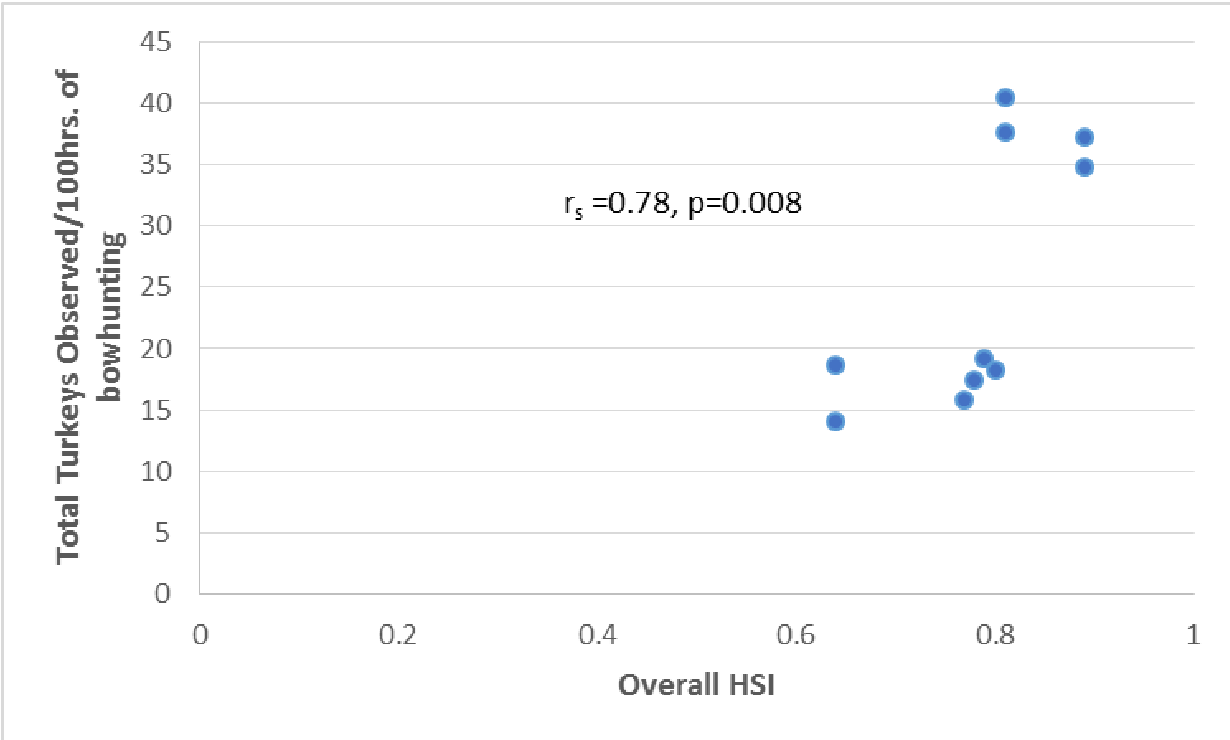

Figure 3-14. Correlation of the 3-year mean wild turkey observations by bowhunters (n=10) for each physiographic region of Virginia with the overall habitat suitability for wild turkeys in each physiographic region for 2 samples of National Land Cover Database (NLCD) data (2001, 2006).

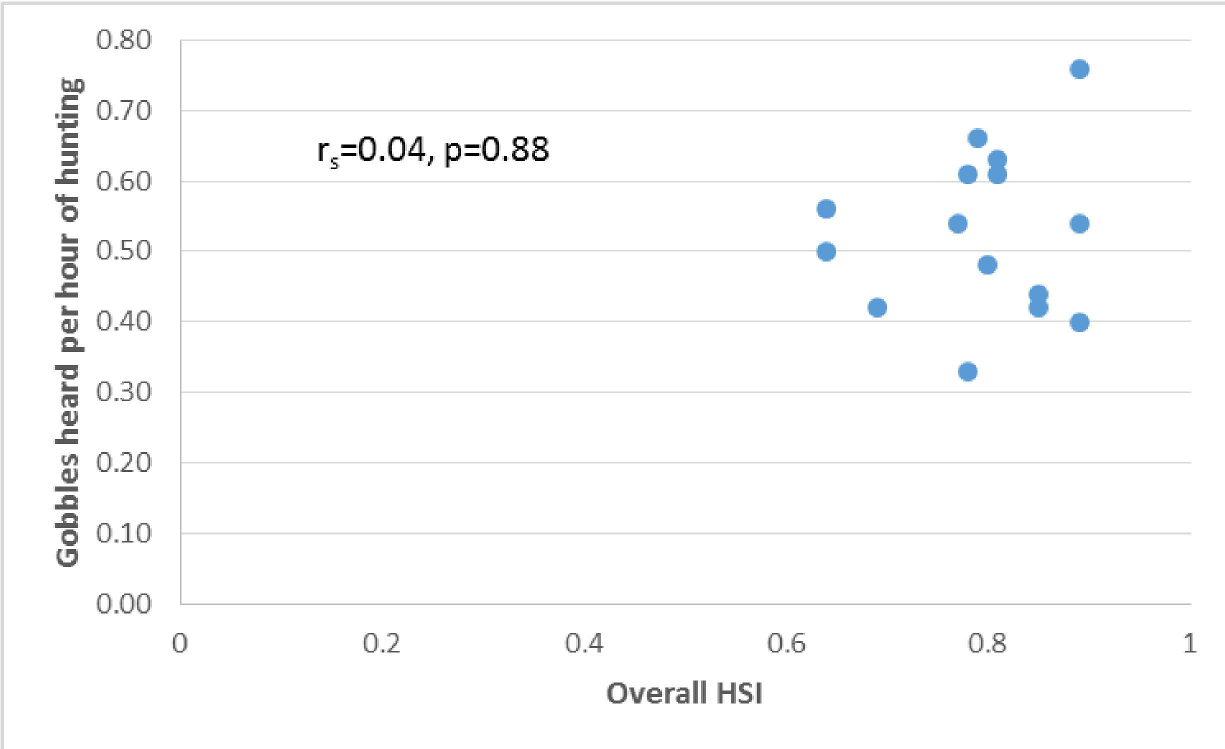

Figure 3-15. Correlation of the mean number of gobbles heard per hour of hunting by spring gobbler survey participants (n=15) for each physiographic region of Virginia with the overall habitat suitability for wild turkeys in each physiographic region for 3 samples of National Land Cover Database (NLCD) data (1992, 2001, 2006).

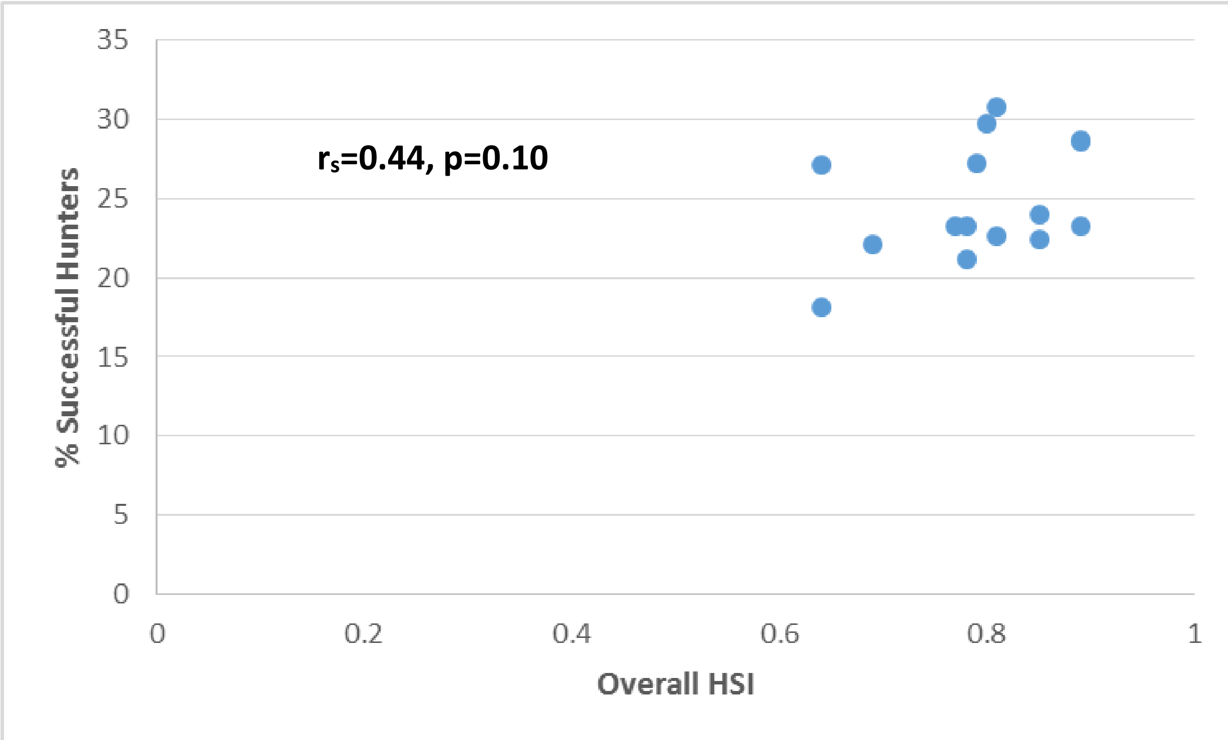

Figure 3-16. Correlation of the mean percent of successful spring turkey hunters as indicated by participants in the Virginia Department of Game and Inland Fisheries (VDGIF) Hunter Survey (n=15) for each physiographic region of Virginia with the overall habitat suitability for wild turkeys in each physiographic region for 3 samples of National Land Cover Database (NLCD) data (1992, 2001, 2006).

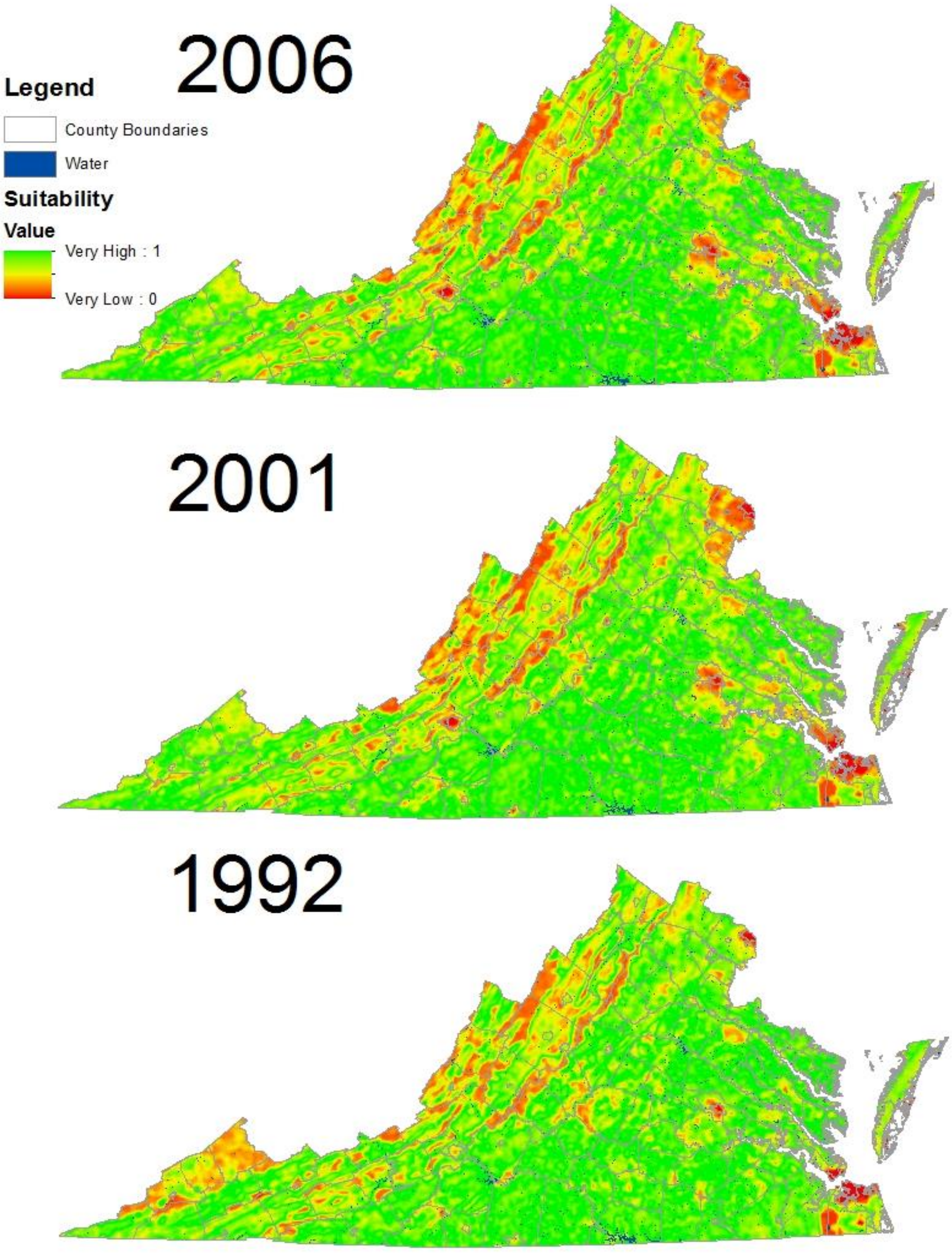

Figure 3-17. Overall habitat suitability for 2006, 2001, and 1992 based on the habitat suitability model for the wild turkey in Virginia. The habitat suitability model used the National Land Cover Database (NLCD) to generate output. The suitability is measured on a continuous scale, ranging from 0 – 1, with 0 (dark red) being unsuitable and 1 (bright green) being optimal for wild turkeys.

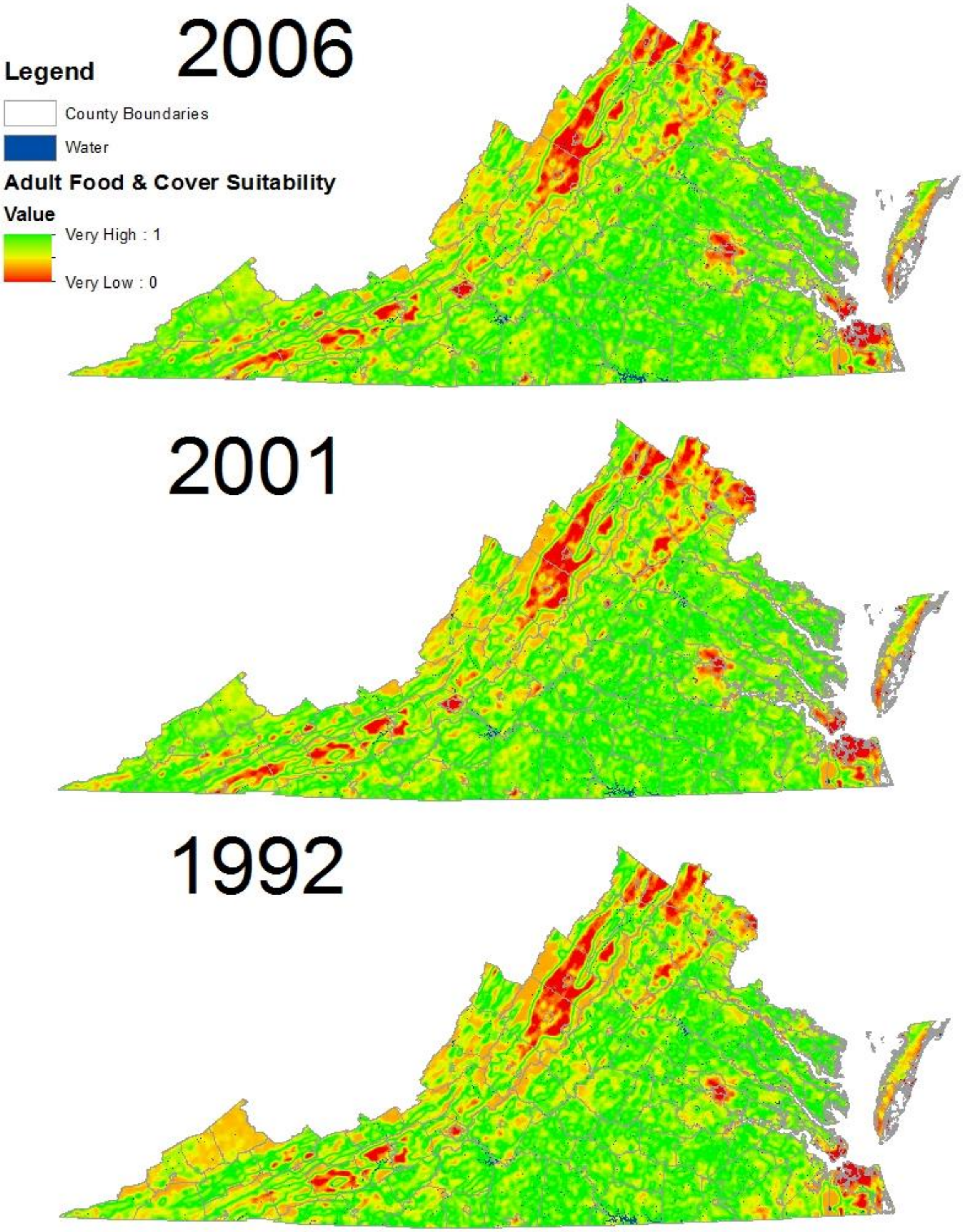

Figure 3-18. Adult food and cover life requisite suitability for 2006, 2001, and 1992 based on the habitat suitability model for the wild turkey in Virginia. The habitat suitability model used the National Land Cover Database (NLCD) to generate output. The suitability is measured on a continuous scale, ranging from 0 – 1, with 0 (dark red) being unsuitable and 1 (bright green) being optimal for wild turkeys.

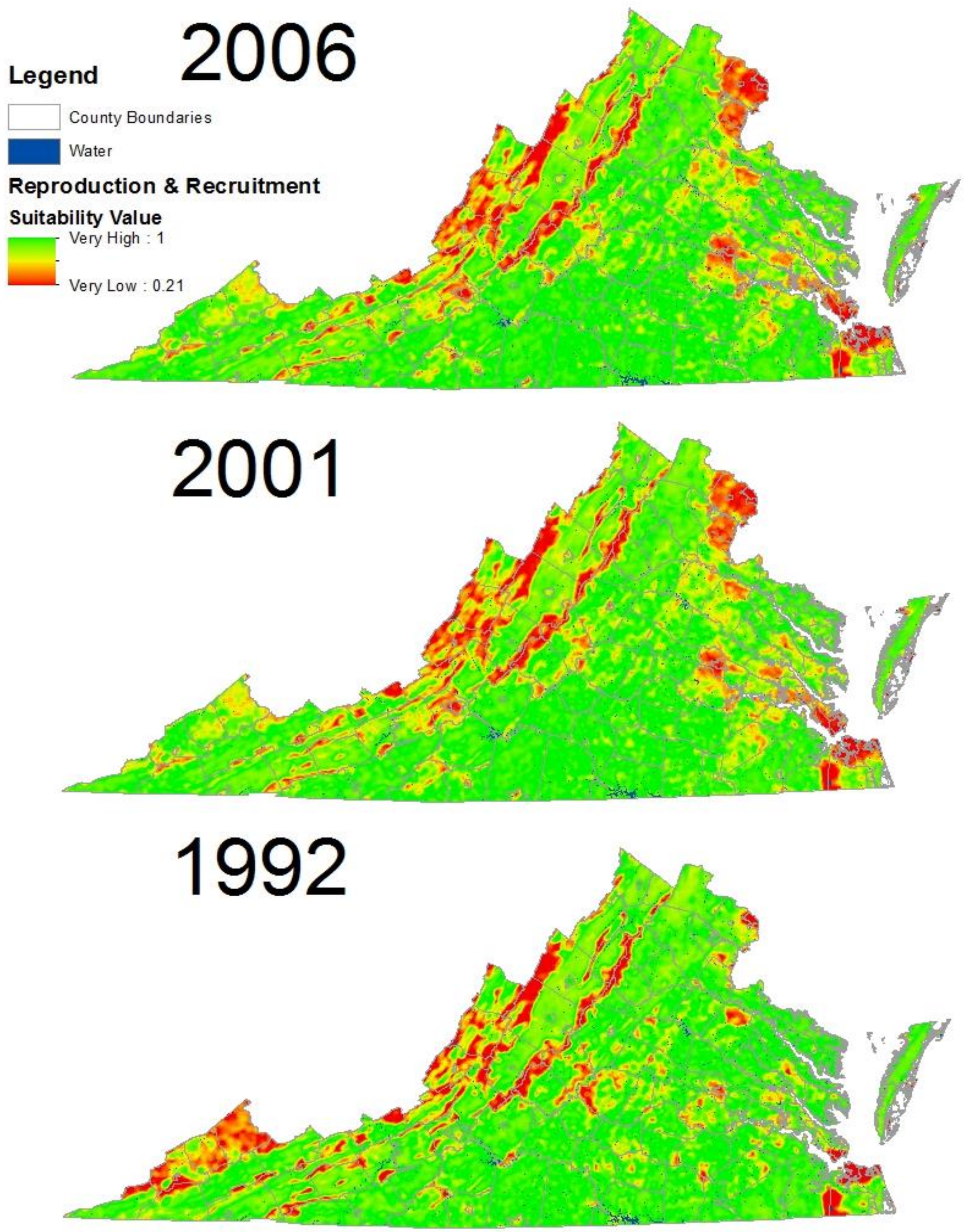

Figure 3-19. Reproduction and recruitment life requisite suitability for 2006, 2001, and 1992 based on the HSI model for the wild turkey in Virginia. The habitat suitability model used the National Land Cover Database (NLCD) to generate output. The suitability is measured on a continuous scale, ranging from 0 – 1, with 0 (dark red) being very low suitability and 1 (bright green) being optimal for wild turkeys.

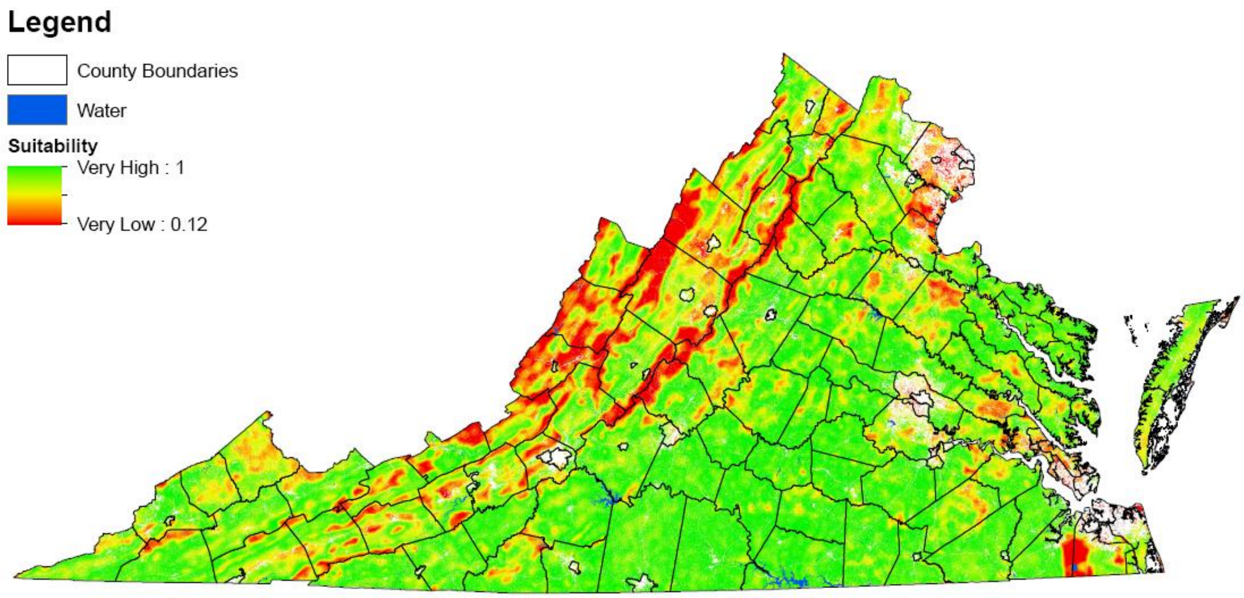

Figure 3-20. Overall habitat suitability for 2006 based on the modified habitat suitability model for the wild turkey in Virginia. Areas classified as unsuitable habitat (i.e., developed, barren land, emergent herbaceous wetlands). The habitat suitability model used the National Land Cover Database (NLCD) to generate output. The suitability is measured on a continuous scale, ranging from 0 – 1, with 0 (dark red) being very low suitability and 1 (bright green) being optimal for wild turkeys.

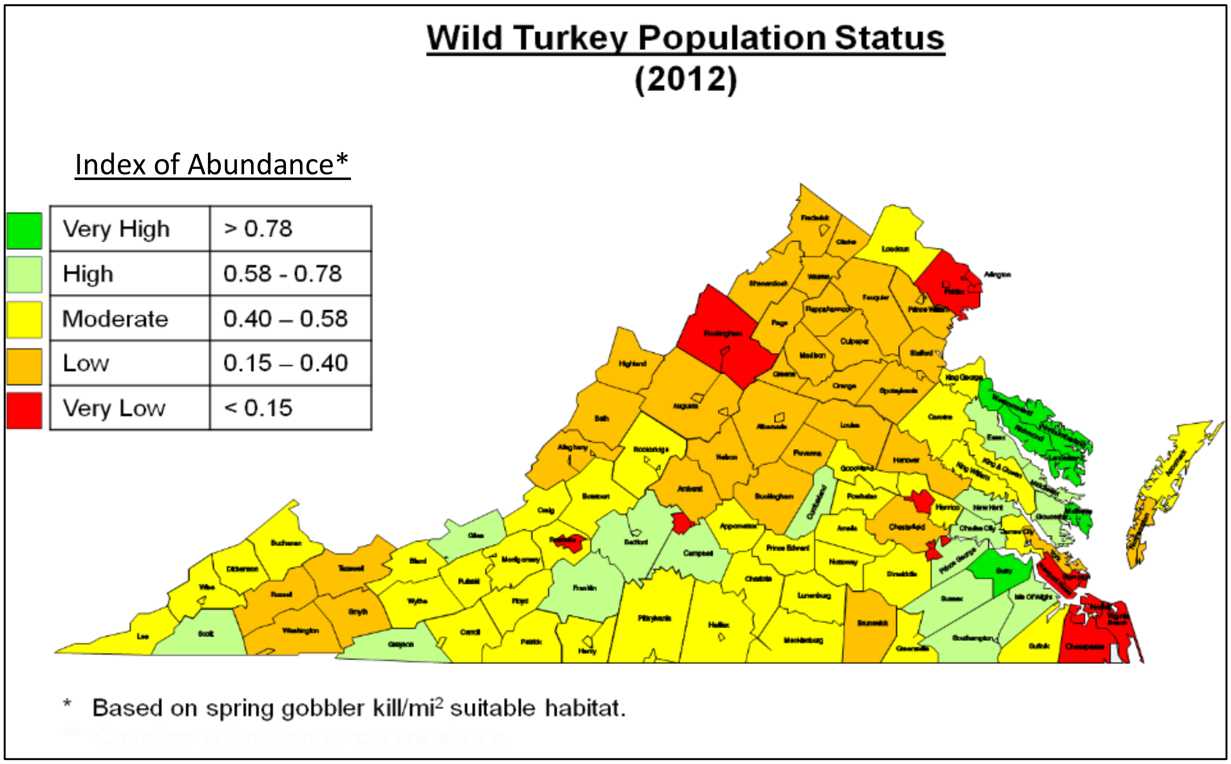

Figure 3-21. Wild turkey population status in Virginia for 2012 by comparing mean 2011 and 2012 spring turkey harvests and the square miles of suitable habitat per county. Suitable habitat includes deciduous forest, evergreen forest, mixed forest, scrub/shrub, woody wetlands, grasslands/herbaceous, hay/pasture, and cultivated crops.

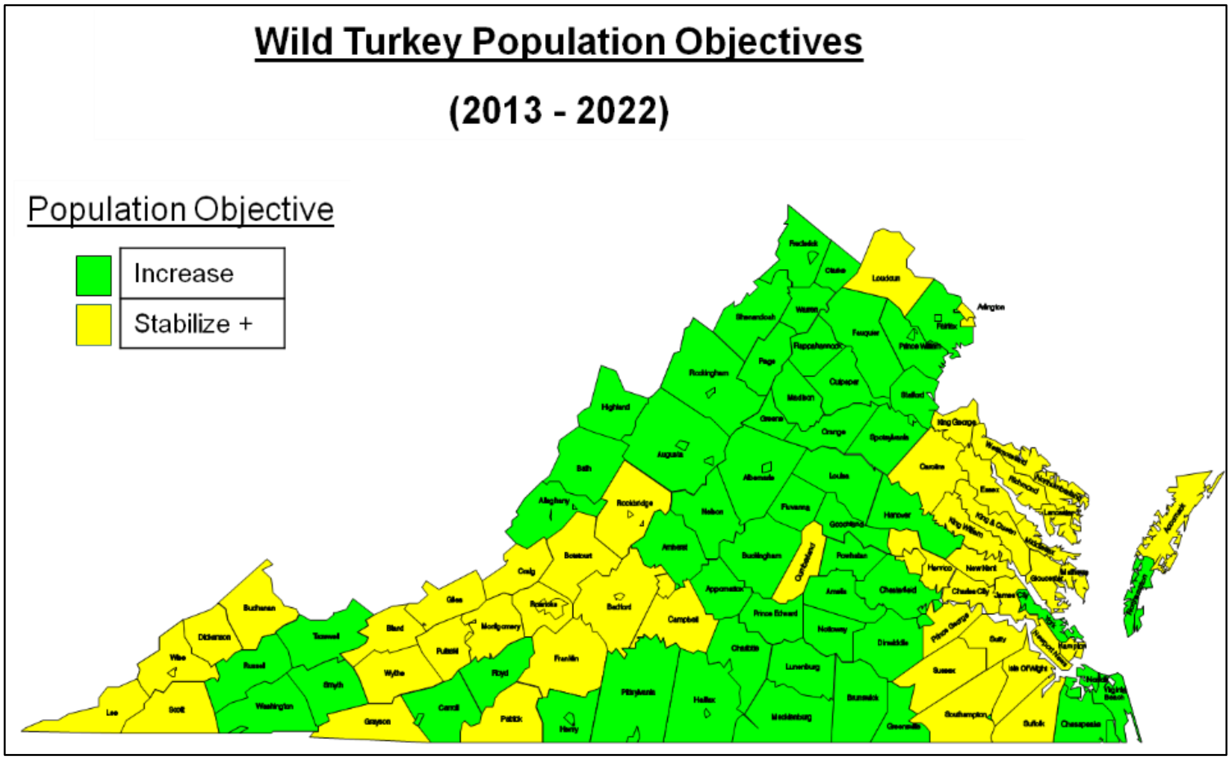

Figure 3-22. Population objectives for the Virginia Wild Turkey Management Plan. Counties designated for population increases (green) had low or very low wild turkey populations based on spring harvest/square mile of suitable habitat and very low to very high habitat suitability. Counties designated for 'stabilize +' were counties that the Virginia Department of Game and Inland Fisheries (VDGIF) was not striving to actively increase the population, however populations could naturally increase; counties with this objective had moderate to high wild turkey populations and moderate to very high habitat suitability.

Landowner/Site Name:______________________ Investigator:____________ Date:________

Acres Owned:________ UTM:______________________ Imagery Source: ______________

Habitat Component	Assessment focusing on the Area of Interest (AOI)				Assessment beyond the AOI *only* if suitability is poor
	Excellent	Good	Fair	Poor	
Adult Food					
1. Mature hard mast producing deciduous trees	70% - 100% of the area contains mature hard mast producing deciduous trees	30% - 69% of the area contains mature hard mast producing deciduous trees	Hard mast species are present, but are not mature enough to bear mast **OR** 1% - 29% of the area contains mature mast producing deciduous trees	No hard mast deciduous tree species are present in the area	Deciduous trees are present within a 1-mi radius from center of AOI
Suitability Value:________	6	4	2	0	2
2. Variety of oak species	≥2 species, one being from the white oak group and the other from the red oak group (1 species must be white oak - *Quercus alba*)	≥2 species, one being from the white oak group and the other from the red oak group (not white oak - *Quercus alba*)	1 species from either the red oak or white oak group	No oak trees are present in the area	
Suitability Value:________	3	2	1	0	
3. Soft mast	Soft mast producing species are present			Soft mast producing species are absent	
Suitability Value:________	3			0	
4. Grain crops	Grain crops are present			Grain crops are absent	
Suitability Value:________	2			0	

Sum from first page:______

Figure 3-23. Rapid habitat appraisal tool for the wild turkey in Virginia.

Habitat Component	Assessment focusing on the Area of Interest (AOI)				Assessment beyond the AOI *only* if suitability is poor
	Excellent	Good	Fair	Poor	
Adult & Brood Food					
5. Herbaceous openings	20% - 30% of the area contains herbaceous openings	10% - 19% or 31%- 50% of the area contains herbaceous openings	<10% or 51% - 100% of the area contains herbaceous openings	No herbaceous openings are present in the area	Herbaceous openings are present within a 1-mi radius from center of AOI
Suitability Value:________	6	4	2	0	2
Nesting Cover					
6. Interspersion index value using 1mi long transects diagonally across AOI	7+ changes in habitat	4 - 6 changes in habitat	1 - 3 changes in habitat	No changes in habitat	5+ changes exist beyond the AOI boundary
Suitability Value:________	3	2	1	0	1
Roost Cover					
7. Roost trees	**IF MOUNTAINOUS:** Conifer trees are present on northeast facing slopes and are large enough to support a roosting turkey	Conifer trees are present and are large enough to support a roosting turkey	Only deciduous trees are present and are large enough to support a roosting turkey	No trees large enough to support a roosting turkey are present on the property	Conifer trees are present within a 1-mi radius from center of AOI
	IF PIEDMONT OR COASTAL PLAIN: Conifer trees are present and are large enough to support a roosting turkey	Only deciduous trees are present and are large enough to support a roosting turkey		No trees large enough to support a roosting turkey are present on the property	Conifer trees are present within a 1-mi radius from center of AOI
Suitability Value:________	2	1.5	1	0	1
Habitat Arrangement					
8. Distance from nest habitat to brood range	Adjacent; brood range cumulatively is ≥ 5 acre	Less than 1/4 mile apart	Between 1/4 and 1/2 mile apart	No brood range **AND** nesting habitat in the AOI	Brood range and nesting habitat are present within 1/4 mi of the property boundary
Suitability Value:________	6	4	2	0	2

Total Suitability: ______	Excellent	Good	Fair	Poor
	31 - 24	23 - 16	15 - 8	7 - 0

Additional items for consideration: Are spring seeps present? Yes / No

Ownership of surrounding lands (Check the boxes and list name if known)

☐ Private citizen owned: ______________________________ ☐ State owned public land: ______________________________

☐ Private corporation owned: ______________________________ ☐ Federal owned public land: ______________________________

Figure 3-21. (Continued)

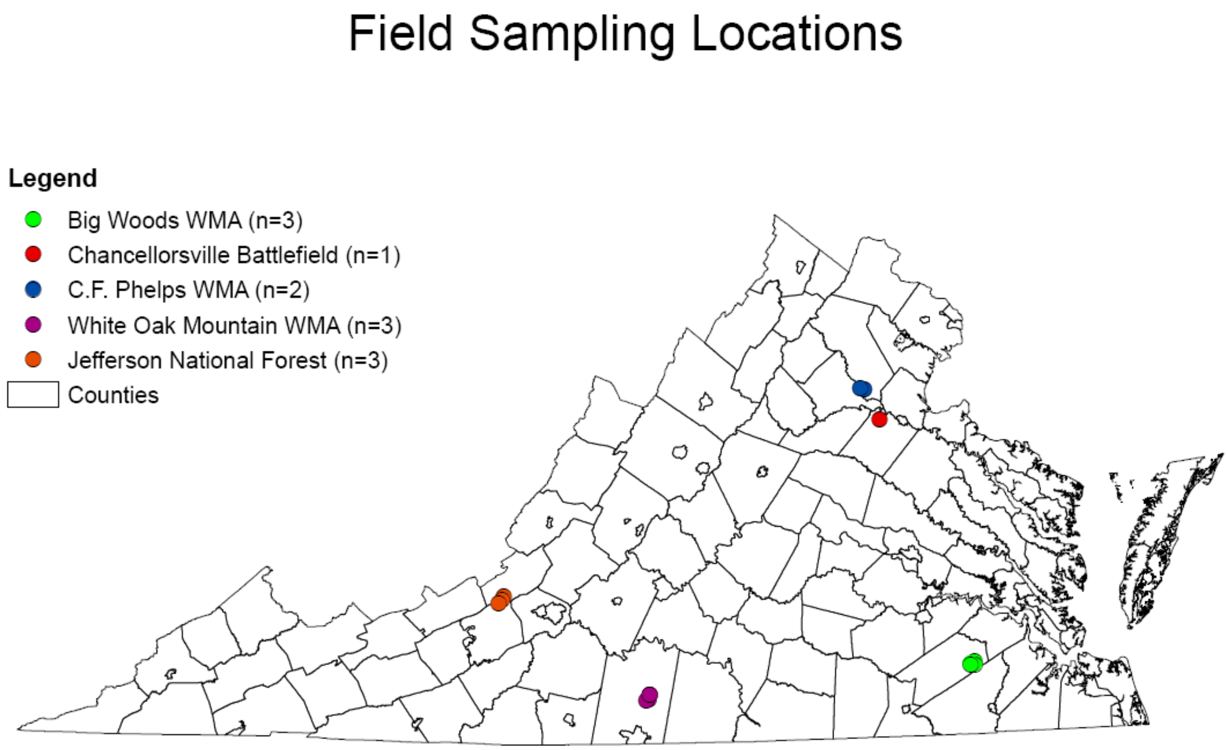

Figure 3-24. Field sampling locations (n=12) for testing the rapid habitat appraisal tool.

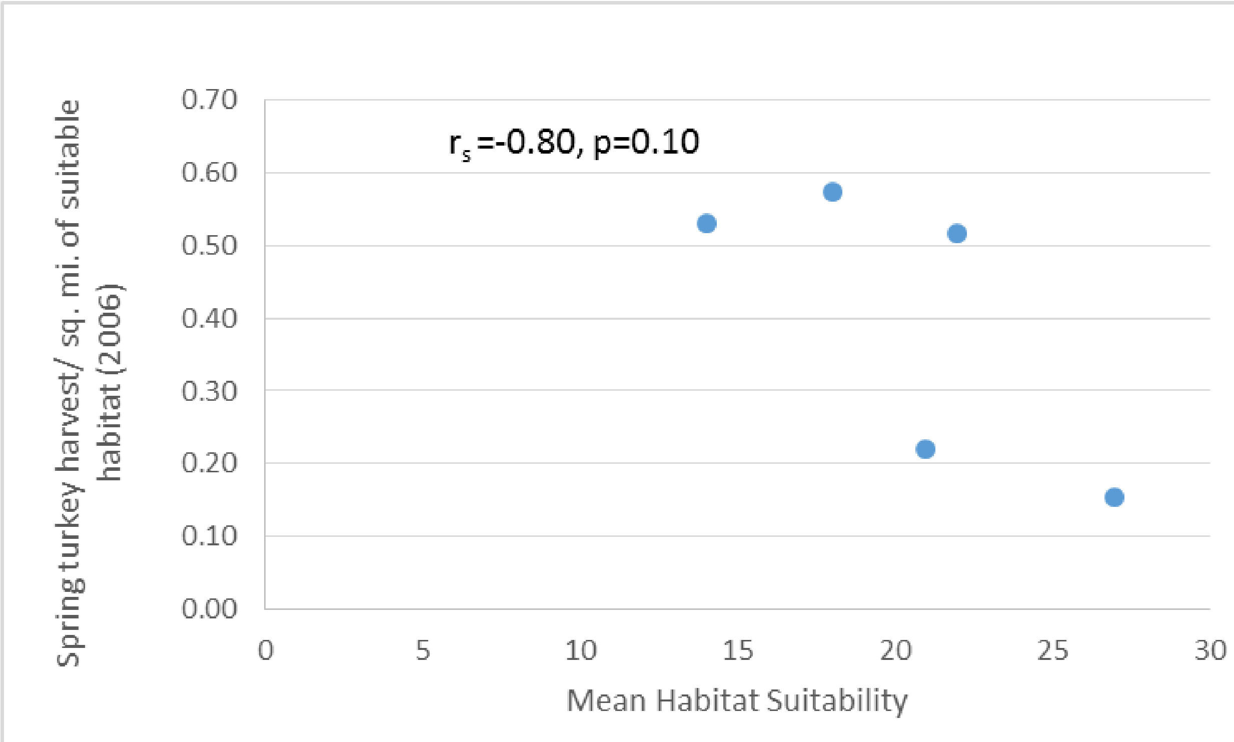

Figure 3-25. Correlation of the spring turkey harvest per square mile of suitable habitat with the county-level mean habitat suitability (n=5) for the sample sites using the rapid habitat appraisal tool.

Table 3-1. Required shapefiles and rasters for use in the habitat suitability model. Some data can be obtained directly from the website, whereas others must be created using existing datasets and geographic information system (GIS) software. Data have been hyperlinked to the location where they can be downloaded.

Source	Type of Data
Shapefiles	
	State boundary with counties
	State boundary with counties/cities open to turkey harvest (user developed)
	US Forest Service boundaries
	Wildlife Management Area boundaries (user developed from agency owned properties)
Rasters	
	National Land Cover Database
	US Forest Service boundaries
	Wildlife Management Area boundaries (user developed from agency owned properties)
	VA Div. of Forestry State Forest boundaries
	US Fish & Wildlife Service refuge boundaries
	National Park Service boundaries
	Department of Defense boundaries
	VA Dept. of Conservation and Recreation boundaries
	A raster representing 'all public land' (user developed)
	A raster representing USFS and WMA boundaries, combined (user developed)
	A raster representing US Forest Service boundaries west of the Blue Ridge (user developed)

Table 3-2. Error matrix for the continental United States 2006 National Land Cover Database (NLCD) using wild turkey habitat classifications (produced using data from the NLCD accuracy data for the continental US (Wickham et al. 2013)). Cell entries identify a percent of the area. Bold diagonal cell entries indicate the agreement. Overall accuracy is 92%.

	Reference					
Map	Water	Not Suitable	Forested	Open	**User's Accuracy [a]**	**Percent Map Area**
Water (11)	**1.99**	0.03	0.05	0.05	0.94	2.12
Not suitable (12, 21,22, 23, 24, 31, 95)	0.14	**5.56**	1.34	1.08	0.68	8.12
Forested (41, 42, 43, 52, 90)	0.04	1.18	**49.22**	1.99	0.94	52.43
Open (71, 81, 82)	0.01	1.31	1.98	**35.12**	0.91	38.43
Producer's Accuracy [b]	0.91	0.69	0.94	0.92	**91.89**	**Overall Accuracy**
Percent Reference Area	2.18	8.08	52.59	38.24		

[a] = the probability that a pixel was labelled correctly

[b] = the probability that the land cover on the ground was classified correctly

Table 3-3. Error matrix for the continental United States 2001 National Land Cover Database (NLCD) using wild turkey habitat classifications (produced using data from the NLCD accuracy data for the continental US (Wickham et al. 2013)). Cell entries identify a percent of the area. Bold diagonal cell entries indicate the agreement. Overall accuracy is 92%.

		Reference				
Map	Water	Not Suitable	Forested	Open	**User's Accuracy [a]**	**Percent Map Area**
Water (11)	**2.00**	0.02	0.07	0.06	0.93	2.14
Not suitable (12, 21,22, 23, 24, 31, 95)	0.11	**5.36**	1.37	1.11	0.67	7.95
Forested (41, 42, 43, 52, 90)	0.02	1.07	**49.53**	2.05	0.94	52.66
Open (71, 81, 82)	0.05	1.12	1.72	**35.33**	0.92	38.22
Producer's Accuracy [b]	0.92	0.71	0.94	0.92	**92.22**	**Overall Accuracy**
Percent Reference Area	2.18	7.57	52.68	38.55		

[a] = the probability that a pixel was labelled correctly

[b] = the probability that the land cover on the ground was classified correctly

Table 3-4. Error matrix for the Mid-Atlantic Region 1992 National Land Cover Database (NLCD) using wild turkey habitat classifications (produced using data from the NLCD accuracy data for the Mid-Atlantic Region (Stehman et al. 2003). Cell entries identify a percent of the area. Bold diagonal cell entries indicate the agreement. Overall accuracy is 74%.

	Reference					
Map	Water	Not Suitable	Forested	Open	**User's Accuracy [a]**	**Percent Map Area**
Water (11)	**3.77**	0.24	0.06	0.06	0.91	4.12
Not suitable (21,22, 23, 31, 32, 33, 85, 92)	0.16	**9.36**	1.95	1.84	0.70	13.31
Forested (41, 42, 43, 51, 91)	0.27	9.15	**44.49**	5.30	0.75	59.20
Open (61,71, 81, 82, 83, 84)	0.08	3.99	3.09	**16.20**	0.69	23.36
Producer's Accuracy [b]	0.88	0.41	0.90	0.69	**73.82**	**Overall Accuracy**
Percent Reference Area	4.28	22.73	49.58	23.41		

[a] = the probability that a pixel was labelled correctly

[b] = the probability that the land cover on the ground was classified correctly

Table 3-5. Results from the Delphi method survey asking participants to estimate the suitability of aerial imagery samples (n=12) across Virginia for wild turkey broods, adults, and for all wild turkeys. I developed revised HSI model suitability values by classifying all 'developed' lands as unsuitable wild turkey habitat.

	Overall Habitat Suitability			Adult Habitat Suitability			Brood Habitat Suitability		
Sample Site	Respondent Mean Suitability Value (n=7)	Initial HSI Model Suitability Value	Revised HSI Model Suitability Value	Respondent Mean Suitability Value (n=7)	Initial HSI Model Suitability Value	Revised HSI Model Suitability Value	Respondent Mean Suitability Value (n=7)	Initial HSI Model Suitability Value	Revised HSI Model Suitability Value
Region 1 Site 1	81	100	97	86	100	99	76	100	96
Region 1 Site 2	65	87	88	66	73	74	65	94	96
Region 1 Site 3	7	32	32	7	7	8	8	68	65
Region 2 Site 4	82	100	100	87	100	100	78	100	100
Region 2 Site 5	46	56	48	67	57	56	23	55	44
Region 2 Site 6	82	93	94	82	86	88	83	97	98
Region 3 Site 7	84	100	95	90	100	94	76	100	95
Region 3 Site 8	46	64	65	46	34	36	52	87	85
Region 3 Site 9	30	90	58	33	75	43	34	98	68
Region 4 Site 10	45	50	27	64	54	52	15	48	21
Region 4 Site 11	50	66	66	48	38	39	56	88	86
Region 4 Site 12	82	100	90	87	100	96	77	100	87

Table 3-6. Mean habitat suitability values by each physiographic region using 1992, 2001, and 2006 National Land Cover Database (NLCD) data.

	Overall HSI			Reproduction & Recruitment Life Requisite HSI			Adult Food and Cover Life Requisite HSI		
	1992	**2001**	**2006**	**1992**	**2001**	**2006**	**1992**	**2001**	**2006**
Tidewater	0.85	0.79	0.80	0.89	0.80	0.81	0.79	0.80	0.79
North Mountain	0.69	0.64	0.64	0.74	0.67	0.67	0.63	0.64	0.64
North Piedmont	0.85	0.78	0.77	0.89	0.80	0.79	0.79	0.76	0.75
South Mountain	0.78	0.81	0.81	0.80	0.84	0.84	0.74	0.78	0.78
South Piedmont	0.89	0.89	0.89	0.90	0.90	0.91	0.87	0.88	0.87

Table 3-7. Changes in the square miles of land cover types based on the National Land Cover Dataset (NLCD) from 1992-2006 for each physiographic province of Virginia.

	Open Water (1992-2006)	Developed - Open Space (2001,2006); Urban/recreational Grasses (1992)	Developed - Low Intensity (2001,2006); Low Intensity Residential (1992)	Developed - Medium Intensity (2001, 2006); High Intensity Residential (1992)	Developed - High Intensity (2001, 2006); Commercial/Industrial/Transportation (1992)
North Mountain (1992)	31.02	1.67	89.01	1.87	26.61
North Mountain (2001)	30.76	287.63	114.67	24.54	9.27
North Mountain (2006)	30.02	289.91	117.92	26.80	9.79
Change from 1992-2006	-1.00	288.25	28.91	24.94	-16.82
Change from 2001-2006	-0.74	2.29	3.26	2.26	0.52
North Piedmont (1992)	91.41	20.20	368.37	3.92	166.91
North Piedmont (2001)	77.68	672.51	305.65	121.30	38.25
North Piedmont (2006)	80.56	699.36	338.12	141.36	42.73
Change from 1992-2006	-10.85	679.16	-30.26	137.44	-124.18
Change from 2001-2006	2.88	26.85	32.46	20.07	4.48
South Mountain (1992)	37.26	2.68	Table 3-775.18	2.06	41.51
South Mountain (2001)	27.97	351.61	118.13	41.05	8.35
South Mountain (2006)	27.88	352.94	119.84	42.17	8.84
Change from 1992-2006	-9.39	350.26	44.66	40.10	-32.67
Change from 2001-2006	-0.09	1.33	1.71	1.12	0.49
South Piedmont (1992)	173.88	4.63	174.79	4.91	67.09
South Piedmont (2001)	156.06	519.43	179.22	43.64	17.01
South Piedmont (2006)	158.62	521.85	182.42	45.73	17.57
Change from 1992-2006	-15.26	517.22	7.63	40.82	-49.52
Change from 2001-2006	2.56	2.42	3.20	2.10	0.56
Tidewater (1992)	129.77	30.82	196.06	39.53	128.43
Tidewater (2001)	100.45	483.60	194.07	76.35	27.40
Tidewater (2006)	117.96	490.06	202.82	84.09	29.72
Change from 1992-2006	-11.81	459.24	6.76	44.56	-98.71
Change from 2001-2006	17.51	6.46	8.74	7.75	2.33

*Cells with N/A=that land cover type was not measured that year.

Table 3-6. (Continued)

	Barren Land (2001,2006); Barren/Quarries/ Transitional (1992)	Deciduous Forest (1992-2006)	Evergreen Forest (1992-2006)	Mixed Forest (1992-2006)	Shrub/ Scrub (2001-06)	Herbaceous (2001-06)	Hay/Pasture (1992-2006)
North Mountain (1992)	22.47	2895.28	238.17	655.24	N/A	N/A	1444.63
North Mountain (2001)	2.90	3157.18	347.30	183.06	0.00	0.00	1291.26
North Mountain (2006)	4.23	3156.60	344.56	182.30	0.88	4.85	1282.33
Change from 1992-2006	-18.24	261.32	106.39	-472.94	N/A	N/A	-162.30
Change from 2001-2006	1.33	-0.58	-2.74	-0.76	0.88	4.85	-8.93
North Piedmont (1992)	147.24	3257.30	490.57	1190.24	N/A	N/A	1814.89
North Piedmont (2001)	13.30	3294.07	716.82	274.12	268.94	52.88	1424.92
North Piedmont (2006)	18.09	3246.83	712.29	263.99	276.47	72.57	1398.79
Change from 1992-2006	-129.16	-10.47	221.72	-926.25	N/A	N/A	-416.10
Change from 2001-2006	4.79	-47.23	-4.53	-10.13	7.53	19.69	-26.13
South Mountain (1992)	62.11	4604.58	520.37	767.17	N/A	N/A	1532.03
South Mountain (2001)	31.41	4871.32	206.59	162.26	33.76	234.96	1691.20
South Mountain (2006)	39.26	4866.40	206.74	160.06	37.44	251.93	1667.47
Change from 1992-2006	-22.85	261.81	-313.63	-607.11	N/A	N/A	135.44
Change from 2001-2006	7.85	-4.93	0.15	-2.20	3.68	16.97	-23.74
South Piedmont (1992)	227.07	5047.33	1294.74	1870.21	N/A	N/A	2120.41
South Piedmont (2001)	24.33	5440.05	1664.06	496.23	214.20	332.92	2129.84
South Piedmont (2006)	22.59	5459.00	1593.04	467.02	289.26	380.48	2064.74
Change from 1992-2006	-204.48	411.67	298.29	-1403.19	N/A	N/A	-55.66
Change from 2001-2006	-1.75	18.95	-71.02	-29.21	75.05	47.56	-65.09
Tidewater (1992)	124.45	1316.83	861.18	1225.26	N/A	N/A	681.52
Tidewater (2001)	21.03	1041.82	1199.80	361.55	438.41	46.51	441.36
Tidewater (2006)	24.09	1036.64	1205.05	341.21	421.73	61.11	431.06
Change from 1992-2006	-100.36	-280.19	343.87	-884.05	N/A	N/A	-250.46
Change from 2001-2006	3.06	-5.18	5.25	-20.34	-16.68	14.61	-10.29

*Cells with N/A=that land cover type was not measured that year.

Table 3-6. (Continued)

	Cultivated Crops (1992-2006)	Woody Wetlands (1992-2006)	Emergent Herbaceous Wetlands (1992-2006)
North Mountain (1992)	121.17	0.00	0.00
North Mountain (2001)	86.89	0.84	0.90
North Mountain (2006)	85.99	0.84	0.92
Change from 1992-2006	-35.18	0.84	0.92
Change from 2001-2006	-0.90	0.00	0.02
North Piedmont (1992)	268.10	143.15	32.09
North Piedmont (2001)	409.90	309.50	14.16
North Piedmont (2006)	388.10	302.95	13.48
Change from 1992-2006	119.99	159.80	-18.61
Change from 2001-2006	-21.81	-6.55	-0.69
South Mountain (1992)	152.26	4.80	2.31
South Mountain (2001)	22.07	3.54	0.07
South Mountain (2006)	21.17	3.86	0.24
Change from 1992-2006	-131.09	-0.94	-2.07
Change from 2001-2006	-0.90	0.32	0.17
South Piedmont (1992)	312.76	201.31	22.68
South Piedmont (2001)	97.36	202.49	3.56
South Piedmont (2006)	114.57	201.40	3.55
Change from 1992-2006	-198.19	0.09	-19.13
Change from 2001-2006	17.21	-1.09	0.00
Tidewater (1992)	1197.46	778.51	341.76
Tidewater (2001)	1050.87	1270.12	291.28
Tidewater (2006)	1090.31	1238.54	293.44
Change from 1992-2006	-107.15	460.02	-48.32
Change from 2001-2006	39.44	-31.58	2.16

*Cells with N/A=that land cover type was not measured that year.

Table 3-8. Suitability of the 12 sample sites across Virginia based on the rapid habitat appraisal tool and habitat suitability model.

Site	Suitability based on small-scale rapid appraisal tool	Suitability based on landscape-level HSI model
White Oak Mountain WMA - Site 1	16 (Fair)	0.99
White Oak Mountain WMA - Site 2	24 (Good)	0.99
White Oak Mountain WMA - Site 3	25 (Excellent)	1
Jefferson National Forest - Site 1	23 (Good)	0.42
Jefferson National Forest - Site 2	16 (Fair)	0.51
Jefferson National Forest - Site 3	15 (Fair)	0.74
Big Woods WMA - Site 1	12 (Fair)	0.5
Big Woods WMA - Site 2	13 (Fair)	0.65
Big Woods WMA - Site 3	17 (Good)	0.62
C. F. Phelps WMA - Site 1	18 (Good)	0.9
C. F. Phelps WMA - Site 2	24 (Good)	0.98
Chancellorsville Battlefield	27 (Excellent)	0.66

Rapid appraisal tool scale is from 0-32, with 0-8 being poor, 9-16 being fair, 17-24 being good and 25-32 as excellent.

HSI model scale is from 0 -1, with 1 being optimum habitat and 0 not suitable habitat

Table 3-9. Rapid habitat appraisal tool mean output by county and spring wild turkey harvest per square mile of suitable habitat (using 2006 harvest and land cover data).

County - Sites	Mean Habitat Suitability	Spring harvest per square mile of suitable habitat (2006)
Pittsylvania - White Oak Mountain WMA (n=3)	22	0.52
Montgomery - Jefferson National Forest (n=3)	18	0.57
Sussex - Big Woods WMA (n=3)	14	0.53
Fauquier - C. F. Phelps WMA (n=2)	21	0.22
Spotsylvania - Chancellorsville Battlefield (n=1)	27	0.15

Rapid appraisal tool scale is from 0-32, with 0-8 being poor, 9-16 being fair, 17-24 being good and 25-32 as excellent.

Literature Cited

Anderson, M. G., M. Clark, C. E. Ferree, A. Jospe, A. Olivero Sheldon, and J. K. Weaver. 2013. Northeast Habitat Guides: A companion to the terrestial and aquatic maps. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office, Boston, Massachusetts, USA.

Dickson, J. G. 1990. Oak and flowering dogwood fruit production for eastern wild turkeys. Proceedings of the National Wild Turkey Symposium 6:90-95.

Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham. 2011. Completion of the 2006 National Land Cover Database for the conterminous United States. Photgrammetric Engineering & Remote Sensing 77:858-864.

Glennon, M. J., and W. F. Porter. 1999. Using satellite imagery to assess landscape-scale habitat for wild turkeys. Wildlife Society Bulletin 27:646-653.

Goetz, S. L. , and W. F. Porter. 2005. Statewide assessment of wild turkey habitat using satellite imagery in Arkansas. Proceedings of the National Wild Turkey Symposium 9:189-198.

Healy, W. M., and W. J. McShea. 2002. Goals and guidelines for managing oak ecosystems for wildlife. Pages 333-341 *in* W. M. Healy, and W. J. McShea, editors. Oak forest ecosystems: ecology and management for wildlife. The John Hopkins Univeristy Press, Baltimore, Maryland, USA.

Healy, W. M., and E. S. Nenno. 1980. Growth parameters and sex and age criteria for juvenile eastern wild turkeys. Proceedings of the National Wild Turkey Symposium 4:169-185.

Healy, W. M., and S. M. Powell. 1999. Wild turkey harvest management: biology, strategies, and techniques. U.S. Fish and Wildlife Service BTP-R5001-1999.

Homer, C., J. Dewitz, J. Fry, M. Coan, N. Hossain, C. Larson, N. Herold, A. McKerrow, J. N. Van Driel, and J. Wickham. 2007. Completion of the 2001 National Land Cover Database for the conterminous United States. Photgrammetric Engineering & Remote Sensing 73:337-341.

Hurst, G. A. 1992. Foods and feeding. Pages 66-83 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Hurst, G. A., and J. G. Dickson. 1992. Eastern turkey in southern pine-oak forests. Pages 265-285 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Korschgen, L. J. 1967. Feeding habits and foods. Pages 137-198 *in* D. G. Hewitt, editor. The wild turkey and its management. The Wildlife Society, Washington, D.C., USA.

Latham, R. L. 1976. Complete book of the wild turkey. Revised edition. Stackpole Books, Harrisburg, Pennsylvania, USA.

Leopold, A. 1986. Game management. University of Wisconsin Press, Madison, USA.

Lint, J. R., B. D. Leopold, and G. A. Hurst. 1995. Comparison of abundance indexes and population estimates for wild turkey gobblers. Wildlife Society Bulletin 23:164-168.

Ludwig, E. 2012. Reproductive ecology of eastern wild turkey hens in Sussex County Delaware. Thesis, University of Delaware, Newark, USA.

McDougal, L. A. 1990. Wild turkey-road interactions on a Virginia national forest. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

McGhee, J. D., J. Berkson, D. E. Steffen, and G. W. Norman. 2008. Density-dependent harvest modeling for the eastern wild turkey. Journal of Wildlife Management 72:196-203.

Miller, D. A., B. D. Leopold, and G. A. Hurst. 1997. Seasonal home ranges of wild turkeys in central Mississippi. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 51:414-425.

Minser, W. G., T. Allen, B. Ellsperman, and S. E. Schlarbaum. 1995. Feeding response of wild turkeys to chestnuts and other hard mast. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 49:488-497.

Missouri Department of Conservation, and USDA Soil Conservation Service. 1988. Wildlife habitat apprasial guide: Missouri. JS-Biol-13(4).

Mosby, H. S., and C. O. Handley. 1943. The wild turkey in Virginia: its status, life history and management. Virginia Commission of Game and Inland Fisheries, Richmond, USA.

Norman, G. W., and D. E. Steffen. 2003. Effects of recruitment, oak mast, and fall-season format on wild turkey harvest rates in Virginia. Wildlife Society Bulletin 31:553-559.

Porter, W. F. 1992. Habitat requirements. Pages 202-213 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Rose, A. K. 2009. Virginia's forests, 2007. U.S. Department of Agricutlure Forest Service Resource Bulletin SRS-159, Southern Research Station, Asheville, North Carolina, USA.

Schroeder, R. L. 1985. Habitat suitability index models: eastern wild turkey. US Fish and Wildlife Service, Biological Report 82(10.106), Washington, D.C., USA.

Steffen, D. E., C. E. Couvillion, and G. A. Hurst. 1990. Age-determination of eastern wild turkey gobblers. Wildlife Society Bulletin 18:119-124.

Stehman, S. V., J. D. Wickham, J. H. Smith, and L. Yang. 2003. Thematic accuracy of the 1992 National Land-Cover Data for the eastern United States: Statistical methodology and regional results. Remote Sensing of Environment 86:500-516.

US Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models. <http://www.fws.gov/policy/ESM103.pdf >. Accessed 3 Mar 2012.

US Fish and Wildlife Service. 1987. Guidelines for using the delphi technique to develop habitat suitability index curves. Biological report 82(10.134).

USDA National Agricultural Statistics Service. 2009. 2007 Census of agriculture. Geographic area series part 51. Document number AC-07-A-51, Washington, D.C., USA.

USDA Natural Resources Conservation Service. 2013a. Soil survey geographic (SSURGO) database. <http://soildatamart.nrcs.usda.gov/ >. Accessed 2 Dec 2013.

USDA Natural Resources Conservation Service. 2013b. US general soil map (STATSGO2). <http://soildatamart.nrcs.usda.gov/ >. Accessed 19 Dec 2013.

VanHorne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management 47:893-901.

Vogelmann, J. E., S. M. Howard, L. Yang, B. K. Wylie, and N. Van Driel. 2001. Completion of the 1990s National Land Cover Data Set for the conterminous United States from Landsat Thematic Mapper data and ancillary data sources. Photgrammetric Engineering & Remote Sensing 67:650-662.

Wickham, J. D., S. V. Stehman, L. Gass, J. Dewitz, Joyce A. Fry, and T. G. Wade. 2013. Accuracy assessment of NLCD 2006 land cover and impervious surface. Remote Sensing of Environment 130:294-304.

Wildlife Management Institute. 2013. Creation of regional habitat cover maps: application of the Northeast Terrestrial Habitat Classification System. <http://rcngrants.org/content/creation-regional-habitat-cover-maps-application-northeast-terrestrial-habitat >. Accessed 2 Dec 2013.

Wunz, G. A., and J. C. Pack. 1992. Eastern turkey in eastern oak-hickory and northern hardwood forests. Pages 222-264 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Chapter 4:

Synthesis

Collaborative management planning for the wild turkey

I found that participation in a collaborative planning process resulted in positive changes in the knowledge, opinions, and attitudes of Stakeholder Advisory Committee (SAC) members and Wild Turkey Technical Committee members (Technical Committee); however, Wildlife Bureau staff did not respond similarly. SAC members improved their knowledge of wild turkey and their management. The SAC also thought VDGIF does a better job obtaining and considering public input and making decisions with public values in mind. Overall, the SAC thought more stakeholder involvement in decision-making was necessary after participating in the process.

The Technical Committee placed more importance on the minority stakeholder groups' values (e.g., individuals who wish to harvest a turkey while pursuing other game species) and became more accepting of VDGIF and turkey management, specifically regarding keeping stakeholders informed, understanding stakeholders, and making decisions with public values in mind. Technical Committee members desired more involvement from stakeholders in in setting goals and objectives, but retained a preference for professional opinion when selecting strategies.

Wildlife Bureau personnel placed more importance on the values of agricultural producers, private urban landowners, and individuals who enjoy viewing wild turkeys, but not for individuals who wish to harvest a turkey while pursuing other game species. Personnel thought VDGIF did a good job of considering public input, basing management on science, and thought the Board of VDGIF did a better job balancing scientific and stakeholder input. Conversely, Wildlife Bureau personnel thought the agency did a poor job of keeping stakeholders informed. Also, Wildlife Bureau personnel did not believe that stakeholders should be involved in decision-making to the degree SAC members and Technical Committee members did; Wildlife Bureau personnel desired more professional involvement in decision-making. Passive involvement in collaborative planning does not yield the same results as active involvement.

This planning effort also provides a template for future iterations of the Virginia Wild Turkey Management Plan, in addition to providing insight to the changes in values, attitudes, and opinions. Technical Committee members can build upon the background material developed previously for future revisions of the plan. In addition, revisions of the management plan and monitoring during the 10-year period could provide insight to changes in stakeholder values and shifts in the desires of fall turkey allocation. Fall turkey season may become less or more popular, and utilization of a collaborative planning process will enable VDGIF to correctly allocate the harvest among hunting groups based on stakeholder values.

Recommendations for future planning efforts

I suggest that VDGIF consider a broader group of stakeholders for inclusion on the SAC, based on the feedback received from the SAC during the phone interviews. When asking stakeholders to participate on the SAC, sharing an electronic or hard copy of the Virginia Wild Turkey Management Plan may encourage non-traditional groups (e.g., non-consumptive users) to participate on future advisory committees. This information would give stakeholder groups an idea of the end product and what goals, objectives, and strategies have included previously. VDGIF should explore the possibility of including other public landowners on the SAC, too. VDGIF needs to develop partnerships with all landowners to achieve the desired population goals for wild turkeys.

The SAC and Technical Committee both indicated a desire for stronger stakeholder roles in making most management decisions. Even after multiple planning efforts, VDGIF's desire for increased public involvement in decision-making is very similar to their initial opinions after participating in a bear management planning effort (Lafon 2002); however, the Technical Committee still expresses substantially different desires for public involvement in decision-making than before that effort. Continuing efforts to involve stakeholders actively in making value decisions, while focusing professional involvement on making technical decisions, should further enhance the knowledge of stakeholders and their views of the agency. Those efforts also should generate greater comfort among wildlife professionals that meaningful public involvement can occur without compromising the scientific basis for management.

Also, VDGIF should direct more effort toward keeping all Wildlife Bureau personnel informed of the management planning process. Obviously, these individuals did not understand the comprehensive process nor the effort put forth by facilitators to keep stakeholders informed during the process. Facilitators should develop and disseminate updates regarding management planning efforts to agency staff, in addition to stakeholders. Technical Committee members could share information from technical meetings with other Wildlife Bureau staff from the area they represent, similar to the role SAC members played. Also, these individuals do not seem comfortable including public opinion in decision-making. This should be alarming, as VDGIF has developed 6 total collaborative management plans and the majority of these individuals apparently did not participate in those processes. VDGIF staff facilitating planning efforts should encourage biologists and others not previously involved in collaborative planning (e.g., administrators, non-game biologists) to attend future SAC meetings and public input events (i.e., focus groups, workshops) to gain an understanding of how stakeholders participate and the benefits of stakeholder involvement. Perhaps encouragement from administrators or developing requirements to interact in management planning efforts would increase the number of staff members attending these events. Overall, study results indicate that some members of the agency may not "buy-in," have not been provided the opportunity to see the process, or are not convinced of the benefits of collaborative planning.

Assessing landscape-level habitat for the wild turkey

My research developed a 2-step comprehensive habitat assessment for the wild turkey in Virginia. The first step of the assessment, the landscape-level habitat suitability model using a geographic information system (GIS), enables managers to evaluate habitat at a large scale (5,167 acres). Using this assessment, the best wild turkey habitat in Virginia exists in the South Piedmont region and the lowest quality habitat exists in the North Mountain region. Habitat quality has declined from 1992 to 2006 in the North Piedmont, Tidewater, and North Mountain regions.

This landscape-level habitat suitability model also provides biologists an improved method of calculating wild turkey abundance estimates. The total area of suitable habitat for wild turkeys can be calculated, which then can be used with wild turkey harvest data to generate county-level turkey abundance estimates. Previously, biologists only included forested area as suitable habitat, which does not accurately represent suitable habitat for wild turkeys.

Future Application and Improvements

Future application of the landscape-level habitat suitably model should include running the model with the 2011 National Land Cover Database (NLCD), anticipated in early 2014. This new data will provide the most recent assessment of wild turkey habitat in Virginia. Also, managers should use the output produced with the 2011 NLCD in conjunction with prior years' output to provide a larger sample size to correlate with wild turkey indices of abundance and harvest to validate the model. The initial validation techniques used only had a maximum of 3 years of NLCD data (1992, 2001, 2006).

In addition to assessing habitat, managers could use the data derived from the habitat suitability model to establish turkey management units. To determine the appropriate grouping, I suggest that managers perform a cluster analysis of wild turkey density estimates for each county. Managers should use their best judgment in grouping counties; a turkey management unit of 4 or 5 counties would provide a meaningful management area, whereas one or two counties would not be realistic to impose landscape-level habitat management and hunting regulations. Managers can re-evaluate turkey management units every 5 years when the Multi-Resolution Land Characterization consortium releases new NLCD data. This approach would make the turkey management units adaptable to changes in habitat and harvest rates.

Wild turkey research in Virginia should focus on obtaining updated home range estimates for wild turkeys. Recent and localized home range data would improve model output, as some areas may be including unnecessary acreage. As habitat quality declines, turkeys will increase their home ranges to fulfill their needs, and in high quality habitat, home ranges will be smaller. I believe the actual mean home range is smaller in higher quality habitat found in the South Piedmont region of Virginia compared to the mean home range of 5,189 acres (McDougal 1990) in the relatively lower quality habitat in the western mountains of Virginia. This large home range estimate may affect model validity to some degree, as the areas identified as poor quality habitat likely would still be poor quality in a smaller home range, whereas fair and good quality areas may decline in suitability if the home range were smaller.

New Sources of Data

Since the completion of my research, a conglomerate of state agency and non-governmental organization personnel developed a new habitat classification system, the Northeast Terrestrial Wildlife Habitat Classification System (NETWHCS) and a guide for its application in the Northeast (Anderson et al. 2013, Wildlife Management Institute 2013). This classification system identifies fine habitat characteristics, unlike the coarse classification of the NLCD. The NETWHCS identifies habitat features (e.g., Central Appalachian Pine-Oak Rocky Woodland) and habitat macrogroups (e.g., Central Oak-Pine). This detailed approach to mapping habitat would enable managers to distinguish between higher quality oak mast producing stands and less desirable northern hardwood stands. I suggest that VDGIF personnel modify the current habitat suitability model to use the NETWHCS data, but only use the NETWHCS data for identifying fine-scale habitat where necessary (i.e., differentiating between deciduous forest types for food sources). To improve the V_f variable of the model, managers could incorporate a ranking system to place more value on high quality oak forest habitat and place less value on northern hardwoods. However, I encourage managers to continue to use the NLCD data, in addition to the NETWHCS. The Multi-Resolution Land Characterization consortium has produced the NLCD since

1992 and managers can use the data to compare current habitat with past conditions, unlike the NETWHCS data that exists for only one year. In addition, the new iterations of the NLCD will be produced every 5 years, and managers can use the data for assessing long term trends.

Additional variables

With the inclusion of additional variables, biologists can assess the full potential of wild turkey populations at the landscape-scale. The current model only accounts for habitat features, but other variables such as weather, fall hunting season length, disease, mast availability, and soil type also can effect wild turkey populations.

Diseases, such as lymphoproliferative disease virus (LPDV), could affect survival or reproduction of wild turkeys. Currently, biologists know little about LPDV and its effects on wild turkey populations; other diseases, such as avian pox, are not found regularly in wild turkey populations and thus pose little threat. VDGIF should continue to collect annual samples and identify where LPDV currently exists in Virginia. This turkey leg collection from spring or fall harvested turkeys would provide a sample to that could be sent to a laboratory for LPDV testing and also could be used to collect age and sex data from harvested birds (Healy and Nenno 1980, Steffen et al. 1990), similar to the previous feather samples collected at check stations. Coloration of the leg samples also can be used to distinguish between juvenile and adult turkeys (Latham 1976). Biologists could summarize this data for each county and a GIS dataset indicating detection or non-detection could be created and incorporated in the model.

Mast production often dictates where turkeys will be found and can pose implications for fall harvest. Hunters harvest more wild turkeys during years of poor mast production because turkeys are more visible to hunters, often visiting open areas and traveling for food (Norman and Steffen 2003). VDGIF, in conjunction with the Virginia Department of Forestry, conducts a statewide mast survey annually indicating the relative abundance of mast (low, moderate, high) (Virginia Department of Forestry, unpublished report). Biologists could compile this information for each VDGIF region, if data are not available for every county, and incorporate the data in the model (3=high, 2=mod., 1=low) to indicate the potential for wild turkey harvest in the fall.

Further, poor quality soils often hamper management improvement efforts. Information on soils could help managers determine appropriate management actions needed to produce more desirable vegetation for wild turkeys. The US General Soil Map (STATSGO2) can be used to identify soil types and could provide sufficient detail necessary for these purposes (USDA Natural Resources Conservation Service 2013b). I suggest incorporating a weighting system based on the habitat type, where the higher quality soil types receive larger values, similar to the approach suggested for establishing values for various deciduous forest types.

Assessing patch-level habitat for the wild turkey

The second component of the habitat assessment includes a rapid habitat appraisal tool that uses aerial imagery and data from a site visit to assess habitats of <1,000 acres. This tool enables wildlife professionals to assess the habitat suitability of individual tracts, e.g., private landowners. Prior to this tool, biologists had no means to assess the quality of habitat on smaller tracts, other than using professional opinion. This tool enables biologists objectively to assess habitat and provides a standardized means of assessing habitat over time. After assessing the area, the appendix provided in the user's manual for the rapid appraisal tool provides users suggestions for improving the habitat. After applying habitat improvement techniques, biologists can monitor areas and determine if the habitat management has successfully improved the suitability for wild turkeys.

Overall, I believe the rapid appraisal reasonably assesses habitat in Virginia. Field testing of the appraisal tool revealed varying results when compared with landscape-level suitability values. I observed fair habitat in the Jefferson National Forest due to the limited number of openings. The Big Woods WMA sample sites in the Tidewater region of Virginia rated with fair-good suitability values due to the extensive pine stands with limited openings. I observed better quality habitat at the Phelps WMA and Chancellorsville Battlefield, where the suitability ranged from good-excellent because of the combination of open and forested cover types. Additionally, the habitat at the White Oak WMA ranged from good-excellent suitability, resulting from the extensive openings and small game management activities on the WMA. Application of this tool at the appropriate scale (<1,000 acres) will ensure reasonable results are produced.

Future Application and Improvements

Individuals revising this appraisal tool should add a section addressing soil type and quality. Because this assessment is designed for use on small areas, users should use the more detailed Soil Survey Geographic (SSURGO) database (USDA Natural Resources Conservation Service 2013a). Depending on the habitat components that need improvement, biologists can use the soil data to identify where landowners should create fields, based on the locations of favorable soils. Biologists also can identify appropriate vegetation that landowners should plant based on the soil types present. Oftentimes, vegetation exhibits a preference for well drained or moist soil; planting ladino white clover or other plants needing fertile soils with appropriate soil pH on a dry, infertile Appalachian ridge will result in a poor growth and little use for wild turkeys. Further, if the landowner or biologist submitted a soil sample for testing, the results from the analysis could enable the biologist to make additional suggestions regarding the vegetation to be planted and fertilizer and lime application rates. Using this information enables biologists to make the best suggestions for improving habitat for wild turkeys and ensuring limited resources (e.g., money) are well spent.

Applying human dimensions and habitat modeling together

Although my work focused on 2 seemingly separate areas, managers should consider both ecological science and social science to be successful in managing the wild turkey. A habitat assessment may provide information regarding the areas in Virginia with low and high quality habitat, but what good is this information if the agency has no guidance regarding the desires of stakeholders for those areas? Should the agency work to improve low quality habitat, which may increase the turkey population? If so, will this pose problems for stakeholders (e.g., viticulturists) as the population of turkeys exceeds cultural carrying capacity? A collaborative planning process enables agency staff and stakeholders to work together to develop a strategic management plan that assists the agency in making management decisions, similar to those I just posed. Both stakeholder values and habitat suitability influence each other, and ignoring one component will cause issues for the agency and stakeholders as management goals may not be met, or difficulties between stakeholders and staff will arise.

Habitat Suitability and Stakeholders

Based on the habitat suitability model I developed for Virginia, the output indicates that private lands provide the best habitat for wild turkeys, whereas public lands provide relatively poor quality habitat. To achieve the county-level population goals as identified in the management plan (Figure 4-1), VDGIF must work with all public land owners. The US Forest Service was the only public landowner that served on the SAC during the development of the first Virginia Wild Turkey Management Plan. Clearly, other large landowners exist (i.e. National Park Service – Shenandoah National Park) and these landowners should be included on the SAC during the revision of the management plan to enable the group to provide their points of view and develop partnerships with the agency to manage habitat for wild turkeys. Inclusion of these landowner groups may identify areas where habitat management may not be attainable (e.g., preservation of lands is the stakeholder group's objective), and this is important to recognize to ensure unattainable population objectives are not established for certain areas (e.g., counties where the Shenandoah National Park encompasses a large proportion).

Further, partnerships with these stakeholder groups may provide a workforce and/or funding to achieve habitat management. Habitat management is one of the primary factors the agency can manipulate to increase turkey populations. Based on National Wild Turkey Federation (NWTF) *Save the Habitat, Save the Hunt* meetings I attended, the NWTF desires to spend more money east of the Blue Ridge Mountains on habitat management. Previously, this group has focused much of their effort on US Forest Service property west of the Blue Ridge Mountains. Providing the NWTF with information on the current habitat suitability across Virginia would show the organization areas with high and low habitat suitability, and enable them to target areas and spend their funds more effectively. The ecological value is minimal when providing large-scale habitat management in an area with relatively high habitat suitability; whereas, large-scale projects on low suitability lands would provide greater value to the resource.

The habitat suitability assessment also identified certain physiographic regions in Virginia have better habitat suitability for wild turkeys than others. The best habitat suitability, based on the 2006 NLCD, exists in the South Piedmont region; however, habitat quality has declined in the North Piedmont, Tidewater, and North Mountain regions. Agency staff must inform stakeholders in these regions regarding the declining habitat suitability and should seek their help to correct the decline. Urban expansion and the decline of forested cover likely is responsible for the decline in habitat suitability for the Tidewater and North Piedmont regions (Table 4-1), and partnering with soil and water conservation districts may provide a partnership to help conserve habitat in these regions. Wild turkeys are not the only species being affected by urbanization; other stakeholders with wildlife interests (e.g., birding groups) may also be beneficial in these areas in providing habitat conservation.

The decline in habitat suitability for the North Mountain region is related to the loss of hay/pasture and cultivated crop cover types, and the increase in evergreen and deciduous forested cover types (Table 4-1). This decline in habitat suitability not only affects wild turkeys, but likely also affects white-tailed deer. Recently in Bath County, hunters and other stakeholders have asked the VDGIF to establish quality deer regulations (e.g., antler restrictions) as a means to provide quality deer to harvest, and in turn, to encourage hunters to travel to the area. Stakeholders recognize the importance of hunting as tourism; in the 1970s, hunters flocked to this region of Virginia to hunt deer when deer population elsewhere were minimal. Hunters could also market this region of Virginia as a prime wild turkey hunting destination that boasts ample public lands, if stakeholder and staff work to improve habitat as a means to increase wild turkey populations.

Wild Turkey Population Objectives and Habitat Suitability

When developing the Virginia Wild Turkey Management Plan, habitat quality, based on the habitat suitability model, provided much needed information in establishing the population objectives for wild turkeys. First, I used the habitat suitability model to produce the mean habitat suitability for each county and independent city in Virginia (Figure 4-2). Next, VDGIF staff developed an index of wild turkey abundance using spring harvest data and the square miles of suitable habitat (derived from the habitat suitability model) (Figure 4-3). This index provided an overall estimate of the current wild turkey population for each county in Virginia. Using both habitat suitability and the turkey abundance index, staff developed a matrix ranking counties from very low – very high based on habitat suitability and the index (Figure 4-4). This matrix provided information to determine which counties have suitable conditions for increasing turkey population objectives. Overall, staff expected counties with high habitat quality to have a high index of turkeys; however discrepancies did exist. Counties with moderate to high wild turkey populations and moderate to very high habitat suitability staff designated these as suitable for increasing turkey population objectives (Figure 4-1). At this point in Virginia, stakeholders have not identified an upper limit on cultural carry capacity of wild turkeys at the county-level; however local discrepancies (e.g., near vineyards) do exist. None of the counties were designated with a decrease turkey population objective.

Focusing on the habitat/turkey index matrix further, counties with high habitat quality and a high index of turkeys would not be suitable for increasing population objectives; it would be unlikely for these areas to achieve more turkeys based on habitat improvements. Increased harvest in these areas would be acceptable, but careful monitoring would be needed to ensure the population is not over-harvested.

Areas with moderate habitat quality but low harvest indicate that the population of wild turkeys may be limited by habitat quality, and it would be best to not recommend increased harvest in those counties at this time. Designating these areas for habitat improvement may provide the means necessary to increase wild turkey populations (as noted by the increase in harvest) and at that time, increasing harvest opportunities would be appropriate.

As habitat quality, turkey abundance, and stakeholder values change, the appropriate population objectives and management strategies (e.g., habitat management, season length) will change. Ignoring any one of these factors can cause problems for managers, as false expectations may be developed (e.g., ability to increase a turkey population in a poor quality area, desire to harvest more birds where the population is relatively low). Careful monitoring of these factors enables managers to base recommendations on sound science and incorporate public values, which enables them to best manage the wild turkey.

Management Recommendations

The agency should focus on the tools and information I have provided them to best manage the wild turkey in Virginia. The comprehensive habitat assessment provides the agency with tools that other states do not have; habitat can be monitored over time, high and low quality areas can be identified, managers can assess habitat for landowners, and property can be assessed before the agency purchases it. The collaborative planning effort provided the agency with a 10-year strategic plan for wild turkeys, and insight to the knowledge, attitudes, and opinions of stakeholders and agency staff.

Habitat in certain regions of the state (e.g., private lands, North Mountain region) need improvement, as these are some of the lowest quality areas for wild turkeys in Virginia. Through the survey effort, I identified that some Wildlife Bureau personnel may not be comfortable with public involvement, have not experienced public involvement, or are not 'sold' on the benefits of public involvement.

Turkey management can be improved by utilizing partnerships with stakeholders (e.g., NWTF) to achieve habitat management needs. The NWTF can provide a workforce and funding to complete habitat projects that often the agency does not have the manpower or funding to accomplish alone. Keeping stakeholders informed of the progress in accomplishing items identified in the Wild Turkey Management Plan will keep stakeholders interested and perhaps increase public knowledge of these collaborative planning efforts; new stakeholder groups may see the benefits of the planning effort and decide they want to be involved in future revisions of the plan.

Threats to achieving the goals in the management plan may include funding and manpower, but also the interest of stakeholders. If staff and stakeholders do not work toward achieving goals (i.e., hunting tradition), there may not be a substantial enough interest in 10 years to revise the plan. The number of hunters has been declining as baby boomers age, and without hunters, little interest will exist in wild turkey management; we saw minimal participation from the non-consumptive users during this planning process. Both the agency and stakeholders have worked hard to develop this plan, and both groups should continue working together to ensure goals become accomplishments and wild turkeys continue to be an important resource for Virginians.

Summary

Wildlife management includes managing populations, habitat, and people (Giles 1978), and prior to my research, VDGIF had minimal information regarding habitat and stakeholders involved in wild turkey management. The collaborative planning process employed to develop the Virginia Wild Turkey Management Plan not only enabled the agency to develop a plan based on public values, but also effected the knowledge, attitudes, and opinions of stakeholders and VDGIF staff, as discovered during my pre- and post-planning survey effort. The landscape-level habitat suitability model for wild turkeys in Virginia provided insight to current and past habitat quality across Virginia and provided information to assist the Technical Committee in determining which counties would be suitable for increased turkey populations, if desired by stakeholders.

The comprehensive habitat assessment, including the landscape-level habitat suitability model and rapid habitat appraisal tool, provides VDGIF with new methods to assess habitat for wild turkeys in Virginia. Information obtained from the habitat assessment will provide managers with a means to quantify habitat quality and observe changes over time, including the effects of implementing management activities designed to improve habitat quality. Biologists can use the rapid habitat appraisal tool on private lands to assist landowners in determining the suitability of their property for wild turkeys and the appropriate actions to improve the habitat quality.

The Virginia Wild Turkey Management Plan and comprehensive habitat assessment will provide strategies and tools for VDGIF biologists to use and ultimately better manage the wild turkey in Virginia. The Wild Turkey Management Plan and habitat assessment may serve as models for other state agencies, too. Fish and wildlife agencies can employ the collaborative process used to develop the Virginia plan to develop their own turkey management plan and improve the relationship and opinions of stakeholders and agency staff. Agency staff or individuals with NGOs directly can apply the habitat assessments in the Mid-Atlantic and Appalachian region, or modify the variables within the habitat model to suit states outside of these regions. Continued application of these tools will identify steps in the processes that could be improved or would benefit from new technology as time progresses.

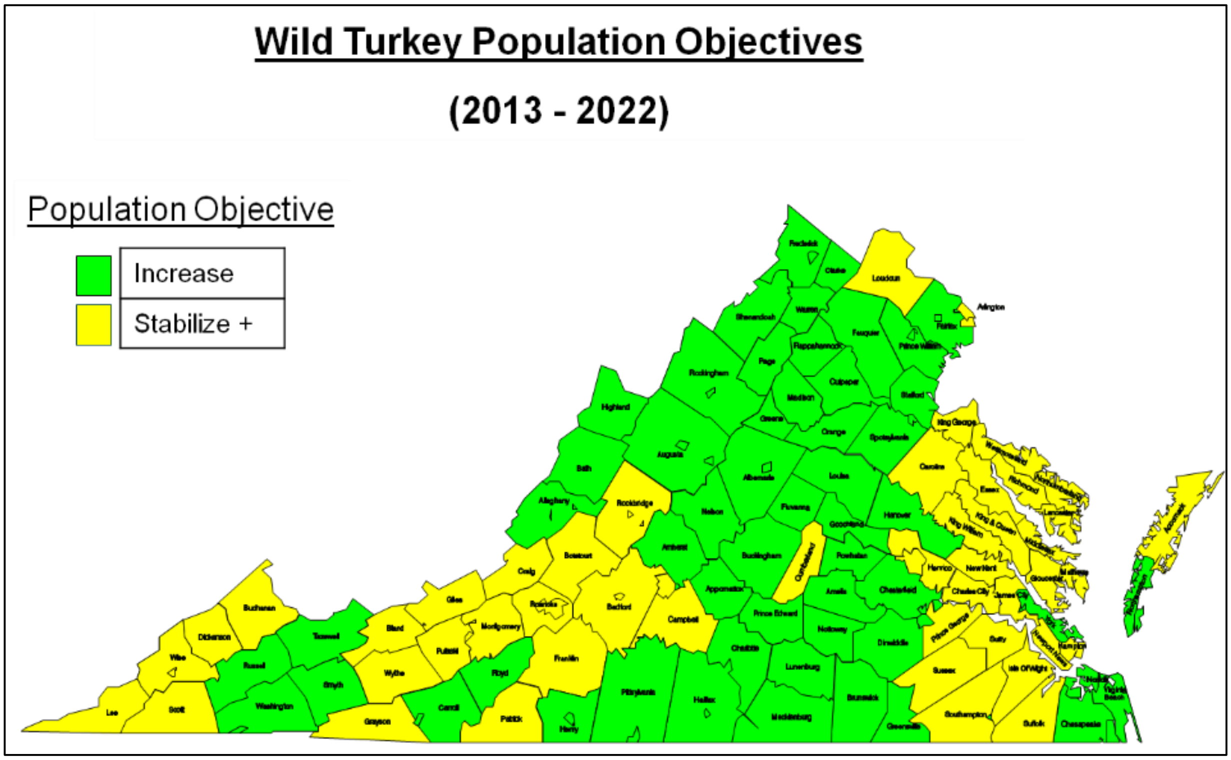

Figure 4-1. Population objectives for the Virginia Wild Turkey Management Plan. Counties designated for population increases (green) had low or very low wild turkey populations based on spring harvest/square mile of suitable habitat and very low to very high habitat suitability. Counties designated for 'stabilize +' were counties that the Virginia Department of Game and Inland Fisheries (VDGIF) was not striving to actively increase the population, however populations could naturally increase; counties with this objective had moderate to high wild turkey populations and moderate to very high habitat suitability.

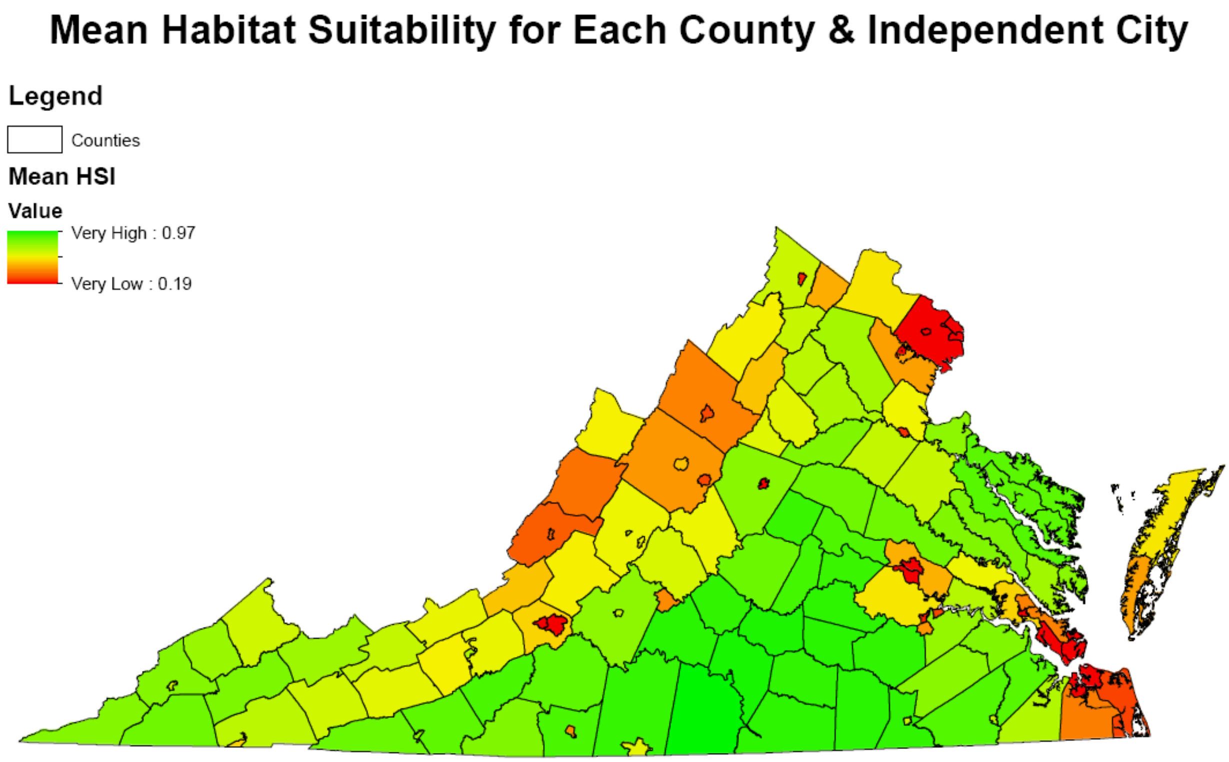

Figure 4-2. Mean habitat suitability for wild turkeys in each county and independent city based on the landscape-level habitat suitability model output.

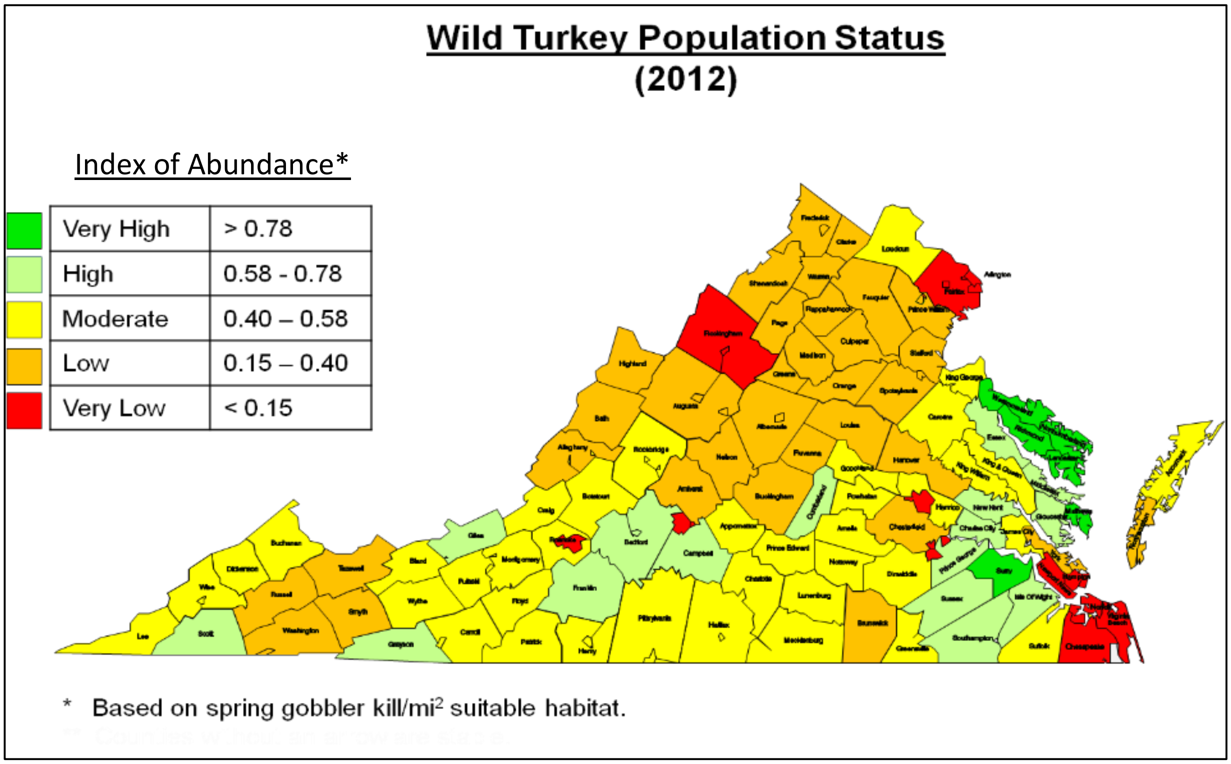

Figure 4-3. Wild turkey population status in Virginia for 2012 by comparing mean 2011 and 2012 spring turkey harvests and the square miles of suitable habitat per county. Suitable habitat includes deciduous forest, evergreen forest, mixed forest, scrub/shrub, woody wetlands, grasslands/herbaceous, hay/pasture, and cultivated crops.

Relative Population Density	Habitat Quality of Suitable Habitat: Very Low / Low	Moderate		High	Very High	
Very Low	Fairfax Chesapeake Rockingham	Virginia Beach				
Low	Alleghany Bath Augusta Clarke Page York	Amherst Chesterfield Frederick Greene Highland Madison Nelson Northampton	Prince William Rappahannock Shenandoah Smyth Spotsylvania Stafford Warren Washington	Albemarle Buckingham Culpeper Fauquier Louisa Orange Russell Tazewell	Brunswick Fluvanna Hanover	
Moderate	Craig	Bland Botetourt Buchanan Caroline Dickenson Henrico James City	Loudoun Montgomery Pulaski Roanoke Rockbridge Wythe	Accomack King and Queen King George King William Lee Patrick Suffolk Wise	Amelia Appomattox Carroll Charlotte Dinwiddie Floyd Goochland Greensville	Halifax Henry Lunenburg Mecklenburg Nottoway Pittsylvania Powhatan Prince Edward
High		Charles City Giles New Kent		Bedford Gloucester Grayson Prince George Scott Sussex	Campbell Cumberland Essex Franklin Isle of Wight Middlesex Southampton	
Very High				Mathews Surry	Lancaster Northumberland Richmond Westmoreland	

Figure 4-4. Matrix of habitat quality and population density to determine which counties have suitable conditions for increasing turkey population objectives. Teal colored cells indicate counties with suitable criteria for population increases.

Table 4-1. Changes in the square miles of land cover types based on the National Land Cover Dataset (NLCD) from 1992-2006 for each physiographic province of Virginia.

	Open Water (1992-2006)	Developed - Open Space (2001,2006); Urban/recreational Grasses (1992)	Developed - Low Intensity (2001,2006); Low Intensity Residential (1992)	Developed - Medium Intensity (2001, 2006); High Intensity Residential (1992)	Developed - High Intensity (2001, 2006); Commercial/Industrial/Transportation (1992)
North Mountain (1992)	31.02	1.67	89.01	1.87	26.61
North Mountain (2001)	30.76	287.63	114.67	24.54	9.27
North Mountain (2006)	30.02	289.91	117.92	26.80	9.79
Change from 1992-2006	-1.00	288.25	28.91	24.94	-16.82
Change from 2001-2006	-0.74	2.29	3.26	2.26	0.52
North Piedmont (1992)	91.41	20.20	368.37	3.92	166.91
North Piedmont (2001)	77.68	672.51	305.65	121.30	38.25
North Piedmont (2006)	80.56	699.36	338.12	141.36	42.73
Change from 1992-2006	-10.85	679.16	-30.26	137.44	-124.18
Change from 2001-2006	2.88	26.85	32.46	20.07	4.48
South Mountain (1992)	37.26	2.68	Table 3-775.18	2.06	41.51
South Mountain (2001)	27.97	351.61	118.13	41.05	8.35
South Mountain (2006)	27.88	352.94	119.84	42.17	8.84
Change from 1992-2006	-9.39	350.26	44.66	40.10	-32.67
Change from 2001-2006	-0.09	1.33	1.71	1.12	0.49
South Piedmont (1992)	173.88	4.63	174.79	4.91	67.09
South Piedmont (2001)	156.06	519.43	179.22	43.64	17.01
South Piedmont (2006)	158.62	521.85	182.42	45.73	17.57
Change from 1992-2006	-15.26	517.22	7.63	40.82	-49.52
Change from 2001-2006	2.56	2.42	3.20	2.10	0.56
Tidewater (1992)	129.77	30.82	196.06	39.53	128.43
Tidewater (2001)	100.45	483.60	194.07	76.35	27.40
Tidewater (2006)	117.96	490.06	202.82	84.09	29.72
Change from 1992-2006	-11.81	459.24	6.76	44.56	-98.71
Change from 2001-2006	17.51	6.46	8.74	7.75	2.33

*Cells with N/A=that land cover type was not measured that year.

Table 3-6. (Continued)

	Barren Land (2001,2006); Barren/Quarries/ Transitional (1992)	Deciduous Forest (1992-2006)	Evergreen Forest (1992-2006)	Mixed Forest (1992-2006)	Shrub/ Scrub (2001-06)	Herbaceous (2001-06)	Hay/Pasture (1992-2006)
North Mountain (1992)	22.47	2895.28	238.17	655.24	N/A	N/A	1444.63
North Mountain (2001)	2.90	3157.18	347.30	183.06	0.00	0.00	1291.26
North Mountain (2006)	4.23	3156.60	344.56	182.30	0.88	4.85	1282.33
Change from 1992-2006	-18.24	261.32	106.39	-472.94	N/A	N/A	-162.30
Change from 2001-2006	1.33	-0.58	-2.74	-0.76	0.88	4.85	-8.93
North Piedmont (1992)	147.24	3257.30	490.57	1190.24	N/A	N/A	1814.89
North Piedmont (2001)	13.30	3294.07	716.82	274.12	268.94	52.88	1424.92
North Piedmont (2006)	18.09	3246.83	712.29	263.99	276.47	72.57	1398.79
Change from 1992-2006	-129.16	-10.47	221.72	-926.25	N/A	N/A	-416.10
Change from 2001-2006	4.79	-47.23	-4.53	-10.13	7.53	19.69	-26.13
South Mountain (1992)	62.11	4604.58	520.37	767.17	N/A	N/A	1532.03
South Mountain (2001)	31.41	4871.32	206.59	162.26	33.76	234.96	1691.20
South Mountain (2006)	39.26	4866.40	206.74	160.06	37.44	251.93	1667.47
Change from 1992-2006	-22.85	261.81	-313.63	-607.11	N/A	N/A	135.44
Change from 2001-2006	7.85	-4.93	0.15	-2.20	3.68	16.97	-23.74
South Piedmont (1992)	227.07	5047.33	1294.74	1870.21	N/A	N/A	2120.41
South Piedmont (2001)	24.33	5440.05	1664.06	496.23	214.20	332.92	2129.84
South Piedmont (2006)	22.59	5459.00	1593.04	467.02	289.26	380.48	2064.74
Change from 1992-2006	-204.48	411.67	298.29	-1403.19	N/A	N/A	-55.66
Change from 2001-2006	-1.75	18.95	-71.02	-29.21	75.05	47.56	-65.09
Tidewater (1992)	124.45	1316.83	861.18	1225.26	N/A	N/A	681.52
Tidewater (2001)	21.03	1041.82	1199.80	361.55	438.41	46.51	441.36
Tidewater (2006)	24.09	1036.64	1205.05	341.21	421.73	61.11	431.06
Change from 1992-2006	-100.36	-280.19	343.87	-884.05	N/A	N/A	-250.46
Change from 2001-2006	3.06	-5.18	5.25	-20.34	-16.68	14.61	-10.29

*Cells with N/A=that land cover type was not measured that year.

Table 3-6. (Continued)

	Cultivated Crops (1992-2006)	Woody Wetlands (1992-2006)	Emergent Herbaceous Wetlands (1992-2006)
North Mountain (1992)	121.17	0.00	0.00
North Mountain (2001)	86.89	0.84	0.90
North Mountain (2006)	85.99	0.84	0.92
Change from 1992-2006	-35.18	0.84	0.92
Change from 2001-2006	-0.90	0.00	0.02
North Piedmont (1992)	268.10	143.15	32.09
North Piedmont (2001)	409.90	309.50	14.16
North Piedmont (2006)	388.10	302.95	13.48
Change from 1992-2006	119.99	159.80	-18.61
Change from 2001-2006	-21.81	-6.55	-0.69
South Mountain (1992)	152.26	4.80	2.31
South Mountain (2001)	22.07	3.54	0.07
South Mountain (2006)	21.17	3.86	0.24
Change from 1992-2006	-131.09	-0.94	-2.07
Change from 2001-2006	-0.90	0.32	0.17
South Piedmont (1992)	312.76	201.31	22.68
South Piedmont (2001)	97.36	202.49	3.56
South Piedmont (2006)	114.57	201.40	3.55
Change from 1992-2006	-198.19	0.09	-19.13
Change from 2001-2006	17.21	-1.09	0.00
Tidewater (1992)	1197.46	778.51	341.76
Tidewater (2001)	1050.87	1270.12	291.28
Tidewater (2006)	1090.31	1238.54	293.44
Change from 1992-2006	-107.15	460.02	-48.32
Change from 2001-2006	39.44	-31.58	2.16

*Cells with N/A=that land cover type was not measured that year.

Literature Cited

Anderson, M. G., M. Clark, C. E. Ferree, A. Jospe, A. Olivero Sheldon, and J. K. Weaver. 2013. Northeast Habitat Guides: A companion to the terrestial and aquatic maps. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office, Boston, Massachusetts, USA.

Giles, R. H., Jr. 1978. Wildlife management. W. H. Freeman & Co., San Francisco, California, USA.

Healy, W. M., and E. S. Nenno. 1980. Growth parameters and sex and age criteria for juvenile eastern wild turkeys. Proceedings of the National Wild Turkey Symposium 4:169-185.

Lafon, N. W. 2002. Evolution of stakeholder knowledge, attitudes, and opinions throughout a participative process to develop a management plan for black bears in Virginia. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Latham, R. L. 1976. Complete book of the wild turkey. Revised edition. Stackpole Books, Harrisburg, Pennsylvania, USA.

McDougal, L. A. 1990. Wild turkey-road interactions on a Virginia national forest. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Norman, G. W., and D. E. Steffen. 2003. Effects of recruitment, oak mast, and fall-season format on wild turkey harvest rates in Virginia. Wildlife Society Bulletin 31:553-559.

Steffen, D. E., C. E. Couvillion, and G. A. Hurst. 1990. Age-determination of eastern wild turkey gobblers. Wildlife Society Bulletin 18:119-124.

USDA Natural Resources Conservation Service. 2013a. Soil survey geographic (SSURGO) database. <http://soildatamart.nrcs.usda.gov/ >. Accessed 2 Dec 2013.

USDA Natural Resources Conservation Service. 2013b. US general soil map (STATSGO2). <http://soildatamart.nrcs.usda.gov/ >. Accessed 19 Dec 2013.

Wildlife Management Institute. 2013. Creation of regional habitat cover maps: application of the Northeast Terrestrial Habitat Classification System. <http://rcngrants.org/content/creation-regional-habitat-cover-maps-application-northeast-terrestrial-habitat >. Accessed 2 Dec 2013.

Appendix A. Approval letters from the Virginia Tech Internal Review Board (IRB)

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: July 13, 2011

TO: Steve L. McMullin, James A. Parkhurst

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: Turkey Management Planning

IRB NUMBER: 11-591

On July 13, 2011, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the interim application for the above-mentioned research protocol under 45 CFR 46.118.

This Interim approval only provides permission to begin the initial planning required in developing study procedures and forms under this protocol and does not provide permission to begin human subject related activities. This Interim approval is being provided based on confirmation received from you that study procedures involving human subjects will not be initiated until regular (i.e., non-Interim) IRB approval is obtained.

Failure to obtain VT IRB approval prior to conducting human subject activities may result in serious sanctions such as the destruction of data, termination of research and loss of privilege to conduct research at VT.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The following chart indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required

Date	OSP Number	Sponsor	Grant Comparison Conducted?
7/13/2011	Pending		Not Required (interim approval)

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

cc: File

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VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

An equal opportunity, affirmative action institution

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: October 28, 2011

TO: Steve L. McMullin, James A. Parkhurst, Holly Morris

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)

PROTOCOL TITLE: Turkey Management Planning

IRB NUMBER: 11-591

Effective October 28, 2011, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date: **10/28/2011**
Protocol Expiration Date: **10/27/2012**
Continuing Review Due Date*: **10/13/2012**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Date*	OSP Number	Sponsor	Grant Comparison Conducted?
6/28/2011	11241405	VA Dept of Game & Inland Fisheries	Not Required (not federally funded)

*Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

cc: File

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, VA 24060
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE:	October 1, 2012
TO:	Steve McMullin, Jim Parkhurst, Holly Noelle Morris
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)
PROTOCOL TITLE:	Turkey Management Planning
IRB NUMBER:	**11-591**

Effective September 28, 2012, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date:	**October 28, 2012**
Protocol Expiration Date:	**October 27, 2013**
Continuing Review Due Date*:	**October 13, 2013**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Date*	OSP Number	Sponsor	Grant Comparison Conducted?
09/20/2012	11241405	VA Department of Game & Inland Fisheries	Not required (Not federally funded)

* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE:	October 1, 2013
TO:	Steve McMullin, Jim Parkhurst, Holly Noelle Morris
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)
PROTOCOL TITLE:	Turkey Management Planning
IRB NUMBER:	**11-591**

Effective September 30, 2013, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date:	**October 28, 2013**
Protocol Expiration Date:	**October 27, 2014**
Continuing Review Due Date*:	**October 13, 2014**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Date*	OSP Number	Sponsor	Grant Comparison Conducted?
09/20/2012	11241405	VA Department of Game & Inland Fisheries	Not required (Not federally funded)

* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

Appendix B. Cover letters, consent form, focus group scripts, and questionnaires

VirginiaTech
College of Natural Resources
and Environment

Fish and Wildlife Conservation
100 Cheatham Hall (0321)
Blacksburg, Virginia 24061
540/231-5573 Fax: 540/231-7580
www.fishwild.vt.edu

March 21, 2012

Name
Address
City, VA Zip

Dear Name:

I am writing to invite you to participate in a focus group meeting with other [spring turkey hunters/fall turkey hunters/individuals who have experienced conflicts with or damage from with wild turkeys] from 7:00-9:00 p.m. on [Day], April [Date] at the [Site] at [Address] in [Town], VA. This focus group meeting is one of several that we are conducting on behalf of the Virginia Department of Game and Inland Fisheries with spring and fall turkey hunters and individuals who have experienced problems with wild turkeys. The focus group meetings are just one part of a much larger effort to communicate with individuals interested in wild turkey management and to involve them in the process of developing a statewide management plan for wild turkeys in Virginia.

Focus group meetings are different from other public meetings that you may have attended. By design, wildlife managers are there to listen to their stakeholders rather than make presentations or try to convince them to agree to some proposed action. We do this by bringing a group of people together who have a similar interest in wild turkeys, asking them some questions, and then listening to their responses and discussions with each other. We will be conducting 7 focus groups around Virginia in April, with a variety of individuals who share a common interest in wild turkey management.

Please contact me at (304-667-7037) or hnmorris@vt.edu to let me know if you will be able to attend the [insert place and date] focus group meeting by April [date]. If you have any questions, please do not hesitate to contact me. I am looking forward to meeting you and hearing your thoughts about wild turkey management in Virginia at the focus group meeting.

Sincerely,

Holly Morris
Graduate Research Assistant

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Informed Consent

Wild Turkey Management Planning in Virginia: Focus Group Consent to Participate

Dr. Steve L. McMullin, Associate Professor
Department of Fisheries and Wildlife Sciences, Virginia Tech

I. Project Purpose

This research project is designed to identify the values and opinions of hunters, individuals who have experienced problems with wild turkeys, and other individuals interested in wild turkey management. Information gained from these focus groups will be used to inform Virginia Tech and the Virginia Department of Game and Inland Fisheries as they work to develop a statewide management plan for wild turkey in Virginia.

II. Procedures

We will be conducting a series of group interviews (called focus groups) involving small groups of hunters and individuals who are interested in wild turkey management in Virginia. Seven focus groups in all will be conducted involving 10-20 individuals each. You are being asked to participate in one of these focus groups.

By signing this document, you agree to be interviewed as part of a group at a specified, pre-arranged time and place regarding your opinions, interests, and concerns related to wild turkey management in Virginia. Interview questions have been pre-prepared for this purpose. If you consent, this group interview will also be tape recorded to ensure that we accurately record your statements and intentions.

III. Risks

There is minimal risk to you as a result of participating in this research. Your responses will be held in strict confidence, and the investigators will never associate your responses with your name in the final report, thesis, manuscripts, or presentations, or in casual conversation with others.

IV. Benefits

The benefit of conducting this research is to understand values and opinions of individuals interested in wild turkey management in Virginia. Each focus group participant will benefit by being able to voice his/her concerns and interests and learn about the concerns and interest of other participants. Documenting this information not only will help natural resource managers communicate more effectively with the public, but also will help decision makers understand what their stakeholders know and think about wild turkey management and to make sound management decisions for the future in Virginia. By participating in the focus group, participants can be assured that this information will be used to help us to conduct a more thorough, qualitative study and present a complete report to the Board of Game and Inland Fisheries.

Participants should understand that no promise or guarantee of benefits has been made to encourage you to participate, and your participation does not guarantee any specific decision. If you wish to receive a summary of our research results, you may contact the investigators upon completion of the final report (expected in December 2013).

V. Anonymity and Confidentiality

All interview responses will be held in strict confidence. The primary investigators will be the only people with access to the data that connect interview responses to individual identities, and they will not share these data with anyone. All interview notes and tapes will be stored at Virginia Tech in Blacksburg, VA, in a private office, and will be destroyed at the close of the project. Only transcribed comments, with no personal identification, will be shared as part of the reporting process.

VI. Compensation

Participants in this and other focus groups will receive no compensation for their participation.

VII. Freedom to Withdraw

You may refuse to answer any question during the interview, and you are free to terminate your participation at any time.

VIII. Subject's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities:

- To participate in a group interview and contribute to discussions that take place.

IX. Permission

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent to the above-described focus group:

Signature	Date	(Initial for audio tape consent)

Should I have any pertinent questions about this research or its conduct, and my rights as a research subject, and whom to contact in the event of a research-related injury to the subject, I may contact:

Dr. Steve McMullin (smcmulli@vt.edu)
Department of Fisheries and Wildlife Sciences
Blacksburg, VA, 24061
108 Cheatham Hall
540-231-8847

If I should have any questions about the protection of human research participants regarding this study, I may contact Dr. David Moore, Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects. Telephone: (540) 231-4991 Email: moored@vt.edu

Virginia Tech Institutional Review Board Project No. 11-591
Approved October 28, 2012 to October 27, 2013

Wild Turkey Management Spring Turkey Hunter Focus Group Script

- Welcome , moderator introduction

- Virginia Tech and the Virginia Department of Game and Inland Fisheries (VDGIF) are conducting a study to learn more about the values and opinions people have who are interested in wild turkey management in Virginia.

- This is one of 7 focus groups we are holding around Virginia related to wild turkey management. These focus groups represent one part of a larger process of involving the public in developing a statewide management plan for wild turkeys in Virginia. The entire process is designed to engage all stakeholder groups that are interested in wild turkey management.

- A focus group is different from other types of public meetings—it is designed to encourage you to talk and for wildlife professionals to listen. There will be no presentation by me or the VDGIF, no proposals for you to consider and no attempts to persuade you to approve a course of action. No decisions will be made in this or other focus group meetings. I have several questions I will ask you. I will encourage each of you to answer the questions and to engage in discussions with your fellow participants.

- How the information will be used: The summary of this focus group, each of the other focus groups, and an overall summary of all focus groups will be provided to the Board of Game and Inland Fisheries (of VDGIF). The information generated will be helpful to VDGIF as they consider the issues and concerns associated with wild turkey management and potential strategies for dealing with them.

- Please put your name & address on sign-up sheet to be sure we have correct information and can keep you informed as this project progresses. Keeping you informed will begin with us sending you a summary of tonight's discussion. If you would prefer to save some paper and receive the summary via email, write your email address on the sheet.

- Informed consent forms: The legal forms are required by the University to ensure that any work we do with people is done ethically and that risk to participants has been minimized. It says that you understand what we are doing in tonight's meeting and that we will protect your confidentiality. If everyone agrees, I'll make an audio recording of the proceedings but I'll need your signature and initials on page two before doing so.

- My role as moderator is to encourage all of you to participate in the discussion, to ensure that everyone is treated fairly and with respect and to try to get us through the discussion and on our way home in two hours or less. I have no stake in the outcome of the process. My entire focus is on ensuring that we have a thorough and fair process for including all user groups who are interested in wild turkey management in Virginia in this process of developing a statewide management plan.

- Introduce other personnel involved with the focus group.

- Agreement of rules of conduct (i.e., respect others' opinions, one person speaks at a time)

- Now, we would like to meet all of you. Please introduce yourself by telling us your name, where you live, any conservation-related organizations you belong to, and how important turkey hunting is compared to other forms of recreation you engage in.

Focus Group Questions

1. How satisfied are you with the current population of wild turkeys in the areas where you usually hunt? Why?
   a. Where would you like the population to be?
2. What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?
3. What do you enjoy most about hunting wild turkeys in the spring?
4. How important is it to have the opportunity to incidentally harvest a turkey in the fall while pursuing other game (e.g., deer, grouse, etc.)?
5. How important is the opportunity to hunt wild turkeys in the spring versus the fall?
6. Do you hunt wild turkeys during the fall turkey season? If not, why not?
7. How satisfied are you with your **spring** hunting experiences with wild turkeys in Virginia? Why?
8. How satisfied are you with the current turkey hunting regulations and seasons? Why?
9. If you could change one thing about how wild turkeys are managed in Virginia, what would that one thing be?
10. What limits you from hunting wild turkeys in the spring more often?
11. Are there any other important issues that this group should discuss?

Wild Turkey Management Fall Turkey Hunter Focus Group Script

- Welcome , moderator introduction

- Virginia Tech and the Virginia Department of Game and Inland Fisheries (VDGIF) are conducting a study to learn more about the values and opinions people have who are interested in wild turkey management in Virginia.

- This is one of 7 focus groups we are holding around Virginia related to wild turkey management. These focus groups represent one part of a larger process of involving the public in developing a statewide management plan for wild turkeys in Virginia. The entire process is designed to engage all stakeholder groups that are interested in wild turkey management.

- A focus group is different from other types of public meetings—it is designed to encourage you to talk and for wildlife professionals to listen. There will be no presentation by me or the VDGIF, no proposals for you to consider and no attempts to persuade you to approve a course of action. No decisions will be made in this or other focus group meetings. I have several questions I will ask you. I will encourage each of you to answer the questions and to engage in discussions with your fellow participants.

- How the information will be used: The summary of this focus group, each of the other focus groups, and an overall summary of all focus groups will be provided to the Board of Game and Inland Fisheries (of VDGIF). The information generated will be helpful to VDGIF as they consider the issues and concerns associated with wild turkey management and potential strategies for dealing with them.

- Please put your name & address on sign-up sheet to be sure we have correct information and can keep you informed as this project progresses. Keeping you informed will begin with us sending you a summary of tonight's discussion. If you would prefer to save some paper and receive the summary via email, write your email address on the sheet.

- Informed consent forms: The legal forms are required by the University to ensure that any work we do with people is done ethically and that risk to participants has been minimized. It says that you understand what we are doing in tonight's meeting and that we will protect your confidentiality. If everyone agrees, I'll make an audio recording of the proceedings but I'll need your signature and initials on page two before doing so.

- My role as moderator is to encourage all of you to participate in the discussion, to ensure that everyone is treated fairly and with respect and to try to get us through the discussion and on our way home in two hours or less. I have no stake in the outcome of the process. My entire focus is on ensuring that we have a thorough and fair process for including all user groups who are interested in wild turkey management in Virginia in this process of developing a statewide management plan.

- Introduce other personnel involved with the focus group.

- Agreement of rules of conduct (i.e., respect others' opinions, one person speaks at a time)

- Now, we would like to meet all of you. Please introduce yourself by telling us your name, where you live, any conservation-related organizations you belong to, and how important turkey hunting is compared to other forms of recreation you engage in.

Focus Group Questions

1. How satisfied are you with the current population of wild turkeys in the areas where you usually hunt? Why?
    a. Where would you like the population to be?
2. What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?
3. What do you enjoy most about hunting wild turkeys in the fall?
4. How important is it to have the opportunity to incidentally harvest a turkey while pursuing other game (e.g., deer, grouse, etc.)?
5. How important is the opportunity to hunt wild turkeys in fall versus spring?
6. Do you hunt wild turkeys during the spring turkey season? If not, why not?
7. How satisfied are you with your **fall** hunting experiences with wild turkeys in Virginia? Why?
8. How satisfied are you with the current turkey hunting regulations and seasons? Why?
9. If you could change one thing about how wild turkeys are managed in Virginia, what would that one thing be?
10. What limits you from hunting turkeys in the fall more often?
11. Are there any other important issues that this group should discuss?

Wild Turkey Management Individuals with Wild Turkey Problems Focus Group Script

- Welcome , moderator introduction

- Virginia Tech and the Virginia Department of Game and Inland Fisheries (VDGIF) are conducting a study to learn more about the values and opinions people have who are interested in wild turkey management in Virginia.

- This is one of 7 focus groups we are holding around Virginia related to wild turkey management. These focus groups represent one part of a larger process of involving the public in developing a statewide management plan for wild turkeys in Virginia. The entire process is designed to engage all stakeholder groups that are interested in wild turkey management.

- A focus group is different from other types of public meetings—it is designed to encourage you to talk and for wildlife professionals to listen. There will be no presentation by me or the VDGIF, no proposals for you to consider and no attempts to persuade you to approve a course of action. No decisions will be made in this or other focus group meetings. I have several questions I will ask you. I will encourage each of you to answer the questions and to engage in discussions with your fellow participants.

- How the information will be used: The summary of this focus group, each of the other focus groups, and an overall summary of all focus groups will be provided to the Board of Game and Inland Fisheries (of VDGIF). The information generated will be helpful to VDGIF as they consider the issues and concerns associated with wild turkey management and potential strategies for dealing with them.

- Please put your name & address on sign-up sheet to be sure we have correct information and can keep you informed as this project progresses. Keeping you informed will begin with us sending you a summary of tonight's discussion. If you would prefer to save some paper and receive the summary via email, write your email address on the sheet.

- Informed consent forms: The legal forms are required by the University to ensure that any work we do with people is done ethically and that risk to participants has been minimized. It says that you understand what we are doing in tonight's meeting and that we will protect your confidentiality. If everyone agrees, I'll make an audio recording of the proceedings but I'll need your signature and initials on page two before doing so.

- My role as moderator is to encourage all of you to participate in the discussion, to ensure that everyone is treated fairly and with respect and to try to get us through the discussion and on our way home in two hours or less. I have no stake in the outcome of the process. My entire focus is on ensuring that we have a thorough and fair process for including all user groups who are interested in wild turkey management in Virginia in this process of developing a statewide management plan.

- Introduce other personnel involved with the focus group.

- Agreement of rules of conduct (i.e., respect others' opinions, one person speaks at a time)

- Now, we would like to meet all of you. Please introduce yourself by telling us your name and where you live.

Focus Group Questions

1. How satisfied are you with the current population of wild turkeys where you live? Why?
    a. Where would you like the population to be?
2. What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?
3. Have you personally experienced conflicts with or experienced damage from wild turkeys? What time of year was it?
    a. What was the nature of the issue and how significant was it?
    b. Was it resolved?
        i. If so, how?
    c. Who helped you resolve the problem?
4. How did you identify that a wild turkey caused the damage?
5. Do you believe incidents with wild turkeys are increasing, declining, or are stable?
    a. What do you believe drives the frequency of these incidents?
6. What actions should be taken to prevent wild turkey problems?
7. What actions should be taken to respond to wild turkey problems?
8. If you could change one thing about how wild turkeys are managed in Virginia, what would that one thing be?
9. Are there any other important issues that this group should discuss?

VirginiaTech
College of Natural Resources and Environment

Fish and Wildlife Conservation
100 Cheatham Hall (0321)
Blacksburg, Virginia 24061
540/231-5573 Fax: 540/231-7580
www.fishwild.vt.edu

[date]

Name
Address
City, VA Zip

Dear Name:

I am writing to seek your opinions and views of wild turkey management in Virginia. The questions on the enclosed document are very similar to the questions we have asked other Virginia stakeholders with an interest in management of wild turkeys in focus groups we have held around the Commonwealth. I hope that you will take a few minutes to respond to these questions so we will better understand your opinions regarding management of wild turkeys in Virginia.

This questionnaire is just one part of a much larger effort to communicate with individuals interested in wild turkey management and to involve them in the process of developing a statewide management plan for wild turkeys in Virginia. Your comments will be anonymous and will be used to develop a summary of the responses by all respondents to the enclosed questions. You will receive a copy of the summary, along with an overall summary of all the focus groups and other questionnaires.

Please return the attached questions in the envelope provided by [date]. If you have any questions, please do not hesitate to contact me at (304-667-7037) or hnmorris@vt.edu. I am looking forward to receiving your thoughts about wild turkey management in Virginia.

Sincerely,

Holly Morris
Graduate Research Assistant

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
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ID#:_________

Wild Turkey Management Plan Questionnaire

1. How satisfied are you with the current population of wild turkeys where you live? Why?
    a. Would you like to see the population increase, decrease, or stay about the same?

2. What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?

3. Have you personally experienced any conflicts with or damage from wild turkeys here in Virginia?
    a. What was the nature of the conflict or damage and how significant, in terms of its physical and/or economic impact, was it?
    b. What time of year did the conflict or damage occur?
    c. Did you seek and/or receive any help in resolving this conflict or damage? If so, from whom did you receive help to resolve your problem?

d. Was the issue resolved? If so, how?

e. On what evidence did you rely to determine that a wild turkey caused the damage?

4. Compared to conditions that existed 5 years ago, do you believe that conflicts with wild turkeys are increasing, declining, or are about the same?
   a. On what factor(s) do you base this opinion?

5. What actions should be taken to respond and to reduce wild turkey problems?

   a. What actions, if any, do you believe need to be taken to resolve problems caused by wild turkey populations in Virginia?

b. Who do you believe is responsible for implementing the actions you seek?

6. If there was one thing that you would recommend needs modification regarding management of wild turkeys in Virginia, what would that one thing be?

7. Are there any other important issues related to wild turkeys not addressed here that you believe should be raised for future discussion?

VirginiaTech
College of Natural Resources and Environment

Fish and Wildlife Conservation
100 Cheatham Hall (0321)
Blacksburg, Virginia 24061
540/231-5573 Fax: 540/231-7580
www.fishwild.vt.edu

[date]

Name
Address
City, VA Zip

Dear Name:

I am writing to seek your opinions and views of wild turkey management in Virginia. The questions on the enclosed document are very similar to the questions we have asked other Virginia stakeholders with an interest in management of wild turkeys in focus groups we have held around the Commonwealth. Unfortunately, we were unable to hold a focus group meeting for individuals whose primary interest is in wild turkey conservation, due to the geographic distribution of the small number of participants. I hope that you will take a few minutes to respond to these questions so we will better understand your opinions regarding management of wild turkeys in Virginia.

This questionnaire is just one part of a much larger effort to communicate with individuals interested in wild turkey management and to involve them in the process of developing a statewide management plan for wild turkeys in Virginia. Your comments will be anonymous and will be used to develop a summary of the responses by all respondents to the enclosed questions. You will receive a copy of the summary, along with an overall summary of all the focus groups and other questionnaires.

Please return the attached questions in the envelope provided by [date]. If you have any questions, please do not hesitate to contact me at (304-667-7037) or hnmorris@vt.edu. I am looking forward to receiving your thoughts about wild turkey management in Virginia.

Sincerely,

Holly Morris
Graduate Research Assistant

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VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

ID#:_________

Wild Turkey Management Plan Questionnaire

1. What is your primary interest in the management of wild turkeys in Virginia?

2. How satisfied are you with the current population of wild turkeys where you live? Why?
    a. Would you like to see the population of wild turkeys in Virginia increase, decrease, or remain about the same?

3. What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?

4. Do you feed wild turkeys? Why?

5. Have you ever hunted wild turkeys, now or in the past? If you haven't hunted turkeys, why not?

6. Do you feel safe when you recreate outdoors during turkey hunting seasons? If not, why?

7. If you could change one thing about how wild turkeys are managed in Virginia, what would that one thing be?

8. Are there any other important issues related to management of wild turkeys in Virginia that we haven't asked about?

Wild Turkey Management Focus Group Meetings

Executive Summary

May 2012

About the process:

The Virginia Department of Game and Inland Fisheries (DGIF), in cooperation with Virginia Tech's Department of Fish and Wildlife Conservation, has begun a process to develop a statewide management plan for wild turkeys. Development of the wild turkey management plan will include numerous opportunities for stakeholder involvement, including: focus group discussions to identify important issues in wild turkey management; a stakeholder advisory committee composed of representatives of all major stakeholder groups with interests in management of wild turkeys; public meetings that will be held in numerous locations around the Commonwealth to solicit comments on the draft management plan; solicitation of written comments on the draft plan through press releases and a forum on the DGIF web page; and a meeting of the Board of Game and Inland Fisheries at which the plan will be presented. To begin the process, DGIF and Virginia Tech invited more than 200 Virginians known to have an interest in management of wild turkeys to attend one of nine focus groups. A focus group is different from other types of public meetings, as it is designed to encourage individuals to talk and for wildlife professionals to listen. The purpose of these focus group meetings was to listen to individuals talk about their views and opinions relative to turkey management and to identify the most important issues that should be addressed in the management plan. The information gained from these focus groups will help the DGIF, Virginia Tech and the stakeholder advisory committee as they work together to develop a plan that balances public opinion and sound biology in management of Virginia's wild turkeys.

Nine 2-hour focus group meetings were held on weeknight evenings in April and May. Six focus groups were held with hunters who primarily hunted turkeys during spring, two with hunters who primarily hunted turkeys during fall, and one with individuals who had experienced damage from or conflicts with wild turkeys. Approximately 230 individuals with interest in wild turkey management were invited to attend the focus group meetings. Invitees were selected because they previously had contacted Holly Morris and expressed an interest in participating, were suggested by the staff of the Department of Game and Inland Fisheries (DGIF), or were participants in the DGIF Spring Gobbler Survey. Of those invited, 82 individuals attended a focus group meeting. All participants were Caucasian; 77 were male and 5 were female.

Because of scheduling conflicts, excessive travel distance, or other constraints, 7 individuals with interests in turkey conflict management were not able to attend a scheduled focus group session. These individuals were provided a questionnaire that solicited response to questions very similar to those presented to session participants; 4 individuals (all male) completed and returned the survey. A similar process was used to solicit input from individuals with general interest in the conservation of wild turkeys. Thirteen questionnaires were distributed and 8 completed surveys were returned (3 male, 5 female). Five unsolicited comments also were received via mail or email from other individuals interested in turkey management, but who were unable to attend the focus groups.

During each focus group meeting, participants responded to a series of broad questions (indicated in bold below) posed by the facilitator that were intended to generate open discussion on issues relevant to turkey management in Virginia. This executive summary provides an overall compilation of the responses obtained from all meetings. Summaries from each of the individual meetings are available and provide more specific details and selected direct quotes that help illustrate particular themes or key points in that discussion. Focus group attendees were not randomly selected from the whole population of people with interests in turkeys and turkey hunting, and therefore, the views and opinions of participants should not be considered representative of all individuals with interests in wild turkey management.

Focus Groups with Turkey Hunters

The number of participants that attended each meeting was:

Spring Turkey Hunters

Marion – 10	Warrenton – 5	Verona – 9
Lynchburg – 12	Richmond – 8	Newport News – 3

Fall Turkey Hunters

Bedford – 15	Fredericksburg - 14

How satisfied are you with the current population of wild turkeys in the areas where you usually hunt? Why? Where would you like the population to be?

Spring Hunters

Although many spring hunting participants were satisfied with the population of wild turkeys, others thought the current population was down from previous years' highs. Some participants thought there were too many hens, and this abundance was affecting gobbling negatively. It appeared that satisfaction for some individuals was derived largely by the number of gobblers heard. Areas east of the Blue Ridge were believed to harbor higher populations of turkeys, primarily on private lands, whereas areas west of the Blue Ridge were thought to have a lower population, due mostly to the predominance of public lands. Predation, poor hatches (due to wet springs), forest fragmentation, poaching, changing farming practices, and the absence of effective habitat management on public lands were noted as limiting turkey populations.

Fall Hunters

Most fall turkey hunting participants were satisfied with the current population of wild turkeys. However, some were unsatisfied and desired an increased population, especially in the Northern Neck of Virginia. Participants thought the population was affected by poaching, predation, and habitat fragmentation/degradation. Fall turkey hunters in the western part of Virginia were concerned with the absence of habitat management on public hunting lands; if more habitat management occurred, turkey populations would increase.

What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?

Spring Hunters

The abundance of predators and their effects, and the need for habitat management overwhelmingly were identified as pressing wild turkey management issues. The desire for active and effective habitat management and maintenance was especially important to participants who utilize national forest or other public lands; this sentiment was raised in Verona, Marion, and Warrenton. In Newport News, participants identified nesting success and the human element (i.e., inconsiderate hunters, poaching) as issues. Participants in Richmond focused on the need to account for regional differences when establishing dates to open hunting seasons (i.e., season should open earlier east of the Blue Ridge). In addition to the need for more active habitat management, participants in Lynchburg thought hunter recruitment and retention were critical issues, given the fact that the hunting population is aging.

Fall Hunters

Some fall hunting participants were concerned that the abundance of predators was affecting the wild turkey population negatively. Others cited concerns about the effects of today's farming practices on turkey populations (i.e., clean farming, providing less desirable habitat, hens and their nests being destroyed when farmers cut hay). More funding for habitat management was desired by some. In eastern Virginia, land availability and accessibility for turkey hunters was a concern because many hunt clubs will not reduce fees for turkey hunters and public land hunting opportunities are limited. Regulations and season changes were issues for many participants. Regulatory changes from the early-1990s (i.e., eliminating the majority of the concurrent turkey and deer firearms season) were questioned because turkey populations do not appear to have increased following those changes, as suggested. Some participants thought hunters should be able to harvest the same number of birds in the fall as the spring season, harvest >1 bird per day, have the option of a fall-only turkey tag, and potentially use all their turkey tags during the fall season. Some thought the hen population was high in areas, and commended the January season as an opportunity to reduce the hen population. Participants were divided as to whether the big game tag should be split into 3 separate tags. A few participants thought hunters weren't purchasing licenses, and instead were willing to risk getting caught in an effort to save money. The accuracy of harvest estimates was questioned; some participants thought hunters (especially incidental muzzleloader and rifle deer hunters) weren't checking their kills. Managing wild turkeys at the county-level, similar to the way deer are managed, was suggested. Hunter recruitment also was a concern for many fall hunting participants.

What do you enjoy most about hunting wild turkeys in the spring? (asked only of spring hunters)

At virtually every focus group session, spring hunters repeatedly commented on how much they enjoyed the challenge of calling in a bird, hearing birds gobble, having the opportunity to experience all aspects of the hunt, and seeing and hearing all that Nature had to offer while in the field (e.g., sunrise, wildflowers, other wildlife).

What do you enjoy most about hunting wild turkeys in the fall? (asked only of fall hunters)

Many fall hunting participants enjoyed working their turkey dogs. Participants also enjoyed being able to hunt at a time when less competition from other hunters existed, unlike the spring gobbler season, and enjoyed being in the woods by themselves. Some participants enjoyed the camaraderie of fellow hunters. Participants also indicated their enjoyment of calling in turkeys and the fact fall turkey hunting can be a physical workout and is hard work.

How important is it to have the opportunity to incidentally harvest a turkey in the fall while pursuing other game (e.g., deer, grouse, etc.)?

Spring Hunters

This discussion focused mainly on firearm deer hunters incidentally harvesting turkeys. Most spring hunting participants disapproved of deer hunters incidentally harvesting a turkey with a rifle, unless a youth was harvesting the turkey. Wanton waste, safety, and ethics were major points of discussion regarding using rifles to harvest turkeys. A few participants indicated they would harvest a turkey while hunting deer during the archery season and some mentioned they have harvested turkeys while hunting ruffed grouse. Participants in Lynchburg were particularly intrigued by this question, and questioned whether it really could be considered "incidental harvest" if the take was made during a legal open fall turkey season. Other participants indicated they enjoyed having concurrent seasons, as it gave hunters an option to choose what game they want to pursue. Many hunters thought individuals should match the choice of weapon to the game being pursued (i.e., not harvesting a turkey with a rifle, but instead using a shotgun). Some participants credited the significant reduction of the concurrent turkey and deer firearms season with increasing the wild turkey population.

Fall Hunters

Fall hunting participants were divided as to whether the opportunity to incidentally harvest a turkey in the fall while pursuing other game was important. Many participants thought there should be a law against incidental harvest, and that shot size should be restricted to prohibit deer hunters from using buckshot to harvest turkeys. Participants also thought providing this opportunity for incidental harvest was restricting the opportunity for traditional fall turkey hunters to hunt. However, other participants thought the opportunity to incidentally harvest a turkey was important for introducing youth to hunting, as it provided a chance for youth to be successful. Also, some participants thought deer hunters weren't harvesting as much as they did 15 years ago, and that the fall turkey season shouldn't be broken into segments.

How important is the opportunity to hunt wild turkeys in the spring versus the fall? (asked only of spring hunters)

All spring hunting participants thought the opportunity to hunt turkeys in the spring was very important and many also thought it was important to have a fall turkey season. Participants recognized that fall turkey hunting was a tradition in Virginia, and the fall season provides more opportunities for people to hunt (including youth). However, because the fall turkey season was recognized as being a population management tool, some participants were concerned hunters could overharvest the population during the fall season, thereby jeopardizing opportunity for spring harvest.

How important is the opportunity to hunt wild turkeys in the fall versus the spring? (asked only of fall hunters)

All fall hunting participants thought the fall turkey season was important, and many noted Virginia had a fall turkey season prior to a spring turkey season. Some participants thought the fall season was important because it provided them an opportunity to use their turkey dogs; in fact, questions were raised as to why more states don't allow use of turkey dogs during the fall season. The ability to use turkey dogs was thought to draw more attention to the fall season. Fall hunters thought the opportunity to hunt turkeys in the spring was important; the spring season was recognized as a management tool by some. However, some fall hunters thought if a turkey season had to be eliminated, it should be the spring season.

Do you hunt wild turkeys during the fall turkey season? If not, why not? (asked only of spring hunters)

Many spring hunting participants stated they did not hunt during the fall turkey season. Reasons offered for why they chose not to hunt during the fall for turkeys included a lack of access to suitable hunting lands (e.g., deer hunters dominated activity on hunt club lands), one's preference to pursue other game, a lack of enough experience hunting turkeys in the fall to be successful, or the decision to save turkey tags for use only during the spring season. Some mentioned they would go out and call in birds for fun or take youth out hunting during the fall turkey season, but would not harvest a turkey personally. However, other participants indicated they did hunt in the fall for turkeys. Participants indicated they grew up fall turkey hunting and wished to continue the tradition, some used dogs to assist with the harvest of turkeys in the fall, and some harvested a turkey while archery hunting for deer.

Do you hunt wild turkeys during the spring turkey season? If not, why not? (asked only of fall hunters)

Many fall hunting participants indicated they also hunted turkeys during the spring gobbler season. Participants enjoyed watching and calling in the birds. Among the few who did not spring gobbler hunt, most stated they didn't have the time, thought it was too easy and wasn't challenging enough, or thought gobblers served as decoys to keep predators away from hens and their nests.

How satisfied are you with your spring hunting experiences with wild turkeys in Virginia? Why? (asked only of spring hunters)

Many participants were satisfied with their spring turkey hunting experiences in Virginia and that satisfaction necessarily was not linked to whether they harvested a bird. For some participants, satisfaction was dictated by the number of gobblers heard. Some participants indicated they had experienced interference from coyotes coming to turkey calls and thought the presence of coyotes was reducing gobbling. In Newport News, access to quality private hunting land was thought to be essential to hunter satisfaction. To improve hunter satisfaction, participants suggested increasing youth recruitment and success (through more youth days, mentoring programs), increasing the likelihood of harvesting a bird, providing more opportunities to hunt (increasing the bag limit to provide hunters more time afield before they fill all their tags, allowing all-day hunting the entire spring season, allowing Sunday hunting), and opening the spring season earlier.

How satisfied are you with your fall hunting experiences with wild turkeys in Virginia? Why? (asked only of fall hunters)

Most fall hunting participants were satisfied with their fall turkey hunting experiences. Some indicated they believed turkey populations were larger now compared to the past, and they could find a flock of turkeys at some point during a day of hunting. Satisfaction levels varied among participants, depending on factors such as the abundance of mast and observed hunting pressure, particularly from deer hunters who used dogs. In the past, when deer hunters who use dogs were able to harvest turkeys anytime during the deer season, they would break up large flocks and birds then would regroup into much smaller flocks. Some participants were not satisfied with the multiple breaks in the fall turkey season and also the blaze orange requirement when deer firearms season is concurrent.

How satisfied are you with the current turkey hunting regulations and seasons? Why?

Spring Hunters

Spring hunters offered many suggestions to change current turkey hunting seasons and regulations. Suggestions directed at the spring turkey season varied; opinions often were based on year-to-year seasonal effects such as weather and if hens were sitting on nests. Suggested modifications to the spring turkey season included: opening the season earlier in the eastern part of Virginia, shortening the season to 3 or 4 weeks in duration, and adding an archery-only spring season between the youth day and the opening of the regular spring gobbler season. Regarding tags, it was suggested that separate tags be established specifically for the fall and spring turkey seasons and there should be an option available for individuals to purchase additional tags. Another suggestion was to have a license run from January through December, allowing those who do not fill their spring gobbler tags to use their tags during the fall turkey season (rather than saving tags for the spring and not hunting the fall). Participants offered conflicting opinions about the spring bag limit; some thought it should increase to provide more hunting opportunities, but others thought it should decrease to 2 birds for fear of reducing the population. Participants were divided regarding the option to hunt all-day during the spring season. Some participants thought all-day hunting should be eliminated because people using rifles are allowed to take birds congregated in fields at long distances and it also increases disturbance of hens on nests. Others thought all-day hunting should be allowed the entire season because it provides more hunting opportunities, especially for youth. Many participants did not support the use of rifles during the spring season (due to safety concerns and the fact that hunters don't have to call in birds), and some thought rifles should be eliminated from the fall season as well. Sunday hunting was viewed by some participants as a desired means to increase hunting opportunities. Providing more youth opportunities, including more youth hunting days, was deemed important to many.

Suggestions offered regarding the fall turkey season included: requiring the fall season to be shotguns-only, continuing to provide fall turkey hunting opportunities both separate from and concurrent with other seasons, allowing shotgun turkey hunting during the archery-only turkey season, standardizing shot sizes to prohibit buckshot, reducing the fall season to be equivalent to the length of the spring season, and establishing the fall turkey season from October 1 through December 31, without any breaks. Many participants discussed the early-1990s regulatory change that eliminated most of the concurrent turkey and deer firearms season. Many thought this was a good idea, as it protected flocks from deer hunters, but it also restricted the opportunity for traditional turkey hunters to hunt. Many questioned the purpose for establishing the new 2-week January season. Some of those who hunted the new season noted it represented good turkey hunting opportunity.

Some participants were interested in how the turkey seasons are established and modified. Participants thought many existing regulations for turkeys were established in the 1970s and needed to be updated. It was suggested that turkey management should be done at a smaller, regional scale that focused specifically on fall bag limits.

Fall Hunters

Fall hunters offered many suggested changes to current hunting regulations and seasons. In Bedford, participants enjoyed the new 2-week January turkey season and suggested it should be an option in Augusta, Bath, and Highland Counties. The new season was viewed favorably because it reduced perceived conflicts between turkey hunters and bear hunters, particularly regarding the effects of lost bear dogs on turkey hunting. However, in eastern Virginia, participants thought the new season was a waste of time because of interference from deer hunters who used dogs; after a flock had been disturbed by dogs, birds were reluctant to yelp when regrouping. The reduction of the concurrent turkey and deer firearms seasons proved to be an important item for discussion. Some fall hunting participants thought it protected turkeys from being harvested by deer hunters. However, others would like the seasons to run concurrently again because, from their perspective, the best part of the turkey season had been eliminated and the fall turkey season should not be broken up into segments. Participants also suggested the need for a longer season in the Northern Neck, providing distinct tags for the fall and spring turkey seasons, and starting the fall turkey season in October (this latter opinion was not universal as some thought it would be too warm to run turkey dogs). Satisfaction could be improved by providing additional fall turkey tags; this also was suggested as a means to improve the accuracy of harvest reporting. From focus groups held in western Virginia, elimination of rifles as a legal weapon for the take of spring turkeys was mentioned, and some people wanted to extend that ban to the fall season, too. Some participants in focus groups conducted in eastern Virginia also spoke in favor of the elimination of rifles, but there was uncertainty as to whether this should apply only to those who used larger calibers (>0.23) or all calibers. Some participants thought rifles enabled hunters to harvest birds at greater distances, thus eliminating the need for calling in birds. It was suggested that birds must be called in, and it should be illegal to wing-shoot a flushed bird during the fall. More youth hunting opportunities were desired by some, including providing Sunday hunting and possibly scheduling the youth hunting days to coincide with when children are on school breaks. A few participants expressed concerned that DGIF might be moving toward eliminating the fall turkey season.

What limits you from hunting wild turkeys in the spring more often? (asked only of spring hunters)

Spring hunters were limited from hunting more often by work, time commitments, school, weather, aging, and lack of access to suitable public and private land. A longer season, more turkey tags, Sunday hunting, all-day spring hunting, and the ability to harvest >1 bird per day were suggested to increase hunting opportunities.

What limits you from hunting wild turkeys in the fall more often? (asked only of fall hunters)

Fall hunters indicated that work, time constraints, and aging restricted them from hunting wild turkeys in the fall more often. Sunday hunting and a longer fall season were suggested as means to provide more hunting opportunities, but many believed the agricultural community and landowners would oppose Sunday hunting. Further, some hunters themselves thought Sunday should be reserved as a day of rest.

If you could change one thing about how wild turkeys are managed in Virginia, what would that one thing be?

Spring Hunters

Many spring hunters indicated that they would like to see more active habitat management on public lands (timber harvesting, plantings for wildlife, maintenance of habitat, providing brood cover). Participants indicated they would like to prohibit rifles from being used in the spring season, and some thought the fall season, too. Additional suggestions included: beginning the spring season earlier in eastern Virginia, allowing Sunday hunting, offering an additional fall-only turkey tag, developing a wild turkey stamp (similar in purpose to a duck stamp), restricting take to gobblers-only during the spring instead of bearded birds, keeping deer firearms and turkey seasons segregated, dismissing the blaze orange requirement during concurrent deer firearm and turkey seasons, and managing turkeys at a regional level. Some people desired more youth hunting opportunities and increasing hunter diversity by encouraging participation by underrepresented ethnic groups. Allowing all-day hunting for the entire spring season was desired by some, whereas others thought at least a few days of all-day hunting was necessary during the beginning of the season. Increased law enforcement to reduce poaching, development and delivery of anti-poaching programs, and implementing education efforts for poachers (to help them understand the damage they are inflicting) were changes some desired. It was suggested that DGIF needs to continue to uphold the tradition of both spring and fall turkey hunting.

Fall Hunters

Few fall hunters expressed complete satisfaction with current wild turkey management. Participants suggested the following changes to wild turkey management: utilizing hunters as the 'eyes and ears' of the woods providing information to DGIF, improving methods of public involvement at public meetings, providing written responses to comments solicited by hunters, and developing a better method (other than DGIF's *Outdoor Report*) for communicating with stakeholders. Changes directed at manipulating current seasons and regulations included: providing the same number of fall turkey tags as spring, creating an additional week at the beginning of the fall turkey season, providing additional days to fall turkey hunt without interference from deer hunters, providing more youth hunting opportunities, reducing the spring turkey season to run from April 1 until April 30, developing a special (unique) wild turkey license, offering bonus turkey tags, considering a gobbler-only fall season to protect the population, and increasing hunting opportunities in the Northern Neck. Participants suggested that the turkey and deer muzzleloader seasons could open at the same time to allow hunters a choice on which species to pursue. In eastern Virginia, participants suggested moving the January season to October and establishing a maximum shot size regulation (prohibiting buckshot), and potentially a minimum shot size. Participants preferred moving toward a county-specific approach, using the turkey population to dictate the number of turkey tags allowed. Some expressed concern that current population estimates were inaccurate, specifically regarding the elimination of the previous feather collection program and questions about how effective mail carrier surveys were.

Are there any other important issues that this group should discuss?

Spring Hunters

Many spring hunters were concerned about the absence of and need for habitat management on public lands. Prescribed burning was applauded, but some thought the practice was performed too late in the spring season and probably was disturbing hens on nests. Some also were concerned about feral dogs and cats, agricultural chemicals, and hunting dogs disturbing and damaging nests. Many comments were directed at specific management tactics of DGIF, including suggestions that DGIF should manage at a smaller scale than statewide for turkeys, update regulations established in the 1970s, use empirical data to support regulation changes, and improve their relationship with the US Forest Service. Others were concerned about how turkeys currently are managed by DGIF, and what metrics are used to establish regulations. Other discussions included: reasons for the declining population across the southeastern US, need for game processing education for after the harvest, educational habitat improvement programs for non-hunting landowners, separating vs. keeping the big game tag, youth recruitment, additional turkey tags, effects of eliminating check stations, issues DGIF staff believe are important in turkey management, number of NWTF members and the work the organization performs, limited access to private land for hunting, and the abundance and effects of predators. Some were concerned that a management plan would put fall and spring turkey hunters against themselves, whereas others thought a plan should encourage people to develop and maintain an interest in turkey hunting.

Fall Hunters

Fall hunters were aware that research was being conducted in the Southeast that involved the collection of turkey livers, and they wanted to know why. Others were curious about the legality of raising turkeys and releasing them into the wild and the collection and incubation of wild turkey eggs, ultimately leading to the release of those birds into the wild. Hunters suggested that

DGIF should develop a fall turkey hunter survey, similar to the spring gobbler survey. Concerns arose regarding the development of a turkey management plan and how it might actually spawn conflicts between hunters. In western Virginia, participants discussed at length why today's youth aren't involved in fall turkey hunting and methods about how youth participation might be increased (e.g., providing more youth opportunities vs. encouraging parents to take their children hunting). Participants discussed the possibility and effectiveness of providing an additional fall turkey tag for bearded-only birds. Some thought DGIF, or other land management agencies, should explore using prescribed burning more often as a habitat management option, and that an agreement should be established between DGIF and the US Forest Service to promote game management on national forest lands. Participants wanted to commend state agencies for their work restoring the wild turkey population, as it was not a sole effort by NWTF.

Wild Turkey Damage and Conflicts

Charlottesville - 6 Questionnaire Respondents - 4

How satisfied are you with the current population of wild turkeys where you live? Why? Would you like to see the population increase, decrease, or stay about the same?

Most, but not all, participants were not satisfied with current wild turkey populations and thought smaller populations were needed to effectively reduce turkey damage on their property; a minority of participants expressed satisfaction with the current population and thought they should stay about the same.

What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?

Most participants with damage stressed they did not have viable options available to mitigate damage when they have problems with turkeys; for vineyard operators, this usually was the period immediately before and during harvest time (mid-July to October). Many participants thought a kill permit or hunting seasons during the summer should be options to mitigate turkey damage, but some also were interested in non-lethal methods. Participants stressed that the need for turkey damage mitigation isn't well-recognized because vineyards aren't widespread or common across Virginia. The reduction in the number of hunters and areas open to hunting were cited as factors contributing to the increase in turkey populations. Participants also were concerned with the growing abundance of turkeys in and near towns and cities where predators are limited and hunting is prohibited.

Have you personally experienced any conflicts with or damage from wild turkeys here in Virginia?

a. **What was the nature of the conflict or damage and how significant, in terms of its physical and/or economic impact, was it?**
b. **What time of year did the conflict or damage occur?**
c. **Did you seek and/or receive any help in resolving this conflict or damage? If so, from whom did you receive help to resolve your problem?**
d. **Was the issue resolved? If so, how?**
e. **On what evidence did you rely to determine that a wild turkey caused the damage?**

Most participants were vineyard owners and had experienced problems with turkeys consuming their grapes. Other participants described different types of damage from and conflicts with turkeys, including pulling up sprouting corn seedlings, scratching and destroying turf, destroying newly emerging vegetation at a nature preserve, and aggressive physical attacks upon a family member. Vineyard damage could range from hundreds to thousands of dollars lost per year according to one participant, and another participant noted he lost approximately 1,000 pounds of grapes per year during the last few years. Damage to cornfields was difficult to quantify in costs because of their size; it was noted that turkey damage caused a complete loss for farmers when turkeys pull up their sprouting corn. The turf damaged by turkeys also caused a complete loss, costing from $3,000 - $5,000 per year. A wild turkey physically is capable of inflicting serious injury to a person, and this was cited as justification for harvesting the offending bird. Damage to vineyards typically occurs from mid-July to October, whereas most other agricultural damage occurs during the spring growing season. The turkey-human conflict was thought to occur during the summer (the participant had difficulty remembering the incident, as it occurred a few years ago). Many participants attempted to obtain a kill permit from DGIF conservation officers, but were informed that kill permits cannot be issued for wild turkeys. Many in the vineyard industry noted that non-lethal methods to deter wild turkeys can be an expensive venture, yet still do not reduce wild turkey damage. The participant with turf damage noted both a DGIF biologist and conservation officer did not believe a wild turkey caused the damage until they were shown visual evidence. The participant that witnessed a wild turkey attack a family member contacted a DGIF conservation officer and was given permission to harvest the bird (although permission to harvest turkeys out of season typically is not granted by DGIF). At the nature preserve, an individual sought permission to host a special wild turkey hunt, but that request was denied. Many participants noted they saw turkeys inflicting physical damage (consuming grapes, eating turf, pulling up corn sprouts), whereas others had game camera pictures displaying turkeys 'in the act.'

Compared to conditions that existed 5 years ago, do you believe that conflicts with wild turkeys are increasing, declining, or are about the same? On what factor(s) do you base this opinion?

Most participants thought that conflicts with wild turkeys were increasing. However, some were uncertain if the population actually was increasing or if turkeys simply had discovered their vineyard after several years of operation and began using it as a source of food. It was noted by many vineyard owners that when they started, it took a few years before wild turkeys became a problem on their property. Better quality habitat was thought to be fueling the increasing wild turkey population (and damage) at the nature preserve.

What actions should be taken to respond and to reduce wild turkey problems?

a. What actions, if any, do you believe need to be taken to resolve problems caused by wild turkey populations in Virginia?

Most participants thought kill permits were necessary to mitigate turkey damage. Other suggested options included developing successful non-lethal methods, trap and transfer of nuisance birds, special controlled turkey hunts, and having a turkey hunting season during the summer months. Some thought professional organizations, such as the Virginia Vineyard Association, should discuss mitigation methods they have tried and which ones have been successful or unsuccessful. The participant who experienced a wild turkey attack was satisfied with the actions taken to solve his problems and had no further suggestions to offer.

b. Who do you believe is responsible for implementing the actions you seek?

Most participants thought the Virginia General Assembly should enable DGIF to issue kill permits specifically for wild turkeys. Others thought it was up to growers to employ techniques to mitigate damage. It was also mentioned that the DGIF Board should be composed of individuals who don't have strong political ties and actually will listen to the suggestions DGIF professionals offer.

If there was one thing that you would recommend needs modification regarding management of wild turkeys in Virginia, what would that one thing be?

Most participants wanted a way to mitigate damage inflicted by wild turkeys, primarily through kill permits, but also using effective non-lethal methods, if those could be identified. Shifting the current turkey season to include some of the summer months was suggested. Some thought better leadership (i.e., informed, educated, and apolitical) from the DGIF Board was necessary.

Are there any other important issues related to wild turkeys not addressed here that you believe should be raised for future discussion?

One participant stressed it was necessary to educate other individuals, including hunters, that turkey damage is occurring and is a serious problem. Quantifying damage is a difficult task; however, smaller vineyards (<10 acres) are well aware of what they lose and it can be a significant loss. Large vineyards (>10 acres) often are the size of one typical agricultural field, so comparisons to other types of agriculture probably are inappropriate or misleading. Participants could not agree on an acceptable (tolerable) amount of turkey damage (i.e., before an operation becomes unprofitable). One participant was especially interested in what growers are doing to deter turkeys, and mentioned numerous techniques he planned to employ this summer to deter turkeys. Education and outreach for producers was desired by one participant, as many growers don't know much about the life history of the wild turkey. That participant also suggested those who enjoy viewing and hunting wild turkeys should fund a program that could reimburse individuals who are experiencing damage. Participants noted turkeys are just one of a long list of problem species that cause damage, including raccoons, songbirds, opossums, and others. DGIF should address issues related to how landowners can open their land for hunting and generate revenue, similar to what Texas Parks and Wildlife has done.

Wild Turkey Conservationists

Questionnaire Respondents - 8

What is your primary interest in the management of wild turkeys in Virginia?

Many respondents expressed joy in viewing wild turkeys. Some respondents had family members who enjoyed hunting wild turkeys. Most respondents desired a healthy population of wild turkeys in Virginia. One respondent noted that the species is native to the environment and inhabited Virginia before Europeans colonized the area. Another respondent was interested in how active habitat management for wild turkeys on national forest lands might negatively affect other species and the overall quality of the habitat. One respondent remembered when turkeys weren't plentiful, and that the restoration of the wild turkey in America has been amazing.

How satisfied are you with the current population of wild turkeys where you live? Why? Would you like to see the population of wild turkeys in Virginia increase, decrease, or remain about the same?

Most respondents expressed satisfaction with the current wild turkey population, though this varied regionally. Some thought the turkey population was fine (Franklin County), while others thought it could be increased (southwest Virginia, Northern Neck). One respondent suggested the length of the turkey season should be reduced and the concurrent turkey and deer season should be eliminated to allow turkey populations to increase. One respondent noted habitat loss to human development was a threat to turkey populations. A "healthy and sustainable population of wild turkeys" was a common desire.

What do you see as being the most pressing issues with management of wild turkeys in Virginia? Why?

Many respondents thought habitat management and habitat degradation were issues in wild turkey management; the lack of maintenance to retain forest openings on national forest lands, the growing human population restricting available habitat for wild turkeys, non-native vegetation displacing native vegetation, and how surface mining is fragmenting turkey habitat all were cited as examples. One respondent thought it was necessary for agencies involved with land management to have a full inventory of suitable habitats on public and private lands before making management decisions. The declining number of hunters in Virginia and concern for who would be willing to pay for wildlife management was a serious concern for one respondent. Predation, especially by coyotes, skunks, opossums, and raccoons, was viewed as being responsible for losses of turkeys and their nests. One respondent was alarmed by the amount of poaching or excessive take occurring in Franklin County; they were aware of numerous hunters who had harvested $\geq$12 turkeys per year. One respondent thought the hunting season was too long for wild turkeys.

Do you feed wild turkeys? Why?

Most respondents did not feed wild turkeys because it brings animals together unnaturally. However, many respondents commented that they, or an organization with which they are affiliated, did plant food plots for wildlife. One respondent noted he had agricultural fields that the turkeys would feed in and he enjoyed their presence. One respondent mentioned he did not feed wild turkeys because he lived in a town, but other members of his organization fed turkeys for viewing enjoyment.

Have you ever hunted wild turkeys, now or in the past? If you haven't hunted turkeys, why not?

Many respondents did not hunt turkeys, for a variety of reasons: never taught how to hunt, didn't have the 'heart' to harvest animals, or just enjoyed watching turkeys. However, some respondents had hunted turkeys in the past; they quit doing so because of a disability or because they enjoyed watching turkeys more than harvesting them.

Do you feel safe when you recreate outdoors during turkey hunting seasons? If not, why?

Although some respondents felt safe when they were outdoors during turkey hunting season, others did not feel safe and would recreate only on Sundays during hunting seasons or would avoid hiking on public land during seasons when hunter participation is high (deer season). Those who recreated during hunting season knew where hunters were or took extra precautions by wearing blaze orange. One respondent did not feel safe during the fall turkey season in particular because those hunters aren't as cautious; however, this individual thought the spring gobbler season was safer because those hunters must track and call in a gobbler, and therefore pay more attention to their targets. Some respondents worried about their pets being mistaken for a white-tailed deer, whereas others thought some hunters did not receive lessons on how to be a responsible hunter.

If you could change one thing about how wild turkeys are managed in Virginia, what would that one thing be?

Responses included suggestions for more public education (particularly youth and others on why population management is necessary), and to provide more opportunities for the public to be involved in decision-making processes. Others thought sources of funding were needed to maintain the clearings on national forest. One respondent thought wild turkeys should be managed as a species of interest for birders, as well as hunters. It was suggested that wild turkeys should be put first, instead of managing them for utilitarian purposes. Some respondents suggested modifying current hunting seasons and regulations, such as providing all-day hunting for the entire spring season, increasing the turkey seasons, and providing more turkey tags. Concern for better law enforcement was noted; check station records should be investigated to identify hunters who always fill the 3rd tag on the last day, indicating that they were saving their last tag to cover for any bird they happened to be caught with (but not intended to check in) while the season was in. However, one respondent thought hunting pressure needed to be reduced. One individual was not knowledgeable enough with current management for wild turkeys to offer suggestions.

Are there any other important issues related to management of wild turkeys in Virginia that we haven't asked about?

Most respondents did not raise additional issues related to wild turkey management, but did have additional concerns. One individual was worried about wild turkeys contracting a disease, such as avian influenza, and the population becoming extirpated. He realized how much work has gone into restoring the wild turkey population in Virginia. Another individual thought more focus should be placed on planting native vegetation to attract turkeys, rather than using exotic plant species. One respondent thought specific ideas for inclusion in the wild turkey management plan should be sought from the public and land managers should have comprehensive inventories of habitat and wildlife corridors before making management decisions.

Appendix C. Cover letters, survey, and interview script for the Stakeholder Advisory Committee

VirginiaTech
College of Natural Resources
and Environment

Fish and Wildlife Conservation
100 Cheatham Hall (0321)
Blacksburg, Virginia 24061
540/231-5573 Fax: 540/231-7580
www.fishwild.vt.edu

«First» «Last»
«address»
«city», «state» «zip»

January 31, 2013

Dear «First»:

We invite you to participate in the enclosed survey to help us identify how knowledge, attitudes, and opinions of individuals may be affected during active participation in a management planning effort. We distributed this survey to all members of the Virginia Wild Turkey Management Stakeholder Advisory Committee and will be distributing a similar version to members of the Virginia Department of Game and Inland Fisheries Wild Turkey Technical Committee. The objective of this specific survey is to examine the knowledge, attitudes, and opinions of the SAC prior to participating in the wild turkey management planning effort. We will ask you to participate in a similar survey after the management plan is complete.

The survey will take approximately 20 minutes to complete. Please answer the survey honestly based on your current knowledge, without relying on any sources (e.g., Internet, books) for assistance. This survey is voluntary and there is no more than minimal risk associated with your participation. Please return the survey by February 9, 2013, via the postage paid envelope found in this packet. Please enter this unique ID number on the cover of the survey: **«PIN»**.

If you have questions regarding this survey, please contact Holly Morris at hnmorris@vt.edu or (304) 667-7037. Thank you for your time and participation.

Sincerely,

Holly Morris	Steve L. McMullin	James A. Parkhurst
Graduate Research Assistant	Associate Professor	Associate Professor

Invent the Future

<Date>

Dear «First»:

We invite you to participate in an online survey to help us identify how knowledge, attitudes, and opinions of individuals may be affected during active participation in a management planning effort. We distributed an identical survey prior to beginning the management planning process to all members of the Virginia Wild Turkey Management Stakeholder Advisory Committee and to members of the Virginia Department of Game and Inland Fisheries Wild Turkey Technical Committee and other agency staff. The objective of this specific survey is to examine the knowledge, attitudes, and opinions of the SAC after to participating in the wild turkey management planning effort.

The survey can be accessed at this link using **your unique PIN «PIN»** and will take approximately 20 minutes to complete. Please answer the survey honestly based on your current knowledge, without relying on any sources (e.g., Internet, books) for assistance. This survey is voluntary and there is no more than minimal risk associated with your participation. We will be closing the survey at **5:00 PM on September 25, 2013**, so please submit your input by then.

In addition to this online survey, I would like to contact you via phone and ask you a few questions regarding your experience as a SAC member after completing the above survey. Please follow this link to access a Doodle poll and sign up for a time that will work for you. The phone interview will take approximately 15 minutes. This interview is voluntary and there is no more than minimal risk associated with your participation.

If you have questions, please contact Holly Morris at hnmorris@vt.edu or (304) 667-7037. Thank you for your time and participation.

Sincerely,

Holly Morris	Steve L. McMullin	James A. Parkhurst
Graduate Research Assistant	Associate Professor	Associate Professor

Photo credit: US Fish and Wildlife Service

Welcome to the Virginia Wild Turkey Management Planning Process Survey!

Your participation in this survey will help us identify how knowledge, attitudes, and opinions of individuals may be affected during active participation in a management planning effort. The survey will take approximately 20 minutes to complete.
This survey is voluntary and there is no more than minimal risk associated with your participation.

Please write your ID number here: ....

Section 1. This portion of the survey is intended to assess your knowledge of wild turkey biology and management in Virginia. Please check only one box that you believe best answers each question. If you do not know or are not sure about the correct answer, please mark 'Not sure'.

(1) The wild turkey was once rare throughout most of Virginia.

❑ True ❑ False ❑ Not sure

(2) Wild turkey population trends are monitored using harvest data from the spring wild turkey season.

❑ True ❑ False ❑ Not sure

(3) Only male wild turkeys have a beard (a tuft of modified feathers on the bird's chest).

❑ True ❑ False ❑ Not sure

(4) After attaining an age of 3, female wild turkeys become barren and no longer attempt to lay eggs.

❑ True ❑ False ❑ Not sure

(5) If the nest of a female wild turkey is destroyed, she will attempt to renest.

❑ Always ❑ Sometimes ❑ Never ❑ Not sure

(6) At what stage of development is a turkey poult's (a young turkey) survival lowest?

❑ Hatching to 2 weeks of age
❑ 2 weeks of age to one month after hatching
❑ One month to 2 months after hatching
❑ All the periods have about the same survival for turkey poults
❑ Not sure

(7) Which of the following statements most accurately describes the relationship between forest openings or fields and young wild turkey poults less than 4 weeks of age?

❑ Poults feed on the abundant herbaceous vegetation found in these areas
❑ Poults feed on the abundance of insects found in these areas
❑ Poults don't use forest openings and fields
❑ None of the above
❑ Not sure

(8) Wild turkeys are considered:

❑ Carnivores (only consume animal matter)
❑ Herbivores (only consume plant matter)
❑ Omnivores (consume both plant and animal matter)
❑ Not sure

(9) Starvation among wild turkeys in Virginia during winter is a problem.

❑ True ❑ False ❑ Not sure

(10) A large or abundant hard mast crop (e.g., acorns) results in birds spending more time in forested areas and traveling less to locate food, therefore they are less vulnerable to hunting mortality in the fall.

- ☐ True ☐ False ☐ Not sure

(11) Using pen-raised turkeys to stock areas with low or nonexistent wild turkey populations usually is not successful because:

- ☐ Pen-raised birds do not recognize naturally occurring food resources
- ☐ Pen-raised birds demonstrate poor skills in evading predators
- ☐ Pen-raised birds are highly susceptible to diseases
- ☐ All of the above
- ☐ None of the above
- ☐ Not sure

(12) Over the past 15 years, the fall turkey harvest has been declining statewide.

- ☐ True
- ☐ False
- ☐ Not sure

(13) The fall turkey hunting season may have a greater impact than the spring gobbler season on the wild turkey population because:

- ☐ Hunters in the fall disrupt turkey flocks making it difficult for birds to find sufficient food for the winter
- ☐ Hunters have the ability to harvest inexperienced juvenile male and female turkeys
- ☐ Harvesting hens in the fall will reduce the number of hens available for breeding the next spring
- ☐ All of the above
- ☐ Not sure

(14) Managers have been cautious to not open the spring gobbler season prior to the date when the majority of hens are on nests incubating eggs because:

- ☐ Hens are with gobblers and are more visible to hunters, and thus more susceptible to illegal harvest, prior to incubation
- ☐ Too many gobblers will be harvested, as gobblers are more vocal (gobbling) when hens are not incubating nests
- ☐ Too many gobblers will be harvested, because green vegetation will be minimal early in the spring which allows hunters better opportunities to see and harvest gobblers
- ☐ All of the above
- ☐ Not sure

(15) Currently in Virginia, the statewide wild turkey population is considered to be:

- ☐ Growing ☐ Declining ☐ Stable

Section 2. The question below is designed to examine the values, attitudes, and opinions stakeholders possess relative to wild turkey management.

(1) Please indicate how important **you** think it is to incorporate the values, attitudes, and opinions of each of the following groups in the management of wild turkeys in Virginia.

	Very Important	Somewhat Important	Somewhat Unimportant	Not At All Important
Spring turkey hunters	❑	❑	❑	❑
Fall turkey hunters	❑	❑	❑	❑
Individuals who wish to harvest a turkey while pursuing other game species	❑	❑	❑	❑
Individuals who enjoy viewing wild turkeys	❑	❑	❑	❑
Agricultural producers	❑	❑	❑	❑
Private rural landowners	❑	❑	❑	❑
Private urban landowners	❑	❑	❑	❑
Public landowners (e.g., U.S. Forest Service)	❑	❑	❑	❑
Virginia Dept. of Game and Inland Fisheries	❑	❑	❑	❑
Hunter-advocacy groups (e.g., National Wild Turkey Federation)	❑	❑	❑	❑
Conservation groups (e.g., Audubon)	❑	❑	❑	❑

Section 3. The question below is designed to identify the perceived importance placed by the Virginia Department of Game and Inland Fisheries (VDGIF) on values, attitudes, and opinions of stakeholders relative to wild turkey management.

(1) Please indicate how important you believe VDGIF thinks it is to incorporate the values, attitudes, and opinions of each of the following groups in the management of wild turkeys in Virginia.

	Very Important	Somewhat Important	Somewhat Unimportant	Not At All Important
Spring turkey hunters	❑	❑	❑	❑
Fall turkey hunters	❑	❑	❑	❑
Individuals who wish to harvest a turkey while pursuing other game species	❑	❑	❑	❑
Individuals who enjoy viewing wild turkeys	❑	❑	❑	❑
Agricultural producers	❑	❑	❑	❑
Private rural landowners	❑	❑	❑	❑
Private urban landowners	❑	❑	❑	❑
Public landowners (e.g., U.S. Forest Service)	❑	❑	❑	❑
Virginia Dept. of Game and Inland Fisheries	❑	❑	❑	❑
Hunter-advocacy groups (e.g., National Wild Turkey Federation)	❑	❑	❑	❑
Conservation groups (e.g., Audubon)	❑	❑	❑	❑

Section 4. The statements below are intended to examine your opinions of wild turkey managment and the Virginia Department of Game and Inland Fisheries (VDGIF). Please rank each of the statements below based on your level of agreement.

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
I believe that VDGIF manages wild turkeys well.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF has a good scientific basis for managing wild turkeys.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF personnel fairly consider the input they receive from the public.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF makes a good effort to obtain input from the public as a whole.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF does a good job keeping stakeholders informed about management.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.	❑	❑	❑	❑	❑	❑	❑
I believe that VDGIF makes decisions with public values in mind.	❑	❑	❑	❑	❑	❑	❑
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.	❑	❑	❑	❑	❑	❑	❑

Section 5. Fish and wildlife agencies set both broad management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) and specific management objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years). After establishing objectives, agencies then must develop the appropriate strategies (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to attain those objectives.

Your participation in this section of the survey will help us assess how various stakeholders view the role they may play in assisting the agency make management decisions. In each of the following questions, please select the response statement that best describes what you believe the balance between professional and public opinion currently is as management decisions are made, and then what you think that balance should be, as decisions are made by VDGIF.

(1) Setting broad management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **currently is:**

- ☐ Mostly a public decision
- ☐ A shared decision, but public opinion is more important
- ☐ A decision shared equally between professionals and the public
- ☐ A shared decision, but professional opinion is more important
- ☐ Mostly a professional decision

(2) Setting broad management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **should be:**

- ☐ Mostly a public decision
- ☐ A shared decision, but public opinion is more important
- ☐ A decision shared equally between professionals and the public
- ☐ A shared decision, but professional opinion is more important
- ☐ Mostly a professional decision

(3) Setting specific management objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **currently is:**

- ☐ Mostly a public decision
- ☐ A shared decision, but public opinion is more important
- ☐ A decision shared equally between professionals and the public
- ☐ A shared decision, but professional opinion is more important
- ☐ Mostly a professional decision

(4) Setting specific management objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **should be:**

- ☐ Mostly a public decision
- ☐ A shared decision, but public opinion is more important
- ☐ A decision shared equally between professionals and the public
- ☐ A shared decision, but professional opinion is more important
- ☐ Mostly a professional decision

(5) Developing strategies (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet an established objective (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **currently is:**

- ❑ Mostly a public decision
- ❑ A shared decision, but public opinion is more important
- ❑ A decision shared equally between professionals and the public
- ❑ A shared decision, but professional opinion is more important
- ❑ Mostly a professional decision

(6) Developing strategies (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet an established objective (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **should be:**

- ❑ Mostly a public decision
- ❑ A shared decision, but public opinion is more important
- ❑ A decision shared equally between professionals and the public
- ❑ A shared decision, but professional opinion is more important
- ❑ Mostly a professional decision

(7) Selecting strategies to implement from among those developed (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet an objective (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **currently is:**

- ❑ Mostly a public decision
- ❑ A shared decision, but public opinion is more important
- ❑ A decision shared equally between professionals and the public
- ❑ A shared decision, but professional opinion is more important
- ❑ Mostly a professional decision

(8) Selecting strategies to implement from among those developed (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **should be:**

- ❑ Mostly a public decision
- ❑ A shared decision, but public opinion is more important
- ❑ A decision shared equally between professionals and the public
- ❑ A shared decision, but professional opinion is more important
- ❑ Mostly a professional decision

(9) Evaluation of progress toward management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **currently is:**

- ❑ Mostly a public decision
- ❑ A shared decision, but public opinion is more important
- ❑ A decision shared equally between professionals and the public
- ❑ A shared decision, but professional opinion is more important
- ❑ Mostly a professional decision

(10) Evaluation of progress toward management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **should be:**

- ❑ Mostly a public decision
- ❑ A shared decision, but public opinion is more important
- ❑ A decision shared equally between professionals and the public
- ❑ A shared decision, but professional opinion is more important
- ❑ Mostly a professional decision

Thank you for taking the time to complete the survey.
Your participation is highly valued.

If you have any questions please contact
Holly Morris, Virginia Tech graduate student, at hnmorris@vt.edu or (304) 667-7037.

Commments:

Interview questions for the SAC

Post-Planning Process

1. Were you satisfied with the <u>process</u> used to develop the Virginia Wild Turkey Management Plan? If not, why?

2. Did you share information with and receive feedback from individuals or groups you were representing as a SAC member?

3. Do you think any other stakeholder groups should have been included in the planning process? Were the right stakeholders at the table?

4. Have your views about other stakeholders interested in management of wild turkeys changed as a result of your participation in this process? How?

5. Do you believe that the opinions of all interests were fairly heard and considered in development of the Wild Turkey Management Plan?

6. Do you believe that any particular interest had too much influence in development of the Wild Turkey Management Plan?

7. What, if anything, did you learn about wild turkeys or their management as a result of your participation in this process?

8. Are you satisfied with the goals, objectives and strategies in the Wild Turkey Management Plan?

    a. If you are dissatisfied with any aspects of the plan, can you describe what you are dissatisfied with?

9. Have your views about the Virginia Department of Game and Inland Fisheries changed as a result of your participation in this process?

Appendix D. Virginia Department of Game and Inland Fisheries wildlife professionals cover letters and survey

[Date]

Dear <Name>:

We invite you to participate in a survey to help us identify how attitudes and opinions of individuals may be affected during participation in a management planning effort. We distributed this survey to wildlife professionals employed by the Virginia Department of Game and Inland Fisheries and an expanded version of the survey including knowledge based questions to all members of the Virginia Wild Turkey Management Stakeholder Advisory Committee (SAC). The objective of this specific survey is to examine the attitudes and opinions of wildlife professionals prior to involvement in the wild turkey management planning effort. We will ask you to participate in a similar survey after the management plan is complete.

The survey can be accessed at xxx using your **unique password** <ID> and will take approximately 15 minutes to complete. This survey is voluntary and there is no more than minimal risk associated with your participation. We will be closing the survey on March 8, 2013, so please submit your input by then.

If you have questions regarding this survey, please contact Holly Morris at hnmorris@vt.edu or (304) 667-7037. Thank you for your time and participation.

Sincerely,

Holly Morris	Steve L. McMullin	James A. Parkhurst
Graduate Research Assistant	Associate Professor	Associate Professor

<Date>

Dear «Name»:

We invite you to participate in a survey to help us identify how attitudes and opinions of individuals may be affected during participation in a management planning effort. We distributed an identical survey prior to the beginning the management planning process to wildlife professionals employed by the Virginia Department of Game and Inland Fisheries and an expanded version of the survey including knowledge based questions to all members of the Virginia Wild Turkey Management Stakeholder Advisory Committee (SAC). The objective of this specific survey is to examine the attitudes and opinions of wildlife professionals after participating in the wild turkey management planning effort.

The survey can be accessed at **XXX** using your **unique password «PIN»** and will take approximately 15 minutes to complete. This survey is voluntary and there is no more than minimal risk associated with your participation. We will be closing the survey at **5:00PM on November 4, 2013**, so please submit your input by then.

If you have questions regarding this survey, please contact Holly Morris at hnmorris@vt.edu or (304) 667-7037. Thank you for your time and participation.

Sincerely,

Holly Morris	Steve L. McMullin	James A. Parkhurst
Graduate Research Assistant	Associate Professor	Associate Professor

Web Page 1:

Welcome to the Virginia Wild Turkey Management Planning Process Survey!

Your participation in this survey will help us identify how attitudes and opinions of individuals may be affected during participation in a management planning effort.
The survey will take approximately 15 minutes to complete.
This survey is voluntary and there is no more than minimal risk associated with your participation.

Please enter the unique PIN I sent to you via email

Start

IRB #11-591 - Approved

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Web Page 2:

Section 1. The question below is designed to examine the values, attitudes, and opinions individuals possess relative to wild turkey management. If you believe a stakeholder has not been mentioned below, please type the stakeholder's name in the 'other' box below and indicate how important you believe the stakeholder is.

(1) Please indicate how important **you** think it is to <u>incorporate the values, attitudes, and opinions</u> of each of the following groups in the management of wild turkeys in Virginia.

	Very Important	Somewhat Important	Somewhat Unimportant	Not At All Important
Spring turkey hunters				
Fall turkey hunters				
Individuals who wish to harvest a turkey while pursuing other game species				
Individuals who enjoy viewing wild turkeys				
Agricultural producers				
Private rural landowners				
Private urban landowners				
Public landowners (e.g., U.S. Forest Service)				
Virginia Dept. of Game and Inland Fisheries				
Hunter-advocacy groups (e.g., National Wild Turkey Federation)				
Conservation groups (e.g., Audubon)				

Other:

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Web Page 3:

Section 2. The statements below are intended to examine your opinions of wild turkey management and the Virginia Department of Game and Inland Fisheries (VDGIF). Please rank each of the statements below based on your level of agreement.

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
I believe that VDGIF manages wild turkeys well.							
I believe that VDGIF has a good scientific basis for managing wild turkeys.							
I believe that VDGIF effectively balances public input with scientific research when making management decisions regarding wild turkeys.							
I believe that VDGIF understands the concerns of all parties interested in wild turkeys.							
I believe that VDGIF personnel fairly consider the input they receive from the public.							
I believe that VDGIF makes a good effort to obtain input from the public as a whole.							
I believe that VDGIF does a good job keeping stakeholders informed about management.							
I believe that VDGIF bases its management recommendations for wild turkeys on sound biological information.							
I believe that VDGIF makes decisions with public values in mind.							
I believe the Board of Game and Inland Fisheries appropriately balances biological information and stakeholder opinions in setting seasons and bag limits for wild turkeys.							

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Web Page 4:

Section 3. Fish and wildlife agencies set both broad management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) and specific management objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years). After establishing objectives, agencies then must develop the appropriate strategies (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to attain those objectives.

Your participation in this section of the survey will help us assess how various individuals view the role they may play in making management decisions. In each of the following questions, please select the response statement that best describes what you believe the balance between professional and public opinion currently is as management decisions are made, and then what you think that balance should be, as decisions are made by VDGIF.

(1) Setting broad management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **currently is:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(2) Setting broad management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **should be:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(3) Setting specific management objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **currently is:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(4) Setting specific management objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **should be:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

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IRB #11-591 - Approved

Web Page 5:

(5) Developing strategies (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet an established objective (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **currently is:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(6) Developing strategies (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet an established objective (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **should be:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(7) Selecting strategies to implement from among those developed (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet an objective (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **currently is:**

- Mostly a public decision
- A shared decision, but public opinion is more important
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- Mostly a professional decision

(8) Selecting strategies to implement from among those developed (e.g., harvest timber from multiple small (<2 acres) areas on selected, high-priority Wildlife Management Areas) to meet objectives (e.g., create 10 new clearings on Wildlife Management Areas over the next 5 years) **should be:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(9) Evaluation of progress toward management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **currently is:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

(10) Evaluation of progress toward management goals (e.g., improve habitat for wild turkeys on VDGIF Wildlife Management Areas) **should be:**

- Mostly a public decision
- A shared decision, but public opinion is more important
- A decision shared equally between professionals and the public
- A shared decision, but professional opinion is more important
- Mostly a professional decision

<< Back | Finish Later | Next >>

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Web Page 6:

Section 4. This section is designed to identify the area you are assigned and how many years you've worked for VDGIF. Please check the answer that fits you best.

(1) What area are you **assigned** to work in?

Region 1 Region 2 Region 3 Region 4 Richmond Headquarters Statewide

(2) How many years have you worked for VDGIF?

1 - 5 years 6 - 10 years 11 - 15 years 16 - 20 years 21 - 25 years 26 + years

<< Back Finish Later Next >>

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Web Page 7:

Thank you for taking the time to complete the survey.
Your participation is highly valued.

If you have any questions please contact
Holly Morris, Virginia Tech graduate student, at hnmorris@vt.edu .

Comments:

<< Back Finish Later Send Answers

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Appendix E. Wild turkey expert surveys using Delphi approach

April 2, 2013

Dear <First> <Last>:

Among your peers, you are recognized as an expert in eastern wild turkey biology and management. Given that, we would like solicit, via a very short survey, your knowledge and expertise to assist us in resolving some specific technical issues related to wild turkeys. The Department of Fish and Wildlife Conservation here at Virginia Tech, in cooperation with the Virginia Department of Game and Inland Fisheries, is attempting to develop a functional and valid habitat model for wild turkeys in Virginia. We envision the model having 2 steps: an initial analysis of habitat at the landscape-level using the National Land Cover Dataset, and a second phase that analyzes habitat at the patch-level, using aerial imagery.

At this stage of the project, we have encountered difficulty quantifying certain brood and food-related metrics believed to be critical to wild turkeys due to a lack of existing, reliable data. Relying solely on information currently available in the literature we believe will produce a poor model as little data now exist on what constitutes optimal conditions for these metrics for turkeys. We recognize that variables we believe should be incorporated in this model likely will have different optimum/maximum levels in different states, and likely across a state, but we hope to identify useful generalized ranges based on "expert knowledge." Thus, this is where we seek your personal experiences from past projects and your understanding of wild turkeys and their habitat. We hope to use your professional knowledge and experiences, together with that of other experts, to establish some viable norms that can be used to develop meaningful suitability curves in the wild turkey habitat model for Virginia. We hope you will be willing to contribute to the creation of this "expert database."

The survey can be accessed at xxx using **your unique password (XX)** and will take approximately 15 minutes to complete. This survey is voluntary and there is no more than minimal risk associated with your participation. We recognize that you are busy and have many other demands on your time, but we would appreciate a timely response, if possible. We will be closing the survey on October 31, 2012, so please try to submit your input by then.

If you have questions regarding this survey, please contact Holly Morris at hnmorris@vt.edu. Thank you for your time.

Sincerely,

Holly Morris
Graduate Research Assistant

Screen 1:

Welcome to the wild turkey habitat survey

The purpose of this survey is to provide data to assist with a research project the Department of Fish and Wildlife Conservation at Virginia Tech is conducting with the Virginia Department of Game and Inland Fisheries. This project is an attempt to develop a multi-level habitat model for wild turkeys in Virginia; one model would analyze habitat at the landscape-level using the National Land Cover Dataset, whereas the other model would analyze habitat at the patch-level using aerial imagery. However, we are encountering difficulty in quantifying certain brood and food-related metrics believed to be critical to wild turkeys. We recognize these variables may have different optimum/maximum levels in different states, and likely across a state, but we hope to identify useful generalized ranges. Thus, we are seeking your professional knowledge and experiences to help establish some viable norms that can be used to develop meaningful suitability curves in the wild turkey habitat model for Virginia.

To begin the survey, enter your 4 digit ID here: . . . .

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Quit

Start

Screen 2:

1. In your state, what is the mean distance that a hen with a brood travels, on average, from her nest site to usable brood range?

<0.5 mi   0.5 mi - 1 mi   1.1 mi - 1.5 mi   1.6 mi - 2 mi   >2 mi

2. In your opinion, what is productive nesting habitat for a hen?

To answer this question, please rate each of the following habitats for their value to a hen wild turkey, where 0 = not utilized, 1 = low value, 2 = moderate value, and 3 = high value. Although we have attempted to devise a representative list of potential nest sites, please identify any other important habitats we may have missed and assess their value to a hen.

	Overall Value Rank			
	0	1	2	3
managed hay fields				
edges where forests and openings meet				
interior of forest clear-cuts				
edges where forests and clear-cuts meet				
fallow fields				
along woods roads				
natural forest gap				
utility right-of-ways				

other: . . . .

other (2): . . . .

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Quit   Back   Next

Screen 3:

3. In your state, what is the maximum distance that a hen with a brood will venture into a maintained hayfield and away from the protection of forest cover (assuming vegetation in the opening does not impede the hen's field of view, obstruct poults' movement, or provide escape cover)?

- <50 yds
- 50 yds - 100 yds
- 101 yds - 150 yds
- 151 yds - 200 yds
- >200 yds

4. In your state, at the landscape-scale, what is the appropriate ratio of open to forested land for wild turkeys of all sexes and ages? (ratios below represent open:forested)

- 10:90
- 20:80
- 30:70
- 40:60
- 50:50

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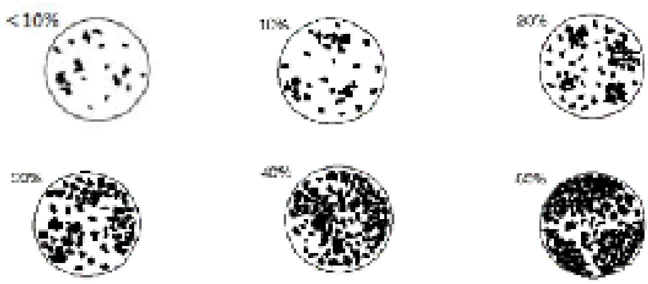
Quit | Back | Next

Screen 4:

Questions 5a and 5b, focus on wild turkey habitat at the patch-scale. These questions are designed to identify the differences in the optimum proportion of openings, if any, between wild turkey adults and poults.

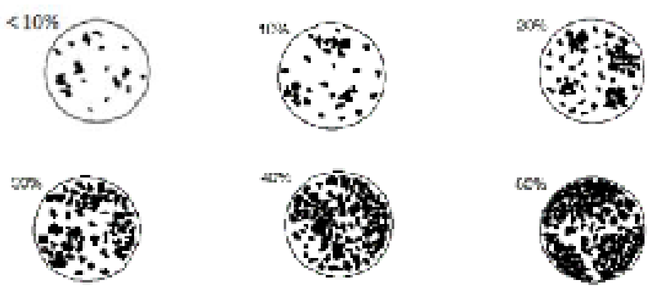
5a. From among the graphic images presented below, please select the one (by checking the box that represents the % you choose) that best depicts the % cover of open land that optimizes brood habitat for wild turkeys. In these graphics, blackened areas represent openings.

<10% 10% 20% 30% 40% 50%



5b. From among the graphic images presented below, please select the one (by checking the box that represents the % you choose) that best depicts the % cover of open land that optimizes habitat for adult wild turkeys. In these graphics, blackened areas represent openings.

<10% 10% 20% 30% 40% 50%



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Quit Back Next

Screen 5:

6. How do you define 'open land' (i.e., what constitutes a viable opening to a wild turkey brood)?

To answer this challenge, please rate each of the following open land habitats for their value to a brood of wild turkeys, where 0 = not utilized, 1 = low value, 2 = moderate value, and 3 = high value. Although we have attempted to devise a representative list of potential 'openings', please identify any other important opening types we may have missed and assess their value to a brood.

	Overall Value Rank 0	1	2	3
managed hay fields				
grazed pasture land				
fallow herbacoues grassland				
row/truck crop fields (vegetables)				
small grain crops				
silage or sweet corn field				
daylighted woods road				
natural forest gap				
utility right-of-ways				
old log landings				
undeveloped vegetated areas in city limits				

other(a): ....

other(b): ....

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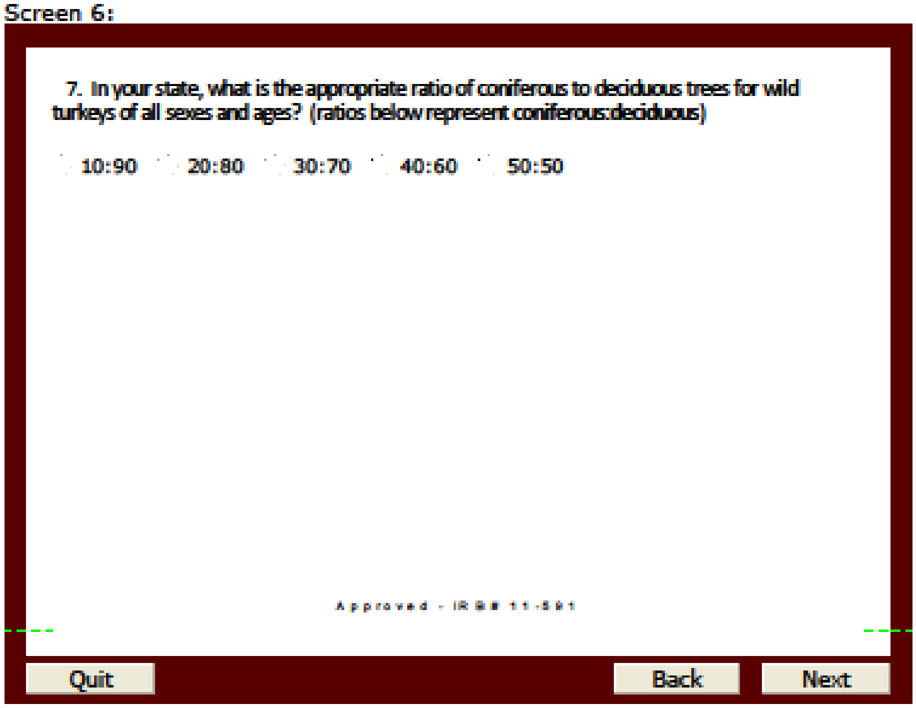
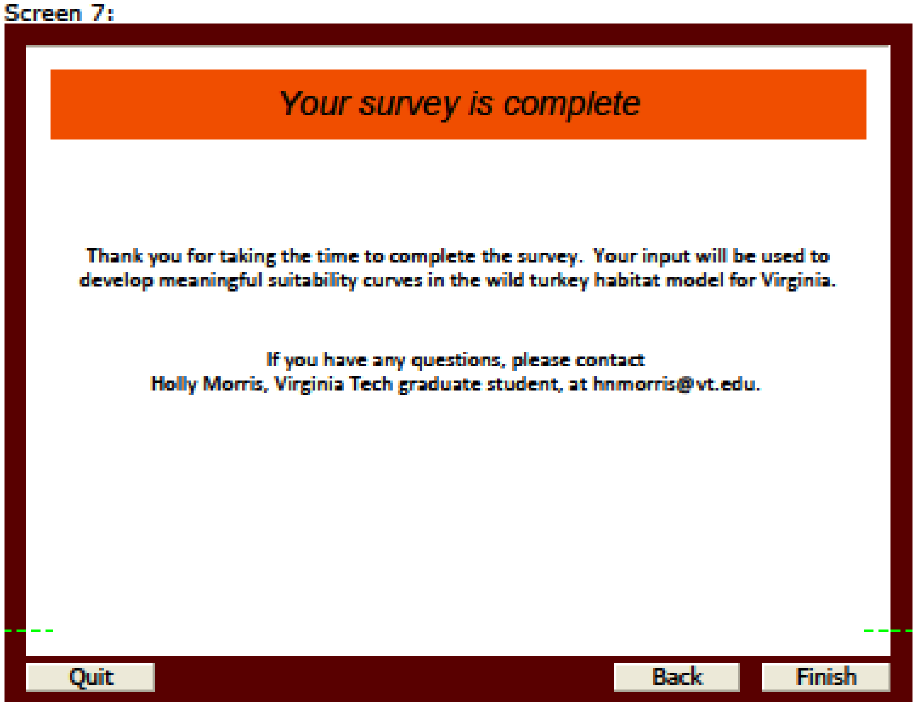
Quit Back Next

Screen 6:



Screen 7:



<Date>

Dear «Name»:

Since we last contacted you, we have finished the first phase of developing a draft landscape-level GIS model that assesses habitat suitability for eastern wild turkeys in Virginia. The input we received from you and other turkey professionals to our survey last fall was incorporated into preliminary revisions of the model, all of which we believe have helped improve its functionality —we extend our sincere thanks for your feedback to that initial request. We now have reached a point where we would like to reach out to you once again and ask for your continuing assistance and expertise. We have constructed a very short survey that will allow us to begin calibrating the model. We invite you to participate in an effort we believe will take you no more than 15 minutes to complete. We are providing you a sample of 12 "snap shots" of habitats from within Virginia and we are asking that you use your professional experience to estimate habitat suitability based on satellite images of randomly selected areas and values calculated of variables used in the model. As a member of our ad hoc "team of experts," we are hoping that you and your peers will participate in this Delphi-like test of habitat judging of the model and help us decide where adjustments should be made, if necessary.

The survey can be accessed by clicking on this **link** and using **your unique PIN («PIN»)** and will take approximately 15 minutes to complete. This survey is voluntary and there is no more than minimal risk associated with your participation. We recognize that you are busy and have many other demands on your time, but we would appreciate a timely response, if possible. The survey will be closed on May 10th, 2013, so please try to submit your input by then.

If you have questions regarding this survey, please contact Holly Morris at hnmorris@vt.edu. Thank you for your time.

Sincerely,

Holly Morris — James A. Parkhurst

Graduate Research Assistant — Associate Professor

Web Page 1:

Photo credit: Greg Thompson, USFWS

Welcome to the wild turkey habitat suitability estimation survey!

This survey will begin the first step in validating the eastern wild turkey habitat suitability GIS model developed by Virginia Tech's Department of Fish and Wildlife Conservation. This survey will require approximately 15 minutes to complete and presents minimal risk to the participants.

On the following pages, 12 samples of aerial imagery (each~5,200 acres) are presented, including specific model variables and their values based on the sample. Forested cover, open cover, and edge are defined in the footer on each page. Please provide an estimate of the habitat suitability for **adults**, **broods**, and **overall** for wild turkeys based on the provided information.

To begin, please enter the numeric 4-digit PIN I provided you via e-mail in the box below.

Enter your 4-digit PIN

Start

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity

Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas

Edge – areas where forested and open cover types are adjacent

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Web Page 2:

Scale 1:25,000

R1-Site1
Percentage of the home range in forested cover types: **78**

Percentage of the home range in open cover types:**22**

Percentage of the home range in edge: **24**

Percentage of the home range in open cover types <150m from forested cover: **22**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Haibtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity

Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas

Edge – areas where forested and open cover types are adjacent

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Web Page 3:

Scale 1:25,000

B1-Site2
Percentage of the home range in forested cover types: **52**

Percentage of the home range in open cover types: **47**

Percentage of the home range in edge: **34**

Percentage of the home range in open cover types <150m from forested cover: **45**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back Finish Later Next >>

Forested cover - deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover - Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge - areas where forested and open cover types are adjacent

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Web Page 4:

Scale 1:25,000

R1-Site3

Percentage of the home range in forested cover types: **7**

Percentage of the home range in open cover types: **93**

Percentage of the home range in edge: **11**

Percentage of the home range in open cover types <150m from forested cover: **31**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity

Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas

Edge – areas where forested and open cover types are adjacent

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Web Page 5:

Scale 1:25,000

R2-Site4
Percentage of the home range in forested cover types: **74**

Percentage of the home range in open cover types: **25**

Percentage of the home range in edge: **35**

Percentage of the home range in open cover types <150m from forested cover: **25**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity

Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas

Edge – areas where forested and open cover types are adjacent

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Web Page 6:

Scale 1:25,000

R2-Site5
Percentage of the home range in forested cover types: **97**

Percentage of the home range in open cover types: **3**

Percentage of the home range in edge: **7**

Percentage of the home range in open cover types <150m from forested cover: **3**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Haibtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge – areas where forested and open cover types are adjacent

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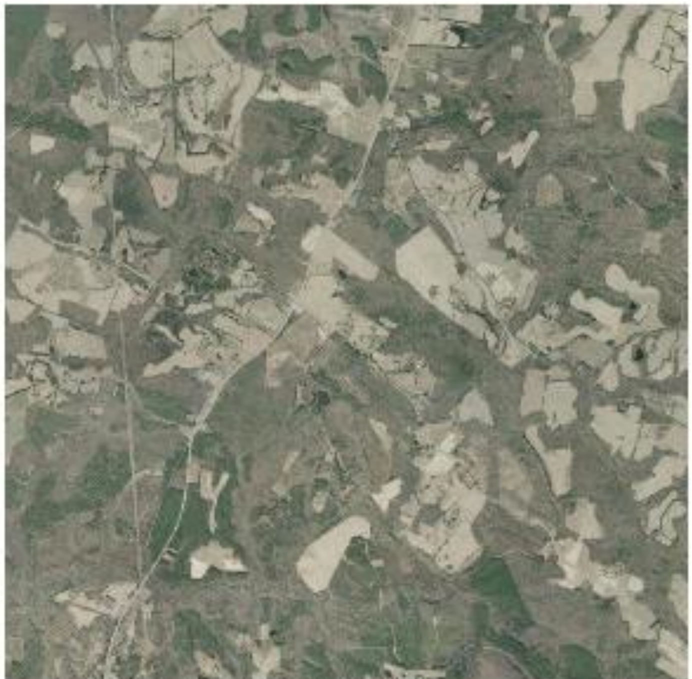
Web Page 7:



Scale 1:25,000

R2-Site6
Percentage of the home range in forested cover types: **61**

Percentage of the home range in open cover types: **39**

Percentage of the home range in edge: **43**

Percentage of the home range in open cover types <150m from forested cover: **39**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover - deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover - Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge - areas where forested and open cover types are adjacent

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Web Page 8:

Scale 1:25,000

B3-Site7
Percentage of the home range in forested cover types: **77**

Percentage of the home range in open cover types: **22**

Percentage of the home range in edge: **46**

Percentage of the home range in open cover types <150m from forested cover: **22**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Haibtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover - deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover - Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge - areas where forested and open cover types are adjacent

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Web Page 9:

Scale 1:25,000

R3-Site8

Percentage of the home range in forested cover types: **26**

Percentage of the home range in open cover types: **74**

Percentage of the home range in edge: **29**

Percentage of the home range in open cover types <150m from forested cover: **56**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity

Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas

Edge – areas where forested and open cover types are adjacent

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Web Page 10:

Scale 1:25,000

R3-Site9
Percentage of the home range in forested cover types: **48**

Percentage of the home range in open cover types: **34**

Percentage of the home range in edge: **52**

Percentage of the home range in open cover types <150m from forested cover: **34**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Haibtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge – areas where forested and open cover types are adjacent

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Web Page 11:

Scale 1:25,000

B4-Site10
Percentage of the home range in forested cover types: **99**

Percentage of the home range in open cover types: **1**

Percentage of the home range in edge: **5**

Percentage of the home range in open cover types <150m from forested cover: **1**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Haibtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover - deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover - Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge - areas where forested and open cover types are adjacent

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Web Page 12:

Scale 1:25,000

R4-Site11
Percentage of the home range in forested cover types: **28**

Percentage of the home range in open cover types: **71**

Percentage of the home range in edge: **31**

Percentage of the home range in open cover types <150m from forested cover: **54**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Next >>

Forested cover – deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover – Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge – areas where forested and open cover types are adjacent

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Web Page 13:

Scale 1:25,000

R4-Site12
Percentage of the home range in forested cover types: **72**

Percentage of the home range in open cover types: **22**

Percentage of the home range in edge: **33**

Percentage of the home range in open cover types <150m from forested cover: **27**

Below please provide your estimate of the habitat suitability for an eastern wild turkey based on the above information and imagery. Please enter a number between 0 and 100, with 0 being not suitable and 100 being optimal suitability.

	Your Estimate
Habitat suitability for ADULT wild turkeys	
Halbtat suitability for wild turkey BROODS	
OVERALL habitat suitability	

<< Back | Finish Later | Send Answers

Forested cover - deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity
Open cover - Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas
Edge - areas where forested and open cover types are adjacent

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Web Page 14:

Thank you for completing the survey. Your participation is highly valued.

If you have any questions, please contact Holly Morris at hnmorris@vt.edu .

Forested cover = deciduous forest, mixed forest, evergreen forest, shrub/scrub, woody wetlands, & developed - low intensity

Open cover = Grassland/herbaceous, pasture/hay, cultivated crops, & developed - open areas

Edge = areas where forested and open cover types are adjacent

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Appendix F. National Land Cover Database error matrices

Table 1. NLCD 2006 Level II error matrix for the continental US obtained from Wickham et al. (2013). Standard errors (SE) for UA and PA are provided in parentheses. Cell entries identify a percent of the area. Bold diagonal cell entries indicate the agreement. Overall accuracy is 78.36%.

Map	Reference														
	11	12	21	22	23	24	31	41	42	43	52	71	81	82	90
11	**1.988**		0.016				0.007	0.007			0.021	0.029	0.001	0.021	0.024
12		**0.006**					0.001					0.004			
21	0.017		**1.615**	0.194	0.029	0.009	0.014	0.272	0.126	0.105	0.138	0.142	0.224	0.203	0.029
22	0.011		0.339	**0.916**	0.096	0.044	0.014	0.018	0.01		0.05	0.012	0.015	0.038	0.005
23	0.021		0.107	0.052	**0.656**	0.074	0.003		0.005			0.022	0.009		
24				0.009		**0.045**									
31	0.034		0.014	0.003	0.001	0.003	**0.828**	0.01	0.029	0.002	0.143	0.135	0.009	0.006	0.001
41			0.175	0.034				**9.799**	0.806	0.404	0.318	0.088	0.152	0.144	0.196
42			0.125					0.733	**10.266**	0.278	0.729	0.136	0.003	0.098	0.001
43			0.018					0.081	0.001	**1.616**	0.106	0.06			0.024
52	0.013		0.446	0.022	0.006		0.096	0.599	0.534	0.283	**18.751**	0.546	0.39	0.146	0.012
71	0.01		0.346	0.039			0.004	0.253	0.187	0.032	0.451	**11.052**	1.569	0.71	0.006
81			0.292	0.032			0.017	0.202	0.032		0.411	0.383	**5.13**	0.083	0.007
82	0.001		0.376	0.007	0.007			0.145	0.033	0.001	0.165	0.223	0.879	**14.08**	0.055
90	0.026		0.02		0.03			1.15	0.341	0.716	0.325	0.08	0.038	0.045	**1.149**
95	0.061		0.003	0.005				0.116	0.008	0.002	0.109	0.107	0.128	0.022	0.161
PA (SE) [b]	91(2)	100(0)	42(4)	70(4)	80(5)	26(10)	84(7)	73(2)	83(2)	47(5)	86(1)	85(2)	60(4)	90(2)	69(6)

[a] = User's accuracy (the probability that a pixel was labelled correctly)

[b] = Producer's accuracy (the probability that the land cover on the ground was classified correctly)

Table 1. Continued.

Map	95	UA (SE) [a]
11	0.003	94(2)
12		53(2)
21		52(2)
22		59(2)
23		69(2)
24		83(2)
31	0.006	68(2)
41		81(2)
42	0.001	83(2)
43		85(2)
52	0.154	85(2)
71	0.124	75(2)
81	0.048	77(2)
82	0.019	88(2)
90	0.056	29(2)
95	**0.467**	39(2)
PA (SE) [b]	53(11)	78.364

[a] = User's accuracy (the probability that a pixel was labelled correctly)
[b] = Producer's accuracy (the probability that the land cover on the ground was classified correctly)

Table 2. NLCD 2001 Level II error matrix for the continental US obtained from Wickham et al. (2013). Standard errors (SE) for UA and PA are provided in parentheses. Cell entries identify a percent of the area. Bold diagonal cell entries indicate the agreement. Overall accuracy is 79.29%.

Map	Reference														
	11	12	21	22	23	24	31	41	42	43	52	71	81	82	90
11	**1.998**		0.016				0.001	0.007			0.008	0.019	0.008	0.029	0.05
12		**0.006**					0.001					0.004			

21	0.005		**1.554**	0.201	0.028		0.002	0.272	0.147	0.099	0.141	0.155	0.221	0.204	0.029
22			0.307	**0.872**	0.091	0.016	0.014	0.016	0.018		0.041	0.019	0.038	0.054	0.016
23	0.006		0.105	0.052	**0.491**	0.029	0.002		0.005		0.009	0.022			
24	0.006		0.009	0.009	0.005	**0.2**									
31	0.039		0.013	0.001		0.001	**0.831**	0.014	0.041	0.002	0.115	0.129	0.012	0.004	0.005
41	0.001		0.146	0.034				**10.154**	0.839	0.291	0.252	0.096	0.105	0.088	0.196
42			0.125					0.835	**10.534**	0.285	0.543	0.157	0.027	0.069	0.001
43	0.001		0.018					0.082	0.072	**1.669**	0.041	0.06			0.024
52	0.008		0.354	0.019			0.095	0.595	0.614	0.293	**18.517**	0.58	0.388	0.217	0.009
71	0.007		0.342	0.037			0.001	0.287	0.196	0.029	0.372	**11.055**	1.457	0.714	0.001
81			0.292	0.016			0.017	0.189	0.033	0.002	0.202	0.253	**5.554**	0.106	0.007
82	0.04		0.227	0.009	0.007		0.001	0.101	0.018	0.001	0.224	0.19	0.896	**14.247**	0.055
90	0.011		0.016		0.03			1.16	0.362	0.762	0.256	0.077	0.034	0.039	**1.143**
95	0.056		0.002	0.005			0.005	0.111	0.008	0.002	0.108	0.111	0.124	0.016	0.167
PA (SE) [b]	92 (2)	99 (1)	44(4)	70(4)	75(6)	81(7)	85(7)	73(2)	82(2)	49(5)	89(1)	86(2)	63(4)	90(2)	67(5)

[a] = User's accuracy (the probability that a pixel was labelled correctly)

[b] = Producer's accuracy (the probability that the land cover on the ground was classified correctly)

Table 2. Continued.

Map		
	95	UA (SE) [a]
11	0.004	93 (1)
12		54(18)
21	0.011	51(3)
22	0.018	57(4)
23	0.009	67(4)
24		87(6)
31	0.005	69(4)
41	0.001	83(2)
42		84(2)
43		85(5)
52	0.157	85(2)
71	0.118	76(3)
81	0.039	83(2)
82	0.017	89(2)
90	0.07	29(3)
95	**0.462**	39(6)
PA (SE) [b]	51(7)	79.287

[a] = User's accuracy (the probability that a pixel was labelled correctly)
[b] = Producer's accuracy (the probability that the land cover on the ground was classified correctly)

Table 3. NLCD 1992 Level II error matrix for the Mid-Atlantic region obtained from Stehman et al. (2003). Standard errors (SE) for UA and PA are provided in parentheses. Cell entries identify a percent of the area. Bold diagonal cell entries indicate the agreement. Overall accuracy is 43.06%.

Class	11	21	22	23	31	32	33	41	42	43	81	82	85	91	92	Total
11	**3.768**	0	0	0.057	0	0	0.114	0	0	0.057	0	0.057	0	0	0.066	4.119
21	0	**1.865**	0.173	0.679	0	0	0.104	0.173	0	0.139	0.262	0.069	0.666	0.035	0	4.165
22	0	0.352	**0.122**	0.39	0	0	0.017	0.006	0	0	0	0	0.017	0	0	0.906
23	0.009	0.027	0.009	**0.662**	0	0	0.009	0.126	0	0	0	0	0.15	0	0	0.993

31	0	0.048	0	0	**0.002**	0	0.002	0	0	0.388	0	0	0	0	0	0.44
32	0	0.007	0	0.007	0	**0.899**	0.482	0.137	0	0.402	0.526	0.022	0.007	0	0.085	2.575
33	0.009	0.018	0	0	0	0	**0.734**	0.062	0.334	0.053	0.245	0.272	0	0	0.009	1.735
41	0	1.523	0	0	0	0.761	4.328	**18.944**	1.217	7.615	2.512	1.655	0.767	0.761	0	40.084
42	0	0.132	0	0.085	0	0	0.557	0.978	**2.476**	1.472	0.34	0.085	0	0.255	0	6.38
43	0.265	0	0.132	0.132	0	0	0.132	2.302	2.139	**3.196**	0	0.586	0.397	0.645	0	9.927
81	0	0.455	0	0.683	0	0	0.455	1.223	0.228	0.455	**4.538**	7.504	1.291	0.228	0	17.061
82	0.081	0.161	0	0.161	0	0	0.242	0.322	0.308	0.242	0.242	**3.919**	0.461	0.081	0.081	6.301
85	0	0.005	0.394	0.061	0	0	0.033	0.005	0.005	0.005	0	0.423	**0.682**	0	0	1.615
91	0	0.05	0	0	0	0	0.151	1.264	0.126	0.418	0.05	0.075	0	**0.68**	0	2.814
92	0.144	0.034	0	0	0	0	0.008	0.017	0.017	0.017	0.008	0.017	0.025	0.025	**0.572**	0.886
Total	4.265	4.679	0.831	2.918	0.002	1.66	7.368	25.56	6.849	14.46	8.725	14.685	4.465	2.71	0.81	**100.001**
PA [b]	0.88	0.4	0.15	0.23	1	0.54	0.1	0.74	0.36	0.22	0.52	0.27	0.15	0.25	0.71	
S.E.	0.05	0.11	0.09	0.06	0	0.23	0.05	0.04	0.07	0.1	0.1	0.04	0.08	0.08	0.13	
n	79	88	33	101	6	23	98	158	68	112	54	107	76	40	61	

[a] = User’s accuracy (the probability that a pixel was labelled correctly)

[b] = Producer’s accuracy (the probability that the land cover on the ground was classified correctly)

Table 3. Continued

Class	UA [a]	SE	n
11	0.92	0.04	73
21	0.45	0.1	76
22	0.14	0.06	70
23	0.67	0.09	65
31	0.01	0.01	42
32	0.35	0.17	77
33	0.42	0.17	66
41	0.47	0.09	118
42	0.39	0.07	66
43	0.32	0.06	68
81	0.27	0.05	77
82	0.62	0.07	64
85	0.42	0.2	79
91	0.24	0.07	79
92	0.65	0.09	84
Total			
PA [b]	43.059		
S.E.		43.06 +/-3.9 Overall accuracy	
n			1104

[a] = User's accuracy (the probability that a pixel was labelled correctly)

[b] = Producer's accuracy (the probability that the land cover on the ground was classified correctly)

Appendix G. Landscape-level habitat suitability model user's guide using GIS for the eastern wild turkey in Virginia

Part I: Landscape-level GIS Habitat Suitability Model for the Eastern Wild Turkey in Virginia

Authors

Holly N. Morris, Graduate Research Assistant, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

James A. Parkhurst, Associate Professor of Wildlife and Wildlife Extension Specialist, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

Dean F. Stauffer, Associate Dean for Academic Programs and Professor of Wildlife, College of Natural Resources and Environment, Virginia Tech, Blacksburg, VA

Gary W. Norman, Wild Turkey Project Leader, Virginia Department of Game and Inland Fisheries, Richmond, VA

This project was funded by the Virginia Department of Game and Inland Fisheries and was completed in 2014. Personnel from Virginia Tech and VDGIF worked together to develop this habitat suitability model as a part of a comprehensive habitat assessment for the eastern wild turkey in Virginia.

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Introduction and Purpose

In 2011, the Virginia Department of Game and Inland Fisheries (VDGIF) identified a need to assess wild turkey habitat to complement the development of a wild turkey management plan in Virginia. Habitat assessment methodology did exist at the time for the eastern wild turkey (Schroeder 1985, Missouri Department of Conservation and USDA Soil Conservation Service 1988); however, researchers determined a new version of an eastern wild turkey habitat suitability model would be necessary to take advantage of today's technology and to meet the desired objectives of the agency. After assessing the life requisites of a wild turkey and the available data for use in a habitat assessment, researchers deemed a two-level habitat assessment necessary. First, a landscape-level habitat suitability model using a geographic information system (GIS) was developed to assess habitat at the scale of the average home range of a wild turkey in VA. Second, a smaller patch-scale rapid habitat appraisal tool was developed, which requires a physical site visit to the area of interest and an evaluation of the land surrounding the area of interest using aerial imagery. This document will explain the requirements for using the model, the habitat needs of wild turkeys, and how to apply and modify the landscape-level habitat model. Use of this habitat suitability model will allow biologists to assess the past and current habitat conditions for wild turkeys, and identify areas where management may be needed to address limiting factors.

Scale

This model was designed with the average home range of a wild turkey in mind. In Virginia, the average home range is 5,189 acres (McDougal 1990). Therefore, using the model on small tracts of land is not advised. It is suggested the model should be applied on areas no smaller than the county-level. The patch-scale rapid habitat appraisal tool should be applied on tracts of interest that are smaller than a turkey's home range.

Software and Data Requirements

This habitat suitability model was designed using ModelBuilder in ESRI ArcGIS 10.1, therefore ArcGIS software is required to use the model. The model can be obtained by contacting the VDGIF Wild Turkey Project Leader, Gary Norman at Gary.Norman@dgif.virginia.gov .

Multiple data are necessary to run the model. The National Land Cover Database (NLCD) is the primary source of data the model uses to calculate the habitat suitability. We selected these data for use in the model because it has been previously produced (1992, 2001, 2006), thus enabling the model to assess past habitat conditions, and likely will continue to be produced in the future, ensuring the model will continue to be operational. This data is produced nationwide, so it also allows the model to be used in other states (with similar habitat types as Virginia or with proper model modifications). The NLCD can be obtained free of charge from the USGS National Resource Conservation Service Geospatial Gateway <http://datagateway.nrcs.usda.gov/>.

For habitat assessment purposes, we reclassified the NLCD to represent forested, open, and unsuitable areas. Forested cover types include (based on the 2006 & 2001 data; modified slightly for 1992 data) deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands. Open cover types include grasslands/herbaceous, hay/pasture, and cultivated crops. Unsuitable habitat includes developed, open space; developed, low intensity; developed, medium intensity; developed, high intensity; barren land; and emergent herbaceous wetlands. We ignored the presence of water during the habitat assessment.

In addition to the NLCD, users also need multiple shapefiles to run the model. A shapefile of the state boundary including individual counties is required as the 'Area of Interest' because later functions in the model assess suitability and other components at the county-scale (e.g., HSI by county). Also, the NLCD data should be clipped (e.g., using Extract by Mask) to match the state boundary. Data focusing on agency regions or districts can be extracted from the model output; using shapefile of county boundaries, shapefiles of agency management districts and regions can be generated by selecting appropriate counties and exporting the selection. Also, using the same method as creating management districts, a shapefile of the counties and independent cities open to wild turkey hunting can be created. This shapefile will be required to assess the suitability of only those areas open to hunting. A statewide shapefile including individual counties can be obtained from the USGS National Resource Conservation Service Geospatial Gateway.

Other shapefiles required include boundaries of US Forest Service (USFS) properties and agency Wildlife Management Areas (WMAs). These files enable the model to calculate the habitat suitability indices for each tract or per total ownership of WMA or USFS land.

Additional raster files needed include boundaries of USFS lands, WMAs, Dept. of Forestry State Forests, US Fish and Wildlife Service refuges, Department of Defense lands, Department of Conservation and Recreation boundaries, and the National Park Service (NPS) lands. These raster files enable the model to assess the suitability of all USFS lands, for an example, compared to all non-USFS lands. A raster file including all 'public lands' (compiled from all rasters previously mentioned) can be used to compare the suitability of all public lands with the suitability of private lands. A separate analysis for USFS lands and WMAs, combined, can be created from the USFS and WMA rasters, enabling a comparison to be made between WMA and USFS lands combined lands vs. non- WMA or USFS lands. These are areas that VDGIF typically can employ habitat management on, unlike those lands owned by the NPS. Also, assessing only USFS lands west of the Blue Ridge (WBR) mountains can identify the suitability of USFS properties WBR compared to non-USFS properties WBR. This enables the agency to compare the suitability of USFS ownership on a smaller scale where habitat is generally similar (e.g., mountainous terrain).

All public land shapefiles were acquired on 9/24/2013 from the Virginia Department of Conservation and Recreation <http://www.dcr.virginia.gov/natural_heritage/cldownload.shtml>. The model was designed for use with data in NAD 1983 UTM Zone 17N; if data are not obtained in this format they must be transformed to this projection and coordinate system for accurate use.

All data necessary for the model has been included in the model package, but was obtained in 2013. Unless the model is being applied outside Virginia or more recent data is available (e.g., updated USFS boundaries, 2011 NLCD released) it is not necessary to acquire data for the model. Duplicate versions of the habitat model have been developed for the 1992 and 2001 datasets with appropriate modifications (e.g., the 1992 data has slightly different NLCD classifications), and are provided in separate GIS toolboxes. Shapefiles of VDGIF regions and districts, and counties/cities open to wild turkey harvest also have been developed and are included in the model package.

Shapefiles Required:

- State boundary with counties
- State boundary with counties/cities open to turkey harvest (user developed)
- US Forest Service boundaries
- Wildlife Management Area boundaries (user developed from agency owned properties)

Rasters Required:

- National Land Cover Database
- US Forest Service boundaries
- Wildlife Management Area boundaries (user developed from agency owned properties)

- VA Div. of Forestry State Forest boundaries
- US Fish & Wildlife Service refuge boundaries
- National Park Service boundaries
- Department of Defense boundaries
- VA Dept. of Conservation and Recreation boundaries
- A raster representing 'all public land' (user developed)
- A raster representing USFS and WMA boundaries, combined (user developed)
- A raster representing US Forest Service boundaries west of the Blue Ridge (user developed)

Habitat Requirements and Model Variables

Wildlife requires food, water, shelter, and may need other special requirements to survive and prosper (Leopold 1986) and wild turkeys are no different. In the habitat suitability model, food, shelter, and special needs are addressed. Water has been excluded from the assessment; research indicates that turkeys primarily obtain water from their food sources but water may become important during extremely dry conditions (Hurst 1992, Wunz and Pack 1992). Considering the habitat requirements and the landscape-level nature of the model, 5 variables were developed and deemed to be appropriate for use with the NLCD data. Assessing habitat at the landscape-level requires the habitat requisites to be coarsely addressed; for example, the ability to differentiate between red and white oak species does not exist.

In the following sections, the habitat requirements for wild turkeys are discussed and the variables from the habitat suitability model addressing each requirement are explained.

Adult Food

Wild turkeys feed opportunistically on a variety of items, but their main source of food is hard mast produced by deciduous trees; therefore, the abundance of mature hard mast producing trees is important (Hurst 1992, Steffen et al. 2002). However, the species of trees also are important. Wild turkeys prefer the acorns of northern red (*Quercus rubra*) and white oaks (*Q. alba*) over those produced by other oaks and the mast produced by other hardwood species (e.g., mockernut hickory [*Carya tomentosa*], black walnut [*Juglans nigra*]) (Minser et al. 1995). Also, having a variety of white and red oak species present adds habitat value. Late spring frosts can damage acorn production, but the effects of that damage vary by species. Because white oak acorns require only one year to mature, the effect of frost damage will be observed in the year damage occurs. With red oaks, where mast develops over a 2-year period, there can be a delayed carry-over effect from frost damage that results in pronounced mast shortages in areas where only red oak species are present (Dickson 1990). However, in mixed species stands, if white oaks fail to produce an acorn crop, red oaks may produce at least some mast due to their 2-year cycle.

Soft mast also represents an important food resource for wild turkeys. Important soft mast species include dogwood (*Cornus spp.*), grape (*Vitus spp.*), blueberry (*Vaccinium spp.*), and pokeweed (*Phytolacca* spp.*)*. Korschgen (1967) noted that the fruits of dogwoods were the second most commonly occurring food item found in turkey crops, after acorns. Soft mast items may attract wild turkeys to an area, particularly if hard mast is scarce.

Wild turkeys also attracted to agricultural areas due to the potential food resource benefits they realize there, either from the agricultural products being grown or the insect communities associated with crop production (for brood "bugging" purposes). Wild turkeys will consume grain crops (i.e., corn, wheat, oats), scavenge for spilled grains left in a field after harvesting, and pluck undigested corn kernels from cattle manure. In winter, wild turkeys use agricultural areas as sources of supplemental food, especially where hard mast crops are poor or unattainable (hard packed snow). During difficult times, wild turkeys often stay in areas where residual grain is available.

Variable 1. -- The potential presence of soft and hard mast as a food source is identified in Variable 1. This variable specifically measures the percent of the area in forested cover types (V_f). The forested cover types include: deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands. The ability of a tree to produce mast (species and appropriate size) cannot accurately be identified at the landscape-level using the NLCD. This variable identifies the potential of an area to provide food (mast) for adult wild turkeys.

Variable 2. -- The potential abundance of soft mast and cropland is identified in Variable 2. This variable identifies the percent of the area in open cover types (V_o), which includes grasslands/herbaceous, hay/pasture, and cultivated crops. The exact type of crop being cultivated, field phase (e.g., fallow, tilled, etc.), or the presence of soft mast cannot be detected at the landscape-level using the NLCD, so the presence of these cover types must serve as a surrogate. These areas provide a source of adult and brood turkey food and cover; birds can directly feed on the vegetation, the soft mast species that may be present, and the insects that exist among the vegetation.

Nesting Cover

Wild turkeys select nesting sites in areas where vegetation obstructs the horizontal line-of-sight exposure of hens to potential predators. Although wild turkeys attempt to nest in a variety of habitats, habitats characterized by dense herbaceous transitional edge zones provide high quality cover. Potential nesting habitat includes herbaceous patches along disturbed forested habitats, such as the edges of a clearcut, an open field, gated forest roads, and utility right-of-ways. Nesting areas are important because, without quality nesting habitat, population growth will be limited and the likelihood of predation and nest abandonment may be high.

Variable 3. -- Potential nesting habitat is identified in Variable 3. This variable represents the percent of the area in edge (V_e). Edge is identified as areas where forested and open cover types are adjacent. Detailed nesting habitat, such as gated forest roads, cannot accurately be identified at the landscape-level using the NLCD; therefore the presence of edge serves as a substitute for potential nesting habitat.

Brood Food

Poults require sufficient protein in the diet to grow properly and mature into adults, and they derive their most of their protein needs from insects they consume. Insects thrive in herbaceous openings, including managed hay fields, cattle grazing areas, abandoned fields, utility right-of-ways, clear cuts, recently burned areas, and grasslands. Adult turkeys also frequent these early succession areas to feed on the abundant insects, seeds, and soft mast that often occur there, more so during years with hard mast failures.

Variable 4. -- The identification of herbaceous areas that broods typically use are identified in Variable 4. This variable identifies the percent of the area in open cover types useful for a brood (open cover <150m from forested cover) (V_b). The open cover types include grasslands/herbaceous, hay/pasture, and cultivated crops. The forested cover types include deciduous forest, evergreen forest, mixed forest, scrub/shrub, and woody wetlands. As with other variables including open cover types, the specific crops grown or current state of the field (e.g., grazing, tilled, fallow) cannot be determined at the landscape-level using the NLCD. Hens with broods will not venture great distances from forested cover when feeding, for fear of predation, therefore we included a distance requirement that openings are accessible only when <150m from forested cover.

Variable 5. -- To measure the potential of an area to provide brood habitat, variable 5 assesses the percent of open cover that is useful for a brood (open cover <150m from forested cover) (V_{ob}). This variable identifies areas that currently serve as a food source for broods and the potential of an area to provide food for broods if forested cover was created nearby. Areas in Virginia, for example the

Shenandoah Valley, may have large openings but do not provide ample forested cover. If cover is not present, broods will not venture in the opening and utilize the area as a food source.

Roost Cover

Wild turkeys require mature trees for roosting and studies have shown turkeys will roost in conifers, when available. Conifers situated on northeastern-facing slopes protect roosting birds from prevailing winds and enable them to regulate body temperature more effectively (Porter 1992). Without suitable roost habitat available, wild turkeys will move to other places to roost and feed, particularly during harsh winter weather.

Variable 1, the percent of the area in forested cover types (V_f), also serves as a surrogate for identifying forest cover for turkeys, i.e., roost habitat. At the landscape-scale using the NLCD, the ability of a tree to support a roosting turkey or identifying the exact species of a tree cannot be determined. Areas classified as 'deciduous forest' indeed may have some conifers present, but an insufficient amount for the NLCD to classify the area as coniferous forest; thus underestimating the abundance of potential roost sites relying on original NLCD classifications.

Habitat Arrangement

Habitats that provide both nesting cover and brood range within close proximity to each other are essential to poult survival. The further poults must travel, oftentimes into unfamiliar areas, the more susceptible they are to predation and accidental death, which leads to lower survival and population growth. During the first 3-5 days after hatching, poults rely on the residual yolk for sustenance, but after that is fully utilized, poults must consume insects or perish.

At the landscape-level, assessing this detail of habitat arrangement is unattainable. However, the presence of each variable within an area does provide value; the overall habitat suitability will be penalized if a component is missing. In the next section, aggregating model variables and determining suitability will be discussed.

Aggregating Variables and Determining Suitability

Model variables are combined to provide a distinct suitability value for adult wild turkeys, and for reproduction and recruitment needs. Both of these components are aggregated to provide an overall index of habitat suitability for the area. A flow chart describing how the variables are combined and the wild turkey life requisites they satisfy is provided in Appendix A. Each variable also has a specific habitat suitability curve that provides a value, from 0 - 1, for the variable depending on the prevalence of the variable (e.g., 5% of the area in forested cover types would result in a low suitability value for V_f). The habitat suitability curve for each variable is provided in Appendix B.

Adult Food and Cover

Based on the life requisites for a wild turkey, it was appropriate to combine V_f (% of the area in forested cover types) and V_o (% of the area in open cover types) to develop a suitability index for adult wild turkeys. Specifically, V_f and V_o are combined using the formula below:

$(V_f{}^{2} * V_o)^{1/3}$ = Adult Food and Cover Life Requisite Suitability Index

In the above formula, a geometric mean was used. When using the geometric mean, the suitability value is more sensitive to low suitability index values than when using an arithmetic mean, providing a more conservative estimate. The percent of forest is more important compared to the percent of open.

Reproduction and Recruitment

The remaining variables represented requirements that would be necessary for wild turkeys to successfully reproduce and raise a brood. V_e (% of the area in edge), V_b (% of the area in open cover types useful for a brood), and V_{ob} (% of open useful for a brood) are combined using the formula below:

$(V_e)*(V_b *V_{ob})^{1/2})^{1/2}$ = Reproduction and Recruitment Life Requisite Suitability Index

The incorporation of a geometric mean requires all components to be present for a suitability value to be generated. The V_e is twice as important as V_b and V_{ob}.

Overall Habitat Suitability

The Adult Food and Cover Life Requisite Suitability Index ($LRSI_A$) and the Reproduction and Recruitment Life Requisite Suitability Index ($LRSI_B$) are combined to formulate an overall habitat suitability value for the area. This will provide a general idea of the suitability, without focusing only on components for adults or broods. The formula below is used to combine both components:

$(LRSI_A * (LSRI_B{}^{2})^{1/3}$ = HSI

Reproduction and recruitment are more important than adult food and cover in calculating the overall habitat suitability for wild turkeys.

Model Output

The model produces a number of GIS layers and tables explaining habitat suitability for turkeys based on multiple scenarios. A table explaining each layer and table produced by the model is presented in Appendix C. In the next paragraphs, the model output will be explained focusing first on statewide and county-by-county data, and then on public and private lands.

A statewide layer displaying the suitability value for each variable is produced, including statewide suitability values for adult and forest cover, reproduction and recruitment, and overall habitat. The average habitat suitability for each county/independent city is produced as a layer, and similarly a layer displaying the suitability for each county/independent city open to turkey harvest is produced; this information is also represented in two tables. This information on a county-by-county basis affords comparison with turkey harvest data. A layer with counties classified into 4 groups, with the top category representing the best 15% of the counties based on overall turkey habitat suitability, is also produced as output. For reference, water bodies are identified in an individual layer.

Focusing on land ownership, two layers were produced displaying the habitat suitability of each tract of USFS land and WMA, respectively. Tables displaying the suitability of all public lands compared to private lands is generated, with individual tables for each public landholder (e.g., USFS, WMA, NPS, etc.) produced. A table displaying habitat suitability of USFS lands west of the Blue Ridge is produced.

Modifying the Model

Modification to the model will be necessary as new data is available and will provides users the ability to customize the model to specific areas (e.g., application outside of the mid-Appalachian region). If the user has less than a moderate understanding of GIS and ModelBuilder, it is advised that users seek assistance from individuals with expertise in GIS before attempting to make changes to the model. In the paragraphs below, the various modifications will be identified along with methods to make changes.

Within the model, shapefiles easily can be replaced by finding the blue colored circle featuring the shapefile you want to replace and selecting the appropriate data. Raster files of land boundaries will need to be created from existing shapefiles. Keep in mind the 'Area of Interest' shapefile should remain as a state boundary complete with counties; although other files can be used (e.g., region, district), this will prohibit the model from properly running and calculating tables focusing on statewide data (e.g., average suitability for each county). Users should extract specific areas (e.g., agency regions) from the final statewide model output.

Modifying the distance acceptable for a brood to travel into an opening away from forested cover (currently set at 150 meters) can be achieved by clicking on the yellow 'shrink' circle and changing the number of cells from 5 to the desired value. Each cell represents 30m, so the user will need to divide the desired distance by 30 to identify how many cells to shrink by.

Modifying the size of the assessment area can be performed by opening each of the 'Focal Stats' or 'Focal Statistics' yellow circles (5 total) and changing the 'Neighborhood Settings' radius. Currently, these are set to a circle of 86 cells (to achieve 5,167 acres; this is the closest value to a 5,189 acre home range). Below is the mathematics required for selecting the appropriate cell radius.

86 cell radius = 2,580m radius (1 cell = 30m)

$$\text{Area} = \pi * r^2$$

$$\text{Area} = \pi * 2{,}580^2$$

$$\text{Area} = 20{,}911{,}697 \text{ m}^2 = 5{,}167 \text{ acres}$$

To modify the habitat suitability curves, click on the raster calculator (yellow circle) prior to the variable of interest 'Continuous HSI Values' green circle (e.g., Open Continuous HSI Values). This will allow you to edit the formula which matches the current habitat suitability curve.

Additional Model: Unsuitable areas as NoData

We developed an additional model to calculate the habitat suitability of only areas that are suitable habitat; areas that previously classified as 'unsuitable' turkey habitat are ignored in the model and treated as NoData. Therefore, the negative effects on suitability caused by urban areas will not be observed in the model output. This additional model provides managers with a realistic habitat suitability estimate of the habitat people typically can access and hunt, and represents areas the state agency can have management effects (e.g., unlike residential and urban areas).

Also, this model enables managers to calculate the amount of suitable wild turkey habitat per square mile. Previously, managers calculated wild turkey density by comparing the harvest per square mile of forested habitat. However, suitable turkey habitat is not limited to only forest cover types. This improved method for calculating suitable turkey habitat provides managers with a more realistic density estimate when compared with harvest. Suitable habitat measurements (in square meters) are produced under the 'Area' column of the tables featuring habitat suitably values for specific landowners (e.g., USFS_vs_non) when running the 'Unsuitable areas as NoData' model. A table (suitable_turk_hab) is also generated that displays the amount of suitable turkey habitat (square meters) by county/independent city. The area in all tables is produced in square meters and must be converted to square miles. These suitable turkey habitat calculations are not available as output in the standard 'Comprehensive Habitat Model'.

Literature Cited

Dickson, J. G. 1990. Oak and flowering dogwood fruit production for eastern wild turkeys. Proceedings of the National Wild Turkey Symposium 6:90-95.

Hurst, G. A. 1992. Foods and feeding. Pages 66-83 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Korschgen, L. J. 1967. Feeding habits and foods. Pages 137-198 *in* D. G. Hewitt, editor. The wild turkey and its management. The Wildlife Society, Washington, D.C., USA.

Leopold, A. 1986. Game management. University of Wisconsin Press, Madison, USA.

McDougal, L. A. 1990. Wild turkey-road interactions on a Virginia national forest. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Minser, W. G., T. Allen, B. Ellsperman, and S. E. Schlarbaum. 1995. Feeding response of wild turkeys to chestnuts and other hard mast. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 49:488-497.

Missouri Department of Conservation, and USDA Soil Conservation Service. 1988. Wildlife habitat apprasial guide: Missouri. JS-Biol-13(4).

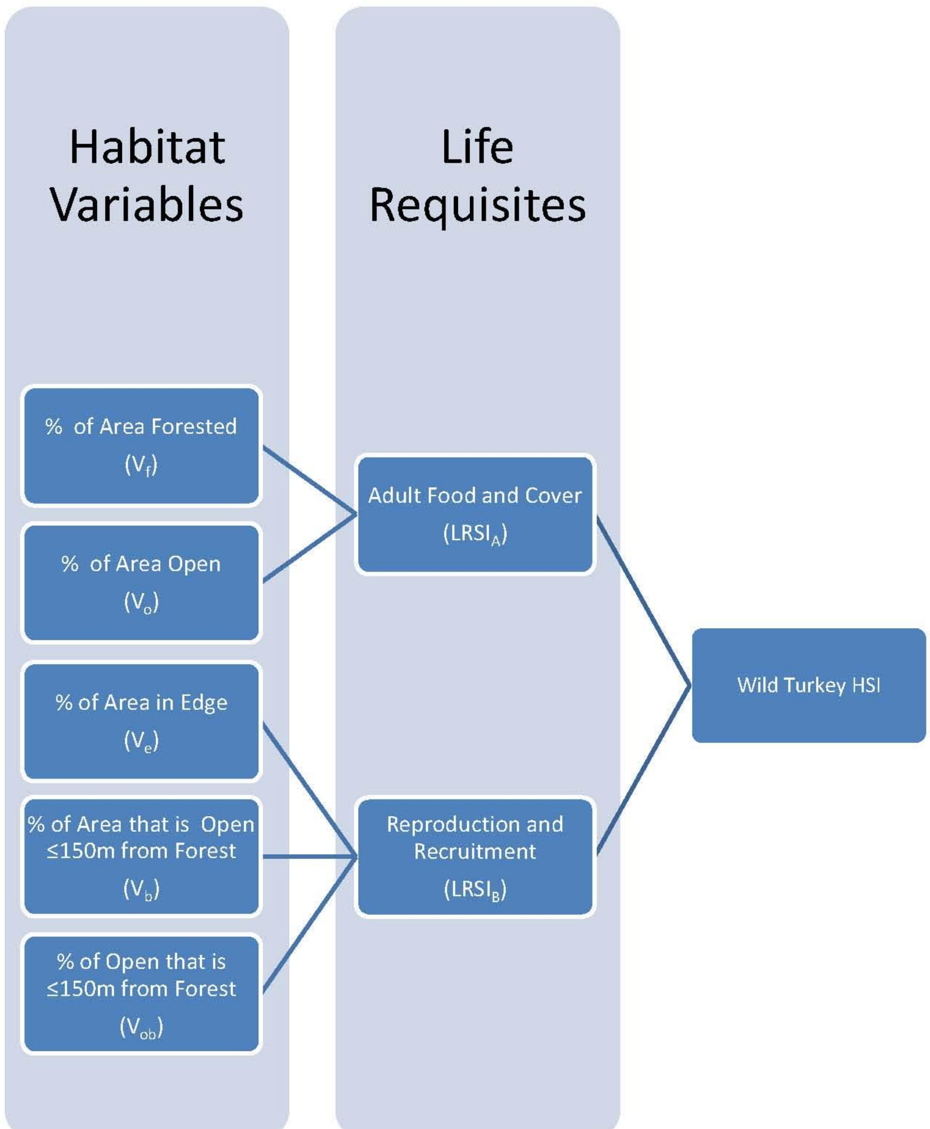
Porter, W. F. 1992. Habitat requirements. Pages 202-213 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Schroeder, R. L. 1985. Habitat suitability index models: eastern wild turkey. US Fish and Wildlife Service, Biological Report 82(10.106), Washington, D.C., USA.

Steffen, D. E., N. W. Lafon, and G. W. Norman. 2002. Turkeys, acorns, and oaks. Pages 241-253 *in* W. J. McShea, and W. M. Healy, editors. Oak forest ecosystems: ecology and management for wildlife. John Hopkins University, Baltimore, Maryland, USA.

Wunz, G. A., and J. C. Pack. 1992. Eastern turkey in eastern oak-hickory and northern hardwood forests. Pages 222-264 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Appendix A. Habitat variables and the life requisites they fulfill within the habitat suitability model



Appendix B. Habitat suitability curves for each variable

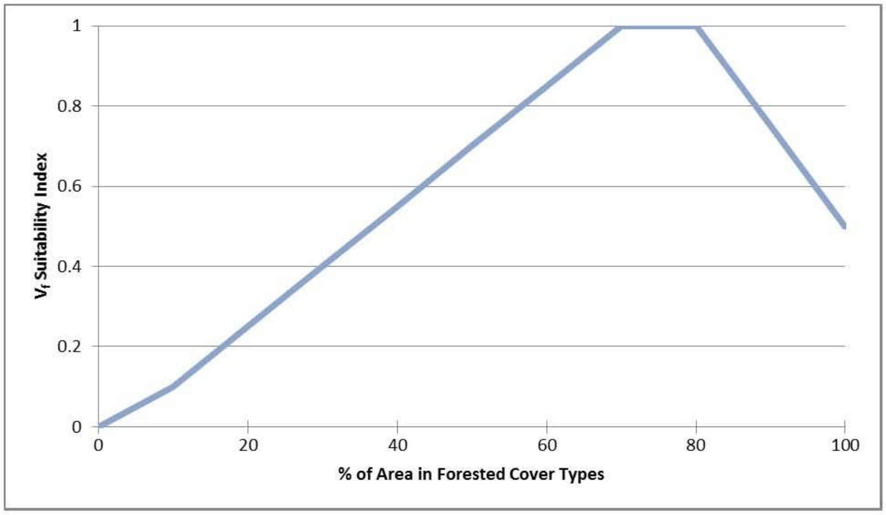


Figure 1. Suitability curve representing the percent of area in forested cover types (V_f). Forested cover types include mixed forest, deciduous forest, evergreen forest, shrub/scrub, and woody wetlands.

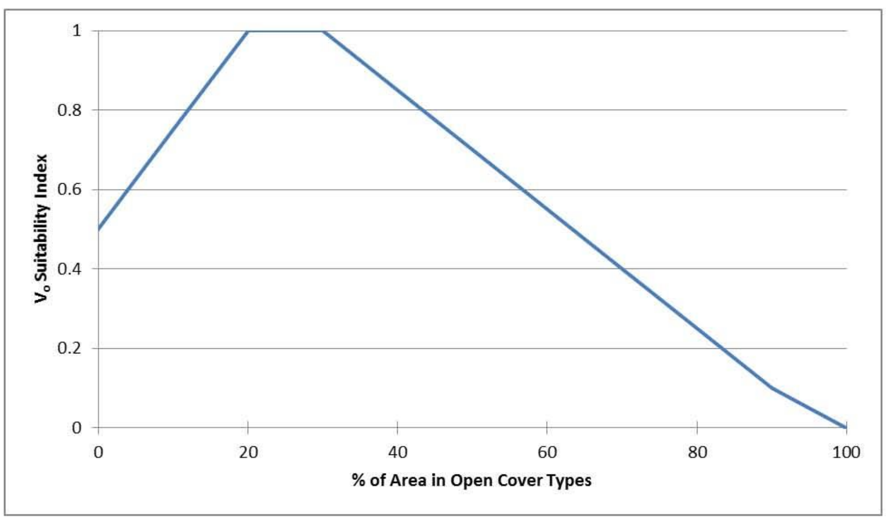


Figure 2. Suitability curve representing the percent of area in open cover types (V_o). Open cover types include grassland/herbaceous, hay/pasture, and cultivated crops.

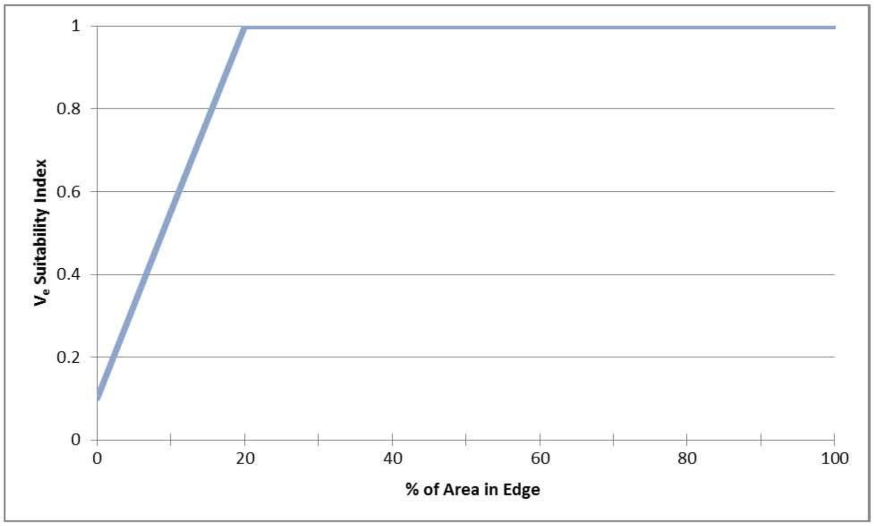


Figure 3. Suitability curve representing the percent of area in edge (V_e). Edge is identified as areas where forest and open cover types are adjacent.

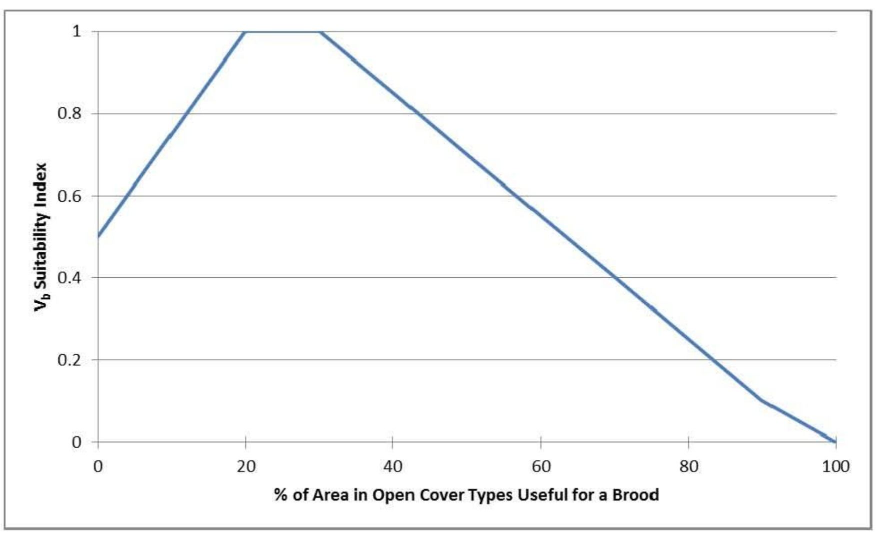


Figure 4. Suitability curve representing the percent of area in open cover types that is useful for a brood (V_b). Open cover types include grassland/herbaceous, hay/pasture, and cultivated crops, and must be <150m from forest cover.

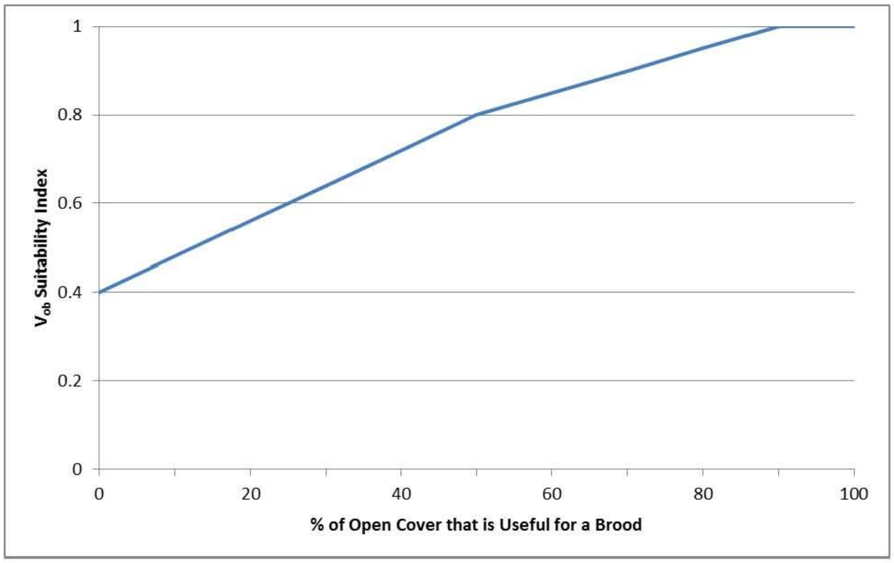


Figure 5. Suitability curve representing the percent of open cover that is useful for a brood (V_{ob}). Open cover types include grassland/herbaceous, hay/pasture, and cultivated crops, and must be <150m from forest cover.

Appendix C. Definitions of model output: layers and tables

File Name	Definition
Layers	
avgHSI_harvst	The average HSI value for each independent city/county open to turkey harvest
each_wma	The average HSI value for each 'tract' for all Wildlife Management Areas
each_USFS	The average HSI value for each 'tract' for all US Forest Service lands
AvgHSI_county	The average HSI value for each independent city/county
water	All bodies of water
turkHSI_class	Overall habitat suitability classified into 4 classes (class 4 represents the 'top' 10% of areas in terms of HSI; other classes divided equally, representing 30% of the values each)
brood_HSI	Habitat suitability for variable x: % of the area in open cover types <150m from forested cover
forest_HSI	Habitat suitability for forest: % of the area in forest cover types
open_hsi	Habitat suitability for open: % of the area in open cover types
open4brod_hsi	Habitat suitability for variable x: % of the open cover types <150m from forested cover
edge_hsi	Habitat suitability for edge: % of the area in edge
Adult_F_O	Habitat suitability for adult food and cover (aggregation of % of area in open and % of area in forest)
repro_recruit	Habitat suitability for reproduction and recruitment (aggregation of % of area in open <150m from forested cover, % of area in edge, and % of open cover >150m from forested cover)
finalturk_HSI	Overall habitat suitability for wild turkeys

File Name	Definition
Tables	
allpub_vs_pvt	The average HSI value for all public lands (1) (VA State Forests, Dept. of Defense lands, US Fish and Wildlife Service refuges, National Park Service lands, US Forest Service lands, Wildlife Management Areas) compared to the average HSI value excluding those lands (0).
stateforest_vs_non	The average HSI value for VA State Forests (1) compared to the average HSI value excluding VA State Forests (0).
usfws_vs_non	The average HSI value for US Fish and Wildlife Service refuges (1) compared to the average HSI value excluding US Fish and Wildlife Service refuges (0).
nps_vs_non	The average HSI value for National Park Service lands (1) compared to the average HSI value excluding National Park Service lands (0).
usfs_wma	The average HSI value for US Forest Service lands and Wildlife Management Areas combined (1) compared to the average HSI value excluding US Forest Service lands and Wildlife Management Areas (0).
usfs_wbr	The average HSI value for US Forest Service lands west of the Blue Ridge (1) compared to the average HSI value excluding US Forest Service lands west of the Blue Ridge (0).
usfs_vs_non	The average HSI value for US Forest Service lands (1) compared to the average HSI value excluding US Forest Service lands (0).
wma_vs_non	The average HSI value for Wildlife Management Areas (1) compared to the average HSI value excluding Wildlife Management Areas (0).
dod_vs_non	The average HSI value for Department of Defense lands (1) compared to the average HSI value excluding Dept. of Defense lands (0).
avghsi_table	The average HSI value for each independent city/county
avghsi_hrvst	The average HSI value for each independent city/county open to turkey harvest
suitable_turk_hab*	The amount (square meters) of suitable habitat per county.

*Table only produced when running 'Unsuitable areas as NoData' model.

Appendix H. Eastern wild turkey habitat appraisal tool and user's guide

Part II: Rapid Habitat Appraisal Guide for the Eastern Wild Turkey in Virginia

Authors

Holly N. Morris, Graduate Research Assistant, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

James A. Parkhurst, Associate Professor of Wildlife and Wildlife Extension Specialist, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

Dean F. Stauffer, Associate Dean for Academic Programs and Professor of Wildlife, College of Natural Resources and Environment, Virginia Tech, Blacksburg, VA

Gary W. Norman, Wild Turkey Project Leader, Virginia Department of Game and Inland Fisheries, Richmond, Virginia

This project was funded by the Virginia Department of Game and Inland Fisheries and was completed in 2014. Personnel from Virginia Tech worked to develop this rapid-appraisal tool as a part of a comprehensive habitat assessment for the eastern wild turkey in Virginia.

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Cover page photo credits: 2nd column, 2nd row – Amy Carrozzino-Lyon; 3rd row and 1st column, 2nd row – Alan Shipley; all others Holly N. Morris

Introduction and Purpose

In 2011, the Virginia Department of Game and Inland Fisheries (VDGIF) identified a need to assess wild turkey habitat statewide to complement the adoption of a new 10-year wild turkey management plan in Virginia. At that time, habitat assessment methodology did exist for the eastern wild turkey (e.g., Schroeder 1985, Missouri Department of Conservation and USDA Soil Conservation Service 1988); however, these previous methods did not take advantage of today's newer technology or specifically meet VDGIF's desired objectives.

After assessing the critical life requisites of wild turkeys in Virginia and investigating what data were available for use in conducting a habitat assessment, researchers settled on a 2-level habitat assessment approach. First, using the average home range of a wild turkey in Virginia to define the scale of interest, a landscape-level habitat suitability model using a geographic information system (GIS) was developed. Then, a smaller, patch-scale, rapid habitat appraisal tool was developed, which requires a physical site visit to the area of interest (AOI) and an evaluation of the land immediately surrounding that AOI using aerial imagery. After applying this rapid habitat appraisal tool on a property, the user will be able to identify limiting factors within the AOI and suggest methods to improve habitat suitability for wild turkeys.

In Virginia, the home range of a wild turkey averages 5,189 acres (McDougal 1990), privately-owned farm tracts average 171 acres (USDA National Agricultural Statistics Service 2009), and 89% of forested lands in private ownership are <50 acres (Rose 2009). Given these statistics, the typical landowner is unlikely to fulfill the needs of wild turkeys within the boundaries of their own AOI; meaningful management must consider habitat values and/or resources provided on surrounding lands. Obviously, if an AOI does not satisfy the needs of a wild turkey, the bird will move to an area that does.

Researchers designed this tool for application on areas <1,000 acres; however, this tool can be used on larger tracts. To perform an assessment on very large tracts, it is suggested that the AOI is divided into sections and the tool is applied for each section. Do not average the suitability values for each section to obtain an overall suitability for the AOI; this can conceal limiting factors on very diverse AOIs and make habitat management ineffective. This same technique should be applied on irregular shaped AOIs where the entire AOI cannot be appraised in one assessment.

In the following sections, data and software requirements of the rapid habitat appraisal tool, habitat requirements for eastern wild turkeys, and components of the habitat appraisal tool are discussed.

Data and Software Requirements

To assess suitability within and beyond the AOI, aerial imagery is required. Aerial imagery reduces the amount of time needed to be spent afield and, because physical access to surrounding properties in other ownership often is limited, allows investigators to judge certain aspects of habitat quality remotely. Access to recent, high-quality aerial imagery (suggested scale 1:15,000) is required to perform the rapid habitat appraisal. Users should keep the acquisition date of the imagery in mind, as the imagery may not accurately reflect the most recent state of the AOI (e.g., timber harvest). In this case, the user should use assess the site based on the physical visit. A professional biologist is best suited to perform the habitat appraisal because he/she typically has access to cost-free imagery and software to perform the assessment. ESRI ArcMap 10.1 is suggested as the software for performing the analysis. Aerial imagery of Virginia used to develop and test this tool was obtained from the Virginia Base Mapping Program, Virginia Geographic Information Network (VGIN).

Habitat Requirements and Components of the Tool

All wildlife need food, water, shelter, and perhaps other special requirements to survive and prosper (Leopold 1986). Wild turkeys are no different, so the rapid habitat appraisal tool specifically focuses on the essential needs of these birds in Virginia. Because wild turkeys satisfy their water needs primarily from the food resources they consume, water has been excluded from this appraisal; however, water may become important during periods of extreme drought (Hurst 1992, Wunz and Pack 1992).

In the following sections, habitat requirements for wild turkeys are discussed and the habitat appraisal metrics that address each requirement are explained.

Adult Food

Wild turkeys feed opportunistically on a variety of items, but their main source of food is hard mast produced by deciduous trees; therefore, the abundance of mature hard mast producing trees is important. However, the species of trees also are important. Wild turkeys prefer the acorns of northern red (*Quercus rubra*) and white oaks (*Q. alba*) over those produced by other oaks and the mast produced by other hardwood species (e.g., mockernut hickory [*Carya tomentosa*], black walnut [*Juglans* *nigra]*) (Minser et al. 1995). Also, having a variety of red and white oak species present adds habitat value. Late spring frosts can damage acorn production, but the effects of that damage vary by species. Because white oak acorns require only one year to mature, the effect of frost damage will be observed in the year damage occurs. With red oaks, where mast develops over a 2-year period, there can be a delayed carry-over effect from frost damage that results in pronounced mast shortages in areas where only red oak species are present (Dickson 1990). However, in mixed species stands, if white oaks fail to produce an acorn crop, red oaks may produce at least some mast due to their 2-year cycle.

Soft mast also represents an important food resource for wild turkeys. Important soft mast species include dogwood (*Cornus spp.*), grape (*Vitus spp.*), blueberry (*Vaccinium spp.*), and pokeweed (*Phytolacca* spp.*)*. Korschgen (1967) noted that the fruits of dogwoods were the second most commonly occurring food item found in turkey crops, after acorns. Soft mast items may attract wild turkeys to an area, particularly if hard mast is scarce.

Wild turkeys also attracted to agricultural areas due to the potential food resource benefits they realize there, either from the agricultural products being grown or the insect communities associated with crop production (for brood "bugging" purposes). Wild turkeys will consume grain crops (i.e., corn, wheat, oats), scavenge for spilled grains left in a field after harvesting, and pluck undigested corn kernels from cattle manure. In winter, wild turkeys use agricultural areas as sources of supplemental food, especially where hard mast crops are poor or unattainable (hard packed snow). During difficult times, wild turkeys often stay in areas where residual grain is available.

The abundance of mature hard mast producing trees is addressed in **question #1**. A site visit must be performed to determine the percentage of the AOI that contains mature (i.e., >30 cm DBH; Healy and McShea 2002) hard mast producing trees. For AOIs with poor ratings on this metric, overall suitability can be supplemented by accounting for mast production on bordering lands; the presence of deciduous trees within a 1mi radius from the center of the AOI is determined using aerial imagery. This provides an estimate of the potential of mature mast producing trees in the surrounding area.

Identifying varieties of oak (*Quercus* spp.*)* tree species present on an AOI is addressed in **question #2**. Species verification can be assessed accurately only by performing a site visit because discrimination to species is not possible from aerial imagery. The rating on this metric cannot be supplemented by an assessment beyond the AOI due primarily to the inability to field-verify diversity on properties outside the AOI.

Question #3 assesses the presence of soft mast and **question #4** addresses the presence of grain crops, both potentially important food resources for adult wild turkeys. These assessments require field verification and, like metric 2, resources outside the AOI cannot be used to supplement a poor rating within the AOI due to limitations on field verification; aerial imagery alone cannot sufficiently identify these criteria.

Brood Food

Poults require sufficient protein in the diet to grow properly and mature into adults, and they derive their most of their protein needs from insects they consume. Insects thrive in herbaceous openings, including managed hay fields, cattle grazing areas, abandoned fields, utility right-of-ways, clear cuts, recently burned areas, and grasslands. Adult turkeys also frequent these early succession areas to feed on the abundant insects, seeds, and soft mast that often occur there.

Question #5 assesses the abundance of herbaceous openings, and can be measured within the AOI by performing a site visit or by using aerial imagery. Creating a dot grid using GIS may help the user to estimate the percentage of herbaceous openings in the AOI. Users should keep in mind that savannah-like areas will not be observable using imagery and will need to be added to the imagery estimate, if present. If the AOI suitability is poor, the suitability rating can be supplemented by assessing the presence of herbaceous openings within a 1mi radius from the center of the AOI, as determined from aerial imagery.

Nesting Cover

Wild turkeys select nesting sites in areas where vegetation obstructs the horizontal line-of-sight exposure of hens to potential predators. Although wild turkeys attempt to nest in a variety of habitats, habitats characterized by dense herbaceous transitional edge zones provide high quality cover. Potential nesting habitat includes herbaceous patches along disturbed forested habitats, such as the edges of a clearcut, an open field, gated roads, and utility right-of-ways. Hens also use areas of dense woody regeneration (i.e., 2-5 year old clearcuts). Nesting areas are important because, without quality nesting habitat, population growth will be limited and the likelihood of predation and nest abandonment may be high.

The abundance of quality nesting areas is assessed in **question #6** by measuring an index of interspersion. This is performed using aerial imagery and drawing two 1-mile long, perpendicular intersecting diagonal lines centered on the AOI (thereby creating four ½-mile radiating transects); these transects may extend beyond the boundary of the AOI. Actual length of diagonal transects on the imagery will be determined by the scale of the imagery (1:15,000 is suggested), but regardless of scale, ½-mi long transects are used to standardize the assessment. The index of interspersion is measured by counting the number of distinct habitat types encountered as one moves along each line within the AOI; these unique type shifts are summed to calculate a total interspersion index for the AOI. To be tabulated, a habitat must be wider than 50 ft. in width at the point where the transect crosses. If suitability within the AOI is poor, the rating can be supplemented by calculating an index value for surrounding lands using only the portion of each transect that extends beyond the outer boundary of the AOI; the sum of unique habitat types encountered on each transect line beyond the boundary provides this measure. A high index indicates an abundance of potential nesting cover. An example is provided below.

Figure 1. Sample of nesting habitat suitability calculation. Red box represents a 110 acre AOI. Green lines represent ½ mi transects. This example has 4 habitat changes within the AOI; however, no habitat changes exist beyond the AOI. (Scale 1:15,000)

Roost Cover

Wild turkeys require mature trees, particularly conifers, for roosting. Conifers situated on northeastern-facing slopes protect roosting birds from prevailing winds and enable them to regulate body temperature more effectively (Porter 1992). Without suitable roost habitat available, wild turkeys will move to other places to roost and feed, particularly during harsh winter weather.

Question #7 evaluates the presence and classification of mature trees and the aspect of such trees on the landscape. This question must be addressed by a site visit, as the size of trees cannot be assessed accurately using only aerial imagery. The region (e.g., mountainous, piedmont, coastal plain) in Virginia the AOI is located also determines what factors (e.g., NE slope) should be considered when assessing roost suitability. Many estimates for suitable roost trees have been provided (Mosby and Handley 1943, Hurst and Dickson 1992, Ludwig 2012), and it appears that a tree ≥10" DBH is most appropriate. The user of this tool must take tree size into consideration, but also use professional judgment to determine whether each tree being evaluated truly can support a roosting turkey.

To supplement an AOI's poor suitability rating, imagery can be used to identify the presence of conifer trees within a 1mi radius from the center of the AOI. This will provide an estimate of potential roost sites surrounding the AOI.

Habitat Arrangement

Habitats that provide both nesting cover and brood range within close proximity to each other are essential to poult survival. The farther poults must travel, the more susceptible they are to predation and accidental death, which leads to lower survival and population growth. During the first few days after hatching, poults rely on the residual yolk for sustenance, but after poults consume the yolk, they must consume insects or perish.

This distance between habitat features is covered in **question #8**. The assessment of this metric requires the use of aerial imagery to identify and measure the distance between nest habitat and brood range. Nest habitat has been identified previously in **question #6.** Brood habitat (i.e., herbaceous openings) has been identified in **question #5.** To determine the suitability for **question #8**, the user must measure the distance from the change, or edge habitat, to the closest area that provides brood habitat. If multiple possibilities exist, the configuration with the shortest distance is used. If both nest habitat and brood habitat do not exist within the AOI, this poor suitability rating can be supplemented by including brood range and nest habitat that exists within ¼ mi of the outer boundary of the AOI.

Determining and Improving Habitat Suitability

A final suitability value is calculated by summing the individual suitability ratings for each question and identifying the category into which the summary value falls in the table provided. Suitability values from 0-7 are considered poor, 8-15 are fair, 16-23 are good, and 24-31 are excellent. Depending on the suitability value and the individual suitability ratings for each question, a biologist can recommend steps to improve the area's suitability for wild turkeys.

Additional items for consideration include the presence of spring seeps. Seeps provide green vegetation for consumption and potential access to mast or other food items that otherwise likely would be inaccessible during winter (seeps prevent snow accumulation) (Wunz and Pack 1992).

The ownership of surrounding lands also should be considered when applying the rapid habitat appraisal tool. Adjoining landowners may have very different management priorities for their property that are incompatible with those on the AOI or could provide real opportunities to create working partnerships that lead to meaningful improvements of wild turkey habitat.

It is strongly advised that users do not compare the AOI suitability with the landscape-level GIS habitat suitability model suitability for the same area. The landscape-level GIS model operates at the scale of a wild turkey's home range and includes areas that will be excluded from the rapid appraisal tool.

Appendix 2 provides users with a small list of potential strategies to improve the habitat suitability depending on the component that is limiting. This is not an exhaustive list; rather, it provides a few examples and items to consider. When selecting strategies, the effects of such actions should be considered for not only the specific habitat component that is limiting, but also how the action may affect the suitability of other components. A timber harvest may improve habitat diversity (interspersion index value), but could reduce the abundance of mature deciduous hard mast producing species. Careful planning will ensure the effects of such management actions are understood and the best management strategies are selected.

Literature Cited

Dickson, J. G. 1990. Oak and flowering dogwood fruit production for eastern wild turkeys. Proceedings of the National Wild Turkey Symposium 6:90-95.

Hurst, G. A. 1992. Foods and feeding. Pages 66-83 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Hurst, G. A., and J. G. Dickson. 1992. Eastern turkey in southern pine-oak forests. Pages 265-285 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Korschgen, L. J. 1967. Feeding habits and foods. Pages 137-198 *in* D. G. Hewitt, editor. The wild turkey and its management. The Wildlife Society, Washington, D.C., USA.

Leopold, A. 1986. Game management. University of Wisconsin Press, Madison, USA.

Ludwig, E. 2012. Reproductive ecology of eastern wild turkey hens in Sussex County Delaware. Thesis, University of Delaware, Newark, USA.

McDougal, L. A. 1990. Wild turkey-road interactions on a Virginia national forest. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, USA.

Minser, W. G., T. Allen, B. Ellsperman, and S. E. Schlarbaum. 1995. Feeding response of wild turkeys to chestnuts and other hard mast. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 49:488-497.

Missouri Department of Conservation, and USDA Soil Conservation Service. 1988. Wildlife habitat apprasial guide: Missouri. JS-Biol-13(4).

Mosby, H. S., and C. O. Handley. 1943. The wild turkey in Virginia: its status, life history and management. Virginia Commission of Game and Inland Fisheries, Richmond, USA.

Porter, W. F. 1992. Habitat requirements. Pages 202-213 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Rose, A. K. 2009. Virginia's forests, 2007. U.S. Department of Agricutlure Forest Service Resource Bulletin SRS-159, Southern Research Station, Asheville, North Carolina, USA.

Schroeder, R. L. 1985. Habitat suitability index models: eastern wild turkey. US Fish and Wildlife Service, Biological Report 82(10.106), Washington, D.C., USA.

USDA National Agricultural Statistics Service. 2009. 2007 Census of agriculture. Geographic area series part 51. Document number AC-07-A-51, Washington, D.C., USA.

Wunz, G. A., and J. C. Pack. 1992. Eastern turkey in eastern oak-hickory and northern hardwood forests. Pages 222-264 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Appendix A. Rapid-appraisal tool for the eastern wild turkey in Virginia

Landowner/Site Name:__________ Investigator:__________ Date:__________

Acres Owned:_______ UTM:__________ Imagery Source: __________

Habitat Component	Assessment focusing on the Area of Interest (AOI)				Assessment beyond the AOI *only* if suitability is poor
	Excellent	Good	Fair	Poor	
Adult Food					
1. Mature hard mast producing deciduous trees	70% - 100% of the area contains mature hard mast producing deciduous trees	30% - 69% of the area contains mature hard mast producing deciduous trees	Hard mast species are present, but are not mature enough to bear mast **OR** 1% - 29% of the area contains mature mast producing deciduous trees	No hard mast deciduous tree species are present in the area	Deciduous trees are present within a 1-mi radius from center of AOI
Suitability Value:_______	6	4	2	0	2
2. Variety of oak species	≥2 species, one being from the white oak group and the other from the red oak group (1 species must be white oak - *Quercus alba*)	≥2 species, one being from the white oak group and the other from the red oak group (not white oak - *Quercus alba*)	1 species from either the red oak or white oak group	No oak trees are present in the area	
Suitability Value:_______	3	2	1	0	
3. Soft mast	Soft mast producing species are present			Soft mast producing species are absent	
Suitability Value:_______	3			0	
4. Grain crops	Grain crops are present			Grain crops are absent	
Suitability Value:_______	2			0	

Sum from first page:______

Habitat Component	Assessment focusing on the Area of Interest (AOI)				Assessment beyond the AOI *only* if suitability is poor
	Excellent	Good	Fair	Poor	
Adult & Brood Food					
5. Herbaceous openings	20% - 30% of the area contains herbaceous openings	10% - 19% or 31%- 50% of the area contains herbaceous openings	<10% or 51% - 100% of the area contains herbaceous openings	No herbaceous openings are present in the area	Herbaceous openings are present within a 1-mi radius from center of AOI
Suitability Value:________	6	4	2	0	2
Nesting Cover					
6. Interspersion index value using 1mi long transects diagonally across AOI	7+ changes in habitat	4 - 6 changes in habitat	1 - 3 changes in habitat	No changes in habitat	5+ changes exist beyond the AOI boundary
Suitability Value:________	3	2	1	0	1
Roost Cover					
7. Roost trees	**IF MOUNTAINOUS:** Conifer trees are present on northeast facing slopes and are large enough to support a roosting turkey	Conifer trees are present and are large enough to support a roosting turkey	Only deciduous trees are present and are large enough to support a roosting turkey	No trees large enough to support a roosting turkey are present on the property	Conifer trees are present within a 1-mi radius from center of AOI
	IF PIEDMONT OR COASTAL PLAIN: Conifer trees are present and are large enough to support a roosting turkey	Only deciduous trees are present and are large enough to support a roosting turkey		No trees large enough to support a roosting turkey are present on the property	Conifer trees are present within a 1-mi radius from center of AOI
Suitability Value:________	2	1.5	1	0	1
Habitat Arrangement					
8. Distance from nest habitat to brood range	Adjacent; brood range cumulatively is ≥ 5 acre	Less than 1/4 mile apart	Between 1/4 and 1/2 mile apart	No brood range **AND** nesting habitat in the AOI	Brood range and nesting habitat are present within 1/4 mi of the property boundary
Suitability Value:________	6	4	2	0	2

Total Suitability: ______	Excellent	Good	Fair	Poor
	31 - 24	23 - 16	15 - 8	7 - 0

Additional items for consideration: Are spring seeps present? Yes / No

Ownership of surrounding lands (Check the boxes and list name if known)

☐ Private citizen owned: ______________________ ☐ State owned public land: ______________________

☐ Private corporation owned: ______________________ ☐ Federal owned public land: ______________________

Appendix B. Suggestions for improving limiting factors

Habitat Component	Suggestions to improve suitability
Mature hard mast producing deciduous trees	If hard mast species are present but not mature enough to produce mast, ensure that a sufficient percentage of that stand will be allowed to mature. Consider performing timber stand management, including thinnings and crop tree releases, as the stand ages for maximum production. If hard mast species are not present, planting such species in the area is suggested. Consider planting red and white oak-group species (particularly *Quercus alba*) to improve suitability and focus on other species that will provide abundant mast. As the stand ages, shelterwood cuts, thinnings, and crop tree releases are recommended.
Variety of oak species	If the area only has one species from the red oak-group, plant species from the white oak group – preferably white oak (*Quercus alba*). If the area only has species from the white oak group, plant species from the red oak group, with a preference for heavy mast producers in your region. If species from both the white and red oak groups are present, but none are white oak (*Quercus alba*), plant white oak to provide a high quality mast producer.
Soft mast	Soft mast can be encouraged by performing timber cuts on the property, as many species such as fire cherry (Prunus pensylvanica) and blackberries (Rubus spp.) will grow after disturbance. If a timber harvest would not be beneficial for your property, consider planting soft mast species such as dogwood (Cornus spp.). Allowing fields to become fallow also will promote soft mast (e.g., pokeweed [*Phytolacca spp.*]).
Grain crops	Consider planting grain crops to supplement wild turkey food sources, particularly if your area has few mature mast producing trees and experiences significant snowfall on occasion.
Herbaceous openings	Plant herbaceous openings to achieve the deficient percentage on the property. In addition to creating designated openings, consider daylighting roads, and planting abandoned roads and old log landings. Depending on site needs, grains (e.g., oats) can be planted to achieve a portion of the needed herbaceous areas while providing a supplemental food source.
Interspersion index value	Harvest timber and allow the site to naturally regenerate, or establish herbaceous openings to create habitat diversity. Keep other limiting factors of the site in mind when making these decisions, as you may be able to improve multiple habitat components.
Roost trees	If mountainous and no mature deciduous or coniferous trees are present, select a stand of timber that will be permitted to grow to maturity. This may also provide a mast source once the stand is mature if the stand contains mast producing species. If northeast facing slopes are present on the property, utilize that area as a preferred site and allow those trees to reach maturity. If necessary, consider planting conifers first on NE facing slopes and secondly on other aspects. If piedmont or coastal plain, select a stand of deciduous or coniferous trees to conserve so they reach maturity. If only deciduous trees are present or are limited on the site, consider planting a stand of conifers to provide optimal roost cover.
Distance from nest habitat to brood range	If additional brood range is necessary, consider creating herbaceous openings. If nesting habitat is limited, investigate where timber cuts or herbaceous openings could be established. Make sure other habitat components are considered when choosing which strategy is best for the site. Establishing many herbaceous openings could acquire excellent brood range suitability, but the action may reduce the percentage of mature mast producing trees on the site.