Valuing Habitat Regime Models for the Red-cockaded Woodpecker in Mississippi

Rebecca O Drier[1], Stephen C. Grado[2], Rebecca J. Barlow[2], and Donald L. Grebner[2]

Acknowledgements

Financial support for this project was provided by a Wood Utilization Research grant. We thank K. Hunt and S. Dinsmore for constructive article reviews and comments. We thank B. Meneghin and K. Greer for providing technical support for *Spectrum*. This manuscript is publication No. FO 367 of the Forest and Wildlife Research Center, Mississippi State University.

[1] Graduate Research Assistant, College of Forest Resources, Mississippi State University, Box 9681, Mississippi State, MS 39762. (662) 325-8358. rod1@msstate.edu

[2] **Professor , Graduate Research Assistant, and Associate Professor, Department of Forestry, Box 9681, Mississippi State University, Mississippi State, MS 39762**

Valuing Habitat Regime Models for the Red-cockaded Woodpecker in Mississippi

Abstract

The management of forested wildlife habitat across different regions in Mississippi is of great concern to both forest managers and the public. The goal of this study was to quantitatively estimate monetary gains and losses and changes in timber inventories relative to the timber growing stock when producing more or less wildlife habitat for the Red-cockaded Woodpecker (RCW) (*Picoides borealis*). The baseline vegetative data set was compiled from the 2000 USDA Forest Service Resource Planning Act (RPA) data. The data set was then analyzed using the USDA Forest Service based forest planning software, *Spectrum*. An important input in the model is habitat quality relative to various forest practices. A self-administered mail survey was developed to obtain information on specific habitat characteristics in regards to defined stand types and common forestry practices and sent to wildlife professionals (n = 4) with knowledge of Mississippi land types and RCWs. A specific model was developed to maximize net present value (NPV) as a baseline scenario over a 50-year rotation. Two alternative models were run; one maximizing high quality RCW habitat, and the other maximizing low quality RCW habitat. The analysis looked at the South Central Hills and Pine Belt regions (7,096,000 acres). As expected, when maximizing for high quality RCW habitat, the revenue forgone was high, approximately $871/acre/year, while low quality was approximately $58/acre/year. High quality habitat yielded approximately 617,499 cunits harvested while low quality habitat yielded approximately 3,060,953 cunits. Lower levels of habitat management allowed for an increased emphasis on timber harvesting. In general, we determined that increases in habitat quality resulted in lower timber harvest levels and increased revenue forgone than the scenarios maximizing NPVs. While this result may be expected, of greater importance are the relative differences between scenarios and the ability to use these values for policy decisions.

Key Words: Equivalent annual income (EAI), land expectation value (LEV), Red-cockaded Woodpecker habitat, *Spectrum*

Introduction

Managing timberland and wildlife populations presents many challenges for foresters. First, both timberland and wildlife have aesthetic, cultural, ecological, monetary, and recreational benefits and values (Grado et al. 1997). Second, maintaining habitat for rare, threatened, and endangered (RTE) species is also important for biodiversity and meeting legal mandates (George 1996). Third, maintaining wildlife habitat is an essential requirement to meet forest certification standards for landowners. This is particularly relevant for RTE species.

Researchers can help decision-makers by providing realistic measures of the benefits and values of maintaining wildlife habitat along with costs to achieve these objectives. Quantitative measures are needed by forest mangers to evaluate investment decisions and monetary trade-offs involving forest manipulation aimed at increasing or decreasing quality and quantity of available wildlife habitat. This process takes on greater importance when dealing with RTE species. Habitat for RTE species is limited, specialized, and protected. Policymakers also need to be aware of the potential impacts on the timber supply if these habitat-related decisions become widespread.

The goal of this study was to examine how timber inventory manipulation may impact timber-habitat relationships for the Red-cockaded Woodpecker (RCW) (*Picoides borealis*), an endangered species in Mississippi.

REVIEW OF LITERATURE

Rare, Threatened, and Endangered Species

During the 1960's in the United States, several laws were passed to list floral and fauna species that were in danger of becoming rare, threatened, endangered, and possibly extinct. Unfortunately, these laws provided minimal protection for species. The Endangered Species Act of 1973 (ESA) was enacted in response to concerns about the decline of flora and fauna species around the world, but applied only to the United States (16 U.S.C. §§ 1531-1544). The purpose of the ESA in the United States is to "conserve the ecosystems upon which endangered and threatened species depend, and to conserve and recover listed species" (U.S. Fish and Wildlife Service 2002). The ESA continues to be reauthorized and amended, most recently in 1988 (U.S. Fish and Wildlife Service 2002). The U.S. Fish and Wildlife Service and the National Marine Fisheries Service administer the ESA and work with other agencies to conserve species and minimize impacts to species and their habitats. Each state is also encouraged to develop and maintain programs to conserve listed species within its borders. Financial and technical assistance is provided for private landowners that may have threatened or endangered species on their property. Incentives were developed to encourage private landowners to promote RTE species, while protecting their interests.

After passage of the ESA, concerns for private landowners and how forestry practices would be conducted on their land became an issue. In 1982, Section 10 of the ESA was amended to include development and implementation of Habitat Conservation Plans (HCP), which allowed "incidental take" permits (Nelson 1999). Nelson (1999) stated that an incidental take permit allowed a property owner to conduct otherwise lawful activities in the presence of listed species. HCP include measures to protect proposed species, as well as species of concern at the time HCP are developed or permits submitted. This may help provide early protection and ensure landowner protection in case a species is subsequently listed.

Mississippi has a Non-game and Endangered Species Conservation Act (Miss. Code Ann. §§49-5-101 et seq.) that protects species and subspecies of animals but not plants (George 1996). Although recovery plans are authorized, they are not required, nor is critical habitat designation and agency consultation. There are also provisions for state-owned lands to help preserve biodiversity. The Mississippi Prescribed Burning Act (Miss. Code Ann. §§49-19-301 et seq.) and the Coastal Wetlands Protection Act (Miss. Code Ann §49-27-1 et seq.) were authorized to ensure biodiversity sustainability, while a statute (Miss. Code Ann. §49-19-53) ensures that forest lands are managed to preserve them for future generations (George 1996).

RTE Species Habitat Requirements

The Red-cockaded Woodpecker is the only North American woodpecker to nest and roost in living pine trees (Dickson 2001). They prefer 80 to 100 year-old pines that contain the red heart fungus (for cavity excavation). Longleaf pines (*Pinus palustris*) are preferred, but other southern species, such as loblolly pine (*Pinus taeda*), are used as well (Dickson 2001). Quality RCW habitat consists of park-like (open stands with little underbrush, and basal area of 50-80 square feet) pine stands with little or no hardwood component (Dickson 2001). The birds may forage in smaller, mixed pine/hardwood stands but prefer older stands for their nests.

The RCW's historic range extended from Florida to New Jersey, as far west as Oklahoma and Texas, and inland to Missouri, Tennessee, and Kentucky (U.S. Fish and Wildlife Service 2003). There are currently an estimated 14,000 birds ranging from southeast Oklahoma and eastern Texas and east to Florida and Virginia, comprising about 3% of the original population at the time of European settlement (U.S. Fish and Wildlife Service 2003). In Mississippi, the RCW mainly occurs in the North Central Hills, South Central Hills, and Pine Belt physiographic regions. Red-cockaded Woodpeckers were federally listed as endangered on October 13, 1970. They are still listed as endangered at both the federal and state level. Suppression of fire and the loss and fragmentation of longleaf pine forests are the main causes for the decline in RCW numbers (Dickson 2001). Shorter rotations, clean forestry practices, and plantings of other less preferred pine species, such as slash pine (*Pinus elliottii*), have also limited RCW recovery (Dickson 2001). Recent attempts in the South to reintroduce longleaf pine back to its original range may ultimately prove beneficial to this species.

Models

Forested habitats contain both monetary and ecological values. Designing forested ecosystems to manage for both of these goals will be important for the sustainability of forest and wildlife habitats. Timber management practices can result in wildlife habitat improvement for a given species (Hall and Holbrook 1980). Cooperation is needed within the natural resource community if forest managers, economists, and ecologists are to correctly interpret impacts made on a landscape scale (Schaberg et al. 1999). Sharitz et al. (1992) explained the need to integrate ecological concepts with southern forest management practices. Increasing public awareness regarding environmental issues and legal mandates are requiring more emphasis for ecosystem biodiversity and RTE species. Additionally, addressing species of concern is critical to most forest ownerships if they intend to seek forest certification.

Quantifying trade-offs between economic and ecological resources and assigning values to ecological components remains an obstacle for land managers, forest planners, and economists (Rohweder et al. 2000). Management costs influence the feasibility of any strategy, regardless of biological merit, and requires knowledge of relative values when optimizing between timber and non-timber commodities (Rohweder et al. 2000).

Li et al. (2000) discussed the use of the Landscape Evaluation of Effects of Management Activities on Timber and Habitat (LEEMATH) as a decision support tool. It provided a framework to integrate empirical and mechanistic models and spatial analysis. This expert systems is integrated to apply the principles of ecosystem management. LEEMATH allowed land managers to plan different scenarios for both wildlife and timber management while also considering habitat quality for different species. Species looked at in their study included the Acadian Flycatcher (*Empidonax virescens*), Bachman's Sparrow (*Aimophila aestivalis*) and barking treefrog (*Hyla gratiosa*). LEEMATH also provided a thorough analysis of habitat quality for wildlife species under various management regimes.

McComb et al. (2000) explored the use of ecological models to map potential habitat at a landscape level using the Northern Spotted Owl (*Strix occidentalis caurina*). Spatial models were developed to quantify possible sites across the Oregon coastal range and provide estimates of habitat capability in future landscapes. The model also assessed the effects of alternative land scenarios should changes occur in federal or state policies regarding habitat protection. Overall, the model provided a basis for understanding possible habitat recovery rates from current forest management practices.

Marzluff et al. (2002) discussed the implications of forest management on wildlife habitat and resulting economic trade-offs. Economic trade-offs for various landscape level projects currently are not considered in existing habitat models (Marzluff et al. 2002). By linking wildlife habitat suitability models with habitat projection, an assessment of possible planning regimes, with both economic and ecological values, was established.

Forest Management Evaluation Criteria

There are several financial models and criteria that can be used to evaluate alternative land use practices. Net present value (NPV) is a valuation technique commonly used to evaluate potential capital investments in forest management (Bullard and Straka 1998). Estimates of all revenues and costs are discounted to the present, with costs subtracted from revenues. Projects are considered acceptable if the NPV is greater than or equal to zero (Bullard and Straka 1998). NPV can also be used to derive equivalent annual income (EAI) and land expectation values (LEVs). An EAI consists of the NPV expressed as an annual amount, and is used to compare returns from forestry with those obtained from other land uses that yield annual returns (Bullard and Straka 1998). EAI assumes NPVs are calculated for a finite period of years. Its criteria also allow for a comparison or ranking of investments that are not equal in duration (Bullard and Straka 1998). If the NPV is positive, the EAI will also be positive and show acceptable results. LEVs estimate the value of growing timber on a tract of land by using the NPV of all revenues and costs used to produce outputs from the forest, with the exception that land costs are eliminated from consideration (Bullard and Straka 1998). LEV can assist in selecting forest management regimes because it represents the bare land value when committed to a certain regime into perpetuity. It allows for ranking of investment decisions, like EAI.

Wildlife Habitat Evaluation Criteria

Wildlife habitat does not have a monetary value directly associated with it. Values are assigned based on choices made by decision makers. There are two ways values can be assigned: choices based on established values or establishing values by choices made (Davis et al. 2001). It is becoming increasingly difficult or impossible to infer values implied by decisions. However, professionals are attempting to assign monetary values on outcomes and conditions for items that do not contain a market value and, by doing so, imply those items are comparable with items containing a market value (Davis et al. 2001). Once monetary values are assigned to non-market outputs such as wildlife habitat, traditional financial valuation techniques can be used.

METHODS

The study area for this project consisted of specific regions within the state of Mississippi. The state is broken down into physiographic regions. Those regions of concern in this study are the South Central Hills and the Pine Belt. Wildlife professionals selected physiographic regions that contain suitable habitat (habitat that meets, or could meet, requirements for RCWs) characteristics to assess different timber activities, and possible effects on the habitat.

The methodology involved four main components: a mail survey process, two sets of vegetation data, the *Spectrum* model, and an economic analysis. Mail surveys or person to person interviews were used to learn the usefulness of certain forest stand types for Red-cockaded Woodpeckers. Wildlife professionals (n = 4) with an expertise concerning RCW habitat and various regions within Mississippi were asked to rate habitat quality on 14 management scenarios for two physiographic regions. These professionals were selected based on academic research and job positions that required them to have working knowledge of RCW and its habitat. These scenarios contain common practices found in timber production (Table 1). The management scenarios were divided into five year increments (i.e., 0, 5, 10…) ranging from age 0 to age 60. For each management scenario, wildlife professionals ranked each five year increment on a scale of 1-5 (1 being lowest quality; 3 being neutral; and 5 highest quality). Assessment scores were averaged for each five year increment to give an overall rating for that timber management scenario over time and its usefulness for RCWs. Those numeric ratings were then used as data entries for the scenario planning generated by the model.

Table 1. The fourteen management scenarios, over a 60-year planning period, that wildlife professionals were asked to rate for habitat quality of Red-cockaded Woodpeckers in Mississippi during the fall of 2003.

Forest Type			
Pine Plantation	Mixed Pine Harwood	Upland Hardwood	Bottomland Hardwood
No activity	No activity	No activity	No activity
One thin		One thin	One thin
One thin-3burn[1]		Two thins	Two thins
One thin-5burn[2]			

Two thins
Two thins-3burn[1]
Two thins-5burn[2]

---

[1] A burn will be applied every 3 years after the last thin.
[2] A burn will be applied every 5 years after the last thin.

The 1994 U.S.Forest Service (USFS) Forest Inventory Analysis (FIA) and the 2000 USFS Resource Planning Act (RPA) data were acquired from the U.S.Forest Service Southern Research Station to use as vegetative data sets for this project. FIA data includes information collected from a set of permanent plots spaced throughout Mississippi. Each plot is measured every seven to 12 years and data collected on vegetative structure as well as individual tree characteristics (Hamel and Dunning 2000). Growing stock acreage, tree species, and age classes were extracted from the overall FIA data set to locate plots in certain physiographic regions throughout the state. FIA volume estimates were used as a baseline data set for the RPA data. The RPA timber assessment project reports both the current situation and projected changes over the next 50 years for both land and timber resources (Mills and Zhou 2003). A longer rotation was used because the project dealt with wildlife habitat, not just maximizing timber, which normally deals with shorter rotations. The current and projected volumes were data entries placed in the model.

Data analysis was undertaken using the USFS forest planning model *Spectrum*, a model building software. *Spectrum* is a multiple decision modeler that uses linear programming to examine alternative forest management plans (Barlow and Grado 2002). Through matrix development, *Spectrum* generated optimized land allocation and management schedules among different analysis units over a given planning horizon (USFS 1999). *Spectrum* uses a C-Whiz optimizer, which employs a simplex method with custom algorithms for speedy solutions for its mathematical optimization method. In this case, the analysis units were the different habitat management scenarios. The RCW quality rating and volumes were entered into the model for each management scenario. Three situations were developed to compare land management objectives. *Spectrum* contains few assumptions of its own. Most assumptions deal with the data entered into the model. Also, there are four underlying assumptions to consider with linear programming: linearity, divisibility, nonnegativity and independency.

The economic analysis was derived from outputs produced for the various model results. Results focused on inventories, harvests, and monetary values associated with each situation. The model estimated potential monetary gains and losses for each region resulting from the manipulation of growing timber stock for the creation of varying levels of wildlife habitat. Monetary values for each scenario were determined through the use of NPV, LEV, and EAI. These measures also determined landscape level trade-offs or opportunity costs for timber and non-timber values.

RESULTS

Model Outputs

We completed and compared three alternative land management objectives on the 7,096,000 acres of the South Central Hills and Pine Belt regions of Mississippi. The first maximized NPV. The second maximized low quality habitat levels of Red-cockaded Woodpecker (RCW1). The third maximized high quality habitat levels for Red-cockaded Woodpecker (RCW5). Total acres available for harvest remained constant throughout the rotation, but were allocated differently for each scenario (Table 2).

Table 2. Acres harvested and volume removed for each of three management scenarios, net present value (NPV), low quality Red-cockaded Woodpecker habitat (RCW1), and high quality Red-cockaded Woodpecker habitat (RCW5), in the South Central Hills and Pine Belt regions in Mississippi for a 50-year rotation.

Management Objectives	Harvest (acres)	Volume removed (cunits)[a]	Volume/acre (cunits)[a]
NPV	194,038	2,222,223	0.31
RCW1	250,388	3,060,952	0.43
RCW5	55,397	617,499	0.09

[a] 100 cubic feet.

Economic Analysis

LEV and EAI were calculated and compared for each of the three land management scenarios (Table 3). As expected, as habitat quality increased, there was a decrease in LEV and EAI. The difference in revenues forgone greatly decreased as habitat quality increased.

Table 3. The land expectation value (LEV), expected annual increment (EAI) and revenue forgone for providing different levels of habitat quality for the South Central Hills and Pine Belt regions of Mississippi (1994).

Management Objectives	LEV ($/ac)	EAI ($/ac/yr)	Revenue Forgone ($/ac/yr)
NPV	1,143.91	57.20	
RCW1	1,083.36	54.32	2.88
RCW5	273.18	13.66	43.54

DISCUSSION AND CONCLUSIONS

This study examined the impacts of qualitative habitat requirements for the Red-cockaded Woodpecker, and how the forest can be manipulated to create more or less habitat for this species of interest. As expected, when maximizing for NPV, a higher LEV and EAI were produced and fewer acres of available habitat for RCW were allotted. When the goal was to produce higher quality habitat for RCWs in this area, it was determined that an increase in habitat quality resulted in lower timber harvest levels and increased revenue forgone than scenarios maximizing NPVs. One reason is because of the longer rotations associated with producing RCW habitat. For timber production, a rotation may range between 20 and 30 years (Barlow and Grado 2002). RCWs do not use pine trees for nests until the tree is between 80 and 100 years old (Dickson 2001). The delayed harvest results in a monetary loss.

The results of this project may provide land managers or legislators with the ability to compare non-timber land use in terms of opportunity costs. By taking into account timber production and quality of wildlife habitat for RTE species, we were able to examine potential monetary returns that may result in the manipulation of Mississippi's timber supply. In some cases, revenues forgone by creating RTE habitat may be offset by benefits associated with providing other opportunities. For example, fee-based guided tours for birdwatchers may help lessen the monetary losses associated with forgone timber production. Habitat created for RCW also provides habitat for other game species. A fee-base hunt on this land could also provide additional funds for the landowner.

A loss of monetary value is dependent on the ownership type. Lands owned by the government would not be as concerned with monetary losses, whereas private and industry landowners would. Incentive programs set up through the state and federal governments may increase support for private landowners to create habitat for an endangered species on their lands. Values, such as those developed by our model and data, could lend support for determining levels of compensation. Currently, the 2002 Farm Bill provides funding through the Wildlife Habitat Incentive Program (WHIP). This program encourages the creation of high quality habitat for wildlife species and places an emphasis on enrolling lands that contain species in decline. Active maintenance of favorable habitat, set aside for RTE species, could help entities seeking forest certification for other forest land uses. Implicit in this effort is the potential to achieve additional social and economic benefits.

Literature Cited

Barlow, R.B., and S.C. Grado. 2002. Linking scenario planning with GIS to develop a decisions support system for multiple-use in Mississippi. Proceedings of the 31st Annual Southern Forest Economics Workshop. Atlanta, Georgia. pp. 56-60.

Bullard, S.H. and T.J. Straka. 1998. Basic Concepts in Forest Valuation and Investment Analysis. 2nd Edition. Preceda. Auburn, Alabama.

Dickson, J.G. 2001. Wildlife of Southern Forest Habitat and Management. Handcock Publishers. Blaine, Washington. 480 p.

Davis, L.S., K.N. Johnson, P.S. Bettinger, and T.E. Howard. 2001. Forest Management 4th Edition. McGraw Hill Publishers. Boston, Massachusetts.

George, S. 1996. Saving Biodiversity: A Status Report on State Laws, Policies and Programs. Defenders of Wildlife Publishers. Washington, D. C.

Grado, S.C., G.A. Hurst, and K.D. Godwin. 1997. Economic impact and associated values of Wild Turkey in Mississippi. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies. 51:438-448.

Hall, L.K., and H.L. Holbrook. 1980. Wildlife management on Southern National Forests. In: R.C. Chabeck and R.H. Mills eds. 29th Annual Forestry Symposium: Integrating Timber and Wildlife Management in Southern Forests. Louisiana State University. Baton Rouge, Louisiana. pp. 33-40.

Hamel, P.B., and J.B. Dunning, Jr. 2000. An approach to quantifying long-term habitat change on managed forest lands. Studies in Avian Biology 21: 122-129.

Li, H., D.I. Gartner, P. Mou, and C.C. Trettin. 2000. A landscape model (LEEMATH) to evaluate effects of management impacts on timber and wildlife habitat. Computers and Electronics in Agriculture 27:263-292.

Marzluff, J.M., J.J. Millspaugh, K.R. Ceder, C.D. Oliver, J.Withey, J.B. McCarter,

C.L. Mason, and J. Comnick. 2000. Modeling changes in wildlife habitat and timber revenues in response to forest management. Forest Science 48(2):191-202.

McComb, W.C., M.T. McGrath, T.A. Spies, and D. Vesely. 2000. Models for mapping potential habitat at landscape scales: an example using Northern spotted owls. Forest Science 48(2):203-216.

Mills, J.R. and X. Zhou. 2003. Projecting national forest inventories for the 2000 RPA timber assessment. Gen. Tech. Rep. PNW-GTR-568. Portland, Oregon: U.S.Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Nelson, M. 1999. Habitat conservation planning. Endangered Species Bulletin. 24(6):12-13.

Rohweder, M.R., C.W. McKetta and R.A. Riggs. 2000. Economic and biological compatibility of timber and wildlife production: an illustrative use of production possibilities frontier. Wildlife Society Bulletin 28(2):435-447.

Schaberg, R.H., T.P. Holmes, K.J. Lee, and R.C. Abt. 1999. Ascribing value to ecological processes: an economic view of environmental change. Forest Ecology and Management 114: 329-338.

Sharitz, R.R., L.R. Boring, D.H. VanLear, and J.E. Pinder, III. 1992. Integrating ecological concepts with natural resource management of southern forests. Ecological Applications 2(3): 226-237.

U.S. Fish and Wildlife Service. 2002. ESA Basics – Over 25 years of protecting endangered species. n. pag. Online. Internet. 05 June 2003. Available http://endangered.fws.gov.

U.S. Fish and Wildlife Service. 2003. Recovery plan for the Red-cockaded Woodpecker (Picoides borealis): second revision. U.S.Fish and Wildlife Service, Atlanta, Georgia.

U.S. Forest Service (USFS). 1999. Spectrum Users Guide. USDA Forest Service. n. pag. Online. Internet. 26 August 2002. Available http://www.fs.fed.us /imi/planning_ center/download_center.html