Helping Communities Make Watershed-Based Land Use Decisions: Three Successful "Real World" Examples that Make Use of GIS Technology

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At some point, all watershed management efforts must confront the common denominator of local land use policies. Local land use decision-makers—whether elected or appointed, professional or volunteer—need assistance in overcoming the many barriers to making watershed-based, environmentally sound land use decisions. Among these barriers are the narrow focus of most land use boards and commissions, their high turnover rate, their inability to predict or track cumulative impacts, and their decision-making framework defined by political boundaries.

The key to addressing these problems is education and information. Perhaps the most unexplored tool for supporting educational and informational programs is geographic information systems, or GIS. GIS is increasingly used at the federal and state levels of government for natural resource management, including many new watershed-based studies and inventories. At the local level, GIS, where used at all, is most often applied to problems like school bus routing or property tracking for the tax rolls. However, the use of GIS as a tool to help municipal officials protect their water resources is being explored by relatively few. GIS images can convey an enormous amount of information in a succinct, understandable format especially useful to busy decision-makers needing to put their actions into a "bigger picture."

This panel session brings together three groups of projects in New England that are making use of GIS to help communities change the way they look at land use decisions. All are educational projects spearheaded by the Cooperative Extension Service (CES), in partnership with other agencies. In Connecticut, CES is teaming with The Nature Conservancy to do two watershed projects in the lower Connecticut River, one of 40 places designated as a "Last Great Place" by the Conservancy. The projects make use of a wide range of digitized data, including cutting-edge remotely-sensed land cover data, to create educational products and programs. Through the use of GIS parcel (property) data, these programs are targeted to specific audiences. In Rhode Island, CE staff are not only using GIS as an educational tool, but they are training local officials in the use of GIS. In addition, GIS information is used to run a new risk assessment model that estimates nonpoint nutrient loadings. In New Hampshire, extensive data from the state GIS system was combined with ten years of water quality data collected by citizen monitoring programs to analyze subwatersheds of the Squam Lakes system, with regard to their impact on water quality and wildlife habitat. GIS is also being used to help communities inventory, evaluate and prioritize their natural resources.

Taken together, these projects demonstrate the wide range of creative ways that GIS can be applied to watershed projects—from visualization to loadings analysis to audience targeting, with a few stops in between. This panel is not about technology, but about education and the use of this new technology to better inform the local land use process. We hope that it will stimulate discussion of new and better ways to tackle watershed management at the all-important local level.

The Tidelands Watershed Projects: Using Computerized Natural Resource Information to Promote Watershed-Based Decision-Making at the Local Level

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Overview

The University of Connecticut Cooperative Extension System and The Nature Conservancy, Connecticut Chapter are collaborating on two innovative watershed projects in the lower Connecticut River, an area designated as a "Last Great Place" by The Nature Conservancy in 1993. The Chester Creek and Eightmile River watershed projects are non-regulatory, non-advocacy natural resource management public education initiatives, conducted in close cooperation with local residents and town officials. The projects were begun with seed funds from the Environmental Protection Agency, and are continuing with ongoing USDA funding through Cooperative Extension, and the support of The Nature Conservancy.

During the course of the projects, a multi-disciplinary team from Cooperative Extension and The Nature Conservancy conduct a series of educational workshops on a number of natural resource management issues including nonpoint source pollution, forest stewardship, and environmentally-sensitive property management. The workshops, planned and conducted with input and guidance from a local advisory committee, are supported by maps and information collected by the project on a geographic information system, or GIS. GIS is used not only to collect, analyze, and display data, but to target the educational message to key audiences. While these projects are relatively young, there are already strong indications that this approach is an effective one at helping both individuals and municipal entities adopt a watershed perspective, and become stewards of their natural resources.

A Last Great Place

In March, 1993, the *Tidelands of the Connecticut River* region was designated by The Nature Conservancy (TNC) as one of forty "Last Great Places" in the western hemisphere. The *Tidelands* region encompasses the lower 37 miles of the Connecticut River, from the Rocky Hill/Glastonbury area of Connecticut to the mouth at Long Island Sound. The region is the southernmost portion of the Connecticut River watershed, a major basin which incorporates an extensive area surrounding the River from the Canadian border down through Vermont, New Hampshire, Massachusetts and Connecticut. The *Tidelands* stretch of the River was singled out because of its exemplary complex of high quality salt, brackish and freshwater tidal marshes, and the many threatened and endangered species that the complex supports.

The "Last Great Places" initiative constitutes a commitment by TNC to preserving the ecological integrity of areas far too large to be addressed solely by TNC's traditional methods of land protection. Such large-scale efforts require that public agencies and private organizations work together to promote and assist natural resource conservation at the local level. Land use and resource management issues at the regional or watershed levels are complex, and have not lent themselves well to resolution through conventional regulation and enforcement approaches. In the Northeast, the strong tradition of local "home rule" also serves to work against "broad brush" solutions mandated by federal or state authorities. Education—of local officials, of individual landowners, of the general public—

can be an effective, nonregulatory method for addressing these complex issues.

This paper describes the ongoing development of an education-driven approach to watershed management. At the time of the *Tidelands* announcement, the University of Connecticut Cooperative Extension System (CES) *Nonpoint Education for Municipal Officials* (NEMO) Project had been working with coastal communities in Connecticut on the issue of nonpoint source water pollution. Over the past four years, the NEMO project team has developed an effective educational methodology using geographic information system (GIS) computerized mapping as a tool to help municipal officials understand the impacts of land use on water quality and options available for managing those impacts (Arnold et al., 1994). With the "Last Great Places" designation as a catalyst and the NEMO model as a programmatic basis, CES and TNC staff conceived the *Tidelands* watershed projects, which were given a crucial boost from two one-year "start-up" grants from the Environmental Protection Agency.

Project Areas

As part of the "Last Great Place" designation, TNC-Connecticut Chapter had identified 17 "core sites" in the *Tidelands*, based on their assessment of habitat value. The first step in selecting a project site was to view these core wetlands not as isolated units, but as natural resources affected by the activities in the local watershed subbasins draining to them. Of the 17 areas, potential project sites were considered based on the natural resource base, land use patterns, availability of digital data, watershed size, and the number and enthusiasm of the affected towns. Based on these criteria, Chester Creek watershed was chosen for the first project in late 1993, and a year later the Eightmile River watershed was selected for the second project.

The Chester Creek watershed is a 14.5 square mile basin located on the western side of the lower Connecticut River, approximately 25 miles upstream of Long Island Sound (Figure 1). Almost 80% of the watershed is in the town of Chester. The 63 square-mile Eightmile River watershed lies just across the River on the eastern side, and includes major acreage in three towns. In addition to the critical tidal marsh habitat to which both of these watersheds drain, each area has significant upland biological and aquatic resources (Nelson and Arnold, 1995).

Key Project Elements

The *Tidelands* watershed projects have several key elements that we wish to highlight. The first is the partnership between Cooperative Extension and The Nature Conservancy. While private-public partnerships may be fairly common these days, truly successful ones are a bit more scarce. The *Tidelands* partnership creates overall benefits for the watershed projects that go beyond the skills and expertise of the individual team members. Both TNC and CES are organizations with non-advocacy, research-based philosophies. However, the "Last Great Place" designation gives the projects a regional framework and a "reason for being" that the University alone could not provide. In return, the experience of CES in dealing with property owners and municipal officials on land use and conservation issues provides the projects with an educational "track record" at the local level that TNC alone could not match.

The second key element is yet another partnership—that between the project team and the towns with significant acreage in the watershed. A key criteria for selection of the two project sites was the strong support of the chief elected officials of each town involved. After that step, advisory committees were formed of key land use and other officials from each town. These committees meet frequently with the project team to review the GIS maps, discuss local concerns, and assist in planning and publicizing the educational workshops. The goal is to have these committees, or some combination of the groups that they represent, take complete ownership of any resource management initiatives resulting from the projects' education and information.

The third key element is the educational use of GIS technology. While GIS is often used for natural resource planning and analysis at the state and federal level, at the local level it is typically reserved for things like tracking property taxes or routing school buses. Through the NEMO project, the University of Connecticut CES has been exploring the use of GIS to educate municipal officials. The emphasis is not on the analytical ability of GIS so much as the ability of well-crafted, colorful maps to convey complex issues and relationships in a simple and understandable manner. In the case of NEMO, the focus is on portraying the links between land use and

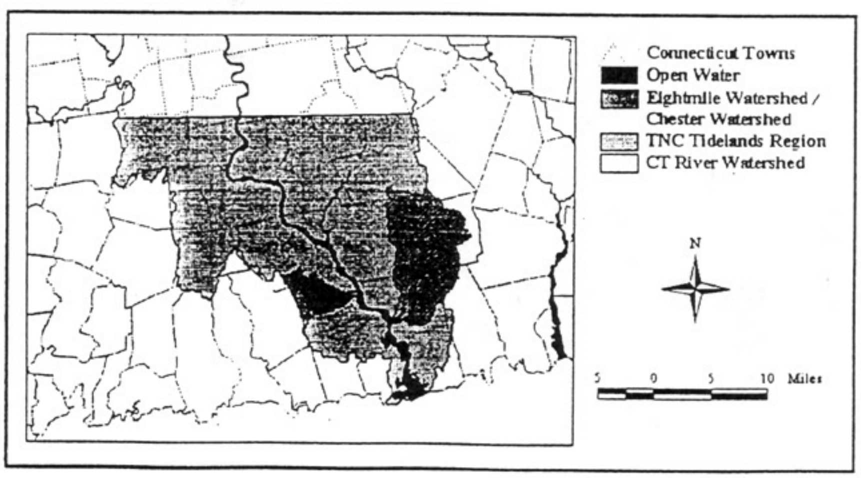

Figure 1. Tidelands region and watershed project areas.

water quality through the display of satellite-derived land cover information.

The *Tidelands* watershed projects expand on this basic NEMO methodology in several important ways. The start-up grants enabled the projects to hire a private GIS consulting firm to collect, and in some cases digitize, a wide variety of information on the watersheds. Data layers include land cover, water features, open space, soils, drainage basins, wetlands, roads, zoning categories, and parcel boundaries (property lines). This list goes well beyond what is available for any of our NEMO programs, and allows the project team to expand the range of the educational programs beyond nonpoint source pollution to include other topics relevant to the watershed. In the Eightmile project, for instance, we are planning programs on forest stewardship, open space management, and streamside property management.

An expanded list of educational topics translates to a longer list of target audiences, broadening the constituency base for the projects. While the nonpoint source and open space programs remain targeted at municipal officials and local groups like land trusts, the forestry and property owner programs are largely aimed at individuals. With a slight twist to our use of GIS, we have devised a technique to help us reach these individual audiences. Using the parcel data layer, we can identify specific target audiences for a given educational program. For example, in Chester Creek the GIS was queried to identify all properties within the watershed over 5 acres in size with predominately forested land cover. Linking this list to a tax assessor's database gave us the names and addresses of the owners of the properties, which we then used to do a direct mailing announcing a forest stewardship workshop. The turnouts at programs for which we have used this targeting method have been very impressive. In the next few months, we'll be using information similar to that portrayed in Figure 2 to promote streamside property owner programs in the Eightmile watershed. The addition of individual land owners as a target audience for our watershed programs, and the targeting of this critical sector via GIS, is an improvement on the NEMO educational model that we think will greatly enhance the success of these projects.

So, Is it Working?

Our experience suggests that it often takes years for natural resource management educational programs to bear fruit in the form of significant changes to local land use policies or practices. While working to change individual practices may have a somewhat faster turnaround time, working with local officials, many of whom are volunteer members of town commissions, takes thoroughness, patience, and often considerable repetition. The Chester Creek project conducted its first educational program in June of 1994, while the Eightmile River project programs began in early 1996; thus, these projects have been in town for only a brief period.

That being said, we feel that significant progress has been made, and that the potential exists for even greater gains. In Chester, a year of educational programming was followed by a quiet period, during which the various audiences digested and discussed the information provided to them. It now appears that the "digestion" period is over and the real work of institutionalizing change has begun. In August of 1995, the project advisory committee submitted a report to the Board of Selectmen, with recommendations for actions to be taken by the town to protect the watershed. The Selectmen then formally appointed this *ad hoc* committee to a two-year term, and charged them with pursuing implementation of these actions. The recommendations include development of comprehensive watershed management and open space plans; multi-commission review of water quality issues and forest management strategies; continuation of environmental studies focused on the Chester Creek watershed at the elementary school; and, investigation of the development of a town Natural Resources Center. With the town committee now as the driving force behind this strategy, the CES/TNC project team will provide technical support in the form of continuing educational programs that will be tailored as needs arise. Clearly, Chester is well on it's way toward local ownership of project initiatives.

While it is too soon to report such progress for the Eightmile River project, the productive sessions with the ten-person, three-town advisory committee have been very encouraging, as has the positive reaction to the educational programs done to date. This project, which is perhaps a more representative model based on the watershed's size and number of political jurisdictions, is already

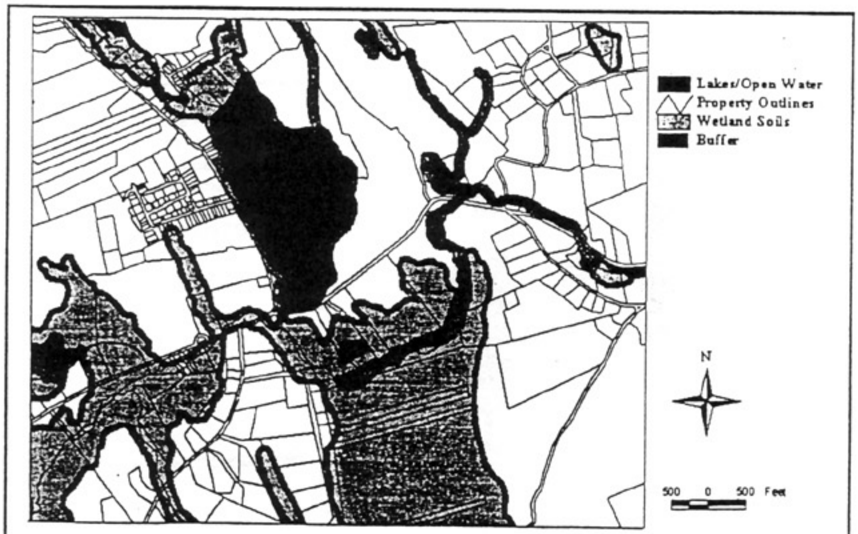

Figure 2. Map used to target streamside property owners.

reinforcing our belief in the effectiveness of GIS-based education to promote the watershed approach. With the watershed maps serving as the common denominator among the advisory committee members, watershed-wide issues can be discussed while still recognizing the dominant role of municipal policies and individual actions in determining land use.

It's been said that "knowledge is power." In our experience, maps can be a uniquely effective tool for transferring knowledge, with their ability to convey complex information in a succinct and understandable way. Once armed with this knowledge, it appears that local officials and land owners are much better able to work together to prioritize problems, discuss solutions, and chart courses of action. While this may seem an obvious point, it doesn't make the implementation of such a program any easier. The trick is in crafting the right maps and devising appropriate educational programs to accompany them, and in providing long term assistance to local decision-makers and residents to facilitate their use of this information.

With our NEMO experience and the commitment of TNC and CES staff to working with these communities over the long haul, we are confident of our ability to meet these requirements. However, we are still working on the problem of making the GIS data readily available and useable to the locals, independent of our involvement. None of the towns involved with these two projects has its own GIS system, and Connecticut, as yet, has no centralized GIS repository. Hard copies of the maps can and will be provided, but this falls short of the goal of true accessibility. The project team and towns are exploring various options to rectify this situation.

References

Nelson, Heather L. and Chester L. Arnold. (1995). *The Chester Creek Watershed: A Progress Report on a Unique Natural Resource Management Partnership.* Publication of the University of Connecticut Cooperative Extension System.

Arnold, Chester L., H.Crawford, C.J. Gibbons, and R.F. Jeffrey. (1994) *The Use of Geographic Information System Images as a Tool to Educate Local Officials about the Land Use/Water Quality Connection.* Proceedings of Watersheds '93 conference, Alexandria, VA, March 1993.

Promoting Watershed Based Land Use Decisions in New Hampshire Communities: Geographic Information System Aided Education and Analysis

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Introduction

In New England we place great importance in the local decision making process. These local decision makers are primarily elected or appointed or may be volunteers. They may or may not have the direct assistance of a planning or environmental professional. They often do not have, or lack access to, the proper resource information and education on which to base their decisions. Yet, these local officials are responsible for evaluating development, subdivision, residential, industrial, commercial and recreational projects all of which can have significant impact on a community's natural resources. They are also responsible for the implementation of land use and zoning regulations and the development of the community's master plan which affects the future land use of their community. Thus, while local decision making is the key to watershed based community resource protection, the information and education required to make informed decisions is often lacking or severely limited.

Watershed assessment and protection efforts have generally been driven by more "reactive" approaches in which wetlands and waters that show signs of degradation are examined and the resulting diagnostics are used to attempt to mitigate the damage. A more proactive approach is necessary for the high quality wetland or water body, typical of New Hampshire, since a major concern is to keep the ecosystem in as pristine a condition as possible. Information and understanding of connectedness, linkages and interrelationships between land use activities and the watershed resources are critical to local decision makers and landowners alike.

In an attempt to address these complex issues, various method manuals have recently been developed to assist local officials and interested citizens in finding or assembling the information necessary for planning and decision-making. These valuable manuals include methods for evaluating the functional values of freshwater and coastal wetland systems (Amann and Lindley-Stone, 1991; Cook et al., 1993) as well as a handbook on community natural resource inventories (Auger and McIntyre, 1992). This latter work offers suggestions and provides examples of a resource inventory process that is based within the *political boundaries* of the community. This resource inventory process has also been adapted to demonstrate this approach in the context of a *watershed based* assessment and analysis (Schloss and Ruben, 1992).

The advent of Geographic Information Systems (GIS) has brought a new and potentially powerful inventory, analysis and educational tool to watershed investigators and decision makers. Although GIS natural resource applications are currently being developed and explored on a statewide and regional scale there has been less effort to transfer and utilize the technology at the local level. This paper presents two examples of approaches undertaken by University of New Hampshire Cooperative Extension educators and other to use GIS as an information, analysis and education tool. The first case study presented involves towns that are part of a multi-jurisdictional lake watershed and the second involves multiple wetland watersheds within a single town.

GIS Inventory and Analysis of the Squam Lakes Watershed

As part of a model watershed study under the direction of the NH Office of State Planning, a multi-agency task force worked to create a GIS based resource inventory of the Squam Lakes Watershed (Scott et al., 1991). The state's GIS , GRANIT (for Geographically

Referenced Analysis and Information Transfer) is housed at the University of New Hampshire but linked to state agencies and regional planning commissions. Data "layers" used in this GIS study included bedrock geology, hydrology (streams, wetlands, lakes, ponds and aquifers), soils, elevation, land use zoning, land cover (from aerial photographs and satellite images) and wildlife habitats. This was in addition to a base map of roads and political boundaries. Also included was ten years of water quality data, collected weekly during the ice free season throughout the lake, by volunteer monitors of the Squam Lakes Association under the direction of the NH Lakes Lay Monitoring Program.

A conventional GIS analysis of land capability was undertaken to displays all of the developable area remaining in the watershed. The GIS was also used to analyze information on zoning specific to each town (i.e., land area required for each house lot) and provide a "buildout scenario" that could estimate the number of new houses by town and by subwatershed, and the resulting increase in population. When this was done for the Squam Lakes watershed it was found that about 12 percent of the watershed was currently developed or protected, about 52 percent was constrained or restricted to development, and almost 37 percent of the watershed was left to be developed. While, as a whole, the lake displayed excellent water quality and was relatively pristine in nature, there were areas within the lake with less desirable water quality conditions. Thus, the problem was defined: areas of the lake were already showing signs of water quality degradation yet current laws and regulations would allow development within the watershed to expand over three times the area of what was already developed. What was still needed was a method to locate critical lake areas and produce additional GIS products to educate and support decision makers and their communities.

With that in mind, it was time to go beyond the traditional GIS approaches and "push the envelope" by exploring GIS data display and visualization. Displaying the water quality data spatially, it became apparent that many of the small coves and embayments were areas of more degraded water quality. The data suggested that the lake did not react uniformly to watershed inputs; that it was not just one big reaction vessel or "bathtub" as is commonly assumed for many large systems. This concept was further enhanced by taking the bathymetric map (depth contour plot) of the lake and using the GIS to create a 3-D model of the lake bottom. No experience in topographic readings was necessary to be able to see how the lake was really made up of multiple basins connected together and that each of these basins had high sills around them.

With the basins defined, they could be associated through the GIS with the abutting subwatersheds. This would allow for analyses of what characteristics of the land around the basins had an influence on the basin's water quality. While our study team had the luxury of an extensive GIS data-base of land cover (down to the type of tree stand from aerial photography !), we started with some basic GIS analysis using information that would be more readily available to localities across the state. With some relatively simple data analyses, areas of the lake that react more critically to nutrient loading were defined. A land cover analysis found that land cover within the shoreland zone (a 250 foot area from the lake shore) explained less water quality variation than the total subwatershed land cover. Thus, although shoreline regulations are important for the Squam Lakes, activities *throughout* the watershed also have a major impact. The results of these applied analyses and others were then built into our community educational programs.

Through community advisory groups we learned that other aspects of the watershed besides water quality held equal if not greater importance. To that end, a GIS layer of loon habitat (provided by volunteers of the NH Loon Preservation Society), bass nesting areas, cold water fish reefs and holes, and smelt brooks (from NH Fish & Game and volunteer surveying) was created. The GIS could then reference the various in-lake and shoreline wildlife extent contained in each of the basins. Now the GIS was complete with information of in-lake water quality conditions and wildlife resources. From this information the GIS was used to locate the lake's most critical areas. For each basin and adjoining subwatersheds the GIS simply averaged together all of the criteria scores. The resulting integration was best visualized by draping a color (light or "cold" for less critical, reddish or "hot" for most critical areas) over the 3-D plot of the lake basins.

A color slide program that best visualized the procedures and concepts of this demonstration study was developed and presented at educational sessions to communities throughout the state. However, the materials produced for the communities and decision makers in the watershed had to be more functional; Towns and most citizens still do not have easy access to GIS systems so a more "low tech" set of products were developed. For the town decision makers, a map of the watershed area was provided, delineating the various subwatersheds and subbasins of the lake labeled by number. These numbers were then referenced to a printed table which contained the water quality and resource information of both the basins and the abutting sub-watersheds. Thus, instead of having to decide on the approval of a project based solely on information provided by the applicant, the decision maker can look up the subwatershed where the project is being proposed, check on the important lake resources that may be impacted, weigh benefits and concerns, and have the applicant address specifically how they will minimize loss or impacts to that resource. Tabled information could also be captured to a spreadsheet or a database system and digital maps could also be provided to those with GIS display systems. However, there have been no requests for GIS products at this level of sophistication to date.

GIS Analysis of Local Wetland Buffer Options for Deerfield, NH

This past fall, a new guidance document was published on riparian buffer function that included recommendations for regulatory and nonregulatory buffer widths (Chase et al., 1995). It represents a collaborative effort between the Audubon Society of New Hampshire, NH Office of State Planning, UNH Cooperative Extension and the USDA Natural Resources Conservation Service. The guidebook focuses on water quality and wildlife habitat as two key functions of upland buffers. It provides municipalities with both a scientific rationale and practical actions for protecting and preserving naturally vegetated upland areas that border surface waters and wetlands. Ultimately, local decision makers will need to determine the most appropriate buffers to suit their needs and the means for establishing them. In an effort to introduce this new tool and to demonstrate how GIS might be used to assist in the decision making process, a pilot project was undertaken and the results presented to a statewide audience at a GIS workshop for decision makers sponsored by the NH Office of State Planning and the University of New Hampshire.

The Town of Deerfield, NH completed a comprehensive inventory of its natural resources in the spring of 1991 extensively using GIS (see Appendix D in Auger and McIntyre, 1992). For investigating the various buffer scenarios it was first necessary to take an inventory of the water resources of concern. From the GIS base map, surface waters are already delineated. The GIS soils coverages were used to delineate wetlands areas (from Hydric soils classifications). Other options for NH towns to delineate wetlands include digitized or hard copy National Wetland Inventory maps and Landsat derived wetland classifications, both available through GRANIT. The inventory of Deerfield disclosed that wetlands comprise 86% of the town's water resources acreage and many are connected and lie within stream corridors that run throughout the town.

The existing regulatory buffers and setbacks in the town were analyzed using GIS. Two sets of state laws and regulations are already concerned with maintaining a vegetated buffer at the shoreline of lakes and streams. The Comprehensive Shoreline Protection Act requires that a minimum tree basal area must be maintained at greater than 50 percent within 150 feet from the shore of lakes greater than 10 acres and 4th order or greater streams (except those in the NH Rivers Program). State forestry regulations also maintain this requirement for land within 50 ft from a perennial stream or brook. There is also a setback of 75 feet for buildings and septic systems bordering wetland areas required under town regulations. The GIS display of these overlay zones indicates the existing acreage of these areas as 434 acres under the Shoreland Protection Act, 577 acres under the forestry regulations and 2880 acres bordering wetlands with town mandated setback restrictions.

Through a review of the current scientific literature and recommendations of other states, and with priority focused on water quality protection, a "reasonable" minimum buffer width of 100 feet is recommended in the buffers guide. A larger buffer is recommended for sensitive wetlands (bogs, fens, white cedar swamps), prime wetlands, endangered or threatened species protection, or to support wildlife habitat more thoroughly. Through the use of GIS, maps were produced that visualized the extent of lands that would be impacted by the new recommendations. Imposing the 100 ft buffer overlay for wetlands and streams about doubles the protective acreage around streams and adds another thousand acres that border wetlands. This represents a 40 percent increase in the protected areas. Using an overlay of the town tax map the decision makers are now able investigate the degree to which different lands might be affected by various regulatory approaches.

Through use of the NH Method (Ammann and Lindley Stone, 1991) the Town of Deerfield evaluated the functional values of all of its major wetland areas and is proposing some of these for designation as prime wetlands. As the buffers document suggests a buffer larger than 100 feet, our study explored the use of a 200 foot buffer in our analysis. An overlay of this buffer was created to visualize the impact and to discern whether the size chosen was adequate to serve both water quality and wildlife habitat concerns. The resulting analysis indicated that with the 200 ft buffer some wetlands in the sample area would be connected to each other, but others would not. If habitat considerations are a goal, the GIS analysis indicated that other, perhaps nonregulatory, methods would be needed to establish habitat connections among all of the critically important wetlands.

Nonregulatory approaches to buffer protection were also explored with GIS analyses. For purposes of wildlife habitat and travel corridor protection and to maximize the benefits of conservation lands, acquisition of larger buffer areas may be required. To achieve this level of protection a town may have to rely on land acquisition and/or conservation easements. Use of the GIS information regarding the wetland and stream locations, existing and proposed buffer overlays and habitat land cover information along with property or tax map overlays and existing conservation lands can help decision makers choose the most cost-effective way of achieving their goals.

Conclusion

All of the community and watershed based inventory processes and guidance documents discussed in this presentation offer a proactive approach for decision making, resource protection, and stewardship. They encourage the community to become involved in defining what resources are important and why. They also provide the information required to develop protection and management strategies. The use of GIS in educating the local communities, especially exploring and visualizing the extent, impacts and benefits of various protection and management alternatives, can greatly enhance the local decision making effort.

References

Ammann, Alan. and Amanda Lindley Stone. (1991). *Method for the Comparative Evaluation of Non-*

tidal Wetlands in New Hampshire. NH Department of Environmental Services, Concord, NH. NHDES-WRD-1991-3.

Auger, Phil and Jennie McIntyre. (1992) *Natural Resources: An Inventory Guide for New Hampshire Communities*. Upper Valley Land Trust and University of New Hampshire Cooperative Extension. Durham NH.

Chase, Victoria, L.S. Deming and F. Latawiec. (1995) *Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities*. Audubon Society of New Hampshire. Concord NH.

Cook, Richard A., A. Lindley Stone and A. Ammann. (1993) *Method for the Evaluation and Inventory of Vegetated Tidal Marshes in New Hampshire*. Audubon Society of New Hampshire. Concord, NH.

Schloss, Jeffrey A. and Fay A. Rubin. (1992) *A "Bottom-Up" Approach to GIS Watershed Analysis*. Proceedings of the 1992 GIS/LIS Conference. November 10-12, 1992. San Jose, CA. American Society for Photogrammetry and Remote Sensing (and others). Volume 2. pages 672-679.

Scott, David, J. McLaughlin, V. Parmele, F. Latawiec-Dupee, S. Becker and J. Rollins. (1991) *Squam Lakes Watershed Plan*. Office of State Planning, Concord, NH.

Training Local Officials in Watershed Management Using User-Friendly Geographic Information Systems

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Targeting Local Officials for Nonpoint Training and Technology Transfer

Rhode Island cities and towns, like other New England communities, play a key role in protecting water quality. They develop community plans, review subdivision proposals, approve zone changes, and manage community water supply systems. Through these routine land use decisions, local officials have the opportunity to control nonpoint pollution. Yet, volunteers serving on planning and zoning boards, town councils, and other boards making these decisions often have limited expertise in watershed management. Perhaps more importantly, water quality protection is only one of many competing and sometimes conflicting issues that local decision makers face. Unless there is an immediate threat to community water supplies or economically important recreation or shellfishing areas, pollution prevention may not be perceived as an urgent priority, especially when economic development needs and other local issues vie for local attention and available funds.

With support from the Cooperative State Research Education and Extension Service (CSREES), the University of Rhode Island (URI) Cooperative Extension has developed a technology transfer/education program for local decision makers that addresses the unique challenges of dealing with municipal audiences. The aim of this project is to reduce nonpoint inputs to Narragansett Bay, an EPA-designated national estuary, by providing local officials with the skills and resources they need to manage nonpoint pollution in local watersheds. Our strategy is to capture local interest by focusing on local resources and problems through the use of Geographic Information Systems (GIS) map products, offer a mix of training opportunities to meet various levels of interest, and supply practical nonpoint assessment tools to identify and manage nonpoint pollution problems. Unlike many GIS-based education programs, local staff are also trained in the use of GIS software so they can continue to take advantage of its analytical capabilities long after training workshops and demonstration programs are completed. The purpose of this paper and our panel presentation is to describe successful application of GIS technology as an education and analytical tool using three approaches:

1. Enhance awareness of local resource values and illustrate the relationship between watershed land use and water quality using GIS products.
2. Provide decision makers with an analytical tool for watershed-level nonpoint management using a GIS-based pollution source identification and nutrient loading model currently under development.
3. Teach municipal officials to incorporate geographic data in routine planning and land use decisions through introductory workshops that demonstrate GIS capabilities and hands-on practice in using the ArcView GIS software.

Geographic Information Systems as an Education Tool in Local Nonpoint Education

Local Outreach Strategies

Local officials are often eager to learn practical techniques for dealing with immediate problems but they have busy schedules with little time for generalized training. To overcome this initial barrier the URI training program relies on tiers of training strategies to reach various municipal audiences based on their level of commitment or time constraints, and their level of expertise. Our objective is maximize our limited staff resources to reach as many local land use decision makers throughout the Narragansett Bay watershed while concentrating our efforts in priority subwatersheds. Our target audience is planning and zoning board members, planners, conservation commissioners, council members, water suppliers, and others involved in local land use.

We offer three tiers of training and assistance to towns: (1) Brief presentations that can be scheduled during regular board meetings, evening workshops, and one to three day conferences on priority topics such as stormwater controls, wetlands protection, and wastewater management. These attract both new and experienced board members and professionals from throughout the watershed. The time commitment is minimal but gives local officials an opportunity to improve skills when they are ready. Attendance in one workshop frequently leads to participation in other workshops and interest in the next level of training. (2) Intensive watershed-level short courses in watershed management for board members and town staff in priority subwatersheds. This is where we can best use GIS as an educational tool to enhance awareness of local resource values and nonpoint problems. (3) Follow-up assistance in implementing nonpoint source controls based on interest generated from topical workshops and short courses above. This includes, for example, assistance in developing local ordinances and nutrient loading analysis to identify relative impacts of nonpoint sources and control options.

Watershed-Based Training

Short courses in watershed management target all local officials from two or more communities within a priority watershed. Through a series of six to thirteen workshops, this intensive program is ideal for building relationships among board members within a town and among communities within a watershed. These sessions cover topics such as the relationship between watershed land use and water quality, development review techniques, watershed protection strategies, stormwater and wastewater management techniques, board procedures and legal issues, and coordination among local boards. Because the watersheds selected are normally small, 15,500 acres or less, it is also an ideal opportunity for using powerful GIS imagery to illustrate the relationship between watershed land use and nonpoint pollution sources.

This watershed-based training focuses on watershed aquifers and reservoirs to incorporate GIS analysis, local case studies and field training sites. Because they are predominantly interested in local water supplies and shellfishing areas, local officials learn best from these targeted examples. Using coverages available through the Rhode Island Geographic Information System (RIGIS) GIS products are used to

illustrate land use patterns and to describe watershed features such as subwatershed boundaries, aquifers, well head areas and wetland resources and to illustrate the relationship between sensitive water bodies and riparian areas with high risk land uses (McCann et al., 1994). Following the NEMO approach used by the University of Connecticut Cooperative Extension (Arnold et al., 1993), percent impervious cover under existing land use and potential land use with build out under present zoning are also analyzed.

The geographic analyses generate awareness and interest in watershed protection issues which are then explored at the parcel-scale through subdivision and commercial development case studies. Generally, two or three case studies are used repeatedly in several sessions to illustrate a range of realistic nonpoint problems and practical control options. For example, one subdivision may be used to demonstrate a variety of techniques, such as subdivision review procedures, creative zoning or cluster options to reduce impervious area, specific stormwater controls, and wetland protection options. A field review of at least one site is conducted to improve map reading and plan interpretation skills, demonstrate field assessment techniques and promote discussion of local regulatory issues. Following this progression from watershed-scale GIS analysis to the parcel-level site evaluation, we may select one area of the watershed for more detailed analysis of nonpoint control options based on local interest. Other features of the watershed-level training are summarized below:

- Target local interests that are compatible with pollution prevention. Because water resource protection are usually one of many local concerns, we focus attention on opportunities to achieve local land use goals through implementation of nonpoint control. For example, discussions of techniques to minimize impervious area focus on reducing pollution, minimizing the size of stormwater facilities needed, and preserving community character. Stormwater management practices discussed emphasize designing for low maintenance as well as water quality enhancement.
- Work closely with municipalities to develop and conduct the training series. Planners and board members are surveyed to determine their areas of interest. Survey results are used to select course topics and identify priority areas for in-depth evaluation of nonpoint pollution sources and control options. To ensure local commitment to participate in development of the program, a Memorandum of Agreement (MOA) between URI and each municipality is developed and signed.
- Collaborate with other university groups, state regulators and planning staff and federal partners in developing and conducting the program. Watershed-level training areas are selected based on state nonpoint priority watersheds and local interest.
- Design each session to promote discussion and sharing of local expertise. Provide opportunities for board members to build relationships with each other and with state regulators, resource managers and consulting professionals from the region people they can call on for assistance long after the training is completed.

Tools for Watershed Management GIS-based Nutrient Loading

Assessments of high risk land uses and impervious coverage are useful as a first cut analysis of nonpoint problem areas, but municipal officials considering adoption of costly and perhaps controversial nonpoint control measures often need stronger evidence to justify the need for additional controls and to demonstrate their benefits. As a second tier of assistance to these communities, the URI Cooperative Extension is developing a practical nutrient loading method (Kellogg et al., 1995) that land use decision makers can use to compare nonpoint impacts under present and future land use, and to evaluate the effectiveness of alternative best management practices. Known as MANAGE: a Method for Assessment, Nutrient-loading, and Geographic Evaluation of Nonpoint Pollution, the method is designed to estimate nitrogen and phosphorus loading to surface waters and nitrogen loading and concentrations in aquifers. It also estimates average annual runoff and infiltration volumes and mass-balance nutrient loading using readily available RIGIS based on land use as well as soil hydrologic group and riparian area relationships.

The following case study illustrates one application of GIS-based nutrient loading analysis, using a simplified phosphorus mass balance model developed by the R.I. Department of Environmental Management, to identify nonpoint management options and to promote adoption of best management practices as a spin-off project of a watershed-level short course.

Case study: St. Mary's Watershed, Portsmouth, Rhode Island

The Problem: As a result of concern over water supply protection generated in a URI watershed management short course on Aquidneck Island, R.I., a local watershed group was formed, known as the St. Mary's Watershed Group. This group was initiated by members of the local Portsmouth Agricultural Advisory Committee who participated in the training program, with support by the Eastern Rhode Island Conservation District. Other members of the group included local planners, administrators, the municipal water supply company and Cooperative Extension. St. Mary's watershed was selected for analysis because of its small size and mix of residential and agricultural land uses. Because previous studies had suggested that both residential and agricultural land uses were contributing to eutrophication of the water supply, the group set out to conduct a detailed watershed assessment to identify the relative nonpoint pollution inputs and suitable control measures. Using the results of field analyses conducted by the Conservation District, URI updated the GIS land use coverage and subwatershed boundaries.

Results: A nutrient loading conducted by the District and URI showed the following.

- The amount of phosphorus moving into the St. Mary's pond is estimated to be roughly five times higher that the pond can assimilate without excessive algal growth.
- agricultural activities and polluted runoff from residential land contribute phosphorus to St. Mary's pond in roughly equal proportions.
- A combination of both agricultural conservation practices and stormwater controls are needed to effectively reduce phosphorus concentrations to approach acceptable levels.

Action:

- The members of the St. Mary's watershed group prepared a fact sheet summarizing their findings, using the results of the GIS-based nutrient loading and GIS watershed map, as shown in Figure 2.
- The group presented their findings to the Portsmouth planning board and Aquidneck Island Planning Commission. Both boards agreed to support efforts to construct stormwater basins and seek funding through Section 319 of the Clean Water Act.
- Portsmouth local officials and Newport Water Supply Company are continuing discussions to determine locations of basins and to resolve issues relating to ownership and maintenance of basins.

Setting Up Local GIS Capability

With the advent of user-friendly Geographic Information System software the possibility that local planners can incorporate geographic data in their land use decisions is no longer just wishful thinking. In comparison to full-scale GIS systems, software technologies developed or improved within the last few years are relatively low cost, easy to use without extensive training, and run on computers with 486 or Pentium processors typically found in most offices. These new technologies enable local planners to easily access and view extensive resource databases and perform fairly sophisticated watershed analysis with minimal investment in equipment and staff time. For Rhode Island cities and towns, the incentive to use GIS is particularly attractive. The state RIGIS database is one of the most comprehensive, high-quality and up-to-date compiled for a large area and the data is readily available at low cost. All municipalities are familiar with GIS products, having received State-supplied GIS coverages of their community for use in updating local comprehensive plans.

Hands-on short courses in user-friendly GIS software, as a third tier of nonpoint training, enables planners and other municipal staff to set up and use a local GIS. Since local planning is a dynamic process, constantly evolving as development pressures and management opportunities arise, this capability is essential to continued use of geographic data for watershed management over the long term. Thirteen Rhode Island municipalities have participated in GIS training to date; almost all of these communities have either established or are developing a local GIS.

Summary and Future Direction

The URI Cooperative Extension municipal training program demonstrates the effectiveness of a tiered approach to nonpoint education and the value of incorporating GIS as both an educational and analytical tool. Based on the success of the program we plan to continue offering a range of training opportunities for local officials to meet their interests and educational needs, including workshops on priority topics and watershed-level short courses in watershed management. We are continuing to develop the MANAGE method as a GIS-based watershed assessment and nutrient loading tool. To promote use of geographic data in local planning we will continue to offer workshops and short courses in application of the user-friendly GIS software. In addition, we will provide technical assistance to municipalities in implementing local nonpoint source controls as a follow-up to training in priority watersheds.

References

Arnold, C.L. et al. 1993. The Use of Geographic Information System Images as a Tool to Educate Local Officials about the Land Use/Water Quality Connection. Proceedings of Watershed '93 Conference, VA.

Kellogg, D.Q., L. Joubert, and A. Gold. 1995. MANAGE: a Method for Assessment, Nutrient-loading, and Geographic Evaluation of nonpoint pollution. Draft Nutrient Loading Component. University of Rhode Island, Kingston, RI.

McCann, A.J. et al. 1994. Training Municipal Decision Makers in the Use of Geographic Information Systems for Water Resource Protection. Conference proceedings, Effects of Human-Induced Changes on Hydrologic Systems, AWWA.