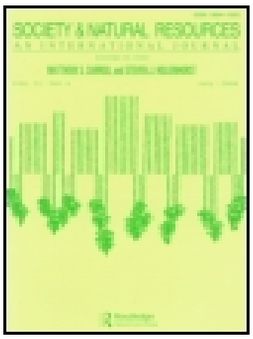

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Research Notes

Layering Natural Resource and Human Resource Data for Planning Watershed Conservation Strategies

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This article provides a case study of how natural resource inventory information from preexisting geographic information system (GIS) data layers and an analysis of IKONOS satellite imagery can be combined with data from a survey of landowners to create a unique strategic planning process for watershed protection. The ability to identify important environmental features such as unfragmented forest, stream systems, and forested wetlands is an important part of watershed conservation projects, as is the ability to identify landowners cost/benefit perceptions and intentions concerning conservation practices such as forest stewardship. Together these two functions permit land protection techniques and landowner outreach strategies to be targeted where they will be most efficient and effective. Knowing the disposition of landowners in priority areas allows decision makers to plan their communication with these landowners strategically.

Keywords geographic information systems, outreach strategies, survey Research, watershed protection

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This article provides a case study of how natural resource inventory information from preexisting geographical information system (GIS) data layers and an analysis of IKONOS satellite imagery can be combined with data from a survey of landowner cost/benefit perceptions and intentions. The result is a strategic planning process for watershed protection. The use of GIS technology is common practice in watershed conservation planning efforts today, focusing mostly on the use of natural resource and land-use data to provide a spatial analysis of the physical attributes of a watershed and to educate local land-use decision makers about natural-resource-based planning (Arnold et al. 2000; Civco et al. 2000). Models of forest fragmentation patterns have been developed from remotely sensed data and analysis of historical land development patterns (Hurd et al. 2001; Radeloff et al. 2001). While efforts to integrate biophysical, landownership, and psychosocial data spatially have been reported (Kuscinski et al. 2000; Parisi et al. 2003), and attempts to represent personal survey data in spatial models have been made (Srinivasan 2002; Matei, Ball-Rokeach, and Qiu 2001), the juxtaposition of survey data with key natural resource components in a GIS to guide local conservation strategy is still somewhat unique.

The setting for the case study is the Higganum Creek watershed, one of 17 watersheds in the Tidelands Region of the lower Connecticut River. The watershed makes up most of the area in the Higganum section of the Town of Haddam in south-central Connecticut (population approximately 4500; 19.7 square miles). It consists of three subwatersheds (Ponset Brook, Candlewood Hill Brook, and Bible Rock Brook) that feed into Higganum Creek, which flows into the Connecticut River. The case study is based on a project completed for the Haddam Land Trust, a nonprofit organization that accepts land donations, manages lands, and educates landowners in the interest of land, water, and wildlife conservation. Results of the study are guiding their decisions about landowner education and land acquisition. Knowledge of this process may be useful to other groups planning watershed-based conservation projects.

A Natural Resource/Human Resource Planning Process

Generating a base map of natural resource features in the watershed is the first step in the process. Types of land use and locations of important natural resources (e.g., unfragmented forest, water/wetlands) are plotted. Land ownership parcel data is then mapped, with parcels that are permanently protected from development highlighted. Data on landowner cost/benefit perceptions and intentions regarding key conservation practices are collected via a survey. Numerical representations of landowners' intentions are then layered on a map. According to the Theory of Reasoned Action (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975), analyzing a person's cost/benefit perceptions and behavioral intentions to understand factors that lead to the person's behavioral decisions can help guide persuasive communication efforts.

Visual inspection of maps gives project staff the information they need to (a) identify particularly sensitive and/or important areas within the watershed needing protection, (b) identify landowners' existing intentions about engaging in key conservation practices, (c) prioritize areas where change is needed and/or probable so that limited campaign resource can be directed where they are most apt to have an effect, and (d) as described next, identify the educational, persuasive, or acquisition strategies that may be required when dealing with landowners in these areas.

- Survey data indicating there are significant numbers of proconservation respondents within priority areas suggest change is probable and that an educational strategy might best be followed because landowners already possess positive intentions and cost/benefit perceptions—they only need information to enact desired changes.
- Survey data indicating there are significant numbers of neutral respondents within priority areas suggest communication with landowners will require more effort and that a persuasive strategy might best be followed. Landowners will need convincing that the benefits outweigh the costs.
- Survey data indicating there are significant numbers of unmotivated respondents within priority areas suggest a land acquisition strategy might be tried because landowners are not expected to adopt desired practices.

Mapping Natural Resource Features in the Higganum Creek Watershed

Multiple layers of data were combined to identify the most important land parcels to protect within the study area. First, forested wetlands were mapped using data from a satellite image analysis and field data from a vegetative inventory. Second, stream systems were mapped using University of Connecticut's MAGIC web-site data. Forested wetlands and stream systems are important as source water areas and habitat for amphibians, birds, and unique vegetative communities, and as such are important to Land Trust conservation activities.

In addition, because protection of forest cover, particularly unfragmented forest tracts, is necessary for protecting water quality, parcels within contiguous forest areas of 500 acres or more were identified from satellite and aerial photos. Identifying forested areas at risk for development is an important step in directing conservation efforts. Within the Higganum Creek Watershed, some parts of the forest already have a level of protection due either to conservation easements or ownership by state, town, or the Land Trust. Knowing the location of unprotected/unfrag-unfragmented forested lands in close proximity to wetlands and stream systems is the key to identifying which areas to focus on.

Mapping Parcel Ownership in the Higganum Creek Watershed

Identifying property boundaries and the name and contact information of the landowners in the watershed can be a laborious task. Because Land Information Systems data was unavailable for the Higganum Creek watershed, necessary data was obtained at the town hall in Haddam. It was found in three different locations: (a) the property boundary keyed on the Tax Assessor's map, (b) the name of the corresponding landowner in a card catalog, and (c) the contact information for the person in a separate book. The information was collected for landowners who owned at least one parcel greater than 10 acres and used to create a database of property locations and mailing addresses. A GIS data layer showing parcel boundaries was obtained from Midstate Regional Planning Agency.

Mapping Human Resource Features in the Higganum Creek Watershed

A survey was initiated to assess landowner's cost/benefit perceptions and intentions regarding forest stewardship planning. The degree that private landowners engage in forest stewardship practices is critical to natural resource conservation in a state

where 75% of the land is forested and 80% of this land is privately owned (Tyson and Broderick 1999; Broderick, Hadden, and Heniger 1994; Snyder and Broderick 1992). The survey questionnaire was distributed in fall 2001 in a three-wave mailing consisting of (a) an initial questionnaire/cover letter mailing, (b) a reminder postcard for nonrespondents, and (c) a second questionnaire/cover letter mailing for nonrespondents (Dilman 2000). The questionnaire took about 5 min to complete.

One hundred sixty-seven landowners with at least one parcel of 10 or more acres of contiguous forested land in the watershed received the survey. Fifty-eight individuals (35%) responded. Recipients of the survey were told in a cover letter that their responses were not anonymous and that their personal attitudes toward land use would be linked with data about natural resources on or near their property and they might be selected to receive information specially tailored to their particular responses. They were also told that no one but project staff would have access to their specific survey responses, but that the Haddam Land Trust would receive a report identifying the educational, persuasive, and land acquisition strategies that might best be employed in the watershed.

The survey questionnaire asked respondents to indicate their cost/benefit perceptions and intentions concerning forest stewardship planning using 7-point Likert scales (see Table 1). Established questions were used to assess these variables (Tyson and Worthley 2001; Tyson, Broderick, and Snyder 1998). The following definition was provided: ''Forest stewardship plans are based on a description of the natural resources on your property and outline plans for managing your forests.''

Based on a map showing unprotected/unfragmented forested land and the proximity of stream systems and forested wetlands and keyed to the location of landowners' properties, the numeric values of landowners' intentions (first question in Table 1) were simply collapsed into the following three groups, assigned as an

TABLE 1 Questions Assessing Forest Stewardship Practices

Intentions (item rated on 1–7 scale, very unlikely–very likely)
In the next five years it is (unlikely–likely) I will develop a forest stewardship plan for my property.
Benefits (items rated on 1–7 scale strongly disagree to strongly agree)
Developing a forest stewardship plan for my property . . .
. . .would increase my property's value.
. . .would help make sure that those who inherit my land enjoy the natural resources that I do now.
. . .would help preserve the beauty of my property.
. . .would improve recreational opportunity on my property.
. . .would help increase wildlife on my property.
Costs (items rated on 1–7 scale strongly disagree to strongly agree)
Developing a forest stewardship plan for my property . . .
. . .would take more time than I am willing to spend.
. . .would require too much money on my part.
. . .would require too much effort on my part.

attribute in the parcel shape-file database in a GIS, provided a color-coding, and represented spatially and graphically.

- Those with strong intentions (those indicating 6 or 7 on 7-point scale).
- Those with neutral intentions (those indicating 3, 4, or 5 on 7-point scale).
- Those with little intention (those indicating 1 or 2 on 7-point scale).

It should be noted that for audiences unfamiliar with GIS visual analyses, greater clarity may be achieved by creating a series of maps in which each data layer is introduced in sequence (Worthley, Prisloe, and Kane 2000).

Use of Layered Data in Local Programming

In Figure 1, parcels A and B are high priority for outreach efforts by the Land Trust because of the convergence of key natural resource components and landowners who expressed strong intentions to prepare a forest management plan for their property. An educational strategy describing how forest stewardship plans can be prepared for their property is being employed with these landowners because they already possess positive intentions; that is, they only need information to pursue the desired goal—they don't need persuading. An analysis of the cost/benefit perceptions of all respondents with strong intentions (those who responded with a 6 or 7 to the intention question) indicates an average score of 2.0 for the three cost questions and 5.8 for the five benefit questions (on a 1 to 7 scale, strongly disagree to strongly agree).

The next level of priority is assigned to the owners of parcels C and D. One property is contiguous to protected land; the other contains sizable unfragmented forest acreage with a wetlands component. These landowners are being targeted with a persuasive strategy because of their neutral intention to engage in forest stewardship planning. An analysis of the cost/benefit perceptions of all respondents with neutral intentions (those who responded with a 3, 4, or 5 to the intention question) indicates an average score of 3.2 for the three cost questions and 5.2 for the five benefit questions (on a 1 to 7 scale, strongly disagree to strongly agree). Their greatest concern is with financial costs and their greatest perceived benefits are increasing wildlife and preserving beauty. These issues play a prominent role in outreach messages with these landowners.

Landowners of parcels E and F indicate little intention to engage in forest stewardship planning. An analysis of the cost/benefit perceptions for this type of respondent (those who responded with a 1 or 2 to the intention question) indicates an average score of 4.1 for the three cost questions and 4.3 for the five benefit questions (on a 1 to 7 scale, strongly disagree to strongly agree). At this point, Land Trust decision makers have elected not to invest their limited time and resources on outreach to these owners. Later, if forest resource protection is deemed important in these areas, then an acquisition strategy may be tried.

Application of the Planning Process in Other Watersheds

With limited time and financial resources, organizations like the Haddam Land Trust sometimes end up using a scattershot method of communicating with landowners. They wait for people to contact them who (a) know about the organization, (b) are conservation minded, and (c) know about mechanisms for protecting land.

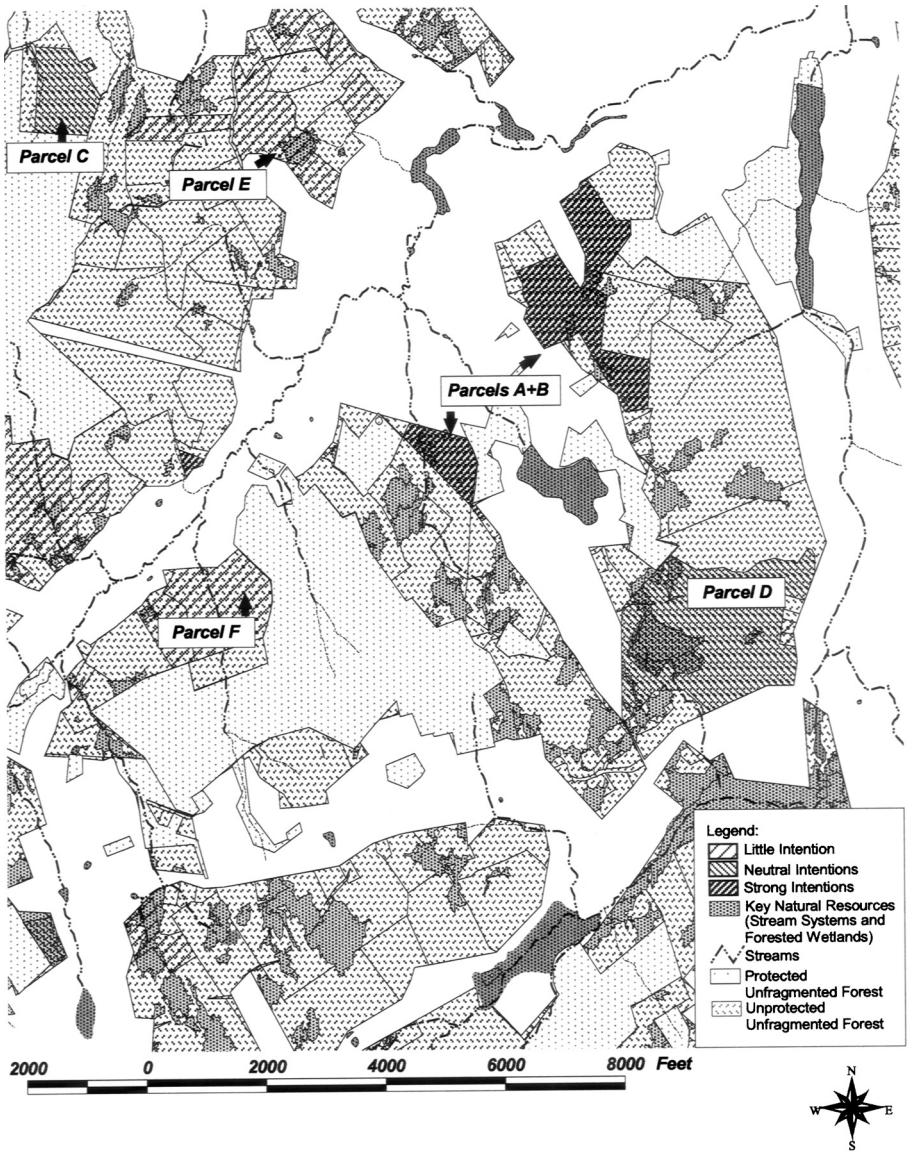

FIGURE 1 Landowner intentions about forest stewardship planning in relation to key natural resource components within unprotected unfragmented forest areas.

If it is the interest of local conservation organizations to protect water quality and wildlife habitat, it is fair to assume that land in the proximity of streams systems and forested wetlands is important. Further, such areas found in forests that are unfragmented, yet unprotected, would be prioritized. And further, knowing the cost/benefit perceptions and intentions of landowners regarding key conservation practices in these priority areas would allow the organization to plan their communication with these landowners strategically or better target the allocation of open-space protection funds. In addition, organizations like the Haddam Land Trust that apply the strategic planning process described in this article can contribute to the

efforts of those attempting to control haphazard land conversions. They can provide planners with the ability to visualize a pattern on the landscape that should remain as open space and to direct development to areas where conditions are more suitable.

Limitations

Several possible limitations are apparent in using the strategic planning process described in this article. First, an organization trying to follow the process will need a database of landowner names and addresses keyed to parcel in the watershed. Constructing an accurate parcel map is a fundamental step. In the case of the Higganum Creek watershed, this was accomplished by doggedly assembling information found in three separate locations. Second, GIS data and satellite images that are used to plot the natural resource data on the parcel map must be current. Dated information will limit the value of the process.

Third, because recipients of the survey questionnaire are told that their responses will not be anonymous, researchers can expect a less-than-optimum response rate. Nonresponse to the survey threatens the validity of the process. Though the 35% response obtained in the Higganum Creek survey can be considered a fair rate for mail surveys (Fowler 1988), a significant number of parcels in the watershed lack human resource data. Any effort expended trying to maximize the response rate to the survey will be well spent. This might include offering incentives for responding (e.g., cash prize, free services) or persistently contacting nonrespondents (via mail, phone, or in person) to solicit their responses.

A post hoc phone survey of nonrespondents to the original survey was conducted to assess the degree of response bias experienced. Ten questions were asked. Thirty of the 109 original nonrespondents were successfully contacted. Sixty-seven could not be reached during the week allocated for this exercise because no one answered, the line was busy, or the phone number was unpublished, and 12 refused to participate. As might be expected, findings show that there are key differences between respondents and nonrespondents to the original survey. Respondents are more likely than nonrespondents to own more land (average 23.4 vs. 13.7 acres), regard their property as their primary residence (89% vs. 67%), and live there most of the year (92% vs. 71%). And though there was little difference in their reported intention to develop forest stewardship plans (an average of 3.5 vs. 3.3 on a 1 to 7 scale, unlikely to likely), respondents are more likely to perceive that costs are less critical than nonrespondents (an average of 3.3 vs. 4.9 for three cost variables on a 1 to 7 scale) and benefits are more likely incurred (an average of 5.1 vs. 4.0 for three benefit variables on a 1 to 7 scale). When nonrespondents were asked why they did not respond to the initial survey, one half stated that they forgot and one third stated that they had been too busy. Three individuals were concerned about anonymity. Hence, the respondent sample was biased to property owners residing more often on more acreage who are more apt to believe that the benefits of forest stewardship planning outweigh the costs—the type of audience that the Haddam Land Trust might consider their primary target audience.

Last, in the case of the Higganum Creek watershed project there is a need to monitor the effectiveness of subsequent educational, persuasive, and acquisition interventions instigated by use of the process to truly assess its worth as a strategic planning tool; and there is a need to test the efficacy of the process in other, perhaps larger, watersheds. Prescribing interventions simply based on one intention measure

is a heuristic device. The casual relationship between knowledge, attitudes, intentions, and behavior can be very complex. For instance, it may be that some landowners who indicated that they had little intention to develop forest stewardship plans may have done so because they did not know enough about the issue, not because they perceived the costs outweighed the benefits. Yet, as a heuristic device, the strategic planning process described in this article may provide some helpful guidance to local conservation organizations and land use planners.

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