

Internet and GIS Tools for Environmental Management: The Wisconsin DNR Program



Bureau of Science Services
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

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Summary: This document describes grant-funded work undertaken by the Wisconsin DNR and its partners between 2003 and 2008 to assess the technology transfer needs of specific target audiences and then build capacity among those audiences to use various Internet and GIS-based tools. (These technology transfer efforts are referred to throughout this report as “the Wisconsin DNR program”). The document also describes the results of the Wisconsin DNR’s efforts to assess and evaluate the efficacy and transferability of these educational efforts and presents lessons learned and implications for other states wishing to similarly transfer technology to their local decision-makers. We make recommendations to address challenges associated with the tools, to better understand the needs of particular audiences, and to improve technology transfer efforts. The report also documents our work to further evaluate and refine water quality modeling tools included in the program. Finally, this document fulfills our reporting requirements for a U.S. EPA Federal Assistance Agreement.

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Cover Illustration: Citizen planners and local government decision makers participate in a hands-on training session focused on “Internet Tools for Planning, Conservation, and Environmental Protection.” Photograph by Dana Lucero.

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**Internet and GIS Tools
for Environmental Management:
The Wisconsin DNR Program**

Dreux J. Watermolen

Chief, Science Information Services
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707-7921

(608) 266-8931

Dreux.Watermolen@Wisconsin.gov

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1. Introduction

What This Report Is About

In 2003, the Wisconsin Department of Natural Resources (Wisconsin DNR) prepared a concept paper addressing “Environmental Protection through Sound Land Use Decisions: A Federal-State-Local Partnership.” That concept paper defined a set of goals and spelled out a technology transfer program focused on Internet and geographic information systems (GIS) computer technologies that could be used to achieve those goals. The envisioned partnership involved on-the-ground outreach and assistance through regional sessions that support and enhance community land-use decision making. In 2004, the U.S. Environmental Protection Agency (U.S. EPA) awarded a water quality management planning grant to the Wisconsin DNR under this partnership to build capacity and provide technical assistance focused on Internet tools for planning, conservation, and environmental protection.

This document describes work undertaken by Wisconsin DNR and its partners between 2003 and 2008 to assess the technology transfer needs of specific target audiences and then build capacity among those audiences to use various Internet and GIS-based tools. (These technology transfer efforts are referred to throughout this report as “the Wisconsin DNR program”). The document also describes the results of Wisconsin DNR’s efforts to assess and evaluate the efficacy and transferability of these educational efforts and presents lessons learned and implications for other states wishing to build capacity among their local decision-makers. We make recommendations to address challenges associated with the tools, to better understand the needs of particular audiences, and to improve technology transfer. The report also documents our efforts to further evaluate and refine water quality modeling tools included in the program. Finally, this document fulfills our reporting requirements for the U.S. EPA Federal Assistance Agreement (No. C6-96539401-0).

Why We Did This Work

Many modern environmental issues (e.g., nonpoint source water pollution, greenhouse gas emissions, habitat fragmentation and loss, etc.) result from the cumulative actions of numerous individuals and the land-use decisions we collectively make. As such, dealing with these concerns requires new ways of looking at their causes, effects, and possible solutions. To be successful in addressing environmental concerns, natural resources agencies must work with others to help guide development patterns to prevent or minimize negative environmental impacts.

Through the Smart Growth Network, the U.S. EPA works with states and communities to find ways to grow while minimizing environmental and health impacts. “Smart growth” development approaches have clear environmental benefits, including improved air and water quality, increased wetland preservation, additional brownfields site remediation and reuse, and expanded open space preservation. To encourage smart growth, the U.S. EPA works with others to identify and pursue new policies, facilitate collaboration and communication between varied interests, provide technical assistance, and create incentives for increasing the efficiency of environmental protection. An important part of the U.S. EPA’s science-based efforts includes the development and dissemination of tools that can support local planning and environmental management efforts. These federal efforts parallel state efforts begun in the mid-1990s.

Effective local land use and watershed management efforts depend on an integrated approach that brings together scientific, education, and training advances made across many disciplines and modified to fit the needs of the individuals and groups who must write, implement, evaluate, and adjust community plans. Increasingly, government agencies are harnessing the power of the Internet, GIS, and related technologies to help meet increasing service demands and stretch tax payer dollars. Innovative applications of these computer-based tools are improving citizens’ accessibility to information that affects them where they live and work. These tools can play a central role in informing and improving decision making.

Recognizing the potential of the Internet to support local environmental management, U.S. EPA's Region 5 office, Michigan State University, and Purdue University co-hosted a "Midwest Web-based Spatial Workshop" in Chicago in April 2002. Participants included state, federal, and tribal water resource managers, the land grant university extension community, and local government representatives. Tool developers demonstrated various GIS and decision-support systems and the practitioners shared experiences and "wisdom" learned from their "on-the-ground" experience. Workshop outcomes included a commitment by participants to advance region-wide, Web-based decision support efforts for watershed management and formation of the Midwest Partnership for Watershed Management Spatial Decision Support Systems (referred to as the Midwest Partnership throughout this report). Wisconsin DNR became a member of this partnership in 2003. Purposes of the Midwest Partnership include:

- Improve the management of watersheds in U.S. EPA's Region 5 through the development, promotion, and use of Web-based, user-friendly, geo-spatial, watershed management data and decision support systems.
- Help set the standard for other watershed management programs across the country.

We undertook the work described in this report to complement these ongoing efforts. We believe the lessons learned through the Wisconsin DNR program and our involvement in the Midwest Partnership can inform current and future tool development and technology transfer initiatives and ultimately improve environmental decision making. These outcomes are consistent with the goals identified in Wisconsin DNR's strategic plan: making people our strength, sustaining ecosystems, and protecting public health.

Report Organization

Our work to implement the Wisconsin DNR program has been interdisciplinary; our approach draws on research and practice from diverse disciplines, often tying these fields together in complex (and, perhaps, innovative) ways. As a result, detailing our work is a complicated process. We found it necessary to divide this report into several main sections in order to present a comprehensive and coherent review of our work:

Transfer of Science Knowledge and Technology – We begin the report by describing the educational model employed in the Wisconsin DNR program. Chapters 2 and 3 in this section provide an overview of outreach, training, technical assistance, and capacity building approaches, as well as our learning objectives, outputs, and outcomes.

Internet Tools – The second section addresses the various Internet and GIS technologies addressed by the Wisconsin DNR program. Chapter 4 includes a discussion of our assessment activities and presents a useful inventory of Web-based tools.

The Wisconsin DNR Program – The central part of our report describes the outreach, training, and technical assistance activities undertaken with various target audiences as part of the Wisconsin DNR program. Chapters 5-10 document our work to measure outcomes and evaluate the effectiveness of the various technology transfer efforts. They also list outputs we produced during the grant period, including professional presentations and publications.

Evaluation and Refinement of Water Quality Modeling Tools – Our work with the tools and local decision makers resulted in a number of interesting research questions related to some of the tools. Chapters 11 and 12 report on efforts to further evaluate and refine specific tools through a model comparison study and an investigation of soil data resolution effects on model outputs. We also describe the use of newly available soils data in state and local decision-making process. Lists of outputs, including professional presentations and publications, produced during the grant period conclude each chapter.

General Project Administration – Chapter 13 overviews administrative details associated with our water quality planning grant. As part of the work plan for this grant, U.S. EPA requested that we place an emphasis on the transferability of the Wisconsin DNR program to other states (i.e. treat

this effort as a model program). Chapter 14 summarizes a number of initiatives we undertook in response to this request.

Lessons Learned, Transferability of Program, and Recommendations – This section, Chapters 15-17, summarizes lessons learned about Internet tools and technologies, the different target audiences, the use of the tools in state and local processes, and our instructional approaches and outreach materials. It concludes with recommendations for further research, additional technology transfer efforts, and ideas that other states might consider in their own programs.

Supporting Materials – A consolidated list of references cited throughout the report and further reading and background sources (Chapter 18), acknowledgements, and various appendices providing supplemental materials, including listings of project outputs, complete the report.

We hope this organization facilitates access to the information presented.

Transfer of Science Knowledge and Technology

2. Outreach, Training, Technical Assistance, and Capacity Building

At the heart of our efforts is a desire to understand how state and federal agencies can improve their ability to successfully influence widespread adoption of the Internet and GIS innovations that they generate. Such successful adoption will require the transfer of both science knowledge and technology to specific audiences who have needs that these innovations can address. This chapter defines key terms, briefly describes overarching agency concerns, and summarizes our current thinking about the primary purposes of educational programs as the context for our technology transfer efforts (referred to throughout the report as “the Wisconsin DNR program”). We also briefly describe how change relates to education programs and outline steps we took to address “success” factors. Finally, we conclude by listing references we found particularly useful in defining and developing the Wisconsin DNR program.

Key Terms

Our technology transfer work draws on research from a variety of social and cognitive sciences including educational and social psychology, anthropology, neuroscience, behavioral ecology, sociology, marketing, and adult education. Each field has its own specialized jargon. Some disciplines use different terms to describe the same concept. In other cases, researchers in different fields give the same term different meanings. As a result, we find it helpful, even necessary, to define certain terms in order to accurately characterize and clearly describe our work. Throughout this report, the following definitions, adapted from a range of sources, apply to the terms used in the Wisconsin DNR program.

Education – the acquisition of knowledge, skills, and competencies through the gradual process of learning and instruction; the formal and informal activities that impart knowledge, skills, and competencies on learners.

Outreach – the provision of programs, services, activities, and/or expertise by individuals in an organization to connect the organization’s ideas, tools, or practices to the efforts of other organizations, groups, specific audiences, or the general public.

Training – the acquisition of *practical* knowledge, skills, and competencies as a result of teaching related to specific useful competencies; planned learning experiences in which individuals learn to perform specific skills.

Technical Assistance – assistance provided to specific audiences by sharing expert knowledge to improve the adoption and implementation of specific tools, programs, policies, and evaluations.

Consultation – assistance provided to facilitate the identification and resolution of specific issues/problems pertaining to individuals or programs.

Capacity Building – assistance provided to entities which have a need to develop a certain skill or competence, or for general upgrading of performance ability; the process of developing and strengthening the skills, instincts, abilities, processes, and resources that organizations need to survive, adapt, and thrive in a changing world.

Of these technology transfer terms, education is broadest in its conception (i.e. “education is preparation for life”) and encompasses the others. Training, outreach, technical assistance, and consultation are generally interpreted as being more narrowly focused than education. Capacity building efforts include educational elements, but go further by creating enabling environments with appropriate policy and legal frameworks, managerial systems, institutional and human resources development, and community participation.

Approaches to outreach vary from impersonal, mass-marketing strategies that reach wide audiences to personalized, one-on-one efforts that target specific audiences. Outreach, which is generally proactive and program-focused, can be provided either on a gratis basis or with an associated charge and can reflect a

one-time or on-going, long-term effort. Regardless of the technique, outreach is generally one-way, with the organization being the provider.

Like outreach, technical assistance can be one-way, but differs in that it is responsive to the recipient's specific need (i.e. technical assistance is generally program-focused and reactive, offering a prescriptive solution). For example, a computer help-desk staffer will answer questions a user has about a software program thus maximizing the utility of that program for the user. When non-expert personnel carry out programs, data collections, or evaluations, or make policy decisions, technical assistance can inform their activities through the use of "best practices". In this way, technical assistance helps ensure the quality of the work/decisions and that the wanted outcomes match the end goals. Delivery of technical assistance is generally short-term in duration.

Consultation services are interactive. They rely on the process and subject expertise of the consultant and involve the client and other resources in applying solutions. Consultation may be short- or long-term in duration, but in either case, the services are time and task focused.

Approaches to training can be one-way, with the provider planning and conducting the learning experiences. Successful training programs, however, increasingly recognize the value of engaging the learners in defining the specific skills and competencies that training activities focus on (i.e. training generally relies on interactive approaches).

Capacity building leads to fluidity, flexibility, and functionality of an organization to adapt to changing needs. Most capacity is built by organizations themselves, although coaches, mentors, trainers, consultants, and technical assistance providers may play supporting roles. Capacity Building is more than outreach, training, technical assistance, and consultation, however, and includes:

1. Human resource development, the process of equipping individuals with the understanding, skills, and access to information, knowledge, and training that enables them to perform effectively. This can include mentoring and coaching, as well as training, consultation, and technical assistance.
2. Organizational development, the elaboration of management structures, processes, and procedures, not only within organizations but also the management of relationships between different organizations and sectors (e.g., public, private, community of practice, etc.). These aspects of capacity building also can include training, consultation, and technical assistance.
3. Institutional and legal framework development, making legal, regulatory, and policy changes to enable organizations, institutions, and agencies to enhance their capacities (Maconick and Morgan 1999, Linnell 2003, Global Development Research Center 2008). As with other aspects of capacity building, institutional development can include training, consultation, and technical assistance.

Most organizations that support capacity building recognize that capacity building is a long-term, continuing process, in which all stakeholders participate. For an organization, capacity building may relate to almost any aspect of its work: improved governance, leadership, mission and strategy, administration (e.g., human resources and financial management), program development and implementation, fundraising and income generation, diversity, partnerships and collaborations, evaluation, advocacy and policy change, marketing, positioning, planning, etc. For individuals, capacity building may relate to leadership development, advocacy skills, technical skills, and other areas of personal and professional development (Global Development Research Center 2008).

Education professionals recognize that successful transfer of science knowledge and technology requires work in all of these areas. These fields, however, continue to evolve. Historically, technology transfer methods have reflected linear "assembly-line" approaches that treat information as a product that is moved from a producer to the consumer. Over the past 20 years, however, these approaches have evolved to incorporate such concepts as multiple channels, customer-relationship management, partnerships, back-and-forth exchange, and personalization (Moeller and Seal 1984, Miner et al. 2007, Nadkarni and Stevenson 2009). New, state-of-the-art technologies, a multiplicity of technology transfer programs and projects, and advances in our understanding of how people acquire and use knowledge and skills suggest these fields will become even more diverse and complex.

The Purpose of Technology Transfer

Many types of organizations provide outreach, training, technical assistance, or other educational opportunities for adult learners. The centrality of these programs varies with the mission and goals of the organizations. The U.S. EPA and Wisconsin DNR have missions focused primarily on environmental protection and resource management. These agencies view technology transfer as a means to an end (i.e. environmental results), not necessarily an allied or corollary mission. Effective program planning requires these efforts to recognize the relationship between the overall agency missions and the primary purposes of their educational programs. This section briefly describes overarching agency concerns and summarizes current thinking about the primary purposes of educational programs as the pedagogic context for the Wisconsin DNR program.

Overarching Agency Concerns

The U.S. EPA's mission focuses on protecting human health and safeguarding the natural environment. The agency plays a leadership role in advancing environmental science, research, and assessment efforts and works closely with other federal agencies, state and local governments, and Native American Indian tribes to uphold its mission.¹ Similarly, the Wisconsin DNR strives for the preservation, protection, effective management, and maintenance of Wisconsin's natural resources. The agency is responsible for implementing state laws and, where applicable, federal laws that protect and enhance natural resources. It is the one Wisconsin state agency charged with full responsibility for coordinating the many disciplines and programs necessary to provide a clean environment and a full range of outdoor recreational opportunities for the state's citizens and visitors.²

How we use land and the land use decisions made today are some of the most important, long-term environmental issues our nation faces. In 1996 as a response to increasing concerns about the environmental effects of rapid urban and rural growth, the U.S. EPA formed the Smart Growth Network. Through this network, the U.S. EPA works with states and communities to find ways to grow while minimizing environmental and health impacts. Studies have demonstrated that "smart growth" development approaches have clear environmental benefits, including improved air and water quality, increased wetland preservation, additional brownfields site remediation and reuse, and expanded open space preservation. To encourage smart growth, the U.S. EPA works with others to identify and pursue new policies, facilitate collaboration and communication between varied interests, provide technical assistance, and create incentives for increasing the efficiency of environmental protection.³ An important part of the U.S. EPA's science-based efforts includes the development and dissemination of tools that can support local planning and environmental management efforts.

These federal efforts parallel state efforts begun in the mid-1990s to address land use issues. Among other actions, Wisconsin's Natural Resources Board in 1995 adopted two action items affirming a continued commitment to support local land-use decision making. These are to:

- develop a cooperative program with other agencies, businesses, organizations, and local governments to share information and increase knowledge on environmental issues and local land use planning and decision making, and
- develop public information and education programs with other agencies and organizations that explain the potential impacts of land use decisions and encourage informed, voluntary actions to minimize negative environmental impacts.⁴

¹ <http://www.epa.gov/epahome/aboutepa.htm>

² <http://dnr.wi.gov/aboutdnr/>

³ <http://www.smartgrowth.org/sgn/partdes.asp?partid=16&res=800>

⁴ Action A.2 and Action A.3 from Watermolen, D.J. and S.M. Fenner. 1995. *Common Ground: Report of the DNR Land Use Task Force*. Madison, WI: Wisconsin Department of Natural Resources.

In order to be successful in addressing environmental concerns, natural resources agencies must work with others to help guide development patterns. The Wisconsin DNR program reflects this thinking. It also recognizes that increasingly government agencies are harnessing the power of the Internet, geographic information systems (GIS), and related computer technologies to help meet increasing service demands and stretch tax payer dollars. Innovative applications of these computer-based tools are improving citizens' accessibility to information that affects them where they live and work. The Wisconsin DNR program also recognizes the central role that these tools can play in improving local decisions.

Why Educational Programs?

Contemporary program planning literature suggests that organizations conduct adult education and training programs, including outreach, technical assistance, and capacity building programs, for five primary purposes:

1. To encourage continuous growth and development of individuals.
2. To assist people in responding to practical problems and issues.
3. To prepare people for current and future work opportunities.
4. To assist organizations in achieving desired results and adapting to change.
5. To provide opportunities to examine community issues, foster change for the common good, and promote a civil society.

The Wisconsin DNR program serves several of these program purposes.

One primary program focus is on achieving desired outcomes (i.e. environmental results) and adapting to change (e.g., new regulations). For example, some computer tools allow users to predict changes in the quantity and quality of stormwater runoff resulting from land use modifications. Through the Wisconsin DNR program, awareness of and proficiency with these tools can help communities achieve reductions in runoff (environmental results) and compliance with Clean Water Act phase II stormwater rules (new regulations).

Through the Wisconsin DNR program, the agency seeks to provide opportunities for citizens, elected officials, planners, and natural resource professionals to examine a variety of local environmental issues. For example, Internet and GIS tools can be used to address issues like storm water runoff, groundwater recharge, air quality, and brownfields redevelopment. Further, the Wisconsin DNR program attempts to "foster change for the common good and promote a civil society" by bringing science-based tools to local decision-making processes. For example, when used properly, Internet and GIS tools can enhance public participation, community visioning, alternatives analyses, and impact predictions. They can also inform policy choices and legislative and administrative decisions.

Because land use issues (and therefore many environmental issues) are inherently local and often quite personal, the Wisconsin DNR program addresses practical problems and real-life issues. Through careful needs assessment, thoughtful program planning, and focused implementation, participants from each of the program's target audiences are able to use a variety of tools when carrying out their day-to-day, land-use planning and decision-making activities.

Finally, the Wisconsin DNR program compliments the agency's professional development initiatives. The agency endorses training and learning strategies intended to build knowledge, skills, and competencies on a department-wide level (Wisconsin DNR 2008). Along these lines, the Wisconsin DNR program targets agency staff in a range of natural resources and environmental programs statewide.

Change as a Program Outcome

Implicit in nearly all education programs (and each of the five program purposes outlined previously) is the expectation of change as an outcome or result. In order to be successful in affecting change, however, program planners must consider a number of factors when designing and implementing programs. This section briefly describes how change relates to education programs and outlines steps taken to address critical “success” factors when developing the Wisconsin DNR program.

The program planning literature outlines three types of change that education programs foster:

1. Individual change related to acquiring new knowledge, building skills, and examining personal values and beliefs.
2. Organizational change resulting in new or revised policies, procedures, and ways of working.
3. Community and social change that allows for differing segments of society to respond to the world around them in alternative ways.

The Wisconsin DNR program addresses all three types of change. First, the program helps participants develop practical knowledge and skills. For example, the learning outcomes for all target audiences include being able to identify tools that can be used in day-to-day work, as well as demonstrating the skills needed to use specific tools proficiently. The program also seeks to cultivate organizational changes. Specifically, the Wisconsin DNR program encourages modifications in the types of assistance Wisconsin DNR staff and UW-Extension educators provide local communities. The program also seeks to foster change in the manner in which local government officials make decisions by encouraging the use of science-based tools in local processes. Finally, the Wisconsin DNR program fosters change in the ways that citizens participate effectively in local processes. The use of the tools can give voice to those not usually heard, including those who may depend on particular environmental resources for their health, livelihood, and quality of life. This may be particularly important given the general public’s understanding of scientific content (e.g., only roughly one-third of the population has the ability to carry on a literate conversation about the science that underlies the important policy decisions of today [Miller 2004, 2006]).

Change is a process and not an event. In other words, change is not accomplished by having a one-time announcement by an executive leader, a two-day workshop... and/or the delivery of [equipment or other resources]. Instead change is a process through which people and organizations move as they gradually come to understand, and become skilled and competent in the use of new ways.

- Hall and Hord 2001

Factors Leading to Successful Technology Transfer

When developing the Wisconsin DNR program, we took steps to address three specific factors that have been identified as being critical to the success of adult learning programs (see “References and Related Reading” section for key information sources).

First, in order for education programs to result in change, concrete and workable transfer of learning plans must be developed and carried out. Such plans require technology transfer practitioners to identify clearly what is to be transferred: knowledge, skills, attitudes, and beliefs. Along these lines, we sought to articulate specific learning outcomes for each target audience within the context of a broader conceptual framework (see the “Conceptual Framework and Learning Outcomes” section below).

Second, contextual factors that affect the change process, such as political and economic realities, must be taken into account. As we developed the conceptual framework and articulated learning outcomes, we considered the factors unique to each target audience. For example, we acknowledged the various roles and responsibilities that Cooperative Extension educators fulfill by building on an existing document and articulating the relationship between Internet and GIS tools and the principles and roles that UW-Extension has defined relative to its programming (Wisconsin DNR 2004a). We also examined the *You, Extension, and Success (YES!)* competency-based professional development system put together by Texas Extension (2005). A set of core competencies forms the foundation for YES! These were built from focus groups and interviews with Extension faculty; the competencies describe the knowledge, skills (including technical skills), and attributes that they believe make Extension employees successful in their jobs. While not specific to Wisconsin, this program provides insights into the broader Extension culture. For more focused insight related to UW-Extension's professional development needs, we examined Cooperative Extension's "Career Development Model" (available online at <http://www.uwex.edu/ces/ag/facstaff/countyresourceguide.html>). Finally, we looked at recent evaluation efforts undertaken by UW-Extension (e.g., the article "Evaluating Extension-based water resource outreach programs: are we meeting the challenge?" [Shepard 2002]), as well as the commentaries on extension educational approaches and philosophies published in recent issues of the *Journal of Extension*.

Finally, to ensure success, planned assistance and support must be an integral part of technology transfer programs. As we carried out outreach efforts, training workshops, and consultations, we actively engaged participants in defining post-training support needs. We also looked to our institutional partners (e.g., UW-Extension Center for Land Use Education, University of Wisconsin Land Information and Computer Graphics Facility, Wisconsin Chapter of the American Planning Association, etc.) for advice and counsel on what capacities must be developed to successfully accomplish our program objectives. We outline ways Wisconsin DNR will provide follow up support as part of the program in the "Lessons Learned, Transferability of Program, and Recommendations" chapter. However, the development of further assistance and support approaches will, in part, depend on the availability of financial support.

References and Related Reading

We found the following references helpful in defining and developing our approach to technology transfer. We list these works, all other references cited, and additional useful sources together in the "Literature Cited, Further Reading, and Background Material" section at the end of this report.

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3. Learning Objectives, Outputs, and Outcomes

Current economic conditions increasingly require state and federal agencies be held to heightened standards of accountability. Through our efforts, we seek to increase efficiency through purposeful transfer from research and development to practice. This chapter defines key terms associated with measuring accountability, outlines the objectives for the Wisconsin DNR program, describes our program outputs and outcomes, and presents the underlying conceptual framework and specific learning outcomes for the Wisconsin DNR program. We also provide an overview of our approach to measuring outcomes. We conclude by listing references we found particularly useful in defining and developing these aspects of the Wisconsin DNR program.

Key Terms

Our technology transfer work, including the approach to assessment and evaluation, draws on a variety of disciplines including performance management, program planning, marketing, and adult education. Each has its own specialized jargon. Some disciplines use different terms to describe the same concept (e.g., output and deliverable). In other cases, practitioners in different fields give the same term different meanings (e.g., goal and objective). As a result, we define terms used in the Wisconsin DNR program in order to accurately characterize and clearly describe our work. Throughout this report, the following definitions, adapted from a range of sources, apply to the terms used.

Objective – a result that a program is attempting to achieve; a projected state of affairs that a program intends to accomplish.

Output – activity, effort, or associated work products related to a goal or objective, produced or provided over a period of time or by a specified deadline; a project deliverable.

Outcome – the result, effect, or consequence that will occur from carrying out a program or activity that is related to a programmatic goal or objective.

As indicated earlier, a primary focus of the Wisconsin DNR program is to understand how state and federal agencies can improve their ability to successfully influence widespread adoption of their Internet and GIS innovations. To this end, the Wisconsin DNR program includes documentation and measurement of objectives, outputs, and outcomes.

Program Objectives

Most decisions that affect the quality of the environment are made by individuals and local units of government. The Wisconsin DNR program works to enable people involved in local environmental management to use science-based computer tools to inform their planning and decision making and consider priority environmental issues.

Consistent with contemporary program planning approaches and adult learning theories, we ensured that measurable and non-measurable program outcomes were included in the Wisconsin DNR program. The concept paper that originated our efforts and the Wisconsin DNR's application for funding included the following program objectives:

- Increase use of data and decision support tools in local comprehensive planning processes.
- Increase natural resource management and environmental protection in local comprehensive plans.
- Increase use of data and decision support tools in land use decisions at the local level.
- Increase natural resource and environmental protection considerations in local decisions.
- Increase participation in local land use planning and decision making.
- Increase coordination, access, and cooperation between federal and state resources.

Using these program objectives as a base, we developed a conceptual framework and learning outcomes that reflect what participants would learn (see the “Conceptual Framework and Learning Outcomes” section and Table 3.3 below), the resulting changes from that learning, and the operational aspects of the Wisconsin DNR program (described for each target audience in later chapters).

Measuring Outputs and Outcomes

Outputs result from activities or processes and are generally tangible products (i.e. they can be seen, felt, or moved about) that are produced for a specific customer/audience. In technology transfer programs, example activities and their corresponding outputs might include:

- Raising awareness of a new technology – a factsheet.
- Teaching someone how to use a new tool – a workshop.
- Sharing lessons learned – a conference presentation.

Other examples of outputs from technology transfer projects include technical assistance services, consultations, Webconferences and Webcasts, peer-reviewed journal articles, instruction manuals and other documents, and similar deliverables. The Wisconsin DNR program resulted in many outputs. At the end of each chapter, we list presentations and publications specifically related to the work discussed in the chapter.

Audiences usually have expectations about both the process (how they get what they want) and the output (what they actually get). For example:

A factsheet may be:

- correct, or full of errors (accuracy).
- easy to understand by the audience, or full of jargon (customer perception of clarity).
- what the customer wanted to see or not (customer satisfaction).

A workshop may be:

- at an inappropriate time for the users’ process (timeliness).
- include too much or too little information (quantity).
- address needs, or not (customer perception of relevance).

We continually refined our products based on feedback from our target audiences. For example, we developed instruction manuals and reference materials tailored to the specific audience for each workshop that we conducted. We tailored these materials to the specific audience based on feedback from previous sessions (e.g., we asked how helpful the materials were and how they might be improved in workshop evaluation questionnaires) and input collected during workshop registration (e.g., we asked registrants how they might use the tools in order to develop appropriate classroom exercises).

Outcomes can be associated with a process or an output. Outcomes from environmentally focused technology transfer programs may be knowledge or attitude-based, behavioral, health-related, or environmental in nature, and ultimately reflect improvements in environmental or environmentally-based health-risk conditions. Outcomes can be categorized as follows:

First Order Outcomes: Changes in Knowledge, Attitudes, or Skills – First order outcomes reflect changes in learning, knowledge, understanding, attitude, or skills. First order outcomes are sometimes referred to as short-term or initial outcomes. For example, a short-term outcome could be an increase in regulated entities’ understanding of available options for “beyond compliance” management.

Second Order Outcomes: Changes in Behavior – Second order outcomes reflect changes in behavior, practice, or decisions. Second order outcomes are outcomes that are expected to lead to beneficial long-term outcomes but are not themselves “ends.” These are sometimes referred to as intermediate outcomes. An example of a second order outcome could be an improvement in

compliance (e.g., an increase in the number of facilities that monitor and report emissions with the proper frequency).

Third Order Outcomes: Changes in Condition – Third order outcomes reflect environmental results. These long-term outcomes stem from program objectives and are the ultimate reason for undertaking work efforts.

A primary difference between outputs and outcomes are time and measurability. Outputs are typically tangible and more easily measured objectively (e.g., we can count the number of presentations made, the number of factsheets distributed, etc.). Outcomes are often more difficult, but not impossible, to measure. Outcomes are documented through evaluative actions taken after some interval following project completion and are often measured subjectively by approximation. Being able to document results in the form of what actually happens is critical to an outcome orientation. However, without good information on what has happened, a focus on results is not possible. And for good information, one requires monitoring or tracking of progress in accordance with objectives and indicators, along with evaluation that can look at broader considerations. Such monitoring requires development of a baseline against which measurements can be made. We developed such a baseline through various needs assessments, pre-workshop questionnaires, and conference surveys.

The professional literature has long recognized the assessment and understanding of needs to be a critical element in educational program development (Boone 1985, Birkenholz 1999, Boleman and Cummings 2005). Rigorous assessment supports development of transfer of learning plans that effectively meet participants' needs, a key success factor. Target audience assessment is also critical to understanding how likely participants will be to adopt a new technology. As such, we assessed the needs of each target audience we worked with prior to initiating outreach, training, and technical assistance efforts. We wanted to use findings from our assessment efforts to avoid duplication of efforts among our partners and design program components that address the most critical issues and concerns of the various target audiences. In addition, research (e.g., Irani 2000, Nedovic-Budic and Godschalk 1996) suggests that previous computer experience, perceived usefulness/advantage, and exposure to technology are strong predictors of behavioral intent to use Internet and GIS tools. Similarly, direct experience research, such as the Technology Acceptance Model (Figure 3.1), suggests that those with greater prior experience with a technology will more likely use it than those who lack such experience and that increased perceptions of ease of use and technology usefulness lead to increased use. Therefore, understanding the factors that influence attitude and user perceptions toward Internet tools is another essential part of program design (Irani 2000).

Educational evaluation is often overlooked or avoided by technology transfer programs, but it is necessary to understand whether technology transfer efforts effectively reach their intended audience(s). In addition to our initial audience assessment work with each target audience, we implemented a participatory evaluation approach (Upshur and Barreto-Cortez 1995) to provide information for program improvement and organizational development. This on-going process identified issues, concerns, needs, capacities, and assets through pre- and post-workshop survey and evaluation forms, interactive discussions regarding the value of the tools and the information delivery mechanisms, and informal follow-up with participants.

We measured outcomes through a variety of workshop evaluation forms, follow-up surveys, and in-depth interviews, as well as through anecdotal evidence collected during the course of routine business:

- In-depth interviews of UW-Extension educators, 10-11 months post workshop.
- In-depth interviews of Wisconsin DNR staff, 6 months and 1 year post workshop.
- Convenience survey of planners, at conference 1 year after initial presentation.
- Online poll of WisLine Webconference participants (local government officials), post session.
- E-mail survey of local government officials, approximately 6 months post Webconference sessions.
- Workshop evaluation forms for all audiences.

Figure 3.1. *The Technology Acceptance Model. Modified from Hubona and Geitz (1999) and Irani (2000).*

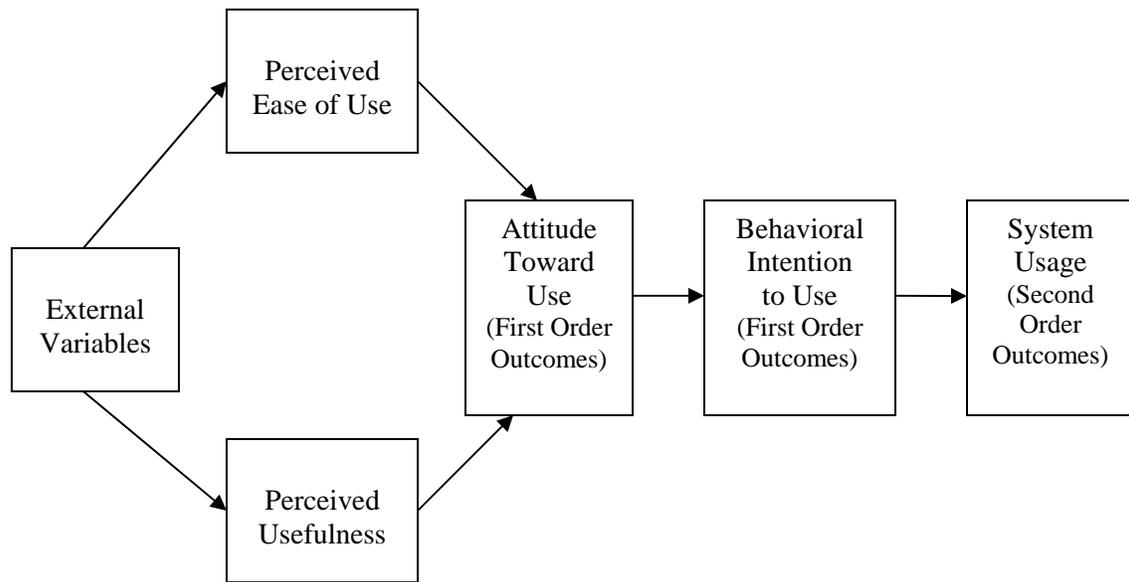


Table 3.1. *Program Activities, Outputs, and Outcomes: Use of Internet Tools in Local Decisions.*

Activities	<ul style="list-style-type: none"> Agency develops tradeshow display, PowerPoint presentation, fact sheets, instructional materials, workshop formats, presentation materials, Web site, etc.
Outputs	<ul style="list-style-type: none"> Display exhibited at local government association meetings. Fact sheets distributed at conferences, workshops, and events. Web site made available to public. Presentations made at professional meetings, conferences, etc.
Initial (First Order) Outcomes	<ul style="list-style-type: none"> Target audiences hear or read about Internet tools and their potential application.
Intermediate (Second Order) Outcomes	<ul style="list-style-type: none"> Target audiences are knowledgeable about tools and their uses. Target audiences use tools in planning and decision making processes.
Long-term (Third Order) Outcomes	<ul style="list-style-type: none"> Target audiences make more scientifically informed decisions. Target audiences make more environmentally sound decisions. Environment is protected and wisely managed.

In all cases, we asked if respondents used the tools and what impact the tools had on their decisions. Results of these evaluative measures are described for each of our target audiences in later chapters. Measureable outcomes from the Wisconsin DNR program include primarily first- and second order outcomes, that is, changes in awareness, knowledge, understanding, and tool use by the target audiences (Table 3.1). Given that major outcomes depend upon numerous factors working together and can occur in a more distant future, it was not possible to fully measure third order outcomes during the short duration (<5 years) of our grant period. As a result, our evaluations, interviews, and surveys paid particular attention to short-term and intermediate-level outcomes, and even to outputs in some cases. We did make an effort, however, to ascertain if our efforts led to any environmental results (third order outcomes).

The U.S. EPA funded the Wisconsin DNR program with the understanding that the program potentially could serve as a model for what other state environmental agencies might do to more fully integrate science knowledge and technology into their program implementation and policy decision making, particularly as that knowledge and technology might inform “smart growth” approaches. As a result, the Wisconsin DNR program includes outputs and outcomes related to the transfer of lessons learned to other states and agencies (Table 3.2).

Table 3.2. *Program Activities, Outputs, and Outcomes: Application of Lessons Learned by Other States.*

Activities	<ul style="list-style-type: none"> • Program staffers develop PowerPoint presentation and talking points summarizing lessons learned and assessment findings.
Outputs	<ul style="list-style-type: none"> • Presentations given at professional meetings attended by representatives from other states’ agencies. • Fact sheets distributed at conferences, workshops, and events.
Initial (First Order) Outcomes	<ul style="list-style-type: none"> • Target audiences hear or read about Wisconsin DNR’s experiences and their potential application.
Intermediate (Second Order) Outcomes	<ul style="list-style-type: none"> • Target audiences are knowledgeable about tools and their uses. • Target audiences evaluate tools for their own planning and decision-making processes.
Long-term (Third Order) Outcomes	<ul style="list-style-type: none"> • Other states develop technology transfer programs that support more environmentally sound decisions. • Environment is protected and wisely managed.

Conceptual Framework and Learning Outcomes

The conceptual framework (Table 3.3) builds on a recognized learning and instructional model used widely in the development of environmental education curricula (e.g., see Engleson and Yockers 1994). A fundamental underlying concept of this model is that learners move along a continuum of learning from perceptual awareness to informed action. Along the way, learners develop attitudes, knowledge, and skills (often collectively referred to as competencies).

In developing learning objectives, we considered a variety of contextual issues and acknowledged current theories about adult learning. Specific key principles of adult learning that we considered when developing the framework include:

1. Adults have a rich background of knowledge and experience and learn best when this experience is acknowledged and new information and skills build on their past knowledge and experience.
2. Adults are not likely to willingly engage in learning unless the learning is meaningful to them.
3. For the most part, adults are pragmatic in their learning. They want to apply their learning to present situations.

Table 3.3 presents the conceptual framework and learning outcomes for the Wisconsin DNR program. In developing Table 3.3, we first used brainstorming techniques to identify and list a full range of awareness, knowledge, skills, and actions that all four target audiences *could* learn. We then organized these outcomes under the “awareness,” “knowledge,” “skills,” and “action” headings (structuring outcomes in this manner fosters a logical progression of learning). This table encompasses the full range of educational possibilities.

Next, we identified a subset of concepts that each audience *should* learn. These learning objectives are indicated with an “X” in Table 3.3. Consistent with current educational approaches, learning objectives for the different audiences fall into five major categories of learning outcomes:

1. Acquisition of knowledge.
2. Enhancement of cognitive skills.
3. Development of psychomotor skills.
4. Strengthening of problem-solving and finding capabilities.
5. Changes in attitudes, values, beliefs, and/or feelings.

Generally, a mix of outcomes is included under the “awareness,” “knowledge,” “skills,” and “action” headings for each audience.

Finally, we identified those attitudes, concepts, skills, and actions that each audience *must* learn in order for the objectives of the Wisconsin DNR program to be considered successful. These objectives are identified with a boldfaced “X” and are shaded in gray in Table 3.3.

In deciding what participants *should* and *must* learn, we took into consideration a variety of economic and political factors. For example, the U.S. EPA’s Office of Wetlands, Oceans, and Watersheds provided the initial funding for the Wisconsin DNR program, while the State’s forest mill taxes and nonpoint source water pollution control funding support the UW-Extension’s basin educator positions. Therefore, a stronger emphasis was placed on tools that address forestry and water quality issues in the objectives for UW-Extension agents and Wisconsin DNR staff. Similarly, we emphasized tools developed by the U.S. EPA and Wisconsin DNR for all audiences.

Since Wisconsin DNR staff members serve functionally as consultants to local government staff and decision makers, we place a greater emphasis on awareness and knowledge of a broad spectrum of tools and their applications and a lesser emphasis on the skills needed to use most of the specific tools. Similarly, because UW-Extension’s primary focus is on education, we place an emphasis on UW-Extension educators developing technology transfer skills (i.e. an ability to convey information about tools to others).

Finally, the learning objectives included in Table 3.3 were modified from earlier versions (e.g., Wisconsin DNR 2004b) to reflect refinements in our thinking developed during program implementation and evaluation.

Table 3.3. Conceptual Framework and Basic Learning Outcomes for Wisconsin DNR Program (First and Second Order Outcomes).

	Extension Educators	DNR Regional Program Staff	Planners	Local Government Decision Makers
Awareness				
Participants will be able to:				
- Describe various types of available tools and technologies:				
- Data access and data provision tools	X	X	X	X
- Interactive mapping tools	X	X	X	X
- Data analysis and predictive modeling tools	X	X	X	X
- Explain the concepts of planning and decision-support tools		X	X	X
- Identify resources for accessing tools:				
- County Land Information Surveys	X	X	X	
- Midwest Spatial Decision Support System Partnership	X	X	X	X
- Wisconsin DNR Web site	X	X	X	X
- PlaceMatters.com	X	X	X	X
- LICGF Community Planning Resource	X	X	X	X
- Describe the benefits and limitations of using decision support tools	X	X	X	X
Knowledge				
Participants will be able to:				
- Identify specific tools available for use in Wisconsin				
DATA ACCESS AND DATA PROVISION TOOLS				
- WISCLINC	X	X	X	
- ATRI – Metadata Explorer	X	X	X	X
- Natural Heritage Inventory Online Database	X	X	X	X
- WisAHRD	X		X	X
- Wisconsin Coastal Image Server	X	X	X	
- Environmental Remote Sensing Center Web site	X	X	X	
- Window to My Environment	X	X	X	X
- Geospatial One-Stop	X		X	
- National Geospatial Clearinghouse	X		X	
- Soils Data Mart	X	X	X	
- USDA Geospatial Data Gateway	X	X	X	
- WATERS	X	X		
- EPA AirData	X	X		
- EGIS	X		X	
- Applied Population Laboratory’s WisStat	X	X	X	

Table 3.3, Continued.

	UW-Extension	DNR	Planners	Decision Makers
Knowledge, Continued				
- Identify specific tools available for use in Wisconsin, Continued				
INTERACTIVE MAPPING TOOLS				
- ATRI – Comprehensive Planning Web Mapping Site	X	X	X	X
- DNR WebView Site	X	X	X	
- DNR Dam Safety Site	X	X		
- DNR Floodplain Analysis Database Site	X	X		
- DNR Registry of Closed Remediation Site	X	X	X	
- UW Botany Dept. BioMapper	X	X		
- EnviroMapper for Water	X	X	X	X
- National Map On-line Map Service	X		X	
- National Wetlands Inventory Mapper	X	X	X	
ANALYSIS AND PREDICTIVE MODELING TOOLS				
- CITYgreen	X			
- CommunityViz	X		X	
- Digital Watershed	X	X	X	X
- Water Erosion Prediction Project	X			
- LTHIA	X	X	X	X
- TURM	X			
- Uplan	X		X	
- PLACE ³ S	X		X	
- TRANSIMS	X		X	
- Explain how tools can be used in each step in the planning process				
- Visioning (e.g., CommunityViz, CITYgreen, ...)	X		X	X
- Inventory (e.g., ATRI, NHL, Window to My Environment...)	X	X	X	X
- Analysis (e.g., LTHIA, ATIOD, ...)	X	X	X	X
- Alternatives Selection (e.g., LTHIA, What if?, ...)	X	X	X	X
- Implementation and Monitoring (e.g., TURM, WATERS, CommunityViz, CITYgreen, ...)	X		X	X
- Plan Updating (e.g., Dane INDEX, Place IT, ...)	X		X	X
- Explain how tools can be used in other types of land use decisions				
- Special use permits	X		X	X
- Zoning classifications and variances	X		X	X
- Subdivision platting (LTHIA, ...)	X		X	X
- Site design (LTHIA, ...)	X	X	X	X
- Road siting and expansion	X	X	X	X
- Transportation infrastructure improvements	X	X	X	X
- Sewer service area extensions (LTHIA, ...)	X	X	X	X
- Land acquisition (ATRI, Digital Watershed, LTHIA, ...)	X	X	X	X

Table 3.3. Continued.

	UW-Extension	DNR	Planners	Decision Makers
Knowledge, Continued				
Participants will be able to:				
- Explain how tools can be used in other types of land use decisions, Continued				
- Recreational facilities development	X	X	X	X
- Facilities siting (ATRI, LTHIA, ...)	X	X	X	X
- Trail opportunities	X	X	X	X
- Identify appropriate tools for specific environmental issues				
- Watershed planning	X	X	X	X
- Non-point run off	X	X	X	
- Storm water, flooding	X	X	X	X
- Groundwater recharge		X	X	
- Wetland protection and restoration		X	X	
- Shoreland management and restoration	X	X	X	
- Air emissions		X		
- Greenhouse gases/global warming		X		
- Urban forestry	X	X		X
- Tree canopy	X	X		
- Forest fragmentation	X	X		
- Invasive and exotic species		X		
- Wildlife management	X	X		
- Noise pollution		X	X	X
- Light pollution		X	X	X
- Historic preservation	X		X	X
Skills				
Participants will be able to:				
- Convey basic information about tools, tool use, and tool resources	X	X	X	
- Use specific tools proficiently				
DATA ACCESS AND DATA PROVISION TOOLS				
- WISCLINC	X	X	X	
- Wisconsin EcoAtlas	X	X	X	X
- Natural Heritage Inventory Online Database	X	X	X	X
- WisAHRD			X	
- Wisconsin Coastal Image Server	X	X	X	
- Window to My Environment	X	X	X	X
- Soils Data Mart		X	X	
- WATERS		X	X	

Table 3.3. Continued.

	UW-Extension	DNR	Planners	Decision Makers
Skills, Continued				
Participants will be able to:				
- Use specific tools proficiently, Continued				
INTERACTIVE MAPPING TOOLS				
- ATRI – Comprehensive Planning Web Mapping Site	X	X	X	X
- DNR WebView		X		
- DNR Dam Safety Site	X	X	X	
- DNR Floodplain Analysis Database Site	X	X	X	
- DNR Registry of Closed Remediation Sites	X	X	X	
- EnviroMapper for Water	X	X	X	X
ANALYSIS AND PREDICTIVE MODELING TOOLS				
- CommunityViz	X		X	
- Digital Watershed	X	X	X	
- LTHIA	X	X	X	X
- What if?	X		X	
Action				
Participants will:				
- Convey information about tools to others:				
- Describe various types of available tools and technologies	X	X	X	
- Identify resources for accessing tools	X	X	X	
- Describe the benefits and limitations of using decision support tools	X	X	X	X
- Identify specific tools available for use in Wisconsin	X	X	X	
- Explain how tools can be used in each step in the planning process	X	X	X	
- Explain how tools can be used in other types of land use decisions	X	X		X
- Identify appropriate tools for specific environmental issues	X	X	X	
- Use tools in the planning process	X	X	X	X
- Use tools in other land use decision processes	X	X	X	X
- Encourage others to use tools in decisions	X	X		
- Evaluate their use of tools in decisions	X		X	X
- Share experiences with technical assistance providers (i.e. Wisconsin DNR, UW-Extension, etc.)	X	X	X	X

References and Related Reading

We found the following references helpful in defining and developing learning objectives and output and outcome measures. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, Further Reading, and Background Material” section at the end of this report.

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Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described the Wisconsin DNR program, the underlying conceptual framework, and our approach to learning objectives and outcome measures. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

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Watermolen, D.J. 2005. Computer Tools to Link Smart Growth with Clean Water. 4th Annual New Partners for Smart Growth: “Building Safe, Healthy, and Livable Communities” and “Water, Water Everywhere: Protecting Water Resources with Smart Growth.” Deauville Beach Resort Hotel, Miami Beach, FL. (January 27-29, 2005).
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Watermolen, D.J. 2004. Outreach to Local Decision Makers: A Wisconsin Case Study. “Public Sector Approaches to Promoting Sustainable Development” conference. U.S. Environmental Protection Agency, Region 5, Ralph Metcalfe Federal Building, Chicago. (July 26-27, 2004).

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Internet Tools

4. Assessment and Inventory of Tools

Local, state, and federal agencies and their academic and private sector partners have developed a wide range of tools that are now accessible via the Internet. In this chapter, we describe the range of available tools, report on our work to determine what features make specific tools particularly useful for the target audiences we work with, and present an inventory of available tools that meet these criteria. Finally, we list references we found particularly useful in developing our understanding of the various tools and underlying technologies. We presented much of this work at professional meetings and previously published some of our results in various peer-reviewed outlets. A list of these outputs appears at the end of the chapter.

Key Terms

We draw from a wide variety of disciplines, many which readers may not be particularly familiar with. Each has its own specialized jargon. As a result, we find it necessary to define certain terms in order to accurately characterize and clearly describe the tools we work with. Throughout this report, the following definitions, adapted from a range of sources, apply to the terms used.

Geographic Information System (GIS) – a system of hardware, software, data, people organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth.

Internet GIS – the integration of Internet technologies with geographic information systems technologies. Authors refer to Internet GIS using various terms including Web-based GIS, online GIS, and Internet distributed GIServices.

Visualization Tool – desktop application or Web-based tool that enables users to graphically represent sets of data, often in 3-dimensional models. When data are large or abstract, visualization tools that employ virtual reality technology can help make the data easier to interpret or understand.

Expert System – desktop application or Web-based tool that applies artificial intelligence to narrowly and clearly defined problems. Expert systems typically combine rules with facts to draw conclusions, rely heavily on theories of logical deduction, and are developed using heuristic methods or conventional computer programs (Ortolano and Perman 1990).

Planning Support System (PSS) – interactive computer-based system, typically a desktop application or set of applications, that enables users to complete comprehensive planning analyses and tasks, such as gathering relevant information, evaluating alternative scenarios (quantitatively and visually), preparing plans, monitoring results, and evaluating contingencies. Planning support systems can be data-driven, model-driven, communication-driven, or a combination.

Decision-Support System (DSS) – interactive computer-based system that helps decision makers use data and models to solve unstructured problems (Sprague and Carlson 1982). Decision support systems can improve the process or outcome of decision-making through analysis and visualization of alternatives and their effects, assimilation of available knowledge and data into a decision-making process, and assessment of the level of certainty of different predictions (Gorry and Morton 1971, Siepl 1997).

Spatial Decision Support Systems (SDSS) – a decision-support system that includes spatial data and analysis. A spatial decision support system typically consists of: 1) a database management system (to hold and handle the geographical data), 2) analytical and statistical models that can be used to predict the possible outcomes of decisions, and 3) an interface to aid the users' interaction with the computer system and to assist in analysis of outcomes.

Internet Tools – Web-based tools that allow users to discover, access, acquire, manipulate, analyze, or map data for planning and decision-making purposes. We use this term to encompass a range of technologies including the types of tools that follow.

Data Discovery Tools – Web-based tools that allow users to discover and learn about available data or information.

Data Access Tools – Web-based tools that allow users to access available data or information by providing either directions or the contact information for data custodians. These tools prove useful when data is proprietary or in cases when making information broadly accessible creates security concerns (e.g., revealing specific locations of sensitive water supply infrastructure). These tools can also direct users to a source when data do not exist electronically, such as paper maps or historical records.

Data Provision Tools – Web-based tools that allow users to acquire available data or information either through free downloads or purchase. Increasingly, state and federal agencies are making data they maintain accessible free-of-charge or at low cost over the Internet.

Interactive Mapping Tools – Web-based tools that allow users to visualize spatially-referenced data by producing maps. These tools may additionally allow users access to downloadable data with the ability to integrate those data spatially to produce customizable maps. This added visual element can be an effective way to communicate consequences of land use decisions and evaluate decision alternatives.

Data Analysis Tools – Web-based or downloadable tools that allow users to manipulate data in order to test different scenarios or hypotheses. A user can set up constraints, indicators, variables, and assumptions, and by changing the values of these settings can use the tool to interpret new representations of the landscape.

Predictive Modeling Tools – Web-based or downloadable tools that allow spatial data manipulation for hypothetical scenarios (e.g., land use futures) with predictive results, often including some type of visual imaging. Predictive modeling tools can be costly and must be developed by individuals with technical expertise. Once developed, however, they can be used for similar situations using different data.

Assessment of Tools

The ultimate value of a technology lies in the extent to which it is transferred and adopted and used by individuals and groups who can apply it to their particular needs. Surprisingly, we have found that developers of many computer applications built for the explicit purpose of assisting decision makers and interested publics have not considered two key aspects of such development:

1. the types of tools that specific stakeholders need, and
2. the characteristics that make particular tools useful.

Ongoing consideration of these interrelated factors should be requisite when investing in emerging technologies and developing new tools. We can capitalize on our investments most effectively when we fully understand the business needs that the data and technology are intended to support. Failure to consider the needs and preferences of end users can result in data and tools that do not adequately address organizations' goals and processes, resulting in tools that largely go unused. Over the past few decades, state and federal government agencies have spent millions of dollars developing environmental modeling tools. These tools may be used widely in research settings, but we have found that local officials rarely incorporate these tools into their decision-making processes (e.g., only 16% of Georgia land use planners indicated that they used land cover change models in their planning processes [Merry et al. 2008a]). These tools often lack the type of cross-community translation and outreach functions needed to meet the needs of the planning community's constituencies (Stein 2007).

The Wisconsin DNR program addressed these issues. In an effort to understand how GIS and Internet technologies might aid local decision making, the Wisconsin DNR assembled representatives from diverse agencies and organizations that make or influence land use decisions for two workshops in 2003 and 2004. These workshops, “Changing Landscapes: Anticipating the Effects of Local Land Use Decisions” and “Changing Landscapes 2,” each introduced over one hundred participants to a wide range of technologies, with an emphasis on Web-based, decision-support tools. Tool developers demonstrated their tools, asked for participant feedback regarding their utility and accessibility, and discussed strategies for promoting their use. We also asked the participants to evaluate the tools against a number of measurable criteria to help us understand how useful these tools would be to the participants’ work as well as to the public at large. We wanted to identify the factors that make tools particularly useful. Lucero (2003, 2004) summarized results from these workshops and we highlight key points below.

What Types of Tools Do People Need?

To maximize their return on investment in data and technology, governmental agencies need to look beyond the technologies and examine the actual tasks or business processes the tools are capable of addressing. Not surprisingly, we learned from our workshops that different users have different needs and as a result need/want a range of GIS and Internet tools—data discovery, data access, data acquisition, interactive mapping, analytical and predictive modeling, and decision-support (Figure 4.1). For example, citizen planners generally lack access to GIS hardware, software, and data, and as a consequence rely on Internet mapping applications to aid their involvement in planning and decision-making (e.g., see Welch 2005). Professional planners, however, often have access to GIS resources and therefore find data discovery and data access tools more useful. From work elsewhere, we also know that carefully constructed spatial models can be particularly useful for integrating ecological information and communicating assumptions, potential uncertainties, and the complexity of feedbacks to various local stakeholders and can enhance public participation in local processes (Convis 2001, Dale 2003, Conroy and Gordon 2004, Aggett and McColl 2006a, 2006b).

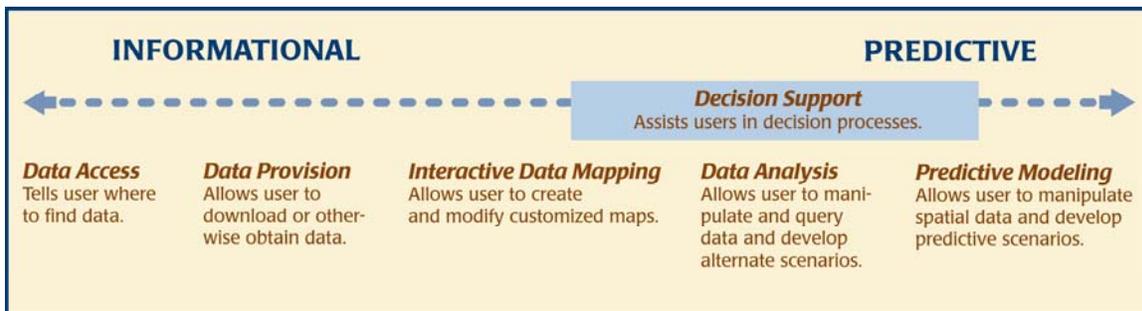


Figure 4.1. *Functional Range of Tools Desired by End Users Working at Local and State Levels (Modified from Lucero et al. 2004, Watermolen 2008).*

Based on feedback received at our workshops, we suggest that agency efforts include the development, maintenance, and promotion of a wide range of data products and tools. Different users will need to discover available data conveniently, easily access those data, generate useful map products derived from the available data, and manipulate those data to predict outcomes and impacts of various types of decisions.

What Makes a Tool Useful?

Our analysis of participant evaluations of the various tools demonstrated during the “Changing Landscapes” workshops yields a list of criteria (Table 4.1) that characterize tools identified as being most useful to a range of local government decision makers. For example, Purdue University’s Long-term Hydrologic Impact Assessment (LTHIA; see <http://www.ecn.purdue.edu/runoff/lthianew/>) tool, which

participants considered very useful, can help regional planning commissions quantify nonpoint source water pollution impacts from alternative land management decisions, however, citizen watershed groups also can use it effectively to document the water quality benefits of their land protection efforts (Welch 2005). These criteria are consistent with factors identified in previous research and technology acceptance models (e.g., Irani 2000, Nedovic-Budic and Godschalk 1996).

Table 4.1. *What Makes a Tool Useful?*

<u>Characteristic</u>	<u>Explanation</u>
Web-based	Accessible via the Internet; only required software or hardware is an Internet browser.
Cost-free	Housed within the public domain; no purchase cost. Our research indicates that tools that perform basic functions like data access, interactive mapping, and routine modeling increasingly will be made available in the public domain.
Data included	Data required for the tool to function is implicit to the tool. For example, all mapping tools contain spatial data sets that can be customized and displayed to illustrate local conditions. For modeling tools, only the most basic inputs are required. Thus, there is no cost to create unique scenarios when using the tools.
Scalable	Data are accessible at various spatial scales. Tool allows user to assess local conditions within a regional context.
Customizable	Users can address specific needs through features inherent in the tool or through “plug-in” components.
Relatively intuitive	Tools have a user friendly interface. As users and tool developers increasingly rely on Internet-based services for their daily activities (e.g., travel arrangements, news sources, search engines, etc.), consistent, intuitive navigation features are becoming increasingly common. We know from research elsewhere that perceptions of ease of use affect technology use (Hubona and Geitz 1999).

Inventory of Tools

The tools included in our “tool box” met many, if not all, of the criteria listed in Tables 4.1 and 4.2. Criteria in Table 4.1 consider usefulness and accessibility (adapted from Lucero 2003, Lucero 2004, and Lucero et al. 2004); those in Table 4.2 consider relevance to the Great Lakes Basin and natural resources management/environmental protection topics. When we began our inventory efforts, we conducted a nation-wide industry scan to identify tools that fit the criteria in Table 4.1. The large number of available tools astonished us and we found it necessary to focus our inventory effort by applying the criteria in Table 4.2. Initially, we focused on tools relevant to Wisconsin, but then expanded our inventory efforts at the request of the U.S. EPA’s Great Lakes National Program Office to include those tools with relevance to decision makers in other Great Lakes states as well.

Table 4.2. *What Makes a Tool Relevant?*

<u>Characteristic</u>	<u>Explanation</u>
Has a natural resource component	Tools that address natural resource issues. Tools incorporating multiple issues—environmental features, social issues, economic development, etc.—may be the most useful tools.
Applicable for use in the Great Lakes Basin	The geographic scope of the tool includes part or all of Wisconsin or the Great Lakes Basin, at a minimum. Many tools capture national data sets and also can be applied elsewhere.
Useful for resource inventory	Cataloging and inventorying resources and environmental features is an essential step in the planning process. Tools that allow this enable decision makers and planners to address current issues and plan for future scenarios.
Can help fulfill requirements or meet regulations	Tools that help citizens and government accomplish their central roles and make informed decisions, or otherwise support government functions with regard to natural resource management and environmental protection.
Useful for developing or implementing natural resource/environmental programs or plans	Tools that help municipal staff, elected officials, nonprofit groups, environmental educators, consultants, and others prepare programs and plans to preserve or manage important environmental resources.
Connect natural resources and comprehensive planning	Tools that allow natural resource issues to be integrated within the context of various plan elements. Comprehensive planning defines a process and framework for considering how disparate issues fit together.

Government agencies collect and manage lots of data, much of which have value for local environmental protection and management efforts. Fortunately, various clearinghouses, Web portals, Internet mapping sites, and online analysis and modeling tools help organize, catalog, and make these data accessible and meaningful. In the following sections, we present an inventory of Internet tools that generally meet the criteria discussed above and that we believe will prove useful to individuals working in the Great Lakes states. We deviate, however, from a strict application of the criteria in Tables 4.1 and 4.2 when presenting our inventory of tools for finding and accessing data. Two primary reasons underlie this approach. First, many of the available tools for finding and accessing data were developed by technical workers and are not necessarily “relatively intuitive” to the uninitiated user. Second, planners and natural resources professionals repeatedly told us of the importance of being able to find and access data. So, although these tools may not meet the predefined criteria in the strictest sense, they are *the* tools that are available to planners and natural resources professionals and are therefore included in the inventory.

We identify the tools and their developers, briefly describe their functionality, and provide URLs for each. We present the tools in functional categories to correspond with the types of tools that end users identified as important during the *Changing Landscapes* workshops. We also present tables that identify tools for use in specific Great Lakes states (Table 4.3) and for addressing impaired beneficial uses in the Great Lakes Basin (Table 4.5).

Tools for Finding and Accessing Data

Federal Agency and National Web Portals and Clearinghouses

AirData: Access to Air Pollution Data

Developer: U.S. EPA

Description: This clearinghouse provides access to air pollution data for the entire United States. Users can generate reports and maps of air pollution data based on criteria that they specify.

URL: <http://www.epa.gov/air/data/index.html>

Census TIGER, TIGER/Line, and TIGER-Related Products

Developer: U.S. Census Bureau

Description: This site provides access to TIGER[®] (Topologically Integrated Geographic Encoding and Referencing) Map Service (TMS) and Gazetteer applications and related Census Bureau geography products. TIGER/Line Shapefiles contain features such as roads, railroads, rivers, as well as legal and statistical geographic areas used to provide a digital base for GIS maps.

URL: <http://www.census.gov/geo/www/tiger/>

Data.gov Geodata Catalog

Developer: various federal agencies

Description: Data.gov’s Geodata Catalog provides a catalog of trusted, authoritative, federal geospatial data. The catalog includes links to download the datasets and a metadata page with details on the datasets, as well as links to more detailed Federal Geographic Data Committee (FGDC) metadata information.

URL: <http://www.data.gov/catalog/geodata>

EPA Geospatial Data

Developer: U.S. EPA

Description: U.S. EPA's National Geospatial Program coordinates the agency's geospatial data, applications, policies, and programs. This Web site provides an overview of EPA's National Geospatial Program including applications and data, most of which are for technical users.

URL: <http://www.epa.gov/geospatial/>

EROS Data Center (EDC): Entry Point to Geospatial Data Clearinghouse

Developers: U.S. Geological Survey and Federal Geographic Data Committee (FGDC)

Description: This site provides several interfaces that can be used to search for spatial data. Options allow searching by location, time period of content, full-text, and fielded search. Users can select one or more collections to query. These interfaces may also be used to search for spatial data that has been made available using Open Source GIS specifications. Once discovered, these map services can be viewed together.

URL: <http://clearinghouse1.fgdc.gov/fgdc/EDCgateway.html>

FEMA Map Service Center

Developer: Federal Emergency Management Agency

Description: This site provides access to the National Flood Hazard Layer, including online viewing, access via various Web mapping services, and ordering by state on DVD.

URLs: <http://msc.fema.gov> and <https://hazards.fema.gov/wps/portal/mapviewer>

FGDC Cadastral Data Land Records Viewer

Developer: Federal Geographic Data Committee (FGDC)

Description: The Land Records Viewer site lists states, counties, and cities known to serve land records information via the Web. In addition, the site has the federal and state agency contacts for cadastral information by state.

URLs: <http://www.nationalcad.org/> and http://www.nationalcad.org/lr_index.asp

The [FGDC] Clearinghouse Registry

Developer: Federal Geographic Data Committee (FGDC)

Description: This link provides access to the FGDC Clearinghouse Registry system. This system manages Z39.50 metadata servers located around the world. Users can access this Web site to edit their Z39.50 node information or to view the daily status of all nodes registered in the system.

URL: <http://registry.fgdc.gov/serverstatus/>

Forest Inventory Data Online (FIDO)

Developer: U.S. Forest Service

Description: The Forest Inventory Data Online tool provides access to the National Forest Inventory and Analysis databases. Users can generate tables and maps of forest statistics through a Web browser without having to understand the underlying data structures. The site provides standard reports for specific areas of interest and survey years, as well as customized reports based user selected criteria.

URL: <http://199.128.173.26/fido/index.html>

Geography Network

Developer: ESRI and partners

Description: The Geography Network site supports the sharing of information among data providers, service providers, and users. Through the Geography Network site, you can access many types of geographic content including dynamic maps, downloadable data, and more advanced Web services.

URL: <http://geographynetwork.com/>

Geospatial One-Stop Geodata.gov Portal

Developers: Federal Geographic Data Committee (FGDC) and National Spatial Data Infrastructure (NSDI) Clearinghouse Network

Description: This portal, a part of the Geospatial One-Stop Initiative, provides “one-stop” access to registered geographic information and related online access services. Geographic data, imagery, applications, documents, Web sites, and other resources have been cataloged for discovery in this portal. Registered map services allow users to build online maps using data from many sources. Registered data access and download services exist for downloading and analyzing the data using GIS or viewer software.

URLs: <http://www.fgdc.gov/dataandservices/>; <http://gos2.geodata.gov>

Great Lakes Information Network GIS

Developers: Great Lakes Commission and Great Lakes Information Network

Description: The Great Lakes Information Network Data Access site provides a suite of open source tools and applications intended to aggregate and disseminate geospatial datasets for the Great Lakes region. These data are organized and made available through the GLIN in a variety of formats and themes.

URL: <http://gis.glin.net/ogc/services.php>

National Biological Information Infrastructure

Developer: National Biological Information Infrastructure partners

Description: The National Biological Information Infrastructure (NBII) is a broad, collaborative program to provide increased access to data and information on the nation's biological resources. The NBII links diverse, high-quality biological databases, information products, and analytical tools maintained by various contributors in government agencies, academic institutions, non-government organizations, and private industry.

URLs <http://www.nbio.gov/portal/server.pt> and
[http://www.nbio.gov/portal/community/Communities/Geographic Perspectives/](http://www.nbio.gov/portal/community/Communities/Geographic_Perspectives/)

NOAA National Ocean Service Data Explorer

Developer: National Oceanic and Atmospheric Administration

Description: The National Ocean Service (NOS) Data Explorer serves as a portal to obtain NOS spatial data. This site allows users to search NOS data holdings, view metadata, and link to and/or download specific data sets. Data Explorer also offers interactive mapping tools that allow users to locate NOS products in any area in the United States and its territories through a metadata catalog.

URL: <http://oceanservice.noaa.gov/dataexplorer/>

NSGIC Ramona GIS Inventory

Developer: National States Geographic Information Council (NSGIC)

Description: Ramona provides a tool for states and their partners to track the status of GIS in state and local government to aid the planning and building of Spatial Data Infrastructures. Ramona is designed to work in concert with Geospatial One Stop.

URL: <http://www.gisinventory.net/> <http://www.gisinventory.net/summaries/>

The Nature Conservancy's Spatial Data Resources

Developer: The Nature Conservancy

Description: Spatial data and related information plays a vital role in The Nature Conservancy's approach to conservation. There is a wealth of data generated across the organization. The primary purpose of this site is to make these data publically available through easy-to-use map viewers for non-GIS users as well as directly via map services for more experienced GIS professionals.

URL: <http://maps.tnc.org/#webmaps>

Public Records Online: Mapping and GIS Records Resources

Developer: Online Searches, LLC

Description: This site provides an inventory of state and local GIS resources. A number of states and counties provide GIS maps online for free. Other states and counties have GIS programs in place whereby the consumer must pay to view or access this information. Still other areas of the country are only in the beginning stages of these programs and little information currently exists

URL: <http://publicrecords.onlinesearches.com/GIS-and-Mapping.htm>

USDA Geospatial Data Gateway

Developer: U.S. Department of Agriculture

Description: This site provides easy and consistent access to natural resource data. You can search for available data by geographic area or data theme. You can then view a thumbnail, or sample of the data and can either download the data directly onto your machine, pick it up via FTP site, or order it on media such as CD.

URL: <http://datagateway.nrcs.usda.gov/about.html>

Watershed Assessment, Tracking & Environmental Results (WATERS)

Developer: U.S. EPA

Description: This integrated information system for the nation's surface waters data unites water quality information previously available only from several independent and unconnected databases. Use it to download data sets, such as 303(d) listed impaired waters, or to perform nation-wide analyses across states.

URL: <http://www.epa.gov/waters/>

State Agency Web Portals and Clearinghouses

Illinois Natural Resources Geospatial Data Clearinghouse

Developer: Illinois State Geologic Survey

Description: This clearinghouse provides access to Illinois GIS data sets and documentation (metadata) for ArcIMS Interactive Map Services, U.S. Geological Survey digital topographic maps, aerial photography, orthoimagery, orthophotography, geology, land use, natural resources, and infrastructure. Data sets and map data layers are available for download free of charge.

URL: <http://www.isgs.uiuc.edu/nsdihome/>

Indiana Geological Survey Data Downloading

Developer: Indiana Geological Survey

Description: The Indiana Geological Survey offers a suite of interactive mapping Web sites which allow users to create custom maps using a variety of geographic, geologic, environmental, and demographic content. Desktop GIS users may also connect to the map services directly and stream the data for use with their GIS applications.

URL: <http://igs.indiana.edu/geology/maps/datadownloading/index.cfm>

Indiana Spatial Data Portal

Developer: Indiana University

Description: The Indiana Spatial Data Portal provides access to more than 17 terabytes of Indiana geospatial data. Most datasets are available to the public for download and have no use restrictions. Indiana University's networks and computing infrastructure support the portal which archives and provides access to imagery provided by various data partners.

URL: <http://www.indiana.edu/~gisdata/>

IndianaView

Developers: Ball State University and partners

Description: IndianaView makes aerial photography and satellite imagery of Indiana available to the public for free over the Web.

URL: <http://www.indianaview.org/>

Michigan Center for Shared Solutions and Technology Partnerships

Developer: Michigan Center for Shared Solutions and Technology Partnerships

Description: Michigan's Center for Geographic Information and Office of Technology Partnerships recently combined to form a new Center for Shared Solutions and Technology Partnerships. This Web site provides access to the new agency's data and applications.

URL: <http://www.michigan.gov/cgi>

MichiganView

Developers: Michigan Tech Research Institute and partners

Description: MichiganView makes aerial photography and satellite imagery of Michigan available to the public for free over the Web.

URL: <http://wiki.americaview.org/display/miview/Home>

Mineralogy of Wisconsin

Developer: University of Wisconsin-River Falls

Description: This Web site provides access to a database of minerals found in Wisconsin. Use it to search for minerals found at the county level and obtain information about the minerals.

URL: <https://falconfil.uwrf.edu/home/W1014120/personalweb/WiscMin.html>

The [Minnesota] DNR Data Deli

Developer: Minnesota Department of Natural Resources

Description: The Minnesota DNR Data Deli provides access to a wide variety of spatial data at no cost, within the constraints of the Minnesota DNR GIS Data License Agreement. Some system constraints are placed on users who are acquiring data. Data are available only in predefined extents (tiles). The system will not "clip" data to user-defined areas of interest. Data cannot be acquired in bundles greater than 500 Mb in size.

URL: <http://deli.dnr.state.mn.us/index.html>

Minnesota Geographic Data Clearinghouse

Developer: Minnesota Land Management Information Center

Description: The Minnesota Geographic Data Clearinghouse (MGDC) serves as a source for geographic data, ranging from simple state maps to complex geospatial data. Coordinated by the Land Management Information Center, the MGDC provides access to a wide variety of sources making it a "First Stop" for geographic data for Minnesota

URL: <http://www.lmic.state.mn.us/chouse/index.html>

Minnesota Pollution Control Agency Environmental Data Access (EDA)

Developer: Minnesota Pollution Control Agency

Description: The Minnesota Pollution Control Agency Environmental Data Access system allows users to view and download environmental data that is collected and stored by the agency and its partner organizations.

URL: <http://www.pca.state.mn.us/data/eda/index.cfm>

Minnesota River Basin Data Center

Developer: Minnesota State University

Description: The Minnesota River Basin Data Center provides for the inventory, development, retrieval, interpretation, and dissemination of pedigreed data and information on topics that impact the environment, economy, and communities within the Minnesota River Basin. This Web site provides access to the Center's inventory data and GIS products and services.

URL: <http://mrbdc.mnsu.edu/>

MinnesotaView

Developers: University of Minnesota and partners

Description: MinnesotaView makes aerial photography and satellite imagery of Minnesota available to the public for free over the Web.

URL: <http://minnesotaview.gis.umn.edu/>

New York State Geographic Information Systems Clearinghouse

Developer: New York State Office of Cyber Security and Critical Infrastructure

Description: The New York State Geographic Information Systems Clearinghouse disseminates information about New York's statewide GIS coordination program and provides access to the New York State GIS Data and Metadata Repository, a central location where state agencies and local governments list the GIS data sets that they have. Users can browse the list, or search for specific keywords, to find out what data are available, who holds those data, and how the data can be obtained. In some cases, users can download the actual data set.

URL: <http://www.nysgis.state.ny.us/>

Ohio Metadata Explorer

Developer: Ohio Office of Information Technology

Description: Ohio's Metadata Explorer allows users to search and browse the contents of a central repository for metadata. Users can search by geographic extent, content type, content theme or keyword, or browse through all of the available metadata documents.

URL: <http://metadataexplorer.gis.state.oh.us/metadataexplorer/explorer.jsp>

OhioView

Developers: Bowling Green State University and partners

Description: OhioView makes aerial photography and satellite imagery of Ohio available to the public for free over the Web.

URL: <http://www.ohioview.org/>

Pennsylvania Department of Conservation and Natural Resources GIS Data

Developer: Pennsylvania Department of Conservation and Natural Resources

Description: Pennsylvania DCNR developed this site to meet increasing demand for digital geologic and topographic data, particularly georeferenced data. The agency has developed several data sets that are available from this page.

URL: <http://www.dcnr.state.pa.us/topogeo/gismaps/index.aspx>

Pennsylvania Groundwater Information System

Developer: Pennsylvania Topographic and Geologic Survey

Description: The Pennsylvania Groundwater Information System (PaGWIS) provides an online water well database with records from various sources (U.S. Geological Survey, Pennsylvania Dept. of Environmental Protection, Susquehanna River Basin Commission, water well drillers). Data can be exported for use in ArcMap as point files.

URL: <http://www.dcnr.state.pa.us/topogeo/groundwater/PaGWIS/PaGWISMenu.asp?c=t>

Pennsylvania Spatial Data Access (PASDA)

Developer: Pennsylvania State University

Description: Pennsylvania Spatial Data Access (PASDA) provides public access to a comprehensive geospatial data digital library by providing free, universal access to geospatial data and information by, for, and about the Commonwealth of Pennsylvania.

URL: <http://www.pasda.psu.edu/>

Wisconsin DNR Drinking Water Quality Data

Developer: Wisconsin DNR

Description: This portal accesses four Wisconsin DNR drinking water quality databases: Drinking Water Systems, Groundwater Retrieval Network, Drinking Water and Groundwater Standards & Health Advisory Levels, and Source Water Assessments. Use it to find out about drinking water and groundwater quality, view source water maps and susceptibility determinations, and access recommendations for protection.

URL: <http://www.dnr.wi.gov/org/water/dwg/data.htm>

Wisconsin DNR GIS Data Holdings

Developer: Wisconsin DNR

Description: Frequently-requested DNR geospatial data holdings are available for download from a public FTP site at no cost. DNR geospatial data are shared in the agency's standard coordinate reference system and standard data format.

URLs: <http://dnr.wi.gov/maps/gis/geolibrary.html> and <http://dnr.wi.gov/maps/gis/databureau.html>

Wisconsin EcoAtlas

Developer: Wisconsin DNR

Description: This on-line database locates and accesses ecological data affecting Wisconsin's landscape. At this site you will find information about past and current research and monitoring activities including reports, Web pages, XML files, and maps.

URL: <http://ecoatlas.wiatri.net/>

Wisconsin Land Information Clearinghouse

Developer: Wisconsin State Cartographer's Office

Description: WISCLINC is a clearinghouse effort in Wisconsin that pulls together records of geospatial data, land records Web sites, and the statewide land information inventory survey.

URL: <http://sco.wisc.edu/wisclinc/index>

Wisconsin View

Developer: Space Science and Engineering Center, University of Wisconsin and partners

Description: WisconsinView makes aerial photography and satellite imagery of Wisconsin available to the public for free over the Web.

URL: <http://wisconsinview.ssec.wisc.edu/>

Wisconsin Water Science Center

Developer: U.S. Geological Survey

Description: This clearinghouse provides real-time and historic data on water quality, stream flow, and groundwater levels throughout Wisconsin. Use it to access data that investigates the occurrence, quantity, quality, distribution, and movement of surface and underground waters as well as link to water-related publications, projects, and case studies.

URL: <http://wi.water.usgs.gov/>

Interactive Mapping Tools

Federal and Regional Agency Mapping Tools

Numerous federal agencies and private sector partners have developed Internet mapping applications and many more are under development. This listing provides a comprehensive inventory of sites applicable to Great Lakes states at the time of report preparation (mid-2008). Users may want to check some of the clearinghouses and portals identified above to learn about additional more recently developed/modified sites.

Alien Forest Pest Explorer

Developer: U.S. Forest Service

Description: This Internet mapping tool allows users to explore spatial data relating to non-indigenous forest pests. It can be used to generate customized maps that depict historical and future range expansion, historical damage and forest susceptibility. Currently, the Explorer contains data for three major forest pests in the eastern US: Gypsy Moth, Beech bark disease and Hemlock woolly adelgid.

URL: <http://svinetfc4.fs.fed.us/afpe/viewer.htm>

Carbon Query and Evaluation Support Tools (CQUEST)

Developer: National Aeronautics and Space Administration

Description: This Internet mapping tool provides access to geographic data from NASA Ames Research Center, Ecosystem Science and Technology Branch for carbon sequestration predictions throughout the United States. This Viewer application allows users to display CASA-CQUEST data interactively as a map, customize the view, print image files, and obtain data values in tabular format.

URL: <http://geo.arc.nasa.gov/sge/casa/cquestwebsite/enter2.html>

CUAHSI Hydrologic Information System

Developer: Consortium of Universities for the Advancement of Hydrologic Science, Inc.

Description: The Hydrologic Information System is a geographically distributed network of hydrologic data sources and functions that are integrated using Web services so that they function as a connected whole. The Web interface enables users to query networks of hydrologic observation sites and extract hydrologic observation data from them in the form of time series of measurements at individual sites or collections of them.

URLs: <http://www.cuahsi.org/>, <http://his.cuahsi.org>, and <http://river.sdsc.edu/dash/>

Enviromapper for Environmental Justice

Developer: U.S. EPA

Description: This Internet mapping site allows you to view U.S. Environmental Protection Agency geospatial data, including information useful for analyzing environmental justice concerns. Users can locate an area of interest and display and obtain information on permitted facilities, pollution sources, and impaired waters.

URL: <http://www.epa.gov/enviro/ej/>

EnviroMapper for Water

Developer: U.S. EPA

Description: This Internet mapping site allows you to view U.S. Environmental Protection Agency geospatial data, including the National Hydrography Dataset. Users can locate an area of interest and display and obtain information on watershed needs, permitted facilities, and impaired waters.

URL: <http://www.epa.gov/waters/enviromapper/>

Environmental Mercury Mapping, Modeling, and Analysis (EMMMA) Tool

Developer: U.S. Geological Survey

Description: The Environmental Mercury Mapping, Modeling, and Analysis (EMMMA) Tool supports mercury research and decision-making by providing tools for the mapping, modeling, and analysis of mercury data. The site contains a database of ~35,000 fish tissue mercury records was compiled by USGS from various sources.

URL: <http://emmma.usgs.gov/datasets.aspx>

GLIFWC-maps.org

Developer: Great Lakes Indian Fish and Wildlife Commission

Description: This Internet mapping site provides a communications infrastructure to facilitate and enhance regional coordination of natural resource management efforts, with an emphasis on invasive species.

URL: <http://www.glifwc-maps.org/>

HUD Locator Services

Developer: U.S. Department of Housing and Urban Development

Description: This Internet mapping site provides access to HUD data along with U.S. EPA, Federal Emergency Management Agency, and Census Bureau data. It can be used to support housing and community development programs at the state, county, city, and neighborhood levels.

URL: <http://egis.hud.gov/egis/>

NOAA NowCOAST

Developer: National Oceanic and Atmospheric Administration

Description: Currently, NowCOAST provides public access to its data in two ways. Any user may load the NowCOAST GIS Web-Mapping Portal to view their desired imagery, observations, or forecasts. However, for those would prefer to view the data through a GIS desktop application, such access is made possible through NowCOAST's ArcIMS* Image Services.

URL: <http://nowcoast.noaa.gov/>

National Wetlands Inventory

Developer: U.S. Fish and Wildlife Service

Description: This Internet mapping site hosts current digital data and metadata for the U.S. Fish and Wildlife Service's Wetlands Master Geodatabase. Use it to view digital wetland data and create maps using a standardized projection.

URL: <http://www.fws.gov/wetlands/>

Web Soil Survey

Developer: Natural Resources Conservation Service

Description: This Internet mapping site provides soil survey data and related information. Map the soil types for an area of interest and view suitability and limitation ratings for a variety of land uses on the different soil types.

URL: <http://websoilsurvey.nrcs.usda.gov/app/>

State Agency Mapping Tools

Numerous state agencies have developed Internet mapping applications and many more are under development. This listing provides a comprehensive inventory of sites in great Lakes states at the time of report preparation. Users may want to check some of the clearinghouses and portals identified above to learn about additional more recently developed/modified sites.

Illinois Base Data

Developer: Illinois State Geological Survey

Description: This Internet mapping site allows users to create, view, and print maps showing county and municipal boundaries, highways, and land cover.

URL: <http://runoff.isgs.uiuc.edu/website/il%5Fbasedata/viewer.htm>

Illinois Historical Aerial Photography, 1938-1941

Developer: Illinois State Geological Survey

Description: This Internet mapping site provides an index of available historical aerial photographs from throughout Illinois.

URL: <http://runoff.isgs.uiuc.edu/website/ilhap/viewer.htm>

Illinois Natural Gamma Ray Logs

Developer: Illinois State Geological Survey

Description: This Internet mapping site to create, view, and print maps showing locations with gamma ray logs.

URL: <http://runoff.isgs.uiuc.edu/website/geolog/viewer.htm>

Illinois Oil and Gas Resources

Developer: Illinois State Geological Survey

Description: This Internet mapping site allows users to construct custom maps with layers showing information about oil and gas resources in Illinois.

URL: <http://ablation.isgs.uiuc.edu/website/ilwater/viewer.htm>

Water and Related Wells in Illinois

Developer: Illinois State Geological Survey

Description: This Internet mapping site allows users to construct custom maps with layers showing information about water and related wells in Illinois.

URL: <http://ablation.isgs.uiuc.edu/website/ilwater/viewer.htm>

Illinois EPA Water Quality Information

Developers: Illinois Environmental Protection Agency and U.S. Geological Survey

Description: This mapping tool provides access to water-quality information collected and distributed by the Illinois EPA. Users can locate, create, and print maps of any area within Illinois providing lake and stream information as well as geographic reference information.

URL: <http://maps.epa.state.il.us/website/wqinfo>

IndianaMap Viewer

Developer: Indiana Geological Survey

Description: This Internet mapping site allows users to construct custom maps with layers showing information about coal, environment/biology, geology, hydrology, and infrastructure/demographics. The information available in two previously built online GIS atlases for specific regions of Indiana eventually will be incorporated into the statewide atlas.

URL: <http://inmap.indiana.edu/index.html>

Indiana Coal Mine Information System (CMIS)

Developer: Indiana Geological Survey

Description: This Internet mapping site allows users to create, view, and print maps showing locations of surface and underground coal mines and documented subsidence areas in Indiana, and obtain data about the mines.

URL: <http://coalminemaps.indiana.edu/>

Indiana Historical Aerial Photo Index

Developer: Indiana Geological Survey

Description: This Internet mapping site provides an index map for locating Indiana aerial photos from the 1930s through the 1980s. The database includes more than 1130,000 images from several state archives. Thumbnail images are viewable for the 40,000 images from the IGS repository.

URL: <http://129.79.145.7/arcims/IHAPI/index.html>

Indiana Petroleum Database Management System

Developer: Indiana Geological Survey

Description: This Internet mapping site distributes petroleum-related information from the Indiana Geological Survey. The database contains information on more than 70,000 petroleum-related wells drilled in Indiana. The Map Viewer displays interactive maps of petroleum well data.

URL: <http://igs.indiana.edu/pdms/index.cfm>

Indiana Water Quality Atlas

Developers: Indiana University-Purdue University and Indiana Department of Environmental Management

Description: This Internet mapping site focuses specifically on Indiana's water quality as affected by land use change. It uses an L-THIA watershed delineation and water quality model, as well as several other GIS-based resources.

URL: <http://iwqa.idem.in.gov>

Michigan Endangered Species Assessment

Developer: Michigan Department of Natural Resources

Description: This Internet mapping site provides a preliminary evaluation of whether endangered, threatened or special concern species, high quality natural communities, or other unique natural features have been known to occur at or near a site of interest. The purpose of this site is to provide a simplified and efficient assessment of rare species and other unique natural features at user identified locations.

URL: <http://www.mcgi.state.mi.us/esa/>

Michigan Environmental Mapper

Developer: Michigan Department of Environmental Quality

Description: This Internet mapping site allows users to view sites of contamination and underground storage tank sites. The user can display the sites based on search criteria by city, county, Michigan Department of Environmental Quality district, and Michigan legislative district. In addition the user can view sites within a certain distance of a location, a land lot, or a stream segment. The results can be printed, with the map, and/or exported to an Excel spreadsheet.

URL: <http://www.mcgi.state.mi.us/environmentalmapper/>

Michigan Surface Water Information Management System (MiSWIMS)

Developers: Michigan Department of Information Technology (DIT), Department of Environmental Quality (DEQ), and Department of Natural Resources (DNR).

Description: This Internet mapping site allows users to view information about Michigan's surface water. Users are able to view and download data collected by the DEQ and DNR from surface water monitoring sites located throughout Michigan.

URL: <http://www.mcgi.state.mi.us/miswims/>

Local Ordinances Regulating Livestock in Minnesota

Developer: Minnesota Department of Agriculture

Description: This Internet mapping site provides information on local ordinances regulating animal agriculture in Minnesota's counties and townships. The information includes the most common areas of regulation such as setbacks and separation distances, conditional use permits, feedlot size limitations, and minimum acreage requirements. It also provides local contact information and links to local ordinances when available.

URL: <http://www.mda.state.mn.us/animals/aodisclaimer.htm>

Purdue University's Local Decision Maker

Developer: Purdue University

Description: Local Decision Maker provides a decision support system for comprehensive planning. It brings together data, current research, analyses, mapping tools, and models to assist communities throughout the planning process.

URL: <http://ldm.agriculture.purdue.edu/>

Wisconsin Bioenergy Sites and Sources

Developers: University of Wisconsin-Extension and Focus on Energy

Description: This Web site provides information relevant to siting and operating facilities for producing biofuels and energy from sources of biomass in Wisconsin. It provides multiple resources through an integrated collection of spatial data which may have some relevance to siting, feasibility assessment, impact assessment, and other bioenergy facility questions.

URLs: <http://www.uwex.edu/ces/cced/bioeconomy/>

Wisconsin Coastal Image Server

Developer: University of Wisconsin Sea Grant

Description: This Internet mapping site makes geographic data about Wisconsin's Lake Michigan and Lake Superior coasts available. Use it to zoom to a specific area of interest and download the geospatial data. The purpose of this site is to evaluate methods of distributing geographically referenced digital data via the Web for use in GIS and coastal management applications.

URL: <http://ortho.lic.wisc.edu/orthoserver/>

Wisconsin DNR Air Monitoring Network

Developer: Wisconsin DNR

Description: This Internet mapping site uses Wisconsin DNR data to provide a composite view of air quality in the state. Users can view real-time and historic air monitoring data, as well as county Air Quality Index ratings.

URL: <http://www.dnr.wi.gov/maps/gis/applist.html>

Wisconsin DNR Comprehensive Planning Webmapping Site

Developer: Wisconsin DNR

Description: This Internet mapping site provides natural resource data and guidance relating to nine planning elements. You can locate an area of interest, display natural resource data, and print maps you create.

URL: <http://maps.wiatri.net/Landuse/>

Wisconsin DNR Remediation & Redevelopment Sites Map

Developer: Wisconsin DNR

Description: This Internet mapping site provides information on property in Wisconsin that is or was contaminated with hazardous substances. Use it to view sites with both ongoing and completed cleanups of soil and groundwater contamination.

URL: <http://www.dnr.wi.gov/org/aw/rr/gis/>

Wisconsin DNR Surface Water Data Viewer

Developer: Wisconsin DNR

Description: This Internet mapping site provides information regarding water resources, monitoring stations, and quality assessments. Use it to display data such as dams, exceptional resource waters, or areas of special natural resources interest.

URL: http://www.dnr.wi.gov/org/water/data_viewer.htm

Wisconsin Livestock Siting Law Interactive Map

Developer: Wisconsin Department of Agriculture, Trade and Consumer Protection and University of Wisconsin Soil Science Extension

Description: This Internet mapping site provides information on local requirements for the siting or expansion of livestock facilities in Wisconsin municipalities. Use this application to learn the requirements in your municipality, including whether or not a conditional use permit is required.

URL: <http://datcpgis.wi.gov/livestock>

Wisconsin NatureMapping

Developer: Wisconsin DNR

Description: This Internet mapping site allows citizens, school groups, and professionals to enter wildlife observations into a statewide database. Submit observations on-line and view data to become more aware of your surroundings, deepen your sense of place, and strengthen your connection to the environment.

URL: <http://www.wisnatmap.org/>

Analytical and Predictive Modeling Tools

The use of modeling tools in various types of decision making has been reviewed by a number of authors (see, for example, the works by U.S. EPA 2000, Niemann and Limp 2004, and Manno et al. 2008). We have not, however, found a published comprehensive listing of Web-based tools specifically for planning, conservation, and environmental management applications. Those listed below generally fit the criteria listed in Tables 4.1. and 4.2 and can be applied in these contexts.

Better Assessment Science Integrating Point & Nonpoint Sources (BASINS)

Developer: U.S. EPA

Description: This multi-purpose environmental analysis system integrates GIS, national watershed data, and environmental assessment and modeling tools. Use it to examine environmental information, support analysis of environmental systems, and examine management alternatives.

URL: <http://www.epa.gov/waterscience/BASINS/>

Biotas

Developer: Ecological Software Solutions

Description: Biotas is a statistical and GIS tool for Windows written for ecologists and resource professionals. Biotas has been designed to assist in the analysis and understanding of spatial and temporal data from biogeographical and ecological studies including, but not limited to, those dealing with wildlife (home range, habitat use, etc.), fisheries (movements), plant or animal ecology (spatial randomness tests).

URL: <http://www.ecostats.com/software/updates.htm#biotas>

Carbon On-Line Estimator

Developer: National Council for Air and Stream Improvement

Description: This Web-based analysis tool enables you to examine forest carbon characteristics. Use it to generate a carbon report for a particular state or county.

URL: <http://ncasi.uml.edu/COLE/index.html>

Digital Watershed

Developer: Michigan State University

Description: This centralized information repository and on-line computing center for U.S. watersheds allows you to delineate a watershed at any point, change land use in the watershed, and simulate hydrologic impact of land use based on area climate data.

URL: <http://www.iwr.msu.edu/dw/>

GForest

Developer: National Council for Air and Stream Improvement

Description: Users can visualize and analyze US forest inventory data for the lower 48 states and Alaska with GForest. GForest makes it possible to access publicly available USDA Forest Service's Forest Inventory and Analysis data via the Google Maps interface.

URL: <http://ncasi.uml.edu/google/>

Green Infrastructure Cost-Benefit Calculator

Developer: Center for Neighborhood Technology

Description: This modeling tool provides information on green infrastructure and calculates the costs and benefits of applying it. Enter a scenario, choose the type of green infrastructure to incorporate, and calculate the financial and hydrologic costs/benefits associated with its use.

URL: <http://greenvalues.cnt.org/>

Huron-Erie Corridor Nowcast/Forecast

Developer: Great Lakes node of the national Integrated Ocean Observing System (GLOS)

Description: You can use this tool to view real-time and forecasted waterways data, including water levels and surface water speed.

URL: <http://www.glos.us/hecwfs/>

Indoor Air Quality Building Education and Assessment Model (I-BEAM)

Developer: U.S. EPA

Description: This Web site provides comprehensive guidance for managing indoor air quality in commercial buildings. Use it as a reference for specific issues, to train management and building personnel, or to set up an indoor air quality management program.

URL: <http://www.epa.gov/iaq/largebldgs/i-beam/index.html>

Long-Term Hydrologic Impact Assessment

Developer: Purdue University

Description: This modeling tool estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. Use it to evaluate potential effects of land use change and to identify the best location of a particular land use.

URL: <http://www.ecn.purdue.edu/runoff/lthianew/>

Mitigation Impact Screening Tool

Developer: U.S. EPA

Description: This modeling tool assesses the likely impacts of heat island mitigation strategies. Use it to increase or decrease a city's albedo (reflectance) and/or vegetative cover and learn how these actions will affect temperature, ozone air quality, and energy consumption.

URL: <http://www.heatislandmitigationtool.com/>

NatureServe Vista

Developer: NatureServe

Description: NatureServe Vista is a tool for conducting conservation planning and integrating conservation with other assessment and planning activities such as land use, transportation, energy, and natural resources management. NatureServe Vista has functions to import data, crosswalk it to a common data scheme, and depict the distribution of land uses, disturbances, management practices, climate change effects, invasive species spread, etc. You can create as many scenarios as you wish such as current actual land use, future scenarios based on current policy or economic or ecological trends, proposal based scenarios, etc.

URL: <http://www.natureserve.org/prodServices/vista/overview.jsp>

Paleoclimatology World Data Center (WDC) Pollen Viewer

Developer: National Oceanic and Atmospheric Administration

Description: The Paleoclimatology World Data Center (WDC) Pollen Viewer is an interactive animation that allows the user to see spatial distribution changes in 50 North American pollen taxa from 21,000 years BP to present. The user can choose pollen type, request Latin or common name, display sites, reverse animation and compare images.

URL: <http://www.ncdc.noaa.gov/paleo/pollen/viewer/webviewer.html>

Soil and Water Assessment Tool (SWAT)

Developer: U.S.D.A. Agricultural Research Service

Description: SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. The SWAT model software is available for download. Note: This tool does not meet the criteria in Tables 4.1 and 4.2 (i.e. it is not Web-based, does not have a user friendly interface, does not have data included, etc.). It is included here because participants in many of our technology transfer sessions asked about it.

URL: <http://www.brc.tamus.edu/swat/>

UrbanSim

Developer: University of Washington

Description: This downloadable modeling tool can be used for integrated planning and analysis of urban development. Use it to create different scenarios by inputting population and employment estimates, economic forecasts, transportation system and land use plans, and land development policies.

URL: <http://www.urbansim.org/>

Walk Score

Developer: Front Seat

Description: Walk Score ranks 2,508 neighborhoods in the largest 40 U.S. cities. The tool calculates the walkability of an address by locating nearby businesses, schools, parks, etc. Walk Score measures how easy it is to live a car-lite lifestyle, but not how pretty an area is for walking.

URL: <http://www.walkscore.com/>

Water Erosion Prediction Project (WEPP)

Developer: Purdue University

Description: This modeling tool predicts soil erosion at the field scale using climate, management, soil, and topography data. Choose from over 30 management techniques and add buffer strips or strip cropping to the simulation.

URL: <http://topsoil.nserl.purdue.edu/nserlweb/weppmain>

Web-Based Hydrography Analysis Tool (WHAT)

Developer: Purdue University

Description: The Web-Based Hydrography Analysis Tool (WHAT) allows users to view USGS stream flow data in a GIS setting. Users can also upload their own stream flow data to be visualized in this map service which is created using the open source mapserver technology. A flow statistics model was added to the system to generate models for flood scenarios.

URL: <http://cobweb.ecn.purdue.edu/~what/>

World Wind

Developer: National Aeronautics and Space Administration

Description: World Wind allows any user to zoom from satellite altitude into any place on Earth, leveraging high resolution Landsat imagery and SRTM elevation data to experience Earth in visually rich 3D, just as if they were really there. Particular focus was put into the ease of usability so people of all ages can enjoy World Wind. Navigation is automated with single clicks of a mouse as well as the ability to type in any location and automatically zoom into it.

URL: <http://worldwind.arc.nasa.gov/>

Table 4.3. Internet Tools for Use in Specific Great Lakes States.

Tool	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvania	Wisconsin
Data Discovery, Data Access, and Data Provision Tools								
AirData: Access to Air Pollution Data	X	X	X	X	X	X	X	X
Census TIGER Products	X	X	X	X	X	X	X	X
Data.gov Geodata Catalog	X	X	X	X	X	X	X	X
EPA Geospatial Data	X	X	X	X	X	X	X	X
EROS Data Center (EDC): Entry Point to Geospatial Data Clearinghouse	X	X	X	X	X	X	X	X
FEMA Map Services Center	X	X	X	X	X	X	X	X
The [FGDC] Clearinghouse Registry	X	X	X	X	X	X	X	X
Forest Inventory Data Online (FIDO)	X	X	X	X	X	X	X	X
Geography Network	X	X	X	X	X	X	X	X
Geospatial One-Stop Geodata.gov Portal	X	X	X	X	X	X	X	X
Great Lakes Information Network GIS	X	X	X	X	X	X	X	X
National Biological Information Infrastructure	X	X	X	X	X	X	X	X
National Ocean Service Data Explorer	X	X	X	X	X	X	X	X
NSGIC Ramona GIS Inventory	X	X	X	X	X	X	X	X
The Nature Conservancy's Spatial Data Resources	X	X	X	X	X	X	X	X
Public Records Online	X	X	X	X	X	X	X	X
USDA Geospatial Data Gateway	X	X	X	X	X	X	X	X
Watershed Assessment, Tracking & Environmental Results (WATERS)	X	X	X	X	X	X	X	X
Illinois Natural Resources Geospatial Data Clearinghouse	X							
Indiana Geological Survey Data Downloading		X						
Indiana Spatial Data Portal		X						
IndianaView		X						
Michigan Center for Shared Solutions and Technology Partnerships			X					
MichiganView			X					
Mineralogy of Wisconsin								X

Table 4.3. *Continued.*

Tool	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvania	Wisconsin
The [Minnesota] DNR Data Deli				X				
Minnesota Geographic Data Clearinghouse				X				
Minnesota Pollution Control Agency Environmental Data Access (EDA)				X				
Minnesota River Basin Data Center				X				
MinnesotaView				X				
New York State Geographic Information Systems Clearinghouse					X			
Ohio Metadata Explorer						X		
OhioView						X		
Pennsylvania Department of Conservation and Natural Resources GIS Data							X	
Pennsylvania Groundwater Information System							X	
Pennsylvania Spatial Data Access (PASDA)							X	
Wisconsin DNR Drinking Water Quality Data								X
Wisconsin DNR GIS Data Holdings								X
Wisconsin EcoAtlas								X
Wisconsin Land Information Clearinghouse								X
WisconsinView								X
Wisconsin Water Science Center								X
Interactive Mapping Tools								
Alien Forest Pest Explorer	X	X	X	X	X	X	X	X
Carbon Query and Evaluation Support Tools (CQUEST)	X	X	X	X	X	X	X	X
CUAHSI Hydrologic Information System	X	X	X	X	X	X	X	X
EnviroMapper for Environmental Justice	X	X	X	X	X	X	X	X
EnviroMapper for Water	X	X	X	X	X	X	X	X
GLIFWC-maps.org			X	X				X
HUD Locator Services	X	X	X	X	X	X	X	X
NOAA NowCOAST	X	X	X	X	X	X	X	X

Table 4.3. *Continued.*

Tool	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvania	Wisconsin
National Wetlands Inventory	X	X	X	X	X	X	X	
Environmental Mercury Mapping, Modeling, and Analysis (EMMMA) Tool	X	X	X	X	X	X	X	X
Web Soil Survey	X	X	X	X	X	X	X	X
Illinois Base Data	X							
Illinois EPA Water Quality Information	X							
Illinois Historical Aerial Photography, 1938-1941	X							
Illinois Natural Gamma Ray Logs	X							
Illinois Oil and Gas Resources	X							
Water and Related Wells in Illinois	X							
IndianaMap Viewer		X						
Indiana Coal Mine Information System (CMIS)		X						
Indiana Historical Aerial Photo Index		X						
Indiana Petroleum Database Management System		X						
Indiana Water Quality Atlas		X						
Michigan Endangered Species Assessment			X					
Michigan Environmental Mapper			X					
Michigan Surface Water Information Management System (MiSWIMS)			X					
Local Ordinances Regulating Livestock in Minnesota					X			
Purdue University's Local Decision Maker		X						
Wisconsin Bioenergy Sites and Sources								X
Wisconsin Coastal Image Server								X
Wisconsin DNR Air Monitoring Network								X
Wisconsin DNR Comprehensive Planning Webmapping Site								X
Wisconsin DNR Remediation & Redevelopment Sites Map								X
Wisconsin DNR Surface Water Data Viewer								X

Table 4.3. Continued.

Tool	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvania	Wisconsin
Wisconsin Livestock Siting Law Interactive Map								X
Wisconsin NatureMapping								X
Analytical and Predictive Modeling Tools								
Better Assessment Science Integrating Point & Nonpoint Sources (BASINS)	X	X	X	X	X	X	X	X
Biotas	X	X	X	X	X	X	X	X
Carbon On-Line Estimator	X	X	X	X	X	X	X	X
Digital Watershed	X	X	X	X	X	X	X	X
GForest	X	X	X	X	X	X	X	X
Green Infrastructure Cost-Benefit Calculator	X	X	X	X	X	X	X	X
Huron-Erie Nowcast/Forecast			X		X	X	X	
Indoor Air Quality Building Education and Assessment Model (I-BEAM)	X	X	X	X	X	X	X	X
Long-Term Hydrologic Impact Assessment	X	X	X	X	X	X	X	X
Mitigation Impact Screening Tool	X	X	X	X	X	X	X	X
NatureServe Vista	X	X	X	X	X	X	X	X
Paleoclimatology World Data Center (WDC)								
Pollen Viewer	X	X	X	X	X	X	X	X
Soil and Water Assessment Tool (SWAT)	X	X	X	X	X	X	X	X
UrbanSim	X	X	X	X	X	X	X	X
Walk Score	X	X	X	X	X	X	X	X
Water Erosion Prediction Project (WEPP)	X	X	X	X	X	X	X	X
Web-Based Hydrography Analysis Tool (WHAT)	X	X	X	X	X	X	X	X
World Wind	X	X	X	X	X	X	X	X

Internet Tools to Aid Restoration of Beneficial Uses in Great Lakes Areas of Concern

Near the conclusion of our grant period, staffers in the U.S. EPA's Great Lakes National Program Office requested that we identify tools that could be used to help address beneficial use impairments at Great Lakes Areas of Concern (AOCs). Under the Great Lakes Water Quality Agreement, impairment of beneficial use is defined as "a change in the chemical, physical, or biological integrity of the Great Lakes system sufficient to cause any of the 14 use impairments listed in Table 4.4 or other related uses covered by Article IV such as the microbial objective for waters used for body contact recreational activities."

Table 4.4. *Beneficial Use Impairments.*

-
- Restrictions on Fish and Wildlife Consumption
 - Tainting of Fish and Wildlife Flavor
 - Degraded Fish and Wildlife Populations
 - Fish Tumors or Other Deformities
 - Bird or Animal Deformities or Reproductive Problems
 - Degradation of Benthos
 - Restrictions on Dredging Activities
 - Eutrophication or Undesirable Algae
 - Restrictions on Drinking Water Consumption or Taste and Odor Problems
 - Beach Closings
 - Degradation of Aesthetics
 - Added Costs to Agriculture or Industry
 - Degradation of Phytoplankton and Zooplankton Populations
 - Loss of Fish and Wildlife Habitat
-

In 1991, the International Joint Commission approved guidelines for listing and delisting Areas of Concern in the Great Lakes Basin Ecosystem. The intent of these listing/delisting guidelines was to serve as an initial reference point on which restoration criteria could be based. Delisting criteria are recommended in order to provide direction and focus for the Remedial Actions Plans (RAPs) developed for each AOC.

Since 1991, many government agencies, local RAP groups, and others have worked to develop systematic and comprehensive restoration targets for their AOCs. The list of restoration targets is intended to assist RAP groups that have not yet established targets. We reviewed the targets and identified available Internet tools from our inventory that could be used to address each impaired beneficial use (Table 4.5)

Manno et al. (2008) recently examined how computer simulation models have been used in decision making processes in the Great Lakes. Their review examined four case studies in which models were an important feature: phosphorus loadings (1970s); PCB mass balance (1980s); Lake Ontario fish stocking (1990s); and water level regulation in Lake Ontario and the St. Lawrence River (2000s). While their review does not specifically focus on Internet GIS tools, it does adequately describe the increasing demands being placed on models, modelers, and managers by trends in environmental protection and natural resource management. In addition, their synthesis paper (Manno et al 2008) not only describes and evaluates how models have been used in decision making, but also discusses the models' strengths and weaknesses as decision tools, the way models have enhanced or undermined specific decision processes, and ways the constructive use of models can be advanced. We recommend that practitioners in the Great Lakes Basin consider Manno et al.'s (2008) findings when to looking to employ Web-based modeling tools.

Table 4.5. *Example Internet Tools That Can Be Used to Help Address Beneficial Use Impairments.*

Restrictions on Fish and Wildlife Consumption

Watershed Assessment, Tracking, and Environmental Results (WATERS)
Enviromapper for Water
Environmental Mercury Mapping, Modeling, and Analysis (EMMA)
Michigan Surface Water Information Management System (MiSWIMS)
Wisconsin DNR Surface Water Data Viewer
National Biological information Infrastructure

Degraded Fish and Wildlife Populations

EROS Data Center
The Nature Conservancy's Spatial Data Resources
Wisconsin EcoAtlas
Michigan Endangered Species Assessment
Biotas
NatureServe Vista
National Biological information Infrastructure

Restrictions on Dredging Activities

Great Lakes Information Network
Enviromapper for Water
Wisconsin DNR Surface Water Data Viewer
Wisconsin DNR Remediation and Redevelopment Sites
CUAHSI Hydrologic Information System

Eutrophication or Undesirable Algae

Great Lakes Information Network
Watershed Assessment, Tracking, and Environmental Results (WATERS)
Wisconsin Water Science Center
Enviromapper for Water
Web Soil Survey
Illinois EPA Water Quality Information
Indiana Water Quality Atlas
Michigan Surface Water Information Management System (MiSWIMS)
Wisconsin DNR Surface Water Data Viewer
Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)
Long-term Hydrologic Impact Assessment (LTHIA)
Soil and Water Assessment Tool (SWAT)
Water Erosion Prediction Project (WEPP)

Restrictions on Drinking Water Consumption or Taste and Odor Problems

Watershed Assessment, Tracking, and Environmental Results (WATERS)
Wisconsin DNR Drinking Water Quality Data
Enviromapper for Water
Water and Related Wells in Illinois
Wisconsin DNR Remediation and Redevelopment Sites

Table continues on next page.

Table 4.5. *Continued.*

Beach Closings

Great Lakes Information Network
Watershed Assessment, Tracking, and Environmental Results (WATERS)
Wisconsin Water Science Center
Enviromapper for Water
Huron-Erie Corridor Nowcast/Forecast
Michigan Surface Water Information Management System (MiSWIMS)
Wisconsin DNR Surface Water Data Viewer
NOAA NowCOAST
Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)
Long-term Hydrologic Impact Assessment (LTHIA)

Degradation of Aesthetics

AirData: Access to Air Pollution Data
Illinois Historical Aerial Photography
Indiana Historical Photo Index
Wisconsin DNR Remediation and Redevelopment Sites
Green Infrastructure Cost-Benefit Calculator
WalkScore

Added Costs to Agriculture or Industry

Enviromapper for Environmental Justice
HUD Locator Services
Web Soil Survey
Local Ordinances Regulating Livestock ion Minnesota
Wisconsin DNR Remediation and Redevelopment Sites
Wisconsin Livestock Siting Law interactive Map
Mineralogy of Wisconsin
Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)

Loss of Fish and Wildlife Habitat

EROS Data Center
Forest Inventory Data Online (FIDO)
The Nature Conservancy's Spatial Data Resources
Wisconsin EcoAtlas
Alien Forest Pest Explorer
GLIFWC-maps.org
National Wetlands Inventory
Illinois Historical Aerial Photography
Indiana Historical Photo Index
Michigan Endangered Species Assessment
Wisconsin Coastal Image Server
GForest
NatureServe Vista

References and Related Reading

We found the following references helpful in understanding and defining the range of Internet tools and the underlying technologies. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, References, and Background Material” section at the end of this report.

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Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described Internet tools, our approach to inventorying and evaluating tools, and their application in planning and decision-making processes. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

Watermolen, D.J. and J.G. Sullivan. 2008. Interoperable Spatial Decision Support Tools: Wisconsin's Approach. U.S. EPA's joint GIS Work Group and Statistics Users Group fall meeting. Ralph Metcalfe Federal Building, Chicago, IL. (September 16, 2008).

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Lucero, D. and M. Murrell. 2004. Enhancing Local Land Use Decisions through the Evaluation and Use of Web-based Tools. Wisconsin Land Information Association 2004 Annual Conference, Wisconsin Dells, WI. (March 4, 2004).

Watermolen, D.J. 2003. Supporting Local Decision Making: A Wisconsin Case Study. "Growth and Water Resources: Using Smart Growth to Protect Watersheds" seminar. U.S. Environmental Protection Agency, Washington, DC. (December 8-9, 2003).

Lucero, D. and M. Murrell. 2003. Wisconsin User Feedback: A Process for the Review and Evaluation of Impact Assessment Tools. "Lake Michigan: State of the Lake '03." GVSU Annis Water Resources Institute and U.S. EPA Great Lakes National Program Office, Muskegon, MI (October 21-22, 2003). See http://www.gvsu.edu/forms/education/state_lake_2003.pdf

Outputs: Publications Related to Our Work

Over the course of our grant period, we published results of our work in various peer-reviewed outlets. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

Lucero, D. (ed). 2003. *Proceedings of Changing Landscapes: Anticipating the Effects of Local Land Use Decisions, March 31-April 1, 2003, Madison, Wisconsin*. Madison, WI: Wisconsin Department of Natural Resources. 90 pp. Available online at http://dnr.wi.gov/org/es/science/landuse/Changing_Landscapes/proceedings03.htm.

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Lucero, D., D.J. Watermolen, and M.D. Murrell. 2004. A State-Federal Partnership to Understand the Usefulness of Decision Support Tools for Natural Resources Management. Proceedings of Watershed 2004, Water Environment Federation Annual Meeting (July 11-14, 2004). CD-ROM, 1 disc.

Watermolen, D.J. 2008. Land cover data and tools for analyzing alternative futures: One state's lessons learned. Chapter 16, pp. 293-330. In J.C. Campbell, K.B. Jones, J.H. Smith, and M.T. Koeppe (eds.). *North American Land Cover Summit*. Washington, DC: Association of American Geographers. Available online at <http://www.aag.org/books/nalcs/chapters/CH16.pdf>.

Welch, R.C. 2005. L-THIA – Three versions, three groups, three projects. University of Wisconsin-Stevens Point Center for Land Use Education *The Land Use Tracker* 5(3):6-9. Available online at <http://www.uwsp.edu/cnr/landcenter/tracker/winter2005/TrackerWinter2005.pdf>.

The Wisconsin DNR Program

5. Introduction

Because we are concerned about the environmental impacts of land-use decisions, the Wisconsin DNR program identified audiences comprised of individuals who make and influence those decisions. We found that a wide range of “actors” get involved in land-use planning and decision making. Landowners, realtors, developers, investors, local governments, regional planning commissions, tribal governments, and state and federal agencies all play a role in decisions that affect land use. However, the vast majority of land in Wisconsin is, and will remain, privately owned, making individual landowners and developers some of the principal land-use decision makers. Conducting technology transfer activities with this large and disparate audience, however, was not possible within the resource limitations of our grant funding. Instead we focused our technology transfer efforts on four primary audiences who make or significantly influence land-use decisions. Although not initially included in the scope of our efforts, we added two additional, smaller audiences during the grant period. Target audiences for our technology transfer work included:

Local Government Decision Makers – The primary administrator of land use *regulation* is local government through its planning and zoning powers. Local government decision makers comprise a large audience with highly diverse roles, responsibilities, interests, backgrounds, and skill sets. Meeting the technology transfer needs of this audience proved difficult with the limited grant resources available. To maximize the return on investment, we took a “train the trainer” approach and placed emphasis on the other primary audiences whose members work directly with these local officials and who often serve in similar technology transfer roles. As a result, our work with local officials focused primarily on understanding how and when they can use Internet tools in their planning and decision making. We did, however, undertake some outreach, training, and technical assistance efforts with this audience, primarily in cooperation with Wisconsin’s local government associations and the University of Wisconsin-Extension.

University Extension Educators – We worked to develop capacity among Wisconsin’s Extension educators, recognizing that these county-based agents are often the “go to” people in a community. Our efforts with this audience focused on assessing needs, developing awareness, knowledge, and skills, supporting educational programming, evaluating our efforts, assessing outcomes, and sharing lessons learned.

Planners – We attempted to build capacity among Wisconsin’s planning community, including professional planners as well as citizen planners (an audience that overlaps with local government decision makers). We focused on assessing needs, developing awareness and knowledge, sharing data, evaluating our efforts, and sharing lessons learned.

Natural Resources Professionals – Many communities request Wisconsin DNR staff involvement in their planning and land-use decision making. As such, Wisconsin DNR staff often act as consultants and information providers. Internet tools improve the efficiency of these activities. Therefore, we identified Wisconsin DNR staff and related natural resources professionals as a target audience at the onset of the project. Our efforts with Wisconsin DNR staff focused on assessing needs, developing awareness, knowledge, and skills, evaluating our efforts, assessing outcomes, and sharing lessons learned.

Librarians and Educators – Working with these audiences could facilitate outreach to and training of local officials and help promote a future workforce better able to use Internet tools effectively. Our limited efforts with public librarians and K-12 educators focused on developing awareness, knowledge, and skills. We did not attempt to assess outcomes from these efforts.

In the following five chapters, we describe the outreach, training, and technical assistance activities undertaken with each of these target audiences. We document our work to assess needs, measure outcomes, and evaluate the effectiveness of the various technology transfer efforts. We also list outputs we produced during the grant period, including professional presentations and publications.

6. Target Audience: University of Wisconsin-Extension Educators

Communities often call upon Extension educators to supply technical expertise in local planning and decision-making processes. As a result, Extension faculty are uniquely situated to play an important role in increasing public understanding of planning laws, the consequences and impacts of development, and alternative growth management approaches. Aside from formal instruction, Extension educators sometimes play informal roles in the facilitation of land-use planning or the creation of subdivision regulations and zoning ordinances (Civittolo and Davis 2008, Merry et al. 2008b). Some work on farmland conservation issues; others focus on economic development. Because Extension professionals are often in contact with many different stakeholder groups and are seen frequently as a source of information and support, they may also facilitate community efforts to build consensus regarding land use solutions.

Internet and GIS technologies can help Extension educators make scientific data available, provide decision support functions, and enhance public participation for these local processes (Estrada and Steil 1997, Wisconsin DNR 2004a). Milla et al. (2005), however, describe how the rapid development of spatial technologies has created “many new tools for Extension professionals, but [has] also widened the ‘digital divide,’ leaving many with little understanding of the technology and potential applications.” These authors further observe that “to the uninitiated Extension specialist, the complexity and vast array of potential applications can be confusing and intimidating” and that “as a result of the relatively fast evolution of geospatial technologies, many professionals may either be unaware of their capabilities or may have an obsolete understanding of their potential and current implementation.” These observations coupled with the phenomenal growth of the Internet (Horrigan 2006, Netcraft 2007) suggest a need to build competencies among Extension professionals to tap effectively into these technologies. In this chapter, we overview the UW-Extension audience, describe our assessment, outreach, training, and technical assistance efforts, and report on our outcome evaluations. We conclude the chapter by listing publications and professional presentations related to this work. Much of this work and our evaluation results are summarized in a peer-reviewed journal article (Watermolen et al. 2009).

Background: University Extension Mission and Organization

Through partnerships with 26 University of Wisconsin (UW) campuses, counties, tribal governments, and other organizations, the UW-Extension provides a spectrum of lifelong learning opportunities for Wisconsin citizens. The size of the effort is extensive, with more than one million Wisconsin residents participating in outreach programs annually through four divisions: Cooperative Extension, Outreach and E-Learning, Broadcasting and Media Innovations, and Business and Manufacturing Extension. The Wisconsin DNR program targeted faculty and staff working in the Cooperative Extension division.

Cooperative Extension maintains offices in all 72 Wisconsin counties with educators who specialize in one or more program areas. These educators excel in leadership development, consensus building, and organizational development. University specialists at UW campuses serve as resources to these county educators. High-priority programs focus on economic development, water quality, solid and hazardous waste management and recycling, families and youth at risk, and helping Wisconsin's agricultural industry remain profitable and productive.

The UW-Extension Mission

“Through the University of Wisconsin-Extension, all Wisconsin people can access university resources and engage in lifelong learning, wherever they live and work.”

A central role of UW-Extension professionals is to provide research-based programming, technical expertise, and leadership in response to community needs. Specifically, Cooperative Extension educators deliver education where people live and work – on the farm, in schools and community centers, etc. UW-Extension educators also speak to civic groups and county boards, write newspaper columns, do radio and TV programs, facilitate meetings, and build coalitions to solve community problems. To reach a wider

audience – and make it easy for those in remote areas to “attend” programs – Cooperative Extension also uses satellite technology, teleconferencing, and interactive video to link people around the region.

Wisconsin DNR and UW-Extension partner through the Basin Education Initiative to design and deliver educational programs, assist organizations, and build partnerships to promote understanding and stewardship of natural resources at the watershed and landscape scale. The program involves a team of 15 Basin Educators located throughout Wisconsin in areas coinciding with the state's major river and Great Lakes basins. Staff members at UW-Extension's Environmental Resources Center provide statewide support for program evaluation and development of regional and statewide educational materials. The program coordinates with the educational efforts of agencies and citizen organizations. Basin Educators provide expertise in:

- Natural resources issues.
- Group process and facilitation.
- Organizational capacity building.
- Adult education principles.
- Educational program design/implementation.

The Basin Education Program works primarily with adult audiences but may incorporate other educational activities as part of a specific community-based initiative. Basin educators do the following:

- Develop, deliver and evaluate educational programs and materials.
- Engage people in natural resource issues.
- Support organizational development.
- Design and conduct participatory group processes.
- Provide access to sound science that supports informed decision making.
- Connect with the University of Wisconsin System.

UW-Extension educators come from a variety of backgrounds and have diverse educational and technical experiences. Community officials often call on UW-Extension educators to supply technical expertise in planning and decision-making processes; often, UW-Extension educators serve as the primary point of contact for involved citizens and elected officials. As such, UW-Extension is uniquely suited to play an important role in increasing public understanding of Wisconsin's comprehensive planning (“smart growth”) law, the consequences and impacts of development, alternative ways of managing growth, and in building consensus regarding land use solutions. Cooperative Extension, in particular, has a long history of being active in public education related to land use planning and natural resource management. It has also been involved in community economic development education.

Audience Assessment: Web-based Survey of Extension Educators

In fall 2004, we conducted a Web-based survey of Wisconsin Extension educators to determine their interest in Internet GIS tools and assess their technical assistance needs. The survey instrument included 26 questions related to Internet tools and their application. An earlier report (Wisconsin DNR 2004c) documented the survey design, methods, and results and suggested implications for the Wisconsin DNR program. Here, we summarize the most relevant findings from that effort.

The Need for and Experience with GIS Tools: We asked educators to rank, based on the anticipated needs of their county, how important they felt various program emphases were (e.g., developing public participation plans, designing community planning processes, collecting GIS or other data, monitoring and evaluating plan effects, etc.). Most educators (>80%) considered “assessing the impacts of options using decision-support tools” to be important to very important. They also considered “using GIS data to help groups make decisions” and “proposing alternative future community scenarios” to be somewhat important to important. Studies elsewhere have reported similar findings. For example, Merry et al. (2008b) reported that 85% of Georgia extension educators felt that land cover change model projections would be helpful to the planning process or their Extension effort.

In contrast to these findings, many educators (> 70%) felt collecting and analyzing GIS data were among their least important program emphases. This may be because Extension educators rely on others (government employees or consultants) to do that job, or it could be due to the “digital divide” phenomenon.

The Web survey results support earlier findings related to the accessibility and usability of Internet GIS tools (Lucero 2003, Lucero et al. 2004), which indicated that the most useful modeling tools have the necessary databases imbedded within the tool structure (i.e. users do not have to independently obtain data needed to use the tools effectively) and have intuitive interfaces that make the underlying GIS functions transparent to the user.

In a related finding, 50% of surveyed educators felt they were either “not too experienced” or had no experience with Internet GIS tools. Nonetheless, a community of users exists within many county offices:

- 55% of respondents indicated others in their office regularly use these tools.
- 66% replied that they have access to needed technical support.

In addition, educators expressed interest in the tools:

- 57% indicated being “very interested” in learning more about the tools.

Training Preferences: Finally, we asked educators what formats both they and their audiences prefer for receiving training and technical assistance related to the tools. Survey results suggested that workshops supported by Web modules and printed materials would be the most effective means of reaching Extension educators. Our results paralleled what Merry et al. (2008b) found in their survey of Georgia Extension educators: 81% preferred workshops as the extension training method. Wisconsin survey responses also suggested that printed materials and workshops supported by online resources would be the most effective approaches for helping Extension educators meet the needs of their audiences. In addition, survey responses suggested Extension educators would like their statewide specialists to conduct workshops, both for Extension agents and their local audiences.

Training: Hands-on Workshops

Based on the Web-survey results and our stated learning objectives, we developed a two-day, hands-on workshop for UW-Extension educators, which we offered twice (Table 6.1), after a pilot test with a small group of educators. We publicized the workshop through previously established partner groups within the Extension network (Center for Land Use Education, Local Government Center, and Environmental Resources Center).

Table 6.1. *Hands-on Training Sessions Conducted for UW-Extension Educators.*

Dates	Workshop Location
November 18, 2004*	Madison
February 14-15, 2005	Stevens Point
August 17-18, 2005	Madison

* The November workshop was a shortened 1-day session that served as a pilot session to refine training methods and instructional materials.

The workshop included direct instruction on specific tools for finding information, for creating maps, and for modeling decision impacts (Table 6.2). Learning outcomes for the session focused on identifying and using tools in the education and community planning work that Extension educators routinely undertake.

Table 6.2. *Tools Included in Workshops for UW-Extension Educators.*

Internet Tools		
Tool	Developer	Internet URL
Window to My Environment	U.S. Environmental Protection Agency	http://www.epa.gov/enviro/wme/
ATRI Metadata Explorer	Wisconsin DNR	No longer available on the Internet
Comprehensive Planning Mapping Site	Wisconsin DNR	http://maps.wiatri.net/Landuse/
WISCLINC	Wisconsin State Cartographer's Office	http://www.sco.wisc.edu/wisclinc/
Geospatial One-stop	Federal Geographic Data Committee	http://gos2.geodata.gov/wps/portal/gos
EnviroMapper for Water	U.S. Environmental Protection Agency	http://www.epa.gov/waters/enviromapper/
Registry of Closed Remediation Sites and Brownfields Remediation & Redevelopment Tracking System	Wisconsin DNR	http://dnr.wi.gov/org/aw/rr/gis/
Digital Watershed	Michigan State University	http://www.iwr.msu.edu/dw/
Long-term Hydrologic Impact Assessment (LTHIA)	Purdue University	http://www.ecn.purdue.edu/runoff/lthianew/
Non-Internet Tools		
Tool	Developer	Internet URL
CommunityViz	Orton Family Foundation	http://www.communityviz.com/
What if?	What if?, Inc.	http://www.what-if-pss.com/
Place IT	University of Wisconsin Land Information & Computer Graphics Facility	Currently no Internet site available for this tool

The workshop agenda also incorporated an introduction to GIS and related technologies, an overview of various federal government GIS activities, and resources for accessing Internet tools. Classroom instruction and hands-on experience focused on day-to-day applications of the tools, including various entertaining, but real-world, techniques to help participants determine if they had mastered each new skill. Because Extension's primary focus is on education, we also placed an emphasis on educators developing technology transfer skills (i.e. an ability to convey information about the tools to others). Participants received a booklet with instructional worksheets and guided activities for each tool and we distributed a CD with all handouts and presentations to all workshop participants following the workshop.

Participatory Evaluation: Workshop Feedback

At the beginning of each workshop and prior to any instruction, we administered a short questionnaire to assess participants' current use of the tools, future interest in using the tools, and previous GIS experience. We wanted to confirm our earlier survey work and have a basis for determining, at a future time, if the workshop changed participants' use of the Internet GIS tools. At the conclusion of each workshop, participants completed evaluation forms, the results of which we tallied.

Consistent with these Web survey results, tallies from our pre-workshop questionnaire highlight a discrepancy in action versus attitude:

- 52% indicated they used the tools occasionally, but 43% indicated they rarely or never use these types of tools in their work.

- 39% indicated they felt these tools were essential to their work and another 61% indicated the tools were somewhat important.

Prior to the workshop, none of the participants felt that they were highly proficient with GIS and only 11% indicated they were somewhat proficient. On the other hand, 68% reported having some exposure, but 21% indicated having no GIS experience at all. Interestingly, this measure illuminated the increasing transparency of GIS, i.e. many participants who have used applications that rely on GIS are unaware of the underlying technology.

The immediate feedback provided on the post-workshop evaluations suggested the training sessions were relatively effective in building knowledge and skills:

- 91% indicated that they “understand how the tools can be used for planning, conservation, and environmental protection.”
- 73% indicated “the tools can enhance the work that I do.”
- 80% felt the tools could enhance the work of others they interact with.

Similar positive responses were provided when participants were asked about specific individual tools:

- 91% stated “I understand what it does.”
- 77% felt they could use it on their own.
- 59% stated “I could use it in my work.”
- 59% indicated “I could show others how to use it.”
- 51% stated “I plan to use it in the future.”

Measuring Outcomes: Post-workshop Interviews

To more fully assess the effectiveness of the workshops and find out how the Internet tools were being used, we also asked an independent researcher to interview workshop participants 10 to 11 months following the actual workshops (January 2006, June 2006). She interviewed all participants for 30 to 55 minutes and asked questions related to the educators’ use of the tools, technology transfer to others, and use of available resources, such as Web sites.

Results from the follow-up interviews support the workshop evaluation findings with respect to these second order outcomes:

- 72% of the educators used at least one tool following the workshop, but none of the educators used all nine tools (average number of tools used was 1.9).
- Each tool was used at least once by at least one educator, but the frequency of use was low.
- All but one educator expected they might use the tools at a future time.

The primary reason educators cited for not using tools was a lack of a specific opportunity or need for using the tools in their jobs since the workshop.

Following the workshops, 78% of educators had made someone else aware of the tools and 11% organized or sponsored workshops focused on the tools. One educator used Web-based tools in high school classrooms to identify and map urban development and its contribution to storm water runoff (see Welch 2005). Generally, however, the participants did not consider teaching about Internet GIS tools to be part of their job responsibilities. Rather, they indicated a preference for having a “computer expert” either do the teaching or at least support them in their efforts.

We hoped to identify specific decision outcomes and environmental results (i.e. third order outcomes) from use of the tools. We found this was not always possible, partly because the educators do not always know what comes out of their provision of information, sharing of tools, presentation of maps, etc. At the time of the interviews, most of the educators had not yet applied the tools to any conservation or land use decisions being made. Two educators, however, did say their use of the computer tools impacted a decision. One indicated that using EnviroMapper for Water and Digital Watershed resulted in refocusing a community group’s efforts on a lake’s riparian area rather than at the watershed boundaries. The other used the

Registry for Closed Remediation Sites to discover a former dump site near a house being considered for purchase, a factor that ultimately influenced the selection of a different location.

Miscellaneous Outreach and Technical Assistance

At the request of one of the participants in our 2-day February 2005 workshop, we offered a scaled down (3-hour) mini-workshop for Extension educators in northeastern Wisconsin as part of that region's monthly in-service training offerings. We did this to expand the reach of our efforts within Wisconsin's Great Lakes Basin.

When conducted in conjunction with UW-Extension, our workshops, Webconferences, and outreach efforts for other audiences provided additional opportunities to build expertise among Extension educators as well. For example, Dane County's Extension educator asked program staff to demonstrate Internet tools that could be applied in private forest management as part of the Madison Area Woodland Owners Conference held in February 2007. This request followed the Extension agent's participation in the 2005 hands-on workshop, which did not include tools specifically for forestry management. Similarly, program staff participation in the Monroe County Extension educator's hands-on workshop for citizen planners provided an opportunity to work through logistical issues with the educator. (See the chapter dealing with our work with planners for more information on this workshop.)

References and Related Reading

We found the following references helpful in defining and developing our approach to working with Extension educators. We list these works, all other references cited, and additional useful sources together in the "Literature Cited, Further Reading, and Background Material" section at the end of this report.

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- Civittolo, D. and G.A. Davis. 2008. Ohio township trustees' land use planning knowledge and practices: a statewide survey to better target programmatic resources. *Journal of Extension* [On-line] 26(5) Article 5RIB6. Available online at www.joe.org/joe/2008october/rb6p.shtml.
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Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described our technology transfer work with Extension professionals, our assessment and evaluation of these efforts, as well as lessons learned along the way. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

- Goranson, S. and D.J. Watermolen. 2007. Bridging the Gaps in Environmental Information Sharing. "Government Data Sharing in the Information Age," Illinois Data Exchange Affiliates and Chicago Metropolitan Agency for Planning, Sears Tower, Chicago, IL. (March 20, 2007).
See [http://www.chidataexchange.net/upcomingevents_copy\(1\).htm](http://www.chidataexchange.net/upcomingevents_copy(1).htm).
- Lucero, D., D.J. Watermolen and D. Bellrichard. 2006. Using Internet Mapping Services (IMS) for Planning, Conservation, and Environmental Protection: An IMS Capacity Building Program. North American Cartographic Information Society: NACIS 2006 Conference. Inn on the Park, Madison, WI. (October 18-21, 2006).
See http://dev.nacis.org/documents_upload/FinalProgramXXVI.pdf.
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See <http://www.smartgrowth.org/library/articles.asp?art=1493&res=1024>.
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Outputs: Publications Related to Our Work

The publications listed below transferred findings from the Wisconsin DNR program's work with Extension educators. These publications were not part of the actual technology transfer efforts, but rather made lessons learned from Wisconsin DNR's efforts available to others.

Watermolen, D.J., E. Andrews, and S. Wade. 2009. Extension educators can use Internet GIS and related technologies. *Journal of Extension* (In press).

Welch, R.C. 2005. L-THIA – Three versions, three groups, three projects. University of Wisconsin-Stevens Point Center for Land Use Education *The Land Use Tracker* 5(3):6-9. Available online at <http://www.uwsp.edu/cnr/landcenter/tracker/winter2005/TrackerWinter2005.pdf>.

7. Target Audience: Planners

Planners play an essential role in shaping Wisconsin's landscape. They coordinate public and private interests to develop a community vision for the future. Planners help shape the economy, social community, and natural environment via the processes they guide and the documents they help create, both of which provide a rational basis for land-use decision making. Planners employ processes that involve defining problems and opportunities, setting goals, generating alternate strategies, choosing appropriate strategies, implementing planned strategies, and evaluating progress toward plan goals. Sound planning has always been an important means of ensuring a community is able to meet its future needs while providing for present quality of life. In this chapter, we overview the planner audience, describe our assessment, outreach, training, and technical assistance efforts, and report on our outcome evaluations. We conclude the chapter by listing publications and professional presentations related to this work.

Background: Planners and Their Role in Local Decisions

A current emphasis on planning and GIS is particularly pertinent. In 1999, Wisconsin passed legislation that mandates all local governments who make decisions affecting land use (zoning, subdivision ordinance adoption, and official mapping) to create and adopt comprehensive plans. The law sets up a framework for the structure of a comprehensive plan requiring communities to address nine general elements, but does not prescribe any particular policies or principles, sound or otherwise, and the state holds no authority over the contents or quality of adopted plans. The Wisconsin DNR, however, recognizes the significant long-term impact sound planning can have on preserving and managing a community's natural resources and protecting an area's environmental quality. GIS and Internet tools can help effectuate sound planning. Therefore, it is imperative that the Wisconsin DNR program target the two groups that affect the planning process most directly, professional planners and citizen planners.

Professional planners use their academic training and expert skills to help communities understand their current conditions and define a future vision. They often use specialized tools to guide those processes. Professional planners typically have academic training in the following aspects of planning:

- Structure and function of cities and regions
- History and theory of planning processes and practices
- Administrative, legal and political aspects of plan making
- Public involvement and dispute resolution techniques
- Research design and data analysis techniques
- Written, oral, and graphic communication skills
- Ethics of professional practice
- Collaborative approaches to problem solving

Wisconsin has a relatively long history of public sector investment in land information and GIS through its Wisconsin Land Information Program (Kuhlman 1994, Tulloch and Niemann 1996). This investment coupled with decreased costs associated with the technology, increased availability and accessibility of geospatial datasets, coordination and communication between agencies and organizations, and a new generation of trained staff have resulted in an increased popularity for GIS-based tools that aid planning and decision making. Today, all Wisconsin regional planning commissions and counties and two-thirds of municipalities with a population greater than 5,000 have in-house GIS capabilities and practice planning to some extent (Gocmen 2008). Similar trends have been observed in other states (Budic 1993, Haithcoat et al. 2001, Caron and Bédard 2002, Public Technology, Inc. 2003, Patterson and Hoalst-Pullen 2009), but it has also been recognized that small communities often lack GIS staff and the resources to construct and maintain a GIS (DeLozier et al. 2004).

Unlike professional planners, citizen planners typically volunteer their time to help influence and guide the future of their communities, and they may or may not have planning education or experience. Often, these individuals participate in their town or city planning organization because they are concerned about factors that compromise their quality of life. Citizen plan commissions advise their local governing body on

comprehensive planning and land use issues and may make related decisions that are delegated by the governing body. And, often these citizen planning bodies operate with little or no budgetary support. As a result, the needs of citizen planners can be quite different from those of professional planners. In addition, citizen planners often “wear multiple hats” and assume other roles within their local government structure resulting in some overlap between this part of the planner audience and the local government decision makers audience discussed in a later chapter. Some of our efforts targeted these groups together.

As a result of our audience assessment work, which indicated that a primary need of professional planners was ready access to data, we expanded this audience to include GIS practitioners, who may or may not consider themselves planners. Although not within the original scope of our project, we deemed work with this group of professionals as essential for responding to the needs of both professional and citizen planners.

Audience Assessment: Web-based Survey of Wisconsin Planners

The Wisconsin Chapter of the American Planning Association (WAPA) conducted a Web-based survey of Wisconsin planners in 2003 and 2004 to obtain feedback regarding the services that the organization provides. We assessed the survey results to better understand planners’ interests and needs. An earlier report (Wisconsin DNR 2004c) presented survey results and discussed their implications for the Wisconsin DNR program. Here, we summarize the most relevant findings.

Professional Association Membership: Of the 165 respondents, 90% were members of the national American Planning Association (APA) and 90% were WAPA members. Fifty percent of respondents were members of the American Institute of Certified Planners (AICP). These results suggested that most Wisconsin planners belong to their professional association and that a large percentage of this audience is committed to professional development (i.e. AICP certification). From this, we concluded that partnering with WAPA to identify and address training and technical assistance needs could increase the likelihood of achieving a high level of results with this target audience. We also surmised that the national association might be an appropriate partner to work with to expand the reach of Wisconsin’s model to other states as U.S. EPA requested.

WAPA Conferences: The survey asked respondents what they thought about the quality of WAPA conferences. Results suggested participating in conference planning; plenary, paper, and poster sessions; and workshops, seminars, and trade show exhibits could all be effective means of reaching this audience:

- 62% felt these conferences provide quality information.
- 41% felt the conferences met their educational needs.
- 65% gave an overall conference rating of “very good” or “excellent.”
- 81% felt the conferences were well organized.
- 79% thought the cost for the conferences was reasonable.

Survey respondents were asked to list topics they would like to see at future conferences. Some of the suggested topics (Table 7.1) could be addressed with sessions focused on Internet tools. In addition, specific environmental topics listed by respondents included water resource management, open space planning, forest planning, and urban agriculture. These results suggested Wisconsin planners have an interest in GIS and related technologies. In addition, several of the interests listed by respondents aligned with the objectives of the Wisconsin DNR program and suggested the climate was right for offering training and technical assistance focused on these technologies. We surmised that conference sessions specifically focused on the use of tools for assessing impacts and enhancing public participation could be effective ways of promoting the use of Internet tools for local planning and environmental management.

Table 7.1. *Some Topics Planners Indicated They Would Like to See at Future Conferences.*

-
- GIS management
 - GIS applications
 - environmental vs. development controversies
 - characterizing and assessing the quality of the built environment - techniques for working with citizens to identify what they like/don't like about their built environment
 - fiscal impact analysis
 - economic consequences of development regulations
 - effectively dealing with anti-planning sentiments
 - ways to get the public interested and involved
 - public participation training
 - Wisconsin's comprehensive planning law - resources/approaches for completing the nine elements; more nuts and bolts topics
-

WAPA Newsletter: The survey asked respondents for their opinions regarding WAPA's quarterly newsletter. Results suggested the WAPA newsletter might be an effective tool for promoting the Wisconsin DNR program:

- 61% indicated that they felt the newsletter provides quality information
- 59% felt the newsletter was interesting and informative.
- 66% felt the newsletter was well organized.
- 61% said the frequency of the newsletter was adequate.

Survey respondents were asked what suggestions they have for any changes to the WAPA newsletter. Some suggestions related to Internet tools or relevant to the Wisconsin DNR program included:

- Have articles with solid recommendations and tools.
- Add ideas and tips to utilize the technology such as GIS, within planning offices.
- Identify informational links, resources.
- Consider detailed study cases.
- More how-to sections; case studies.
- Highlight technology and planning.

These results suggested newsletter articles that address specific tools and ways that the tools can be used for specific planning efforts (i.e. case studies) might be one way of informing planners about tools and their use for planning, conservation, and environmental protection.

WAPA Listserve and Web Site: The survey asked respondents about their awareness and use of the WAPA listserve and Web site. Results suggested the WAPA listserve and Web site might be effective tools for promoting aspects of the Wisconsin DNR program:

- 66% indicated they were aware of the WAPA listserve
- 40% indicated that they subscribe to the listserve
- 44% found the Web site interesting and informative
- 46% indicated the site provided quality information
- 33% found the site well organized and frequently updated
- a little more than half of the respondents indicated that they check the Web site for news, RFP's, job notices, etc.

We also deduced that the WAPA listserve might be an appropriate venue for inquiring about the current use of Internet tools for planning. Finally, we concluded the WAPA Web site would be an appropriate vehicle for highlighting case studies and real world examples of the use of Internet tools.

Additional Chapter Services: Survey respondents were asked to list any other services they would like to see WAPA provide. The results (Table 7.2) suggested Wisconsin planners have an interest in Internet tools and related technologies. We concluded conference sessions specifically focused on the use of Internet tools for assessing impacts and enhancing public participation could be effective ways of promoting the use of the tools. These results also suggested planners may be interested in Web training modules or Webcasts/Webconferences.

Table 7.2. *Planner Suggestions Related Relevant to the Wisconsin DNR Program.*

- training workshops on current issues
 - sponsor plan commission workshops with UWEX
 - specialized training on specific topic; census and demographics analysis; computer applications in planning, etc.
 - I would like to see online training
 - additional training and/or skills workshops
 - partner with others to offer additional training, put more resources on the Web site
 - skills workshops
 - additional training and/or skills workshops
 - skills workshop
 - help provide planner GIS training at reasonable cost (our employers are not going to pick it up in these tight budget times) with an emphasis on tools like ArcView
 - additional training and workshops - including 1 day workshops which combine 2 hours Web-based plus on-site presentations
 - skills workshops
 - training focusing on skills - the how-to approach
 - online training with the World Wide Web is growing rapidly; it reduces cost and time
-

Audience Assessment: Planning Conference Survey

As a follow-up to the Web-based survey, we partnered with WAPA during its 2004 statewide planning conference. The registration packets that all conference participants received upon arriving at the conference included a questionnaire asking about experience with computer-based, decision-support tools in the planning process, planners' level of comfort with using the tools, and their interest in learning more about such tools. During the conference's opening session, the moderator called attention to the survey and asked participants to fill out the form and turn it in at Wisconsin DNR's exhibit booth. We collected surveys throughout the 2-day conference. While this approach represents a convenience sample of a somewhat limited segment of the Wisconsin planner population (i.e. only those who attended the conference), the results presented below corroborated our other assessment work and provided a baseline for future qualitative measurement.

Tool Use: Planners indicated that they currently use these types of tools to inform their planning work:

- 71% of respondents indicated that they personally "routinely" use decision-support tools in their planning work.
- 21% indicated they "sometimes" use decision-support tools in their work.
- 36% indicated others in their organization use decision-support tools, but 21% were unsure if others in their organization used the tools.

Planners indicated they use decision-support tools throughout the planning process:

- 79% of respondents indicated they use the tools for data gathering.
- 71% said they use the tools for data analysis.
- 64% indicated they use the tools for public participation.
- 36% said they use the tools in the visioning process.
- 29% said they use decision-support tools to analyze alternatives.
- 14% indicated they use the tools during plan implementation and monitoring.

Given the relatively high level of use, we found it a little surprising how planners categorized their experience with decision-support tools. When we asked how they would categorize their experience, many planners felt they had “little” (29%) or “no” (21%) experience. Only 7% claimed to be “very” experienced, and 36% indicated they were only “somewhat” experienced. This could be because the planners used the outputs of the tools in their planning work, but others within their organization actually worked with the tools.

The survey asked about planners’ use of six specific tools. Only a small number of planners has used tools developed by the Midwest Spatial Decision Support Systems Partnership:

- 1 had used the LTHIA (Long-term Hydrologic Impact Assessment) tool.
- 1 had used the Digital Watershed tool.

None of the respondents had used U.S. EPA’s Window to My Environment or the other well known planning support tools (CommunityViz, What If?, CITYgreen). These findings suggest a need for outreach efforts to make planners more aware of available tools.

We also asked planners for reasons they did not use decision-support tools in their planning work. Reasons were varied:

- 29% of respondents indicated they were “not aware” of the tools’ planning applications.
- 29% said they did not have training in any decision-support tools.
- 14% indicated that decision-support tools were not used in their workplace.
- 7% said the tools were not available in their office.

These findings confirmed our earlier thinking about the importance of outreach and technical assistance efforts to make planners more aware of decision-support tools and how such tools can be used in planning processes.

Interest in Learning More and Training Preferences: We asked questions to ascertain planners’ interest in learning more about computer-based, decision-support tools and their training preferences. Ninety-three percent of respondents indicated that they were either “somewhat” (50%) or “very” (43%) interested in learning more about the tools. This high percentage may have reflected a sampling bias as those who were not interested in decision-support tools may have opted not to complete or turn in the survey. Nonetheless, we believe this high level of interest underscored the value of both the tools and the Wisconsin DNR program.

Planners who expressed an interest in learning more about decision-support tools indicated a variety of preferences for learning more about the tools:

- 43% indicated they would prefer hands-on workshops.
- 36% said they preferred classroom style sessions.
- 36% suggested Web-based sessions as their preferred method.
- 29% said they preferred receiving printed materials.

These findings were consistent with the results of the previous Web-based survey of Wisconsin planners. In addition, 64% of respondents indicated they would be willing to pay a nominal fee to attend a classroom session (\$20) or workshop (\$50).

Finally, we asked how planners would like to be kept informed about the Wisconsin DNR program. Sixty-four percent of conference respondents said they preferred being kept up-to-date through e-mail updates. Another, 43% expressed interest in a Web site dedicated specifically to the program.

Audience Assessment: Professional Planners Focus Group

We conducted a focus group discussion with a small group of professional planners to supplement our initial assessments. In November 2005, program staff conducted the focus group at the University of Wisconsin-Madison's Pyle Center. We worked closely with WAPA's Southwest District Representative to identify planners from the area who could provide insight into the needs of this particular target audience.

Specifically, we wished to answer two questions:

1. What do professional planners need in terms of Internet tools for planning, conservation, and environmental protection?
2. How can we help meet those needs?

Invitational materials (Figure 7.1) were distributed to a listserv by the Southwest District Representative. Six planners participated in the focus group discussion:

Andrew Curtiss
Vandewalle & Associates

Peter Herried
Wisconsin Department of Administration

Jessica Fink
Smith Group JJR

Ezra Meyer
Wisconsin Association of Lakes

Gary Peterson
President, WAPA

Charles Wade
Short Elliott Hendrickson, Inc

The moderator began the session by asking participants to complete our Baseline Survey, a form that conveys a person's experience with, and interest in using, Internet computer tools. She then provided background information about the Wisconsin DNR program to give the group an understanding of the types of Web-based technologies and types of outreach provided to other groups included within the program. She then opened the session up to discussion and idea sharing to discover ways to include professional planners in this effort. The following concepts were gleaned from the five major topics covered in that exchange.

Hands-on Workshops: Earlier assessment efforts suggested hands-on workshops might be of interest to planners. The group offered opinions about this approach.

- It is possible, depending on the content of a workshop and the proficiency of the planners, that workshops may be *unnecessary*.
- Planners are more likely to attend workshops if they are local.
- One planner could attend a workshop and then teach others in her/his firm about the tools featured.
- Planners expressed interest in the possibility of offering continuing education credits for these types of courses and suggested exploring this option with WAPA.

Other Training Opportunities: The group also discussed other approaches to training.

- Individual firm-focused training sessions would be welcome (e.g., brownbag presentations).
- Lunch time Webcasts/Webconferences would be an effective way to reach planners statewide.

Computer Tool Database: Focus group participants recognized the tremendous technological advances that have occurred recently and the proliferation of available Internet and GIS tools.

- An interactive database with varying ways to query computer tools would be highly useful.
- A querying function that would let users either ask questions of the database (e.g., what are some practical methods of conservation?) or, conversely, display leading answers to planning questions (e.g., sample conservation subdivision ordinance language) would be useful.
- Planners would be more likely to discover and use the database if we provided a direct mailing of a paper copy (i.e., sample search) illustrating its capabilities and where they can locate it on the Internet.

Figure 7.1. *Invitation Sent to Professional Planners Soliciting Participation in the Focus Group Session.*

Wisconsin DNR is presently engaged in a program to promote Web-based computer tools for planning, conservation, and environmental protection. This program targets specific audiences who make or influence land use decisions. DNR is asking you to provide input on how this program could best provide information and technical assistance to professional planners. We invite you to join us for a discussion.

There are two upcoming opportunities. Please RSVP to dana.lucero@dnr.state.wi.us.

Wednesday, Nov. 2 and Thursday, Nov. 3
4:15 - 5:00 pm
Pyle Center, Room 217
UW-Madison
702 Langdon Street
Madison, WI 53706

- Hear about our current efforts with free Internet tools for accessing data, creating maps, and modeling impacts of land use change. Find out about an extensive new portal for free tools, coming soon.

- Tell us about your need for this type of capability for you, your staff, or the public you work with.

- Share ideas for how DNR can support Wisconsin planners. Help shape our outreach program so we can meet your needs.

For more information, visit <http://dnr.wi.gov/org/es/science/landuse/CompTools/>, or contact Dana Lucero at the contact information below.

Planning Related Material on State Agency Websites: Focus group participants discussed the Internet as a source of planning related information.

- It would be useful if all state agencies' planning information and resources were located in a single place, or starting point, on the Internet.
- Wisconsin DNR's Web site can be very confusing for someone unfamiliar with it.
- Wisconsin DNR's Web site seems scattered. There should be a means to easily guide users to topics or questions.
- What planners need most is data from Wisconsin DNR. The mapping applications are good, but planners tend to have mapping software systems themselves or someone in their office that produces maps with proprietary mapping programs.
- It is difficult to get currency information about some digital and paper forms of Wisconsin DNR data.

General Publicity to Professional Planners: The focus group provided an opportunity to ask planners how they wanted to be kept abreast of the Wisconsin DNR program and related resources.

- Explicitly communicate to planners what they can do with these tools and that they can do it cheaply.
- The awarding of comprehensive planning grants has become increasingly competitive. Extra efforts should count in the selection process. Include distinctions (like inclusive natural resources data) beyond the basic plan requirements.

At the end of the session, the group was able to synthesize these ideas into the most basic of needs for professional planners. They need explicit natural resources data to help them complete the nine elements of the comprehensive plan. All agreed that Webcasts, preferably at lunchtime, provide a meaningful and simple way to conduct outreach to professional planners. They also agreed that technology transfer efforts should focus primarily on data access tools, with lesser emphasis on mapping and modeling tools.

Audience Assessment: Discussions with GIS Practitioners

Given the consistent emphasis professional planners placed on the need for data, particularly GIS data, we felt it important to reach out to the GIS community. In March 2006, program staff met with the Bay-Lake Regional Planning Commission (B-LRPC) GIS User Group⁵ to talk about Internet tools and the Wisconsin DNR program. This meeting represented the first time the Wisconsin DNR program specifically reached out to GIS professionals.

Staff provided an overview of the program, namely the types of tools included within the scope of our efforts (i.e. Web-based, intuitive, scalable, etc.) and then shared thirteen different tools that may be of use to this specific group. We then asked the User Group about their needs. The primary lesson learned from this meeting mirrors what we learned from our professional planner focus group (November 2005): their primary need is data. GIS professionals rely on their personal desktop GIS software to create and manipulate map products, and require a set of sophisticated tools not offered by most Internet mapping services.

We also uncovered the potential to collaborate with county-based mapping providers through the joint development of user surveys. For example, when a resident of Brown County visits the Brown County interactive mapping site, a brief pop up window could survey the user as to their interests and intent in using the mapping site. This user-based information would let the county know the kinds of information that are most useful to users and would help Wisconsin DNR and tool developers know what kinds of questions people are turning to mapping sites to answer. Although this type of partnership was not initiated during the grant period, discussions will take place as a part of Wisconsin DNR's Exchange Network Challenge Grant project.

Outreach and Technical Assistance: Planning Conference Participation

Building on the lessons learned in our audience assessment work, we partnered with the Wisconsin Chapter of the American Planning Association (WAPA) in several different ways at the organization's annual conferences.

Beginning in 2004, we began exhibiting in the annual conference's trade show. Each year, we set up and staffed our multi-media exhibit. This visible presence created opportunities for conference attendees to seek out consultation and technical assistance services from Wisconsin DNR and sign up for information regarding upcoming training sessions.

In May 2005, program staff presented an hour-long session on "Computer Tools for Addressing Elements of the Comprehensive Plan". During this session, staff members identified various Web-based tools, presented our preliminary work on the "Computer Tools and Wisconsin's Comprehensive Planning Law"

⁵ B-LRPC is a multi-county, advisory planning body that provides guidance and expertise to member communities in the northern Lake Michigan region of Wisconsin. B-LRPC leadership and staff have participated in various aspects of the Wisconsin DNR program dating back to the first *Changing Landscapes* workshop in 2003. For example, B-LRPC hosted sessions of our 2006 webcast series for interested planners and local government partners. The GIS User Group, comprised of local GIS technicians working for member communities, meets regularly to discuss planning issues and learn about emerging technologies.

matrix (see Internet and GIS Tools chapter), and solicited participant feedback on our approach and products. Staff also demonstrated the Digital Watershed and LTHIA tools and offered suggestions for online sites to find data and information for planning.

At various times throughout the grant period, we worked with conference organizers to make information available to conference participants. As previously mentioned, our Planning Conference Survey was included in the registration packets at the 2004 conference. In 2005, we made available the publications “Using Computer Tools to Find the Information You Need” and “Using Computer Tools to Make Maps You Need” to all registrants. In 2008, we included additional information about Internet tools for planning in conference registration packets.

Outreach and Training: Webconference Series

We developed a series of four Webconferences for citizen planners and local government decision makers (see discussion of the series and our evaluation of it in the Local Government Decision Makers chapter). While our primary focus was on citizen planners, we also targeted professional planners with our advertising, as both survey respondents and focus group participants expressed interest in Web-based sessions. At least two of Wisconsin’s regional planning commissions served as host sites for the series.

Outreach: GIS Day with Planning Students and Faculty

Each year, GIS Day provides an international forum for GIS users to demonstrate real-world applications that are making a difference in society. Principal sponsors in the United States include the National Geographic Society, Association of American Geographers, University Consortium for Geographic Information Science, U.S. Geological Survey, Library of Congress, Sun Microsystems, Hewlett-Packard, and ESRI. Participants in many countries hold local events such as corporate open houses, hands-on workshops, community expos, and school assemblies.

Program staff participated annually (2004–2007) in the GIS Day celebration on the University of Wisconsin-Madison campus, including a staffed booth with exhibit, handout materials, and live demonstrations (Figure 7.2) and various presentations. The purpose of the day-long event was to promote awareness of GIS in today’s society for research, planning, management, education, and decision making in a wide-array of application areas.

The event gave program staff the opportunity to talk with numerous individuals about Web-based resources. Our exhibit was visited annually by approximately 60-70 people, including graduate and undergraduate students, GIS professionals from other state and federal agencies and the private sector, school teachers and children, interested citizens, and others. Many of the participants were interested in discovering how they could acquire information and data to assist them with academic and research projects. We provided fact sheets describing various Internet tools and encouraged participants to visit Wisconsin DNR’s “Internet Tools” Web portal, which was demonstrated on a nearby laptop. Other tools demonstrated included Surface Water Data Viewer, Digital Watershed, Remediation and Redevelopment Sites Map, WisStat, Wisconsin Nature Mapping, and ArcGIS Explorer. A binder with a print copy of “Streaming Web Mapping Services to Your Desktop” was displayed and a sign-up sheet allowed people to request a digital version. Participants could also take down the document’s URL address or sign up for information regarding upcoming training sessions.

At the 2007 event, staff made presentations on “Web-Based Spatial Decision Support Systems for Citizens, Activists, and Planners” and “National Environmental Information Exchange Network” as part of a Campus Geospatial Interoperability Summit. Staff also participated in a panel discussion focused on “Promoting Data Integration in Wisconsin Using Free and Open Source Software and OGC Web Services: the Role of UW-Madison.” This summit was attended by approximately 350 people, including many on the “leading edge” of GIS, both professional and academic.

Figure 7.2. Trade Show Exhibit and Demonstrations at the UW-Madison GIS Day Celebration.



Discussions with GIS Day participants provided interesting ideas and feedback regarding user capacity, data availability, and inter-operability, particularly as these issues relate to land use decisions. One real estate professional we spoke with was developing a GIS-project that incorporates various data of interest to appraisers and developers, including data on environmental resources and hazards, such as contaminated areas and air pollution. He had learned about the Wisconsin DNR program from an earlier staff presentation at an ESRI Wisconsin User's Group meeting, and had visited Wisconsin DNR mapping sites since then but was not aware of the range of data and functionality available. He was particularly interested in the fact that data from sites like the Remediation and Redevelopment Sites Map cannot only be downloaded, but can be streamed into ArcGIS, allowing what would otherwise have been "discreet boxes" to become inter-operable tools. A Town Planning Board member expressed how useful the demonstrated tools could be in developing a local comprehensive plan.

Outreach: GIS Conference Presentations

Since many professional planners indicated that accessing spatially-referenced data was a primary need, we felt it was important to reach out to GIS practitioners—an audience that we found overlaps substantially with the professional planning community—to introduce them to the Wisconsin DNR program, share state and federal agency data sources, and offer up lessons we learned through our work with planners and local government officials. To this end, we made a number of presentations at professional conferences that were heavily attended by the GIS community (Table 7.3).

Table 7.3. *Presentation by Wisconsin DNR Program Staff Members at Conferences Attended by Wisconsin’s GIS Community during the Grant Period.*

Conference	Date(s) and Location	Presentation Titles
Wisconsin Land Information Association 2004 Annual Conference	March 4, 2004 – Wisconsin Dells	“Enhancing Local Land Use Decisions through the Evaluation and Use of Web-based Tools”
ESRI Wisconsin User Group’s 2005 Conference	November 10, 2005 – Green Bay	“A Look at the WDNR’s Computer Tools for Planning, Conservation, and Environmental Protection Technical Assistance Program”
ESRI Wisconsin User Group’s 2006 Conference	November 1-2, 2006 – Appleton	“Webcasting as a Training Method for Internet GIS Resources”
North American Cartographic Information Society 2006 Annual Meeting	October 2006 – Madison	<p>“An IMS Capacity Building Program”</p> <p>“Building Capacity among Extension Educators to Use IMS”</p> <p>“Building Capacity among Nonprofit Conservation Leaders to Use IMS”</p> <p>“Building Capacity among Natural Resources and Planning Professionals to Use IMS”</p>
ESRI Wisconsin User Group’s 2007 Conference	October 9-10, 2007 – Madison	“Internet Mapping and Related Tools for Community Outreach: Lessons from Wisconsin DNR’s Capacity Building Efforts”
Wisconsin Land Information Association 2008 Annual Conference	February 27-29, 2008 – Lake Geneva	“Geospatial Decision Support Systems for Land Planning and Natural Resources Professionals”
Wisconsin Land Information Association Regional Meeting	June 7, 2008 – Wausau	“Internet-based Spatial Decision Support Tools: Increasing User Capacity and Lowering Barriers”
ESRI Wisconsin User Group’s 2008 Conference	October 29, 2008 - Appleton	“Web Services for Watershed Planning”

In an effort to help GIS and planning professionals make use of recent data products, program staff presented three poster maps at the Wisconsin Land Information Association’s 2008 conference:

- “Landscape Visualization Using the NLCD 1992-2001 Change Product”.
- “Creating a Digital Landscape Using Web Services”.
- “Water Boundary Database 1:24K”.

This last poster earned second place in WLIA’s Map and Poster Competition.

Training: Hands-on Workshops for Citizen Planners

While professional planners generally expressed a need for data and were less interested in training focused on using tools, citizen planners, who generally lack professional planning experience, regularly expressed interest in hands-on sessions. UW-Extension educators who we worked with also expressed an interest in helping organize and conduct such workshops for this audience.

Over the course of the grant period, we offered several hands-on workshops for citizen planners (Table 7.4). Workshops ranged in length from 1 to 4 hours and generally featured 1-3 tools. Workshops included direct instruction on specific tools for finding information, creating maps, and modeling decision impacts. Learning outcomes for the sessions focused on identifying and using tools in the community planning work that citizen volunteers routinely undertake. Participants received a booklet with instructional worksheets and guided activities for each tool featured in the workshop, as well as resources for finding and using additional Internet tools. Given the multiple “hats” that citizen planners sometimes wear, these workshops also provided training for local government decision makers.

Table 7.4. *Hands-on Workshops Conducted for Citizen Planners and Local Government Decision Makers during the Grant Period.*

Organization/Event	Date(s), Location, and Workshop Format	Primary Audience Segments
Fox-Wolf Watershed Alliance “Stormwater Conference 2005: Bringing It All Together”	March 8-9, 2005 – Green Bay (two half-day sessions)	Watershed protection groups, town sanitary district officials, elected municipal officials, city engineers, public works department employees, citizen planners
Rock River Coalition “Using the Internet for Land Use Decisions”	June 23, 2005 – Johnson Creek (4-hour session)	Citizen planners, watershed protection groups, elected municipal officials, local government employees
Rock River Coalition “Revitalizing the Rock: The Land, the Water, and the Communities”	August 26, 2005 – Fort Atkinson (conference session)	Citizen planners, watershed protection groups, elected municipal officials, local government employees
Rock River Coalition “Using the Internet for Comprehensive (Smart Growth) Planning”	November 3, 2005 – Johnson Creek (2.5-hour session)	Citizen planners, watershed protection groups, elected municipal officials, local government employees
River Alliance of Wisconsin and Friends of Wisconsin State Parks “Conservation in Common”	March 31, 2006 – Fond du Lac (4-hour session)	Citizen planners, watershed protection groups, friends group members, elected county and municipal officials
Wisconsin Towns Association annual conference	October 2006 – La Crosse (4-hour drop-in session; two 1- hour workshops)	Elected town board members, elected town clerks, boards of adjustment members, town government employees
UW-Extension Monroe County “Internet Tools for Planning, Conservation and Environmental Protection”	April 23, 2008 – Tomah (2.5-hour session)	Citizen planners, elected town officials, local government employees

Training: Instruction of Pre-service Planners

Beginning in 2008, program staff members lectured and conducted three hands-on laboratory sessions in the University of Wisconsin urban and regional planning school's "Planning for the Ecological City" class. Through these efforts, we introduced pre-service planners to a wide range of Internet GIS and related tools, including the Digital Watershed and Long-term Hydrologic Impact Assessment tools. Students then completed a graded assignment using the LTHIA tool. These pre-service planners were extremely interested in both the tools and in ways in which the tools can be incorporated into various planning processes. Interaction with these students provided additional insights into how the tools can support planning processes. Plans were made to repeat the lecture and lab sessions in 2009 and future years.

In addition to learning about the tools, these students provided written feedback and observations on the tools. Their observations corroborated findings from other work we undertook, including:

- Many Internet tools lack metadata and other relevant documentation.
- Although some tools have help features, many Internet tools lack tutorial features like FAQs, instructional videos, etc.
- Most Internet tool sites could be made more intuitive with the inclusion of simple features like pull-down menus.
- Internet tools are hard to find, often buried deep within the structure of a complex agency Web site.
- Limitations seem to be common between various tools (e.g., restrictions on size of area of interest, in ability to upload/download data in needed formats, inability to export data as shape files, etc.).
- Most Internet mapping sites, while generally helpful, lack spatial analysis capabilities.
- The planning community seems to reflect society as a whole in that many people using Internet tools actually have little or no GIS familiarity or training.

References and Related Reading

We found the following references helpful in defining and developing our approach to working with planners. We list these works, all other references cited, and additional useful sources together in the "Literature Cited, Further Reading, and Background Material" section at the end of this report.

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- Wisconsin DNR. 2004c. Target Audience Assessment for a Technical Assistance Program Focused on Computer Tools for Planning, Conservation, and Environmental Protection, Part 1. Unpubl. Rept. to U.S. Environmental Protection Agency–Region 5. Madison, WI: Wisconsin Department of Natural Resources. Available online at <http://www.dnr.state.wi.us/org/es/science/landuse/CompTools/AARept.pdf>.

Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described our technology transfer work with planners, our assessment and evaluation of these efforts, as well as lessons learned along the way. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

- Watermolen, D.J., A. Mednick, and J. Sullivan. 2008. Geospatial Decision Support Systems for Land Planning and Natural Resources Professionals. “Leaping into Enterprise: Building on 20 Years of Land Records Integration,” 2008 Annual Conference, Wisconsin Land Information Association. Grand Geneva Resort, Lake Geneva, WI. (February 29, 2008).
- Watermolen, D.J. 2007. Providing On-line Data and Decision Support Tools to Local Planners. Exchange Network National Meeting, U.S. Environmental Protection Agency and Environmental Council of States, Marriott New Orleans Convention Center, New Orleans, LA. (April 25, 2007). See <http://www.exchangenetwork.net/2007Meeting/presentations.htm>.
- Watermolen, D.J. 2006. Bridging the Gaps in Government Information Sharing: Providing On-line Data and Decision Support Tools to Local Planners. “Using Information to Accelerate the Pace of Environmental Protection,” U.S. EPA 2006 Environmental Information Symposium, Savannah International Trade & Convention Center, Savannah, GA. (December 4–7, 2006). See <http://www.epa.gov/oei/proceedings/2006/proceedings06.htm>.
- Lucero, D., D.J. Watermolen, and D. Bellrichard. 2006. Building Capacity among Natural Resource and Planning Professionals to Use IMS. North American Cartographic Information Society: NACIS 2006 Conference. Inn on the Park, Madison, WI. (October 18-21, 2006). See http://dev.nacis.org/documents_upload/FinalProgramXXVI.pdf.
- Lucero, D. and D.J. Watermolen. 2006. Internet Tools to Help Citizens Find Environmental Information, Make Maps, and Predict Impacts. “Something Is Brewing: Achieving Environmental Results through Community Involvement,” 2006 EPA Community Involvement Conference and Training. Hyatt Regency, Milwaukee, WI. (June 27-30, 2006).

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Lucero, D., R.C. Welch, and D.J. Watermolen. 2005. Computer Tools for Planning, Conservation, and Environmental Protection: Building Capacity among University Extension Educators. Upper Midwest Regional Planning Conference: "Making Great Plans, Putting the Pieces Together." Arrowwood Resort and Conference Center, Alexandria, MN. (September 28-30, 2005).

Lucero, D. 2004. Using Web-based Decision Support Tools for Modeling Land Uses. "Planning at the Crossroads: Making Great Communities Happen in the Heartland" Regional Planning Conference. Crowne Plaza Hotel, Union Station, Indianapolis, IN. (October 14, 2004).

Watermolen, D.J. 2004. Supporting Local Decision Making: An Overview of Wisconsin's Efforts. "GIS Tools and Community Watershed Planning Workshop." Northwest Indiana Regional Planning Commission and Purdue University Calumet School of Science, Mathematics, and Engineering, Hammond, IN. (May 25-26, 2004).

Lucero, D. and M. Murrell. 2004. The Results Are in: Which Web-based Tools Enhance Public Dialogue and Decision Making? "Wisdom of Voices 2004," International Association of Public Participation (IAP2) International Conference, Madison, WI. (May 4, 2004).

Lucero, D. and M. Murrell. 2004. Enhancing Local Land Use Decisions through the Evaluation and Use of Web-based Tools. Wisconsin Land Information Association 2004 Annual Conference, Wisconsin Dells, WI. (March 4, 2004).

Outputs: Publications Related to Our Work

The publications listed below transferred findings from the Wisconsin DNR program's work with planners. These publications were not part of the actual technology transfer efforts, but rather made lessons learned from Wisconsin DNR's efforts available to others.

Watermolen, D.J. 2008. Land cover data and tools for analyzing alternative futures: One state's lessons learned. Chapter 16, pp. 293-330. In J.C. Campbell, K.B. Jones, J.H. Smith, and M.T. Koeppe (eds.). *North American Land Cover Summit*. Washington, DC: Association of American Geographers. See <http://www.aag.org/books/nalcs/chapters/CH16.pdf>.

Welch, R.C. 2005. L-THIA – Three versions, three groups, three projects. University of Wisconsin-Stevens Point Center for Land Use Education *The Land Use Tracker* 5(3):6-9. Available online at <http://www.uwsp.edu/cnr/landcenter/tracker/winter2005/TrackerWinter2005.pdf>.

8. Target Audience: Natural Resources Professionals

Over the past two decades, natural resource managers have developed and used place-based decision support systems to address a wide variety of ecological issues (e.g., see Daniel 1992, Brown et al. 1994, Siepel 1997, Prato 1999, Crist et al. 2000, Kepner et al. 2002, Korschgen et al. 2005). Like many state agencies, the Wisconsin DNR has invested heavily in the development of GIS-based data management and mapping systems. The full potential of these tools, however, has yet to be realized and the integration of such tools into day-to-day decision making and program implementation has been slow to come. As a result, we included natural resources professionals as a primary audience in the Wisconsin DNR program. This chapter documents our outreach, training, and technical assistance work with Wisconsin DNR staff and related professionals during the grant period. We conclude the chapter by listing professional presentations and publications resulting from this work.

Background: Wisconsin DNR Mission and Organization

The Wisconsin DNR is responsible for implementing state laws and, where applicable, federal laws that protect and enhance natural resources. It is the one agency charged with full responsibility for coordinating the many disciplines and programs necessary to provide a clean environment and a full range of outdoor recreational opportunities for Wisconsin citizens and visitors.

Organizationally, the agency is made up of six divisions (Table 8.1). To carry out the policies of each of the six programs so that the needs of local citizens can be best met, the agency divides the state into five administrative regions (Figure 8.1), with regional headquarters in Eau Claire (West Central Region), Fitchburg (South Central Region), Green Bay (Northeast Region), Milwaukee (Southeast Region), and Rhinelander and Spooner (Northern Region).

Table 8.1. Wisconsin DNR's Program Divisions*.

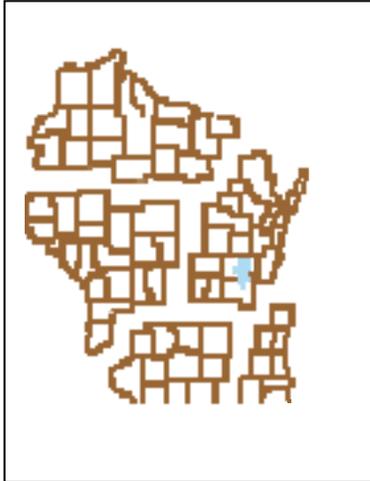
Air and Waste	Forestry
Land	Customer and Employee Services
Water	Enforcement and Science

* More detailed organizational charts are available online at www.dnr.wi.gov.

Staff in the Wisconsin DNR's Central Office (located in Madison) work with the Natural Resources Board to establish policies and programs, administer state laws and rules, distribute grants and loans, interact with the Governor, Legislature, other agencies, and interest groups, support agency field responsibilities, and evaluate progress toward agency goals.

More than two-thirds of Wisconsin DNR's workforce is assigned to field offices located in the five regions (Figure 8.1). Throughout each region, geographically based work teams draw expertise from different disciplines and combine their efforts with county, city, and town leaders, business owners, private homeowners and landowners, outdoor enthusiasts, young people, and other state residents to manage public resources. Regional staff members are responsible for understanding their area's ecology and identifying local threats to natural resources and the environment. These staff members come from a variety of backgrounds, possess diverse educational and technical experiences, and sometimes have limited experience working with land use or planning issues. Nonetheless, communities often call on these individuals to advise citizens and decision makers about environmental and conservation concerns. Staff members rely upon their technical expertise to provide sound information. Internet tools can expedite and enhance the services that Wisconsin DNR staff members provide the public.

Figure 8.1. Wisconsin DNR's Administrative Regions.



Audience Assessment: Review of Institutional Context

Early in the grant period, we talked with Wisconsin DNR's upper and mid-level managers about GIS, the Internet, and the integration of these technologies to support agency decision making. We asked for their opinions on how we could best build capacity among DNR staff to discover and use these tools in their day-to-day, program work. Senior managers asked how our technology transfer efforts would support implementation of the agency's strategic plan and priorities, if surveys of the extent of GIS use in natural resources had been conducted, and how technology transfer efforts would fit with other ongoing land use-related work. In order to answer these questions, we examined the agency's strategic plan and learning curriculum, conducted a literature review to identify previous survey work, and assessed the role of Internet and GIS technologies in addressing recommendations in the Wisconsin DNR report *Common Ground*.

Agency Strategic Plan and Learning Curriculum: Wisconsin DNR's strategic plan outlines goals and strategies that reflect the agency's approach to carrying out its mission and vision. In brief, these goals include: making people our strength, sustaining ecosystems, protecting public health and safety, and providing outdoor recreation. Internet and GIS tools can be used to address each of these goals. Specific strategies for accomplishing these goals which our technology transfer work helps to implement include:

- Provide leadership, information, education, technical assistance, and outreach so that people can make informed environmental decisions and be actively involved in setting... priorities.
- Find and develop ways to enable department employees, together with our external partners, to fulfill the department's mission by: working across disciplines; seeking innovative ways to improve services; keeping abreast of technological advances; ...
- Work with educators to develop the leadership, communication and technological skills our employees need for the future.
- Use planning and management methods that address the connection between pollution problems on land, in water, and in air.
- Provide the tools, information, and incentives needed for governments, people, and their organizations to make environmentally sound land use and land management decisions that protect ecosystems and improve quality of life.

Knowledge and skills associated with Internet and GIS tools can also help employees develop the competencies and skills listed in Wisconsin DNR's "Organizational Learning: Competency Based Curriculum" (Wisconsin DNR 2008). Consideration of these documents helped inform the development of our conceptual framework and learning outcomes (Table 3.3) for Wisconsin DNR staff.

Surveys of GIS Use in Natural Resources Management: Various surveys have been conducted regarding different aspects of GIS education in natural resources management. Most have focused on the educational systems training GIS users or the employers who hired GIS users (e.g., Sader et al. 1989, Brown and Lassoie 1998, Sample et al. 1999, Sader and Vermillion 2000). We found only one survey of practicing, entry-level professionals (Merry et al. 2007, Merry and Bettinger 2008). In addition, Li et al (2007) provided a useful overview of how GIS and remote sensing technologies have been used in natural resources management based on a review of the forestry literature. Collectively, these studies provide insight into the ways natural resources professionals use GIS, their training and support needs, and the effectiveness of various technology transfer methods.

Merry and Bettinger (2008) found that almost half of natural resources professionals indicated that they used GIS either every day or every other day. Another 23% used GIS once a week and 34% reported using it once a month or never. Their survey included respondents from a range of employers. Anecdotal evidence gathered from managers within Wisconsin DNR suggests a somewhat lower level of use by Wisconsin DNR staff. In fact, a review of GIS software license holders within the agency shows a large percentage of employees either do not routinely undertake GIS work, seek out the assistance of GIS professionals who can do the work, or rely on Internet mapping applications to meet their needs.

Merry and Bettinger (2008) gave survey participants a list of processes and asked how frequently they used them. Processes identified by respondents as frequently used included:

- Heads-up digitizing (14%).
- Manual editing of attributes (12%).
- Manual editing of spatial positions (11%).
- Querying of attribute tables (11%).

Processes that were more moderately used included:

- Combining features (45%).
- Erasing features (42%).
- Spatial queries (44%).
- Splitting polygons (42%).

These results seem to suggest a relatively high level of GIS proficiency by entry-level resource managers. Yet, our experience in Wisconsin DNR suggests these functions are most often performed by GIS practitioners, who may or may not have resource management responsibilities, than they are by program staff. In addition, Wisconsin DNR has made significant investments in the development of Internet mapping applications with relatively user-friendly interfaces for several program areas (e.g., Wisconsin DNR's Surface Water Data Viewer). Anecdotal evidence suggests staff rely on these applications for their GIS work.

Finally, Merry and Bettinger (2008) asked what types of GIS support natural resources professionals use. Responses varied:

- 25% indicated that they relied on their GIS managers for support.
- 23% took advantage of "help" topics accompanying their GIS software.
- 17% used books and manuals.
- Nearly 80% responded that they rarely used online support.

These latter results provided some direction for our technology transfer efforts. They also suggested some things we might want to consider when planning for continued technical support beyond the grant period. (As noted in Chapter 2, ongoing technical support can be a factor affecting the ultimate success of technology transfer efforts.)

Relevance to *Common Ground*: In adopting the 1995 report *Common Ground*, the Wisconsin Natural Resources Board included among other actions two items affirming a continued commitment to support local decision-making. These are to: 1) develop a cooperative program with other agencies, businesses, organizations, and local governments to share information and increase knowledge on environmental issues

and local land use planning and decision making; and 2) develop public information and education programs with other agencies and organizations that explain the potential impacts of land use decisions and encourage informed, voluntary actions to minimize negative environmental impacts.⁶ We found that our technology transfer objectives meshed well with the direction outlined in *Common Ground*.

Recognizing the strategic plan goals and identifying supporting strategies upfront ensured our work aligned with the agency's mission and vision. As indicated earlier, contextual factors, such as political and economic realities, must be taken into account if we want to affect the change/learning process—consideration of such factors is one key to successful technology transfer.

In addition to the overarching view, agency managers also offered concrete suggestions for how we could approach our work. Primary among these were:

- Conduct relatively frequent informal opportunities for staff to learn about individual tools.
- Ask staff how they want to learn about the tools before creating resources or setting up workshops.
- Respond to specific program needs/issues.

Audience Assessment: Focus Group with Regional Staff

We conducted a focus group with Wisconsin DNR regional staff members from our Southeast Region in May 2005. This session helped us further understand this target audience's needs. After a presentation about the kinds of computer tools, and their corresponding functions, all 19 of the participants at the session indicated an interest in future hands-on training. Ideas were exchanged regarding the grouping of program-oriented tools (i.e. what programs would benefit from learning about particular tools), timeframe for training, duration of the sessions, and a means to generate participation in the sessions. This session also confirmed the value of informal "brown bag" sessions.

Outreach: Informal "Brown Bag" Seminars

We initiated a series of informal "brown bag" seminars in 2005, with the kick off to National Environmental Education Week. Based on our own program experience and conversations with agency staff, we focused sessions on a select set of tools that we felt would be most useful to Wisconsin DNR staff. We often tied the sessions to other events as means of linking the tools to existing work efforts and maximizing promotion. For example, a session on Web tools for invasive species management was held during Invasive Species Awareness Month (June 2005), a session on sources of historical maps was held during National Historic Preservation Week (May 2008). In 2006, 2007, and 2008, we conducted seminars to celebrate National Community Planning Month. In total, we conducted 26 brown bag sessions during the grant period (Table 8.2).

These sessions proved to be popular with Wisconsin DNR staff. For example, more than 80 individuals from 14 different Wisconsin DNR programs participated in the 2005 kick off series and 36 staff from 8 programs participated in the spring 2006 sessions. In addition, the relatively informal nature of these sessions allowed us to interact with the attendees and gain further insights into how the tools can be applied in various natural resources and environmental protection programs.

⁶ Action A.2 and Action A.3 from *Common Ground: Report of the DNR Land Use Task Force* (Watermolen and Fenner 1995).

Table 8.2. *Informal “Brown Bag” Seminars Conducted for Wisconsin DNR Staff.*

<u>Date</u>	<u>Topic/Featured Tool(s)</u>
April 2005	An Introduction to Computer Tools for Planning, Conservation, and Environmental Protection
April 2005	U.S. EPA Computer Tools for Finding and Mapping Data
May 2005	Wisconsin DNR’s Surface Water Data Viewer and Watershed Web Mapping Application
May 2005	Computer Planning Tools (presented in Southeast Region headquarters)
June 2005	Eight Tools for Watershed Protection in Developing Areas
June 2005	Computer Tools for Invasive Species Management
August 2005	Dynamic and Distributed GIS to Support Coastal Management (along Lake Superior’s Coast)
May 2006	Wisconsin DNR Surface Water Data Viewer
May 2006	Wisconsin DNR Air Monitoring Network
May 2006	NRCS Web Soil Survey
May 2006	NRCS Web Soil Survey (presented at the Science Operations Center)
June 2006	Wisconsin DNR Surface Water Data Viewer (presented at the Science Operations Center)
July 2006	Digital Watershed (presented at the Science Operations Center)
August 2006	EcoAtlas (presented at the Science Operations Center) – postponed
October 2006	HUD Locator Service
October 2006	Wisconsin DNR’s Land Use Resources Portal
October 2006	Green Infrastructure Cost-Benefit Calculator
December 2006	EcoAtlas
October 2007	WisStat and Related Census Data Tools
October 2007	NRCS Web Soil Survey
October 2007	How DNR Staff Can Influence Local Land Use Decisions: Preserving the Highland Way Parcel
October 2007	U.S. EPA’s BASINS 4.0
December 2007	A Comparison of Three GIS-based Runoff Modeling Tools
April 2008	New Land Cover Data Sources
May 2008	Sources of Historical Maps

Table 8.3. *Hands-on Training Sessions Conducted for Wisconsin DNR Staff*.*

<u>Dates</u>	<u>DNR Region and Workshop Location</u>	<u>No. DNR Staff Attending</u>	<u>No. DNR Programs Represented</u>
October 4-5, 2005	Southeast: Milwaukee	19	12*
September 6-7, 2006	Northern: Ashland	7	4
September 12-13, 2006	Northeast: Green Bay	37	9

* Regional staff members from the following Wisconsin DNR programs participated: Air Management, Community Financial Assistance, Drinking Water and Groundwater, Environmental Enforcement, Facilities and Land, Fisheries Management, Law Enforcement, State Parks and Recreation, Remediation and Redevelopment, Waste and Materials Management, Watershed Management, and Wildlife Management.

Training: Hands-On Workshops for Regional Staff

We conducted two half-day, hands-on workshops for Wisconsin DNR staff in each of three regions (Table 8.3). These Wisconsin DNR regions lie within the Great Lakes Basin and were selected to capitalize on funding received through U.S. EPA's Great Lakes National Program Office. Sessions that took place in Milwaukee served as a pilot for the 2006 sessions. We publicized the workshops through various internal means.

The workshops included direct instruction on specific tools for finding information, for creating maps, and for modeling decision impacts. Day one of the workshop focused on water resource-related computer tools and featured instruction on the following tools:

- Wisconsin DNR's Surface Water Data Viewer;
- U.S. EPA's EnviroMapper for Water;
- NRCS's Web Soil Survey (not included in pilot workshops);
- Long-term Hydrologic Impact Assessment model; and
- Digital Watershed.

The second day included land resource related computer tools and featured the following tools:

- Wisconsin DNR's GIS Registry of Closed Remediation Sites;
- Great Lakes Indian Fish and Wildlife Commission's Invasive Species Mapper (included in the pilot workshop but not others);
- Wisconsin NatureMapping;
- Wisconsin DNR's EcoAtlas and NRCS's Web Soil Survey (not included in pilot workshops);
- Wisconsin DNR's WebView and Managed Lands applications.

By focusing the sessions in this way, program staff members were able to choose to attend either both days or only the session related to their program area. Classroom instruction and hands-on experience centered on day-to-day applications of the tools, including various entertaining, but real-world, techniques to help participants determine if they had mastered each new skill. Wisconsin DNR staff members are in a key position to enable others to use the tools, so we also placed an emphasis on staff developing technology transfer skills (i.e. an ability to convey information about the tools to others).

Participants completed a baseline survey to indicate their interest in using these types of tools in their work, as well as tool-specific evaluation forms to convey the perceived usefulness of each tool featured. Following the workshop, we distributed a CD with all session handouts, PowerPoint presentations, and additional resource materials to participants with a "Dear Colleagues" letter.

Measuring Outcomes: Post-Workshop Interviews

We sought out the assistance of an environmental education researcher unaffiliated with the Wisconsin DNR program to help us evaluate our workshop efforts. Social science researcher Susan Gilchrist interviewed 50 (~80%) of the 63 workshop participants⁷ in October and November 2006, approximately one year after the Milwaukee workshop, and in February and March 2007, approximately 6 months following the other two workshops. The in-depth telephone interviews ranged in length from 15 to 90 minutes (the average interview took about 35 minutes). She asked questions regarding (a) participants' use of the tools covered in the workshops, including frequency, products, benefits, and limitations; (b) their role in teaching others (e.g., local decision makers) about these tools; and (c) resources that enable or impede their use of the tools. Questions varied slightly between the rounds of interviews to reflect lessons learned from the pilot session and resulting changes in the tools included in the workshop.

⁷ Seven participants were no longer employed by the Wisconsin DNR at the time of the interviews. The remaining 6 declined to be interviewed, primarily due to scheduling conflicts. Participants who were interviewed included 31 males and 19 females.

Pooled results of the workshop evaluation interviews are presented below. Because a few questions were worded slightly differently between rounds of interviews, responses could not be pooled in every case. When results are interpreted from only interviews following the 2005 workshops or the 2006 workshops, we indicate that to be the case.

Post-workshop Use of Tools: The interviews included questions about which, if any, tools the participants used following the workshop. Participants in the 2005 workshop indicated that on average they had used 2 tools following the workshop. Those in the 2006 workshop had used an average of 1.5 tools post workshop. Of the 10 tools taught in the workshops, Wisconsin DNR's WebView tool was used by the most people (62% of participants in the 2005 workshop; 57% of participants in the 2006 workshop)⁸.

The interviews included questions about how frequently participants had used the tools following the workshops. Participants indicated they had used individual tools 2.8 times on average following the 2005 workshop. Those in the 2006 workshop used the tools an average of 9 times following the workshop. We believe the increase in the number of uses reflects a change in instructional strategies to more closely focus on how tools could be applied in day-to-day work, as opposed to general awareness of the tools and their functionality.

Although several participants indicated some prior knowledge of some of the tools, in nearly every case (91 of 110 responses) participants indicated that their post-workshop use of the tools was due to their participation in the workshop. Most of the participants who said they knew about or used a tool prior to the workshop explained that the workshop improved or increased their ability to use the tool.

Twenty percent of workshop participants indicated that they had not used any of the tools following the workshops. Overwhelmingly, the most frequently stated reason for nonuse of the tools was that there was no opportunity or need for the tool in their current jobs. The second most frequent answer was that other tools sufficed. Other reasons for not using the tools included:

- Other people supplied the information needed so they didn't need to use the tools themselves.
- They did not think the specific tools would help in their work effort.
- They changed jobs so the tools were less applicable to their work.
- They forgot about the tools.

We suspected some Wisconsin DNR staff might not feel confident in their abilities to use some of the tools featured in the workshops. Therefore, the interviews included questions to assess participants' confidence with using the tools. Most interviewees reported a high level of comfort with the tools they used. For example, following the 2006 workshops, 86% of responses claimed a "high" or "okay" level of confidence in using a tool. Less than 15% of responses reflected a "low" level of confidence in using a tool.

However, when asked specifically about their confidence level in using each tool they reported using, a few users in each case reported low confidence regarding their use of that specific tool. For example, following the 2005 workshops, one of 3 users reported low confidence in using Digital Watershed and Surface Water Data Viewer, and 3 out of 8 users of WebView and 1 of 2 users of EPA's EnviroMapper reported low confidence.

The interviews included questions about future use of tools. All of the workshop participants, except one who had not used any of the tools, thought they would use at least some of the tools in the future. In addition, of the participants in the 2006 workshops who reported using some of the tools, 93% said they also foresee using some of the tools in the future. In addition, for every tool, more people said they might use it in the future than had already used it. For example, only one person reported having used LTHIA, yet nine said they might use it in the future.

⁸ Only one of the tools introduced during the pilot workshop, the GLIFWC Invasive Species Mapper, was not used by any of the participants following that workshop (although 6 participants indicated they might use it in the future). As a result, we dropped this tool from the instructional line up for the other workshops.

Technology Transfer: We believe Wisconsin DNR staff members are in a key position to enable others to use the tools featured in the workshops. As such, the follow-up interviews included questions about participants' roles in teaching others about the featured tools. Most Wisconsin DNR staff members, however, felt it was not their role or responsibility to teach others about the tools. Yet, a relatively large percentage indicated they had in fact told someone else about the tools or showed someone else how to use a particular tool following the workshop. For example, following the 2005 workshop, 46% of participants said they had made other Wisconsin DNR staff aware of the tools and 38% had taught co-workers how to use at least one of the tools. Similarly, following the 2006 workshop, 87% had made someone else aware of at least one of the tools, mostly by sharing Internet links or workshop handouts, primarily with coworkers. Some participants indicated they had shared the tools with local government staff, environmental consultants, real estate and other professionals, landowners, the general public, college students, or family members.

Environmental Decisions and Outcomes: We were interested in knowing if the use of tools by Wisconsin DNR staff impacted environmental decision making (i.e. resulted in any third order outcomes). To assess this, the interviewer asked questions about how tools were used and how they impacted decisions.

Following the 2005 workshops, 40% of the participants who used some of the tools reported that their use of the tools resulted in environmental decisions. Similarly, 49% of participants in the 2006 workshop indicated their use of the tool impacted environmental decisions. The tools were applied to decisions about permits, plans, environmental assessments, clean-up goals, real estate transactions, and various management activities (Table 8.4). One interviewee explained that the Internet tools had a significant impact on conservation by improving communication within the agency: "They are really communication tools."

Workshop Feedback and Additional Training Needs: We were interested in knowing what participants thought about the hands-on workshops, instructional materials, and future training needs. The interviewer asked several questions to get their thoughts on these topics. Ninety-six percent of workshop participants indicated they felt the workshop was "worth their time." Even those who said they did not use any of the tools still said that they considered learning about what tools are available to be worthwhile. One person said, "Even if the phone survey is not glowing, don't give up. We ought to be going in this direction with Internet tools for staff. Just tailor the training for each group and render it specific for their jobs." Another commended the staff for "pushing us where we need to go."

Most of the participants valued the opportunity for exposure to the tools, the hands-on practice, the chance to ask questions, the relaxed atmosphere of the workshop, and the expertise of the staff. Many liked the exercises, though there were mixed reviews about the "Datatona 500" activity. Some thought the length of time was just right; others said they needed more time, or fewer tools within the time. Participants generally liked the small group size, but several complained that there were too many people in the Green Bay workshop. Many participants indicated that they liked the fact that each participant had access to a computer. Frustration was expressed regarding the difficulty accessing the Internet tools when so many people tried to log onto the same tool at once. That said, one person noted that even the server problems were realistic and it was nice to have someone there to help deal with them.

While some liked the overview of what was available and did not care much about learning how to use the tools, others especially liked getting tips and shortcuts that could make their work more efficient. One participant noted that it was a good mix of staff, and that when they worked on teams during the workshop, there was integration of water and land resources expertise. Another mentioned it was good to interact with others to see how they got to the available information too. One participant said: "The workshop was well organized, well presented, slow enough and extremely well done with a secure feeling you could go back and use the tools." Lastly, participants appreciated the fact that the workshops were brought to the regions, as budget restrictions make it hard for them to get to any training in Madison. One commented that the Internet "closes the connection gap between Madison and the regions."

Table 8.4. *Representative Uses of Tools (Second Order Outcomes) Reported by Wisconsin DNR Staff.*

- Storm water plans
 - Determination regarding wetland restoration
 - Decisions about what sites to clean up and how
 - Approval of projects or not
 - Evaluation for permits on a landscape scale
 - Construction permits
 - Highway building
 - Construction variance approval
 - Land purchase decisions
 - Decisions regarding validity of complaints
 - Recommendations for Smart Growth
 - Purchases and loans
 - Post-construction storm water management
 - Determining what seed mix to use for prairie restoration
 - Decision not to fill a wetland
 - Consideration of how invasive plants might spread and what kind of vegetation would do well on a site
 - Decision about a well
 - Decision for a wind farm to do research
 - Information to investigate the possibility of a new wolf pack's existence
 - Increased public enjoyment of wildlife areas and forests
 - Determination about a suitable site for compost
 - Better land use decisions
 - Denial of motor vehicle access
 - Roadwork development
 - Determination about the need for an environmental impact statement for a proposed landfill
 - The price paid for land
 - Use of the Wisconsin DNR WebView provided information on the distance of the waterway
 - Led to the decision to buy ArcView
 - Contributed to decisions about purchasing properties
 - Verified the size of a spillage way so staff could draw it down to the size it was supposed to be and helped determine posting for leased hunting lands
 - BRRTS was used for figuring out whom to identify as the responsible party in a violation
 - Used for real estate transaction and developing reports on activities that occurred on contaminated property
 - Resulted in real estate transactions and development of reports on activities that occurred on contaminated property
 - Provided coordinates for boundary issues with adjacent landowners and information for posting state land for hunting and fishing
-

When asked about the kinds of additional training or technical assistance they would find useful, participants indicated an interest in several areas (Table 8.5). Responses regarding additional training, however, were inconsistent. Some participants who indicated they did not want additional training went on to describe training that might interest them. Some merely requested updates on the Internet tools.

Table 8.5. *Additional Training or Technical Assistance Needs Identified by Wisconsin DNR Staff.*

- Refreshers/improvements/updates – ½ day or on-line
 - Introduction to new/improved tools
 - Specific training on using different layers and putting wetlands on the same maps with others
 - Arcview
 - To use GIS
 - More geared to her job in wildlife, not remediation sites
 - Hands-on training
 - Improved skill in making maps and using air photos
 - General training to know what's out there without training on the details of how to use it
 - Don't know: global warming / climate change – using software to map greenhouse emissions
 - Tools more focused on waste management and tools that use multiple data sources and bring them to one product or result
 - Integration of land use projects with point source discharges to watersheds
 - Advanced workshop on the same tools, introducing new features and updates
 - More advanced training with case scenarios based on a survey of participants
-

Several participants summed up by saying that they wanted training in order to learn about Internet tools that would make their jobs easier or more efficient. One gave an example of a training program with specific appeal: “How the Internet can make a Biologist’s Job Easier.” Generally, while participants wanted training on things they do not know about now, they also wanted to be notified of changes and updates related to the Internet tools they were introduced to during the workshop.

Training: Hands-On Workshops for Grants Program

In June 2006, program staff met with the chief of Wisconsin DNR’s Grants Administration Section to discuss the potential use of Internet tools to inform grant-writing and grant-processing practices. The Bureau of Community Financial Assistance requested support following the 2005-2006 hands-on workshops for regional Wisconsin DNR staff. Although not included in the original scope of our project, we felt it important to be responsive to the program’s request and modified our work plan to include some additional efforts.

Specifically, program staff reviewed Wisconsin DNR’s grant programs and determined which Internet tools might best address the associated grant requirements and program needs. In September, we followed up by developing a specific training and technical assistance approach for Grants Administration staff. We then conducted a demonstration at a Grants Administration staff meeting in December to introduce the tools, explain the training approach we would employ, and outline how we had linked Internet tools to various grant requirements and program needs.

In February 2007, we followed up with a half-day, hands-on training session for Central Office Grants Administration staff. Tools featured in the workshop included Wisconsin DNR’s Surface Water Data Viewer and RR Sites Registry, the NRCS Web Soil Survey, Digital Watershed, and LTHIA. Classroom instruction focused on the functionality of the tools as well as on ways the tools could be applied in grants

processes. In June 2007, program staff conducted a second half-day, hands-on training session for 13 Community Financial Assistance staff members working in Wisconsin DNR’s regional offices. This additional training workshop was requested by the program following the Central Office session.

As a follow up to each session, we sent every participant a CD with instruction sheets for the tools demonstrated as well as additional resources. This effort could reach beyond Wisconsin DNR staff members, who would use mapping and data access tools to evaluate grant applications in a uniform manner, to potentially include community-level outreach as well.

In April 2008, the Bureau of Community Financial Assistance requested additional support. The program was considering purchasing hand-help GPS Units (\$600 each) to assist staff with compliance checks for parcels purchased through the Federal Land and Water Conservation Fund program (over 1,800 such properties purchased over the last 40 years). A Government Outreach Team Leader who had attended the hands-on workshops wondered if staff could obtain longitude-latitude information free-of-charge from existing on-line mapping services and whether a "cheat sheet" could be developed to help in this regard. Program staff responded by preparing step-by-step instructions for “Locating Properties and Reporting Latitude/Longitude Coordinates” using Wisconsin DNR’s Web View tool.

Participatory Evaluation: Workshop Feedback

At the conclusion of each of the workshops, we asked each participant to complete an evaluation form. Questions addressed the workshop overall, as well as the participants’ understanding of and comfort with using each of the demonstrated tools. We pooled and summarized results from the workshops.

Participants found the tools helpful:

- 100% indicated they “understood how the tools could be used” for planning and conservation.
- 100% stated the “tools can enhance my work”.
- 100% said the “tools can enhance the work of others I work with”.

Participants expressed a high level of understanding of what the individual tools do, a high level of confidence in their ability to use the tools and to show others how to use them, and a relatively high level of relevance to their current and future work (Table 8.6).

Table 8.6. *Percentage of Participants Answering “Yes” to Questions about Select Tools Included in Hands-on Workshops (Second Order Outcomes).*

<u>Question</u>	<u>Response</u>			
	Surface Water Data Viewer	RR Sites Map	Web Soil Survey	LTHIA
Understand what it does	100%	100%	100%	85%
Could use on my own	89%	93%	74%	70%
Could use in my work	89%	70%	59%	44%
Could show others how to use	74%	81%	59%	56%
Plan to use in the future	85%	74%	59%	48%

Miscellaneous Outreach, Technical Assistance, and Capacity Building Efforts

In addition to the informal “brown bag” seminar series and the formal, hands-on training workshops for Wisconsin DNR staff, we conducted a number of other outreach, technical assistance, and capacity building efforts throughout the grant period. These efforts capitalized on opportunities as they arose.

APA Audio Conference: In order to ensure that program staff members and partners maintained a high level of proficiency and current understanding of technology and planning issues, Wisconsin DNR regularly sought out appropriate professional development opportunities. In November 2004, program staff participated in the American Planning Association’s audio conference titled *New Technologies for Planning and Public Participation*. Wisconsin DNR hosted staff from the Wisconsin Department of Transportation, University of Wisconsin-Extension, and Center for Land Use Education for this session. During the session presenters spoke about the evolution of decision-support technology and highlighted the current state of 3-D visualization, impact assessment tools and methods, GIS, online data sources, and urban development models. Presenters also promoted Wisconsin DNR as a source of data and environmental information for planners. This APA session involved several individuals that Wisconsin DNR had been networking and coordinating efforts with, including PlaceMatters.com and Criterion Planners (creator of the INDEX model).

Forestry Division Statewide Meeting: Wisconsin DNR’s Forestry Division held a statewide training conference in late January 2006. The conference, “Going Out on a Limb: A Look at the Future of Wisconsin Forestry,” was designed to encourage discussion about changes Wisconsin is or will soon be facing as we travel our second century of forestry in the state. Program staff displayed the “Internet Tools for Planning, Conservation, and Environmental Protection” trade show exhibit as part of the conference’s Information Marketplace. We spoke to dozens of Wisconsin DNR foresters and related staff about ways Internet tools can inform and support their work. This participation was significant in that previous efforts as part of the Wisconsin DNR program had not targeted forestry staff.

Connection with NRCS: Following the international Land Use and Healthy Watersheds conference in September 2006, local NRCS staff expressed an interest in learning more about various Internet tools and their potential application to watershed assessment and planning work that the agency undertakes. In October and November, program staff met with the cartographer from the NRCS’s Madison office. We introduced the Digital Watershed and LTHIA tools and discussed ways these tools could be integrated into NRCS assessment and planning efforts.

Conference Presentations: We made a number of presentations and conducted several demonstrations at professional conferences that were heavily attended by natural resources professionals during the grant period (Table 8.7). Participation in these conferences occasionally created new opportunities for the Wisconsin DNR program. For example, the Wisconsin County Code Administrators invited Wisconsin DNR to submit articles featuring specific Internet tools for publication in WCCA’s quarterly e-newsletter.

DNR Headquarters Celebration of GIS Day: In 2007 and 2008, we teamed up with Wisconsin DNR’s Bureau of Technology Services to celebrate the annual GIS Day with a series of presentations and demonstrations highlighting the use of GIS technologies by various Wisconsin DNR programs. The sessions took place in the Madison Central Office and all Wisconsin DNR employees were invited to attend.

In 2007, staff from various programs conducted the following presentations:

- *Welcome to GIS Day – Introductions*
- *Exploring Web Mapping Services in ArcMAP and (FREE) GIS Software*
- *New! Improved! Surface Water Data Viewer, WATERS, and SWIMS*
- *WisFIRS: Wisconsin Forest Inventory & Reporting System*
- *FEMA Floodplain Map Modernization, Incorporating Local Data*
- *Applying GIS to Map Ephemeral Pond Wetlands in Southeast Wisconsin*
- *Improving Wisconsin State Agency GIS Coordination*

The afternoon concluded with networking time for GIS users and an opportunity to share recent innovations. All sessions were well attended by both Wisconsin DNR and outside agency staff.

Table 8.7. *Presentations at Conferences Attended by Wisconsin’s Natural Resources Professionals.*

Conference	Date(s) and Location	Presentation Title
Wisconsin Chapter, American Water Resources Association Annual Conference	March 3-4, 2005 - Delavan	“Computer Tools for Watershed Management: Digital Watershed and Long-term Hydrologic impact Assessment”
Wisconsin Wetlands Association “Great Lakes Coastal Wetlands: 10 th Annual Wetland Science Forum”	January 26-27, 2005 – Green Bay	Exhibit: “Computer Tools for Planning, Conservation, and Environmental Protection”
Wisconsin County Code Administrators Annual Spring Conference	March 31, 2006 – Mosinee	“Internet Tools for Planning, Conservation, and Environmental Protection”
Johnson Foundation Wingspread Conference: “Planning for Land Use and Healthy Watersheds: An International Conference”	September 2006 – Racine	No specific presentation title – this was a working session; participation was in various conference working groups.
Wisconsin Wetlands Association “Riverine Wetlands: Connections, Corridors, and Catchments: 12 th Annual Wetland Science Forum”	February 1-2, 2007 – La Crosse	“Internet Tools for Locating Wetlands and Assessing Functional Values”
Wisconsin Association of Floodplain, Stormwater and Coastal Managers Annual Conference	November 7-9, 2007 – Appleton	“Internet Tools for Floodplain and Stormwater Management”
Wisconsin Association of Floodplain, Stormwater and Coastal Managers Annual Conference	November 13, 2008 – Wisconsin Dells	“Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools”

References and Related Reading

We found the following references helpful in defining and developing our approach to working with natural resources professionals. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, Further Reading, and Background Material” section.

Broberg, L. 2003. Conserving ecosystems locally: a role for ecologists in land-use planning. *Bioscience* 53(7):670-673.

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Stokes, D. and P. Morrison. 2003. GIS-based conservation planning: a powerful tool to be used with caution. *Conservation in Practice* 4(1):38-41.

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Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described our work to build capacity among natural resources professionals, our assessment and evaluation of these efforts, as well as lessons learned along the way. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

Watermolen, D.J., A. Mednick, and J. Sullivan. 2008. Geospatial Decision Support Systems for Land Planning and Natural Resources Professionals. "Leaping into Enterprise: Building on 20 Years of Land Records Integration," 2008 Annual Conference, Wisconsin Land Information Association. Grand Geneva Resort, Lake Geneva, WI. (February 29, 2008).

Goranson, S. and D.J. Watermolen. 2007. Bridging the Gaps in Environmental Information Sharing. "Government Data Sharing in the Information Age," Illinois Data Exchange Affiliates and Chicago Metropolitan Agency for Planning, Sears Tower, Chicago, IL. (March 20, 2007).
See [http://www.chidataexchange.net/upcomingevents_copy\(1\).htm](http://www.chidataexchange.net/upcomingevents_copy(1).htm).

Watermolen, D.J. 2007. Internet Tools for Locating Wetlands and Assessing Functional Values. "Riverine Wetlands: Connections, Corridors, and Catchments," Wisconsin Wetlands Association 12th Annual Wetland Science Forum, La Crosse, WI. (February 1-2, 2007).
See <http://www.wisconsinwetlands.org/2007forum.htm>.

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See http://dev.nacis.org/documents_upload/FinalProgramXXVI.pdf.

Lucero, D., D.J. Watermolen, and D. Bellrichard. 2006. Building Capacity among Natural Resource and Planning Professionals to Use IMS. North American Cartographic Information Society: NACIS 2006 Conference. Inn on the Park, Madison, WI. (October 18-21, 2006).
See http://dev.nacis.org/documents_upload/FinalProgramXXVI.pdf.

Watermolen, D.J. 2005. A Look at the WDNR's Computer Tools for Planning, Conservation, and Environmental Protection Technical Assistance Program. ESRI Wisconsin User Group 2005 Conference. Best Western Midway, Green Bay, WI. (November 10, 2005).
See <http://www.ewug.org/page3.html>.

Watermolen, D.J. 2004. Remote Sensing/GIT Outreach Strategies and Programs. "Northeastern Local, Regional and State RS/GIT Outreach Workshop." Institute for the Application of Geospatial Technologies, Skaneateles Falls, NY. (October 26-28, 2004).
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Lucero, D., D.J. Watermolen, and M.D. Murrell. 2004. A State-Federal Partnership to Understand the Usefulness of Decision Support Tools for Natural Resources Management. "Watershed 2004." Water Environment Federation Annual Meeting, Hyatt Regency, Dearborn, MI. (July 11-14, 2004).

Outputs: Publications Related to Our Work

Over the course of our grant period, we published results of our work in various outlets. We here list publications that address our work with natural resources professionals.

Lucero, D., Watermolen, D.J., and Murrell, M.D. 2004. A state-federal partnership to understand the usefulness of decision-support tools for natural resources management. In "Watershed 2004," *Proceedings of the Water Environment Federation Annual Meeting*, Hyatt Regency, Dearborn, MI. (July 11-14, 2004). CD-ROM, 1 disc.

9. Target Audience: Local Government Decision Makers

In Wisconsin, the primary administrator of land use *regulation* is local government through its planning and zoning powers. Cities, villages, towns, and counties can adopt comprehensive zoning and land use regulations, although some communities have chosen not to⁹. Community plans can establish guidelines and standards to follow when making long-range, local development decisions, while zoning maps and ordinances designate the types of allowable uses on specific pieces of land. Public planning, zoning, and infrastructure siting processes play an important role in guiding desirable growth, while protecting resources. In this chapter, we overview the local government decision maker audience, describe our assessment, outreach, training, and technical assistance efforts, and report on our outcome evaluations. We conclude the chapter by listing publications and professional presentations related to this work. Some of this work is reported in Wisconsin DNR's *Research/Management Findings* series (Bellrichard and Watermolen 2007).

Background: Local Government Officials and Local Decisions

Decision makers involved in local planning, zoning, and related processes include elected officials, local government staff members (in a variety of departments like public works, assessor's office, parks, and solid waste), and appointed advisory bodies. With more than 1,900 units of local government in Wisconsin (72 counties, 190 cities, 402 villages, and 1,259 towns), this particular clientele group is large and dispersed. The number of local elected officials in Wisconsin alone – excluding appointees and staff – is upwards of 20,000, based on contact lists from Wisconsin's local government associations¹⁰. Moreover, this group is somewhat transitory. According to data on county and municipal officials from the Wisconsin Department of Revenue, more than a quarter of the 5,500-plus mayors, administrators, board chairs, clerks/treasurers, recorders of deeds, highway commissioners, and property listers in Wisconsin have been in office for two years or less. Our analysis shows a similar situation throughout the Great Lakes basin (see "Lessons Learned, Transferability of Program, and Recommendations" chapter).

At the Town level in particular, officials are generally non-professional and serve only part-time. With the exception of the position of Clerk/Treasurer, virtually all elected town officials in Wisconsin are part-time, with a 20-25% turnover every two years, according to Wisconsin Towns Association records. Johnson (2003) conducted an extensive survey of town board members in Wisconsin, and found that 58% are over the age of 55, while 29% are over the age of 65. Members are predominantly male (89%) and without a college degree (60%). Civittolo and Davis (2008) reported a similar situation among township trustees in Ohio, noting additionally that trustees in metropolitan statistical areas were more frequently female, older, and more educated than trustees in more rural areas.

One particularly important group of local decision makers is a community's zoning board of adjustment. These quasi-judicial bodies apply local ordinances and related state laws to specific development proposals in three general categories: administrative appeals, variances, and special exceptions/conditional uses. People of diverse backgrounds comprise these boards. These may include citizen volunteers with no connection to the planning profession, architects, university professors, business and civic leaders, and neighborhood activists. Past research in Wisconsin demonstrated that these individuals want to make sound decisions that consider environmental consequences, but their decisions are often incremental (Last 1995).

Earlier needs assessment work as part of a coastal GIS applications project (Rink et al. 1998) uncovered a need for GIS training directed at the local government level. County staff indicated that while resources were generally available for GIS hardware and software acquisition and database development, training funds were scarce in most county budgets.

⁹ Fifty-seven of Wisconsin's 72 counties have county-wide zoning. Seventy-one percent of Wisconsin towns operate under zoning ordinances, and all but three Wisconsin cities have zoning ordinances.

¹⁰ Wisconsin Towns Association's contact list included 7,858 town officials; the League of Wisconsin Municipalities' list included approximately 9,000 elected city and village officials; and Wisconsin County Association's list included 1,827 elected supervisors, executives, clerks, and administrators.

Audience Assessment: Association/Professional Meeting Participation

Local officials and citizen planners can be a difficult audience to reach because of their geographic dispersion, frequent turnover due to local politics and elections, and the wide range of local priorities and topical areas that compete for their limited time and interest. Wisconsin's local government associations (i.e. Wisconsin Counties Association, Wisconsin Towns Association, League of Wisconsin Municipalities, and Wisconsin Alliance of Cities), however, work hard to maintain regular communications with local elected officials and staff and to meet their training and technical assistance needs. These organizations are widely respected and relied upon by local officials as information and technical assistance resources. As such, it seemed natural for us to tap into the existing forums that these organizations provide in order to better understand the needs of this audience.

We developed a multimedia tradeshow exhibit to be used at local government association conferences, workshops, and seminars (Figure 9.1). The exhibit focused on "Computer Tools for Planning, Conservation, and Environmental Protection" and presented tools in three broad categories: tools for accessing and acquiring data, tools for mapping data, and tools for analyzing and modeling data. The 3-panel exhibit described each type of tool and how it can be used, and presented examples of various user interfaces. An automated PowerPoint Presentation accompanied the exhibit. We exhibited the multimedia display at numerous conferences and workshops during the grant period (Table 9.1).

Although this represented a significant outreach effort (i.e. participation provides visibility for both the Wisconsin DNR program and the tools themselves), it was not our intention to participate in these conferences as a technology transfer effort. Rather, our participation allowed us to more fully assess the needs of our target audiences. These events provided an opportunity to interact with a large number of local officials in a relatively short time. For example, approximately 800 county supervisors and staff attended the Wisconsin Counties Association conference and about 960 town board members and town residents attended the Wisconsin Towns Association conference. While we made contact with a small percentage of participants at each conference, it is likely one of the only opportunities to do so during the year. We also made contact with other professional organizations interested in collaborating with us (e.g., Wisconsin Real Property Listers' Association and Wisconsin Society of Land Surveyors).

During the multiday conferences, we spoke at length with local officials about computer tools, their application to local-level processes and issues, and upcoming training opportunities. We learned what elected officials felt the benefits of using computer tools to improve planning and decision-making were and what their training and technical assistance preferences were. We ascertained, through in-depth discussions with participants, which environmental issues are of concern in different areas of the state. For example, we learned that navigable waters and wetland issues are important to northern residents. Access to information about contaminated lands is important to residents in multiple areas of the state. Bluff and scenic river protection remains a concern along the Mississippi River and wind farm developments raise issues along the Niagara Escarpment and adjacent Horicon Marsh. This input provided some direction for focusing and marketing our technology transfer efforts.

Our experience parallels that of Civittolo and Davis (2008), who found in a survey of Ohio township trustees that trustees' understanding of land use planning tools was associated with their location. Those indicating higher levels of understanding were located in areas of the state that have recently experienced the greatest degree of development pressure. They also found that participation in training was highest in those areas experiencing unprecedented development.

At each of these events, local officials were able to sign up to receive information about future training opportunities. We used these occasions to ask local officials about their preferred formats for learning about the tools, preferences for training/technical assistance providers, and any environmental issues they felt could be addressed better by using the tools. We felt this particularly important, as others have noted that if local officials have doubts about training providers or training methods, there will only be a greater disincentive for them to participate in training. As Kelsey et al. (2002) noted "the majority of local officials... are volunteers who work at another job during the day and conduct their local government work

during the evening and weekends. Getting these officials to attend trainings can be difficult, at best, even when they understand they need training because they have enough other activities demanding their time.”

Most officials mentioned face-to-face training or workshops, but some expressed interest in webcasts/webconferences or online learning modules. These responses parallel Kelsey et al.’s (2002) findings that “the overwhelming choice for most types of officials” in New York, Pennsylvania, and West Virginia “was face-to-face training.” In fact, they found 96% of Pennsylvania township officials and 100% of West Virginia city officials liked a “face-to-face classroom setting in their county” over all other formats.

Figure 9.1. *Tradeshow Exhibit, “Computer Tools for Planning, Conservation, and Environmental Protection,” Used at Local Government Association Meetings.*

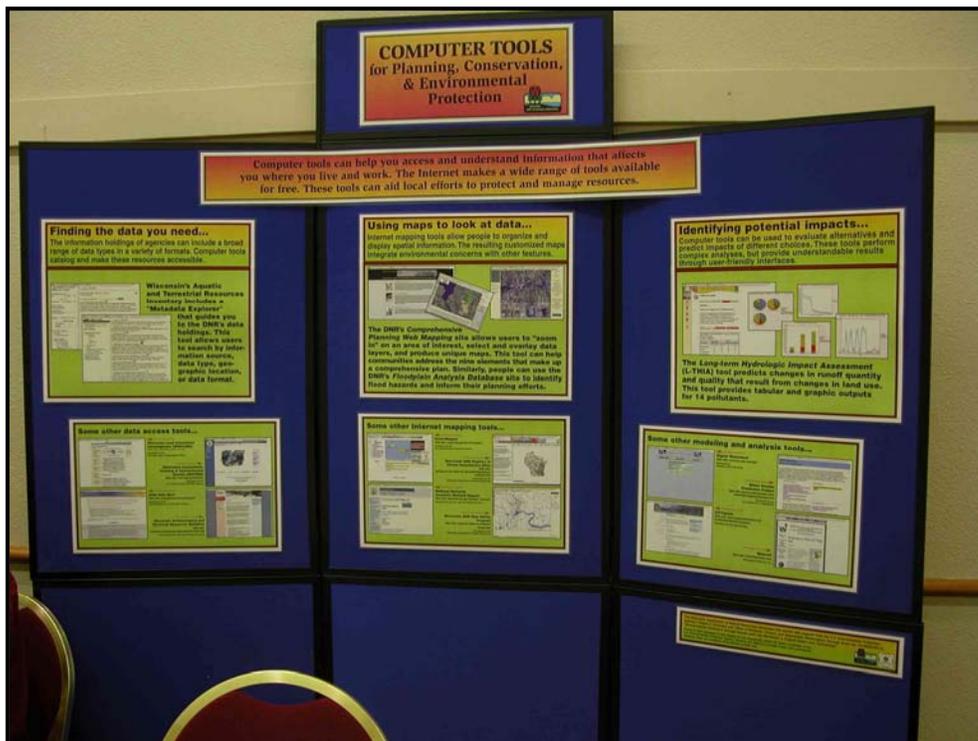


Table 9.1. *Wisconsin DNR Participation in Local Government Association Conferences and Professional Meetings and the Primary Segments of the Local Government Audience Targeted.*

Event	Date(s) and Location	Primary Local Government Audience
Wisconsin Counties Association annual conference	September 27-28, 2004 – Milwaukee	Elected county board supervisors, elected county clerks, elected county executives, county government employees
Wisconsin Towns Association annual conference	October 3-4, 2004 – Appleton	Elected town board members, elected town clerks, boards of adjustment members, town government employees
Wisconsin DNR’s Citizen-based Monitoring Conference	August 20-21, 2004 – Madison	Volunteer citizen monitors, local government staff
Dane County “Voices of Our Waters” Workshop	November 6, 2004 – Madison	Dane County Lakes and Watersheds Commission, watershed protection groups, town sanitary district officials, citizen planners
Fox-Wolf Watershed Alliance “Stormwater 2005: Bringing It All Together”	March 8-9, 2005 – Green Bay	Watershed protection groups, town sanitary district officials, elected municipal officials, city engineers, public works department employees, citizen planners
Great Lakes Commission “Wisconsin Waterfront Revitalization Conference: From Vision to Reality”	April 13, 2005 – Sheboygan	Elected municipal officials, local government employees, private consulting companies
Wisconsin Lakes Convention	April 28-30, 2005 – Green Bay	Lake association members, lake district members, lakes and watersheds commission members, town sanitary district members, volunteer citizen monitors, local watershed protection groups, extension educators, local elected officials, local government staff
Wisconsin Counties Association annual conference	September 19-20, 2005 – Milwaukee	Elected county board supervisors, elected county clerks, elected county executives, county government employees
Wisconsin Towns Association annual conference	October 2006 – La Crosse	Elected town board members, elected town clerks, boards of adjustment members, town government employees
Wisconsin Land Information Association annual conference	February 27-29, 2008 – Lake Geneva	Land information officers, county clerks, property assessors, planners, local government employees

With respect to learning about the tools, we found the majority of local government officials we talked with preferred to learn about the tools through their local government association (i.e. the Wisconsin Towns Association or Wisconsin Counties Association), UW-Extension programs, or regional planning commission staff. Some officials from communities that employ a professional staff stated a preference for learning about new tools from those staff. These observations were similar to the survey findings of Civittolo and Davis (2008), who found 60% of Ohio township trustees preferred to learn about land use tools from the Ohio Township Association, 45% from regional planning commissions, and 25% from Extension. These findings underscored the importance of working with the local government associations, UW-Extension, and regional planning commissions as we implemented the Wisconsin DNR program.

Interaction with local officials from throughout Wisconsin confirmed the diversity of this audience. As one town chairman (Beckford 2008) recently pointed out, “every government entity is different!” It is important to “do your homework, get to know your local government people, explain what you want to do..., get them to embrace your vision and cause, and it can work for you.” Further, Beckford (2008) points out “they will not come to you in most cases, so we have to go to them and establish a relationship.” From these collective findings, we surmised it would be important to spend time with local individuals and groups prior to designing or implementing outreach and training options at the local level.

Outreach: Newsletter Article Series

Beginning in 2004, we partnered with the Wisconsin Towns Association (WTA) to publish a series of articles, “Computer Tools for Planning, Conservation, and Environmental Protection,” in the WTA magazine (Table 9.2). This publication reaches 7,000 local officials in 1,265 towns and 18 villages throughout Wisconsin. Articles from the series were later republished in the Wisconsin Real Property Listers Association’s (WRPLA) and Wisconsin County Code Administrators’ (WCCA) newsletters. WRPLA’s newsletter goes to real property listers in all 72 Wisconsin counties. Additional recipients include approximately 40 associate members, retired professionals, and private businesses. The WCCA’s *DeCoder* goes out to every county zoning, planning and sanitation department in Wisconsin. PDF versions of many of the articles were archived on Wisconsin DNR’s technical assistance Web site for local government decision makers: <http://dnr.wi.gov/org/es/science/landuse/CompTools/local.htm>.

Table 9.2. *Representative Tools Covered in the “Computer Tools for Planning, Conservation, and Environmental Protection” Newsletter Article Series.*

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- U.S. EPA’s Windows to My Environment
 - Wisconsin DNR’s Registry of Closed Remediation Sites
 - Purdue University’s Long-term Hydrologic Impact Assessment tool
 - Wisconsin DNR’s ATRI Metadata Explorer tool (now defunct)
 - Wisconsin DNR’s Surface Water DataViewer IMS
 - Wisconsin DNR Drinking Water databases
 - Geospatial One-Stop
 - Wisconsin State Cartographer’s WICLINC
 - Wisconsin DNR’s Natural Heritage Inventory online database
 - U.S. EPA’s AirNOW
 - Wisconsin DNR’s Air Monitoring IMS
 - NRCS’ Web Soil Survey
 - ForestPal
 - Place Matters.com
 - Mineralogy of Wisconsin Web site
 - Wisconsin DNR’s WebView IMS
-

The focus of these articles was on how computer tools can assist the readers with their planning and decision-making responsibilities. For example, the article dealing with U.S. EPA's Window to My Environment tool discussed use of the Web site as a screening tool for zoning debates or as a way to assist local governments with their storm water Phase II responsibilities. The discussion of Web Soil Survey centered on how the tool could be used in facility siting decisions.

Audience Assessment and Outreach: Work with Regional Planning Commissions

Participants in the local government association meetings expressed interest in learning about Internet and GIS tools from their local regional planning commissions (RPCs). Based on this input, we initiated several efforts with RPCs as a means of reaching our local government decision maker audience.

As discussed in the chapter dealing with planners, program staff met with the Bay-Lake Regional Planning Commission (B-LRPC) GIS User Group in March 2006. This interactive session gave us an opportunity to learn more about the needs of RPCs. We learned that their primary need is access to data and information. We also uncovered the potential to collaborate with county-based mapping providers in the form of developing user surveys. For example, when a resident of Brown County visits the Brown County interactive mapping site, a brief pop up window would survey the user as to their interests and intent in using the mapping site. This user-based information would let the county know the kinds of information that are most useful to users and would help Wisconsin DNR to know what kinds of questions people are turning to mapping sites to answer.

East Central Wisconsin RPC and B-LRPC coordinated a mini-conference in January 2006. Entitled "Improve Your Planning Using Today's Technology: A Geographic Information Systems (GIS) Primer for Decision Makers," this was the RPCs' first conference to explore technology as it applies to planning at all levels of government. The primary focus of the conference was to expose the 100 plus attendees to the fundamental components of what GIS is, what the technology is used for, what data is available to support the technology, and to provide specific examples of local GIS project implementation. As part of the conference, Wisconsin DNR program staff presented an overview of GIS related decision-support tools and explained how these tools support decision making and effective communication. We explained also the different types of modeling and concluded the session by briefly demonstrating common software programs and Web applications.

Outreach: Discussion with Statewide Nonprofits

We initiated previously unplanned work to build capacity among leaders and staff of statewide conservation organizations. By building capacity among these nonprofit leaders, we hope to further strengthen outreach efforts to local government and citizen planners, ultimately increasing their ability to use Internet tools to manage and protect natural resources. In March 2006, we hosted an afternoon-long workshop for staff from a number of statewide conservation organizations including:

- River Alliance of Wisconsin
- Wisconsin Association of Lakes
- Wisconsin Wetlands Association
- Gathering Waters Conservancy
- 1,000 Friends of Wisconsin
- Friends of Wisconsin State Parks
- Urban Open Space foundation
- Natural Resources Foundation of Wisconsin
- Aldo Leopold Foundation

At this workshop, we introduced the Wisconsin DNR program, demonstrated a variety of Internet and GIS tools, brainstormed ways we could work with the organizations (individually and collectively), and outlined a limited number of next steps that could be taken to further our efforts.

We discussed the training and technical assistance needs of *local* groups and existing programs that the statewide organizations currently provide to address those needs. Participants agreed that what would be most helpful to them was to have simple instruction sheets for the tools and some type of guidance as to which tools can be used for which kinds of decisions. It was also noted that a couple statewide organizations have developed GIS data layers/coverages, but that they did not have the ability to make these accessible via the Internet. It was suggested that perhaps some of these layers could be hosted on a Wisconsin DNR Web mapping application. The group also encouraged us to continue partnering with the Wisconsin Towns Association and the Wisconsin Counties Association as a means of increasing local capacity to use the tools.

Outreach and Training: Wisconsin Towns Association Annual Meetings

Given that many elected officials prefer their local government association as a primary training and technical assistance provider, we partnered with the Wisconsin Towns Association (WTA) to capitalize on its annual conference as an outreach and training venue. We participated in the WTA's 2006 Annual Meeting in La Crosse. We held a 4-hour, "drop-in" session and two workshops. At the "drop in" session, program staff set up laptop computers and demonstrated a variety of Wisconsin DNR mapping tools along with Digital Watershed, LTHIA, and Web Soil Survey. While program staff sat with groups of 3-6 conference participants demonstrating the Web sites, they facilitated discussions on how the tools could be applied. A third computer was available for individuals wanting to explore the tools on their own. Over 50 people attended the "drop in" session. We also facilitated two, hour-long workshops. In a classroom setting, program staff demonstrated Surface Water Data Viewer, Remediation and Redevelopment Sites Map, Natural Heritage Inventory Online Database, Web Soil Survey, Digital Watershed, and LTHIA. Over 40 participants attend the two workshops. At both the "drop in" session and the workshops, instruction sheets for the different tools were distributed. Town officials took advantage of this opportunity and both the drop-in and workshop sessions had a steady stream of eager participants. Follow up conversations with WTA officials confirmed the interest in and value of this approach and "opened the door" for a continued training presence at the WTA's annual meetings.

The WTA also helped us promote the 2005 Webconference series, *Internet Tools for Natural Resources: Local Government Webcast Series*, by including a promotional flyer in 1,300 Annual Conference programs. In 2007, we worked with the conference organizers to include information about Internet tools that can aid town officials in carrying out their responsibilities in each of the conference registration packets.

Training: Hands-on Workshops

Table 7.4 in the chapter dealing with our work with Wisconsin's planning community provides a list of hands-on workshops that we conducted for citizen planners, a group that significantly overlaps with the local government decision maker audience. Because of the significant overlap, we marketed these workshops to local government decision makers as well. Workshops ranged in length from 1 to 4 hours and generally featured 1-3 tools. Workshops included direct instruction on specific tools for finding information, creating maps, and modeling decision impacts. Learning outcomes for the sessions focused on identifying and using tools in the community planning work that citizen volunteers routinely undertake. Participants received a booklet with instructional worksheets and guided activities for each tool featured in the workshop, as well as resources for finding and using additional Internet tools.

Training: WisLine Conference

UW-Extension’s “WisLine Series” is designed to provide information to county, city, village, and town officials charged with adopting and administering land use planning and regulatory programs. At the invitation of UW-Extension’s Environmental Resources Center, program staff participated in this series several times during the grant period, first to describe the *Changing Landscapes* evaluation workshops and later by presenting information about specific tools.

The WisLine Series typically relies on telephone conferencing as the mode of presentation and participation. County Extension educators around the state provide a location where local government officials and others gather and listen to the teleconference. We capitalized on WisLine’s Web technologies for the April 2005 “Growing Communities, Greening Communities: Computer Tools for Comprehensive Planning” session. This session was a live, interactive Webcast. Twenty-four remote locations, representing 16 counties from throughout the state, logged on to participate in the session. Program staff presented information about how Internet tools can enhance comprehensive planning. We provided resources for accessing tools, including Wisconsin DNR’s Community Planning and Land Use Management Web site and the Midwest Spatial Decision Support Systems Partnership Web site. Program staff then used the WisLine Web technology to demonstrate real-time use of two tools. Wisconsin DNR’s Registry of Closed Remediation Sites was used to address the brownfields remediation component of the Economic Development element required under Wisconsin’s comprehensive planning statute. We showed participants how to find and use the tool to provide products that could be incorporated into a local plan. Next, we showed how Wisconsin DNR’s WebView can aid with the development of the Agricultural, Natural, and Cultural Resources element. Again, we demonstrated the functionality of the tool and its application to natural resource planning and management.

Participatory Evaluation: WisLine’s Interactive Features

We took advantage of the WisLine technology’s interactive features to assess participant interest in the tools and the technology used for the WisLine Web session. We asked participants five questions related to the session. Real-time results were recorded from the 13 (of 26) sites that regularly responded (Table 9.3).

Table 9.3. *Participant Responses to Questions Asked Regarding the Tools Demonstrated during Our WisLine Conference and the WisLine Technology.**

This session was useful and informative.	Yes – 12	No – 1	Unsure – 0
I am interested in using WDNR’s Registry of Closed Remediation Sites.	Yes – 10	No – 0	Unsure – 3
I am interested in using WDNR’s WebView.	Yes – 13	No – 0	Unsure – 0
I would be interested in attending a hands-on computer workshop to learn more about computer tools.	Yes – 10	No – 1	Unsure – 4
This meeting technology (WisLine Web) is an effective way to participate in workshops and meetings.	Yes – 13	No – 0	Unsure – 0

* Of the 24 locations participating, only 13 locations answered regularly.

Because of the overwhelmingly positive response to both the usefulness of the session and the perceived effectiveness of the Webconferencing technology, program staff partnered with UW-Extension to produce a series of Webconferences highlighting different tools for local government decision makers.

Training: Webconference Series

Webconferencing combines audio conference calling with visually interactive, Web-based materials. Participants dial in to a telephone conference call and use their Internet browsers to access a pre-assigned URL to access a conference. This modern training method used for distance learning gives participants the ability to hear an instructor while simultaneously viewing the instructor's computer monitor. The technology allows participants to give instructors feedback on the pace of the presentation and their comprehension of the material presented. An instant messaging function allows participants to ask questions privately in real-time.

As noted in our audience assessment discussion above, some local government officials expressed interest in Webcasts/Webconferences or online learning modules as means of learning about Internet and GIS tools. In addition, participants in the focus group we conducted with planners agreed that Webcasts provide a meaningful and simple way to conduct outreach to professional planners, while GIS professionals expressed interest in Internet-based sessions.

We hosted four monthly, 1.5-hour, topic-specific Webconferences in early 2006. UW-Extension's Environmental Resources Center provided advice on appropriate teaching approaches, facilitated a pilot testing opportunity, and publicized the series. During each session, we provided information about and demonstrations of two Internet tools.

Local officials could register for an individual Webconference or the entire series. When registering, they chose to view the Webconference either by attending a group viewing or by participating at their own computer. UW-Extension's county-based educators hosted group viewings in 19 Wisconsin counties.

Prior to each Webconference, we sent two instructional e-mails to all registered participants. The first provided instructions for using the Webconference technology (i.e. downloading the free software needed to view the Webconference, connecting to the Web and audio portions, contacting technical support for help with any difficulties, etc.). A second e-mail contained instructions for using each of the featured tools, as well as additional resources for further exploration.

Measuring Outcomes: Post-Webconference Survey

In early August 2006, a little more than 6 months after the first Webconference, we conducted an e-mail survey of participants. We asked participants for feedback regarding the tools demonstrated during the Webconference sessions. An earlier report (Bellrichard and Watermolen 2007) documented the survey design, methods, and results. Here, we summarize the most relevant findings from that effort.

Interest in and Understanding of the Tools: We asked each participant how interested s/he felt about trying a specific tool after the Webconferences. Asking about a specific tool allowed us to separate participants' general interest in Internet resources from their interest in the specific tools. Ninety-three percent indicated they were either somewhat or very interested (as opposed to not too interested or not at all interested) in trying the specific tool they were asked about.

We recognize that a participant may know what a specific tool is and how it functions, but not know how to apply it in her/his day-to-day work. Therefore, we also asked participants to estimate their level of understanding of how the tool can be applied to their work. Seventy-eight percent felt they had a good or very good understanding (as opposed to fair, poor, or unsure understanding) of how the tool could be applied.

Using the Tools: We asked participants how confident they felt using the tools on their own following the Webconference. Ninety-six percent indicated they were somewhat or very confident (as opposed to not too confident or not at all confident). This suggests the tools demonstrated during the Webconferences are user friendly and the Webconferences were effective enough for participants to feel confident in using the tools on their own.

We asked participants if there were opportunities to use the tool in their work. Seventy-eight percent thought there was probably or definitely an opportunity to use the tool in their work. We also asked participants how many times they had used the tool for their work since the Webconference (3-6 months later):

- 71% used the tool at least once.
- 54% indicated they had used a given tool for their work 2 or more times.

We asked participants to share specific tasks that they employed the tools for (second order outcomes). Table 9.4 provides representative responses to this open-ended question.

Table 9.4. *Representative Responses to the Question “What did you use the tool for?” (Second Order Outcomes).*

- Sorting out soil layers for slopes and depth to bedrock.
 - Comprehensive land use planning, storm water management planning, storm water permitting, site and public infrastructure engineering and design.
 - Showing others that it existed and how to use it.
 - Checking distribution of threatened and endangered species.
 - Show landowners what’s available.
 - It had to do with water quality issues on Lake Koshkonong but I don’t remember exactly.
 - A Landscape Ecology/GIS class.
 - Review some sites in our community.
 - Subdivision reports.
 - To determine if there were prime statewide important soils on a parcel of land we were considering protecting.
 - Research for hydric soils.
 - Project planning.
-

Finally, we asked participants how likely it was that they would use the tool in their future work. Seventy-five percent thought it was somewhat or very likely (as opposed to not too likely, not at all likely, or unsure) that they would use the tool in the future. No single one tool can be used for everything and many times tools are only needed in specific situations. Nonetheless, taken together, these results suggest that local government officials value the tools we demonstrated for the work that they do. We cannot, however, conclude that the low level of use of a tool implies that it is not useful or that it will not be used for work. It is quite possible that a situation to use it hasn’t arisen yet.

Accessing the Tools: Participants may understand a tool, be interested in a tool, and know how to apply a tool in their work, but still might not go back to the Internet tool Web site and use it. Therefore, we asked participants how soon after the Webconference they visited the tool’s Web site:

- 82% visited a tool’s Web site within 1 week after the Webconference.
- Only 11% never visited the tool’s Web site following the Webconference.

The quickness of visiting the site may be a further indication of participants’ interest in the tools.

We also asked if participants bookmarked the tool's Web site or added it to their Internet "favorites" folder. Given the sometimes long and strange URLs associated with the different tools, bookmarking provides an efficient way of repeatedly accessing a site. In addition, experience tells us that users often bookmark frequently used Web sites. Thus, bookmarking may be an indication of the interest in a tool and the possibility of future use. Therefore, we were a little surprised that despite their interest in, and use of, the tools, only 42% of participants indicated they bookmarked a tool's Web site. There are, however, other ways to get to sites quickly and participants in other sessions we conducted suggested assembling links to the most useful tools on a single Web site.

Teaching and Learning about the Tools: When participants share their knowledge with colleagues or customers, they extend the benefits of our work. Given this, we assessed participants' confidence in showing someone else how to use a tool. Sixty-seven percent indicated they were either somewhat or very confident (as opposed to not too confident or not at all confident) in showing others how to use the tool.

High and Jacobson (2005) described in two case studies how "the growth of the Internet, combined with the shifting demographics of private forest landowners that indicate increasing Internet use, presents great opportunities for natural resource extension." We have observed similar circumstances throughout the Midwest and wanted to assess participants' training preferences related to the Internet. We asked participants if given a choice would they rather participate in a Webconference or an in-person workshop:

- 44% indicated they would rather participate in a Webconference
- 30% said they would prefer an in-person workshop.
- 11% indicated they would participate in either a workshop or a Webconference.
- 15% felt unsure.

These results paralleled results found elsewhere. Local officials in New York, Pennsylvania, and West Virginia "predominantly prefer face-to-face training," but were willing to give distance learning a chance (Kelsey et al. 2002). In Georgia, 93% of the respondents to a survey following a virtual conferencing session indicated they would attend future sessions in that format (Hurt et al. 2008). On a scale of 1 to 5, with 5 being the highest, the average response on the personal value of that interactive session was 4.1. A majority (55%) of county Extension agents from 6 southern states (Alabama, Georgia, South Carolina, North Carolina, Florida, and Virginia) thought that training offered through the Internet can be as effective as a face-to-face learning environment (Lippert, et al. 2000). Together these results seem to suggest that Webconferencing could be an important element of the environmental outreach tool kit.

Reference and Related Reading

We found the following references helpful in defining and developing our approach to working with local government officials. We list these works, all other references cited, and additional useful sources together in the "Literature Cited, Further Reading, and Background Material" section at the end of this report.

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Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described our work with local decision makers, our assessment and evaluation of these efforts, as well as lessons learned along the way. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

- Watermolen, D.J. 2007. Providing On-line Data and Decision Support Tools to Local Planners. Exchange Network National Meeting, U.S. Environmental Protection Agency and Environmental Council of States, Marriott New Orleans Convention Center, New Orleans, LA. (April 25, 2007). See <http://www.exchangenetwork.net/2007Meeting/presentations.htm>.
- Goranson, S. and D.J. Watermolen. 2007. Bridging the Gaps in Environmental Information Sharing. "Government Data Sharing in the Information Age," Illinois Data Exchange Affiliates and Chicago Metropolitan Agency for Planning, Sears Tower, Chicago, IL. (March 20, 2007). See [http://www.chidataexchange.net/upcomingevents_copy\(1\).htm](http://www.chidataexchange.net/upcomingevents_copy(1).htm).
- Bellrichard, D. and D.J. Watermolen. 2006. Webcasting as a Training Method for Internet GIS Resources. ESRI Wisconsin User Group 2006 Conference, Paper Valley Radisson, Appleton, WI. (November 1-2, 2006). See <http://www.ewug.org/page3.html>.
- Lucero, D., D.J. Watermolen and D. Bellrichard. 2006. Using Internet Mapping Services (IMS) for Planning, Conservation, and Environmental Protection: An IMS Capacity Building Program. North American Cartographic Information Society: NACIS 2006 Conference. Inn on the Park, Madison, WI. (October 18-21, 2006). See http://dev.nacis.org/documents_upload/FinalProgramXXVI.pdf.

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See http://dev.nacis.org/documents_upload/FinalProgramXXVI.pdf.
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- Watermolen, D.J. 2004. Remote Sensing/GIT Outreach Strategies and Programs. "Northeastern Local, Regional and State RS/GIT Outreach Workshop." Institute for the Application of Geospatial Technologies, Skaneateles Falls, NY. (October 26-28, 2004).
See <http://www.iagt.org/gov.asp>.
- Watermolen, D.J. 2004. Outreach to Local Decision Makers: A Wisconsin Case Study. "Public Sector Approaches to Promoting Sustainable Development" conference. U.S. Environmental Protection Agency, Region 5, Ralph Metcalfe Federal Building, Chicago. (July 26-27, 2004).
- Lucero, D., D.J. Watermolen, and M.D. Murrell. 2004. A State-Federal Partnership to Understand the Usefulness of Decision Support Tools for Natural Resources Management. "Watershed 2004." Water Environment Federation Annual Meeting, Hyatt Regency, Dearborn, MI. (July 11-14, 2004).
- Watermolen, D.J. 2004. Supporting Local Decision Making: An Overview of Wisconsin's Efforts. "GIS Tools and Community Watershed Planning Workshop." Northwest Indiana Regional Planning Commission and Purdue University Calumet School of Science, Mathematics, and Engineering, Hammond, IN. (May 25-26, 2004).
- Lucero, D. and M. Murrell. 2004. The Results Are in: Which Web-based Tools Enhance Public Dialogue and Decision Making? "Wisdom of Voices 2004," International Association of Public Participation (IAP2) International Conference, Madison, WI. (May 4, 2004).
- Watermolen, D.J. 2003. Supporting Local Decision Making: A Wisconsin Case Study. "Growth and Water Resources: Using Smart Growth to Protect Watersheds" seminar. U.S. Environmental Protection Agency, Washington, DC. (December 8-9, 2003).
- Lucero, D. and M. Murrell. 2003. Wisconsin User Feedback: A Process for the Review and Evaluation of Impact Assessment Tools. "Lake Michigan: State of the Lake '03." GVSU Annis Water Resources Institute and U.S. EPA Great Lakes National Program Office, Muskegon, MI (October 21-22, 2003).
See http://www.gvsu.edu/forms/education/state_lake_2003.pdf

Outputs: Publications Related to Our Work

Over the course of our grant period, we published results of our work in various outlets. We here list publications that address the aspects of the Wisconsin DNR program that focused on local government decision makers.

Bellrichard, D. and Watermolen, D.J. 2007. Using webconferencing to teach about Internet mapping and related technologies. Wisconsin Dept. Natural Resources *Research/Management Findings* (58):1-4. See http://dnr.wi.gov/org/es/science/publications/PUB_SS_758_2006.pdf.

Lucero, D. 2006. Internet tools bring science to local decisions in Wisconsin. *ECOStates: The Journal of the Environmental Council of States* (Spring):14-16. See http://www.ecos.org/files/2196_file_ECOStates_Spring_2006.pdf.

Welch, R.C. 2005. L-THIA – Three versions, three groups, three projects. University of Wisconsin-Stevens Point Center for Land Use Education *The Land Use Tracker* 5(3):6-9. See <http://www.uwsp.edu/cnr/landcenter/tracker/winter2005/TrackerWinter2005.pdf>.

10. Target Audiences: Public Librarians and K-12 Educators

Early in the grant period, program staff identified two additional target audiences for our technology transfer work: public librarians and K-12 educators. We thought that working with these audiences could facilitate outreach and training of local government officials and help promote a future workforce with the capacity to use Internet tools effectively. In this chapter, we describe our outreach, training, and technical assistance efforts with librarians and educators. Since work with these audiences was not part of the original scope of our grant, however, we did not attempt to measure outcomes from our efforts and do not list program outputs at the conclusion of the chapter as we have for our work with other target audiences.

Public Librarians

Libraries have long been recognized for their roles in providing environmental information and fostering civic involvement in environmental decision making (e.g., see Libraries for the Future 1993, 1997). While academic libraries have been at the forefront of making GIS resources available to researchers and academia (Adler 1995, Argentati 1997, Suh and Lee 1999), the Internet has enhanced the ability of public libraries to extend the reach of these tools to the general public (Hawkins 1994, Carver et al. 2001). Carver et al. (2001) relate how “[p]rovision of full access to spatial and aspatial data, along with the appropriate tools with which to use it, may greatly empower the general public” by giving the public “greater opportunities of engagement, at a more equal level.” They further note the role public libraries can play in combating the potential development of an “information underclass” by providing public access terminals. As educators and technical assistance providers, public librarians can help us reach a wider audience, including many citizen planners and local officials who rely on their local libraries as places for accessing information.

In fact, libraries may contribute significantly to the provision of equal access to Internet tools (see “Lessons Learned”, Chapter 15 for more on why this is a concern). Data collected by the Wisconsin Department of Public Instruction (Wisconsin DPI) shows that 345 Wisconsin libraries, serving 97 percent of the state’s population, offered free wireless Internet at the end of 2008. In 2008, the Wisconsin DPI set a goal of 100 percent of Wisconsin residents having access to free wireless at their public libraries and began targeting federal Library Services and Technology Act (LSTA) funding to help libraries add wireless Internet. Ninety-three public libraries added the service in 2008 and grants awarded by Wisconsin DPI will help 21 additional libraries begin to provide access in 2009.

We initiated our work with libraries at the Wisconsin Library Association’s annual conference in October 2007. Program staff conducted a workshop titled “Helping Patrons Understand Environmental Issues: An Introduction to Internet Map Tools and Related Resources.” They highlighted several library-maintained environmental Web sites and demonstrated free, intuitive Internet tools that library patrons can use to map and understand natural resources features (soil type, location within a watershed, air quality advisories, etc.) and evaluate some of the impacts of local land use decisions. The session was both well attended and well received. Several librarians requested additional assistance or further presentations at future conferences. We repeated the session at the Wisconsin Library Association’s 2008 annual conference. Again, the session was well attended and well received.

K-12 Educators

Enthusiastic educators and GIS practitioners have begun introducing GIS into K-12 education. The National Research Council (2006: Appendix G) provides a timeline (1986-2003) detailing significant events, activities, and organizations related to GIS in education. Contemporary trends in technology adoption and communication behaviors suggest Internet GIS may prove a valuable addition to the classroom and home learning environments. In fact, many national environmental education curricula (e.g., American Forest Foundation 2006, Council for Environmental Education 2008b) attempt to make technology connections as a way of furthering their learning objectives.

We initiated our work with K-12 educators at the Wisconsin Association for Environmental Education's (WAAEE) fall conference in October 2004, by exhibiting our multimedia "Computer Tools for Planning, Conservation, and Environmental Protection" tradeshow display. Program staff used this opportunity to speak directly with conference attendees about the use of computer tools in environmental education. U.S. EPA's Window to My Environment and Wisconsin DNR's Comprehensive Planning Web Mapping site generated considerable interest from the educators, who quickly recognized the tools' potential for introducing mapping, basic GIS, and natural resources to students at the middle school and high school levels. Several individuals signed up to receive information about future training sessions.

Following up on the enthusiasm witnessed at the fall conference, program staff prepared and submitted a workshop proposal for WAAEE's January 2005 Winter Workshop. The proposal was accepted and program staff conducted an hour and forty-five minute, hands-on session on "Integrating Computer Tools into Land Use Activities" (Figure 10.1). The overall workshop theme, "Education for Sustainability," focused on the role of environmental educators in today's complex world. Our session was designed to assist educators with incorporating Internet-based tools into their instruction. Participants learned about free, Web-based data and mapping tools (Table 10.1) and how they can be integrated into existing environmental lessons (Durney 1995, Council for Environmental Education 2008b).

Figure 10.1. *Environmental Educators Learned about Internet Tools in a Conference Workshop.*



Table 10.1. *Internet Tools and Associated Lessons Covered in the WAAEE Winter Workshop Session.*

-
- U.S. EPA's Window to My Environment (with an extension of the *Project Wild Aquatic* activity "What's in the Water")
 - Wisconsin DNR's Registry of Closed Remediation Sites (with an extension of the *Project WET* activity "A Grave Mistake")
 - Long-term Hydrologic Impact Assessment (with an extension of the *Project Wild Aquatic* activity "Where Does Water Run?")
-

In addition to elementary school teachers, participants in this session included a college professor developing new course materials, a nature center naturalist, and a UW-Extension basin educator. The information presented was well-received and the diverse group participating in the session generated many ideas on how the tools could be used in educational settings. Evaluation survey results showed that all participants left with a good working knowledge of the tools and were planning to incorporate the tools into classroom activities.

In October 2005, program staff conducted a second hands-on workshop on “Integrating Computer Tools into Land Use Activities” at WAEE’s Fall Workshop, *EE History in Action*. This session assisted educators with incorporating Internet-based tools into existing land use education activities. Featured tools included U.S. EPA’s Window to My Environment, NRCS’ Web Soil Survey, Wisconsin DNR’s Registry of Closed Remediation Sites and DNR WebView, LTHIA, and Digital Watershed. We also set up and staffed our “Computer Tools for Planning, Conservation, and Environmental Protection” tradeshow display in the conference’s exhibit area.

In cooperation with the Monona Terrace Community and Convention Center, the Wisconsin DNR program contributed to the biennial Terrace Town program. A school year-long project, Terrace Town introduces elementary school students and their teachers to the role the built environment plays in our daily lives. Through a hands-on, community design process, students learn how cities are planned, what makes a quality city, and how citizens can participate in community improvements. Interdisciplinary curricula and in-service training help educators use the built environment as a sustainable development teaching resource. Volunteer mentors (planners, architects, resource professionals) add real-life perspectives to the classroom instruction. Participating classes exhibit model cities at a Terrace Town School Day and the public view student work during a day-long Terrace Town Open House. As part of this effort, program staff conducted four in-service workshops for participating teachers and mentors. One of these sessions focused specifically on “Internet Map Resources for Your Classroom.”

Finally, as a result of our work with this audience, program staff members are now preparing a review of the literature on Internet GIS applications in K-12 classrooms.

References and Related Reading

We found the following references helpful in defining and developing learning objectives and program outputs for our work with librarians and educators. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, Further Reading, and Background Material” section at the end of this report.

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Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made professional meeting presentations that described our work to build capacity among K-12 educators and librarians. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

- Watermolen, D.J. and A.C. Mednick. 2008. Helping Patrons Better Understand Environmental Issues: An Introduction to On-Line Tools and Resources. "Wisconsin's Libraries: Building a Better Tomorrow," Wisconsin Library Association Annual Conference. Madison Marriott West, Middleton, WI. (November 6, 2008).
- Sabin, H. and D.J. Watermolen. 2008. Terrace Town: Elementary Students Building Sustainable Communities. "Urban EE: There's More to a City than Its Skyline," 2008 Wisconsin Association for Environmental Education Fall Conference. Wyndham Airport Hotel and Convention Center, Milwaukee, WI. (October 30, 2008).
- Mednick, A. and D.J. Watermolen. 2007. Helping Patrons Understand Environmental Issues: An Introduction to Internet Map Tools and Related Resources. "Libraries Here and Now," Wisconsin Library Association Annual Conference. Regency Suites and KI Convention Center, Green Bay, WI. (October 19, 2007).
- Watermolen, D.J. 2007. Providing On-line Data and Decision Support Tools to Local Planners. Environmental Information Exchange Network National Meeting. U.S. Environmental Protection Agency and Environmental Council of States, New Orleans, LA. (April 25, 2007).

Evaluation and Refinement of Water Quality Modeling Tools

11. Model Comparison Research

Our work to help local officials integrate environmental information and scientific methods into their planning and decision making and to transfer technology resulted in a number of previously unanswered questions regarding the differences between various runoff modeling tools. In 2007, we modified our approved work plan to address some of these questions. Specifically, we evaluated the relative usability and appropriateness of four widely-available tools at geographic scales relevant to community planning. Much of this work is reported in articles submitted to peer-reviewed journals (Mednick, In Review). Here, we summarize the most relevant materials from those manuscripts. We conclude the chapter by listing professional presentations and publications related to this work.

Background and Study Objectives

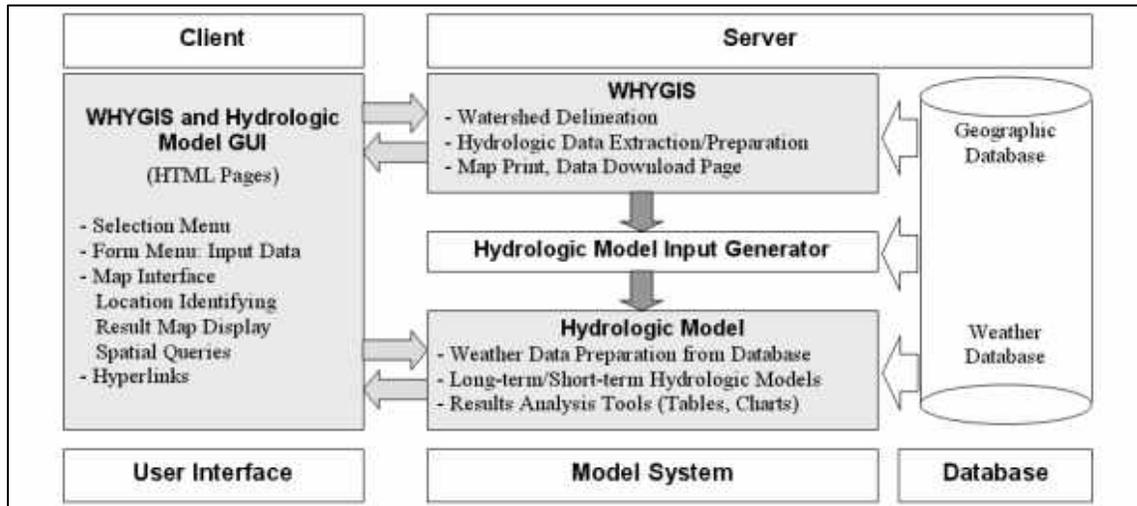
While there is a growing realization that community planning can play an important role in managing the hydrologic impacts of growth (Berke et al. 2003, Stone and Bullen 2006), there has been a considerable lag in the creation of readily-available, user-friendly planning support tools that can be used to predict the potential impacts of land use change on runoff. Fifteen years ago, Harbor (1994, pg. 95-96) noted that:

Despite the existence of [numerous] hydrologic models, and the clear need for planners to provide general estimates of the potential hydrologic impacts of land-use change, such analyses are rarely performed as an integral part of practical planning... [E]xisting models are so complex and data intensive that either they are beyond what a local planner can manage in terms of time and/or expertise, or the planning agency cannot afford the cost of hiring a professional consultant to perform the analysis.

This largely remains the case. While hydrologic modeling capabilities have in recent years been linked with desktop GIS software and packaged as spatial decision-support tools (Wilson et al. 2000, Xu et al. 2001, Lohani et al. 2002), desktop tools—even open source tools like BASINS (U.S. EPA 2008)—continue to place the burden for maintaining the applications, databases, models, and supporting information on users who may lack the time or expertise to successfully use them (Miller et al. 2004). LTHIA-GIS (Grove 1997), AGWA (Miller et al. 2002), and the CITYgreen hydrologic modeling component (Woodward 2005) were developed explicitly for users with limited technical expertise. At present, LTHIA-WWW (Pandy et al. 2000) is the only fully-contained, Web-based decision-support tool for hydrologic modeling that can be used to model runoff impacts anywhere in the U.S. A prototype, Web-based version of AGWA (“Dot-AGWA”) has been developed for the Walnut Gulch experimental watershed in southern Arizona (Cate et al. 2007). Web-based tools can help community planners to overcome difficulties with data access, model operation, and results interpretation (Miller et al. 2004, Choi et al. 2005).

Hydrologic models are at the core of GIS-based tools such as LTHIA-GIS, AGWA, and CITYgreen, as well as Web-based tools such as LTHIA-WWW (Figure 11.1). Most hydrologic models share five basic components: input data, initial and boundary conditions, hydrologic processes, governing equations, and output (Singh 1995). Hydrologic models are often divided into three broad categories, according to how they treat spatial variation within modeling components. “Lumped-parameter” models treat entire areas of interest (typically watersheds) as singular units of analysis, with lumped or composite parameters. “Partially distributed” models sub-divide areas of interest into smaller elements (typically sub-watersheds or catchments) that have similar hydrologic properties. “Distributed” models attempt to account for as much spatial variability as possible by solving their governing equations for disaggregate units of analysis, ranging from individual pixels to zones of unique combinations of land cover and soil conditions. Methods for transforming land use and land cover characteristics into parameters are not well developed or documented for all possible conditions. Ideally, models should be calibrated to local conditions, by adjusting parameters, so as to raise or lower predicted runoff under current conditions to match runoff measured by stream gauges. Such data, however, are often unavailable, and procedures for base-flow separation and model calibration often require considerable technical and scientific know-how (Lim et al. 2006).

Figure 11.1. Web-Based Spatial-Decision Support Systems for Hydrologic Modeling.



Source: Midwest Spatial Decision Support Partnership

In response to questions raised during our workshops and technical assistance consultations, we wanted to evaluate the relative usability and appropriateness of LTHIA-WWW, LTHIA-GIS, AGWA, and CITYgreen at geographic scales relevant to community planning. Our second objective was to determine whether and to what extent differences in tools’ underlying modeling components, including their spatial units of analysis, default input datasets, parameter-assignment schemes, and assumptions related to open water, wetlands, and the hydrologic condition of upland areas, account for wide variations in the different tools’ predicted runoff responses to land use change.

Study Methods

We used the LTHIA tools, AGWA and CITYgreen to predict the impact of anticipated future development in three study sites in Wisconsin. Two model runs (current and future land use) were conducted in each of the three study sites, using each of the four tools, for a total of 24 model runs. Tools were compared to one another on several dimensions of usability relevant to community planning, as well as the plausibility of their runoff predictions, where stream gauge data were available. Tools were also compared in terms of their respective modeling components through a series of sensitivity analyses (an additional 504 model runs). These analyses illustrate how differences in the tools’ spatial units of analysis, default data inputs, land use reclassification/curve number assignment schemes, and their underlying assumptions regarding water, wetlands, and the hydrologic condition¹¹ of upland areas, affect their predictions. Variations in these modeling components reflect key differences between the tools, both as they are presently configured and with respect to modifications that could be made in the future.

One study site was selected from each of three different regions based on recommendations from members and/or staff of their respective regional planning commissions¹². Sites were selected because of their relative likelihood of development in the near or mid-term (1-10 years). In addition, the sites were selected

¹¹ Hydrologic condition typically ranges from “good” to “fair” to “poor” and is based on a combination factors affecting infiltration and runoff. These include the density of vegetative cover, the amount of cover that is year-round, the amount of grass or close-seeded legumes within crop areas, and the percentage of crop residue left after harvest.

¹² The Capital Area Regional Planning Commission in south-central Wisconsin; the Bay-Lake Regional Planning Commission in northeastern Wisconsin; and the East Central Wisconsin Regional Planning Commission.

to cover a range of spatial scales reflective of typical community planning activities, such as subdivision review, neighborhood development planning, and community-wide land use planning and zoning:

- Site 1, *Misty Valley*, is a 50-acre, agricultural property approved for residential subdivision in Dane County.
- Site 2, *Greenville Farms*, is a 1.1 square-mile, primarily agricultural site in Outagamie County, for which concept plans are being drafted for a mixed-use neighborhood.
- Site 3, *Upper Baird Creek Watershed / Humboldt and Eton*, is a 17 square-mile mainly agricultural area, comprising portions of two townships falling within a small watershed.

The latter site was the focus of a previous planning study by the Bay-Lake Regional Planning Commission.

The study sites' boundaries were expanded outward from those provided by the regional planning commission. The reason for this is that the different hydrologic modeling tools evaluated for this study have different spatial extents and units of analysis. It was necessary, therefore, to select a common set of boundaries that each tool could use as its spatial extent—in this case, watershed and subwatershed boundaries delineated by AGWA. This ensured that comparisons between the different tools' aggregate runoff predictions were directly comparable.

Table 11.1 summarizes basic features of the tools. The tools share several fundamental steps in their runoff estimation processes, including: (1) the acquisition and formatting of necessary data inputs, (2) the delineation of the extent of analysis; i.e., the study area, (3) the reclassification of land use/land cover and soils data according to curve number-assignment schemes, (4) the assignment of curve numbers, (5) the modeling of direct runoff, (6) the output and display of model results as data, graphics, or a combination of the two.

Table 11.1. *Summary of Runoff Modeling Tools Evaluated.*

	LTHIA-GIS	LTHIA-WWW	AGWA	CITYgreen
Developers	Purdue University	Purdue University	EPA-ORD, USDA-ARS, U. of AZ	American Forests
Required Software	Web Browser	ArcView 3x	ArcView GIS V.3x or 9x	ArcView GIS V.3x or 9x
Model Outputs	Average Annual Direct Runoff (in)	Average Annual Direct Runoff (in)	Daily, Monthly, and Annual Average Direct Runoff (mm)	Design-Storm Direct Runoff (in)
Modeling Scale	Catchment -> Watershed	Site -> Up	Watershed -> Basin	Site -> City
Model Type	Distributed	Distributed	Partially Distributed	Lumped

The three desktop tools were each used to predict the impact of anticipated future land use change on direct stormwater runoff within the three selected study sites. LTHIA-WWW proved difficult to use for the purposes of this study in that the mechanism provided for entering map-based land use change into the online system was limited in its ability to capture spatially detailed land use change. For comparison purposes, it was necessary that these scenarios be consistent across the different tools. Therefore, LTHIA-GIS was run two times: first, using local land use and SSURGO soils; then, using NLCD and STATSGO soils (the datasets bundled with LTHIA-WWW). In this way, LTHIA-GIS effectively “doubled” for both versions of LTHIA, providing a comparable set of model outputs.

All four tools were evaluated according to a set of usability criteria developed as part of the Wisconsin DNR program (Table 11.2).

Table 11.2. Usability Criteria*.

1. Web-based	Accessible via the Internet. Only required software is an Internet browser.
2. Free	Housed within the public domain. No purchase cost.
3. Data Included	Data required are bundled with the tool.
4. Data Exchange	Users have the ability to exchange alternative, preferred datasets for default datasets.
5. Scalable	Tools function at various spatial scales – local to regional.
6. Customizable	Tools can be modified or customized to meet site- or user-specific needs..
7. Intuitive	Step-by-step processes, with “user-friendly” interface. Navigation features are consistent and easy-to-follow.
8. Help Features	Help files and tabs. User guides and documentation are comprehensive, well-organized, and readable..

*Adapted from Lucero et al. (2004) and Watermolen (2008)

While this study is not intended to serve as a model validation, it was necessary to have some basis for judging the relative plausibility of the different tools’ modeled outputs. For this purpose, U.S. Geological Survey stream gauge data were compared to model-predicted runoff under current land use conditions. Only the Upper Baird Creek / Humboldt and Eaton site is gauged, with recent runoff data available for comparison. Daily direct runoff was separated from base-flow by the Eckhardt filter method and downloaded from the Web-based Hydrologic Analysis Tool (WHAT)¹³ for the period of gauge operation (2003 to the present). Data were converted from cubic feet per second as measured by the gauge to inches of runoff over the full drainage area—both as an annual average (for comparison with LTHIA, LTHIA-WWW, and AGWA results), and for the single 24-hour rain event closest to the study area’s two-year, 24-hour design storm.

The tools evaluated for this study produce widely varying predictions, in terms of both absolute runoff and the percent change between current and future land use scenarios. As previously noted, the different tools evaluated for this study vary considerably with respect to several of their underlying modeling components, including spatial units of analysis, input datasets, land use reclassification/curve number assignment schemes, and underlying assumptions related to open water, wetlands, and the hydrologic condition of upland areas (see Table 11.3). This multi-dimensional variation makes it difficult to assess the magnitude of different potential causes of systematic over- or under-predictions. To do so, requires that the different tools be identical in all aspects save the individual modeling components being evaluated. Therefore, we conducted a set of sensitivity analyses by modifying and re-running LTHIA-GIS (the only tool with the data exchange capabilities necessary to match the underlying components of the other tools). Eighty-four model runs were conducted for both the existing and proposed land use scenarios in each of the three study sites—for a total of 504 model runs.

¹³ WHAT enables users to access daily stream flow data from U.S. Geological Survey stream gauges across the U.S., and run base-flow/direct runoff separations via different methods. Available at <http://cobweb.ecn.purdue.edu/~what/>.

Table 11.3. Variation in Tools' Modeling Components.

	LTHIA-WWW	LTHIA-GIS	AGWA	CITYgreen
Spatial Units of Analysis	Land Cover/ Soil Zones	Land Cover/ Soil Zones	Sub-Watersheds	Study Area
Base Land Use/ Land Cover	NLCD (30m national land cover)	Local (county-mapped, parcels)	Local (county-mapped, parcels)	Local (county-mapped, parcels)
Soils Data	STATSGO (generalized, statewide soils)	SSURGO (county soil survey data)	STATSGO (generalized, statewide soils)	STATSGO (generalized, statewide soils)
CN Assignment Scheme	29 possible CN assignments (8 land use/ land cover classes, including water)	29 possible CN assignments (8 land use/ land cover classes, including water)	81 possible CN assignments (21 land use/ land cover classes, including water)	300+ possible CN assignments (80+ land use/ land cover classes and conditions)
Assumed Hydrologic Conditions	Hydrologic condition = "good" or "fair"; No CN adjustment or calibration	Hydrologic condition = "good" or "fair"; No CN adjustment or calibration	Hydrologic condition = "poor"; CN's modified (calibrated to Walnut Gulch, AZ)	Hydrologic condition="good" or "fair"; No CN adjustment or calibration
Water and Wetland Assumptions	Water and Wetlands CN=0	Water and Wetlands CN=0	Water CN=100; Wetlands range from CN=77 to CN=92	Water and Wetlands CN=100

Study Results

Tools varied according to the extent to which they satisfied the eight different “usability” criteria developed for the Wisconsin DNR program (Table 11.4) LTHIA-WWW, while Web-based, free and including input data, is limited in its data exchange capabilities. Spatially detailed land use scenarios, such as those used for this study, are difficult to enter via the existing table-entry or online digitizing features, and cannot be uploaded as GIS files. Were this otherwise, LTHIA-WWW would clearly be the most usable of the four tools. As it is, LTHIA-GIS rates as the most usable of the tools. It is far more scalable than AGWA—both in terms of scaling up, as well as scaling down to individual neighborhoods or subdivisions—and is far easier to use and more intuitive. While LTHIA-WWW and AGWA are relatively customizable, in that they allow users to manually substitute modified CN values in lookup tables¹⁴, it is reasonable to assume that community planners will generally use the default values of these tools.

Tables 11.5 and 11.6 show the absolute runoff predicted under current land use conditions by the four different tools, as well as a hypothetical “optimized” tool. The optimized tool denotes a combination of model characteristics assumed to be optimal, *a-priori*, including the maximum number of land use/soil classes to which unique curve numbers could be assigned (300+), spatially-distributed parameters (i.e., disaggregate spatial units of analysis), the best available soil and land use data (1:24,000 SSURGO soils and locally-mapped land use), moderate assumptions with respect to the hydrologic condition of upland areas (“fair”), and conservative assumptions with respect to runoff associated with open water and wetlands (curve number = 0). This optimized model is essentially LTHIA-GIS with the full-range of land use/land cover classifications published in *TR-55* (SCS 1986), as opposed to eight aggregated classes.

¹⁴ LTHIA-WWW has an Advanced Inputs option that allows users to add custom land use classes and curve numbers.

For the Upper Baird Creek Watershed/Humboldt and Eaton site, which comprises a U.S. Geological Survey-gauged watershed, it is possible to compare these results to measured data. As shown in Table 11.5, the optimized L-THIA model predicted annual runoff closest to the gauge data. While comparisons based on a single case cannot be used to validate or invalidate any of the underlying models, they can provide a means of assessing the plausibility of model predictions.

Table 11.4. Usability of Modeling Tools Evaluated.

	LTHIA-WWW	LTHIA	AGWA	CITYGreen
1. Web-based	+			
2. Free	+	+	+	
3. Data Included	+			+
4. Data Exchange		+	+	
5. Scalable		+		+
6. Customizable	+		+	
7. Intuitive	+	+		
8. Help Features	+	+	+	

Table 11.5. Modeled vs. Observed Runoff Depth (Inches).

Modeled	Baird Creek Watershed	Greenville Neighborhood	Misty Valley Subdivision
LTHIA-WWW	3.86	5.40	15.15
“Optimized”	6.23	7.24	20.54
LTHIA-GIS	6.53	7.34	19.50
AGWA	13.81	13.69	21.99
CITYgreen *	0.87	0.87	0.71
Measured (stream gage data)			
Avg. Annual Runoff (2003-)	5.10	-	-
24-hour Runoff (2.39" storm)	0.29	-	-

Note: “Optimized” is effectively LTHIA-GIS with the full-range of land use/land cover classifications published in TR-55 (SCS 1986), as opposed to eight aggregated classes.

* CITYgreen-modeled runoff is for a 24-hour design storm.

Table 11.6. Modeled vs. Observed Runoff Depth (Percent of Precipitation).

Modeled	Baird Creek Watershed	Greenville Neighborhood	Misty Valley Subdivision
LTHIA-WWW	12.6%	16.4%	35.7%
“Optimized”	20.3%	22.1%	48.3%
LTHIA-GIS	21.3%	22.4%	45.9%
AGWA	45.1%	41.7%	51.8%
CITYgreen *	38.7%	38.7%	25.8%
Measured (stream gage data)			
Avg. Annual Runoff (2003-)	16.6%	-	-
24-hour Runoff (2.39" storm)	12.9%	-	-

Note: “Optimized” is effectively LTHIA-GIS with the full-range of land use/land cover classifications published in TR-55 (SCS 1986), as opposed to eight aggregated classes.

* CITYgreen-modeled runoff is for a 24-hour design storm.

Table 11.7. Predicted Runoff Response to Future Land Use Change (Percent Increase).

Percent Increase	Baird Creek Watershed	Greenville Neighborhood	Misty Valley Subdivision
LTHIA-WWW	+ 13.8%	+ 26.7%	+ 6.3%
“Optimized”	+ 5.9%	+ 23.0%	+ 6.0%
LTHIA-GIS	+ 5.7%	+ 20.3%	+ 4.3%
AGWA	+ 0.5%	+ 1.5%	+ 1.0%
CITYgreen *	0.0%	+ 6.9%	+ 5.6%
Increased Depth (inches)			
LTHIA-WWW	+ 0.53	+ 1.44	+ 0.96
“Optimized”	+ 0.37	+ 1.66	+ 1.23
LTHIA-GIS	+ 0.37	+ 1.49	+ 0.84
AGWA	+ 0.06	+ 0.20	+ 0.22
CITYgreen *	0.00	+ 0.06	+ 0.04

Note: “Optimized” is effectively LTHIA-GIS with the full-range of land use/land cover classifications published in TR-55 (SCS 1986), as opposed to eight aggregated classes.

* CITYgreen-modeled runoff is for a 24-hour design storm.

In this case, it is readily apparent that both AGWA and CITYgreen over-predict stormwater runoff. The LTHIA tools are relatively close to the stream gauge data, with the optimized tool falling the closest. Results for the un-gauged study sites generally follow the same pattern, although the magnitude and direction varies somewhat from the largest to the smallest study area. The patterns are reversed when looking at the relative runoff response to runoff change (Table 11.7). AGWA and CITYgreen appear to under-predict runoff response, or at least are less sensitive to land use change.

Table 11.8 shows the results of the sensitivity analyses for the different study sites. The left three columns specify the units of analysis, land use data, and soils data used for the different model runs. To the right, the columns under the joint headings “CITYgreen,” “AGWA,” and “LTHIA,” present predicted runoff responses under default and modified versions of each the tools’ land use reclassification/ CN assignment schemes, and their underlying assumptions regarding open water, wetlands and the hydrologic condition of upland areas. Defaults for these components are listed in Table 11.3. Predicted runoff responses under the modified CITYgreen column in Table 11.8 reflect a change in CITYgreen’s assigned CN values for open water and wetlands, from CN = 100 to CN = 0. Values under the modified AGWA column reflect changes in the assumed hydrologic condition of upland areas. Under the modified model run, AGWA land use/land cover classes were re-assigned curve numbers corresponding to their comparable classes, as published in SCS (1986), under “fair” hydrologic conditions (or “good” conditions, where “fair” is not an option). Values under the modified LTHIA columns reflect changes in assigned curve number values for open water, from CN = 0 (default) to CN = 100 (both modified versions); as well as wetlands, from CN = 0 (default) to CN = 100 (Mod1), to CN = between 72 and 92 (Mod2) depending on whether wetlands are forested or emergent and their underlying soils.

Runoff response predictions made under the exact combinations of modeling components matching the four tools are denoted in Table 11.8 by bold-type italics. Those of the “optimized” tool described above are highlighted. Scanning the results reveals several significant relationships between certain tools’ apparent over- or under-prediction of runoff responses to land use change, and one or more of their modeling components. For example, the use of NLCD as the base land use data layer by LTHIA-WWW is the principal cause of that tool’s apparent over-prediction of the runoff response. The 30-meter, national land cover data are coarse relative to parcel-based, locally mapped land use/land cover, and do not capture the same level of variation in land use intensity and imperviousness.

Results also indicate, that all else being equal, CITYgreen’s use of a single unit of analysis and its assignment of CN = 100 to wetlands explain its apparent under-prediction of the runoff response to land use change. Spatially-averaging curve number values over an entire study site reduces the model’s ability to detect such changes—particularly in a site with a relatively small area subject to land use change. Assigning CN = 100 to wetlands means that any predicted conversion of a wetland area to residential, commercial, or industrial use will lead to a prediction of *reduced* stormwater runoff.

Similarly, results indicate that AGWA’s use of the subwatershed as its unit of analysis, and its assignment of wetlands with relatively high curve number values (ranging from 77 to 92) explain the bulk of its apparent under-prediction. AGWA’s pre-calibration of curve number parameters to the reflect the poor hydrologic conditions of the Walnut Gulch Experimental Watershed in Arizona, somewhat counter-intuitively, make the model more sensitive to land use change in the three study sites investigated here, all else being equal. Recalibrating the curve number parameters to reflect more typical hydrologic conditions did reduce the absolute amount of runoff predicted for each land use scenario; however, the reduction was greater for the future land use scenario, reflecting the very high curve numbers assigned to residential uses in the original calibrated model. In either case, it is clear that pre-calibrating the model impacts not only the absolute runoff predictions, but the relative runoff response predictions as well.

More generally, the resolution of soils data was found to have a varying effect on predicted runoff response. All else being equal, the use of higher-resolution SSURGO soils in place of generalized STATSGO soils, led to a change in the predicted runoff response to land use change in 94% of the model runs over the three study sites. Of those changes, exactly half were increases, while the other half were decreases.

Table 11.8. Sensitivity of Predicted Runoff Response to Variation in Model Components.

A. Baird Creek Watershed / Humboldt and Eaton Townships

UNITS OF ANALYSIS	LAND USE	SOILS	CITYgreen		AGWA		LTHIA ¹		
			Default	Modified	Default	Modified	Default	Mod1	Mod2
Study Area	NLCD	STATSGO	na	na	na	na	na	na	na
Study Area	NLCD	SSURGO	na	na	na	na	na	na	na
Study Area	Local	STATSGO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Study Area	Local	SSURGO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sub-Watersheds	NLCD	STATSGO	3.9%	8.1%	4.2%	2.6%	9.4%	5.8%	3.9%
Sub-Watersheds	NLCD	SSURGO	6.4%	8.3%	2.9%	3.2%	8.3%	4.6%	6.5%
Sub-Watersheds	Local	STATSGO	1.6%	4.8%	4.3%	1.6%	1.5%	2.1%	3.4%
Sub-Watersheds	Local	SSURGO	2.6%	3.1%	2.8%	0.5%	3.6%	1.4%	2.7%
Land Cover/ Soil Units	NLCD	STATSGO	5.4%	13.9%	5.1%	5.9%	13.8%	11.0%	5.4%
Land Cover/ Soil Units	NLCD	SSURGO	5.3%	13.0%	4.8%	5.3%	13.0%	10.0%	5.3%
Land Cover/ Soil Units	Local	STATSGO	3.1%	5.9%	3.4%	2.5%	5.7%	4.8%	3.0%
Land Cover/ Soil Units	Local	SSURGO	3.1%	5.9%	3.1%	2.2%	5.7%	4.5%	3.1%

B. Greenville Farms Neighborhood

UNITS OF ANALYSIS	LAND USE	SOILS	CITYgreen		AGWA		LTHIA ¹		
			Default	Modified	Default	Modified	Default	Mod1	Mod2
Study Area	NLCD	STATSGO	na	na	na	na	na	na	na
Study Area	NLCD	SSURGO	na	na	na	na	na	na	na
Study Area	Local	STATSGO	11.7%	12.8%	12.3%	0.0%	12.5%	11.6%	11.7%
Study Area	Local	SSURGO	11.7%	12.8%	0.0%	11.7%	0.0%	11.6%	11.7%
Sub-Watersheds	NLCD	STATSGO	10.0%	13.3%	4.9%	7.4%	13.3%	10.6%	10.0%
Sub-Watersheds	NLCD	SSURGO	12.0%	17.8%	7.7%	3.2%	13.3%	12.3%	5.3%
Sub-Watersheds	Local	STATSGO	9.2%	16.7%	7.5%	5.8%	15.9%	10.4%	11.2%
Sub-Watersheds	Local	SSURGO	9.5%	17.7%	4.8%	8.9%	21.3%	10.0%	9.2%
Land Cover/ Soil Units	NLCD	STATSGO	23.9%	34.3%	9.7%	16.3%	26.7%	30.5%	18.6%
Land Cover/ Soil Units	NLCD	SSURGO	23.2%	32.9%	9.2%	14.9%	25.6%	28.4%	18.1%
Land Cover/ Soil Units	Local	STATSGO	12.6%	23.3%	8.0%	12.2%	20.6%	18.3%	11.2%
Land Cover/ Soil Units	Local	SSURGO	12.5%	23.0%	7.6%	11.4%	20.3%	17.1%	11.1%

C. Misty Valley Subdivision

UNITS OF ANALYSIS	LAND USE	SOILS	CITYgreen		AGWA		LTHIA ¹		
			Default	Modified	Default	Modified	Default	Mod1	Mod2
Study Area	NLCD	STATSGO	na	na	na	na	na	na	na
Study Area	NLCD	SSURGO	na	na	na	na	na	na	na
Study Area	Local	STATSGO	4.1%	4.2%	4.4%	0.0%	4.2%	4.1%	4.1%
Study Area	Local	SSURGO	4.2%	4.0%	4.5%	0.0%	4.0%	4.1%	4.2%
Sub-Watersheds	NLCD	STATSGO	3.8%	3.9%	2.0%	2.0%	3.8%	3.9%	3.8%
Sub-Watersheds	NLCD	SSURGO	3.7%	3.8%	1.9%	1.9%	3.8%	3.7%	3.7%
Sub-Watersheds	Local	STATSGO	4.1%	2.2%	2.0%	2.1%	2.1%	4.3%	4.0%
Sub-Watersheds	Local	SSURGO	4.0%	4.2%	3.9%	2.0%	2.1%	4.1%	1.8%
Land Cover/ Soil Units	NLCD	STATSGO	6.5%	8.1%	3.3%	4.5%	6.3%	6.9%	5.1%
Land Cover/ Soil Units	NLCD	SSURGO	6.2%	7.7%	3.1%	4.2%	6.0%	6.5%	4.8%
Land Cover/ Soil Units	Local	STATSGO	4.7%	6.2%	3.4%	3.6%	4.4%	5.3%	3.3%
Land Cover/ Soil Units	Local	SSURGO	4.6%	6.0%	3.2%	3.4%	4.3%	5.0%	3.2%

Note: Italicized values represent the combination of model characteristics matching the default versions of the respective tools being compared: CITYgreen, AGWA, LTHIA-WWW, and LTHIA-GIS. Highlighted entries correspond to the “optimized” tool, which effectively is LTHIA-GIS with CITYgreen’s more expansive list of potential land use/soil combinations to which curve numbers can be applied.

¹ In terms of those modeling components tested here, LTHIA-WWW and LTHIA-GIS differ only in their input datasets for current land use and soils. LTHIA-WWW uses NLCD for current land use and STATSGO for soils. The LTHIA-GIS model runs for this study employed locally-mapped land use and SSURGO soils.

Finally, a comparison between CITYgreen and LTHIA, holding all else equal¹⁵, indicates that collapsing the full range of land use / land cover classes into a small set of aggregated classes has a measurable impact on predicted runoff responses. LTHIA's collapsing of the 80+ land use classes published in *TR 55* (SCS 1986) to just eight classes lowers that model's sensitivity to land use change, particularly in the two smaller study sites.

Conclusions

Results of the usability analysis and comparison of the different tools' runoff predictions with stream-gage data indicate that LTHIA-GIS is the best-suited and most appropriate of the tools for the purpose of predicting the impact of proposed or anticipated community land use change on direct stormwater runoff. AGWA and CITYgreen proved less user-friendly and appeared to under-predict the impact of land use change on stormwater runoff, due to their aggregation of curve number parameters to sub-watersheds and entire study areas, respectively. Modifying LTHIA-GIS to reflect the full range of land use/land cover classes published in *TR-55*, as does CITYgreen, appears to optimize the uncalibrated model and was found to predict absolute runoff under current conditions more accurately than any of the existing tools in the gauged study site.

We found that while LTHIA-WWW overcomes many of the usability challenges faced by local planners, its use of NLCD for base land use/land cover appears to result in the over-prediction of runoff responses to land use change. At the same time, its current on-screen digitizing feature does not enable users to map future land use change at a level of detail and precision required for many planning activities. For the purpose of this study, LTHIA-GIS was used as a surrogate for LTHIA-WWW, using all of the latter model's default and bundled datasets to predict runoff as if that tool enabled the same precision in current and future land use mapping. Adding enhanced data exchange capabilities, such as the ability to upload GIS shapefiles with associated projection files to the online platform, or the ability to stream local data in from other online Web-Mapping Services, would help to overcome these issues.

The sensitivity analyses provided additional findings relevant to the ongoing migration of these tools from the desktop to the World-Wide Web:

- All else being equal, disaggregate units of analysis—as used in both versions of LTHIA—are preferable in terms of reducing the likelihood of under-predicting runoff responses to proposed or anticipated land use change. This comports with previous research on the effect of composite versus distributed curve numbers in urbanized watersheds (Grove et al. 1998).
- The use of simplified land use classification/curve number assignment schemes, such as that used in both versions LTHIA, has a measurable impact on predicted runoff responses, and tends to make models less sensitive to land use change. To the extent that it is practicable, incorporating expanded pull-down menus for assigning curve numbers to a wider range of land use/land cover classes, as does CITYgreen, would increase model sensitivity to land use change.
- Pre-calibrating upland curve number parameters to reflect the hydrologic conditions in particular regions or watersheds can significantly affect model predictions of not only absolute runoff, but relative runoff responses to land use change as well. This is significant given that calibration is more often seen as a concern for absolute predictions.

¹⁵ In Table 11.8 the default CITYgreen and modified LTHIA columns each represent water and wetland curve numbers of 100, while the modified CITYgreen and default LTHIA columns represent water and wetland curve numbers of 0. In each case, the only difference between the two models is the number of land use classes available for curve number assignment. CITYgreen allows unique assignments for the full range of land uses published in *TR 55* (SCS 1986), whereas LTHIA allows assignment to only eight aggregated classes.

- Assumptions about wetlands' runoff responses have a significant impact on model predictions. Changing assigned wetland curve numbers from 100 (or otherwise high values) to 0 increases predicted runoff responses to land use change considerably. Assigning wetlands (and water) with CN = 0 effectively limits modeling to upland areas; i.e., only stormwater runoff generated in uplands is considered. Whether or not this is a reasonable simplification is subject to further investigation. However, it is highly unlikely that wetland conversions will result in reduced runoff.
- Results of the sensitivity analyses reinforce previous studies (e.g., Grove et al. 2001) showing that the use of SSURGO versus STATSGO soils has a widespread, if relatively small, impact on modeled runoff and runoff responses. Where available, SSURGO should be the default soils input.

References and Related Reading

We found the following references helpful in developing and carrying out the model comparison research. We list these works, all other references cited, and additional useful sources together in the "Literature Cited, Further Reading, and Background Material" section at the end of this report.

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Outputs: Presentation Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described the model comparison study and the results we found. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

Watermolen, D.J., A. Mednick, and J. Sullivan. 2008. Geospatial Decision Support Systems for Land Planning and Natural Resources Professionals. "Leaping into Enterprise: Building on 20 Years of Land Records Integration," 2008 Annual Conference, Wisconsin Land Information Association. Grand Geneva Resort, Lake Geneva, WI. (February 29, 2008).

Mednick, A.C. 2008. Internet-based Spatial Decision Support Tools: Increasing User Capacity and Lowering Barriers. Wisconsin Land Information Association Regional Meeting. Wausau, WI. (June 7, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Joint Annual Conference of the Association of Collegiate Schools of Planning and Association of European Schools of Planning. Chicago, IL. (July 11, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Midwest SDSS Partnership Annual Meeting. Ralph Metcalfe Federal Building, Chicago, IL (July 24, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Department of Urban and Regional Planning, University of Wisconsin. Madison, WI. (August 7, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Wisconsin Association of Floodplain, Stormwater, and Coastal Managers Annual Conference. Wisconsin Dells, WI. (November 13, 2008).

Outputs: Publications Related to Our Work

Over the course of our grant period, we published results of our work in various outlets. We here list publications that address the aspects of the Wisconsin DNR program that focused on the comparison of runoff models.

Mednick, A.C. (In Review). Predicting the impact of local land use change on stormwater runoff: an evaluation of four GIS-based planning support tools. *Environmental Management*.

12. Soils Data in Water Quality Modeling and Local Decision-making

Many people assume that soils are all more or less alike. The exact composition, form, and structure of soil, however, changes from one location to another. In fact, great differences in soil properties can occur even within short distances (Ashman and Puri 2002, Buol et al. 1997, Soil Survey Staff 1993). Understanding the soil characteristics of a particular site can inform many decisions related to its use and management (Dent and Young 1981). For example, knowing soil properties can help homebuyers or developers determine soil-related hazards or limitations that could affect the development or alterations of future home sites. Farmers can use soils data to estimate the potential crop or forage production of their lands. Sanitary inspectors can use soils data to determine the suitability of areas for onsite sewage disposal systems or land application of municipal sewage sludge. Engineers and planners can determine the suitability and limitations of soils for pipelines, buildings, landfills, recreation areas, and many other uses. Considering the soil properties and limitations of an area can help one avoid unnecessary complications, including extensive structural repairs caused by adverse soil properties at a site. In some cases, special foundations, walls, or other accommodations can be planned if soil hazards indicate that standard engineering designs would likely fail (ASTM 1993). As such, consideration of soils data is a fundamental part of environmental decision making.

Our work to help local officials integrate environmental information and scientific methods into their decision making and to build capacity among various audiences to access and use Internet-based decision-support tools resulted in a number of previously unanswered questions regarding soils data. In 2007, we modified our approved work plan to address some of these questions. Specifically, we assessed the effects of soils data resolution on water quality model outputs and evaluated the online Web Soil Survey tool for its applicability in state regulatory and local land-use decision making. In this chapter, we describe our work with soils data and water quality models. We conclude the chapter with lists of professional presentations and publications related to this work.

Effects of Soil Data Resolution on Water Quality Modeling: A Literature Review

Soil data comprise a basic input for most hydrologic models. A number of authors have noted that models for predicting runoff, sediment, agricultural chemical yields, and stream flow using STATSGO¹⁶ as opposed to SSURGO can produce different simulation results (summarized in Mednick et al. 2008). Understanding the effects of differing soil databases (i.e. differing spatial resolution of the data) on model outputs has implications for the reliability of the models in land planning and storm water regulation. Further, the amount of time and computing resources needed to acquire, process, and use the more complex SSURGO data may be unnecessary. On the other hand, if the models are sensitive to the scale of soils data, it may be worth the extra effort to use the more detailed data. During the course of our grant-funded project, SSURGO data became more readily available via the Internet. As a result, several end-users and interest groups suggested SSURGO should replace STATSGO in existing models, but no comprehensive review had yet been published on the relative effects of the different datasets.

To better understand the effects of soil data spatial resolution on model outputs, we summarized findings from all known studies that have assessed the effects of using STATSGO versus SSURGO as inputs for different water quality-related models (Mednick et al. 2008). We identified 18 studies through extensive literature and Internet searches and discussions with model developers. We focused our efforts on studies

¹⁶ The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) leads the National Cooperative Soil Survey and is responsible for collecting, storing, maintaining, and distributing soil survey information. The NRCS maintains three soil geographic databases representing the kinds of soil maps produced from different intensities and scales of mapping: the Soil Survey Geographic database (SSURGO), State Soil Geographic database (STATSGO), and National Soil Geographic database (NATSGO). Mednick et al (2008) and references cited therein describe the STATSGO and SSURGO databases. The NATSGO database is used primarily for national and multi-state regional analyses and was therefore not considered in our work.

that include an evaluation of the effect of soil database selection on model-predicted runoff, stream flow, or other water quality parameters.

On balance, the 18 studies summarized in our report (Mednick et al. 2008) seemed to confirm the *a priori* assumption that higher resolution soils data are preferable for modeling hydrologic and water quality parameters, at least from an accuracy standpoint. That said, the available findings at the time of our review remained far from unanimous and revealed no clear pattern with respect to response variable, model type, units of analysis, or scale of analysis, as these factors relate to the variation in model predictions using STATSGO versus SSURGO.

Effects of Soil Data Resolution: Modeled Comparisons

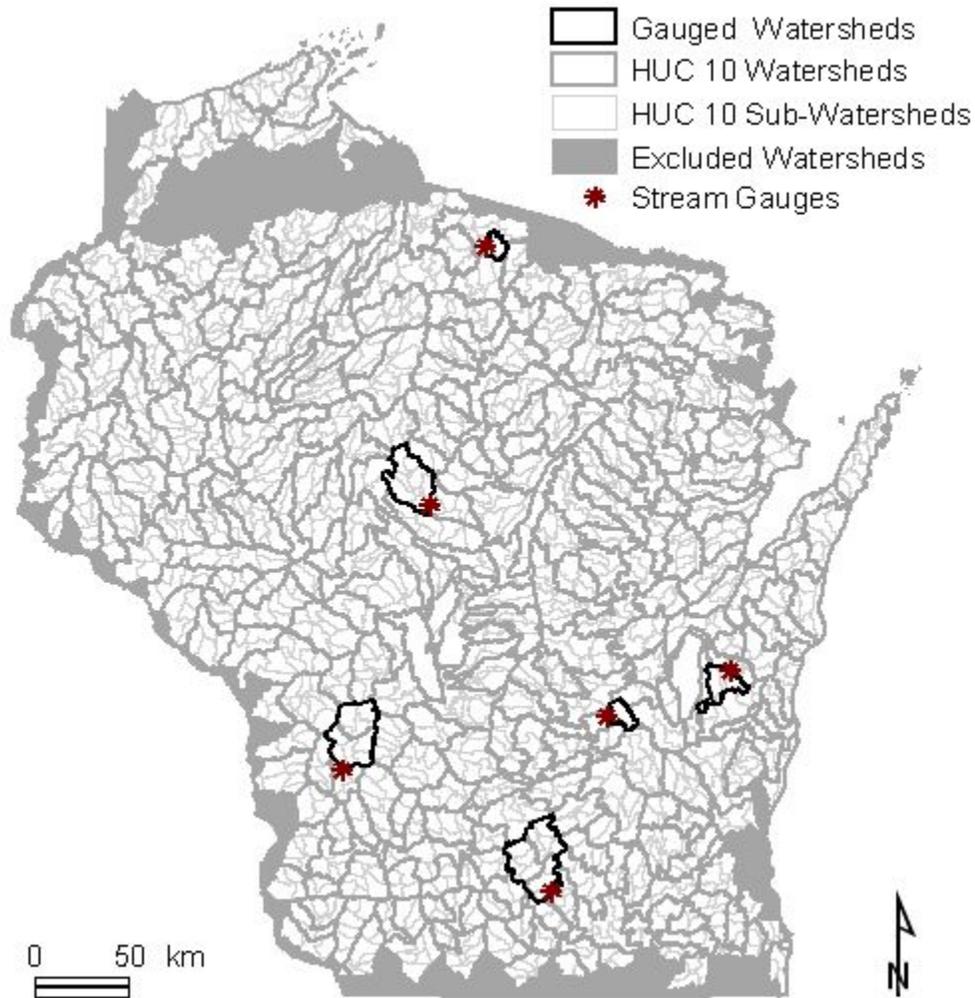
One likely cause for the lack of an explanatory pattern found in our review of the literature is the small sample size within and across the different studies we found. Fourteen of the 18 studies relied on a single watershed or study area. The others ranged from 3 to 11 watersheds. As a result, we felt sensitivity analyses with larger sample sizes were needed, but many models are both data and time-intensive and do not lend themselves to widespread replication. Nonetheless, we evaluated the sensitivity to soil data resolution using the Long-term Hydrological Impact Assessment (LTHIA) tool by modeling direct runoff, using STATSGO and SSURGO soils, alternatively, in nearly 300 contiguous watersheds across Wisconsin.

We wanted to determine whether a systematic bias exists in STATSGO-based runoff predictions, and if so, the extent to which it is affected by the spatial “lumping” of model parameters into successively larger units of analysis: stream catchments, sub-watersheds, and full watersheds. We also wanted to determine whether, and in what direction, any such bias is related to the proportion of a watershed’s surface area covered by land uses that discourage infiltration. Such a relationship has implications for the use of STATSGO-based models within a land use planning context. Detailed descriptions of the study site, data sources, and study methods, along with the results and our conclusions are included in an article submitted to a peer-reviewed journal (Mednick, In Review). Here we extract and summarize the most relevant materials from that manuscript.

Study Area and Methods

The study area (Figure 12.1) includes 298 contiguous 10-digit hydrologic unit code (HUC 10) watersheds, comprised of 1,524 12-digit (HUC 12) sub-watersheds and their 44,821 stream catchments, spanning approximately 125,000 km², or 89% of Wisconsin’s total land area. Six gauged watersheds were additionally selected from within the study area for the purpose of comparing modeled runoff to observed data.

Figure 12.1. Study Area: 298 Contiguous Watersheds in Wisconsin.



In order to test the sensitivity of runoff to alternative soil data inputs, the desktop LTHIA extension for ArcView GIS (Engel 2005) was used to model direct runoff (total runoff minus base-flow) in response to an average two-year, 24-hour rainfall event, applied uniformly across all watersheds in the study area. The underlying modeling framework is a spatially distributed automation of the Soil Conservation Service curve number (CN) method (SCS 1986), coupled with a series of empirically derived event mean concentration coefficients for different NPS pollutants.

Using STATSGO and SSURGO-based curve number grids, respectively, LTHIA was used to model runoff for a uniform 7 cm rainfall event (the average 2-year, 24-hour storm event over two-thirds of the study area) assuming an initial abstraction of 0.2*S and average antecedent soil moisture conditions (AMC II). Raw outputs consisted of predicted runoff depth (in centimeters) per 30-meter grid cell, which were subsequently averaged across each catchment, sub-watershed, and watershed. To test whether the “lumping” of model parameters affects the STATSGO-SSURGO differential in predicted runoff, LTHIA was re-run with curve number values spatially-averaged across stream catchments, sub-watersheds, and watersheds, respectively.

In addition to modeling 24-hour runoff across the full study area, a modified version of LTHIA was used to predict runoff associated with observed daily rainfall within each of the six gauged watersheds, for the months of May through September¹⁷ in the years 1999 through 2003. The midpoint of this period corresponds with NLCD land use data. Daily rainfall data collected from cooperative weather stations within or near each of the gauged watersheds were downloaded from the National Climatic Data Center (NOAA 2008a). Daily runoff was estimated from flow data collected at each U.S. Geologic Survey stream gauge using the local minimum base-flow separation method within the Web-Based Hydrologic Analysis Tool (Lim et al. 2005). Curve number values were adjusted for each time-step to account for variable antecedent soil moisture conditions (AMC I-III), based the preceding 5-days of precipitation (Mishra and Singh 2003).

In order to determine whether or not there is an independent correlation between the percent of a watershed unit covered by intensive land uses (those that discourage infiltration) and the STATSGO-SSURGO differential in predicted runoff, a series of control variables was derived reflecting the extent to which STATSGO misclassifies soil hydrologic group. Statewide grids of STATSGO and SSURGO hydrologic groups were combined into a single grid containing each of the 12 possible misclassifications per cell (Table 12.1). The percent of each misclassification type was then calculated for each sub-watershed. The difference between STATSGO and SSURGO based model predictions for a 7-cm rainfall event was regressed on each of these percentages, as well as the combined percentage of NLCD land uses with the five highest curve number values (i.e. “Developed, High Intensity”; “Developed, Medium Intensity”; “Developed, Low Intensity,” “Barren Lands”; and “Cultivated Crops.”).

Table 12.1. Study Area-wide Misclassification of Hydrologic Group by STATSGO.

Type	STATSGO	SSURGO	Area (km ²)	Percent
'A (D)'	A	D	3,354	2%
'A (C)'	A	C	773	1%
'A (B)'	A	B	4,524	3%
'B (D)'	B	D	12,717	9%
'B (C)'	B	C	8,918	6%
'C (D)'	C	D	6,222	4%
			36,508	26%
'D (A)'	D	A	1,497	1%
'D (B)'	D	B	2,324	2%
'D (C)'	D	C	1,490	1%
'C (A)'	C	A	817	1%
'C (B)'	C	B	4,808	3%
'B (A)'	B	A	5,497	4%
			16,433	12%
'Match'	STATSGO = SSURGO		85,528	62%
			97,237	100%

¹⁷ Daily and monthly predictions were limited to Wisconsin’s growing season, as the simple rainfall runoff models do not account for snowmelt, snow cover, or frozen soil.

In order to avoid the serial correlation of ordinary least-square residuals among neighboring or nearby cases, 200 sub-watersheds were randomly selected from the full sampling domain (N=1,524) by randomly-generating “x,y” coordinates and selecting the sub-watersheds intersecting the resulting points. Separate ordinary least-square regression models were run for this sub-sample alternatively using values resulting from different levels of model aggregation, including: (1) spatially-distributed, (2) partially-distributed (curve numbers averaged over stream catchments), and (3) lumped (curve numbers averaged over sub-watersheds). For each regression model, Pearson’s correlation matrices and variance inflation factors were used to confirm the absence of multi-collinearity between the different explanatory variables.

Results and Discussion

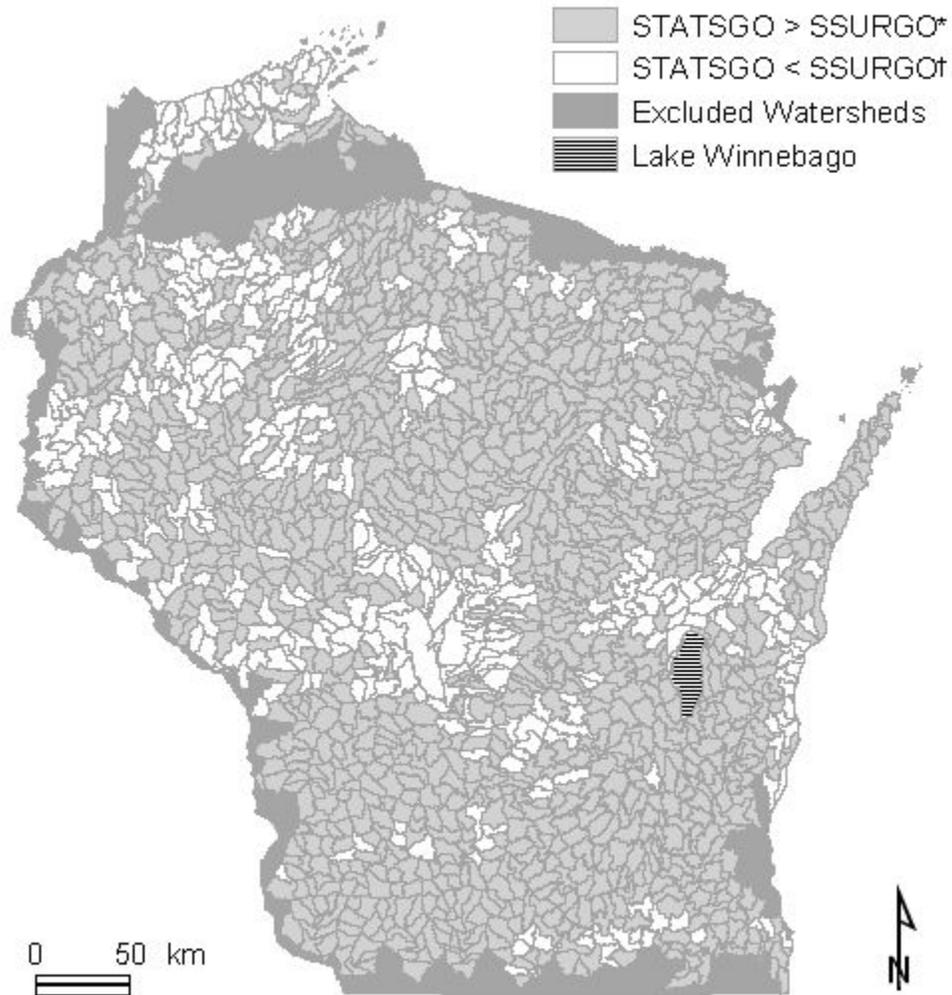
The use of STATSGO underestimated soil hydrologic group over a total of 36,508 km² or 26% of the study area, compared to just 12% where STATSGO overestimated the same variable. These results generally agree with the findings of Juracek and Wolock (2002) in Kansas and Murray (2002) in Colorado, and suggest a systematic bias by which STATSGO-based models will under-predict runoff relative to SSURGO. Subtracting each 30-meter grid cell’s SSURGO-estimated minimum infiltration rate from its corresponding STATSGO-estimated rate outputs a continuous surface of variable under- and over-estimation of soil runoff potential. Averaging these values across watershed units indicates whether STATSGO-based models are likely to bias runoff predictions in one direction or the other, in any given stream catchment, sub-watershed, or watershed in the study area. Positive values indicate units where STATSGO, on average, overestimates infiltration. Across the study area, this outcome occurred in 66% of stream catchments, 75% of sub-watersheds, and 81% of watersheds (Figure 12.2).

The negative bias in STATSGO-estimated soil runoff potential across the study area is reflected in the LTHIA outputs for direct runoff depth. Table 12.2 lists descriptive statistics for the difference between STATSGO and SSURGO-based runoff predictions for a 7 cm rainfall event. These results indicate that the STATSGO-based runoff predictions are lower, on average, than their SSURGO-based counterparts, and that the degree of this under-prediction is highest for spatially disaggregated (distributed-curve number) models. Moreover, the degree of dissimilarity between the STATSGO and SSURGO-based runoff models increases as the watershed unit becomes smaller – from watershed, to sub-watershed, to stream catchment. These results are similar to statistics reported by Juracek and Wolock (2002) on several related soil physical properties.

Table 12.2. *STATSGO-SSURGO Difference in Modeled Runoff for a 7 cm Rainfall Event.*

Difference (cm), STATSGO–SSURGO						
Watershed Unit	Model Type	Mean	Median	Min	Max	Standard Deviation
Catchment (N=44,821)	Distributed CN	-0.23	-0.18	-3.23	3.23	0.60
	Lumped CN	-0.13	-0.10	-3.41	3.26	0.63
Sub-watershed (N=1,524)	Distributed CN	-0.24	-0.22	-1.43	1.22	0.33
	Partially-Distributed	-0.13	-0.12	-1.27	1.51	0.34
	Lumped CN	-0.15	-0.14	-1.44	1.58	0.34
Watershed (N=298)	Distributed CN	-0.23	-0.21	-1.00	0.87	0.26
	Partially-Distributed	-0.13	-0.14	-0.93	1.05	0.26
	Partially-Distributed	-0.15	-0.14	-0.92	1.03	0.27
	Lumped CN	-0.17	-0.15	-0.98	1.01	0.27

Figure 12.2. *STATSGO vs. SSURGO Estimation of Runoff Potential by Sub-watershed.*



Daily outputs from the various STATSGO and SSURGO-based lumped, partially-distributed, and distributed curve number models for the six gauged watersheds (Figure 12.1) were totaled for the months of May through September, 1999-2002, and tested for agreement with estimated monthly runoff from their U.S. Geological Survey stream gauges, using the Nash-Sutcliffe Efficiency (E_{NS}) coefficient (Nash and Sutcliffe 1970). As shown in Table 12.3, three of the six watersheds had positive E_{NS} values for the different models, indicating that their respective runoff predictions were more accurate than the mean of observed values.

Table 12.3. Nash-Sutcliffe Efficiency coefficients (E_{NS}) for the Various Models.

Watershed	Lumped CN		Partially-Distributed CN		Distributed CN	
	STATSGO	SSURGO	STATSGO	SSURGO	STATSGO	SSURGO
1	0.80	0.80	0.80	0.81	0.81	0.84
2	-0.91	-0.84	-0.90	-0.82	-1.36	-0.74
3	-35.87	-35.40	-35.68	-35.26	-35.32	-34.92
4	0.18	0.22	0.19	0.22	0.25	0.30
5	0.37	0.26	0.37	0.24	0.32	0.16
6	-1.05	-0.91	-1.03	-0.89	-0.94	-0.79

It is important to note that these models are not calibrated and that this analysis is principally concerned with the relative efficiency of the STATSGO and SSURGO-based models. In five of the six watersheds, the model with the highest E_{NS} value was the SSURGO-based, distributed CN model. This model produced the highest runoff values for each watershed, whereas the STATSGO-based, lumped CN model produced the lowest values.

The negative bias in STATSGO-based runoff predictions has implications for the application of STATSGO-based models to land use planning processes. All else being equal, the impact of converting land uses from those that encourage infiltration to those characterized by more impervious surfaces, or otherwise lower quality vegetative cover, will vary according to the physical properties of the underlying soils. Altering land use in an area dominated by soils with high infiltration rates will have a greater impact on runoff than will the same change within an area dominated by soils with lower infiltration rates. It should follow, then, that wherever STATSGO over-estimates soil infiltration relative to SSURGO, STATSGO-based models should over-predict the impact of land use conversion.

Table 12.4 reports the partial regression coefficients for the percent coverage of each of the possible STATSGO misclassifications of soil hydrologic group ($\% \text{ MISCLASS}$), as well as the combined percent coverage of land uses that discourage infiltration ($\% \text{ LANDUSE}$), including high-, medium-, and low-intensity urban development, cultivated crops, and barren land. The response variable is the difference between STATSGO and SSURGO-based runoff predictions, in centimeters. For the distributed-CN model, a higher $\% \text{ LANDUSE}$ is associated with slightly higher levels of predicted runoff when using STATSGO in place of SSURGO, controlling for $\% \text{ MISCLASS}$. The coefficient is small (0.001) but statistically significant, indicating that an additional 10% of a sub-watershed's area covered by urban, cropped, and/or barren land will correspond with a 0.01 cm increase in STATSGO-based runoff relative to SSURGO. This finding suggests that STATSGO-based, distributed parameter models will tend to over-predict the impact on direct runoff of increasing urban development or taking agricultural land out of conservation reserve or less intensive uses.

The sign of the coefficient for $\% \text{ LANDUSE}$ changes, however, when the dependent variable is the differential in predicted runoff for the partially-distributed and lumped CN models. In both cases, the coefficient is -0.001, indicating that a 10-point increase in $\% \text{ LANDUSE}$ will correspond with a 0.01 cm decrease in STATSGO-based runoff relative to SSURGO, controlling for $\% \text{ MISCLASS}$. This suggests that STATSGO-based lumped and partially-distributed models will, on average, *under-predict* the effect of varying land use intensity. This is caused by the fact that urban development and cropland tend to avoid areas reported as poorly-drained in SSURGO but well or moderately-well drained in STATSGO. Such areas often represent pockets of land that are less suitable for more intensive land uses than their surroundings, but are too small to be captured by STATSGO.

Table 12.4. *Partial Regression Coefficients (Dependent Variable = RUNOFF DIFF).*

	Distributed	Partially-Distributed	Lumped
Adjusted R Square	0.997	0.962	0.921
Partial Regression Coefficients			
Constant	-0.019	0.064	<u>0.042</u>
% MISCLASS			
A (D)	0.026	0.026	0.018
A (C)	0.016	0.026	0.020
A (B)	0.005	0.014	0.017
B (D)	0.018	0.020	0.023
B (C)	0.011	0.012	0.011
C (D)	0.008	<u>0.004</u>	0.004
D (A)	-0.025	-0.013	-0.016
D (B)	-0.019	-0.017	-0.017
D (C)	-0.007	-0.007	-0.006
C (A)	-0.017	-0.030	-0.035
C (B)	-0.011	-0.012	-0.012
B (A)	-0.006	-0.008	-0.009
% LANDUSE	0.001	-0.001	<u>-0.001</u>

Note: Italicized values represent coefficients that are statistically significant at a confidence level of 95%. Underlined values are statistically significant at a confidence level of 90%.

These results are relevant to land use planning in individual watershed units. Assuming that planned or proposed land use conversions will continue to avoid those areas where STATSGO significantly over-estimates infiltration, the use of STATSGO soils in lumped parameter or partially-distributed models has the potential to significantly under-predict the impact of such changes on direct runoff. Across the study area, 68% of the more intensive land use areas occur in locations where STATSGO and SSURGO are in agreement, while only 8% occur in areas classified as hydrologic group “D” in SSURGO, but “A” or “B” in STATSGO. Many of these misclassified areas follow stream networks, providing additional support for the earlier findings of Juracek and Wolock (2002).

Study Conclusions

This study revealed a systematic, negative bias in STATSGO-based runoff models across the majority of Wisconsin, relative to SSURGO. This bias is the result of the widespread over-estimation by STATSGO of infiltration rates, as reflected in soil hydrologic group ratings, which are a key input in many hydrologic models. This finding is consistent with previous comparative studies conducted in Kansas (Juracek and Wolock 2002) and Colorado (Murray 2002), suggesting that the widespread negative bias in model predicted runoff revealed in this study is likely to occur in other regions as well. Comparisons between modeled runoff and runoff estimated from U.S. Geological Survey stream gauge data further suggest that SSURGO-based, distributed-curve number models are, on average, the most accurate of the various combinations of the alternative soil databases with different levels of model aggregation – with STASGO-based, lumped models typically producing the least accurate outputs.

While these models are uncalibrated and are therefore generally poor predictors of absolute runoff, under current conditions, this fact has limited bearing on their utility for predicting relative changes in runoff associated with alternative land use futures. Results of the regression analyses conducted on a sample of sub-watersheds suggest that STATSGO-based models will, on average, over-predict the impact of land

conversions from lower intensity uses, such as forest and pasture, to higher intensity uses, such as cultivated crops and various levels of urban development. This finding is not unexpected, since the impact of over-estimating infiltration should be less pronounced in areas with higher proportions of impervious surface and/or poor quality vegetative cover. This finding only holds, however, for distributed curve number models. The use of more common, partially-distributed models (as well as fully lumped models) produces the opposite outcome, with STATSGO-based models predicting less, rather than more, runoff in more-intensely developed sub-watersheds, relative to the SSURGO-based models.

The implication of the combined findings of this study is that two of the most common approaches to improving the computational efficiency of hydrologic and NPS pollution models: the use of lower resolution soils data and the lumping of model parameters, combine to reduce the accuracy of modeled runoff under current conditions, while simultaneously under-estimating the impact of land use change. While the use of SSURGO soils in place of STATSGO entails additional time and resources to pre-process, build, and run watershed models, users should take special care to balance this cost against the potential inaccuracies associated with using STATSGO, particularly when used in a land use planning context, where a bias in the predicted impact of proposed land use changes can have long-term consequences.

NRCS' Web Soil Survey and Natural Resources Management Decisions

One of the main tools available to help land users determine the potentials and limitations of soils is a soil survey. Soil surveys describe in detail the properties of soils in the areas surveyed and show the location of each kind of soil on detailed maps (Soil Survey Staff 1993, 2001). NRCS's Web Soil Survey tool (<http://websoilsurvey.nrcs.usda.gov/app/>) provides a single authoritative source for these soil data, including easy access to information on soil limitations for various planting, building construction, and other projects. As scientists looking for ways to make environmental information available to local decision makers, we were interested in examining the usability of Web Soil Survey for better informing various resource management activities. Participation in the Wisconsin Wetlands Association's annual Science Forum and a local dialog regarding trails in a conservancy area provided such opportunities.

Wetland Assessment Case Study: The Wisconsin DNR's "Rapid Assessment Methodology for Evaluating Wetland Functional Values" is a qualitative method developed to provide a standardized process for professionals to evaluate the extent to which a specific wetland performs a given function (Beilfuss and Siebert 1996). The full range of wetland functions and values are covered. Biologists use the presence or absence of specific characteristics to determine the importance of each functional value for a site. The method documents the best professional judgment of the evaluator. In 2007, as part of the Wisconsin Wetlands Association's annual Science Forum, program staff assessed the application of Internet tools for locating wetlands and assessing their functional values.

While the Rapid Assessment Methodology requires one or more field visits, biologists often complete deskwork in preparation for their site visits. Such preparation can include the use of Internet tools such as the NRCS's Web Soil Survey. For example, Part 1 of the Rapid Assessment Methodology focuses on the hydrologic setting of the wetland in question. Web Soil Survey can provide preliminary answers regarding geomorphology, evidence of wetland hydrology, such as organic soils layers, and hydroperiod (seasonal water level pattern), all of which are factors that the Methodology asks about. Part 3 of the Rapid Assessment Methodology addresses soils specifically. Web Soil Survey can be used to answer questions on NRCS Soil Map Classification and supplement the investigator's field descriptions of organic (histosol) content, mottling, gleying, organic streaking, iron or manganese concretions, depth of A Horizon, etc. The various suitability and limitations analyses available in Web Soil Survey can also help inform the investigator's responses to questions about flood and storm water storage/attenuation, water quality protection, shoreline protection, and groundwater recharge/discharge in the "Functional Assessment" section of the Rapid Assessment Methodology. Program staff documented these examples in a PowerPoint presentation and demonstration given to dozens of wetland practitioners at the WWA's Science Forum.

In 2008, program staff integrated findings from this work into a presentation for the Northeast Wisconsin Woodland Owners Conference held in Green Bay. This presentation included a demonstration on how Web Soil Survey could be used to help identify ephemeral pond sites in wooded habitats.

Local Decision-making Case Study: Pheasant Branch Conservancy, a regionally significant natural area, is located on the northwest side of Lake Mendota in central Dane County. Pheasant Branch Creek, a Lake Mendota tributary, which drains about 12% of the total watershed area and supplies about 5% of the total surface water runoff to the lake, meanders through the conservancy. Habitats present in the 500+ acre conservancy include a marsh with open water, natural springs and seeps, prairies, old fields, lowland forests, and wooded hills. These habitats support a wide variety of plants and animals, including rare, threatened, and endangered species. The Dane County Parks Department owns the northern portion of the conservancy, while the city of Middleton's Public Lands Department owns the southern portion. The city and county cooperatively manage the conservancy as a single ecological and recreational unit.

Although surrounded on three sides by urban development, this easily accessible area provides a quiet refuge for bird-watchers, hikers, and other nature enthusiasts. In mid-2008, conservancy visitors, property managers, and local elected officials began publically discussing the potential benefits and detriments of converting current woodchip and gravel (crushed limestone) hiking, biking, and multi-use trails within Pheasant Branch Conservancy to blacktop or paved trails. The City of Middleton's proposed *2009 Bicycle and Pedestrian Plan* called for paving two segments of trail within Pheasant Branch Conservancy's boundaries. The nonprofit Friends of Pheasant Branch felt an analysis of soil suitability and limitations could inform this discussion and requested our help in providing information.

In response, we used Web Soil Survey to generate an objective analysis of soil suitability and limitations for recreational developments within the Pheasant Branch Conservancy. The verbatim results of our analyses and the conclusions we drew from reviewing the soils data were presented in a report published by Friends of Pheasant Branch in September 2008 (Watermolen et al. 2008).

More than half of the soils in the Pheasant Branch Conservancy are under water, near saturation, or frozen during much of the year, making them unsuitable for most recreational uses/developments. The other primary soil types present in the area are high in silt content resulting in significant challenges for developing paths and trails, playgrounds, picnic areas, and roads due to their lack of cohesion when either wet or dry. The suitability analyses generated by Web Soil Survey show that 73.5% of soils in the area are somewhat or very limited in their suitability for paths and trails, 76.4% are somewhat or very limited in their suitability for picnic areas, 83.6% are somewhat or very limited in their suitability for playgrounds, 78.4% are poorly suited for roads with natural surfaces (the remaining 21.6% are only moderately suited), and 91.6% are very limited in their suitability for paved roads and streets. These findings underscore the logic of maintaining Pheasant Branch Conservancy in a primarily undeveloped state, especially for the flood prevention and control functions the predominant soil types provide.

The Friends of Pheasant Branch posted our report on its Web site (<http://www.pheasantbranch.org/>; Figure 12.3) and shared it with conservancy visitors, property managers, and local elected officials. A brief article announcing the availability of the report appeared in the organization's newsletter (Figure 12.4). In a separate article in the same newsletter (Riley 2009), one of the Friends of Pheasant Branch board members described the city's proposed *2009 Bicycle and Pedestrian Plan* and summarized the relevance of our Web Soil Survey findings to the local discussion.

Unfortunately, our grant period ended prior to a decision by local officials and we were unable to determine if the use of Web Soil Survey had effectively informed or influenced decision-makers (i.e. resulted in any third order outcomes). Nonetheless, we found that Web Soil Survey provides a user-friendly, intuitive means of accessing and evaluating soil survey information for local resource management applications. The tool is accessible easily via a standard Internet browser and is able to produce a wide variety of reports that can inform various land use and management decisions. Information from the detailed soil surveys can be presented and organized in a variety of ways.

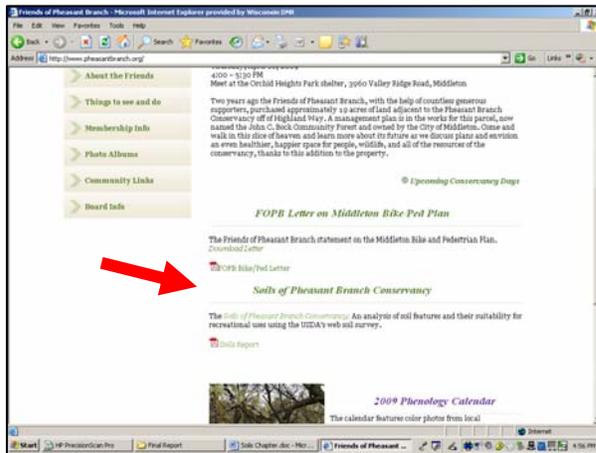


Figure 12.4. The Friends of Pheasant Branch printed a brief announcement in the organization's newsletter letting members and others know about our analysis of soil suitability and limitations.

Figure 12.3. The Friends of Pheasant Branch posted our analysis of soil suitability and limitations on the organization's Web site.

New Soils Study is Available

A new study, "Soils of Pheasant Branch Conservancy", is available from the Friends web site at www.pheasantbranch.org/pdf/PBCSoilsFinalReport.pdf. The study was sponsored by the Friends and prepared by three local scientists using the United States Department of Agriculture's Web Soil Survey information. The study analyzes the suitability of conservancy soils for various recreational uses such as picnic areas, paths, trails, and roads.

Maps in the report identify the types of soils present and limitations for recreational development. More than half the soils in the conservancy are under water or near saturation during much of the year and are somewhat or very limited for most recreational uses. The soil study findings confirm the logic of maintaining the conservancy area in a primarily undeveloped state.

References and Related Reading

We found the following references helpful in developing and carrying out the soils data resolution and related research. We list these works, all other references cited, and additional useful sources together in the "Literature Cited, Further Reading, and Background Material" section at the end of this report.

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Available online at <http://www.pheasantbranch.org/pdf/PBCSoilsFinalReport.pdf>.

Outputs: Professional Presentations Related to Our Work

Over the course of our grant period, we made numerous professional meeting presentations that described the Web Soil Survey and related Internet-based soils data tools, our assessment and evaluation of these tools, and our approach to using these tools in planning and decision-making processes. We here list presentations that specifically addressed these aspects of the Wisconsin DNR program.

Watermolen, D.J. 2007. Internet Tools for Locating Wetlands and Assessing Functional Values. "Riverine Wetlands: Connections, Corridors, and Catchments," Wisconsin Wetlands Association 12th Annual Wetland Science Forum. La Crosse, WI. (February 1-2, 2007).

Watermolen, D.J. 2008. There's a Tiger in Your Woods! Keeping Wooded Wetlands Wildlife Friendly. Northeast Wisconsin Woodland Owners Conference. Northeast Wisconsin Technical College, Green Bay, WI. (January 12, 2008).

Watermolen, D.J., A. Mednick, and J. Sullivan. 2008. Geospatial Decision Support Systems for Land Planning and Natural Resources Professionals. "Leaping into Enterprise: Building on 20 Years of Land Records Integration," 2008 Annual Conference, Wisconsin Land Information Association. Grand Geneva Resort, Lake Geneva, WI. (February 29, 2008).

Mednick, A.C. 2008. Internet-based Spatial Decision Support Tools: Increasing User Capacity and Lowering Barriers. Wisconsin Land Information Association Regional Meeting. Wausau, WI. (June 7, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Joint Annual Conference of the Association of Collegiate Schools of Planning and Association of European Schools of Planning. Chicago, IL. (July 11, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Midwest SDSS Partnership Annual Meeting. Ralph Metcalfe Federal Building, Chicago, IL (July 24, 2008).

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Department of Urban and Regional Planning, University of Wisconsin. Madison, WI. (August 7, 2008).

Watermolen, D.J. and J.G. Sullivan. 2008. Interoperable Spatial Decision Support Tools: Wisconsin's Approach. U.S. EPA's joint GIS Users Group and Statistics Work Group fall meeting. Ralph Metcalfe Federal Building, Chicago, IL. (September 16, 2008).

Mednick, A.C. 2008. Does Soil Data Resolution Matter? STATSGO versus SSURGO in Stormwater Runoff Modeling. Science Seminar, Wisconsin Department of Natural Resources. GEF-2 State Office Building, Madison, WI. (October 23, 2008).

Watermolen, D.J. 2008. Soils of Pheasant Branch Conservancy. Board Meeting, Friends of Pheasant Branch Conservancy, Wood Creek Neighborhood, Middleton, WI.

Mednick, A.C. 2008. Predicting the Impact of Land Use Change on Stormwater Runoff: An Evaluation of GIS- and Web-Based Planning Support Tools. Wisconsin Association of Floodplain, Stormwater, and Coastal Managers Annual Conference. Wisconsin Dells, WI. (November 13, 2008).

Mednick, A.C. 2009. - *Forthcoming*: Does Soil Data Resolution Matter? STATSGO versus SSURGO in Rainfall-Runoff Modeling [Poster Presentation]. Science Services Bureau Statewide Meeting and Training Session, Wisconsin Department of Natural Resources. Stoney Creek Inn and Conference Center, Wausau, WI. (February 11, 2009).

Mednick, A.C. 2009. - *Forthcoming*: Does Soil Data Resolution Matter? STATSGO versus SSURGO in Rainfall-Runoff Modeling [Poster Presentation]. Wisconsin Chapter of the American Planning Association/American Society of Landscape Architects, 2009 Spring Conference. Blue Harbor Resort, Sheboygan, WI. (March 26-27, 2009).

Outputs: Publications Related to Our Work

Over the course of our grant period, we published results of our work in various outlets. Others also covered our work. We here list publications that address the aspects of the Wisconsin DNR program that focused on the use of soils data.

Mednick, A.C., J. Sullivan, and D.J. Watermolen. 2008. Comparing the use of STATSGO and SSURGO soils data in water quality modeling: a literature review. Wisconsin Dept. Natural Resources *Research/Management Findings* (60):1-6.
Available online at http://dnr.wi.gov/org/es/science/publications/PUB_SS_760_2008.pdf.

Watermolen, D.J., S.J. Kefer, and A.C. Mednick. 2008. *Soils of Pheasant Branch Conservancy: An Analysis of Soil Features and Their Suitability for Recreational Uses Using the USDA's Web Soil Survey*. Friends of Pheasant Branch Conservancy, Middleton, WI.
Available online at <http://www.pheasantbranch.org/pdf/PBCSoilsFinalReport.pdf>.

Anonymous. 2009. New soils study available. *SPRINGS: Friends of Pheasant Branch Conservancy Newsletter* (Spring):2.

Riley, J. 2009. Paving Conservancy trails? A new transportation plan for the city recommends it. *SPRINGS: Friends of Pheasant Branch Conservancy Newsletter* (Spring):3-4.

Mednick, A.C. (In Review). Does soil data resolution matter? STATSGO versus SSURGO in rainfall runoff modeling across Wisconsin. *Journal of Soil and Water Conservation*.

General Project Administration

13. Project Administration

This chapter provides an overview of project administration, including information on the Federal Assistance Agreement, grant period and extensions, project staffing, key collaborators, and communications with U.S. EPA.

Grant Period and Extensions

U.S. EPA Federal Assistance Agreement (No. C6-96539401-0) was initially awarded for the period June 15, 2004 through September 30, 2005 in the amount of \$100,000. The project was awarded additional funding (\$120,000) and extended through September 30, 2007 in the fall of 2005. The agreement reflected a commitment for an additional \$20,000 to support potential work with the Maryland Coastal Bays Program. Although specific work tasks were undefined, it was anticipated we would be responsive to that program’s needs/interests. A no cost extension was granted in 2007 to extend the project period until September 30, 2008, primarily due to staff transitions. The project work plan was modified in 2007 to refocus efforts from the Maryland Coastal Bays Program towards model evaluation and related soils data research. In August 2008, the agreement was amended a final time to reflect the actual funding provided by U.S. EPA (the additional funding for work with the Maryland Coastal Bays Program was unavailable).

Project Staffing

Dreux Watermolen, Wisconsin DNR’s Chief of Science Information Services, served as the project manager for the entire project period and was responsible for day-to-day oversight of the Wisconsin DNR program. He served as the primary developer of the conceptual framework and author of the initial audience assessment documents.

The Federal Assistance Agreement provided funding for several limited-term employees during the grant period (Table 13.1).

Table 13.1. *Wisconsin DNR Limited-term Employees with Project Responsibilities.*

Employee	Time Period	Major Role(s) in Project
Matthew Murrell	June 2004 – July 2004	Conceptual design of program, Internet tools evaluation workshops
Dana Lucero	June 2004 – December 2006	Conceptual design of program, Internet tools evaluation workshops, target audience assessment, technical assistance and training
R. Chris Welch	October 2004 – September 2005	Outreach, technical assistance, and training; follow-up evaluation
Dan Bellrichard	January 2006 – December 2006	Outreach, technical assistance, and training; follow-up evaluation
Adam Mednick	April 2007 – September 2008	Outreach, technical assistance, and training; model comparison research; soils data resolution research

Several permanent Wisconsin DNR staff members contributed to program implementation. Science communications manager Martin P.A. Griffin assisted us with development and maintenance of the Internet Tools Web site. Environmental education researcher Susan Gilchrist conducted numerous post-workshop interviews with Extension educators and Wisconsin DNR staff and summarized her findings in internal reports. Social science researchers Ed Nelson and Jordan Petchenik assisted us in developing interview scripts for the post-workshop interviews and in designing the post-Webconference e-mail surveys. Members of Wisconsin DNR's regional land use teams assisted with logistics for the hands-on training workshops and helped recruit participants

Key Collaborators

We worked with several collaborators from the University of Wisconsin and UW-Extension. Elaine Andrews (Acting Director, Environmental Resources Center), Suzanne Wade (Rock River Basin Educator), Dr. Steve Ventura (Director, Land Information and Computer Graphics Facility) advised us throughout the project. Their input helped shape our approach to evaluating decision-support tools, provided guidance for our technology transfer work, and supported implementation and evaluation of our training efforts.

The Wisconsin DNR program collaborated with the University of Wisconsin-Stevens Point's Center for Land Use Education (Dr. Anna Haines, Director) to conduct the Web-based survey of Extension educators. The Center (Doug Miskowiak, now with the UWSP Department of Geography and Geology) and the UW-Madison Land Information and Computer Graphics Facility (Tom McClintock, Training Manager) provided support for our workshops for Extension educators and Wisconsin DNR staff. UW-Extension's Local Government Center sponsored the WisLine teleconference.

Throughout the course of our efforts, we partnered with numerous organizations to provide outreach, training and technical assistance. These included the Wisconsin Towns Association, Wisconsin Counties Association, Wisconsin Real Property Listers Association, Wisconsin County Code Administrators, Wisconsin Chapter of the American Planning Association, River Alliance of Wisconsin, Friends of Wisconsin State Parks, Fox-Wolf Watershed Alliance, Rock River Coalition, UW-Sea Grant, Bay-Lake Regional Planning Commission, and East Central Wisconsin Regional Planning Commission. Our partnerships and collaborative efforts with these organizations are described in the chapters describing our work with the various target audiences (Chapters 6-10).

Members of the Midwest Spatial Decision Support Systems Partnership worked with us to make tools available, provide direct feedback to tool developers, and conduct research on specific water quality modeling tools.

Recognition of all of this collaboration and support is provided in the acknowledgments sections of our various publications and presentations, as well as in Chapter 19 of this report.

Quarterly Reports and Briefings with U.S. EPA

We provided U.S. EPA Region 5 with written quarterly progress reports for each quarter of the grant period. These reports highlighted work completed during the previous quarter, documented project deliverables, outlined future plans, and served as a basis for coordinating efforts. We also shared these reports with key staff in U.S. EPA's Office of Water.

We participated in face-to-face status briefings at the beginning of nearly every quarter (a few status briefings were scheduled to coincide with Midwest Spatial Decision Support Systems Partnership or similar meetings, and a couple were done by telephone to better accommodate schedules). These meetings provided U.S. EPA project contacts an opportunity to react to written reports and project deliverables, to ask questions and seek additional information, and to provide guidance and direction for future work

efforts. The meetings also provided opportunities for Wisconsin DNR program staff to meet with U.S. EPA staff and managers, in addition to the project contacts, to share progress and lessons learned.

Communication with U.S. EPA Office of Research and Development

The project manager joined Region 5 staff for a meeting in mid-December 2004 with staff from the U.S. EPA's Office of Research and Development at the National Exposure Research Laboratory in Las Vegas, NV. At this meeting, he made a presentation about the Wisconsin DNR program and its transferability to other places within the Great Lakes basin. This meeting helped lay the groundwork for the Office of Research and Development's participation in the Midwest Spatial Decision Support Systems Partnership.

U.S. EPA's Office of Research and Development sponsored a meeting in Chicago in conjunction with the Midwest Spatial Decision Support Systems Partnership in May 2007. This meeting focused on ORD's Ecological Research Program, a proposed bio-fuels ("Future Midwestern Landscapes") study, and ORD's new strategic focus on ecosystem services. Program staff participated in this meeting and contributed to the discussion on the merits and value of the proposed research effort.

Program staff also participated in a November 2007 meeting at U.S. EPA Region 5 headquarters to discuss the use of U.S. EPA's Regional Vulnerability Assessment (ReVA) tool in local and state planning and to review the draft Midwest Environmental Decision Toolkit (EDT) being developed by the ReVA team. During that meeting, the ReVA project manager requested Wisconsin DNR's review of ReVA and the EDT. Program staff agreed to introduce other Wisconsin DNR staff and local stakeholders to the ReVA and EDT tools and provide feedback to the ReVA team early in 2008. Following the meeting, we introduced Wisconsin DNR staff to ReVA and the draft EDT. The staff group had a good overview discussion and developed a plan for getting the ReVA team and contractors meaningful feedback within the specified timeframe. We communicated that plan to the ReVA program manager in early December, with a commitment to provide a consolidated response by the end of January. The ReVA program manager indicated that the contractors would be working on the EDT in the coming weeks and suggested that Wisconsin DNR wait until around mid-January before actually conducting a review.

Program staff members spent considerable time reviewing the ReVA and EDT tools during January and February. We submitted comments to the project director in March 2008. Our comments were offered from the perspective of collaborators looking to make investments in ReVA and the EDT meaningful to a broader range of users (i.e. the state and local people we regularly work with). Although the use cases included in the draft EDT design document suggest this was the direction the ReVA team was pursuing, the program manager's response to our review and comments suggested this apparently was not the ReVA team's interest/intent. We therefore discontinued our involvement in this particular effort.

14. Transfer of Program Experience

The U.S. EPA funded the Wisconsin DNR program with the understanding that the program potentially could serve as a model for what other state environmental agencies might do to more fully integrate Internet tools and technology transfer into their program implementation, particularly as they might inform smart growth approaches. Throughout the grant period, representatives from agencies in other states contacted us to learn about Wisconsin's comprehensive planning law and our approach to supporting local decision making with Internet tools. We also consulted with national non-profit organizations and participated in numerous national and regional conferences to share our approach and lessons learned. In this chapter, we describe these various consultations and related work undertaken during the grant period. Appendix A and Appendix B provide complete lists of conference and workshop presentations.

Participation in U.S. EPA-sponsored Conferences

U.S. EPA annually sponsors a number of national conferences and regional workshops as a means of transferring science knowledge, technology, and agency policy to tribal, state, and local environmental agencies, environmental planners and consultants, and other practitioners. Throughout the grant period, we participated in a number of these U.S. EPA events, often at the request of U.S. EPA staff.

Public Sector Approaches to Promoting Sustainable Development: In response to a request from U.S. EPA Region 5 staff, Dreux Watermolen spoke about "Outreach to Local Decision-Makers: A Wisconsin Case Study" at this Region 5 symposium in Chicago, Illinois. This presentation occurred as part of the "Promoting Sustainable Development through Comprehensive Planning" session. Mr. Watermolen also moderated a session on "Models/Tools to Support Sustainable Development."

New Partners for Smart Growth: In January 2005, Dreux Watermolen presented "Computer Tools to Link Smart Growth with Clean Water" as part of "Water, Water Everywhere: Protecting Water Resources with Smart Growth," a pre-conference workshop held in conjunction with the New Partners for Smart Growth national conference in Miami, FL.

EPA Region 5 State Directors Meeting: In May 2005, Dana Lucero and Dreux Watermolen participated in this Region 5 meeting, which focused on use of non-point programs and other non-regulatory approaches and information tools to protect and restore watersheds. This discussion with senior state water program managers focused on the Wisconsin DNR program and its transferability to other places within the Great Lakes basin and nationally.

2005 Science Forum: Collaborative Science for Environmental Solutions: Dreux Watermolen accompanied Region 5's Rich Zdanowicz to represent the Midwest Spatial Decision Support Systems Partnership at this national U.S. EPA meeting in Washington, DC in May 2005. Mr. Zdanowicz and Mr. Watermolen co-presented a talk, "Web-Based Decision Tools for Watershed Management," as part of a session focused on Spatial Analysis Tools and Applications. Mr. Watermolen also participated in a number of meetings and presentations with U.S. EPA Headquarters staff as part of this visit, including a briefing with representatives of the U.S. EPA Administrator's Office.

2006 Community Involvement Conference: Dana Lucero and Dreux Watermolen participated in U.S. EPA's Community Involvement Conference held June 2006 in Milwaukee. They presented a 90-minute session entitled, "Internet Tools to Help Citizens Find Data, Make Maps, and Predict Impacts." Approximately 55 people participated in the session. The session introduced a range of Internet tools that enable effective community participation. The session included a brief discussion of community applications for the tools in the Midwest and nationwide.

North American Land Cover Summit: At the request of the U.S. EPA and U.S. Geological Survey, Dreux Watermolen participated in a North American Land Cover Summit sponsored by the National Academy of Science, American Association of Geographers, and several federal agencies in Washington, DC in September 2006. He made a presentation as part of the “Alternative Futures Analysis” session. The conference proceedings, published in 2008, included a lengthy paper by Watermolen based on the presentation.

2006 Environmental Information Symposium: Dreux Watermolen participated in U.S. EPA’s 2006 Environmental Information Symposium in Savannah, GA in early December 2006. He presented, along with other members of the Midwest Spatial Decision Support Systems Partnership, as part of a plenary panel titled “Bridging the Gaps in Government Information Sharing.” Specifically, he talked about “Providing On-line Data and Decision Support Tools to Local Planners.” The presentation included lessons learned from Wisconsin’s evaluation of tools, capacity building approaches, and technical assistance practices.

2007 Exchange Network National Meeting: U.S. EPA and Environmental Council of States (ECOS) held a National Environmental Information Exchange Network meeting in New Orleans, LA in late April 2007. As part of a plenary session on using published data, Dreux Watermolen presented a talk titled “Providing On-Line Data and Decision Support Tools to Local Planners.” This presentation included many of the lessons learned during the early phases of the Wisconsin DNR program.

Consultation with Other States and Agencies

Throughout the grant period, representatives from agencies in other states contacted us to learn about Wisconsin’s comprehensive planning law and our approach to supporting local decision making with Internet tools. Below we enumerate a number of these contacts as well as how we responded.

Northwest Indiana Regional Planning Commission: In May 2004, Northwest Indiana Regional Planning Commission and Purdue University Calumet School of Science, Mathematics, and Engineering hosted a “GIS Tools and Community Watershed Planning Workshop” for local officials in Hammond, IN. Dreux Watermolen presented “Supporting Local Decision Making: An Overview of Wisconsin’s Efforts” for this audience.

Ohio Balanced Growth Initiative: In March 2005, Dreux Watermolen and other members of the Midwest Spatial Decision Support Systems Partnership participated in an information sharing conference call with representatives from the Ohio Balanced Growth Initiative and Lake Erie Commission. Wisconsin DNR shared its “Conceptual Framework and Learning Outcomes” and “Target Audience Assessment” documents with the Ohio contacts and described how the technology transfer work fit within the context of Wisconsin’s comprehensive planning law. We also shared the *Computer Tools for Finding the Information You Need* and the *Computer Tools for Making Maps* fact sheets.

Connections with NRCS: In January 2005, Dreux Watermolen participated in a discussion with officials from the Natural Resources Conservation Service, U.S. Fish and Wildlife Service, U.S. EPA Region 5, and National Fish and Wildlife Foundation regarding Conservation Security Program implementation and how Internet tools can be applied in that program.

Following the international Land Use and Healthy Watersheds conference in September 2006, NRCS staff expressed an interest in learning more about various Internet tools and their potential application to watershed assessment and planning work that the agency engages in. In October and November 2006, program staff met with the cartographer from the NRCS’s Madison office. We introduced the Digital Watershed and LTHIA tools and discussed ways these tools could be integrated into NRCS assessment and planning efforts.

Northeastern Illinois Regional Planning Commission: The Northeastern Illinois Regional Planning Commission (now called Chicago Metropolitan Agency for Planning, CMAP) is the official planning agency for the six-county Chicago metropolitan area. During the 2006 annual meeting of the Midwest Spatial Decision Support Systems Partnership, Dana Lucero met with Kerry Leigh, the Director of Environment and Natural Resources for NIRPC. NIRPC expressed interest in initiating a program akin to the Wisconsin DNR program. NIRPC hoped to use Wisconsin DNR's approach, tool inventory, and outreach model as a foundation for its program. A follow-up information-sharing meeting was held in July.

Environmental Council of States: The Environmental Council of States (ECOS) is the national non-profit, non-partisan association of state and territorial environmental agency leaders. ECOS seeks to improve the capability of state environmental agencies and their leaders to protect and improve human health and the environment of the United States. ECOS publishes its quarterly newsletter, *ECOSStates*, to share emerging and significant issues facing environmental agencies and is read widely by a national audience. In June 2006, *ECOSStates* published an article by Dana Lucero entitled, "Internet Tools Bring Science to Local Decisions in Wisconsin." The article provided an overview of the purpose and scope of the Wisconsin DNR program, as well as initial results gathered in the evaluation stage of the program. Readers were directed to the Web sites of the Wisconsin DNR program and the Midwest Spatial Decision Support System Partnership.

California Department of Toxic Substances Control: As a result of his presentation at the 2007 National Environmental Information Exchange Network meeting (see above), California's Department of Toxic Substances Control contacted Dreux Watermolen to learn more about the suite of tools being used in the Wisconsin DNR program. We shared information about the Midwest Spatial Decision Support Systems Partnership, a selection of decision-support tools, and lessons learned from our technology transfer and evaluation efforts.

Illinois Data Exchange Affiliates: In March 2007, Dreux Watermolen joined U.S. EPA Region 5's Steve Goranson for a presentation on "Bridging the Gaps in Environmental Information Sharing" as part of Illinois Data Exchange Affiliates and Chicago Metropolitan Agency for Planning's "Government Data Sharing in the Information Age" session held in Chicago.

Discussions with North Carolina DEQ: In early October 2007, a representative of the North Carolina DEQ contacted Wisconsin DNR about the possibility of partnering to initiate and implement a state-local government data exchange through the National Environmental Information Exchange Network. DEQ representatives contacted Dreux Watermolen as a follow-up to his "Providing On-line Data and Decision Support Tools to Local Planners" presentation at the Exchange Network National Meeting that took place in April 2007.

In North Carolina, as in Wisconsin, each county is responsible for managing its own property mapping system, each with its own database schema and ways of doing things. Arriving at a consensus on a plan for counties to switch to a common schema has proven difficult. Staff in the North Carolina DEC have been trying to build critical mass in that state to create a new spatial (Web feature service) cadastral/land use data exchange. Such an effort would enable state and local government agencies in NC to use the Exchange Network to easily and securely exchange parcel and land use data. Wisconsin DNR is participating in similar discussion with the Wisconsin Land Information Association's parcel data task force. Wisconsin DNR and North Carolina DEQ have continued discussions to further pursue this idea.

Great Lakes Commission RDX Meetings: There has been limited emphasis on information standardization across international, state, provincial, and county boundaries in the Great Lakes region, and few data exchange programs between Great Lakes states, provinces, and federal agencies exist. The Great Lakes Commission seeks to enhance data exchange among Great Lakes entities through periodic Regional Data Exchange (RDX) conferences and workshops. Program staff participated in several RDX meetings during the course of the grant period. In May 2008,

Jerry Sullivan made a presentation on “NSGIC RAMONA: GIS Inventory and Directory” as part of the “Coastal Zone Data Management for the Great Lakes” RDX workshop held in Chicago, IL.

Consultation with Nonprofit Organizations

Throughout the grant period, we became aware of technology transfer efforts underway by several non-profit organizations. At the request of U.S. EPA, we tried to coordinate our efforts.

Institute for the Application of Geospatial Technologies: In late October 2004, Dreux Watermolen participated in the “Northeastern Local, Regional and State RS/GIT Outreach Workshop” sponsored by the National Association of Counties, the Institute for the Application of Geospatial Technologies, and several federal agencies in Skaneateles Falls, NY. Municipal, county, regional, and state officials from fourteen northeastern states convened for the 3-day workshop focused on outreach strategies for remote sensing and related geospatial information technologies. The intent was to identify ways of improving and maximizing the outcomes of outreach strategies and programs. Mr. Watermolen profiled Wisconsin DNR’s work in a session related to “Remote Sensing/GIT Outreach Strategies and Programs.” The workshop findings (Warnecke, et al. 2005) provide a foundation for developing and implementing action plans that advocate improved GIT outreach and intergovernmental collaboration.

National Association of Counties (NACo): NACo partnered with U.S. EPA to study how county officials are using GIS-based tools to assist them in examining the link between land use and water quality. NACo conducted a series of educational workshops, developed case studies, created an informational Web site, and drafted a final report with study findings. At the 2006 NACo Annual Conference, their GIS team conducted a “GIS Playground” to bring together county elected and appointed officials with tool developers and practitioners in an informal setting to showcase how GIS-based tools and models have successfully provided insight into issues related to water resource management, public works infrastructure, transportation, and many other topics. NACo updated its publication *Using GIS Tools to Link Land Use Decisions to Water Resource Protection*. The guide (NACo 2006) provides practical case studies, a list of commonly available tools and a newly created tools assessment section. Wisconsin DNR provided NACo with examples of county-based GIS efforts that could be used as national models/case studies (e.g., Kenosha and Waupaca counties).

International City-County Management Association (ICMA): ICMA has been a member of the Midwest Spatial Decision Support Systems Partnership for several years. Throughout the grant period, we interacted with ICMA staff through various partnership meetings and conference calls. We shared materials developed by the Wisconsin DNR program with ICMA. In February 2006, Dreux Watermolen accompanied U.S. EPA Region 5 staff for a series of meetings in Washington, DC. The group met with Mosi Kitswana, Director of Research and Development for ICMA to discuss potential future partnership efforts. As a follow-up to the meeting, Dreux Watermolen provided comments on a draft grant proposal.

Participation in National and Regional Conferences

Wisconsin DNR committed to demonstrating the transferability of the Wisconsin DNR program to other areas. One measure of transferability is the interest shown in our program from other state or national organizations when Wisconsin DNR proposals to present at conferences are accepted. Throughout the grant period, program staff made more than 30 presentations in 12 states (see Appendix A and Appendix B for a complete listing). Here, we highlight several of the significant national and regional events where we described our tool assessment, technology transfer, and evaluation work (i.e. we transferred lessons learned by the Wisconsin DNR program).

Water Environment Federation's Watershed 2004: Dana Lucero presented a paper titled "A State-Federal Partnership to Understand the Usefulness of Decision Support Tools for Natural Resources Management" at the Water Environment Federation's *Watershed 2004* meeting in Dearborn, MI. The paper reviewed the evolution of decision support and planning systems based on increasingly complex technological advances, specifically of data provision and modeling. It overviewed the role of Wisconsin DNR and its partner organizations, including U.S. EPA, in initiating the evaluation of 10 decision support tools by potential users and reviewed in detail the process of evaluation, the actors involved, and results gathered. Finally, the paper included a description of the partners' technology transfer plans for Wisconsin, as well as a means of reviewing the efficacy of the program for national application. The paper was included in the conference proceedings, and copies were distributed electronically to the Midwest Spatial Decision Support Systems Partnership and key U.S. EPA staff in Chicago and Washington, DC.

Regional and National Planning Conferences: Participation in regional and national planning conferences resulted from our audience assessment work. In the Web survey of planners, we found 90% of respondents were members of the American Planning Association (APA) and 90% were members of the APA state chapter (WAPA). In addition, 50% of respondents were members of the American Institute of Certified Planners (AICP). These results suggested that most Wisconsin planners belong to their professional association and that a large percentage of this audience is committed to professional development. Survey results further suggested that participation in planning conferences might be an effective means of reaching this target audience. We also surmised that the national association might be an appropriate partner to work with to expand the reach of Wisconsin's model to other states.

Dana Lucero presented at a session of the 2004 "Planning in the Crossroads: Making Great Communities Happen in the Heartland" Midwest Planning Conference held in Indianapolis. In a session titled "Using Web-Based Decision Support Tools for Modeling Land Uses," Ms. Lucero spoke of the tool evaluation work accomplished in the *Changing Landscapes* workshops and the partnerships leveraged that made such work possible. She characterized the unique makeup of the Midwest Spatial Decision Support Systems Partnership and relayed information about the accessible tools and other resources available at the partnership's Web site. She then described the pedagogy used in the Wisconsin DNR program and the resulting framework for outreach sessions.

At the end of September 2005, Dreux Watermolen presented "Computer Tools for Planning, Conservation, and Environmental Protection: Building Capacity among University Extension Educators" at the Upper Midwest Planning Conference in Alexandria, MN. This presentation focused on ways other states can use Wisconsin's model approach to working with Extension to build capacity among these community educators.

Dana Lucero conducted a session as part of the American Planning Association's 2006 national planning conference. Her session was part of APA's new Technology Showcase, which included demonstrations and discussions of software, project applications, and case studies of GIS, visioning software, and other planning information technology. Ms. Lucero's "Web-based Computer Tools for Planning, Conservation, and Environmental Protection" session enabled attendees to: 1) identify Web-based planning resources, including data access tools, mapping services, and modeling tools, 2) disseminate information about resources for free, Web-based resources to colleagues and clients/public, and 3) run the basic version of a storm water runoff modeling tool and interpret the results.

Planning for Land Use and Healthy Watersheds: An International Conference: In September 2006, Dreux Watermolen participated in this international conference sponsored by UW-Stevens Point's Global Environmental Management Center, Center for Land Use Education, USDA Natural Resources Conservation Service, and The Johnson Foundation. The conference was set up to "develop strategies for implementing land use and watershed planning methods throughout the world." Participants from 14 nations attended. Dreux Watermolen shared information about GIS and decision-support tools and their application to land use and watershed planning approaches.

North American Cartographic Information Society 2006 Annual Conference: NACIS is comprised of specialists from private, academic, and government organizations whose common interest lies in facilitating communication among members of the map information community of practice, including the GIS community. Dan Bellrichard, Dreux Watermolen, and their co-authors presented talks at the “Using Internet Mapping Services (IMS) for Planning, Conservation, and Environmental Protection” session which included four presentations that detailed Wisconsin DNR’s technical assistance program, including an overview of efforts to evaluate tools that met predetermined criteria and determined how those tools might be applied in local decision making. They discussed lessons learned related to maps, GIS, and IMS technologies based on work with specific target audiences, including key findings from audience needs assessments, insights from audience-specific capacity building efforts, and important conclusions from program evaluation efforts. The session presentations included:

- “An IMS Capacity Building Program” - This paper described Wisconsin DNR's ongoing effort to improve the quality of local land use decisions through the promotion and use of decision support and impact assessment tools, including GIS and IMS-based technologies.
- “Building Capacity among Extension Educators to Use IMS” - This presentation described how Extension staff fit within the Wisconsin DNR program’s conceptual framework, with emphasis on the transferability of Wisconsin’s approach to other states with robust Extension programs. We detailed our background assessment of Extension educators’ priorities and preferences regarding involvement in local land use planning, as well as an assessment of their current use and interest in GIS, IMS, and related tools.
- “Building Capacity among Nonprofit Conservation Leaders to Use IMS” - This session described work that Wisconsin DNR has done with local and statewide organizations to build capacity to use these technologies. We described our preliminary needs assessment work, an appraisal of current use and interest in GIS, IMS, and related tools, and lessons learned from recent hands-on computer tool workshops. We also featured a case study of one local organization’s use of GIS-based impact assessment tools.
- “Building Capacity among Natural Resource and Planning Professionals to Use IMS” - This presentation described efforts to build capacity among Wisconsin DNR staff and professional planners to apply Web-based technologies in their work. We contrasted assessments of the training needs and preferences of these two audiences, as well as provided an appraisal of their current use and interest in GIS, IMS, and related tools. The session concluded with a presentation of lessons learned, with emphasis on the transferability of the Wisconsin DNR approach to other states.

References and Related Reading

We found the following references helpful in thinking about how our work might be transferred to other places. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, Further Reading, and Background Material” section at the end of this report.

National Association of Counties (NACo). 2006. *County Water Quality Issue Brief: Using GIS Tools to Link Land Use Decisions to Water Resource Protection: Commonly Used Tools Available to Counties and County Best Practices*. Washington, DC: National Association of Counties. Available online at http://www.naco.org/Template.cfm?Section=New_Technical_Assistance&template=/ContentManagement/ContentDisplay.cfm&ContentID=21056.

Warnecke, L., K. Neimond, R. Brower, M. Mercurio, and E. Miller, 2005. *Final Report for the Northeastern Local, Regional, and State RS/GIT Outreach Workshop*. Auburn, New York: Institute for the Application of Geospatial Technology at Cayuga Community College, Inc.

Lessons Learned, Transferability of Program, and Recommendations

15. Lessons Learned

In this chapter, we summarize lessons we learned about the Internet tools, how the tools can be used in local planning and decision-making processes, the various target audiences, and the different instructional approaches applied in the Wisconsin DNR program. Some of our conclusions and recommendations have been published in conference proceedings and peer-reviewed journal articles (e.g., Lucero et al. 2004, Watermolen 2008, Watermolen et al. 2009). Here we extract and summarize what we feel are the most important lessons others might want to consider to foster technology transfer.

Lessons Learned about Internet Tools

A number of technical issues arose with the tools as we carried out our technology transfer work. While addressing most of these was beyond the scope of our efforts, we nonetheless attempted to document them as they occurred. Our efforts to identify and explain these issues to tool developers and others was one of the tangential benefits of our technology transfer work, and it has enabled us to more effectively advocate for infrastructure improvements and broader scale collaborations. In this section, we briefly describe these lessons learned about the tools and their underlying infrastructure.

Internet Access Can Be Limited: Many local government, nonprofit organization, and citizen users remain unable to access the full technological capabilities of many of the new and emerging tools, especially end users in rural areas (Samson 1998, Malecki and Boush 2000, Rao 2000, Hartell 2001). To the extent that conflicts between land use development and natural resources protection become more pronounced in rural/exurban “fringe” areas, these infrastructure limitations are especially problematic. Although, we do note that Internet penetration in the United States now exceeds 70% (Internet World Stats 2008) is increasing and that this may become less of a concern in the future.

Inadequate Bandwidth Limits Tools: The time it takes to download information is currently an important issue, particularly if people are accessing the information from their homes over slow telephone connections. Many rural users lack access to high-speed connections and rely on older technologies (U.S. Department of Commerce 2002, Malecki 2003). For example, although broadband adoption in rural areas has been brisk (39% growth between 2005 and 2006), it has not been any different from the growth rate in suburban and urban America, where broadband penetration is already more extensive. Thus, broadband penetration rates in rural areas continue to lag behind those in suburban and urban areas (Horrigan 2006). Firmware and hardware associated with security, switching, and routing functions also affect access speed, again with rural areas typically managed with the oldest and slowest equipment.

Spatial data files can be extremely large (>2 Gb) and require considerable bandwidth to move the data over the Internet. While advances in fiber optics, data storage systems, and related technologies have fostered innovative data sharing approaches and applications, these emerging technologies continue to use infrastructure developed in the late 1970s and early 1980s. Voice band modems, the current dominant technology, cannot deliver sufficient bandwidth to meet existing levels of data flow over the Web (Hartell 2001). In addition, the lack of bandwidth slows the response times of many Web-based applications making these tools less than useful for many potential users. The type of Web browser being used can also affect the users’ experience. Given that we have experienced these types of problems in rural areas of Wisconsin, a state that ranks in the middle among the fifty states in broadband penetration (Fleissner 2006; Vanden Plas 2006), as well as in central Minnesota, northern Indiana, and Michigan, these limitations are likely a common problem throughout much of rural America.

We recognize that recent studies suggest broadband penetration among active Internet users could exceed 90% in the U.S. in the very near future (Website Optimization 2008) and that this may become less of a concern in the future. We do note, however, that more and more users are accessing the Internet via “information appliances,” electronics devices with Internet access capability like cellular telephones and PDAs. Hardware restrictions, narrow bandwidths, and accessibility requirements associated with these appliances continue to present serious obstacles to access to most advanced Internet applications.

Choice of Internet Service Providers Can Be Limited: To “get on” the Internet, a user must work with an Internet service provider who provides physical access to the Internet. Unfortunately, many rural users lack choices of service providers (Malecki 2003). Rural users often have to pay toll calls, in addition to the same monthly fees their urban counterparts pay, in order to access online services. This makes access to advanced telecommunications extremely costly in some areas; market competition has simply not lowered prices for these users. For example, monthly costs of having a T-1 leased line to a rural school can be much higher than costs for the same service in urban areas (ITC 2006).

Tools Lack Interoperability: We recognize that no single tool can address all possible questions/problems that local decision makers face, but participants in Wisconsin DNR’s workshops and follow-up interviews regularly note that the “tools do not ‘talk’ to each other” and often comment that the different tools have “a very different look and feel to them.” This lack of interoperability seems to run counter to the requirements for and basic tenets of both comprehensive planning and the “systems approach” that often is touted as a means for making more sustainable decisions. The users we interact with repeatedly asked for the ability of two or more tools to exchange information and have the meaning of that information accurately and automatically interpreted by the receiving systems (i.e. semantic interoperability). Such interoperability would help narrow the choice of tools and create integrated decision-support systems that would allow users to answer questions in a more comprehensive manner.

Our ongoing discussions with tool developers suggest several key factors have hindered interoperability among existing tools: impediments to data sharing, a lack of standards and protocols, a preference by tool developers for developing new tools, and products that are simply not engineered to work together (see Watermolen 2008). While resolution of these concerns seems beyond the scope of our current work, we do note that relatively simple, short-term steps can be taken to considerably further interoperability. For example, many tools that currently incorporate land cover/land use data into their operations rely on different land use classification schemes (e.g., 4 classes versus 12 or more classes) for analyzing and rendering the data. Alignment of the classification schemes or development of a readily available crosswalk between classification schemes would allow users to compare outputs much more easily. Standardizing map legends between tools, a relatively straightforward effort, would also facilitate interoperability.

Tools Remain Difficult to Find: Participants in Wisconsin DNR’s workshops and follow-up interviews regularly noted that it was difficult to remember what tools are available and where to find them. The URL addresses can be long, complicated, and impossible to remember. While several clearinghouses and Web portals have been developed, no single access point exists to help end-users identify and select tools appropriate for the full range of decisions that local officials face.

Tools May Be Inaccessible to Some Users: One area that the Wisconsin DNR program did not assess is how accessible Internet tools might be to individuals with disabilities. For example, we did not assess the ability of blind or visually impaired individuals to access these tools using assistive technologies such as screen reading or screen magnification software. A recent study by the American Federation for the Blind (2008) noted that many online educational tools “pose significant barriers” to individuals with vision loss because the tools do not work well, if at all, with software designed to aid access to screen content. This is an area where additional research might address unmet needs. Access by more remote rural users, who may only connect to the Internet via information appliances (e.g., cellular telephones), also is an area that merits future work.

Metadata and Technical Documentation Are Often Lacking: Metadata—the background information that describes the content, quality, condition, and other characteristics of a particular data set—foster understanding of the quality and currency of data and are one key to making well-informed decisions and the ability to support and defend them. The development and maintenance of metadata for electronic formats often requires a more conscious effort on the part of data producers and the chain of subsequent users, who may modify the data to suit their particular needs. If metadata are created according to standards and contributed to a clearinghouse, it becomes possible for other users to search for and find this information and its related data effectively. Yet, we found it difficult to find metadata for data used by many Internet tools, particularly those with more advanced analytical functions or with data embedded within their tool structure.

Some Interfaces Remain Less than Friendly to Users: Although considerable progress has been made in understanding factors that can hinder the use of Web-based applications, many Internet GIS and related tools still lack basic features that would facilitate their use by non-specialists. Standardization of map legends and land use classification schemes, as noted above, would help simplify the user experience. The addition of pull down menus, “mouse-over” labeling, and similar navigation and operation features could improve many tools in our inventory. The incorporation of additional tutorials, help screens, and similar online technical support also would aid users.

Projection Systems Can Result in Errors: Because the Earth is not a perfect spheroid, numerous projection systems have been devised to transfer points from its irregular curved surface to the plane surfaces of maps. Different projections and coordinate systems can be used for different purposes. When data are stored and distributed in different projections, we must reproject them so that all layers plot in the same coordinate space. Yet, we found that many Web sites that make GIS data available fail to include projection/coordinate system information for those data. As Milla et al. (2005) point out, “[i]t is extremely important to carefully keep track of both the original and reprojected systems” in order to maintain the spatial integrity of the data.

Copyright Laws May Create Problems for Data Sharing: Although we did not specifically encounter copyright concerns, Carver et al (2001) noted that an important legal issue remains unresolved: copyright covering the actual data that are central to the system. These authors asserted “the ownership of all the different pieces of information and data within an on-line system can cause major problems” and that “any system that is map-based could potentially therefore be tied up in complex copyright and legal issues.”

Lessons Learned about Tools and Local Processes

A variety of circumstances as well as access to resources affect the ability of the public to participate effectively in planning and decision-making processes at all levels of government. Several authors note that active civic engagement requires time, familiarity, and confidence with bureaucratic procedures, personal contacts and relationships in key places, adequate financing for campaigns, and transport to attend meetings. Internet and GIS technologies, however, are allowing citizens to engage their governments in new ways. Yet, to be used successfully, Internet tools must be thoughtfully integrated into planning and decision-making processes. Throughout the course of our grant period, we had opportunity to talk and work with people fulfilling various roles and to get their perspectives on how such tools can best be used in local processes in particular. In this section, we outline lessons learned about using the tools to support local planning and environmental decision-making. Like Carver et al. (2001), we recognize that the nature of information and political power goes much deeper than access to information and formal routes of involvement in planning and decision making. We are also sensitive to much wider debates regarding public expenditures, public empowerment, participatory democracy, trust of government, community priority setting, and accountability in policymaking. We cannot, however, discuss all of these issues in detail. Instead, we focus on a few key recurring themes that surfaced throughout our work in Wisconsin and the Upper Midwest.

Some General Principles: Carver et al. (2001) outlined a set of principles as a guide to implementing Web-based public participation GIS strategies. We have found the wisdom in their suggestions extends beyond public participation GIS to the full range of Internet tools. According to these authors, online systems should:

- “Allow the public to explore and experiment with the data and information sources which are available and provide the opportunity to formulate different scenarios and solutions to decision problems;
- Be understandable by all sectors of the community who wish to be involved and not tied up in technical jargon;
- Provide information and data that are both explicit and bipartisan; and
- Foster a high degree of trust and transparency that can be maintained within the public realm to give the process legitimacy and accountability.”

Provide Equal Access to the Tools: Like Carver et al. (2001), we believe one of the most important issues related to the use on Internet tools in local processes is ensuring that everyone involved in the process has access to the tools. If members of the concerned public do not have easy access to the tools, the entire process can become ineffectual. Along these lines, it is important that planners and decision makers leading such processes do not assume that everyone will have Web access and take steps to address issues like band width, etc. (as noted earlier).

Some authors (e.g., Monmonier 1996, Pickles 1995) have considered GIS to be an elitist technology. They claim GIS gives more power to people already possessing it and depriving those, like the general public, who more often than not lack such direct forms of information access. We have found, however, that Internet-based GIS helps overcome such criticism by creating a more even playing field on which to conduct public debate. This is precisely because the Internet allows a broader public to have access to data, information, maps, and analytical results that were previously difficult to obtain or understand.

Establish Trust and Transparency: A degree of trust and transparency needs to be established and maintained among planning groups to give Internet tools legitimacy and establish accountability. There remains very little research on the level of trust the public place on information they encounter on the Internet. Some research suggests that some sectors of society place more trust in information on the Web than in certain magazines or newspapers (Carver et al. 2001). However, a great deal more work is required in this area and we suggest that planners and local officials work to ensure all parties clearly understand the functions and outputs of tools being used in any particular given process.

The range and variety of decision support tools can create difficulty for planning groups when trying to select tools that will be useful and appropriate for their exercise(s). GIS tools are often looked to as the solution to planning problems. As Klosterman (1997) points out, however, “GIS alone cannot serve all the needs of planning” because most systems cannot “easily accomplish all of the particular informational, computational, and display needs of planning.” Each planner must be cognizant of her own abilities, as well as the other members of her group, when she chooses a tool. Tool selection criteria should be determined well before making a survey of all available tools. We have found that promoting a suite of tools with clearly defined uses and applications to be the most appropriate means of advancing the public use of Internet tools. The important, but difficult, task is integrating the tools “into a coherent system that serves the needs of planners” (Klosterman 1997).

Tool developers can help foster public confidence in their Internet tools by incorporating specific design features to help users avoid inappropriate uses. For example, many Internet mapping tools restrict the visibility of data layers at scales inappropriate for their use. Users of tools must also understand the level of complexity being dealt with and the level of uncertainty associated with model outputs. The incorporation of tutorials and help features, as well as easy access to metadata and technical documentation can facilitate transparency and help foster trust.

Introduce Tools Early in a Process: The effectiveness of integrating Internet tools into local decisions often depends upon when the tool is introduced into the planning process. Though it may be the case that use of a particular tool arises late within an overall process to meet an unexpected need or to solve an unanticipated problem, using tools from the beginning often fosters a greater degree of success (Miskowiak 2003b). At the beginning of a planning process, there is generally a period of educational setup needed to bring all participants to an agreed upon level of planning proficiency. This leveling period can help participants understand basic tenets of planning practice and theory, as well as provide case-specific background for the situation the planning or decision process will address. It is during this time that tools can be introduced to the group, along with a discussion about the role of the tools and their abilities and limitations. Familiarity with the functions of a particular tool and the outputs the tool is capable of generating can build acceptance while keeping expectations grounded in reality (Lucero et al. 2004).

Lucero et al (2004) point out how “it is not always possible to foresee all the uses of decision support tools at the onset of a planning process, [but] it is helpful to participants to see the potential benefits of using tools in a planning exercise.” When tools are introduced later in the planning cycle, it is still necessary for participants to understand the role the tool will play well before the participants are given the (often de

facto) outputs of the tool. In our experience, planners too often arrive at a meeting with the results from an impact assessment tool and present the predictions as fact. Without taking the time to help participants understand the scope, validity, inputs, and outputs of a particular tool, the unexpectedly introduced results may be interpreted with an apprehension akin to xenophobia. Fostering a relationship between the planning group and a decision support tool will likely increase involvement in the tool's use as well as acceptance of the tool's results (Lucero et al. 2004). As noted earlier, the level of complexity being dealt with and the level of uncertainty associated with outputs must be understood by tool users. Tool developers can help address these issues by incorporating tutorials and help features into their tools and providing easy access to metadata and technical documentation for those involved in a planning or decision process.

Consider Spatial Scale: Spatial scale can have a significant effect on the manner in which the public respond to particular decision problems (Carver et al. 2001). The majority of people are most interested in those problems that pertain to their area and thus affect them directly. As spatial scale increases from local to regional to national scales, fewer and fewer people remain interested in the issues; only those who are already interested or involved in the problem at the national scale may participate. This is in spite of the fact that in many situations the actual problem becomes more important and more complex the broader it is looked at.

In addition, the scale at which many environmental data are collected and analyzed directly impacts the relevance of analytical results. For example, most broad scale, public domain, land-cover data were collected to meet national needs. As a result, national land cover data sets lack the detailed functional data needed for much regional and local planning and decision making. Ecologists and planners often desire land cover/land use projections at spatial scales relevant to the ecological processes they work with (Kline 2003). While national land cover databases may be suitable for identifying biodiversity hotspots within a large area (e.g., >1000 ha.), these data usually are unsuitable to identify whether or not a particular property (e.g., 10 ha.) has critical habitat (Theobald et al. 2005). Additionally, local and regional environmental applications often require data of various spatial scales; single scale remote sensing data are insufficient to appropriately sample the hierarchical scales encountered in nature (Treitz and Howarth 1996).

On the technical end, many tools restrict the extent of user-defined areas of interest in order to manage the large, complex data sets needed for their analyses (i.e. server capacity and Internet bandwidth can only accommodate so much). As a result, the size of the area of interest available in online applications is not always amenable to local planning processes. For example, planners trying to assess the suitability of a large area for a proposed residential subdivision or business park may need to conduct multiple queries/analyses (using tools like Web Soil Survey and L-THIA) and then manually piece the results together to get the full picture.

Consider Temporal Scale: Many Internet tools rely on land cover or land use data for their analyses and base maps, and many mapping applications rely on aerial photographs or scanned U.S. Geological Survey topographic maps as base images. We have found that end users often have questions about how current these layers and images are, and as a result, wonder about the validity of the tools' outputs.

Until recently, the most current National Land Cover Dataset (NLCD) for the U.S. was derived from early 1990's era Landsat-5 images (Sohl et al 1999) and was thus considerably dated. More recently, the U.S. Geological Survey completed efforts to map the U.S. using circa 2000 Landsat-7 imagery (NLCD 2001; Homer et al 2002, 2004). While potentially useful for many applications, these data are already too dated for others. Mapping land use (as opposed to land cover) remains a challenge, particularly when trying to map residential development in rural areas where the land-use changes often cause only small footprints that are difficult to detect in remotely sensed land cover images (Theobald 2001). Landscapes, especially in urbanizing areas, can be extremely dynamic and a 10-15 year update cycle for the data provides insufficient information for accurate or precise modeling. Although land use can be inferred from parcel scale data (e.g., Kline 2003), we have found only limited efforts to link parcel scale data with remotely sensed land cover data to generate the more complete picture. Finally, U.S. Geological Survey topographic maps are not routinely updated and many smaller communities cannot afford to fund the frequent flyovers necessary for up-to-date aerial images.

Communities May Lack GIS Capability: While the nature of environmental data makes GIS an appropriate technology for viewing and analysis, many small towns and rural communities lack GIS staff and resources (DeLozier et al. 2004, Stein 2007, Gocman et al. 2008). Even where GIS resources are available, many planning agencies are not yet fully using the Internet to provide access to digital information (Knapp and Holler 2003, Conroy and Evans-Cowley 2006). Increasingly, the provision of data, information, maps, analytical models, and other resources by state and federal agencies via the Internet helps address this concern. Still, concerted efforts will be needed to inform most local governments about available Internet tools and their applicability to local processes.

Lessons Learned about Target Audiences

Technology transfer must be audience-focused. Not everyone is technologically inclined or completely comfortable with electronic processes (Garretson 2006). This appears to be the case even with professionals who routinely incorporate computers into their daily work. For example, Milla et al. (2005) describe how the rapid development and integration of spatial technologies have created many new tools, but “have also widened the ‘digital divide,’ leaving many with little understanding of the technology and potential applications.” These authors further observe that “the complexity and vast array of potential applications can be confusing and intimidating” and that “as a result of the relatively fast evolution of geospatial technologies, many professionals may either be unaware of their capabilities or may have an obsolete understanding of their potential and current implementation.” We have observed this “digital divide” phenomenon in several of the target audiences that we work with in the Upper Midwest.

Programs like the Wisconsin DNR program must seek to understand the many and varying players and needs at local, regional, and state levels if they wish to maximize use of their data and applications. These efforts must recognize the complexities of federalism and opportunities to create customized, multifaceted approaches to address the “have-nots” as well as the “have mores.” We must also recognize and understand that local, regional, and state entities have differing sizes, roles, responsibilities, structures, needs, and business processes. Similarly, staff working in local, regional, and state agencies hail from a variety of professional backgrounds. Our work in Wisconsin (Wisconsin DNR 2004c, Watermolen et al 2009) demonstrates that planners, engineers, land conservationists, elected officials, etc. have very different technology transfer needs and preferences for receiving assistance. In this section, we outline some of the lessons we learned about the various audiences we worked with during the grant period.

General Observations

The primary reason members of all audiences cited for not using Internet tools following our technology transfer efforts was that they had not yet had an opportunity to use them. In addition, among the obstacles to increased use were perceived difficulty in accessing the tools, in remembering the tools, and in applying the tools.

Milla et al. (2005) caution that using these technologies effectively “requires a broad understanding of many different concepts, including map projections and coordinate systems, data types and formats, computer literacy, and proper documentation of data.” User friendly interfaces hide much of the GIS technology from the user, but an understanding of how to navigate around a map and understand the map legend can still cause problems for some people. Considerable research has been carried out into the perception and understanding of maps (Keates, 1996), the findings of which could be considered when designing map interfaces for public use. Carver et al. (2001) observed that one of the main obstacles to public participation GIS has been the general lack of familiarity with the technology involved. They noted that a “much smaller number of people had difficulty in understanding the map itself.” Our experience parallels their comments, but we have found that some maps may be difficult for the layperson to understand; simple maps showing roads and water features may be understandable, but other formats may not. The lack of common legends and differing approaches to cartographic rendering fosters confusion.

Carver et al. (2001) describe how users who could not immediately locate their specific area of interest simply found a prominent building or road and moved along the path that they would on the ground, querying features by clicking on them until they reached the area. We have observed similar behaviors in our technology transfer efforts. Incorporation of high quality aerial imagery into map interfaces seems to aid such navigation.

Extension Educators

Lessons we learned with respect to Extension Educators are presented in Watermolen et al. (2009). Workshops, supported with printed materials and Internet resources, appear to be the most effective means of helping Extension educators use these tools. We confirmed that these educators liked making scientific data accessible and having an increased awareness of available tools for their conservation and planning work. We also confirmed that they like to access information via the Web. Similar to High & Jacobson (2005), we found the Internet has become “an important addition to the natural resource learning community.” Given their lack of confidence in using GIS, however, it is unlikely that Extension educators would explore many Internet GIS tools in the absence of workshops like the ones we conducted. Therefore, a need remains for continuing professional development opportunities focused on these resources and their applicability to Extension programming. Also, since Extension educators generally do not consider teaching about Internet tools to be part of their Extension job responsibilities, educators will need to rely on other sources of expertise for training community groups to use the tools to access information and planning resources. Perhaps as important, Extension educators could also use additional experience in how to use maps and data most effectively in an outreach scenario.

Planners

Technology transfer efforts with this audience should focus primarily on data access tools, with lesser emphasis on mapping and modeling tools. Professional planners need access to natural resources data to help them complete their plans. When conducting outreach with this audience, it is important to communicate explicitly what planners can do with these tools and that they can do it cheaply. Webcasts and Webconferences provide meaningful and simple ways of conducting outreach to professional planners. Working with the state chapter of the American Planning Association and existing networks, like the Smart Growth Network, will allow for resources to be leveraged.

DNR and Natural Resource Agency Staff

We found that workshops and informal one-on-one instruction provided the most effective means of technology transfer for this audience. Although, we also note that these professional staff often expressed that it was easier to get someone else to provide needed data or run an analysis than it was to remember how to use one of the Internet tools. Case studies, either in written formats or discussed as part of informal seminar sessions or conference presentations, can be effective in helping natural resource professionals link the tools to their day-to-day work efforts.

Citizen Planners and Local Government Decision Makers

The public remains largely unaware that many of these tools even exist. Carver et al. (2001) found that one of the main obstacles to the use of Web-based tools was the general lack of familiarity with the technology involved. In addition, our own work suggests that many citizen planners and local government officials have little familiarity with how to go about finding and using environmental data in a decision support context. Agency Web sites can be cumbersome to navigate and often lead to frustration for the uninitiated. Similar to what Civittolo and Davis (2008) concluded, we suggest “a coordinated marketing strategy to develop awareness amongst township trustees as well as the agencies that serve them would be helpful.” We suggest this because we believe that the current proliferation of tools, created with sound science and

current data, can increase significantly a user's level of understanding about land use changes and natural resource functions, both of which are essential to improving environmental outcomes.

We found that location is a major factor affecting people's understanding of land use issues and how Internet and GIS tools can be used to address those issues. Gocman et al. (2008) described how larger municipalities are more likely than smaller municipalities to have GIS capabilities. In addition, our experience parallels that of Civittolo and Davis (2008), who surveyed Ohio township trustees and found their understanding of land use planning tools to be associated with their location. Those indicating higher levels of understanding were located in areas of the state that recently experienced the greatest degree of development pressure. These researchers also reported that the highest participation in training occurs in those areas experiencing unprecedented development.

While we found that hands-on workshops were an effective ways of building capacity among this audience, the number of local officials who are able to participate in workshops is somewhat limited. As Kelsey et al. (2002) noted, the "majority of local officials... are volunteers who work at another job during the day and conduct their local government work during the evening and weekends. Getting these officials to attend trainings can be difficult, at best, even when they understand they need training because they have enough other activities demanding their time." Partnering with the local government associations through their annual conferences and newsletters proved effective in reaching this audience.

Case studies can be an effective way of realistically contextualizing applications, particularly for local government decision makers and citizen activists. Finding useful examples of truly outstanding or successful projects that have informed local decision processes, however, remains challenging. By making people aware of the existence of Internet tools, educating them about what the tools can and cannot do, and providing technical assistance, we can move closer to our goals of enhanced protection and management of natural resources.

Lessons Learned About Instructional Approaches and Materials

A policy study by the International Telecomputing Consortium (ITC 2006) recently concluded that without support for training and professional development, Internet connectivity "remains useless." Similarly, the Space Studies Board (2003) identified a "gap in communication and understanding between those with technical experience and training and the potential new end users of [remote sensing] technology." These conclusions mirror Wisconsin DNR's findings (2004c) and underscore the importance of technology transfer efforts. In this section, we describe some of the lessons we learned about technology transfer, both in general and with respect to specific instructional techniques and materials.

General Observations

Several recent efforts have addressed technology transfer on a broad scale. The Space Studies Board's Steering Committee on Space Applications and Commercialization organized a workshop on "Facilitating Public Sector Uses of Remote Sensing Data." Participants examined factors that have led to the development of successful applications of remote sensing data in state and local governments and identified common problems encountered in this process. A report (Space Studies Board 2003) drawing on the workshop provides several broad policy recommendations related to education, training, and outreach. More recently, officials from fourteen northeastern states convened for a 3-day workshop focused on outreach strategies for remote sensing and related geospatial information technologies. The intent was to identify ways of improving and maximizing the outcomes of outreach strategies and programs. The workshop findings (Warnecke, et al. 2005) provide a foundation for developing and implementing action plans that advocate improved outreach and intergovernmental collaboration. Lessons learned while implementing the Wisconsin DNR program resonate with these earlier efforts, and we encourage state and federal agency personnel to consider these collective findings as they design and implement technology transfer efforts.

Strong partnerships forged with state, local, and tribal governments and environmental agencies through their inclusion on steering committees can inform educational programming. Continuous engagement allows organizations to complement each other's strengths and effectively leverage resources to address shared needs and priorities. For example, local government associations are often committed to regularly publishing print or electronic newsletters for their membership, but are often in need of substantive content. Resource agencies on the other hand often have substantive content they want to share, but are limited in their ability to disseminate it. The needs of both organizations can be met through collaboration. Similarly, Extension educators often are skilled in organizing and promoting workshops, but are sometimes reluctant to be "the expert." This concern can be readily addressed when resource agencies partner with Extension and provide an instructor/expert.

Effective technology transfer relies on a variety of approaches and techniques. Current learning theories suggest curricula will need to be based on learners' experiences and interests (Wilson and Hayes 2000, Caffarella 2002, Wisconsin DNR 2004b). Every target audience contains a configuration of idiosyncratic personalities, differing past experiences, current orientations, levels of learning readiness, and individual learning styles. Thus policy makers should be wary of prescribing any standardized approach to facilitating learning (Brookfield 1986, Ota et al. 2006).

Technology transfer efforts can employ a variety of techniques. We believe it is important to evaluate the return on investment prior to employing a particular technique. The impact of a given approach or tool can be assessed in various ways.

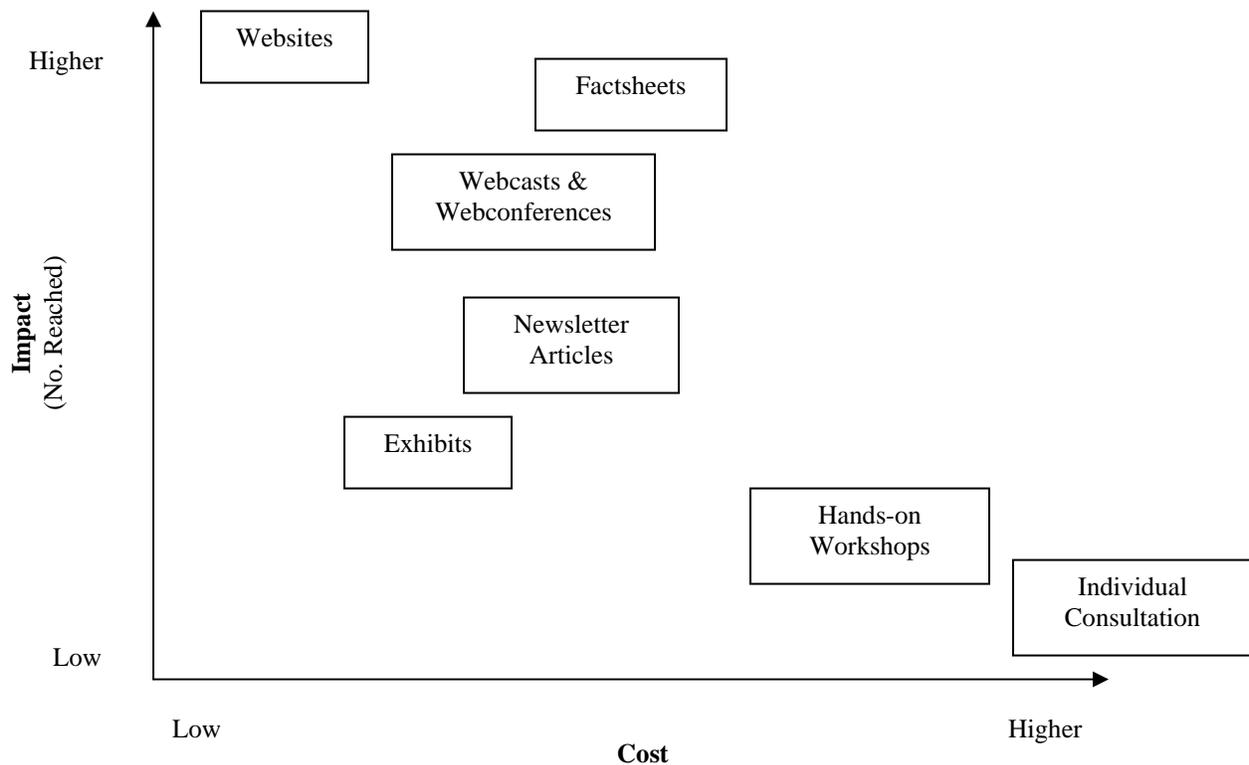


Figure 15.1. *Relative Cost versus Impact (Number of Individuals Reached) of Various Technology Transfer Approaches.*

One method of assessing the impact of technology transfer tools is to consider how many people a given approach will reach. Figure 15.1 depicts the relative cost of producing specific outputs versus their impact as measured in number of individuals reached. Large numbers of individuals need to be reached in order for broad-scale adoption of new technologies to occur. Figure 15.2, however, provides another way of assessing the impact of the same methods considered in Figure 15.1. In this case, impact is measured in terms of the effectiveness of the technology transfer technique (i.e. how often the approach results in second and third order outcomes).

Thinking about approaches in both ways gives a more complete picture of the value of one approach over another. Web sites cost relatively little to produce and have the potential to reach very large audiences. The effectiveness of Web sites for technology transfer, however, can be limited. On the other hand, individual consultations and hands-on workshops reach relatively low numbers of individuals, but these techniques are some of the most effective in altering behavior. Webcasts/Webconferences can reach a relatively large audience, but are generally lower in cost to produce than in-person workshops.

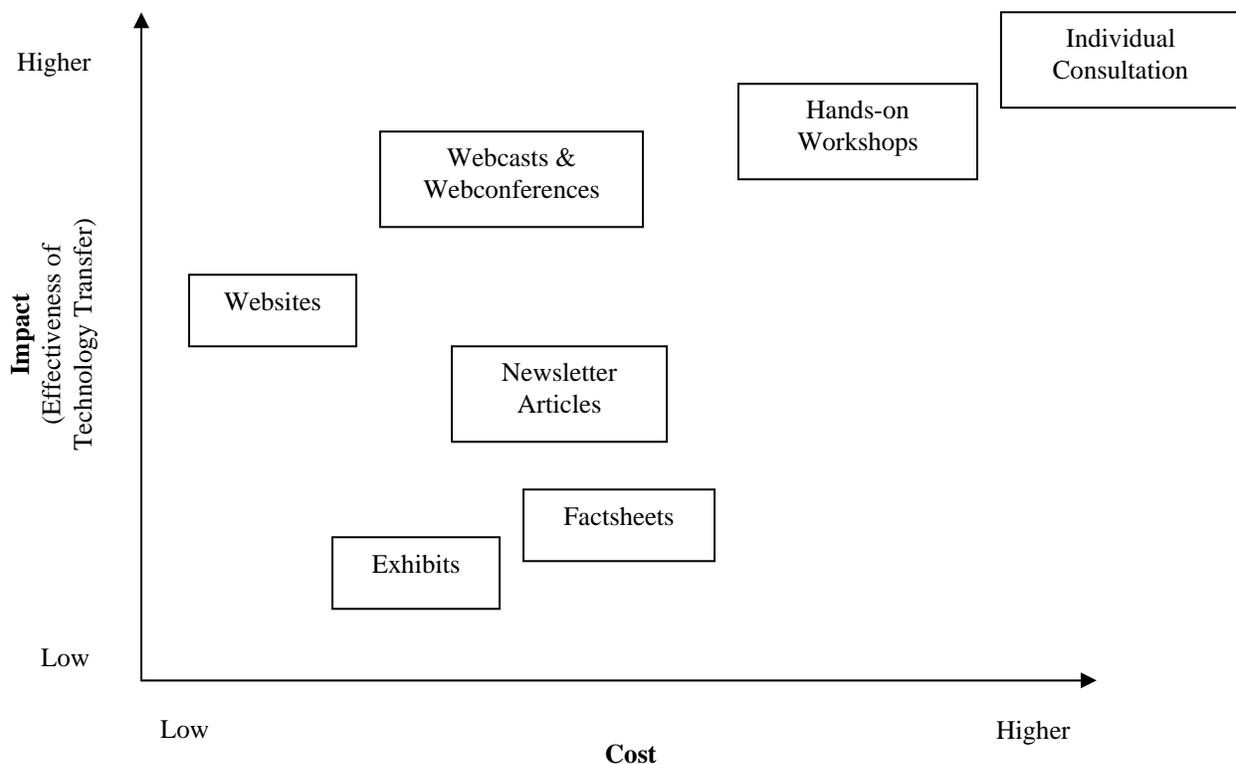


Figure 15.2. *Relative Cost versus Impact (Effectiveness of Technology Transfer, i.e. Resulting in Second and Third Order Outcomes) of Various Technology Transfer Approaches.*

One area that the Wisconsin DNR program did not assess is how accessible the various technology transfer techniques might be to individuals with disabilities. For example, we did not assess the ability of blind or visually impaired individuals to access Webcasts/Webconferences using assistive technologies such as screen reading or screen magnification software. This is an area where further research is warranted.

Workshops

Milla et al (2005) comment on the importance of being realistic in expectations: “It has been our own experience that it is impractical to expect all members of your staff or faculty to learn to use GIS-GPS-RS technologies. Workshops we have held for this purpose have been poorly attended, despite enthusiasm expressed by the would-be attendees.”

Based on the participant feedback from our hands-on sessions, we offer the following tips for improving technology transfer through workshops:

- Emphasize “hands-on” aspects in training sessions. Although they generally felt okay about their ability to use computer technology, educators said they needed more practice using the specific tools so that they would remember which tools they could use and how they could use them. Learning to use a new tool remains difficult when one is in a time crunch of necessity; it simply is easier to fall back on familiar methods, like asking someone else for needed information.
- Include a limited number of tools in training sessions. This reduces the overwhelming aspect of workshops, allows adequate time for hands-on “practice,” and increases the likelihood of post-workshop use.
- Plan training in modules focused on tools for specific purposes. Adults generally like to learn what will help them perform tasks or deal with problems they confront in everyday situations (Knowles et al. 2005, Caffarella, 2002). Therefore, to strengthen the application aspect of the workshop, participants could work on sample real-life problems. For example, a workshop could be designed around a specific land use planning project so that tools are introduced as they are needed to gather and present information for the project.
- Include case studies that illustrate the tools being used. Using case studies can result in better recall, retention, and use of learning following the training (McKeachie 2002).

Webcasts/Webconferences

High tech approaches can be feasible training methods even with audiences who have traditionally depended on more personable approaches to communication. The time and financial costs associated with travel appear to be the main reasons for various audiences preferring distance learning over in-person workshops (Bellrichard and Watermolen 2007, Mahler et al 2008). In fact, Mahler et al. (2008) found that this type of delivery method “brought in crowds to be educated about watershed issues in greater numbers than any other format” that they tried in the Pacific Northwest. From a provider standpoint, Webcasts/Webconferences also allow for more individuals to receive the training at once.

Having the ability to participate as groups during Webconferences can give the Webconference an in-person workshop feel and foster peer learning, while still limiting costs. We found this to be the case when we partnered with county-based Extension educators who provided local host sites for viewing.

Providing advance information is one key to successful use of Webcasting/Webconferencing technology. For example, we found that 100% of survey respondents indicated that instruction sheets e-mailed in advance of our Webconferences were either somewhat or very helpful (as opposed to not too helpful or not at all helpful) (Bellrichard and Watermolen 2007).

Just as others (e.g., Lippert et al. 1998) have concluded that “this approach to in-service training requires considerable planning in anticipation of possible problems,” we too believe effort must be put into prior planning for Webconferencing to be an effective technology transfer technique. We have found that technology can be “our enemy.” Servers occasionally crash. Telephone lines go down. Live broadcasts get interrupted. Nonetheless, contingency plans can be made in anticipation of such events and we have found that Webconferencing can work very well for instructional purposes.

Web Sites

The publication of information on Web sites has the potential of informing a large number of individuals. The audience reached in this manner, however, is difficult to describe and assess. One cannot assume that because information is available via the World-Wide Web that members of a given target audience will benefit from its availability. With millions of sites, finding an Internet tool can still be difficult.

We agree with High and Jacobson (2005) that “[n]atural resource extension Web sites must present information at a level and depth that is comparable to what the user might find through traditional natural resource media” such as newsletters or workshops. The same standards should apply to Internet-based approaches, and in this way those users who are unable to attend more traditional programs can find the same information and derive the same benefits.

Exhibits

Exhibits can convey educational information to a target audience (Wells and Smith 2000). We found, however, that they are more effective for outreach than they are for instruction, as knowledge gained from viewing exhibits is generally modest. We also found that when used in tradeshow settings, exhibits can help facilitate audience assessment work. Observing and understanding how and what people reacted to in our exhibit provided insights into what topics were of most interest to different audiences.

Factsheets and Similar Publications

Many technology transfer efforts rely on publications such as fact sheets and brochures to communicate with target audiences. One efficient technique for developing such publications is to modify an existing publication, intended for a different audience, for a local audience (Yancura 2008). This can best be achieved with input from the target audience. For example, we used information gained during our participation in the Wisconsin Towns Association’s annual meeting to inform the distribution of some of our materials (e.g., fact sheet inserts in the annual conference program booklet).

Case studies can be an effective way of realistically contextualizing applications, particularly for local government decision makers and citizen activists. The International City-County Management Association and National Association of Counties employ this approach in much of their technology transfer work (e.g., Fleming 2005; NACo 2006). Finding useful examples of truly outstanding or successful projects or applications that have informed land-use planning or other local decision processes, however, remains challenging (personal observation; Theobald et al. 2005). Tool developers rarely have time or interest to develop these. Their efforts focus elsewhere (e.g., several tool developers have shared with us that their performance often is measured by the number of tools developed, papers published, etc. rather than by the ultimate adoption/value of their products).

Finally, we must note that the dynamic nature of the World-Wide Web made many of our publications go out of date quickly (e.g., URLs frequently change).

References and Related Reading

We found the following references helpful in describing and documenting lessons learned. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, Further Reading, and Background Material” section at the end of this report.

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16. Applicability of Program to Other States

The U.S. EPA funded the Wisconsin DNR program with the understanding that the program potentially could serve as a model for what other state environmental agencies might do to more fully integrate Internet tools and technology transfer into their program implementation, particularly as they might inform smart growth approaches. As noted in our discussion of factors affecting the success of technology transfer programs (Chapter 2), a variety of contextual factors, including political and economic realities, affect the change/learning process. Although we shared the Wisconsin DNR program widely through multiple conference presentations and state and nonprofit consultations (see “Transfer of Program Experience,” Chapter 14), we felt it was also necessary to assess a variety of factors that could affect transferability of our model to other states in the Great Lakes basin. In this chapter, we present the results of our initial assessment of these underlying factors.

Comparable Landownership Patterns

Neither the Wisconsin DNR nor U.S. EPA can manage and protect all natural resources or every aspect of the environment. To be successful in addressing environmental concerns, agencies must work with others to help guide development patterns to prevent or minimize negative environmental impacts. Wisconsin’s proud tradition of protecting property rights means balancing the public good with those rights can be challenging. Yet, this is essential as private parties own 84% of the land in Wisconsin, making individual landowners the primary land-use decision makers. We find this situation to be the same throughout the Great Lakes basin (Table 16.1), and in fact, throughout much of the United States (Figure 16.1).

Table 16.1. *Percent Private Land in the Great Lakes States.*

<u>State</u>	<u>% Private</u>
Illinois	>90%
Indiana	96%
Michigan	79%
Minnesota	75%
New York	63%
Ohio	96%
Pennsylvania	84%

* Sources: Minnesota House Research Department, U.S. Fish and Wildlife Service, Indiana Division of Fish and Wildlife, Michigan Wildlife Conservancy, and National Wilderness Institute.

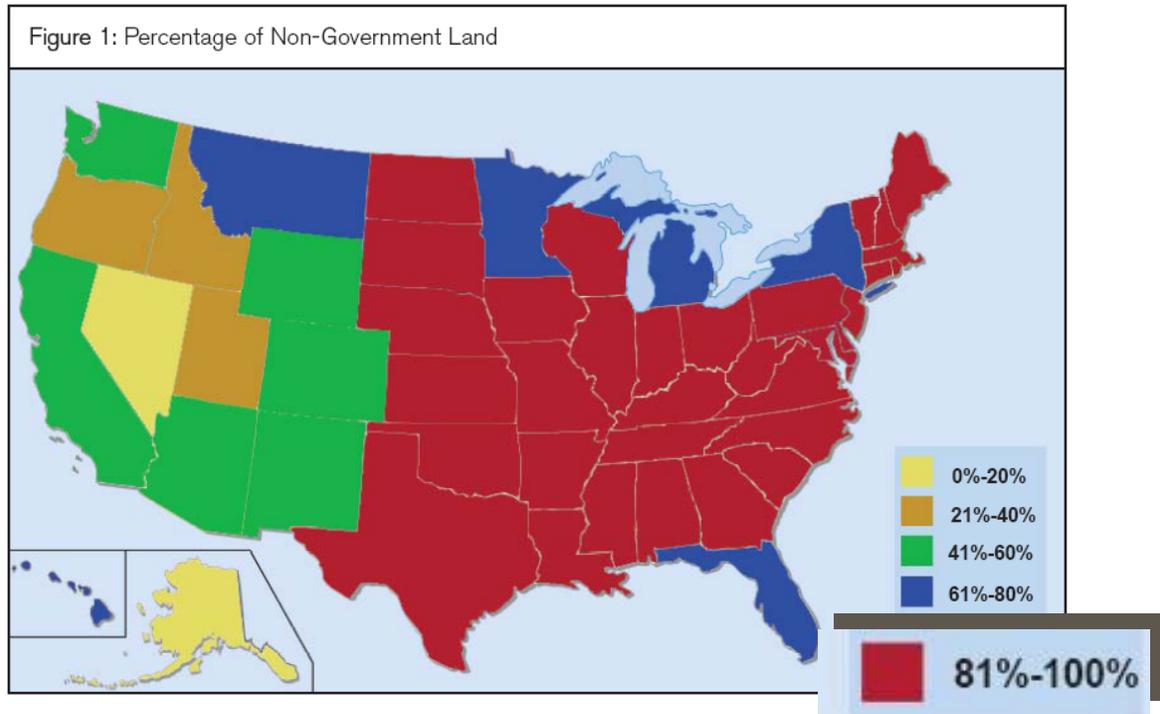


Figure 16.1. Percent Private Landownership in the United States (from Bean et al. 2003).

Comparable Local Government Structures

As discussed in Chapter 9, Wisconsin has over 1,900 local units of government. These local governments have the primary responsibility for regulating land uses. We find this situation to be similar throughout the Great Lakes basin (Table 16.2).

Table 16.2. Number of Local Governmental Units in the Great Lakes States*.

<u>State</u>	<u>Number</u>
Illinois	2,824
Indiana	1,666
Michigan	1,858
Minnesota	2,734
New York	1,602
Ohio	2,338
Pennsylvania	2,630

* Source: Wisconsin Legislative Reference Bureau (2003).

Comparable Extension and Outreach Programs

As documented in Chapter 6, Extension faculty are uniquely situated to play an important role in increasing public understanding of planning laws, the consequences and impacts of development, and alternative growth management approaches. Through their work, Extension professionals are often in contact with many different stakeholder groups and are seen frequently as a source of information and support, they may also facilitate community efforts to build consensus regarding land use solutions. Wisconsin is fortunate to have a well established Extension program that played a critical role in implementing the Wisconsin DNR program. Our analysis suggests similar programs exist throughout the Great Lakes basin (Table 16.3).

Table 16.3. *University Extension Programs in the Great Lakes States.*

<u>Program</u>	<u>Web Site</u>
University of Minnesota Extension	http://www.extension.umn.edu/
University of Illinois Extension	http://web.extension.uiuc.edu/state/index.html
Michigan State University Extension	http://portal.msue.msu.edu/portal/
Ohio State University Extension	http://extension.osu.edu/
Purdue University Extension	http://www.ag.purdue.edu/extension/
Penn State Cooperative Extension	http://extension.psu.edu/
Cornell University Cooperative Extension	http://www.cce.cornell.edu/

In fact, several Great Lakes states extension programs focus specifically on land use issues, the use of GIS, or other areas of emphasis relevant to local environmental management. For example, the Michigan Citizen Planner program at Michigan State University offers land use education and training to locally appointed and elected planning officials. This non-credit course series leads to a certificate of completion awarded by Michigan State University Extension. Advanced training to earn a Master Citizen Planner credential is also available. MSU offers the program through its extension offices in a classroom setting and online. Along with the core series, Michigan Citizen Planner also provides education and training through specialty and regional workshops.

“Encouraging responsible land and natural resource use is a Core Priority.”
- MSU Extension

The University of Illinois Urban Programs Resource Network conducts a Save Our Urban Land (SOUL) program to demonstrate the benefits of water quality education and land restoration to prevent nonpoint source pollution in an urban environment.

Cornell University’s Community and Rural Development Institute supports sound land use through partnerships, research, and training. The program helps coordinate, rationalize, and improve the penetration and quality of training in New York and collaborates directly in the delivery of local land use leadership training programs on a statewide and regional basis.

“Enables people to improve their lives and communities through partnerships that put experience and knowledge to work.”
- Cornell Cooperative Extension

In a similar vein, Ohio State University has developed a comprehensive program to integrate expertise across multiple disciplines to enhance knowledge about geospatial technologies. The Ohio Geospatial Program provides support for outreach and Extension education, as well as applied research on the use of geospatial technologies for a diverse clientele base, with a focus on land and water resource managers. Collaborations of this program involve the NASA Space Grant Consortium, industry partners, and the academic research community in Ohio.

Sea Grant College Program

In addition to university extension programs, Great Lakes states are fortunate to have an active Sea Grant College program (Table 16.4). Sea Grant is a nationwide network (administered through the National Oceanic and Atmospheric Administration) of 32 university-based programs that work with coastal communities. The National Sea Grant College Program engages this network in conducting scientific research, education, training, and extension projects designed to foster science-based decisions about the use and conservation of aquatic resources. This network provides another basis for partnerships that could bring Internet tools to local communities.

Table 16.4. *Sea Grant College Programs in the Great Lakes States.*

<u>Program</u>	<u>Web Site</u>
Minnesota Sea Grant	http://www.seagrant.umn.edu/
Illinois-Indiana Sea Grant	http://www.iisgcp.org/
Michigan Sea Grant	http://www.miseagrant.umich.edu/
New York Sea Grant	http://www.seagrant.sunysb.edu/
Ohio Sea Grant	http://www.ohioseagrant.osu.edu/
Pennsylvania Sea Grant	http://www.pserie.psu.edu/seagrant/seagindex.htm
Wisconsin Sea Grant	http://www.seagrant.wisc.edu/

Comparable Planning Organizations

State chapters provide a local source for networking and professional development, allow members to share experiences with colleagues and broaden their perspective beyond their commission or office. Most chapters offer an annual conference, educational workshops, AICP exam preparation courses, and a newsletter. Many chapters also conduct legislative programs, sponsor planning commissioner training workshops, and conduct public information campaigns. Wisconsin is fortunate to have an active state chapter that played a critical role in implementing the Wisconsin DNR program. Our analysis suggests similar institutional partners are available in other Great Lakes states (Table 16.5).

Table 16.5. *Planning Organizations in the Great Lakes States.*

IL	Illinois Chapter, APA
IN	Indiana Planning Association
MI	Michigan Society of Planning
MN	Minnesota Chapter, APA
NY	New York Metro Chapter, APA
	New York Upstate Chapter, APA
OH	Ohio Planning Conference
PN	Pennsylvania Planning Association

Program Components

Several aspects of the Wisconsin DNR program could be used by other states. First, the inventory of tools presented in the Internet Tools section (Chapter 4) provides a useful starting point for assembling a “tool box” to promote. Both the “Conceptual Framework” presented in Chapter 3 and the approach used to develop it can easily be adapted for use in other technology transfer programs. Outputs from the Wisconsin DNR program (e.g., automated PowerPoint presentation, fact sheets, instruction sheets, flyers, handouts, etc.) can be readily adapted for use elsewhere. Finally, the lessons learned from our assessment and evaluation efforts may be particularly applicable to other states and technology transfer programs.

Others Doing Similar Work

Although not directly applicable to the transferability of the Wisconsin DNR program to other states, U.S. EPA Region 5 staff requested that we look nationwide to see if there were other technology transfer programs similar in scope and approach to the Wisconsin DNR program. A number of others have attempted to assemble Internet based tools for use in planning and community decision making (e.g., PlaceMatters.org). We are aware of limited efforts to evaluate a subset of tools, primarily planning support tools that are not Web accessible (e.g., U.S. EPA 2000, Niemann and Limp 2004). There are several active outreach and technical assistance efforts focused on GIS and related technologies, but these are mostly focused at a state or sub-state scale (e.g., the University of Wisconsin and University of Connecticut Sea grant programs have GIS specialists; see also Warnecke et al. 2005). We have not, however, found another entity that focuses its technology transfer work specifically on Internet tools or which includes evaluative aspects similar to ours. There are, nonetheless, several technology transfer efforts that could be leveraged to further promote the use of Internet tools in local environmental management, planning, and decision making. We outline below those we feel have the most promise for such partnerships.

NOAA Coastal Services Center

The Coastal Services Center works to foster and sustain the environmental and economic well being of the nation’s coast by linking people, information, and technology. To this end, the center supports a variety of outreach and technical assistance efforts related to remote sensing and GIS. According to the Center’s Web site, it is a partner in over 100 ongoing projects geared to resolve site specific coastal issues. In order to better understand how these site specific efforts might inform broader efforts, we reviewed the most recent “NOAA Coastal Services Center Annual Operating Plan” (NOAA 2008b) to identify areas where Internet tools might serve as a focal point for technology transfer. We identified two specific areas, “coastal and ocean planning” and “coastal hazard resilience”, where efforts could be leveraged.

Coastal and Ocean Planning: The Center’s goal for work under this theme is that coastal communities will make land and ocean use decisions that lead to healthy coastal ecosystems and more resilient, economically-stable communities. This goal parallels the goals of the Wisconsin DNR program (see Chapters 1 and 2). Work under this theme includes a focus on land use planning (including smart growth strategies, watershed planning, the effects of land use planning on water quality, the consequences of climate change on land use, and public access). As part of this work, the Center offers “Coastal Community Planning and Development” training. Participants in this course learn about alternatives to how and where growth will occur in their communities as well as strategies to support smart growth. The Center also supports use of the Nonpoint-Source Pollution and Erosion Comparison Tool (N-SPECT), a GIS extension that helps coastal managers and local decision makers predict potential water-quality impacts from erosion and nonpoint source pollution.

Coastal Hazard Resilience: The Center's goal for work under this theme is for coastal communities to increase their resilience to coastal hazards. The concept of coastal hazard resilience emphasizes an integrative, community-based approach to minimize hazards exposure, reduce hazards impacts, and strengthen local resilience capacities. Resilient communities are reasonably capable of bouncing back after

natural disasters. They prepare well for such events and are capable of mitigating vulnerabilities, including those to ecosystems, the built environment, and area residents. The Center's activities are focused on 1) providing users with audience-focused coastal hazards risk and resilience data and information products, 2) providing audiences with improved skills and capabilities for assessing community resilience and hazard risks and vulnerabilities, and 3) supporting regional, state, and local collaborations to reduce community vulnerabilities and improve resilience capacities.

In addition, we note that the Center provides training to coastal resource managers through classes either taught at the Center's training facility or brought to an organization. Although the cost is minimal for participants and host organizations, these courses are limited to "coastal resource management professionals." Thus, their availability to most extension educators, planners, and many local government decision makers would seem to remain limited. To learn more about the Center's training offerings and training policy, peruse training reports, or access individual class links, see its Web site (<http://www.csc.noaa.gov/training/>).

PlaceMatters

PlaceMatters was conceived during the Tools for Community Design and Decision Making workshops, held six times from 1998 to 2005. The organization focuses on the application of innovative decision-making tools and methods, supports informed, effective, and equitable citizen engagement, and works to ensure that communities and organizations design and implement processes that garner broad public involvement and support, educate participants, and lead to sustainable, livable communities. These goals parallel those of the Wisconsin DNR program (see Chapters 1 and 2).

PlaceMatters.com, a program of Civic Results, was launched in 2002. For three years, PlaceMatters provided in-depth technical assistance and public process design, technical audits, and tools recommendations to various projects at the community and regional scale. In 2005, PlaceMatters staff members became the Planning Tools branch of the Orton Family Foundation. While with the Foundation, these staff worked to encourage and explore the innovative use of tools in community participation, planning, and design. In early 2007, PlaceMatters was re-created through a spin-off from the Orton Family Foundation and is now an independent affiliate of the Foundation.

According to the organization's Web site, PlaceMatters tries to accomplish its work by:

- Using novel public engagement techniques.
- Employing innovative decision-support tools.
- Integrating ecosystem based management and community planning.
- Ensuring better understanding of tradeoffs during decision-making processes.
- Sharing outcomes of on-the-ground projects with others in the field through conferences and a Web site (<http://www.placematters.org/>).

National Biological Information Infrastructure

The U.S. Geological Survey spearheads the National Biological Information Infrastructure (NBII) efforts through its Biological Resources Division. This division works with others to provide the scientific understanding and technologies needed to support the sound management and conservation of our Nation's biological resources. The NBII, which employs significant GIS and Internet technology, provides a cornerstone for these efforts. We reviewed the most recent NBII strategic plan (U.S. Geological Survey 2005) to identify technology transfer efforts that could be leveraged to further promote the use of Internet tools in local environmental management, planning, and decision making.

One strategy in this plan (Strategy 7) focuses on the need to "educate NBII users and potential users through outreach, training, and technical support." According to the strategic plan, NBII staff work with partner agencies and organizations to ensure that users have the knowledge they need to interact effectively with and document data and information served via the NBII. The program office provides outreach,

training, and technical assistance to partners, stakeholders, and customers. Outreach efforts include briefings and presentations by staff and partners, the Web-accessible NBII portal, exhibits at natural resources conferences and other gatherings, conference papers and journal articles, press releases and media interviews, and the production and distribution of a variety of educational materials. According to the strategic plan, the type and level of training and technical assistance provided to users is dependent upon: 1) the application or tool needed; 2) the amount of assistance required; and 3) the specific request made. In addition, individual NBII nodes provide as much assistance as possible through online documentation, as well as through personal assistance within available resources.

References and Related Reading

We found the following references helpful in assessing the transferability of our work to other states. We list these works, all other references cited, and additional useful sources together in the “Literature Cited, Further Reading, and Background Material” section at the end of this report.

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17. Recommendations

Based on feedback received at our workshops, in follow-up interviews and surveys, and through discussions with various stakeholders, we have identified a number of recommendations for state and federal agencies to consider as they go about their data management, tool development, and technology transfer efforts. In this chapter, we highlight priority recommendations related to Internet tools and technology transfer programs in general. Specific comments about the affects of soil data resolution, spatial units of analysis, etc. can be found in Chapters 11 and 12. Readers may also want to refer to the “Lessons Learned” in Chapter 15.

Recommendations Related to Tools

Develop a wide range of data products and tools. Agency efforts should include the development, maintenance, and promotion of a wide range of data products and tools. Different users will need to conveniently discover available data, easily access those data, generate useful map products derived from the available data, and manipulate those data to predict outcomes and impacts of various types of decisions.

Provide end-user feedback to developers. We have found through our work with the Midwest Spatial Decision-Support Systems Partnership that there is considerable value in creating a feedback loop that connects end users with tool developers. Our experience resonates with the Space Studies Board (2003), which found that many remote sensing applications have “specific requirements, including continuity in data collection, consistency in format, frequency of observations, and access to comparable data over time.” Further, they concluded that it is important that end user requirements be communicated to data producers and tool developers throughout the process of designing new technologies and producing and disseminating remote sensing data.

Create an easier path/paths to access the tools. Many end-users commented that they would benefit from having a single Web site/portal that listed each computer tool with a short description of what to use it for and how to use it, along with a link. (e.g., see the Wisconsin DNR program’s “Computer Tools” page at <http://dnr.wi.gov/org/es/science/landuse/CompTools/internet.htm>). Placematters.com provides one such portal. That Web site, however, does not focus specifically on *Internet* tools for planning, conservation, or environmental protection. This site also does not provide an extensive listing of data access tools.

Guide users to the appropriate tool(s). More often than not, local decision makers remain unaware of freely available decision-support technologies that can inform their decisions. Further, they often have difficulty identifying the appropriate data and tools to address specific environmental issues. We believe having a straightforward, user-friendly access point to a broad inventory of tools (i.e. a “metatool”) that directs users through a process of selecting tools appropriate for their particular needs would be beneficial.

Work toward interoperability of tools. As noted elsewhere, many users that we interacted with expressed interest in having tools “talk to each other.” There are a number of steps that agencies and their private sector partners can take to foster interoperability. First, we must promote data sharing. The National Environmental Information Exchange Network and the ongoing development of agency Web services are steps in the right direction. Second, interoperability will require establishing standards and standardized protocols. The Open Geospatial Consortium and the XML/GML/KML schema developed for the Exchange Network provide workable examples of such standards. Finally, those that fund tool development can place an emphasis on enhancing features of existing tools and creating interoperability as priorities over the development of new tools.

Evaluate the accessibility of Internet tools to people with disabilities. As noted in several areas of our report, the Wisconsin DNR program did not assess how accessible Internet tools or our instructional approaches (e.g., Webcasts and Webconferences) might be to individuals with disabilities. For example, we did not assess the ability of blind or visually impaired individuals to access the tools or educational formats using assistive technologies such as screen reading or screen magnification software.

Recommendations Related to Technology Transfer

Commit to ongoing technology transfer. Capacity building must be an on-going, sustained effort. Politics and turnover are regular aspects of government, particularly at the local level, that impact the effectiveness of capacity building efforts. One-time approaches will not likely result in institutionalized learning outcomes. Lessons learned from federally funded pilot projects and demonstrations, like the Wisconsin DNR's current efforts, should be shared and applied on a broader scale. The identification of issues, concerns, needs, capacities, and assets should be an on-going process. A number of participants requested post-workshop follow-up. One recurring suggestion focused on periodic electronic newsletters that would remind participants about the tools, update them on new data and tool developments, inform them about related resources, describe examples of uses of the tools, and provide direct links to the tools. This follow-up might increase use of the tools simply by reminding recipients that the tools exist as well as providing models of their application. We have begun implementing this idea.

Prioritize technology transfer for planning and funding. There appears to be relatively little commitment from federal agencies to effectively build capacity to use the data or tools that their programs develop. Budgets for outreach, technical assistance, and similar support are dwarfed by those for data acquisition and tool development (NSF 2002; OMB 2006) and often appear to be afterthoughts in the budget planning process. Agencies that do support these types of programs rarely coordinate their efforts with each other and tend to apply generic technical assistance approaches (e.g., they mass produce fact sheets, brochures, etc.) that may not be fully effective in transferring technology to the wide range of potential target audiences.

Agencies should dedicate and sustain financial resources for technology transfer with meaningful incentives for participation. For example, needs assessment work undertaken in Wisconsin as part of a coastal GIS applications project (Rink, Hart, and Miller 1998) uncovered a need for GIS training directed at the local government level. County staff indicated that while resources were generally available for GIS hardware and software acquisition and database development, training funds were scarce in most county budgets. The Space Studies Board (2003) identified several federal agencies that should provide funding for remote sensing training and educational materials.

Coordinate technology transfer efforts. Federal agencies will be more effective if they synchronize their technology transfer efforts, both within and across agencies—particularly in deployment at regional and field levels—and with similar state and nongovernmental programs targeted toward local and regional organizations. Thoughtfully planned and well coordinated outreach and assistance efforts can help foster data sharing and tool interoperability. As described in Chapter 16, the Sea Grant College Program and National Biological Information Infrastructure initiative already have significant technology transfer programs. Those seeking to pursue technology transfer on a broader scale should consider coordination with these and other similar programs, like the Nonpoint Education for Municipal Officials (NEMO), Space Grant College Program, and U.S. Forest Service technology transfer efforts.

Leverage existing outreach organizations, structures, programs, and events. A number of nongovernmental organizations are already providing effective outreach and technical assistance. For example, the International City-County Management Association assisted Purdue University in developing a user friendly interface for the LTHIA tool and hosts the tool at its Local Government Environmental Assistance Network. As with coordination of federal agency efforts, tapping into these existing organizations and efforts can create economies of scale.

Use the Internet for technology transfer. One area meriting further exploration is the use of the Internet itself to teach about Web-based data, tools, and technologies. Our experience in Wisconsin (Bellrichard and Watermolen 2007) suggests Webconferencing and Webcasting may be effective means of teaching local officials how to access and use GIS data and applications. The U.S. EPA's Watershed Academy Distance Learning Program (<http://www.epa.gov/watertrain/>) provides another model of Web-based learning that should be considered. We have not yet explored the use of other Internet applications/technologies (e.g., RSS feeds, social networking, FaceBook, Twitter, YouTube, etc.) for these purposes, although we believe they merit consideration as technology transfer vehicles.

Evaluate technology transfer efforts. As discussed in Chapters 2 and 3, educational evaluation, which is too often overlooked or avoided by technology transfer programs, remains necessary to understand whether technology transfer efforts effectively reach their intended audience(s). Government agencies responsible for developing Internet tools should develop an organized and systematic means to evaluate and learn from their projects and the associated technology transfer efforts. The U.S. EPA-supported approach applied in the Wisconsin DNR program is one model for such efforts. Readers might also want to consult the references cited at the end of Chapter 3 for additional background on program evaluation.

Investigate public confidence in Internet tools. A high degree of trust and transparency needs to be established and maintained within the public realm to give Web-based tools legitimacy and accountability. There is still very little research on the level of trust the public places on information or analytical tools that they come across on the Internet. Some preliminary research suggests that some sectors of society place more trust in information on the Web than in certain magazines or newspapers. However, a great deal more social science and marketing research work is required in this area.

Investigate public perceptions of spatial problems and means of representation. We note elsewhere that difficulties with navigation and interpretation of map products sometimes hindered members of our target audiences in using some of the tools as effectively as they might have in the absence of such complications. Some of the practical steps for addressing accessibility and usability that are mentioned in the “Lessons Learned” in Chapter 15 could help reduce these hurdles. We think, however, that this is an area that merits additional research by cognitive and social scientists.

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Supporting Materials

18. Literature Cited, Further Reading, and Background Material

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Several institutional partners collaborated with us. The University of Wisconsin-Stevens Point's Center for Land Use Education and the University of Wisconsin Land Information and Computer Graphics Facility conducted workshops with us. The Center for Land Use Education administered the Web-based survey of Extension agents. Suzanne Wade and her educator colleagues in UW-Extension's Southern District helped us pilot test instructional methods and materials. Dan Rolfs, WAPA Southwest District Representative, helped identify and recruit participants for the professional planners focus group. Doug Miskowiak (University of Wisconsin-Stevens Point) and Thomas McClintock (University of Wisconsin Land Information and Computer Graphics Facility) helped instruct some of our workshops. Elaine Andrews (UW-Extension) and Dana Lucero and Dan Bellrichard helped organize and conduct the Webconference series. UW Extension educators throughout Wisconsin hosted viewing sessions at their county offices. Jordan Petchenik (Wisconsin DNR) assisted us with survey design and administration. Steve Ventura (University of Wisconsin Land Information and Computer Graphics Facility) provided counsel throughout the project. We appreciate all of this support.

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Appendix A: Technology Transfer – National/Regional Conference Presentations Resulting from the Wisconsin DNR Program

EPA staff requested that Wisconsin DNR make a concerted effort to transfer findings from its efforts for broader regional and national applications. The following presentations resulted directly from work undertaken as a part of the federal assistance agreement and transferred lessons learned from Wisconsin DNR's capacity building, technical assistance, outreach, and evaluation efforts. These presentations addressed large national and regional audiences. Links to conference proceedings, presentation slides, or related sites are provided when these are available on the Internet.

Watermolen, D.J. and J.G. Sullivan. 2008. Interoperable Spatial Decision Support Tools: Wisconsin's Approach. U.S. EPA's joint GIS Work Group and Statistics Users Group fall meeting. Ralph Metcalfe Federal Building, Chicago, IL. (September 16, 2008).

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- Watermolen, D.J. 2004. Supporting Local Decision Making: An Overview of Wisconsin's Efforts. "GIS Tools and Community Watershed Planning Workshop." Northwest Indiana Regional Planning Commission and Purdue University Calumet School of Science, Mathematics, and Engineering, Hammond, IN. (May 25-26, 2004).
- Lucero, D. and M. Murrell. 2004. The Results Are in: Which Web-based Tools Enhance Public Dialogue and Decision Making? "Wisdom of Voices 2004," International Association of Public Participation (IAP2) International Conference, Madison, WI. (May 4, 2004).
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Appendix B: Technology Transfer – In-State Conference Presentations Resulting from the Wisconsin DNR Program

The conference presentations listed below transferred findings from the Wisconsin DNR's outreach, technical assistance, and capacity building program. These presentations were not part of the actual capacity building effort, but rather transferred lessons learned from Wisconsin DNR's efforts. These presentations addressed large in-state audiences. Links to conference proceedings, presentation slides, or related sites are provided when these are available on the Internet.

Watermolen, D.J., A. Mednick, and J. Sullivan. 2008. Geospatial Decision Support Systems for Land Planning and Natural Resources Professionals. "Leaping into Enterprise: Building on 20 Years of Land Records Integration," 2008 Annual Conference, Wisconsin Land Information Association. Grand Geneva Resort, Lake Geneva, WI. (February 29, 2008).

Watermolen, D.J. 2007. Internet Tools for Locating Wetlands and Assessing Functional Values. "Riverine Wetlands: Connections, Corridors, and Catchments," Wisconsin Wetlands Association 12th Annual Wetland Science Forum, La Crosse, WI. (February 1-2, 2007).
See <http://www.wisconsinwetlands.org/2007forum.htm>.

Bellrichard, D. and D.J. Watermolen. 2006. Webcasting as a Training Method for Internet GIS Resources. ESRI Wisconsin User Group 2006 Conference, Paper Valley Radisson, Appleton, WI. (November 1-2, 2006).
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Watermolen, D.J. 2006. Internet Tools for Planning, Conservation and Environmental Protection. Wisconsin County Code Administrators Spring Conference. Stoney Creek Inn, Wausau, WI. (March 30-31, 2006).
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See <http://www.ewug.org/page3.html>.

Lucero, D. and M. Murrell. 2004. Enhancing Local Land Use Decisions through the Evaluation and Use of Web-based Tools. Wisconsin Land Information Association 2004 Annual Conference, Wisconsin Dells, WI. (March 4, 2004).

Watermolen, D.J. 2002. Tools to Help You with Local Land Use Planning Participation. "Wisconsin's Changing Landscape: Natural Resource Issues on DNR Properties and Statewide." Wisconsin Dept. Natural Resources Bureau of Facilities and Lands Statewide Conference, Wintergreen Resort and Conference Center, Lake Delton, WI. (October 8-10, 2002).

Appendix C: Technology Transfer – Publications Resulting from the Wisconsin DNR Program

The publications listed below transferred findings from the Wisconsin DNR's outreach, technical assistance, and capacity building program. These publications were not part of the actual capacity building effort, but rather transferred lessons learned from Wisconsin DNR's efforts. These publications address a variety of audiences. Links are provided for those available on the Internet.

- Mednick, A.C. (In Review). Does soil data resolution matter? STATSGO versus SSURGO in rainfall runoff modeling across Wisconsin. *Journal of Soil and Water Conservation*.
- Mednick, A.C. (In Review). Predicting the impact of local land use change on stormwater runoff: an evaluation of four GIS-based planning support tools. *Environmental Management*.
- Watermolen, D.J., E. Andrews, and S. Wade. 2009. Extension educators can use Internet GIS and related technologies. *Journal of Extension* (In press).
- Watermolen, D.J. 2008. Land cover data and tools for analyzing alternative futures: One state's lessons learned. Chapter 16, pp. 293-330. In J.C. Campbell, K.B. Jones, J.H. Smith, and M.T. Koeppe (eds.). *North American Land Cover Summit*. Washington, DC: Association of American Geographers. See <http://www.aag.org/books/nalcs/chapters/CH16.pdf>.
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Available online at http://dnr.wi.gov/org/es/science/publications/PUB_SS_760_2008.pdf.
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See http://dnr.wi.gov/org/es/science/publications/PUB_SS_758_2006.pdf.
- Lucero, D. 2006. Internet tools bring science to local decisions in Wisconsin. *ECOSTates: The Journal of the Environmental Council of States* (Spring):14-16.
See http://www.ecos.org/files/2196_file_ECOSTates_Spring_2006.pdf.
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Notes