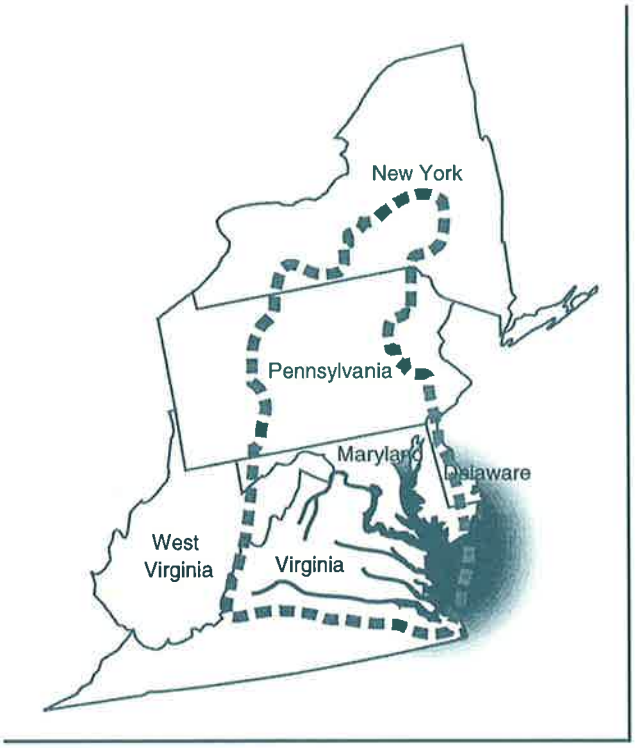

Forest Fragmentation in the Chesapeake Bay Watershed

Ecological, Economic, Policy and Law Impacts

A Professional Roundtable Series
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About the Chesapeake Bay Program

The Chesapeake Bay Program (CBP) is a unique regional partnership that has been directing and conducting the restoration of the Bay since the signing of the historic 1983 Chesapeake Bay Agreement. The CBP partners include the states of Maryland, Pennsylvania, and Virginia; the District of Columbia; the Chesapeake Bay Commission (a tri-state legislative body); the Environmental Protection Agency (EPA), representing the federal government agencies; citizen, local government, and scientific advisory groups; and dozens of private, nonprofit organizations that speak for various stakeholders of the Bay region.

About the Forestry Workgroup

The Forestry Workgroup (FWG) is associated with the Nutrient Subcommittee of the CBP. It was established to address issues of non-point source pollution and to coordinate and enhance the role of state, private, and federal forestry programs in the Bay cleanup. The FWG has a broad-based membership, with representatives of state and federal government, nonprofit organizations, forest industry, and other interest groups, including the USDA Forest Service and the Society of American Foresters. The FWG's aim is to coordinate, develop, and implement plans, projects, and policies that focus on the contributions of forestlands to restoring and maintaining the health and productivity of the Chesapeake Bay watershed. The FWG works to raise awareness about forests' role in protecting and improving water quality, their importance to living resources, and the need to retain their social and economic potential.

About the Society of American Foresters

The Society of American Foresters (SAF) is the national organization representing the forestry profession in the United States, with a mission to advance the science, education, technology, and practice of forestry; to enhance the competency of its members; to establish professional excellence; and to use the skills and conservation ethic of the profession to ensure the continued health and use of forest ecosystems and the present and future availability of forest resources to benefit society.

About the USDA Forest Service, State and Private Forestry

The Forest Service is responsible for providing leadership in forest and range management, and ensuring a continuing flow of natural resource goods and services to help meet the needs of the nation. The Forest Service's mission of *caring for the land and serving people* is accomplished through management of the National Forest System, cooperation with state and private landowners, and promotion of forest and range research. The State and Private Forestry (S&PF) branch supports this mission with such goals as promoting healthy, sustainable forest ecosystems and riparian areas, and providing forest stewardship and conservation leadership, while the Research branch undertakes research in these and other areas.

Forest Fragmentation in the Chesapeake Bay Watershed

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Executive Summary

To help increase our understanding of the impacts of forest fragmentation, the USDA Forest Service and the Society of American Foresters organized and sponsored this Round Table series in partnership with the Chesapeake Bay Program. Its primary objective was to hear from the scientists and experts in the field about how forest fragmentation and landownership parcelization may be affecting our forests.

In all, there were 38 participants from universities, state and federal agencies, and private and nonprofit entities, with expertise in disciplines including landscape ecology, wildlife biology, forest ecology, economics, sociology, land-use planning, policy analysis, and law. The main goals of the Round Table series were: (1) to gain a better understanding of the "state of the science" related to forest fragmentation and its impacts; (2) to gather insights, opinions, and recommendation from the experts; and (3) to gain consensus on what we know, what we do not know, and what we still need to learn about forest fragmentation.

The Round Table series included three one-day sessions on the topics of forest ecology impacts, economic impacts, policy and legal realities and needs. Each Round Table session was divided into three sections. First, panelists presented current research or benchmark studies related to forest fragmentation. A traditional round table discussion followed with targeted questions prepared by a special Bay Program focus group. Finally, the group went through a consensus-building process to gather insights and recommendations on "what we know," "what we do not know," and "what we need to know" about forest fragmentation and its effects.

Key Findings

In general, the ecologists and economists told us that there is a knowledge base sufficient to establish public policy to manage forest fragmentation. There are, however, important questions that still need to be addressed (e.g., *Which objectives will we use to measure if forest fragmentation is having an impact on species and habitats? Can we affect fragmentation with public policy? Are there unique areas that should be protected from irreversibility?*). Public policy experts told us that establishing public policy requires much more than ecological and economic data. Connections and actions between our current institutions must be better coordinated to manage land use in ways that minimize forest fragmentation. To affect public policy, accessible involvement of scientists, resource managers and the other interest groups is required. Also, since the vast majority of society does not know that forest fragmentation is a public policy issue, it will be necessary to take steps to increase public awareness and education.

Several key findings from the Round Table series are:

Ecological Impacts

- Forest fragmentation can have negative and irreversible effects on local environments, especially when associated with development (e.g., loss of rare critical habitat, changes in hydrology and microclimate, reduced water quality, and increased flooding).

- Although we know forest fragmentation is affecting the Chesapeake Bay, we need better estimates of current rates of fragmentation, especially as land use changes and populations increase.

Economic Impacts

- Fragmentation changes the distribution of market and nonmarket benefits and costs from the landscape (e.g., water quality, recreation, temperature and climate control, biodiversity, and wildlife). From an economic perspective, there are both winners and losers as a result of forest fragmentation.
- As fragmentation occurs, the forest base is diminished. Continued fragmentation can lead to a loss of aesthetic values, recreation, forest-based employment, and harvested forest products, and to increased pressure on infrastructure (e.g., roads and utilities).
- A major problem in addressing economic questions is the difficulty in quantifying the value of nonmarket benefits. In other words: Are the human benefits increasing over and above decreases in the ecological integrity of forest ecosystems?

Policy and Law Impacts

- There are policies and other innovative approaches already in place that can be used to reduce fragmentation.
- There are current policies (e.g., regarding tax, transportation, and zoning) that may be promoting forest fragmentation.
- We need to have a better understanding of where fragmentation is occurring. If the problem is eutrophication (endpoint), we may want to look at: (1) areas that are fragmented and are causing most of the eutrophication (e.g., upper versus lower Bay); (2) where fragmentation is occurring; and (3) where it is causing the most environmental harm.

Where Do We Go from Here?

The Round Table events described in this report are part of a longer-term strategy to develop, discuss, distribute, and utilize information about the forest fragmentation issue and related land and resource use problems. The strategy involves convening scientific and technical meetings of professional natural resource societies and associations; facilitating stakeholder awareness, knowledge, and involvement through seminars, workshops, and conferences; and publishing recommendations targeted at various sectors of society that can influence the development, implementation, and monitoring of public policy for mitigating the negative aspects of forest fragmentation.

Introduction

Forests once covered more than 95 percent of the Chesapeake Bay watershed. Although it was not one expansive carpet of ancient giants, it was a continuous mosaic of forest types and successional stages. This dynamic forest housed and fed tens of thousands of Native Americans and newly arriving European settlers, produced crystal clear water flowing from its streams into productive creeks, and contained a diverse community of plants and animals that awed John Smith and other early colonists. For nearly two centuries, the forest endured tremendous reductions: timber was harvested for fuel, shelter, and fences, and land was cleared for agriculture. In recent times, however, we have witnessed a reversal and steady upward trend that began in the mid- to late-19th century. This positive reforestation trend continued up until about the mid-1970s. Since then, the dynamics of population growth, changing ownership patterns, and sprawling suburban development are again threatening landscapes across the Bay region, causing sharp declines in and increased fragmentation of forested area.

Today, forests are still the dominant land cover, making up about 59 percent of the land base—24 million of the 41 million acres in the basin. However, we are currently losing forest by as much as 100 acres per day, due primarily to development. In the last 15 years alone, the Bay's forest has declined by more than 471,000 acres, an area equivalent to almost 391,000 football fields or about half of the state of Delaware. If estimates are correct, the region's population can expect to increase by three million to more than 18 million people by 2020, and the 1.7 million new homes projected by that date will consume more than 636,000 acres of additional forests and farmland. It is important to examine where that loss will take place. Areas closest to the Bay are losing forest the fastest, and a recent EPA study indicates that those coastal watersheds have the highest fragmentation. The question must be asked: What are the potential impacts and consequences of this trend, if it continues or accelerates?

What Is Forest Fragmentation? Why Is It Important?

Forest fragmentation can have several meanings, but the term has been widely used to describe various removals of forest overstory, ranging from small to large areas, from temporary to permanent. But, put simply, it is the process by which larger, contiguous forestlands are broken into smaller, more isolated fragments or islands, surrounded by human-modified environments that are converted to agriculture and urban land uses. The importance of such removals and "forest islands" to wildlife, fish, and human habitats is directly related to their size and permanence. The area of greatest concern and primary focus is the effect on forestlands with long-term or permanent conversion to nonforest use.

Forest fragmentation may have positive or negative consequences, depending on one's perspective. There is concern, however, that continued declines and fragmentation of the forestland base may lead to the impairment of our forest ecosystem's ability to protect water flow and quality, to provide healthy and diverse forest habitat, and to remain a viable economic resource that provides recreation, timber, and other forest products.

Why These Round Tables?

In the spring of 1997, the Forestry Workgroup of the Chesapeake Bay Program conducted a retreat at Orkney Springs, VA to discuss the topic of forest fragmentation, and to ask its members and invited guests if fragmentation is affecting the Bay's resource, community, and economic health. At the retreat, the FWG verified that forest fragmentation is occurring and is a problem in each of the Bay states. The group concluded that among the most important issues facing forest management today are: (1) the declining forestland base; (2) forest fragmentation; and (3) ownership parcelization (landowners grow in number as land is divided into smaller lots). All of these may pose ecological and economic consequences,. Workgroup members also felt that in order to adequately assess the impacts of forest fragmentation, and ultimately to make recommendations and implement sensible conservation solutions, they needed: (1) better scientific definition and characterization of forest fragmentation in the context of various management objectives; (2) data showing the current condition and trends; and (3) consensus on the issues related to fragmentation and its impacts, with input from the scientific, management, and stakeholder communities.

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In all, there were 38 participants from universities, state and federal agencies, and private and nonprofit entities, with expertise in disciplines including landscape ecology, wildlife biology, forest ecology, economics, sociology, land-use planning, policy analysis, and law. The main goals of the Round Table series were: (1) to gain a better understanding of the "state of the science" related to forest fragmentation and its impacts; (2) to gather insights, opinions, and recommendation from the experts; and (3) to gain consensus on what we know, what we do not know, and what we still need to learn about forest fragmentation.

The Round Table series included three one-day sessions on the topics of forest ecology impacts, economic impacts, policy, and legal realities and needs. Each Round Table session was divided into three sections. First, panelists presented current research or benchmark studies related to forest fragmentation. A traditional round table discussion followed with targeted questions prepared by a special Bay Program focus group. Finally, the group went through a consensus-building process to gather insights and recommendations on "what we know," "what we do not know," and "what we need to know" about forest fragmentation and its effects. This report summarizes these presentations and the Round Table discussions. Each Round Table is treated as a separate chapter, and the document concludes with the recommendations offered by each session and an appendix that includes abstracts from each panelist and a list of relevant references.

Round Table Sessions

A series of Round Table sessions was convened to better define and characterize forest fragmentation, gain insight on the state of the science, answer specific questions about effects and consequences of forest fragmentation, and begin the process of forming a strategy for dealing with forest fragmentation in the Chesapeake Bay region. A panel of scientists and experts in forest ecology, economics, land-use planning, and policy analysis was invited to participate in each Round Table session. Initially, each participant presented a brief overview of relevant work or professional opinions about forest fragmentation. These introductions were followed by an in-depth and facilitated discussion of several questions (previously posed by members of the FWG and a specially convened focus group). Priority rankings were given to those items considered most critical.

There was no attempt to edit or interpret what was discussed during the sessions. This report documents free-flowing thoughts, insights, and opinions on the topics by the participants. Any lists presented in the document are not considered complete lists, but represent discussion points listed by participants.

SESSION I

Ecological Impacts of Forest Fragmentation

Participants

Mr. James Garner (Chair), *Virginia Department of Forestry*
Mr. Larry Biles, *USDA CSREES-NRE*
Dr. Grace Brush, *Johns Hopkins University*
Mr. Thomas DeMeo, *USDA Forest Service, Monongahela National Forest*
Dr. Robert Gardner, *UMCES, Appalachian Laboratory*
Dr. J. Christopher Haney, *The Wilderness Society*
Dr. Lou Iverson, *USDA Forest Service, Forest Sciences Laboratory*
Dr. Steward Pickett, *Institute of Ecosystem Studies*
Dr. Charles Smith, *Cornell University*
Dr. Kenneth Stolte, *USDA Forest Service, Southern Research Station*
Dr. James Vogelmann, *EROS Data Center*
Dr. James D. Wickham, *Tennessee Valley Authority*
Dr. Wayne Zipperer, *USDA Forest Service, Northeastern Forest Experiment Station*

Grace Brush: Dr. Brush's research has examined the changing composition of forests over time, based on paleoecological and historical data. Her research indicates that the entire Chesapeake Bay watershed was forested from the time the glaciers began moving northward, approximately 10,000 to 12,000 years ago. It seems, however, that while species composition shifted as climate changed, the spatial mosaic of forest types did not change. Today, this mosaic is controlled by hydrology, elevation, and latitude.

Massive deforestation following European settlement resulted in a shift in species composition from primarily arboreal to herbaceous forests. Forests became increasingly fragmented and deforestation caused soil erosion and increased sedimentation to the Bay. Nitrogen influx into the estuary also increased, suggesting that an effect of fragmentation is the transfer of nitrogen from the terrestrial into the aquatic system. Dr. Brush recommends that future research focus on the effect of deforestation and fertilization on forest succession on the different landscape mosaics.

Thomas DeMeo: Mr. DeMeo's research examines the cumulative effects of forest fragmentation on the Monongahela National Forest, West Virginia, using a fragmentation analysis program (FRAGSTATS) on Landsat imagery. Satellite images are converted from false color composites to open versus forested images. The benefit of the analysis is that proposed management actions, such as logging units and roads, can be added to images and their effects on landscape metrics assessed. Recently, Mr. DeMeo has begun to analyze the cumulative effects of multiple activities on an area's landscape metrics. He is also developing analyses to examine how fragmentation affects forest songbird abundance and viability, an important forest-planning issue throughout the Eastern United States. Results are directly affecting forest planning and influencing outcomes on the ground.

Robert Gardner: Dr. Gardner, who has 15 years of experience in spatial analysis, has focused on forest patch dynamics. He and colleagues have published a series of papers that use neutral models of landscape pattern to understand how species' habitat affinities interact with landscape structure (i.e., habitat abundance, distribution, and quality as measured by carrying capacity) to affect the redistribution of individuals. Results show that landscape connectivity is a threshold phenomenon, in which even small losses of habitat near the critical threshold are likely to disconnect the landscape, having serious consequences for population distributions. Simulations of animal dispersal in simple and complex landscapes indicate that the dispersal between patches is rarely symmetrical. Thus, assessment of changes in landscape structure can be expected to vary from location to location and to differ widely between species with different dispersal characteristics.

Christopher Haney: Forest fragmentation can be considered one of four major types of forest structural conversions, the others being reduction in total forest area, modified age distributions, and altered species composition. Dr. Haney's research focuses on how to evaluate forest alternatives at smaller scales within a context that includes larger, landscape patterns. He identified several other important research opportunities and needs, including examination of cumulative impacts from fragmentation, and understanding how the four major categories of forest conversion interact with each other. From a technical standpoint alone, forest fragmentation may be the easiest of the four conversion categories to correct via restorative methods. He pointed to the extensive use of migratory birds as indicators of habitat impact of forest fragmentation. He suggests that reptiles, amphibians, and other taxa may be better indicators of forest health and impacts of forest fragmentation.

Louis Iverson: Dr. Iverson's studies have been assessing forest fragmentation using a variety of spatial scales and locations. The focus of his research has been: (1) understanding the nature and trends of forest fragmentation in Ohio using a Geographic Information System (GIS); (2) assessing the relationship between plant biodiversity and landscape ecological variables, including fragmentation, in Illinois; (3) assessing bird species richness (via Breeding Bird

Atlas data) and landscape variables in Illinois, where urbanized, fragmented patches in an agriculture-dominated landscape can enhance richness; and (4) modeling potential tree species distribution on 80 Eastern U.S. species, where forest fragmentation is projected to slow tree species migration if the climate changes. Overall, these studies indicate that size, shape, and distribution of forest patches are frequently important ecological factors for a variety of organisms and processes, though much work remains to understand the mechanisms and underlying principles.

Steward Pickett: Dr. Pickett is studying the ecological functions of forest patch edges. He uses a conceptual model to indicate the net effects of forest edges on various organismal and biogeochemical fluxes, to organize the mechanisms and feedbacks that may control those fluxes, and to suggest interactions between the population and ecosystem approaches to forest ecology. His lab has found that the gradients of physical environmental features vary differently from one another and change most rapidly outside the zone, which is often described as the anchor point for edge studies. A novel experimental approach has shown that edge structure determines seed flux, herbivory by different species, and below-canopy nutrient flux. These results indicate that simple rules of thumb for calculating edge depth may be misleading. Furthermore, manipulating structure of edges should be investigated as a forest management tool.

Charles Smith: Dr. Smith coordinates the New York GAP [Gap Analysis Program]. Unfortunately, most research studies of forest fragmentation on wildlife in the Northeastern U.S. continue to focus on birds, leaving an incomplete picture of how other species respond to fragmentation. Dr. Smith feels that it is critical to address the needs of a broader variety of species to get a more complete picture of how fragmentation is affecting ecosystems. He also recommends that studies apply nationally established standards for classification of vegetation (e.g., the National Vegetation Classification and Information Standard, developed by the Federal Geographic Data Committee) and definitions of ecoregional boundaries (e.g., Bailey's Ecoregions, developed by the Forest Service) to reduce ambiguities of defining regional units and characterizing forest fragments within those larger units. Achieving an understanding of forest fragmentation effects that is sufficient to guide conservation efforts will have to be undertaken at landscape and regional scales of resolution, using scales of ecological resolution that are relevant to the home-range requirements for the species or group of species being considered for conservation.

Ken Stolte: Dr. Stolte is currently participating in the development of the Forest Health Monitoring (FHM) report in the Mid-Atlantic Integrated Assessment (MAIA) region. The FHM-MAIA report will consist of a literature review, analysis and reporting on the condition of the forests, determination of past changes and trends, estimates of future condition, identification of data and information gaps, and evaluation of the interaction of forest ecosystem, particularly soil erosion and toxicity, with aquatic ecosystems in the MAIA region. Analysis of each forest issue may be stratified by forest type, ecoregion, and in some cases by species, depending on the issue. As part of FHM analysis, the group will use remote-sensing techniques with low-elevation aerial photographs to assess forest change over the last decade for selected areas in the Mid-Atlantic region.

James Vogelmann: Dr. Vogelmann has been using Landsat and Remote Sensing Multispectral Scanner data (an index using forest area-to-perimeter ratios) to examine forest fragmentation

in New England. His research focused on correlation between population density and occurrence of fragmentation. Initial results show that townships with high population densities are characterized by having high forest area-to-perimeter ratio (i.e., fragmentation) values. While this generality was anticipated, the degree of correlation was much higher than expected. It is likely that similar patterns characterize much of the Eastern United States, including the Chesapeake Bay watershed.

The U.S. Geological Survey, in cooperation with the EPA, is currently developing a general land cover data set for the conterminous United States using 1991–1993 Landsat Thematic Mapper data as the principle source. With some effort, general patterns of forest fragmentation from the early 1990s for the region could be derived using this data set. Determination of rates and trends of forest fragmentation, while very feasible, will require additional classification efforts and analyses using additional multitemporal data sets. Such information would be beneficial to local and regional planning groups.

James Wickham: Dr. Wickham and his colleagues have modeled the relationship between the percentage in the largest forest patch and anthropogenic cover for a set of 125 watersheds in the mid-Atlantic region. They found a significant transition in forest fragmentation between 15 and 20 percent by graphing the first derivative of the model as a function of the proportion of anthropogenic cover. The potential for mitigating fragmentation by connecting two or more disjunct forest patches was low when the proportion of anthropogenic cover was low, highest at moderate proportions of anthropogenic cover, and low again as the proportion of anthropogenic cover increased toward 100 percent.

Wayne Zipperer: Dr. Zipperer's research focuses on structural and functional changes in forest patches along gradients of urbanization within the Baltimore metropolitan region and along the Colorado Front Range. Forest patch research includes (1) a spatial and temporal analysis of configuration and type by social context within an urban watershed; (2) a floristic inventory by configuration, type, and social context; (3) an analysis of ecological functions (productivity, regeneration, nutrient cycling) by configuration, type, and social context; and (4) a long-term monitoring of structure, productivity, regeneration, and nutrient cycling.

The Colorado Front Range study is a collaborative effort with the Colorado Regional Resource Coalition and the Arapaho/Roosevelt and Pike/San Isabel National Forests. The research has two elements: (1) evaluating the change in the frequencies and patterns of human and lightning fire starts over the past 20 years; and (2) developing an Urban-Fire Decision Support Model.

A question and answer session resulted in the following points:

- We need to ask specific questions and measure against defined objectives to say forest fragmentation is having an impact on a given species or habitat.
- It was suggested that a coarse filter approach may be best to analyze effects. Risk of loss and/or degradation should guide the management decision.
- Resource management is an adaptive process. If we determine in the future that fragmentation is good, we certainly know how to do it. Current knowledge suggests that there are negative consequences.

Questions addressed at the Round Table discussion:

1. *What has happened to our forests as a result of forest fragmentation?*
2. *What are the ecological consequences if nothing is done about forest fragmentation?*
3. *What data gaps exist on the environmental effects of forest fragmentation, and how do we fill them?*

1. What has happened to our forests as a result of forest fragmentation?

The discussion centered around the negative and positive impacts of forest fragmentation. Consequences were also examined in the context of: "What do we know?" and "What don't we know?" Participants gave their insights based on the current state of knowledge and findings from their research.

What do we know?

Participants listed a series of negative and positive impacts resulting from forest fragmentation. The following are some of the more critical negative consequences:

- the irreversible loss of habitat
- increased sedimentation to the Bay due to forest loss
- changing stream conditions
  - *changes in stream life*
  - *reduction in macro invertebrate populations*
  - *increased temperature*
- decreased food to system
- changes in microclimate
  - *increased temperature*
  - *night and day temperature fluctuations*
- reduced water quality
- increased nuisance wildlife (e.g., concentrating deer herds that carry diseases, cause traffic accidents, and reduce the rate of forest regeneration by excessive foraging)

Participants also pointed out that fragmentation decreases native biodiversity and leads to an invasion of exotic species (e.g., kudzu and other herbaceous plants).

A positive effect discussed was the fact that forest fires are easier to control if the forests are segmented. However, ignitions are more frequent as human populations gain access to the forest. Increased aesthetic value was viewed as a positive result of forest fragmentation. In some instances, people enjoy seeing a fragmented landscape (e.g., agriculture, mixed with patches of forest, traversing roads, towns, etc.) Fragmentation also leads to an increase in edge, attracting certain wildlife and increasing local edge biodiversity.

What don't we know?

Some effects were labeled as important, but not well understood or studied, such as the effects deer populations have on other wildlife (e.g., birds, reptiles, amphibians). Does forest fragmentation affect forest health? If so, how? The group also agreed that fragmentation may slow the rate of spread of insect-borne diseases. As land is subdivided, management of forests as a continuous unit may become more difficult. Some landowners may not consent to forest management on their properties. The consequences and effects of this inconsistent management are not known.

2. What are the ecological consequences if nothing is done about forest fragmentation?

What do we know?

Round Table members felt that the negative ecological consequences of fragmentation could be severe, depending on where it is occurring. For example:

- fragmentation and deforestation along streams would cause decreases in stream stability, with increased influx of sediment and nutrients to the Bay leading to reduced water quality;
- fragmentation would result in decreased wildlife habitat for interior dwellers;
- loss of forest can lead to increased flooding, decreased water quality, and changes in local climate (e.g., increased temperatures);
- deforestation increases human contact with "nuisance" wildlife, leading to a greater threat of transmitting dangerous diseases (e.g., rabies, Lyme disease); and
- as fragmentation continues, it will be more difficult to reconstruct a historical record and to reverse fragmentation.

What don't we know?

Many ecological consequences of fragmentation are not well known or understood. Members felt that several important questions still need to be answered and better defined, such as: What is the threshold for location of fragmentation on stream stability and function? What is the optimum size of an ecosystem for animals requiring large areas (e.g., some migratory bird species)? How are aquifer recharge rates affected by fragmentation? When does forest fragmentation become a problem?

3. What data gaps exist on the environmental effects of forest fragmentation, and how do we fill them?

What do we know?

Fragmentation has increased in the Chesapeake Bay basin over the last 20 to 25 years. Some data are available, but have not been widely used. An Atlanta study, "American Forests, City Green", has lots of data and outlines the methodology to study population's tie to fragmentation. Digital data from Landsat are available. Studies have examined how to re-establish a forest, but

little has been applied. There are also large quantities of herpetological and fish data available that are underutilized. There are aerial photographs from the 1930s that could be used.

What don't we know?

In order to fully understand the effects of fragmentation, members recommend focusing on several data sets and studies:

Data Sets:

- understory data
- monitoring data on plants and animal taxonomy incidence
- location of the patches and fragments
- dynamically coupled forest, population, and economic data
- data on reurbanization rates and suburbanization
- human disease rates associated with developed versus undeveloped areas
- continual monitoring of land-use changes
- comparative data using aerial photography to observe urban spread (these data will also allow the study of patterns of spread)
- Geographic Positioning System (GPS) coordinates on Forestry Inventory and Assessment (FIA) data
- timely FIA data (shorter cycles), with coupled data on animals and understory
- relationship of fragmentation to water quality (quantitative estimates)
- ongoing, frequent, inventories
- completion and analyses of gap analysis data sets
- physical data (how large is the edge?); and, on the function and process of edge, the data need to be more specific and quantitative

Studies:

- examine how climate is affected by fragmentation
- what are the current rates of fragmentation? As population increases, how does the rate change?
- location of population changes versus fragmentation
- basin-wide "build-out" scenarios
- experimental work is needed for remedial fragmentation (How do we fix it?)
- cumulative impacts of fragmentation on composition, function, and age structure of forests (How does it exacerbate or dampen composition and age?)
- population shifts resulting from forest fragmentation and/or regrowth; e.g., the locations of breeding bird survey (BBS) routes have remained constant over 30 years, whereas species migratory patterns may have changed
- selection of an array of indicators
- examine quantitative relationships between fragmentation, fire, and air pollution (ozone), exotics, carbon sequestration, and forest vitality (windthrow)
- examine correlation between fragments and herps and fish
- thresholds of forest stands and capacity to support forest interior dwellers, monitoring data on plants and animal taxonomy
- analyses of the mechanisms of fragmentation and how they change with scale (e.g., is habitat loss more important than habitat configuration?)

SESSION II

Economic Impacts of Forest Fragmentation

Participants

Mr. James Grace (Chair), *Pennsylvania Bureau of Forestry*
Dr. Thomas Birch, *USDA Forest Service, Northeastern Forest Experiment Station*
Dr. Nancy E. Bockstael, *University of Maryland*
Dr. Harry Haney Jr., *Virginia Polytechnic Institute and State University*
Dr. Ian Hardie, *University of Maryland*
Dr. Fred H. Kaiser, *USDA Forest Service, Forest Valuation and Use*
Dr. D. Evan Mercer, *USDA Forest Service, Southeastern Forest Experiment Station*
Dr. Peter Parks, *Cook College, Rutgers University*
Dr. Alexander Pfaff, *Columbia University*
Dr. David Simpson, *Resources for the Future*

Tom Birch: Dr. Birch's ownership studies in the Northeast indicate that since the mid-70s to mid-90s, forest area has not changed, but ownership has increased by 90 percent. Ownerships larger than 1,000 acres have been steadily decreasing and are being parcelized as the population of landowners ages. Currently, up to 30 percent of the land is owned by retirees, a pivotal fact to consider over the next few decades in evaluating ownership changes and perspectives. His study is examining population density relative to forests and determining what drives the parcelization of forestland.

Nancy Bockstael: Dr. Bockstael and her colleagues have constructed a model that examines and predicts land-use conversion. Currently, the model incorporates seven counties in the Patuxent watershed and links land-use conversion to human decisions, landscape patterns, and environmental consequences such as water quality and fragmentation of habitat. The model can predict land-use patterns under different policy scenarios and will be used to attempt to answer the following questions: What affects the value of land and different parcels? How long does it take to get to employment centers? What is the pattern of land use around residential areas; does a forest make an area more desirable or valuable? An important component of the study is to examine the history of individual parcels to determine what factors affect the value of the land.

Harry Haney: Dr. Haney and his graduate student have been studying conservation easements in the Adirondack region of New York. His student is preparing a user's guide for the local Farm Bureau. Half of the study area now prohibits timber cutting and forest management. Dr. Haney is also studying impacts of federal and state taxes on forestland ownership. He has found that estate planning is low. There is resistance due to a perceived loss of control. As forest property is transferred or inherited, landowners are faced with heavy federal and state estate taxes. Without estate planning, many property owners give up and divide and sell the land, leading to fragmentation. Dr. Haney is looking for ways to streamline the process and educate the landowner. He is also looking at the impacts of small ownerships on forest harvesting. He says that generally, there are negative impacts. He did share an anecodote of a local firm that is making small-lot harvest economical.

Ian Hardie: Dr. Hardie is tracking the effects of Maryland's Forest Conservation Act, specifically, the economic impacts on developers and home builders as land stays forested. He is also examining the effect of grandfathering and riparian forest buffers put in place as development continues. His philosophy is to survey potential environmental effects on the land and then examine socioeconomic impacts. It is also critical to educate landowners about participation in incentive programs. Related to fragmentation, Dr. Hardie says that the issue is irreversibility.

Fred Kaiser: Dr. Kaiser demonstrated the difference in population density in the Eastern United States from the 1950s to the 1990s. The Bay area has seen a significant increase over the last 40 years. Currently, 75 percent of the population lives in urban areas. Rural population increases are expected to keep pace with increases seen between 1980 and 1990 (a decade which saw an increase of two million people). As commuters move further away from work, the option of working at home must be taken into account when considering urban sprawl. From 1.3 to 1.4 million housing starts are anticipated in the next several decades, and one million of these will be single family homes. This means both increased forest loss and increased timber needs. It is critical to examine where this will take place. For example, corridor development between two large cities (e.g., between Richmond, VA and Washington, DC) is also a possibility. The next question is: Where will baby boomers retire? Second-home development could increase.

The probability of commercial forest use is decreasing as a function of population density. At between 100 and 200 people per square mile, the probability of commercial forestry approaches zero. These effects would reduce available timberland by 32 percent in Virginia.

Dr. Kaiser also feels that taxes need to be reexamined at a national level. Estate taxes need to be structured to avoid the parcelization of properties.

Evan Mercer: Dr. Mercer is participating in the Mid-Atlantic Integrated Assessment (MAIA), a multi-agency effort headed by the EPA to assess the health of all ecosystems in the mid-Atlantic region. The MAIA region includes the entire states of Delaware, Maryland, Pennsylvania, Virginia, and West Virginia and parts of New Jersey, New York, and North Carolina, and encompass the Chesapeake, Delaware, Ablemarle, and Pamlico watersheds. The impetus for the MAIA comes from the Center for Environmental and Natural Resource Reseach (CENR) Initiative for Integrated National Environmental Monitoring. It is a pilot project for Vice-President Albert Gore's charge to develop a "national environmental report card." The Forest Service is responsible for assessing the status of forests in the MAIA region, and Dr. Mercer is leading a team responsible for the socioeconomic component of the MAIA forest assessment. The overall goal of the MAIA socioeconomic assessment is to develop systems for understanding and monitoring the relationship between changes in forest ecosystems and human well-being and quality of life in the MAIA region.

Peter Parks: Dr. Parks and his colleagues are integrating models from ecological and economic disciplines to help explain how forest land-use decisions are made within different economic, physical, and regulatory contexts, and to quantify the impact of these decisions on forest fragmentation. The proposed analytical framework integrates landscape ecology with economic policy analysis, within the spatial analytical framework of a subwatershed-scale GIS. This integrated representation of forest habitats allows changes in economic or environmental conditions to be translated into fragmentation effects. The proposed research is designed to permit the potential fragmentation impacts of alternative policies and economic conditions to

be quantified. He will look at fragmentation effects on water quality, and is focused on the New York-New Jersey Highlands region for his analysis.

Alexander Pfaff: Dr. Pfaff most recently has been studying spatial patterns of development in the Brazilian Amazon. He feels there is a strong need to look at choices that people make. It is critical to be able to predict what will happen to the land and how species habitat will be affected when the land is fragmented. Economic factors are often very important (e.g., agriculture will shift out of the region once transportation of goods is possible). In some areas forest level is up; however, species composition and age have changed. Dr. Pfaff is studying the historic change of forest and agricultural land in the Northeast to assess social motivations for land-use change.

David Simpson: Resources for the Future is looking at international development and effects of dam construction in north-central Thailand. Many genetic resources are lost. Afforestation has resulted in a loss of an important teak gene pool. The population as a whole has less opportunity for gathering food and medicinal products. A second project related to fragmentation involves examining the costs of biodiversity conservation in Florida. The concept is to identify indicator species and to conserve enough habitat to support a certain amount of these species. This is being done through outright ownership purchase of land, tax incentives, and easements. He also mentioned a colleague's work, looking at dieback of forests due to El Niies and to conserve enough habitat to supvation in other areas of the U.S.

A question and answer session resulted in the following points:

- We need to be distinct about the definition of fragmentation and parcelization. They are different. (Birch)
- Fragmentation is also occurring because of public policies from tax to transportation, and there are intergenerational consequences. (Bockstael)
- Effects on land and home prices are a function of scarcity of forest area. If forest is scarce, then price increases, but if it is abundant there may be no change. (Parks)

Questions addressed at the Round Table discussion:

1. *What are the social impacts and economic trade-offs of a fragmented and declining forestland base?*
2. *What are the economic and social consequences if current forest fragmentation and ownership parcelization trends continue?*
3. *What are the priorities fro data collection, analysis, and monitoring needs?*
4. *Are we asking the right economic and social questions?*

1. What are the social impacts and economic trade-offs of a fragmented and declining forestland base?

What do we know?

Fragmentation changes the distribution of market and nonmarket benefits and costs from the landscape (e.g., water quality, recreation, temperature and climate control, biodiversity, and wildlife). When observing the consequences of fragmentation, one must also consider the aesthetic values versus the ecological values. What do people consider "valuable," and what are they willing to protect or pay for? Examples of nonmarket values that might be affected are: recreation (e.g., hunting), wildlife values (game and nongame), open space (aesthetics), noise abatement, utility costs, microclimate, carbon storage, and biodiversity. Changes of nonmarket benefits are often site specific and depend on what people value.

As fragmentation occurs, the forest base is diminished and conventional forestry practices for timber are also reduced. This will most likely lead to permanent changes in forestry practices (e.g., in Virginia, changes in cutting and silvicultural practices).

What don't we know?

The group felt uncertain about the effects of fragmentation on the timber supply. Free trade allows easy importing of products and goods from the South. In some cases, parcelization might also increase the quality of hardwoods.

When examining social values placed on different lands, it is very difficult to predict what the individual considers valuable. Forests can be separated into categories of principle use (e.g., urban forests, transitional zone, and rural forests). However, predicting patterns of development often depends on individual values of different age classes or ethnic groups. In some cases, taxes might govern whether land is developed and/or shifted into agriculture.

2. What are the economic and social consequences if current forest fragmentation and ownership parcelization trends continue?

What do we know?

Continued fragmentation can lead to a loss of aesthetic values, recreation, employment, and harvested forest products, and to increased pressure on road systems. The group listed several positive and negative consequences if forest fragmentation and parcelization trends continue:

Positives:

- quality of life increases for those who move out of the city—achieving the American dream and living away from crime; and
- the reduced cost of living outside the city, which stimulates an increase in single-home development.

Negatives:

- increased noise and lights with development

- changes in property value
- changes in living patterns: some areas are controlled and some uncontrolled, and the consequences will differ for each
- irreversibility (it is very costly to remove urban housing and put the land back into forests);
- natural disasters are very costly when rebuilding widely dispersed communities (e.g., Maine)
- traditional activities suffer as parcelization increases; more permits are required to do the same recreation (Cordel Birch, state-level report)
- recreational availability to general public goes down (rural: local people, hunting, trapping, fishing, harvesting, collection of mushrooms [nontraditional forest products], etc.
- reduced water quality

What don't we know?

As mentioned above, one of the major problems in addressing this question is the difficulty in quantifying the value of nonmarket benefits. In other words, as stated earlier: Are the human benefits increasing over and above decreases in the ecological integrity of forest ecosystems? In some cases, fragmentation causes more people to be exposed to forests and might increase awareness of the importance and benefits of forested land. Also, increasing local oversight of property can reduce theft and vandalism.

3. What are the priorities for data collection, analysis, and monitoring needs?

What do we know?

Government data are not available on a small enough scale. It will be necessary to restructure the current monitoring programs and re-examine data-dispersal mechanisms.

What don't we know?

The following lists priority data sets and monitoring needs:

- spatially referenced economic and social data tied to biodiversity, land cover, and policy data; land cover trends over time
- data collection efforts on how people value nonmarket benefits of alternative land uses
- attitudinal data to reveal people's preferences in developed landscape
- develop something better than contingent value (as currently practiced) to estimate nonuse values
- ecological data, ecosystem data and health related to relevant environment services (e.g., production functions output)
- visual resource inventory
- Recreation Opportunity Spectrum (ROS, Forest Service)
- monitoring: parcelization mechanics (how properties transfer over time), more data
- social and economic data added to the forest-health monitoring
- spatially referenced census data, block-group level
- spatially referenced policy data

4. Are we asking the right economic and social questions?

The group feels that there are other questions that may need to be asked:

Can you affect fragmentation with policy? Which policies?

Yes, policy can affect fragmentation. For example, changes in policies regarding taxation (e.g., repealing estate tax), zoning, sewer and water, highway construction, and infrastructure would lead to less fragmentation.

What are the amount and distribution of the costs and benefits from spatial pattern of landscapes?

- current: microdata
- desirable
- theoretical versus empirical

Is there any other irreversibility about the process of fragmentation to make us worry about conservation and/or preservation? What is the cost?

Hydrologic regimes: once area is parcelized it becomes economically infeasible to put it back into one forested area (Weeks Act). Physical irreversibility: large sums of money are spent to slow growth and keep water quality from degrading.

Are there unique areas that we should protect from irreversibility?

Faced with increasing population growth, how does an area accommodate a certain amount of growth? How can policy redirect growth (where we are going to minimize ecological impact)? How would we like it to look?—Link to desired landscape.

Reword question #3: *If current policy continues (frozen as they are today), what are the economic and social consequences if we do nothing? What will happen if current fragmentation and ownership parcelization continues?*

- The most obvious consequence is sprawl. There are so many factors involved that it is very difficult to predict exact patterns of sprawl.

Move to Policy and Law Session: *How do we implement policies to affect fragmentation to minimize ecological impact?*

SESSION III

Policy and Law Impacts of Forest Fragmentation

Participants

Mr. James Mallow (Chair), *Maryland Department of Natural Resources*
Dr. Keith Argow, *National Woodland Owners Association*
Dr. Dave Cleaves, *USDA Forest Service*
Dr. Lester A. DeCoster, *The DeCoster Group*
Dr. Donald W. Floyd, *State University of New York College of Environmental Science and Forestry*
Dr. Sharon Friedman, *USDA CSREES-NRE*
Dr. R. Bruce Hull, *Virginia Polytechnic Institute and State University*
Mr. C. Timothy Lindstrom, *Piedmont Environmental Council*
Mr. William Matuszeski, *US EPA Chesapeake Bay Program Office*
Dr. Robert Pirani, *Regional Plan Association*
Dr. V. Alaric Sample, *Pinchot Institute for Conservation*

Keith Argow: Dr. Argow summarized the predominant landowner attitude: "Your interest in my land stops at my gate." We need to carefully examine three top issues: timber taxes, private property rights, and the right to practice forestry. Loss of these rights is driving fragmentation. As forestland continues to fragment (e.g., Shenandoah), easements are not the answer; counties are not interested in holding title to land.

Dave Cleaves: Dr. Cleaves pointed out that we know the rules that are set up in policy, but we know little about population "behavior." We need to define the problem of fragmentation and change the "behavior" by a set of carefully constructed rules. Decision processes of landowners—Nonindustrial Private Forestland Owner (NIPF) Decision Influence—(**see Figure X.**). The decision to sell can happen very quickly. One quarter of NIPF land will be affected in the next 10 years. Decision processes of landowners need to be taken into account as policy is developed.

Lester DeCoster: There is a 1996 study on public programs and private forests. There is not a reason for the individual to follow a policy unless everyone is forced to do something. Birch's study examined results of current trends in growth until the year 2010. It is not just a matter of more people needing more space: forestland owners are increasing at a higher proportion. Mid-size (100- to 500-acre lands) are being parcelized for both policy and personal reasons. The major drivers are death taxes and lifestyles. Taxes: currently, property taxes are extremely high (four times the inflation rate). As older forestland owners die, mid-size properties are often parcelized and sold to avoid high property taxes. Lifestyles: People enjoy living in the suburbs and having personal greenspace. Taxes are slightly lower in suburbs and transportation and communication networks are slightly newer. Dr. DeCoster also pointed out that forestry programs are not doing an adequate job of public relations and marketing. People don't take responsibility because it is not relevant to them.

Don Floyd: Dr. Floyd pointed out that there are 900 town governments in New York state. This constitutes too many regulations. Local officials have varying attitudes about forests.

Statistically, population growth and density do correlate with adoption of ordinances. Community-based decision processes often have to be ratified by a formal legislative process, making it very slow and cumbersome. He points out that there can be good community consensus, but it often falls apart in the legislature. This needs to be a focus when examining forest fragmentation.

Sharon Friedman: Dr. Friedman feels that forest fragmentation data should be collected so that it can be compiled nationally, so that this issue can get the attention it deserves at the national policy level. There is a major challenge for the forestry profession in dealing with this issue. In addressing it, foresters will be working in areas where their profession is not the dominant player: issues of taxation, transportation, trade, and urban policies are all relevant to forest fragmentation. There are at least four subtrends involved in fragmentation, and each might have different effects and require different policy approach: urban development and expansion of small towns into the countryside (relatively high-density expansion); increasing rural residential living (low-density expansion), whether seasonal or year-round; division of properties into smaller ownerships (which may or may not lead to the above); and increasing population pressure from forest visitors and increasing conflicts among forest users. Dave Kittredge at the University of Massachusetts, Tom Harris at the University of Georgia, and others have studied changes in landownership. In addition to facing massive changes in ownership in the near future, there are a great many questions about who these new owners will be, what their objectives will be, and what effects they will have on the communities. Many of the newer residents do not come from a rural background, so the difference in cultures is likely to be both a challenge and an opportunity.

Bruce Hull: Dr. Hull pointed out that fragmented ownership only produces fragmented forests if there exists fragmented management. Strategies should be developed which encourage landowners to coordinate management with neighbors. These strategies should respect the old adage that "good fences make good neighbors," while being sensitive to ecosystem processes that cross property boundary lines and to the economies of scale of harvesting. The real estate market will continue to fragment forest ownership: new forest owners will offer top dollar for forested lands, and owners of mid-sized tracts will respond by fragmenting their ownership. This wave of real estate development is unlikely to dissipate, so we should not focus solely on tax incentives or development restrictions as a means to stem it. To do so is to build sand castles on the beach, and the waves may wash away these strategies.

An alternative solution to the forest fragmentation "problem" is to coordinate management among the increasingly numerous forest owners. One strategy to coordinate forest management among diverse owners is being examined with the "forest bank" project with the Nature Conservancy in southwestern Virginia. This program attempts to obtain the rights of timber management among adjoining lands. In return for these rights, the "bank" promises the landowners a fixed annuity (at a rate to be determined), landowners are relieved of the risk of losing their investment to ice or insects, and landowners forgo the need to keep abreast of best forest management practices and prices that will optimize their investment. The bank will harvest timber to fund itself in a manner that reflects ecosystem processes, recognizes economies of scale, and generates wood-processing jobs in the local economy.

Tim Lindstrom: The Piedmont Environmental Council (PEC) has focused on land conservation through voluntary donations of land. There is resistance by landowners to being regulated.

Currently, zoning will not protect forestland. The alternative of buying land is too expensive. Mr. Lindstrom pointed out that conservation easements might be a good alternative. These can protect land without much regulation. One option is to try to increase personal benefits with this approach. For example, permanent easements would reduce taxes by the percentage of forested land area. This approach is already making a difference in his region. Mr. Lindstrom discussed the 1997 Tax Relief Act and America's Farm and Range Protection Act. PEC was chiefly responsible for the law that increases the estate tax, adds open space lands, and allows conservation easements to reduce tax bills.

Bill Matuszeski: Mr. Matuszeski reviewed the role of forests in reducing the nutrient loading to the Chesapeake Bay watershed. When dealing with common landowners, it is important to remember their perspective: Why should forests be cut at all? Public education should not be overlooked. Another long-term goal that should be kept in mind is: Assuming that consensus can be reached on the issues, a set of priorities needs to be established. Emphasis should be put on conserving and protecting larger blocks of land and on urban fringe.

Rob Pirani: As part of the Regional Plan Association's (RPA) third regional plan for the New York City metropolitan region, RPA proposes the Greensward Plan, a 21st-century counterpart to the mid-19th-century concept of Central Park in New York City. Over the last 30 years, a 13 percent population increase has caused a 60 percent increase in developed land. This may not be sustainable over time. The traditional response is the creation of parks; however, it is not enough to simply buy land. The New York RPA's approach is adding a system of greenbelts, restoring urban parks and natural resources, and establishing greenways. In places like the Catskills, the Appalachian Highlands, and the Long Island Pine Barrens, RPA's goal has been to protect the large forest patches by using transfer of development rights (TDR).

Al Sample: The Pinchot Institute's philosophy is more about conservation than management. There are 191 million acres of national forest. Dr. Sample and the Pinchot Institute are seeking out private, voluntary methods for land conservation. Virginia has increased in political intervention of forestland management. People are realizing the importance of clean water and habitat and are willing to embrace a higher level of government regulation. What kind of policy and law will be an effective way to have voluntary participation (stewardship: what are your responsibilities as a private landowner)? He suggests that private landowners have rights and are important, but they have responsibilities too. Conservation is the key.

Questions addressed at the Round Table discussion:

1. *If forest fragmentation or parcelization is negative, then how are current policies and laws affecting the trend? And what mechanisms are in place to control it?*
2. *How do forest-based incentive programs help solve the forest fragmentation or parcelization issue?*
3. *How will changing demographics and quality-of-life issues affect policies that can influence forest fragmentation or parcelization?*

4. *How do you answer this hypothetical question as a director of policy: What are you going to do about forest fragmentation or parcelization in the Bay area?*

1. If forest fragmentation or parcelization is negative, then how are current policies and laws affecting the trend? And what mechanisms are in place to control it?

Policies need to be better coordinated and more consistent. The public has a "gut feeling" that forests are important to protect, but they don't understand forests. The group pointed out that fragmented policies promote fragmented forests. For example, regulating a bird species can cause smaller landowners to sell land, because it is not economically viable. In some cases, certain land uses are not obligated to the same law, or the laws differ for foresters and developers. This can also have negative consequences and exacerbate problems associated with fragmentation. Cumulative effects of laws may also cause a result that was unintended ("the law of unintended consequences"). The discussion finally ended up with the thought: Do policies cause fragmentation, is it caused by other things, such as population growth?

Policies in place to control forest fragmentation:

- Maryland's Smart Growth legislation (state legislation geared to direct growth using incentives)
- Virginia's bad actor law (Best Management Practices [BMP] law, Virginia Water Quality Act)
- local- and township-level ordinances
- zoning laws (use and density of lots)
- reduction of property taxes (preferential tax treatment for forestland)
- Critical Areas Act (restricts development within 1,000 feet of the Bay); 30 percent of land is restricted from development. This causes land turnover, timber is removed from the market, and parcelization increases.
- Clean Water Act: forest cover stays because of permits required
- right to practice forestry acts to counteract the ability of landowners to make money from land
- can deal with economics by compensation for public values (e.g., New York state: bond issue to reinvest in rural towns to keep New York City water clean—reinvesting in upstate forests to protect New York City watersheds; clarification of beneficiaries, monopolizing benefits, "bribing" not to pollute
- current structure of regulatory framework is not working
- public regulation is incapable of containing public investment

The point was raised that we need to have a better understanding of where fragmentation is occurring. If the problem is eutrophication (endpoint), we may want to look at areas that are fragmented and are causing most of the eutrophication (e.g., upper versus lower Bay).

2. How do forest-based incentive programs help solve forest fragmentation or parcelization issue?

Current incentive programs:

- tree planting incentive programs
- "forest bank" programs, especially if the program is perpetual. Problem: owners didn't want to commit to long-term, stringent management
- effective use of urban growth boundaries (e.g., Vermont, Oregon, Virginia)
- forest-product companies lease private land
- Oregon Forest Trust: agency buys an interest in the forest, to be exercised in future. This program failed, because most people own land to be able to "control" something and don't trust the next generation. They transferred this right out of their control in the Forest Trust program.

Future incentive programs:

The group's consensus was that, to attract people, incentives need to be quick, simple, and clear. A different package of incentives should be developed for different-sized landowners (e.g., large [>500 acres], medium [100-500 acres], small [<100 acres] landowners). One approach would be to mandate a large common lot for each subdivision. The incentive for the developer would be to pay less for roads and utilities (e.g., develop a golf course). Another option would be to create cluster communities with larger sites under perpetual conservation easements. As county boundaries keep moving out, policies need to be redirected at those people. Incentives should be directed at the development patterns. Other factors that could be reexamined are transportation policies and restructuring local tax systems.

3. How will changing demographics and quality-of-life issues affect policies that can influence forest fragmentation or parcelization?

Changing demographics:

Increased social tension and confrontation have led people to seek an escape in the woods. The people (150,000 per year) who are moving into new homes (either first or second homes) need to be reached. In some cases, parcelization might increase tree cover if people value this on their land. Once a house is built, however, other impacts need to be taken into account (e.g., septic systems, utilities). New technologies (e.g., new septic systems, dry-hydrant programs) have opened up development in areas that were previously inaccessible. If people were paying the true costs of moving to the countryside, there might be less incentive to move outside the urban areas. An increase in pets in these areas was also mentioned as a potentially negative impact of forest fragmentation.

Quality-of-life issues:

People employed by timber companies need to find jobs elsewhere as suburban areas become increasingly developed. Rural communities will see a change in employment opportunities and education. People moving into small towns will change local politics (e.g., changes in legislation and regulation). This may result in clashes between the two different lifestyles.

4. **Interview question for directors of policy: What are you going to do about forest fragmentation or parcelization in the Bay area?**

List of most important things participants thought they would do:

First...

- develop a dialog between the "come heres" and the "go theres"
- control public infrastructure locations
- inventory conditions and trends of fragmentation and parcelization
- estimate true cost of new development
- catalogue old neighborhoods to support growth management
- develop a consensus of what the problems are
- create an office: Development Office for Economic and Environmental Use of Forests
- educate public about the value of forests to the Bay
- draw line around places you really want to protect, and move forward on those
- develop local interest groups around problem

Second...

- remove disincentives for mid-size landowners
- prevent urban outflight by making it more attractive in the cities
- establish urban growth boundaries in the Bay area
- start a public relations campaign "shock treatment"
- work with congressional delegates to include a green investment account pre-tax to improve forestry, add tax policy ("GIPRA concept"—Government Performance and Results Act);
- state grant-in-aid fund (incentive program) to encourage sound local planning
- target education and incentive program to new landowners
- conservation easements, used as more flexible strategies (e.g., term easements: money flows from government to local nongovernment organizations)
- extend forest property incentive acts to contain other than timber harvesting
- work with developers, patterns to reduce environmental footprints (environmentally sensitive)

Top Strategies, Chesapeake Bay Project

1. control public infrastructure locations
2. inventory of conditions and trends
3. conservation easement flexible program (e.g., term)
4. estimate true costs of development
5. set urban growth boundaries

The group discussed currently available efforts and information related to the top strategies.

What is out there?

1. Control public infrastructure locations

- Some laws in Maryland exist to deal with location of public infrastructure; in Virginia, local infrastructure is consistent with compromise plan.
- The National Environmental Policy Act (NEPA) could be used for federal decisions regarding infrastructure.

2. Inventory of conditions and trends

- EPA project to open set of forest fragmentation indicators, eight-digit watershed scale has information where forests exist and what they look like
- inventory of riparian buffers using GIS
- aerial photography from 1930s over the basin
- Maryland Planning Office has lots of data (e.g., newly developed lot has increased 38 percent); Virginia has very little of these data in a central location at the local level; Pennsylvania data are at township level; Virginia has VIRGIS (Virginia Geographical Information System).

3. Conservation easement flexible program (e.g., term)

- Data on conservation easement shows differences in land values; look at land-tax stamps

4. Estimate true costs of development

- cost of community services: Southern New England Forest Consortium (SNEFC) bay program has completed a number of studies, local studies, and literature search
- some models exist to estimate development impact
- cost of development versus bonding to buy land (ad hoc associates for the Trust Republic Lands)
- development programs in Virginia (Haymount): examining economic impact on developers for alternatives and environmental impact
- evaluate natural systems value input and output natural systems: economic value of outputs (e.g., 10-acre wetland in Massachusetts) versus treatment plant cost to process same amount of water;
- American Forests has studies showing the cost of loss of urban forests, conservation easements with tax appraisal uses—could be collected to explain "cost" of land

Needs identified to realize top strategies:

- focused and statistically anchored data on landowner attitudes (psycho-geo demographics)
- cultural anthropology, human dimensions, meaning-based versus product-based
- forestry community does not know enough about psychometrics to do this alone: human dimensions
- forestry needs to lead issue and draw in other groups instead of relying on sociologists, planning, psychology
- to what extent are we dealing with a suburbanization phenomenon versus exurbanization phenomenon?

- bring urban planners into some forestry issues, (e.g., Maryland state planning office)
- politicians need to know political capital will be built by implementing long-term solutions through emphasizing environmental quality
- information and arguments that transportation policy equals economic development
- we don't yet have areas identified as important and have not identified the relative importance of systems to protect
- fragmentation definition impacts

Barriers or strategies for the future?

- bring planners into the loop
- theories of urban growth
- planners need to be educated on value of forests—which are more valuable than others
- governmental agencies' resistance to being regulated by other governmental agencies
- political will to not implement long-term solutions beyond politicians' term of office
- agencies, especially the U.S. Department of Transportation, don't seem to answer to anybody

Conclusions and Recommendations

In general, the ecologists and economists told us that there is a knowledge base sufficient to establish public policy to manage forest fragmentation; however, there still are important questions that need to be addressed. Public policy experts told us that establishing public policy requires a lot more than ecological and economic data. Connections and actions between our current institutions must be better coordinated to manage land use in ways that minimize forest fragmentation. To affect public policy, accessible involvement of scientists, resource managers, and the other interest groups is required. Also, the vast majority of society doesn't know that forest fragmentation is a public policy issue. Therefore, increased public awareness and education are necessary.

Ecological Impacts

Conclusions

The invited ecologists stated as a caution that we need to be very specific in our questions and to use defined objectives when measuring impacts on habitats or species. However, several general conclusions can be drawn from their study and the work of others in the field:

- Forest fragmentation can have negative and irreversible effects, especially when associated with human development. These impacts include loss of forest habitat, changes in stream conditions that can reduce stream life and vitality, alterations to microclimate that can affect local ecology, and impacts linked to reduced water quality and increased flooding. Also, they stated that fragmentation likely decreases native biodiversity and can increase the potential for invasive or exotic species; and
- The positive aspect of forest fragmentation is that it creates increased forest edge habitat attractive to suites of wildlife species, many of which are game species. The ecologists held that forest fire is a double-edged sword; although it would be easier to manage, the ignitions would be more frequent due to greater human access.

Recommendations

Round Table participants went through a prioritization activity and scored items they felt were most critical. According to participants, the priority recommendations for future study are, in descending order:

- what are current rates of fragmentation? As population increases, how does the rate change?
- timely FIA data (shorter cycles), animals, and understory
- basin-wide "build-out" scenarios
- how systems are affected by fragmentation
- relationship of fragmentation to water quality (quantitative estimates)
- physical data (how large is the edge?) and, on the function and process of edge, data need to be more specific and quantitative
- continual monitoring of land-use changes
- examine how climate is affected by fragmentation
- thresholds for changes in effects (does fragmentation affect forest health?)

- water quality and quantity issues
- location of population changes versus fragmentation
- examine quantitative relationships between fragmentation, fire, and air pollution (ozone), exotics, carbon sequestration, and forest vitality (windthrow)

Economic Impacts

Conclusions

The economic Round Table panelists reminded the other scientists that there are both negatives and positives, winners and losers regarding forest fragmentation. It would be unfair to broadly characterize this landscape change one way or another from an economic perspective. They also made it clear that more information and additional data are needed to better account for nonmarket values and to determine what people consider valuable. They also told us that public policy could affect fragmentation (e.g., inheritance and property taxes, zoning, transportation) and create incentives or disincentives to fragment forests. The economists made several general comments regarding the impacts of forest fragmentation based on current knowledge:

- Continued forest fragmentation can lead to negative economic and social outcomes, including loss of aesthetic values, reduced recreation opportunities, decline of forest-based employment and industry, increased pressure on road systems, and increased noise and light with development, as well as the increased costs of addressing negative impacts on water quality and quantity.
- The economists noted that current development patterns and the outcomes of fragmentation are positive for some people. Jobs are produced from new home development, community services increase, and quality-of-life elements increase for those individuals who move out of the city (reduced congestion, perception of reduced risk of crime, achievement of the "American Dream").

Recommendations

Round Table participants went through a prioritization activity and scored items they felt were most critical. According to participants, the priority recommendations for future policy are, in descending order:

- spatially referenced economic and social data tied to biodiversity, land cover, and policy data;
- data-collection efforts on how people value nonmarket values of alternative land use;
- land cover data trends over time
- monitoring the mechanics of the parcelization process (how properties transfer over time)
- attitudinal data to reveal people's preferences in developed landscape
- spatially referenced census data at the block-group level
- ecological data input, ecosystem data and health related to relevant environment services (e.g., production function output)
- spatially referenced policy data;
- develop something better than contingent value (as currently practiced) to estimate nonuse values

Policy and Law

Conclusions

Public policy experts stated that more than ecological and economic data must be considered when establishing policies that address forest fragmentation. Policies can have unintended outcomes (such as transportation, tax), and institutions are generally not well connected or actions coordinated to manage land use in ways to minimize forest fragmentation. The panel acknowledged that policies now exist in some Bay states (Maryland Smart Growth, Maryland Forest Conservation Act), but said that more can be done:

- Policies that are based on incentives and that give clear guidance are best. Strategies that direct growth, address public infrastructure location, acknowledge and compensate developers for environmentally sensitive design, and protect contiguous forest areas by compensating willing landowners fairly (e.g., conservation easements) are seen as preferable.
- A public policy challenge is ahead to balance growth and conservation in rural areas. People are seeking relief from a demanding society. Changing population demographics, new technologies, and changes in attitudes and perceptions about the state of our cities are all working against controlled, condensed development patterns that can reduce forest loss and fragmentation.

Recommendations (in descending order)

- control public infrastructure locations
- inventory of conditions and trends
- conservation easement flexible program (e.g., term)
- estimate true costs of development
- setting urban growth boundaries

Next Steps

Where do we go from here?

It is assumed that the occurrence and spread of forest fragmentation in the Chesapeake Bay watershed negatively affects Bay water quality, but to what extent is largely unknown. A prime objective of the Chesapeake Bay Program is to improve Bay water quality. Resolving forest fragmentation issues, (i.e., preventing or mitigating its negative effects) would help to achieve this objective.

The Round Table events described in this report are part of a longer-term strategy to develop, discuss, distribute, and utilize information about the forest fragmentation issue and related land- and resource-use problems. The strategy involves convening scientific and technical meetings of professional natural resource societies and associations; facilitating stakeholder awareness, knowledge, and involvement through seminars, workshops, and conferences; and publishing recommendations targeted at various sectors of society that can influence the development, implementation, and monitoring of public policy for mitigating the negative aspects of forest fragmentation.

Activities in Addition to the Round Tables

Recently completed:

- The Appalachian and National Capital units of the SAF in the Chesapeake Bay watershed each held scientific or technical meetings of their members concerning particular forest fragmentation issues in their areas of activity. Other such meetings, which could include field trips, may occur in association with other professional resource organizations active in the CBW's geographic area.
- In June 1998, six national professional natural resources organizations held "Science Day" on forest fragmentation issues: the national capital units of the Society of American Foresters, the Wildlife Society, the American Fisheries Society, the Society for Range Management, the Ecological Society of America, and the Soil and Water Conservation Society.

Plans for the future:

- Independent activity on the part of members of these organizations is being encouraged, essentially to develop opportunities to bring forest fragmentation issues and explanations to the attention of individuals and organizations in their neighborhoods and workplaces.
- Develop a GIS-based analysis of forest fragmentation in the Chesapeake Bay watershed.
- The final activity in the overall forest fragmentation study will be a regional conference in early 1999. The conference will be a convocation of forest fragmentation and related natural resources and land-use stakeholders; including scientists, land managers, and resource managers; to discuss the findings and recommendations stemming from the activities cited above. The anticipated output from the conference is a set or sets of recom-

mendations for public and/or private entities of society that have the power to influence policy for preventing or mitigating the negative effects of forest fragmentation in the Chesapeake Bay watershed.

- Complete a literature synthesis of scientific studies related to forest fragmentation.

APPENDIX A

Abstracts from Round Table Participants

Opening Comments

Forest Fragmentation Round Table Discussion

Bill Matuszeski

While forests cover nearly 60 percent of the Chesapeake Bay watershed, they deliver only 14 percent of the nitrogen load to the Bay. This is by far the most beneficial absorption capacity of any land use in the watershed, and has led to the initiatives taken by the Chesapeake Bay Program in recent years to protect and restore riparian forest buffers and to advocate forest preservation in general. From European settlement through the Civil War, forest cover was reduced by conversions to farmland. From 1865 to 1960, however, there was actually a net increase in forests, with harvests in the upper parts of the watershed more than offset by the abandonment of farmland. Since 1960, the trend has been down once again, this time spurred by the spread of urban and suburban development.

In reviewing the materials for this Round Table, it was notable that the list of negative impacts from forest fragmentation includes health and diversity; changes in streams, their health and water quality; habitat for interior-dwelling wildlife; recreation access and use; and community livability, economic diversity, and quality of life. Also listed was the viability of the forest as an economic unit. It must be understood that for many urban dwellers, the latter seems in direct conflict with all the other concerns. It is as though a city official were to give all the reasons for historic preservation of neighborhoods—diversity, character, beauty, a sense of place, etc.—and then say it also will make it more efficient to tear down the neighborhood when urban renewal is deemed necessary. Foresters must deal with this perception of the value of the forest and the evils of harvesting; many folks' only sense of cutting the trees is a clearcut they may have driven by years ago. There is a major education challenge here; much of the urban East is hard-pressed to understand why it is necessary to cut down any trees this side of the Mississippi River.

Finally, we need to think through what is most worth saving. Is it the smaller remaining forested areas near the tidal waters, which are under pressure for suburban development? Or is it the large tracts further up the rivers, which are being split up and inhabited (either full-time or on weekends) by ex-urbanites who pretty much leave the forest alone? These may be two quite separate phenomena and may call for different responses and public policies. Should we take on both at once or focus our efforts?

Bill Matuszeski is Director of the US EPA Chesapeake Bay Program Office.

I. Ecological Impacts

If Abstract is not available, please see summary statement given at Round Table Session I.

Forest Ecology Impacts of Forest Fragmentation

Grace S. Brush

My discussion will center on the changing composition of forests over time based on paleoecological and historical data. Paleoecological records of pollen and seeds preserved in sediment deposited in tributaries throughout the Chesapeake region indicate that all of the watershed was forested since the time the glaciers began to move northward, about 10,000 to 12,000 years ago. However, while species composition differed as climate changed, the spatial mosaic of forest types did not change. This mosaic is controlled today by hydrology, elevation, and latitude. Changes in temperature related to climate change would have occurred within the context of elevation and latitude, and changes in precipitation would be related to geologic substrate that controls hydrology.

Massive deforestation following European settlement resulted in a shift in species composition from primarily arboreal to herbaceous. Forests became increasingly fragmented, particularly as agriculture changed from small farms to much larger-scale operations. The mosaic documented by forest species distributions was no longer visible on the landscape. However, Shreve, reporting on late 19th-century distributions of vegetation, showed that even though the forests were fragmented, occurrences of forest species differed according to soil type. The distributions Shreve reported are similar to distributions mapped by Brush et al. (1980) in the mid- to late 1970s.

Deforestation was accompanied by soil erosion and increased sedimentation within the tributaries. The paleoecological records indicate that as fragmentation increased, nitrogen influxes into the estuary also increased, suggesting that one effect of fragmentation is the transfer of nitrogen from the terrestrial into the aquatic system.

One aspect of fragmentation that needs to be investigated is the effect of deforestation and fertilization on forest succession on the different landscape mosaics. It would be possible to do this by inventorying forest species in different stages of succession on similar mosaics.

Dr. Grace S. Brush is with the Department of Geography and Environmental Engineering at Johns Hopkins University.

Cumulative Effects Forest Fragmentation Analysis on the Monongahela National Forest, West Virginia

Dr. Tom DeMeo

Since 1994, forest fragmentation analysis has been used routinely on environmental assessments on the Monongahela National Forest. Our techniques continue to evolve. FRAGSTATS, a fragmentation analysis program, is used on Landsat imagery. Satellite images are prepared for analysis by conversion of false color composites to open versus forested images. Proposed management actions, such as logging units and roads, can be added to images and their effects on landscape metrics assessed. We find landscape metrics vary in their sensitivity to disturbance, with edge density showing the most increase with logging, core area undergoing slight decreases, and fractal dimension (convolution of edges) rather resistant to change. Recently, we have begun analyzing the cumulative effects of multiple activities on an area's landscape metrics. We are developing analyses of how fragmentation affects forest songbird abundance and viability, an important forest-planning issue throughout the Eastern U.S. Much remains to be elucidated in our understanding of forest fragmentation effects on landscape metrics at multiple scales, and in the associated implications for resource management.

Dr. Tom DeMeo is Forest Ecologist, USDA Forest Service, Monongahela National Forest.

Relating Pattern and Process in Fragmented Landscapes

Robert H. Gardner

Landscape connectivity refers to the functional relationship among habitat patches, owing to the spatial contagion of habitat and the movement responses of organisms to landscape structure. Heterogeneous landscapes provide a particular challenge for modeling population-level responses to habitat fragmentation, because individuals may be utilizing multiple habitats to varying degrees across the landscape. We have published a series of papers that use neutral models of landscape pattern to understand how species' habitat affinities interact with landscape structure (i.e., habitat abundance, distribution, and quality as measured by carrying capacity) to affect the redistribution of individuals. Results show that landscape connectivity is a threshold phenomenon, in which even small losses of habitat near the critical threshold are likely to disconnect the landscape, having serious consequences for population distributions. Simulations of animal dispersal in simple and complex landscapes indicate that the dispersal between patches is rarely symmetrical. Thus, assessment of changes in landscape structure can be expected to vary from location to location and to differ widely between species with different dispersal characteristics.

Dr. Robert H. Gardner is with the University of Maryland Center for Environmental Science, Appalachian Laboratory.

Some Ecological Perspectives on Forest Fragmentation

J. Christopher Haney

Abstract. Forest fragmentation can be considered one of four major types of forest structural conversion, the others being reduction in total forest area, modified age distributions, and altered species composition. Fragmentation has had particularly profound effects on forests in the Mid-Atlantic and Chesapeake region. Indeed, edge effects on forest birds were first discovered and documented primarily in this part of North America. Ecological effects from fragmentation include both direct impacts (biogeographical barriers to plant and animal dispersal) and indirect impacts (declines in forest regenerative capacity from overbrowsing by deer). Current research at the Wilderness Society focuses on how to evaluate forest alternatives at smaller scales within a context that includes larger landscape patterns. Other important research opportunities and needs include: (1) examination of cumulative impacts from fragmentation; and (2) understanding how the four major categories of forest conversion interact with each other. From a technical standpoint alone, forest fragmentation may be the easiest of the four conversion categories to correct via restorative methods.

J. Christopher Haney, Ph.D. is with the Ecology and Economics Research Department of The Wilderness Society.

Studies in Forest Fragmentation

Louis Iverson and Anantha Prasad

We have been assessing forest fragmentation for several years using a variety of spatial scales and locations. I will briefly review four such applications.

1. **Analysis of forest parcel distributions in Ohio.** We have run FRAGSTATS on TM-classified forest and nonforest for 1985 and 1994. Data are reported and mapped for each 10 x 10 km block across the state. These metrics reveal information about the status and trends of the forests in Ohio.

2. **Use of land cover pattern information to help predict plant biodiversity patterns in Illinois.** Landscape variables, including those on pattern, allow us to better understand what variables are most related to native plant diversity, and thus allow us to predict potential biodiversity in those regions that are poorly surveyed.

3. **Relating landscape structure to bird species richness in Illinois.** Breeding bird atlas data were used in conjunction with land-use data to identify the importance of forest and urban patches for bird diversity.

4. **Use of forest density to help predict potential future tree species distributions following climate change.** Migration is expected to be severely retarded in locations of high fragmentation. We used Advanced Very High Resolution Radiometer (AVHRR) estimates of forest density, for 3 x 3 km cells in the Eastern U.S., to help model possible future distributions for, e.g., *Pinus virginiana*.

We have found that size, shape, and distribution of forest patches are frequently important ecological factors for a variety of organisms and processes, though much work remains to understand the mechanisms and underlying principles.

Dr. Louis Iverson is with the USDA Forest Service, Northeastern Forest Experiment Station Forest Sciences Laboratory in Delaware, OH.

Forest Fragmentation and the Ecological Functions of Forest Edges

Steward T.A. Pickett, M.L. Cadenasso, and K.C. Weathers

Fragmentation of forested landscapes, either through forest clearing or old-field succession, creates edges. The trend toward increasing fragmentation makes edges increasingly important in landscapes. Although the physical and biotic structure of edges is known to differ from both forest interiors and the exterior, little is known about the ecological function of edges. We use a conceptual model to indicate the net effects of forest edges on various organismal and biogeochemical fluxes, to organize the mechanisms and feedbacks that may control those fluxes, and to suggest interactions between the population and ecosystem approaches to forest ecology. We have found the gradients of physical environmental features to vary differently from one another, and to change most rapidly outside the zone often described as the anchor point for edge studies. A novel experimental approach has shown seed flux, herbivory by different species, and below-canopy nutrient flux to be determined by edge structure. These results indicate that simple rules of thumb for calculating edge depth may be misleading. Furthermore, manipulating the structure of edges should be investigated as a forest-management tool. Finally, the changing pattern of urbanization, including suburban spread and the establishment of exurbs, may change the role of edges at various locations in landscapes.

Dr. Steward T.A. Pickett is Project Director of the Institute of Ecosystem Studies, Millbrook, NY.

Forest Fragmentation and Wildlife Conservation

Charles R. Smith

Research studies of the effects of forest fragmentation on wildlife in the Northeastern United States have continued to focus upon birds, with little or no attention paid to other vertebrate groups, and even less attention paid to invertebrates, even conspicuous invertebrates like butterflies. Consequently, we are left with a rather incomplete picture of how wildlife other than birds responds to forest fragmentation. Even with birds, changes in patterns of species richness, relative abundance, and density, sometimes attributed to forest fragmentation, also may be explained by other processes, such as gap-phase succession within forested sites, or changes in forest plant species and structure resulting from herbivore pressures (Litwin and Smith 1992). Earlier studies of birds in fragmented forests concentrated upon species-area relationships, generally reaffirming the relationships of area to species richness originally proposed by Leopold (1936) and subsequently formalized by MacArthur and Wilson (1967). Also, most northeastern states, including New York, the New England states, and Pennsylvania, have shown a pattern of afforestation, with an expected consolidation of forest fragments and an increased proportion of the landscape covered by forests approaching 80 or more years of age, in some cases (DeGraaf 1996; Smith forthcoming; Smith and Gregory forthcoming). At the same time, it is clear that abundant and widespread herbivores, like white-tailed deer, can affect forest structure and species composition dramatically, subsequently affecting the breeding productivity of some forest songbirds (DeCalesta 1994). Both of these patterns raise important questions regarding priorities for conservation of migratory birds in the Northeastern United States (Smith et al. 1993).

As our awareness and understanding of forest fragmentation effects has grown, it has become obvious that the suite of mechanisms and processes implied by the phrase "forest fragmentation" is complex, and that the responses of individual species or groups of species to forest fragmentation may be highly variable (Rappole 1996). It is clear to me and others that achieving an understanding of forest fragmentation effects sufficient to guide conservation efforts will have to be undertaken at landscape and regional scales of resolution (Donovan et al. 1997). More sophisticated analytical tools, including GIS and related spatial statistics that only have become widely available within the last decade, will have to be used and new conceptual paradigms considered (Bissonette 1997; Pickett et al. 1997; Turner and Gardner 1991). One example of such analytical tools is the computer package "FRAGSTATS: Spatial Pattern Analysis Program for Quantifying Landscape Structure," distributed by the USDA Forest Service in 1995. Investigators also will have to engage in more coordinated studies at larger landscape and regional scales of resolution, using similar methods and approaches and accounting for the landscape context as well as for the land-use histories of their study sites. For breeding birds, carefully coordinated regional studies using similar methods, involving professional biologists in the collection of reliable information about species richness, relative abundances, relative densities, nesting productivity, nest predation, and brood parasitism, need to be seriously considered. Significant, meaningful insights useful to conservation will result only from coordinated efforts, conducted at landscape and regional scales using common methods, and controlling or accounting for effects of confounding variables such as gap-phase succession, structural variability of vegetation, and landscape contextual and historical differences among study sites.

At this time, large, spatially referenced, digital GIS databases are being assembled for more than 40 states under the National Gap Analysis Program (GAP) of the Biological Resources Division of the U.S. Geological Survey (DeGloria and Smith 1995). Most northeastern states, from Virginia and West Virginia, east and north to Maine, will have completed their GAP databases within the next two years, and possibly sooner. State gap analysis databases will include information about landscape patterns and species occurrences that will be helpful in establishing a regional context for addressing forest fragmentation issues. Boundaries for ecoregions and their subunits will follow nationally established standards (e.g., Keys and Carpenter 1995), building upon the work of the ECOMAP (ecological classification and mapping) initiative of the Forest Service. In addition, vegetative communities, including forested communities, will be characterized according to recently established guidelines for defining plant community associations (Federal Geographic Data Committee 1996), which became official policy for federal agencies in October 1997. Application of both of these standardized systems for naming and defining landscape features, in the context of the GAP, should lead to a reduction in the ambiguities of defining regional units and characterizing forest fragments within those larger units, thereby reducing some of the confusion over what constitutes a forest fragment and how it is characterized or classified vegetatively. In addition, GAP data will help to clarify issues of species content and landscape context with respect to forest fragments (Smith 1991), thereby setting the stage for more coordinated, standardized inquiries at landscape and regional scales of spatial resolution. Currently, we have studies of this kind underway in the Hudson River Valley of southeastern New York.

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Dr. Charles Smith is a Professor in the Cornell University Department of Natural Resources.

FHM Report on Forest Health in the MAIA Region

Ken Stolte

The Forest Health Monitoring (FHM) program is a national, interagency program led by the USDA Forest Service. The purpose of the FHM program is to determine the status, changes, and trends in indicators of forest condition on an annual basis. Currently, the FHM program is in 23 states. The program uses data from ground plots and surveys, aerial surveys, and other biotic and abiotic data sources to address forest health issues that are relevant to the sustainability of forest ecosystems.

The FHM-MAIA report on the state of the forests in the MAIA region is based on the ecological, socioeconomic, and institutional criteria and indicators elucidated in the Santiago Declaration (Anonymous, 1995). The ecological criteria are diversity, productivity, vitality, soil conservation, water conservation, and carbon cycling. The FHM-MAIA report will consist of a literature review, analysis, and reporting on the condition of the forests, determination of past changes and trends, estimates of future condition, identification of data and information gaps, and evaluation of the interaction of the forest ecosystem, particularly soil erosion and toxicity, with aquatic ecosystems in the MAIA region. Analysis of each forest issue may be stratified by forest type, ecoregion, and in some cases, by species, depending on the issue.

For each forest issue, we will attempt to provide the following information:

1. What is the theme and associated assessment questions about, and why are they relevant to, the MAIA region?
2. What is the current status and extent of the issue by species, forest type, and/or ecoregion in the MAIA region? In what proportion of the region does each issue have relevance?
3. What are the historical (recent to past two decades or longer) changes and trends? Are any components or processes degrading or improving? If so, where is this occurring and what proportion of the region is affected?
4. What are the reasons for change (degradation or improvement)? Are there any correlations with abiotic or biotic factors?
5. What components or processes are at risk now or in the future?
6. What is the impact to the people to the people living in or depending on the MAIA region? How can the issue be resolved? Can anything be done about it?

Dr. Kenneth Stolte is with the USDA Forest Service, Southern Research Station, Research Triangle Park, NC.

Assessment of Forest Fragmentation Using Remote Sensing

Dr. James Vogelmann

Spatial patterns and rates of forest fragmentation can be assessed at regional scales using digital remote-sensing data and GIS technology. Current conditions can be assessed using data from a number of available sensors that acquire data at reasonably high levels of spatial resolution, such as the Landsat Thematic Mapper and Systeme Pour l'Observation de la Terre (SPOT) data. Rates of fragmentation that have occurred over the last 26 years can be estimated using Landsat Multispectral Scanner data in conjunction with data from these current sensors.

In an investigation using multispectral scanner data in New England, an index using forest area-to-perimeter ratios, calculated separately for each of 157 townships, was used to estimate regional levels and patterns of forest fragmentation. High forest perimeter-to-area values imply high levels of forest clearing and dissection (i.e., high levels of fragmentation), whereas low forest area-to-perimeter values imply low levels of fragmentation. In the New England study, it was determined that townships with high population densities were characterized by having high forest area-to-perimeter ratio (i.e., fragmentation) values. While this generality was anticipated, the degree of correlation was much higher than expected. It is likely that similar patterns characterize much of the Eastern United States, including the Chesapeake Bay watershed. However, it should be emphasized that the strong relationship between population and forest fragmentation might not be valid for other parts of the country, such as the Pacific Northwest, which are under very different forestry and development regimes. It was also concluded from the New England study that rates of forest fragmentation can be adequately estimated using multitemporal multispectral scanner data, even though the data are spatially and radiometrically more coarse than current systems. It is expected that improved results will be obtainable using Landsat Thematic Mapper data or SPOT data, although it should be noted that such information, for all practical purposes, is only available since 1984.

Currently, as part of the Multiresolution Land Characteristics (MRLC) consortium activities, the U.S. Geological Survey, in cooperation with the EPA, is developing a general land cover data set for the conterminous United States using 1991–1993 Landsat Thematic Mapper data as the principle data source. A land cover data set developed during the course of this project, covering the Chesapeake Bay watershed region, is currently available to interested individuals. With some effort, general patterns of forest fragmentation from the early 1990s could be derived for the region using this data set. Determination of rates and trends of forest fragmentation, while very feasible, will require additional classification efforts and analyses using additional multitemporal data sets. Such information would be of much use to local and regional planning groups.

Dr. James E. Vogelmann is with the U.S. Geological Survey, EROS (Earth Resources Observation Systems) Data Center.

Transitions in Forest Fragmentation: Implications for Restoration Opportunities at Regional Scales

J.D. Wickham, K.B. Jones, K.H. Ritters, T.G. Wade, and R.V. O'Neill

Where the potential natural vegetation is continuous forest, a region can be divided into smaller units (e.g., counties, watersheds), and a graph of the proportion of forest in the largest patch versus the proportion in anthropogenic cover can be used as an index of forest fragmentation. If forests were not fragmented beyond that which was converted to anthropogenic cover, there would be only one forest patch in a unit and its proportional size would equal one minus the percentage of anthropogenic cover. For a set of 125 watersheds in the mid-Atlantic region, we modeled the relationship between the percentage in the largest forest patch and that portion in anthropogenic cover. We found a significant transition in forest fragmentation between 15 and 20 percent by graphing the first derivative of the model as a function of the proportion of anthropogenic cover. These results agree with other fragmentation studies in the Eastern United States. The potential for mitigating fragmentation by connecting two or more disjunct forest patches was low when the proportion of anthropogenic cover was low, highest at moderate proportions of anthropogenic cover, and low again as the proportion of anthropogenic cover increased toward 100 percent.

Dr. James D. Wickham is with the Tennessee Valley Authority.

Forest Patch Research Projects

Dr. Wayne Zipperer

Research Goals:

1. Assess the effects of social patterns and processes on ecological patterns and processes within urban and urbanizing landscapes; and
2. Evaluate the effects of neighboring land-use conversions by urbanization on the natural resource management of public lands.

Overview:

My research focuses on structural and functional changes in forest patches along gradients of urbanization within the Baltimore metropolitan region and along the Colorado Front Range. The Baltimore studies are components of the Baltimore Urban Long-Term Ecological Research Program, located at the University of Maryland, Baltimore County. Forest patch research includes: (1) a spatial and temporal analysis of configuration and type by social context within an urban watershed; (2) a floristic inventory by configuration, type, and social context; (3) an analysis of ecological functions (productivity, regeneration, nutrient cycling) by configuration, type, and social context; and(4) a long-term monitoring of structure, productivity, regeneration, and nutrient cycling. The Colorado Front Range study is a collaborative effort with the Colorado Regional Resource Coalition and the Arapaho/Roosevelt and Pike/San Isabel National Forests. The research has two elements: (1) evaluating the change in the frequencies and patterns of human and lightning fire starts over the past 20 years; and 2) (developing an Urban-Fire Decision Support Model.

Dr. Wayne C. Zipperer is Research Forester, USDA Forest Service Northeastern Experiment Station, Syracuse, NY.

II. Economic Impacts

If Abstract is not available, please see summary statement given at Round Table Session II.

How Conservation Easements Address Forest Values

Steven Bick, Harry L. Haney Jr., and Cynthia D. West

Conservation easements have the power to enhance, extinguish, or modify forest values. A study of conservation easements held by private land trusts reveals several approaches to the timber and amenity benefits coming from the forest. The components of conservation easement deeds work in unison to prevent, restrict, encourage, or guarantee certain uses of the forest and associated management practices. A sample of deeds to conservation easements from around the country shows the variations in values resulting from shared interests in the land. Restrictions address activities that are disagreeable in principal, while reserved rights focus on the needs of the landowner to ensure reasonable uses of the property. Affirmative rights may introduce new uses and encourage sharing of amenity values. Terms and conditions delineate the framework in which the agreement operates. The perpetual nature of most conservation easements dictates the need for careful design to promote and protect forest values.

Harry L. Haney Jr., Ph.D., is Garland Gray Professor and Extension Specialist, Department of Forestry, Virginia Polytechnic Institute and State University.

Results of Valuing Michigan Hardwoods Using FIA Data

Carol A. Hyldahl, Harry L. Haney Jr., and J. Michael Vasievich

The primary objective of this study is to develop financial return estimates by ownership that account for timber price changes, quality changes, actual growth, and in-growth. Timber return proxies were created using Hanks' equations and lumber price data. The Hardwood Lumber Reports provided the lumber price data, and the USDA Forest Service survey data provided the volume, tree grade, and log grade data. Hardwood species, including hard maple, soft maple, red oak, white oak, birch, basswood, yellow poplar, and cherry, were analyzed for selected counties in Michigan. Financial return estimates were compared with other regions in the United States and other financial assets.

Harry L. Haney Jr., Ph.D., is Garland Gray Professor and Extension Specialist, Department of Forestry, Virginia Polytechnic Institute and State University.

The Impact of Federal-State Death Taxes on Forest Management Following the 1997 Taxpayer Relief Act

Dan Peters, Harry L. Haney Jr., John Greene, and Debra Callihan

The federal and state governments continually change and update their death tax laws. Forestland owners must not only keep abreast of the laws, but also must be familiar with estate-planning techniques that allow them to achieve their management objectives while reducing their death tax burden. Careful planning minimizes disruptions in forest management continuity and liquidations to pay taxes. Various planning techniques are reviewed and illustrated for a hypothetical forested estate on which the death taxes are calculated for the federal estate and combined with a state having an estate, inheritance, and piggy-back system. Basic estate planning makes use of the unified transfer credit, marital deduction, and equalization of the estate's value between spouses. The basic planning results are compared and contrasted with more sophisticated planning techniques, including gifting programs coupled with minority discounts, special use valuation, installment payments, and conservation easement donations. Provisions enacted under the 1997 Taxpayer Relief Act include the family-owned business exclusion and the new qualified conservation easement. Estates that adopted basic planning techniques experienced substantial reduction in the present value of their death tax burden. When the special provisions applicable to forestry were incorporated, further significant reductions in the death tax burden were made in present value terms. For estates that failed to qualify for special forestry or family-owned business exclusions, a conservation easement donation plus gifting provided alternative tax relief. The trade-offs between efficiency from total managerial control are contrasted with tax savings made possible by having the decedent divest and diffuse his (her) control of the estate's assets.

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Harry L. Haney Jr., Ph.D., is Garland Gray Professor and Extension Specialist, Department of Forestry, Virginia Polytechnic Institute and State University.

Managing Forest Fragmentation: Integrating Landscape Ecology and Economics

Peter J. Parks and Richard G. Lathrop Jr.

Problem Statement

Land development is threatening the environmental and resource benefits provided by New Jersey's forested habitats. We propose to integrate models from ecological and economic disciplines to help explain how forest land-use decisions are made within different economic, physical, and regulatory contexts, and to quantify the impact of these decisions on forest fragmentation. The proposed analytical framework integrates landscape ecology with economic policy analysis, within the spatial analytical framework of a subwatershed-scale GIS. This integrated representation of forest habitats allows changes in economic or environmental conditions to be translated into fragmentation effects. The proposed research is designed to permit quantification of the potential fragmentation impacts of alternative policies and economic conditions.

Justification

Forest habitats, particularly those in developed and developing regions, are under siege. Population and development continue to increase, and forest habitats are fragmented into smaller, noncontiguous environments. These smaller habitats often cannot support the same rich array of benefits provided by the original forests. For example, recreation opportunities, timber production, habitat for biologically diverse plant and animal communities, and water quality maintenance are all diminished when large forests become fragmented. Understanding the economic processes leading to fragmentation, and managing these processes through policies, is essential if forest benefits are to be sustained in developing regions.

Peter J. Parks is Professor, Department of Agricultural Economics and Marketing, Cook College, Rutgers University.

Remarks

Dr. Alexander Pfaff

Introduction

My work on land use has focused on deforestation in the Brazilian Amazon, although I have also done (or am starting to do) work on deforestation research in other areas of Brazil and in New England and Costa Rica.

I should emphasize that while my land-use work has focused on forests, it has focused more on the amount than on the spatial pattern of forest area. As a result of this work, I have become interested in forest fragmentation, and am starting to work on fragmentation itself. However, I am curious about the focus on fragmentation here. As it is distinct from a general concern with land uses that citizens care about, I am eager to hear why this group's interests are more narrowly focused. Perhaps we are to consider whether that should be the case.

Brazilian Amazon Work

Much of my land-use analysis has been focused on the Brazilian Amazon. I wanted to address the question of what factors had the most influence on land use and deforestation. My goal was to empirically compare stories about the drivers of land-use changes. In particular, I wanted to address the claim (found in a number of cross-country analyses) that population was the main, dominant driver. Also, if possible, I wanted to see which of the number of government policies that people mention appeared to have the greatest effect on clearing.

The empirical work was at the county level, using 1978 and 1988 forest data. The approach was regressions of "what percent of the original forest in a county had been cleared" on "factors expected to change returns of the land." All variables were at the county level, e.g., county population density or road density (using over 300 counties for a given point in time).

Roads mattered quite a bit in the regressions. Subsidized development projects mattered as well, particularly in the earlier time period. The subsidized credit variable was not significant (but it is a rather weak variable). Also, soil quality and vegetation cover mattered, as expected.

Regarding population, I found that, like others, if I used solely population in a regression to try to explain deforestation, I found a significant positive correlation between the two. However, if the regression also included the other economic factors motivated by my model, the population variable did not matter. While I do think that population has an effect (e.g., an airlift of the population of Brazil into the Amazon would lead to demand for food and shelter, and thus to clearing), this suggested that surely population was not the only or even the dominant driver.

However, there are large cities in the Amazon, and the millionth person in a city might have less impact than the first in an empty county. Including population nonlinearly, I found exactly that story. That result is of interest for this round table given its spatial significance; it suggests that the concentration of a given amount of population affects the total land-use impact.

Extensions of That Work, including Fragmentation Work

With co-authors, I am now starting to redo this analysis of the Brazilian Amazon. We aim to take into account, in a model and in the empirical work, that land-use choices are most likely dynamic choices, and that there is a dynamic process of land use on the expanding frontier. The overall aim, of course, is to provide an improved model that links important factors to land-use choices and outcomes. An improved model better informs policymakers regarding both the land-use consequences of any number of policies (including some normally made without any thought about land use) and which policy levers might be most effective in achieving land-use goals.

I am also hoping to redo this type of deforestation analysis for the Amazon (and/or for elsewhere) using a GIS to make use of the great spatial detail available in the satellite land-use images (which above I used in aggregated form). Here, one tries to explain land use at all of a "set of points" within a county. Here, one could know, for instance, that a road is close to one point but quite far from other points within any given county.

While still working on how to do this for the Amazon, I am now starting such GIS work in Costa Rica. Again, the idea is to develop a model that informs empirical analysis in order to inform policymakers regarding land-use consequences of policies and land-use policy levers. This particular project includes biologists focused on carbon sequestration by forests, in light of the idea that limiting carbon emissions may lead to a market for sequestration credits.

Here, too, the potential importance of spatial patterns of forest and forest fragmentation is clear. For instance, if one service from forests that we care about is carbon sequestration, then we might be interested in forest fragmentation per se, i.e., not only in the total amount of forest standing but also in the spatial pattern of that standing forest. This is because the details of forest pattern may affect, for instance, water cycling and forest growth. Further, imagine that two areas of forest are roughly equal in terms of the carbon sequestration they provide, and that in considering where to conserve forests a policymaker wonders about the species habitat that each area provides. This, too, is almost surely a function of forest pattern or fragmentation, per se.

More generally, we should consider exactly why we care about the standing forests, and then ask whether the services in question are a function of forest pattern as well as of forest area. That is true whether the forest in question is in tropical regions or in the Eastern United States.

In terms of empirical analysis, given the spatial precision of the GIS data, patterns could be examined directly. That is, in Brazil, Costa Rica, New England, or anywhere else, spatially precise data permit measurement of fragmentation, and thus also further empirical work.

However, it should be noted that the economic model that explains fragmentation per se may need to be more sophisticated than that explaining deforestation. In particular, it may be important to consider how land-use choices are affected by neighboring land uses, as such effects may be necessary to explain the "clumping" of particular land uses that may drive fragmentation.

Domestic Spatial Forest Patterns

Along these lines (of concentrating on spatial patterns), after observing that spatial concentration of population and urbanization could be important for land use in the Brazilian Amazon, I thought that I might learn from examining historical reforestation in New England. Here, due to sparse historical data, to these points my analysis has been more suggestive.

Here, I have looked at all of the counties in New England, using data from 1790 to 1930 for population, and data from 1850 to 1930 for some rudimentary information about agricultural land use. The first and major conclusion is that population is not the sole or even the dominant land-use driver, as the region reforested significantly while population densities were rising.

The importance of what might be called economic factors, i.e., factors affecting the economic returns to different land uses, is clear. For instance, the turning point in the concentration of population within New England (as diffuse agriculture is replaced by more concentrated manufacturing and urbanization) is very clearly 1830, when the transportation revolution really kicked in. Note that the important economic factors need not be "local"; transportation shocks and the productivity of agriculture in the Midwest were crucial.

The New England experience suggests the importance of increasing concentration of people and production (manufacturing at that point in time). As suggested above regarding a model of fragmentation per se, it may be important that economic activities (such as migration or industrial production) may attract more of the same, i.e., that neighboring activities affect choices.

Finally, note that the New England region's forest stock first dropped and then rose over time as the region became wealthier. Thus, it is possible that the study of the mechanisms behind these shifts in forest area (and pattern) could lead to claims about general mechanisms underlying what has been called an "Environmental (or Resource) Kuznets Curve" (EKC), i.e., that environmental quality might first decrease and then increase as income rises. However, the New England experience does not support claims of universal EKC mechanisms. The reason is that not all regions could follow this pattern, as the return of the region's forest depended on the fact that New England "exported" its clearing for agriculture and timber to the Midwest.

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Dr. Alexander Pfaff is Professor, Department of Economics, Columbia University.

Alternative Approaches to Biodiversity Conservation: A Cost and Policy Assessment

Resources for the Future and The Nature Conservancy

R. David Simpson

Background

In 1994, the Florida Game and Freshwater Fish Commission (FGFFC) published a report entitled "Closing the Gaps in Florida's Wildlife Habitat Conservation System." This pioneering study provides a scientifically based assessment of the amount and distribution of land that must be maintained in current land uses to provide minimum conservation goals for Florida's declining wildlife species and rare plant and animal communities. As such, it provides a first approximation of how much land—both public and private—is enough to achieve the purposes of the Endangered Species Act in that state.

Resources for the Future (RFF) and the Nature Conservancy (TNC) are undertaking (1) an economic assessment of the overall costs of the private land component of the statewide wildlife habitat conservation system proposed in the FGFFC report; and (2) a comparison of the relative merits of a variety of financial incentives that might be employed to support this system. The proposed work is intended to fill the gap in our understanding of the role incentives might play in the conservation of endangered species and overall biodiversity on private lands.

To understand the appropriate role of incentives, and to choose appropriate incentives for the conservation of biodiversity on private lands, the following issues (among others) must be understood:

- Of the privately owned land, what are the current economic uses of this land, presuming that some of the current uses are compatible with the habitat goals?
- What are the options (e.g., regulation, incentives, or acquisition) and the relative economic costs to ensure the continuation of these privately owned lands in compatible uses?

The research will focus on answering these questions, with the heart of the proposed work consisting of two parallel and interrelated research projects. The first is an empirical and quantitative cost-estimation project, which will develop a model that estimates the fee-simple acquisition costs of the property rights earmarked in the Florida study. The second is also an empirical, but necessarily somewhat more qualitative, component which will evaluate the relative merits of alternative preservation policies.

Cost Estimation

The first step in this portion of the project will be to organize and participate in an internal seminar that brings together ecologists and policymakers familiar with studies such as those conducted in the FGFFC project, to clarify the methodology and identify sources of data. Researchers will then outline a coarse aggregate model of the net present cost of land conservation in Florida, and develop and estimate a model to explain the price of land identified as essential habitat in the FGFFC study. Other steps will include:

- determining the extent to which land preserved as habitat may require continued human intervention, in the form of operation and maintenance, to preserve habitat;
- generating scenarios of future land development in Florida, and estimating the pressure for land conversion and the cost of land acquisition; and
- conducting a brief examination of the external benefits of habitat preservation (such as water supply protection, flood control benefits, nonuse values, and other joint products of land preservation) and developing quantitative estimates of the benefits as warranted.

Analysis of Alternative Policies

The policies subcomponent of the project will be a qualitative cost-effectiveness and institutional analysis of alternative conservation strategies. The set of policies to be considered may include, among others, tradable development rights, outright and time-phased purchase, zoning and restrictive covenants, and tax incentives.

This part of the research will involve evaluating the degree of certainty in habitat protection provided by each of the alternatives, developing a taxonomy of the costs associated with the practical implementation of the alternatives (including transaction costs, monitoring, and enforcement costs) and assembling whatever anecdotal or other data are available relating to acquisition costs other than fee-simple ownership. Based on both the cost-effectiveness study of alternative policies and the cost estimation of fee-simple acquisition, the research will provide a ranking of policy options and will address the generalization ability of the policy analysis to other geographic regions, political and legal jurisdictions, and ecological conditions.

Implications

Although this pioneering study may not prove to be the final blueprint for the state's habitat conservation efforts, it is, nonetheless, the first scientifically plausible effort to determine how much land—both public and private—is enough to maintain biodiversity overall for a significantly large region. As such, it provides a basis for articulating the costs of a full solution to the habitat portion of the endangered species problem, and a baseline against which to assess the relative costs and efficacy of various approaches.

Dr. David Simpson is with Resources for the Future.

III. Policy and Law Impacts

If Abstract is not available, please see summary statement given at Round Table Session III.

Forest Fragmentation and Landowner Succession Decisions: Why We Should Understand the Linkages

Dr. Dave Cleaves

Forest fragmentation is the collective result of thousands of landowner decisions. Tenure, harvest, and reforestation decisions are often closely intertwined as existing and new owners struggle with questions about whether and how to care for their forest properties in the face of inevitable life patterns and other changes.

In Southern forests, more than 30 percent of the forestland is owned by individuals 65 years of age or older, where the expected deaths per year range from 200 to 900 per 1,000 in the population. Older owners have proportionately larger ownerships and a larger share of the total forestland, and are more vulnerable to parcelization pressures. Based on actuarial data and forest landowner surveys, more than one-third of the forest ownership acreage will be affected by the death of the owner in the next 10 years. Some portion of this acreage will be broken into smaller parcels as a result of market pressures for development, needs for cash by survivors, and shifts in ownerships objectives.

To better understand the fragmentation problem, we must know more about the landowner decisions that drive it. These decisions are influenced by multiple factors and uncertainties, including asset position, family relations, attitudes and beliefs, and the health of the owners. Often these and other factors combine to influence owners to parcelize or divest themselves of forestland. We need to develop a more detailed model of landowner decision processes, revolving around the issues of succession.

Forester advisors need to develop a more complete understanding of these decision factors and dynamics so that they can better advise landowners about their options. Advisors need to develop clear messages about the range of options available to forest owners for ensuring continuous management and avoiding parcelization. Planners need to more fully incorporate demographic influences in their projections of fragmentation patterns. Policymakers should consider tax structures (income, property, and death taxes) that remove some of the barriers to continuous ownership and management across generations.

Dr. Dave Cleaves is Decision Science Specialist, USDA Forest Service, Ecosystem Management Coordination.

For Too Many Nonindustrial Private Forests, Sustainable Forestry Is Neither, from *American Woodlands*, April 1997

Keith A. Argow

Growing public awareness that America's forests might be sustainable after all holds promise and hope. It is an appealing vision of good stewardship on all the intermingled corporate, government, and individual ownerships that combine to create a forest landscape.

Well-intentioned but outdated government policies make sustainable forestry on nonindustrial private forests (NIPF) woodlands more a myth than a vision.

Sustainable forestry is possible on forest industry lands. It should be if stockholder objectives are to be realized. At the head of the class is the Sustainable Forestry Initiative (SFI), which is setting the course for companies that belong to the American Forest and Paper Association (AF&PA). The CEOs of these corporations have reportedly put their best efforts on the line and are backing the SFI objectives with deeds. Acceptance and compliance with SFI standards is a requirement of AF&PA membership. You comply or you get out. It doesn't get any plainer than that.

Public land managers have different motives to practice sustainable forestry. The adoption of Ecosystem Management and the Pacific Northwest forest plan are examples that the public is willing to forgo the financial rewards of managing for timber in favor of greater emphasis on preservation, recreation, and other uses.

True, more stakeholders are involved in public land policy, and the concept of sustainability at times takes on connotations of biodiversity and social justice. These ideas may have merit, but they can be bewildering to public foresters assigned to put them into practice in the woods.

Where does this leave the nonindustrial private landowners who own 58 percent of the timberlands and produce half of America's wood supply? Bewildered, hurt, and increasingly angry. Well-intentioned but outdated government policies make sustainable forestry on NIPF woodlands more a myth than a vision.

Government can't get thins right if the American people can't get their demands straight. We elected three Congresses in a row that ranged from liberal to conservative to ...well, as yet it is too early to describe the 105th Congress.

If we are to make the nonindustrial private forestry sector (NIPF) sustainable, we must address the problems that are giving us FITS, an acronym for:

"F" is for fragmentation. As we know from the recent nationwide landowner surveys (see Forestry Service Bureau, p. FA4), the number of NIPF jumped from eight million in 1978 to 10 million in 1994. That is a gain of 2,400 a week....great for potential NWOA membership but not very encouraging if only 5 percent of this group has forest management plans, as reported.

"I" is for ignorance. In spite of all our efforts, too many people still don't understand what "sustainable forestry" means. Filling them in will require a commitment to education. Instead

of ending the Forestry Extension programs funded under RREA as proposed (see p.10), we ought to double them, as already authorized by law.

"T" is for taxes. Woodlandowners provide society with all kinds of benefits: clean water, the largest source of wood products, wildlife habitat, and natural beauty. In return, government should restore a reasonable capital gains tax that takes into account the work and long period of time needed to grow the product. Restoring forest management expense deductions and revising estate tax law could be accomplished now at relatively little cost to government while providing significant benefits for society. Reasonable property taxes must be maintained, as well.

"S" is for the myth of sustainability on NIPF lands if they must bear society's competing demands and ever-present need for more revenue.

The window of time for sustainable forestry in America is open now. The forest industry has taken the initiative, and public agencies have joined the trend. Responsible owners of small woodlands would like to come in, but unless these underlying concerns are met, true sustainable forestry for many will remain but a dream.

Keith A. Argow is with the National Woodland Owners Association and publisher of *American Woodlands.*

Selling "Big and Tall" in a City of Petites?

Lester A. DeCoster

> America's private forests have been fragmenting into smaller-sized ownerships for recent decades at rates well above those attributable to more people simply needing more space (about 1.6 times faster than population growth). Mid-size ownerships of 100 to 500 acres each have been especially susceptible to fragmentation.

By 2010, just 12 years from now, if present trends continue, 95 percent of private forest ownerships will be in parcels smaller than 100 acres. Smaller landowners will control 38 percent of all the private forestlands, six percent more than they do now, and 16 percent more than they did in 1978.

The big drivers of this trend are death, taxes, and lifestyles. Forests are being divided among multiple heirs, or subdivided and sold to pay high estate taxes as owners die. Mid-sized owners are especially motivated to sell pieces because their occasional bursts of harvest income don't fit federal tax policies for deducting regular forest maintenance expenses. Dramatic increases in annual property taxes (almost four times above inflation recently) also push land out of long-term forest use. Modern lifestyles favor living in and around forests while earning most income from urban-style, non-resource-related work. People tend to perceive forests as primarily decorations in these situations, greatly changing the acceptability of traditional forestry.

Forestry as we know it is still important for larger forests (tracts of more than 100 acres), accounting for more than 60 percent of all private forestland. But more and more of the forests, and most of the people, will be associated with petite pieces as time goes on. These will exist in a realm where forests are viewed as backdrops to pleasant living but not as something needing deliberate maintenance practices. As a matter of fact, forest maintenance, as normally presented, may be regarded as something to be avoided.

> Forest programs have been chugging along like the old Sears, before their softer side came out ignoring the art and science of public relations and marketing and offering a come-in-and-you'll-find-it-somewhere strategy. Well, the new folks aren't going to be coming in without being wooed, tickled, and amazed. We will not see them (or their land) in forestry circles until we are willing to spend communications efforts on the order of selling shoes, cars, beer, or toothpaste. Such intensive public relations efforts, unfortunately, are considered frivolous for public programs and inefficient as a wood generator for private programs, and so the top of forestry is large but static, the middle is shrinking, and the bottom is growing and dancing to a whole new tune. ... My God! I've just described Dolly Parton's older sister!

Lester A. DeCoster is APR President, The DeCoster Group, Inc. Comments are excerpted from "Public Programs for Private Forestry," by R. Neil Sampson and Lester A. DeCoster (1997). Washington, DC: American Forests Policy Center.

Factors Associated with the Adoption of Timber-Harvesting Ordinances by Local Governments in New York State

Don Floyd

Sixty-two towns in New York State have adopted timber-harvesting ordinances. Based on the literature, we identified seven factors said to be associated with adoption of timber harvest regulations. They are: population density, population growth rate, the environmental attitudes of local officials, local officials' experience with harvesting controversies, adjacency to towns with harvesting ordinances, local officials' knowledge of forest management, and the importance of the forest products industry in the local economy. Using a combination of survey research methods, geographic information systems, and published forest statistics, we found that local officials' experience with harvesting controversy had the strongest association with adoption of ordinances. Population density, population growth rate, and the environmental attitudes of local officials were not associated with adoption of local ordinances.

Dr. Donald W. Floyd is Professor, Faculty of Forestry, State University of New York College of Environmental Science and Forestry.

Forest "Peopleization"— Foresters Take on the Invisible 800-lb. Gorilla

Sharon Friedman

Although this discussion focuses on the Chesapeake Bay, part of the difficulty in discussing this issue is that there are no good numbers that can be combined nationally to show what we understand to be taking place: increasing human density is directly affecting the forest. There are simply more humans, in more places, coming back more frequently, and staying longer, in forests. We foresters go to our usual numbers—the FIA—and they are not set up to detect these kinds of trends. So it seems as if this issue is like an 800-lb. gorilla: it looms over every other forestry issue, and it is invisible, in the sense that we do not have a clear measure of these trends nor their potential impacts. I would submit:

1. Our traditional paths, coalitions and behaviors are not capable of dealing with this issue. Nevertheless, it is possible and indeed desirable for our profession to begin to do business in a different way in order to deal with this, perhaps the most serious, threat to the nation's forests.
2. We in the forestry profession are small players in the overall trend toward population growth and urbanization. We have traditionally not been involved in town and regional planning, transportation policy, immigration policy, urban redevelopment, and other issues that bear directly and indirectly on this problem. To become active, we will have to acknowledge and learn to deal effectively with our profession being a small fish in a big pond. We need to learn to do this, the sooner the better.
3. There are at least four subtrends involved in the "peopleization" trend:
    a. urban development and expansion of small towns into the countryside (relatively high-density expansion);
    b. increasing rural residential living (low-density expansion), whether seasonal or year-round;
    c. division of properties into smaller ownerships, with the assumption that this has negative consequences (although that is not necessarily the case), either development or timber removals to pay estate taxes; and
    d. increasing population pressure from forest visitors (defined as not residents), and increasing conflicts among forest users.

All of these "peopleization" subtrends are related. For example, increasing development may lead to decreased recreation access for visitors. Splitting land through inheritance may lead to increasing sales for low- or high-density development, depending on the demand.

Taken all together, these trends lead to some current issues: fire protection (much more is needed, who pays?); access to forests; absentee owners, leading to questions on governance of communities (forest colonialism); environmental damage from development, recreation, and tourism; conflicts among different users of the forest, traditional subsistence and hunting rights versus views of new owners (Robin Hood versus King John); and a great many more issues.

In terms of public policy, we have to ask, "Is peopleization good for America's forests?" And also, "Is the way the trend is playing out good for all the citizens of the United States?" If not,

"Are there ways that we can mitigate effects or tweak the policy system to make things better?"

Heretofore, the battle for solitude and wildlands has been fought only in the arena of public land. With resources other than land, we have the argument that increasing population will bring in the new ideas and technology so that the positive of population growth will outweigh the negative. However, there is only so much forestland, and no amount of ingenuity can make more (unless we have the equivalent of "Star Trek" holodeck wildernesses). As pricey resorts get pricier and open land gets more rare, where can the current occupants of rural communities go? Is "resortization" the rural equivalent of urban renewal, in terms of displacing functioning communities? What are the ramifications for minority and poor people in these communities? Are there alternatives, or only mitigation of the consequences? What could be more un-American than saying "Don't come—Don't stay—We like things the way they are?"

While these questions are difficult, there are simpler government policies that may be more easily influenced. Some even lie within the realm of the forestry profession, such as the need for new ways to reach landowners and new messages for them once they've been reached. If landowners are managing their lands as if they are their backyard garden, then perhaps we need the equivalent of a Master Gardener program instead of direct technical and financial assistance. If the numbers and concerns of landowners are changing, then landowner programs must change as well. If we are targeting federal funds for nonindustrial land, what is our federal responsibility to others who currently don't own land? Perhaps federal funds are best spent by local community groups to assist their own priorities: buying their own land for community parks and forests, or whatever other priorities they might have.

Research is underway to address some of these issues from many points of view. Certainly, many are dealing with implications of farm land loss to development, and conceptually forestland is no different. Tom Harris of the University of Georgia and Dave Kittredge of the University of Massachusetts (the coiner of the term "understory of swingsets") have both done work in exploring the numbers and doing surveys of the new-style landowners. Mike Foreman of the Virginia Department of Forestry has also documented in some detail the changes in forest ownership and fragmentation (Virginia Forest Land Assessment 1997). We at CSREES are working with Steverson Moffett of North Carolina State University to develop an issue network and a list of researchers and users of information in this area. Our objective is to have a workshop in late summer 1998 to develop a list of research and information priorities on a national level to deal with this issue. The idea is ultimately to submit a proposal to Fund for Rural America (USDA CSREES) or to seek other foundation support. Please give me any names of people working with this issue, whether researchers or users of research, to add to my list.

Dr. Sharon Friedman is with the USDA CSREES-NRE.

Cross-Boundary Management as a Means to Mediate the Forest Fragmentation "Problem"

R. Bruce Hull

The fragmentation of forest ownership is well documented. The extent to which fragmented ownership produces a fragmented forest ecosystem may depend on the willingness of landowners to share and to implement management goals that reflect the ecosystem processes that cross their individual land holdings. It is obvious that ecosystem processes do not stop at most property boundaries. It is not so obvious whether forest management practices need to stop there.

A challenge confronting ecosystem-scale management on multiple, small private landholdings is the diversity of (potentially incompatible) management objectives. Many of the new forestland owners are professional or retired, and ex-urban. A smaller number are modern-day homesteaders, seeking to scratch out a low-tech, back-to-the-land, environmentally sustainable lifestyle. Studies of these new landowners suggest that they share a value system that places priority on the natural, scenic, and wildlife qualities produced by their land. These findings suggest that the new landowners may also share management goals compatible with larger ecosystem management goals that mitigate the forest fragmentation problem.

Even with shared goals, successful implementation of ecosystem management in a highly fragmented ownership pattern requires landowners to willingly practice cooperative, cross-boundary management practices. Such practices contradict the old adage that "good fences make good neighbors." In a recent survey of private forestland owners in Virginia, we asked landowners their opinions regarding 20 forest management practices we told them might promote ecologically sustainable forests (practices such as joint prescribed burning, joint timber harvest, joint forest management plans, siltation ponds, and interconnected wildlife corridors). Landowners told us that they believed these cooperative, cross-boundary practices would improve ecosystem quality. Few landowners currently employed these management practices, but most said that they would, if they had the resources (i.e., time, money, knowledge) to do so. Very few landowners were firmly set against these practices.

These findings suggest that a fragmented ownership pattern need not produce a fragmented forest. Given proper incentive, extension, and educational programs, the forest fragmentation problem might be mitigated using cooperative, cross-boundary forest management practices.

Dr. R. Bruce Hull is with the College of Forestry and Wildlife Resources, Virginia Polytechnic Institute and State University.

Tax Advantages of Conservation Easement Donations

Tim Lindstrom

There are four types of tax benefits available to easement donors and their families, all of which can be enjoyed in combination.

Income Tax Deduction: A gift of a permanent conservation easement to a qualified organization or agency constitutes a charitable contribution. The value of the easement (generally, the difference in the value of the property subject to the easement before and after the easement is put in place) may be deducted from the donor's income for purposes of calculating state and federal income tax.

Estate Tax Reduction: Property included in a decedents' estate which is subject to a permanent conservation easement will have a lower value than it would if there were no easement. This results in reduced estate taxes.

Estate Tax Exclusion: Under the provisions of the American Farm and Ranch Protection Act (section 2031 of the Internal Revenue Code), enacted in August, 1997, the executor of a decedent's estate containing land subject to a qualifying conservation easement may exclude 40 percent of the value of such land after subtracting the value of the easement.

Real Estate Tax Assessment: Under provisions of most state laws, land subject to a permanent conservation easement is entitled to a lower real estate tax assessment to reflect the restrictions of the easement. This can result in substantial local real estate taxes.

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Comments by...

Robert Pirani

Regional Plan Association's proposal for a Metropolitan Greensward is intended as a 21st-century counterpart to Frederick Law Olmstead's visionary mid-19th-century concepts for Central Park. The Greensward initiative, part of Regional Plan Association's Third Regional Plan for the New York-New Jersey-Connecticut Metropolitan Area, addresses the linked issues of suburban sprawl and urban disinvestment by creating greenbelts, restoring urban parks and natural resources, and establishing greenways.

This vision responds to many of the economic and demographic forces causing forest fragmentation in the New York area and elsewhere. Starting in the late 1960s, and accelerating through the 1980s, massive "campus"-style commercial development jumped from cities to residential suburbs. Ninety percent of new jobs between 1975 and 1992 did not locate in the core urban counties of the region. As a result, the leading edge of suburban housing development has moved further out to rural communities. In 1970, about half the population lived in the urban core. Between 1970 and 1990, the suburban and rural ring added 900,000 people while the urban core counties lost about 830,000. We have stopped adding people—the population has increased by only 13 percent in the past 30 years—but we continue to consume vast areas of open land; the amount of developed land has grown by about 60 percent in that same time period.

In places like the Catskills, the Appalachian Highlands, and the Long Island Pine Barrens, RPA's goal has been to protect the large forest patches that can help shape growth as a form of greenbelt or urban growth boundary. To do this, RPA and others are building partnership-planning efforts that match local concerns with the need to protect regionally significant resources. An important tool is transfer of development rights (TDR) programs. Based on Regional Plan Association's experience, five key factors have emerged as critical to the success of these TDR efforts:

- A lack of leadership by local elected representatives and their appointed planning boards. A related issue is a preference by local officials to negotiate development decisions on a case-by-case basis.
- A concern over increased density. Whether it is driven by environmental concerns, a perceived loss of property value, difficulty enabling front-end public investments in needed infrastructure, or a desire to limit school-age children and affordable housing, many communities do not want to consider any increase in the density of residential or commercial uses.
- A perception that the open land in the sending areas will never be developed. Often this is simply related to the perceived or real lack of development potential for these parcels.
- Excessive expectations for these programs account in large measure for their perceived failure: for example, the hope that a TDR program would not only protect a natural resource, but insure responsible town planning in the receiving areas. TDR programs are but one tool in a larger arsenal.
- Allowing developers and landowners to realize their goals through other means. If there are no penalties for not participating in the TDR program (or, conversely, no incentives for purchasing the credits), then these critical stakeholders will not either not participate and/or actively work against any proposal.

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APPENDIX B

References: Forest Fragmentation

Forest Fragmentation References

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APPENDIX C

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