WATER, WATER EVERYWHERE… INTEGRATED RIPARIAN RESEARCH IN THE NORTH CENTRAL REGION

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ABSTRACT.—Riparian areas are important for many reasons including timber, residential areas, biodiversity, recreation, and industry. Because of the intricate land/water interface, these lands require special care. Determining what this care should be requires more knowledge than we currently have. Hence, the North Central Research Station (NCRS) has initiated the Sustaining Riparian Landscapes Integrated Program. NCRS scientists and their partners investigate the impacts of different riparian delineation and quantification methods and the impacts of human actions from development to restoration. Research projects include regeneration of oak bottomlands, landscape impacts of best management practices, landowner understanding of riparian health, and restoration of Rust Belt landscapes.

In the North Central Region of the United States, we have the Great Lakes and great rivers. We have thousands of smaller lakes and smaller rivers, rural riparian areas and urban ones. People are drawn to riparian areas for many reasons: we play in them, we obtain resources from them to build our homes and communities, we seek solace and retreat in them, we value the wildlife and plants that riparian areas support, we rely on their role in maintaining water quality. Because of these critical needs and the resulting policy and management challenges riparian areas present, the North Central Research Station (NCRS) has embarked upon the Sustaining Riparian Landscapes Integrated Research and Development Program.

The North Central Research Station has a long history of riparian research, including bottomland hardwood research and the work of the river recreation research unit in the 1970s. These examples are based in a disciplinary approach to research, in these cases silviculture and recreation research. But rarely are policy questions and conundrums rooted in a single discipline, rather these issues are often multi- and inter-disciplinary. To make headway that is meaningful for science, policy, and management, we need to tie together information from the social, biological, and physical sciences. At the North Central Research Station we are addressing this need to tie it all together through the Sustaining Riparian Landscapes Integrated Program (Riparian Program). In addition, the Station is using the integrated program approach to address landscape change and forest productivity issues.

WHY A RIPARIAN PROGRAM?

Few regions of the country have a greater predominance of riparian areas, or more potential for conflict among their uses, than the North Central Region of the United States. Water, and the surrounding resources, are particularly important in this region. For example, 37 percent of forest land in northern Minnesota is within 57 m of surface water. More broadly, the seven national forests of the upper Great Lakes states make up only 4 percent of total Forest Service lands, yet they contain 41 percent of Forest Service lakes, reservoirs, and ponds. Lakes, open-water wetlands, rivers, and streams are the settings for intense residential, recreational, and industrial development. The importance of riparian areas in the region is clear: our economy, our sense of place, our quality of life depends on riparian areas.

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Riparian area issues vary significantly across the North Central Region. Forests in the southern tier of states in the North Central Region are largely Central Hardwood forests, and the riparian systems tend to be rivers and streams rather than lakes. While abundance of riparian areas characterizes the northern states, loss of riparian forest from human impacts may be the dominant issue in the Central Hardwood riparian areas. An estimate based on USDA Forest Service Forest Inventory data is that 4 percent of the Central Hardwood forests in Missouri, Iowa, Illinois, Indiana, and Ohio are in riparian areas. There used to be more. Conversion to agriculture has been a major force in the dwindling amount of riparian forests in the Central Hardwoods. But in some areas, we are seeing a reversal of this trend as former agricultural bottomlands are returning to forest either by default or through active management. These few bottomland forests are among the most diverse of the Central Hardwood forests in terms of number of species. This species richness is just one of the important characteristics of riparian forests.

Central Hardwoods are important in urban centers, too. For example, oak savanna is an important ecosystem in the Chicago metropolitan area and a primary focus of the Chicago Wilderness coalition. This umbrella organization seeks to restore and promote the native biodiversity of the lands at the southwest corner of Lake Michigan, from northwest Indiana to southeast Wisconsin. Oak was a dominant forest type here, and, like in bottomlands and other oak forests, regeneration is a key issue.

This is why the North Central Research Station has embarked on the Riparian Program: water resources in the North Central Region are of great importance. Our goal is to better understand riparian ecological services, as well as the broader array of societal benefits gained from these areas. Ultimately, our aim is to better inform management and policymaking decisions on riparian land use from the northern coniferous forests to the Rust Belt to the Central Hardwood forest.

CENTRAL RESEARCH QUESTION

The central question guiding the Riparian Program is:
How does diverse land use in the North Central Region change riparian area structure, impact ecological functions, and influence the benefits people derive from riparian resources?

This question gets at the heart of the riparian issue in the North Central Region. North Central riparian areas not only have great ecological value, they also are sources of substantial economic and social benefits from recreation, residential development, timber management, agriculture, wildlife, and industry. These land uses usually threaten ecological value, but in some cases may actually help to restore function (e.g., rehabilitation of agricultural land through forestry, or the development of greener industry).

In our attempt to answer the central question, we identified these three critical problem areas to guide our scientists and research partners:
1) Quantifying riparian areas, their extent, function, and benefits
2) Impacts to riparian areas, investigating factors affecting function and value
3) Rehabilitating riparian areas

These problem areas are described below, with examples of current research addressing each issue.

PROBLEM AREA 1: QUANTIFYING RIPARIAN AREAS, THEIR EXTENT, FUNCTION, AND BENEFITS

A fundamental constraint to understanding riparian land use issues in the North Central Region is the lack of good assessments of the resource at appropriate scales. We need to better understand the amount and ecological condition of riparian areas associated with different types of aquatic systems and in different landscape settings from the Central Hardwoods to the northwoods, and how these variables have changed over time. To get to this understanding, we first must develop sound methodologies to delineate riparian areas at different scales (e.g., watershed or stand) based on ecological properties. We can't know the amount and condition of riparian areas until we understand just which lands *are* riparian, and we don't have precise estimates of how much forest is riparian in the Central Hardwoods or other types of forest in the North Central Region.

At the same time that we expand and refine the delineation methods, we must also consider the economic and social benefits people gain from different riparian land uses, the tradeoffs among riparian benefits individuals and communities are willing to accept, and the social and economic consequences of riparian land use conversion. Projects in this problem area involve quantification of riparian areas from

different perspectives, including ecologically based delineations; indexing of lakeshore development potential; monitoring of recreation use; and assessment of stakeholder perceptions of riparian health. Two projects are outlined below: the North Central Region Riparian Assessment and a study of the contribution of ancient wood to riparian health.

How Much Land is Riparian? The North Central Riparian Assessment

Brian Palik, USDA Forest Service, NCRS, Grand Rapids, MN and Dave Heinzen, Minnesota Department of Natural Resources, Grand Rapids, MN, lead this research. They are trying to answer the question of how do we determine what is and is not riparian? The typical approach has been a fixed width buffer, say 30 or 60 m from the water's edge. But does this approach, based more on available data and expediency rather than ecological realities, best delineate riparian areas? Do policies for riparian areas get applied to the right lands? Both over- and under-application of policy and management techniques for riparian areas could have significant ecological, economic, and social implications. Different methods of delineating riparian areas can give wildly different figures. For instance, Illinois land can be less than 2 percent or over 10 percent riparian, depending on the delineation method used. The riparian assessment seeks to clarify these issues and to develop meaningful definitions and delineation tools for riparian areas.

Taking the first step in the assessment, Brian Palik worked with partners to compare a variety of methods for delineating riparian areas, including fixed widths (30, 60 m), soils (indicators of hydric soils), geomorphology (slope and elevation), and the extent of floods. The intent was to explore approaches having greater links to functional ecotones using existing data layers. This was done at two scales of analysis—the entire North Central Region and a finer grained analysis of two watersheds in Minnesota.

The 30 and 60 m buffers on streams, lakes, wetlands; hydric soil delineations; 100 year flood extent where available; and landuse/landcover analysis have been completed for the entire region. Now, Brian Palik and Dave Heinzen are developing more detailed geomorphic delineation approaches on two Minnesota watersheds. These data are (or very soon will be) available for use on the North Central Web site (http://www.ncrs.fs.fed.us/).

Ancient Wood Uncovered

Daniel Dey, USDA Forest Service, NCRS, Columbia, MO; and Richard Guyette, University of Missouri, Columbia, MO lead this research. They are studying the dynamics of coarse woody debris in streams in the North Central Region to improve our understanding of how forests and aquatic systems interact and to improve our management of riparian forests. They discovered that many streams in northern Missouri contain a substantial amount of very old wood in their channels. As the streams meander across their flood plains, they uncover ancient wood—often entire trees with their root systems—that have been preserved in 30 feet or more of alluvial soil. By using radiocarbon (^{14}C) and tree-ring dating methods, they have found in-stream coarse woody debris that ranged in age from less than 100 years before present (B.P.) to 11,900 years B.P. Furthermore, this ancient wood is not rare—wood older than 500 years B.P. was common in all the streams surveyed. The presence and abundance of ancient wood in Missouri streams was previously unknown.

Discovering wood this old is a dendrochronologist's dream come true, but ancient wood is also important today for stream and forest biodiversity. It provides habitat for aquatic invertebrates, contributes nutrients to the stream, and sequesters carbon. In fact, these ancient trees might have been one of the largest carbon sinks of their day. This raises a new ecological impact of straightening rivers and streams—have we undermined an important carbon sink? Would restoration of stream meanders and riparian forests be a useful component in a larger global change strategy?

This research provides new perspectives on the long-term dynamics of aquatic coarse woody debris and the complexity of how riparian forests and streams interact. Such information can be used to assess changes in riparian forest productivity, carbon sequestration, and forest composition as they relate to changes in climate and human use of these areas since the last ice age.

PROBLEM AREA 2: IMPACTS TO RIPARIAN AREAS, INVESTIGATING FACTORS AFFECTING FUNCTION AND VALUE

When we use things, we usually change them. This is certainly true in riparian areas. These changes (building boat houses, converting forest to agricultural production, straightening rivers, using water for cooling manufacturing equipment)

impact the riparian structure and function, and can impact the sustainability of the very uses and benefits we expect from riparian areas. We need to understand the impacts of these changes across different land uses and in different landscape settings. With this understanding, we can then investigate means to mitigate impacts on riparian and aquatic resources and develop ways to balance multiple benefits within riparian areas. Several current and new Station-led efforts focus on riparian alteration through research into riparian forest management approaches, efficacy of riparian buffers, characteristics of riparian forest fragments, and watershed-scale land use impacts. Two studies addressing these issues are outlined below: a study looking at landscape level impacts of actions at the stand level and an investigation of lake homeowners' perceptions of riparian health.

Assessment of Timber and Wildlife Resources in Missouri Riparian Management Zones as Affected by Best Management Practices (BMPs)

Hong S. He, Department of Fisheries and Wildlife Science, University of Missouri, Columbia, MO; and Steve Shifley, USDA Forest Service, NCRS, Columbia, MO, lead this research. How can we understand potential effects of various forest management techniques at the landscape level? Modeling can help. One current project will analyze the effects of different methods of designating riparian management zones (e.g., as fixed-width buffers vs. buffers based on streamside topography and hydrology) on the size of riparian zones and their contributions to timber and wildlife. We will investigate how the riparian designation method and the application of Missouri's riparian forest BMPs affect the pattern and structure of the larger forest landscape (including riparian and other forests). Within the riparian zones we will assess how the application of BMPs affects forest age structure and timber production over time.

Specifically, this research will look at three or more representative landscapes (from 3,000 to 10,000 acre watersheds) along a major river system in Missouri. In each landscape, we will designate alternative riparian management zone configurations including fixed width riparian zones and functional riparian zones based on topographic features. We will simulate the outcome of applying BMPs within riparian zones during timber harvesting and examine predicted future vegetation age structure within riparian zones and across the entire watershed. The results will be compared with the alternative of not applying BMPs within riparian zones during timber harvesting. Results will also be analyzed within the context of the entire watershed where simulation of upland management alternatives has already been completed.

Landowners' Understanding of Impacts in Riparian Areas May Lack Scientific Basis

Pamela Jakes, USDA Forest Service, NCRS, St. Paul, MN, leads this research. When northern Wisconsin landowners were asked about the impacts of their actions on the health of riparian areas, their perceptions were very different from what science tells us. Landowners were not aware of many of the basic ecological principles that are critical to sustainable land use and how their decisions regarding home and road construction and landscaping, or their choice of recreational activities may impact the environment. The findings suggest that scientists and their colleagues involved in public outreach need to develop ways to better communicate findings regarding potential human impacts on riparian ecosystems and "healthy" alternative land use practices. Managers also need to work with those involved in developing land use policy, such as county zoning or Best Management Practices, so that guidelines and regulations reflect the best science available. This communication is especially critical in riparian areas that are experiencing increased development.

PROBLEM AREA 3: REHABILITATING RIPARIAN AREAS

Restoration or rehabilitation of ecological function and social value is a primary concern in degraded riparian areas. Research needs vary from development and testing of technologies, methods, and materials, to assessing the social implications of rehabilitation and restoration. Severe degradation, seen in many agricultural and urban landscapes of the Central Hardwood Region, often calls for intensive efforts to rehabilitate functions. Functional restoration may not necessarily translate into restoration of original ecosystem characteristics (e.g., vegetation cover or large wetland systems). Several current North Central Research Station research projects focus on riparian restoration or rehabilitation, including development and testing of plant materials, stream-crossing restoration, reforestation of agricultural bottomlands, and balancing of ecological and economic needs in the revitalization of urban riparian areas. Two studies are outlined below: one addressing damaged riparian areas in a Rust Belt landscape, the other looking at the regrowth of oaks in the Missouri bottomlands.

Revitalizing the Rust Belt: The Calumet Initiative

Sandy Verry, USDA Forest Service, NCRS, Grand Rapids, MN; and Lynne Westphal, USDA Forest Service, NCRS, Evanston, IL; lead this research. The Calumet Region of northwest Indiana and northeast Illinois is a quintessential Rust Belt landscape, one of many communities struggling in the former industrial belt that ran from Pittsburgh to Chicago. Many industries still thrive in Calumet and, paradoxically, threatened and endangered species also flourish there in remnant natural areas of oak and wetland nestled among used and abandoned industrial plants. The Calumet Region also draws recreationists hoping to see the rare bird, catch the big fish, or just enjoy the outdoors. The North Central Research Station, along with its many and diverse partners, is working to help local and regional planners and managers decide how to move the area toward ecological and economic health. Our role is to provide information and technology and to facilitate in these efforts.

One research project that epitomizes this intersection of ecological and economic health is the Indian Creek project. Indian Creek is a creek in name only: it is a ditch and provides no habitat for fish or other aquatic life, and its bottom is deep in muck from slag. It was formed as people filled in over 300 acres of the Hyde Lake wetlands. About 40 acres of wetland remain, with the "creek" running adjacent to it. The filled lands have been used for heavy industry and manufacturing waste disposal for decades; currently they are abandoned brownfields. Sites like this can't be restored to pre-settlement conditions—it is financially impossible to remove acres of slag and there is nowhere to put it that would not cause the same environmental injustice somewhere else. But it is possible to increase the ecological health of many of these sites, including Indian Creek and the remnant Hyde Lake wetland.

Sandy Verry has studied the geomorphology of this "creek," creating 36 cross sections to develop a longitudinal profile of the creek including estimates of its bankfull flow, water sources, water velocity, and other critical stream characteristics. With this information, Sandy developed plans for re-engineering Indian Creek's shape and depth to provide pools, riffles, and other aquatic structure. Dan Dey is planning studies to help revegetate Indian Creek's banks—now slag and ash and not hospitable for growing things.

Since this project began, the Ford Motor Company has purchased land neighboring Indian Creek and will develop the first North American Supplier Park Campus on these brownfields. Sandy Verry and other North Central Research Station scientists have contributed to the design plans for this industrial site and Ford has committed to rehabilitate the portion of Indian Creek that runs through its property. Ford plans to take advantage of the creek as an aesthetic aspect of the Supplier Park design, with offices, day care centers, and other components of the Supplier Park using the creek (e.g., office views of the creek, picnic tables adjacent to the creek). North Central Research Station scientists continue to be involved in the development of both the Supplier Park and Indian Creek and will monitor the ecological impacts of the rehabilitation project, leading the way to new techniques for re-creating ecological integrity in places humans have abused.

Regenerating Oak Bottomlands

Daniel Dey, USDA Forest Service, NCRS, Columbia, MO, leads this research. He is examining oak regeneration, an ongoing concern, on productive bottomlands in Missouri, where croplands are reverting back to forests. Oak forests are important for many reasons, including wildlife habitat, native biodiversity, recreation, forest products, and healthy ecosystem processes and functions. In one ongoing project, a new nursery product (RPM™ seedlings), soil mounding, and a cover crop of redtop grass are being assessed for their ability to improve oak seedling survival. The RPM™ seedlings have significantly larger root systems than typical bare root seedlings. The stock planted in this study had 17 to 20 g of dried root in the standard bare root stock compared to 120 to 140 g in the RPM™ stock. Because of the increased root structure, significantly more oaks from the RPM™ stock survived, with some trees even producing acorns in the second year after transplant. Soil mounding and redtop grass were less significant in increasing survival. When complete, this study will produce guidelines to help regenerate native hardwood forests in Missouri and other Central Hardwood states.

WATER, WATER EVERYWHERE

The riparian areas in the North Central Region face many demands. We turn to these lands at the water's edge for everything from timber production to serenity. Riparian areas in the Central Hardwood forests face challenges similar to all of North Central's riparian areas:

definitions and delineation methods need to be refined and made workable on the ground, the wide ranging importance of these riparian areas to people needs to be better understood and placed in a management and policy context, and impacts of actions at the stand or housing development level need to be understood in the wider landscape context. But the Central Hardwood riparian areas also face some unique challenges. So much forest land at the water's edge has been converted to other uses, primarily agriculture and urban development, that we particularly need to understand the lost function and develop tools for restoration and rehabilitation of these riparian areas.

Because of our high expectations of riparian landscapes, and because of the impacts of our past actions, riparian areas in North Central require a sustained initiative developing information that can be readily used by policymakers and managers as they make critical decisions for these important landscapes. The North Central Research Station is providing this research initiative in its Sustaining Riparian Landscapes Integrated Research and Development program. We are investigating the impact of diverse land use in the region on riparian area structure, ecological functions, and the benefits people expect from riparian resources. In this way, we hope to be a part of science for people's sake, and to make a difference for the ecological health of our region and the quality of life for the people who live, work, and play here.

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