Keith Weller for USDA Forest Service, North Central Research Station

Landscape Change in the Midwest

An Integrated Research and Development Program

Contemporary patterns of landownership and development are changing the landscape of urban, suburban, and rural areas, fragmenting the forest resource base and raising concerns among a range of stakeholders. A new Landscape Change Integrated Research and Development Program of the USDA Forest Service, North Central Research Station, is examining the character, causes, and effects of these changes as well as the effectiveness of strategies aimed at stemming the negative consequences of landscape change.

By Paul H. Gobster, Robert G. Haight, and Dave Shriner

Change happens. In the realm of forest landscapes, one of the great realizations of the late 20th century was that forests in the United States and elsewhere often are not the stable systems we once thought them to be, attaining a final "climax" stage through the process of succession. Advances in forest ecology show that landscape change is the rule rather than the exception, and that natural disturbances at scales ranging from tree-tip mounds to 500,000-acre blowdowns make forests dynamic and often unpredictable places (Pickett and White 1985; Botkin 1990). Human-caused disturbances also can profoundly change forest landscapes. Like forest ecologists, many anthropologists and historians have questioned the idea of forests as stable systems; they contradicted the longstanding belief that pre-European-settlement America was an untouched wilderness by showing that for millennia indigenous peoples actively and regularly used fire and other land management tools to create desired forest conditions (Denevan 1992; Pyne 1992).

But despite our acceptance of those historical landscape changes, we have become increasingly wary of the rate and scale at which the landscapes around us are changing because of contemporary trends in land use, ownership, and development. Although some of these changes are considered positive by those interested in forest issues—the Northeast, for instance, has seen a 50 percent increase (70 million acres) in its area of forest cover since 1900

Above: **New second-home development is a likely contributor to the increasing fragmentation of forest resources in the North Central region.**

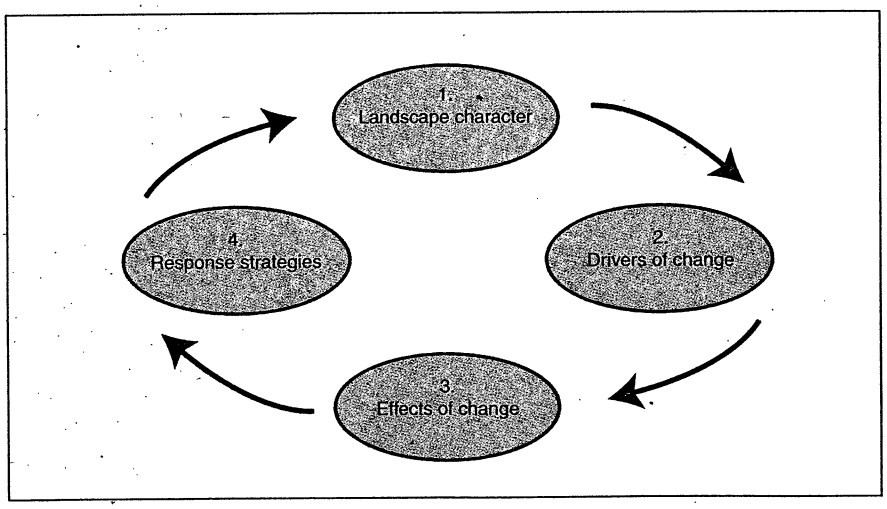


Figure 1. **Model for understanding landscape change.**

(Foster 1999a, 1999b)—many people are concerned about some aspects of development-related landscape changes. In many regions of the nation and the world, critical forest landscapes are becoming increasingly fragmented and transformed by development. Sometimes abrupt, other times subtle, these changes produce unintended consequences for the valued natural character of the region. As a result, people who look to forests for their livelihood and their leisure are finding the characteristics and experiences they seek changing rapidly or disappearing altogether.

The North Central Research Station (NCRS) of the USDA Forest Service has begun a new Landscape Change Integrated Research and Development Program aimed at tackling key problems and issues concerning the development-related aspects of landscape change. With a focus on our seven-state region (Minnesota, Iowa, Missouri, Illinois, Indiana, Michigan, and Wisconsin), we hope to provide the specific information that forest managers and policymakers need to guide growth and change in the Midwest, and to transfer that information elsewhere when possible.

Need for the Program

Concerns raised by landscape fragmentation, urban-suburban sprawl, and rural second-home development usually revolve around reduced quantity or quality of resources, decreased access to them, and higher costs of attaining them. In the North Central region, a wide range of stakeholders have expressed concerns about the effects of changes they have seen or that they anticipate, which translate into significant management and policy issues:

- Commodity concerns—reduced availability of timber and mining resources, greater extraction costs, higher levels of conflict with adjacent landowners.
- Environmental concerns—loss of natural biodiversity, reductions in wildlife habitat, reduced air and water quality.
- Community concerns—overcrowding, conflicts caused by social and economic disparities between new and established residents, loss of unique identity and special places.
- Recreational concerns—loss of access to private lands, conflicts between new and traditional recreational activities, loss of opportunities for solitude.
- Governmental concerns—increased infrastructure costs and planning challenges.

These stakeholder concerns reflect changes in other areas, where communities large and small are grappling with ways to manage growth and protect the critical natural resource base. In the 1998 US general election, voters approved 85 percent of more than 150 antisprawl and open-space ballot initiatives and allocated more than $7 billion in funds for new land acquisition (Gregory 1999). Local, state, and federal programs aimed at "smart growth" and "livable communities" are gaining visibility and show widespread bipartisan support in many areas of the country (Schwab et al. 1997; Salkin 1999). Fragmentation of large forest blocks into smaller parcels concerns environmentalists and timber industry officials alike (Greason 1989; Tyson et al. 1998).

Scientists are beginning to study the patterns of landscape changes, the forces that drive them, and the effects they have on sustainable forest productivity and other ecosystem functions and values (Barlow et al. 1998; LaGro 1998; Wear and Bolstad 1998). Furthermore, there is a growing literature on the relative success of alternative response strategies for guiding change and mitigating its negative consequences (Fischel 1990; Lerner and Poole 1999; O'Neill 1999). This work forms a solid foundation for addressing problems specific to the North Central region, with its complexity of forest types, landforms, and land use issues. Merging our disciplinary capacities in landscape and wildlife ecology, forest inventory and analysis, social sciences and economics, and other areas, we are beginning to work with decisionmakers in the region to provide improved tools and information concerning landscape change. Based on a series of workshops and other communications with researchers and stakeholders, we have identified four overarching objectives that our program in landscape change will address:

- Characterize landscape changes in the region.
- Understand the physical, biological, social, and economic factors and interactions influencing the rate and extent of changes.
- Determine the effects of landscape change on people and ecosystems.
- Assess the effectiveness of public policies that regulate landscape change.

Program Structure

Figure 1 presents a conceptual model for understanding how these objectives relate to one another and how they might be addressed through a program of research and development. Each of the four components in the model corresponds to a different objective in understanding landscape

change, specifies the types of indicators and data needed for their assessment, and suggests the kinds of outputs or products that might be expected from an analysis at each level. In the sections that follow, we describe each of these components and highlight examples of work under way.

1. Landscape character

The aim of this first component is to describe the physical, biological, and social patterns in the landscape at the regional or subregional level—ecological land types, forest cover, land use, population densities, and so forth. What patterns of landscape change affect the health and sustainability of forest resources and related social systems in the region? How can we describe the rate and extent of these landscape changes? What predictions are being made for the location, extent, and timing of future landscape change in the North Central region and around the country? How might these predictions be improved?

Answers to those questions will be useful in understanding the various phenomena of landscape change, and principles and ideas of landscape ecology are particularly important in this respect. Data sources include ecological classification systems (ECS), forest inventory and analysis (FIA), and US Census Bureau topologically integrated geographic encoding and referencing (TIGER) files. Time series data also are critical for identifying the magnitude and rate of landscape change.

Where are the hotspots of change in the North Central region? Landscape changes are the result of complex interactions between physical, biological, and social factors, and are not randomly distributed across the region. To better understand the pattern of these factors and their interactions, an interdisciplinary team of Forest Service researchers is developing a spatial database of changes across the seven-state region that will provide insights into the scope of changes and allow us to investigate their causes. Although much information is available, little of it is assembled in a context suitable for analyzing their spatial interactions.

We are developing an interactive atlas of maps showing the spatial distribution of hotspots of change for a multidisciplinary suite of key socioeconomic and natural resource characteristics. The example shown in *figure 2,* taken from data by demographers Beale and Johnson (1998), shows "recreation hotspots" in the region, nonmetropolitan recreational counties defined by activities such as second-home development and per capita spending on motels and campgrounds. Beale and Johnson's work shows that in the 1990s, these counties grew at twice the rate of other nonmetropolitan counties across the nation, with most growth attributable to in-migration. For the North Central region, much of this growth occurred near national forests, lake districts, and other significant natural amenities.

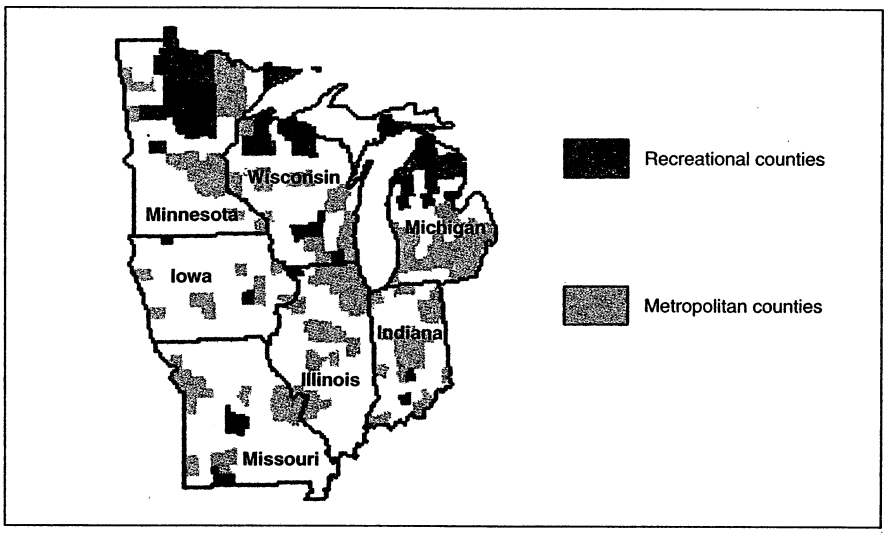


Figure 2. **Recreational and metropolitan counties of the North Central region. SOURCE: Johnson and Beale 1999.**

Maps like these, by themselves and when overlaid with other social and natural resource attributes, are important tools for planners and policymakers. As we progress in this work we will produce risk maps for selected natural resource and social changes, study interactions in rates of change among socioeconomic and natural resource characteristics, and develop methods to determine the drivers that produce patterns of change.

2. Drivers of change

The second component in the model focuses on the drivers of landscape change. Two types of drivers are distinguished here: primary and secondary. Primary drivers are major social and economic forces of change; these push–pull forces include public policies such as tax and incentive programs, improvements in technology such as mound septic systems, infrastructure improvements in transportation and communication, and markets at local to global levels. Although it is useful to describe and understand these principal forces of change in and of themselves, they take on added utility when they can be related to changes in development-related patterns affecting forest landscapes. These secondary drivers (or primary effects) are observable manifestations of landscape fragmentation, urban-suburban sprawl, and related phenomena and include data that quantify changes in landownership, land use, parcel size, and housing and road network density. Data sources include county land records, time series aerial photography, and FIA data.

Ownership fragmentation of Lake States timberlands. Spurred on by primary forces such as changes in disposable income, improved transportation networks, and the aging of the population, there have been substantial increases in second-home development in the forested rural areas of the upper Midwest (Stynes et al. 1997). At the same time, researchers have detected a change in the size classes of forested land parcels owned by private individ-

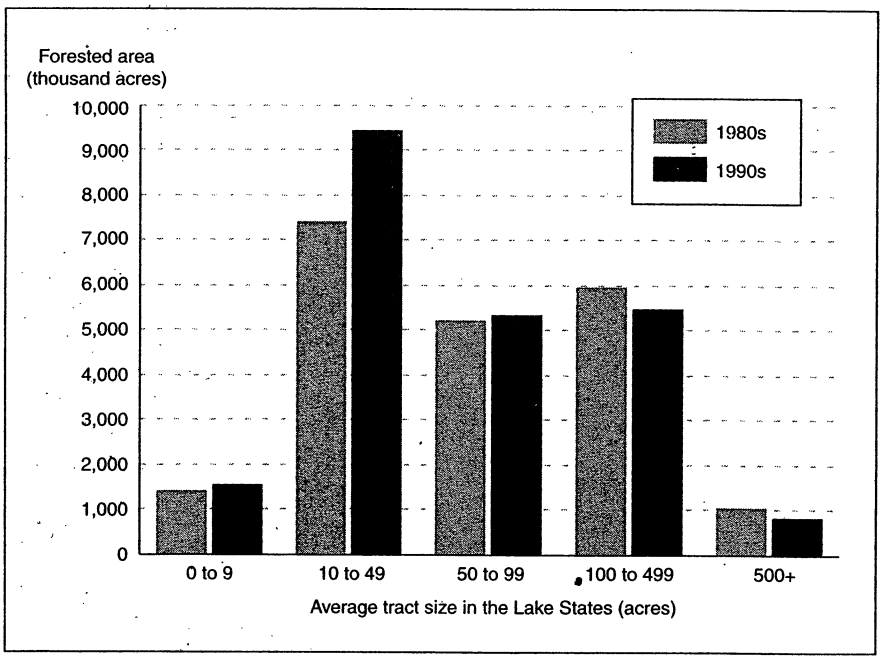


Figure 3. **Lake States Forest Inventory and Analysis (FIA) assessments, 1980s compared with 1990s. SOURCE: Schmidt and Raile 1998.**

uals between the 1980s and 1990s (Schmidt and Raile 1998). In particular, there has been a drop in acreage of privately owned land parcels 100 acres or larger—more than 700,000 acres' worth—and a concomitant rise in acreage of privately owned smaller parcels, especially those between 10 and 49 acres *(fig. 3)*.

Because researchers suspect there is a link between second-home development and reduced parcel size, they are beginning to examine parcel size changes near national forest, riparian, and other amenity resources. The effects of such changes are not fully known, and planned research will examine the impacts of landownership fragmentation on future management capability and availability for harvesting, among other resource goals.

3. Effects of change

The third component in the model tends to draw the most attention from stakeholders, for this is where both positive and negative effects are most directly felt. How will landscape change influence people, including the goods and services available from forest resources; the economies in and near the changed areas; and the quality of life for those who live in, visit, or travel through the landscape? How will landscape change influence ecosystems, including wildlife viability, relative abundance of plant and animal species, air and water quality, and land management objectives? Studies include descriptive analyses of the impacts of current or proposed landscape changes (for example, environmental impact statements) and predictive modeling efforts. The numerous data sources include field assessments and social surveys.

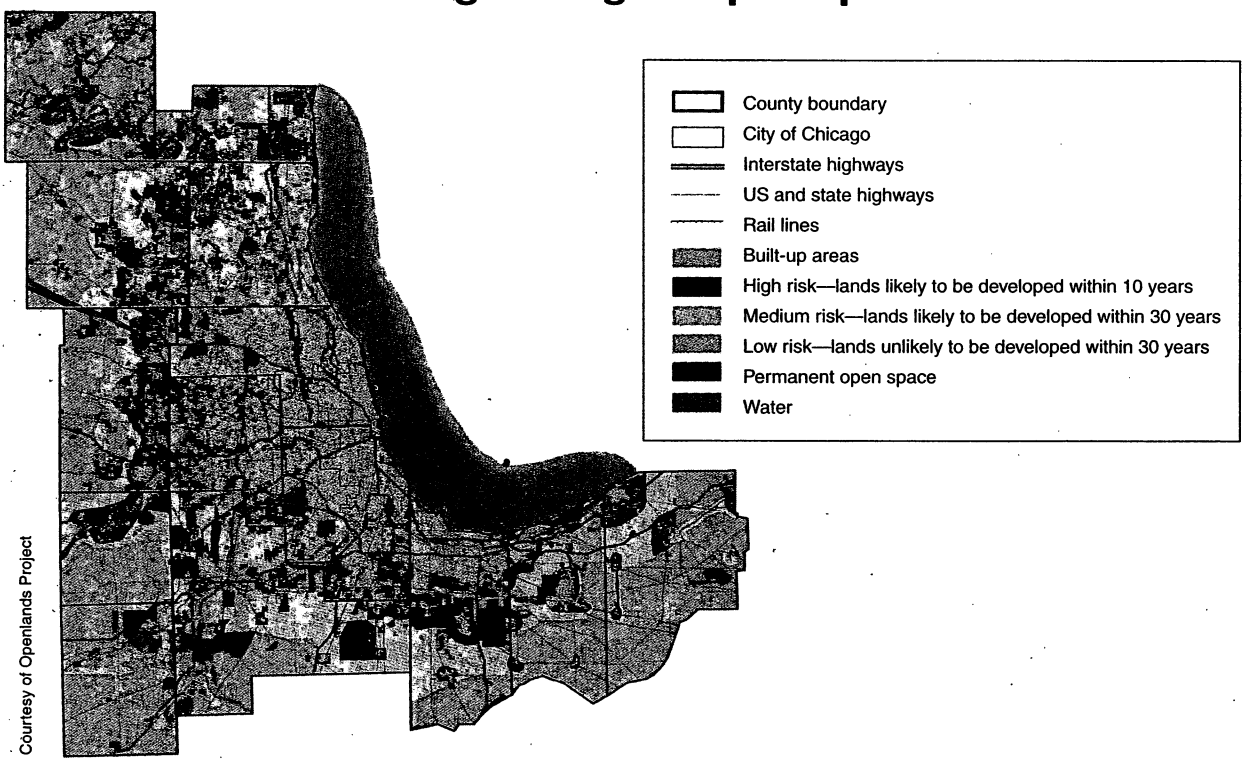
Benefits and costs of "living on the edge." Residential development on the fringes of urban areas and in urban-proximate communities can radically transform landscapes and bring changes in the natural environment, quality of life, economic development, and government programs. An interrelated series of social science research projects is under way in the metropolitan regions of Illinois, Wisconsin, and Michigan that will examine how new development is affecting the perceived quality of life of new and established residents. What do new migrants seek when they decide to move to urban edge and urban-proximate areas, and what do they find when they get there? How important is the natural resource base of these areas to established residents, newcomers, and developers, and what are the perceived impacts of new development on this base? Decision support models and computer simulations will be developed to enable urban planners and policymakers to predict how new regulations, incentives, and zoning policies may affect people's perceptions and behaviors, and in turn, future patterns of metropolitan development.

4. Response strategies

The fourth component in the model examines response strategies to enhance or mitigate the effects of landscape change. How effective are growth management tools, such as purchase of development rights, growth boundaries, and other techniques for preserving forest areas in rapidly growing urban, suburban, exurban, and rural areas? What forest management regimes are compatible with different growth management tools? How can communities that are affected by landscape change enhance forest-based economic growth from tourism, recreation, seasonal homes, and associated developments while retaining control over their local character and quality of life? Work at this level aims to inform managers and decisionmakers of the likely consequences of alternatives and includes technology transfer efforts, policy studies, and attitude and behavior surveys.

Restoring the Rust Belt—the Calumet region. The urban core anchors one end of the urban–wilderness continuum along which landscapes are changing. The Calumet area in southeast Chicago was once the hub of the region's mighty industrial and transportation prowess. It still has some thriving industry, as well as many brownfields (unused industrial sites that, because of contamination concerns, are not redeveloped), Superfund sites, several protected natural areas, and numerous unprotected natural areas with a high potential for ecological restoration. These natural areas support the largest black-crowned night heron rookery in Illinois, viable fisheries, prairie, wetland, and forest. The area has recently been proposed for inclusion in the national park system as a National Heritage Corridor. Other proposals have highlighted the

Urban Landscape Change: Protecting Chicago's Open Spaces



Courtesy of Openlands Project

This map projects land consumption in the 6,890 square miles of the Chicago region to 2028. The "at risk" categories are based on existing development trends. The 1,772 square miles of built-up (urbanized) areas are defined at a low density (at least one housing unit per five acres) because much of the region's outlying development has occurred at such densities.

Chicago lies near the heart of the region studied by the USDA Forest Service North Central Research Station (NCRS). As the region's largest metropolitan area, Chicago has become an important focus for understanding and managing landscape change. Recent studies by Chicago's Openlands Project, an independent, nonprofit organization working to preserve public open space in northeastern Illinois, have called attention to the rapid urbanization of the region and the threats of future development to currently unprotected open spaces. Openlands' "under pressure" map identifies areas at risk over the next 30 years. Given current trends, urbanization will double the size of the metropolitan area, consuming 1.25 million acres of undeveloped land that includes prime farmland and more than 300 high-quality natural areas.

These and other studies have been catalysts for initiatives aimed at managing growth, creating livable communities, and protecting valued open spaces. For example, the Visions project of the Chicago-based Environmental Law and Policy Center has developed smart-growth design options for several communities in the region and is working with local planners to help implement options to uncontrolled sprawl. In the city of Chicago, a host of organizations and agencies are working together to create a greener Chicago with an aggressive reforestation effort, new parks and open spaces, and even rooftop gardens to moderate urban heat island effects. Around the metropolitan region, a consortium of 98 organizations have formed the Chicago Region Biodiversity Council, or "Chicago Wilderness," and have developed a comprehensive biodiversity recovery plan to protect and restore natural areas in the region.

As a collaborator in several of these efforts, NCRS provides information on the natural and social aspects of the environment to help guide planning, design, and management decisions.

The report of the Openlands Project, Under Pressure: Land Consumption in the Chicago Region, 1998–2028, *is available online at www.openlands.org; the Chicago Wilderness biodiversity plan is available online at www.chiwild.org.*

potential of the Calumet region for meeting both economic and ecological redevelopment goals. Balancing these goals is both critical and controversial. Are heron rookeries worth saving if it means tighter environmental controls on industry? Can brownfield redevelopment incorporate ecological issues without compromising commercial interests? Further, can decisionmakers find policies and programs that avoid false dichotomies and maximize win–win solutions?

To answer these and other pressing questions, researchers are assisting stakeholders in a multidisciplinary public–private partnership to guide and monitor the ecological and economic redevelopment of the Calumet area. Tools, techniques, and information developed in this research will help answer policy and management questions for public and private groups at local, regional, national, and international levels of concern. Using a place-based model suggested by Norton and Hannon (1997) and others, the Calumet area could form the urban anchor for a typology of sites in understanding landscape change across the region, especially in how stakeholders can respond to past human-caused catastrophic landscape changes. Critical issues for Calumet share much in common with problems and opportunities of other communities in the Rust Belt and Northeast: balancing environmental and economic interests, creating livable communities, and repairing environmental injustices.

Program Implementation

In *figure 1*, an arrow from the last component back to the first indicates the dynamic nature of landscape change: Response strategies can alter conditions toward a more desired landscape character, which in turn can alter conditions throughout the rest of the model.

Although the process described is generic, the applied model will also account for the variability that exists across the region, especially in terms of forest type and degree of urbanization. The model portrays the understanding of landscape change as a total process—from pattern recognition to causes and effects to response strategies. But studies of landscape change need not address all of these components, nor do they need to begin at the first model component before proceeding to the others. The model is offered as a tool to organize concepts and studies and to map out research efforts as part of the bigger picture.

The Road Ahead

As one of three new integrated research and development programs at NCRS (riparian landscapes and forest productivity are the other two), the ultimate success of the landscape change program depends on the collaboration between multiple disciplines and stakeholders to solve problems of scientific and practical relevance. With our breadth of experience, regional focus, long-term databases, and established partnerships with researchers and stakeholders, we are building a program we believe can address the complex and formidable challenges that lie ahead.

This article described our program's purpose and structure and highlighted some recent research. As a new venture for our station, we hope to build on work by researchers within and outside the region and extend the utility of new and existing information by working across disciplinary boundaries. From forestry professionals and urban planners to policymakers and public interest groups, we are calling on a diverse constituency to help us refine and address the priority issues of our work. We invite *Journal of Forestry* readers to participate in this process. For more information, please contact us or visit our website at www.ncfes.umn.edu/news/junjul99.pdf.

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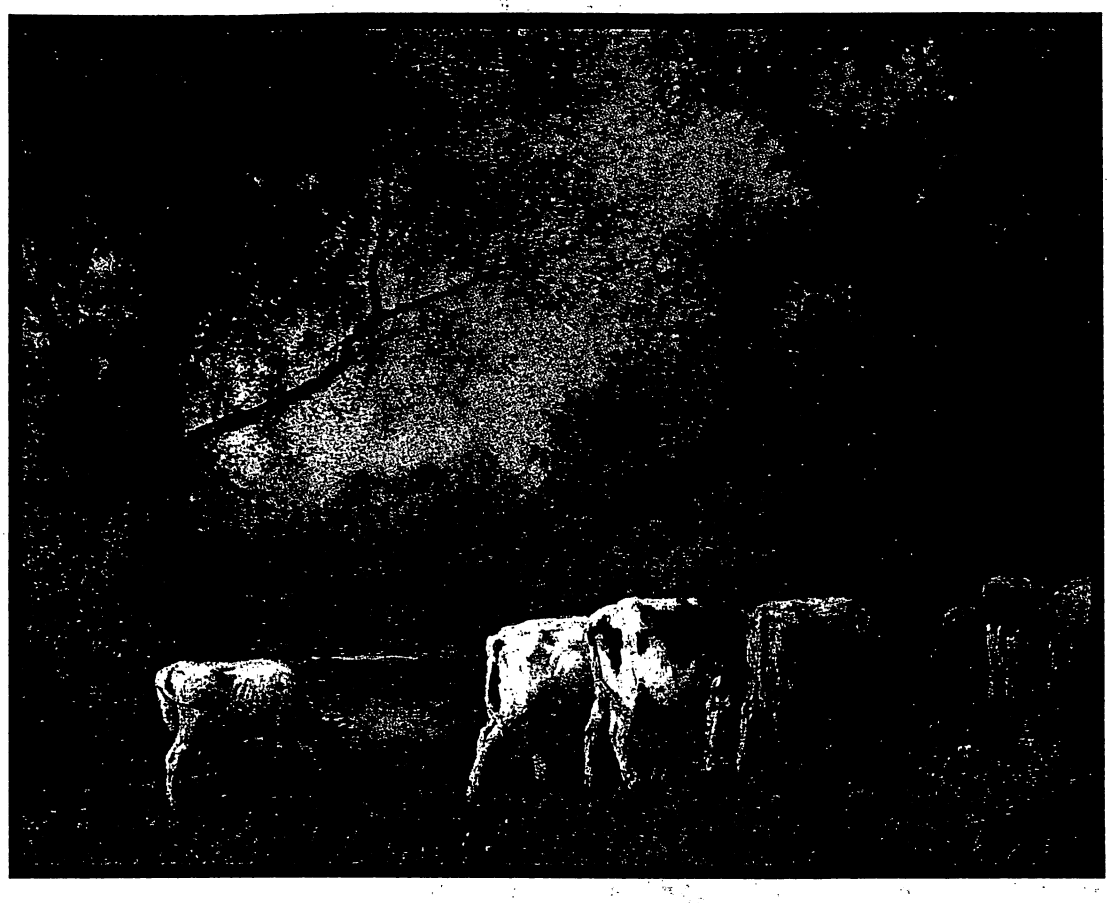

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POSTMASTER: Send address changes to A. Ziadi, *Journal of Forestry*, 5400 Grosvenor Lane, Bethesda, MD 20814-2198; e-mail: ziadia@safnet.org.

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