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Integrating Social Survey Data and GIS to Determine the Needs of a Rural Community in a Geographic Context

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The Town of Wausau, Wisconsin is a rural community in Central Wisconsin with a population of 2,229 (Census 2010). The geographic extent of the town is 37.7 square miles. The political boundary of the town coincides with one surveyed township of the U.S. Public Land Survey System (PLSS) and is subdivided into 36 surveyed sections, each with an area of approximately one square mile. The western boundary of the town is irregular due to annexations by the neighboring City of Wausau (population 39,106, Census 2010) (Figure 1).

The Wausau Town Board wanted to survey the town's residents on the need for specific services, the willingness of community members to pay for specific

services, and other key issues important to the community especially during an economic downturn. The town board contracted with the Wisconsin Institute of Public Policy and Service (WIPPS) in October 2010 to formulate survey questions, compile results, incorporate the survey results within a GIS, and complete a final report. WIPPS is a unit within the University of Wisconsin Colleges and the University of Wisconsin Extension, and is a nonpartisan, nonprofit organization tasked with providing meaningful public outreach to the people of Wisconsin. The town realized a significant savings by partnering with WIPPS to complete the project. My role in the project, as a faculty member at the University of Wisconsin, was as co-principal investigator.

Problem

The Town of Wausau has a population density of 59 people per square mile. (By comparison, the City of Wausau, which borders the Town of Wausau on the east, has a population density of 2,082 people per square mile.) Examination of the Town of Wausau's 2006 comprehensive plan indicates that various agricultural pursuits comprise the leading land use in town at 48.5%. Woodlands and wetlands account for 25.8% and 13.4% respectively of the town's total land area. There is little commercial development, with only 0.4% of the land area devoted to commercial pursuits. Residential development accounts for 6.8% of the land use in the community and is greatest in the western third of the town that borders on the City of Wausau. Population growth has been slow over the last 40 years with a population change of 141 persons (6.2%) between the 1970 and 2010 censuses.

One of the major problems in conducting social surveys in rural areas like the Town of Wausau is the need to protect the anonymity of the respondents. The problem is enhanced when the information is incorporated into a GIS and portrayed as mapped data. The potential exists in rural communities with low population densities for community members to identify responses provided by individual households. Several members of the community expressed concern about this issue and it was a major discussion point between the town board and WIPPS in the formulation and design of the survey and the GIS. The problem

was how to present the survey results in a mapped context without compromising the anonymity of the respondents.

Solution

The problem was solved by using surveyed PLSS sections of the township as a map grid by which the results of survey questions were reported (Figure 2). The responses to the survey questions were broken down by surveyed section using the MYSTAT (version 12) statistical software package and mapped using Caliper's Maptitude (version 5) GIS. Surveyed sections are regularly used as the mapping units for various geological, biological and agricultural studies, but not for mapping the results of data collected from social surveys. I did an extensive search for projects using PLSS sections to map social data in rural America and didn't find any others.

Surveys were sent to all households in the town in October 2010. The residential database of the town was the source of the addresses. Slightly more than 900 surveys were mailed and 505 households returned completed surveys, representing a return rate of 56% (Figure 3). The survey required approximately 10 minutes to complete. All survey responses were anonymous. The first question on the survey asked the respondents to identify the section of the township in which they lived. A map was provided for reference purposes. In Wisconsin, land records for deeds and taxation are kept using the PLSS system, so residents would be very familiar with a PLSS section map. We were confident that they would be able to successfully identify their section. Several background questions were asked of respondents which pertained to the socioeconomic characteristics of the household, including median age, level of educational attainment and household income. Specific questions related to key issues facing the town used a modified Likert scale to determine the strength of agreement or disagreement for each of the questions. The results of the survey had a 95% confidence level with an error range of plus or minus 3%.

Results

The Town of Wausau is an older, middle class community with a median

population age between 45 and 54 years and a median income between \$50,000 and \$74,999. Most of the respondents were high school graduates with some college. The average resident had lived in the community between 11 and 20 years and 95% of the residents owned their own homes.

Several survey questions were designed to gather information about the public services which residents wanted, and their willingness to pay for these services. These public services included: fire service, ambulance service, snow plowing and sanding, road maintenance, garbage and recycling pickup, asphalt roads, town constable and police, town ordinance enforcement, update and upgrade of equipment, and building upgrades and remodeling. The level of the importance of each service to the town's residents and their willingness to pay for each service were each ranked according to the number of responses received. A Spearman ranked correlation coefficient (non-parametric test for ranked statistical data) was calculated to test for the level of agreement between the residents' expressed need for specific public services and their willingness to pay for them. The calculated Spearman correlation coefficient was $r = 0.983$ at a 95% confidence level. The results of the statistical analysis revealed an almost perfect correlation between the public services desired by the residents and their willingness to pay for them.

The survey addressed many other key issues facing the town. Questions pertaining to these issues used a modified Likert scale to gather responses. With each of the questions, residents could express their level of agreement or disagreement. The Likert scale facilitated the mapping of the response data. Proportional pie charts were used to summarize the results for each question by surveyed section. One key issue facing the town is its future development. The question, "Do you think the Town of Wausau needs more commercial development such as offices, retail stores, or service business?" was asked to explore the residents' opinions on future commercial development. The majority of residents responded that the situation was fine as it was (Figure 4). Another key issue of concern to the town was the aesthetics of the community. The opinion on this issue was about equal for and against, as seen in the responses to

the question, “Should the Town of Wausau create and enforce ordinances to ensure appearance standards for lawns, yards, and home property generally?” (Figure 5).

Other issues addressed by the survey pertained to safety issues facing the community such as geographic restrictions on the use of firearms during deer hunting season, especially in more populated areas of the town. Figure 6 shows that most residents felt that there should be no hunting allowed in residential areas, along subdivision borders, or along the city border. A minority of the respondents felt there should not be restrictions to hunting on private land. The presence of certain dog breeds within the town limits was also a concern of the community because of the potential for attacks on the residents. Most residents felt there should be no restrictions to different dog breeds in the community in response to the question, “Should certain dog breeds be banned from the town of Wausau?” (Figure 7).

Conclusions

The use of surveyed sections of the PLSS as the mapping unit to present data collected from rural areas is a straightforward method to portray information in a geographic context. In the United States, access to digital geographic files for the PLSS is universal and easily incorporated into a GIS. The method allows for the preservation of the anonymity of respondents and also allows for the visual presentation of information to decision makers. This project also demonstrates that programs affiliated with state universities, like WIPPS, through their community outreach efforts can provide rural communities the expertise and resources needed to complete complex projects in a timely manner with a significant cost savings.

Figures and Captions (click for larger image except on Figure 2)



Figure 1. Town of Wausau PLSS sections showing land use patterns and the city of Wausau on the western boundary of the town

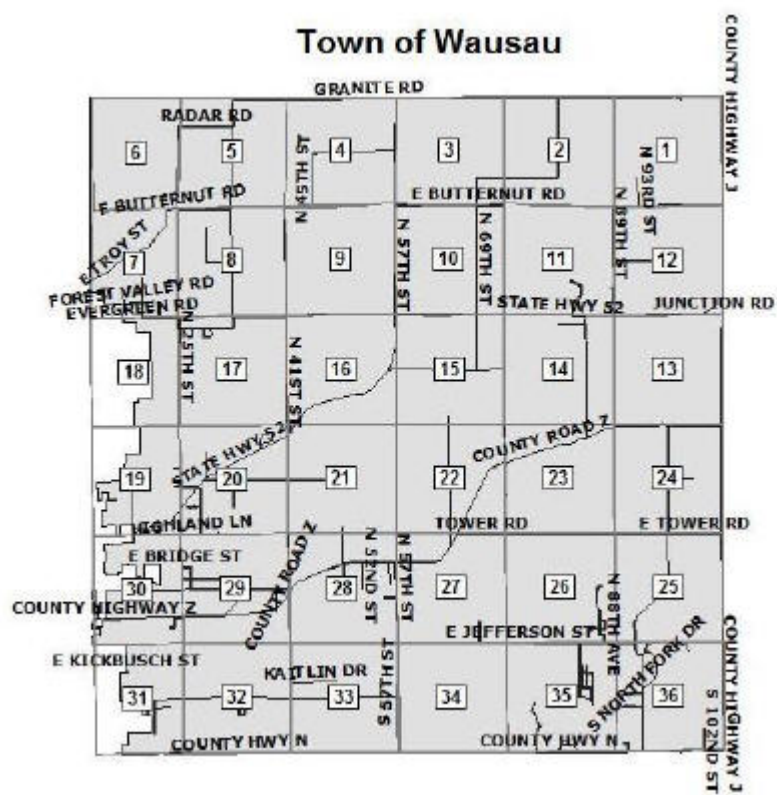


Figure 2. Mapping grid of the Town of Wausau PLSS sections used as mapping units to portray survey results

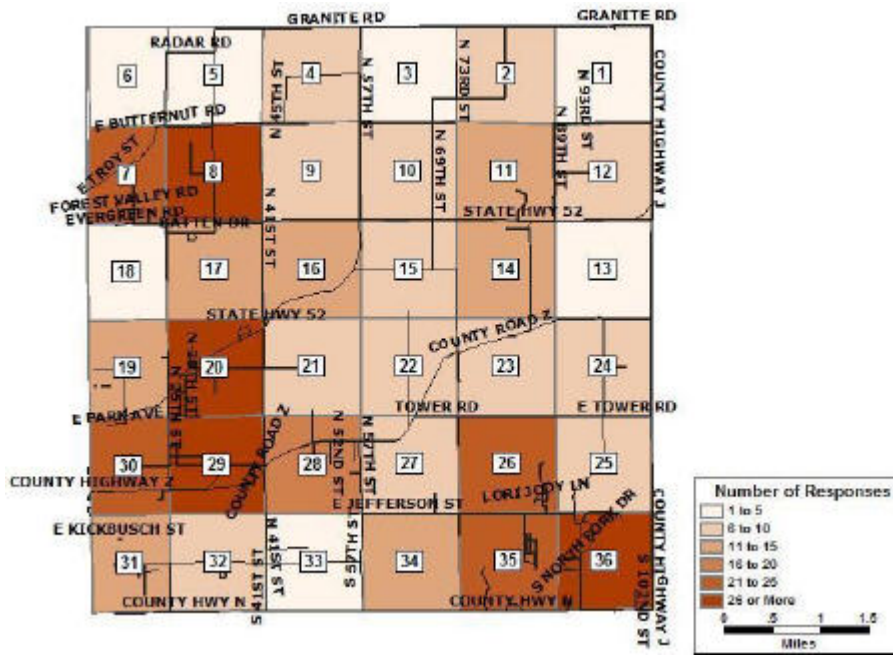


Figure 3. Number of respondents by PLSS survey section

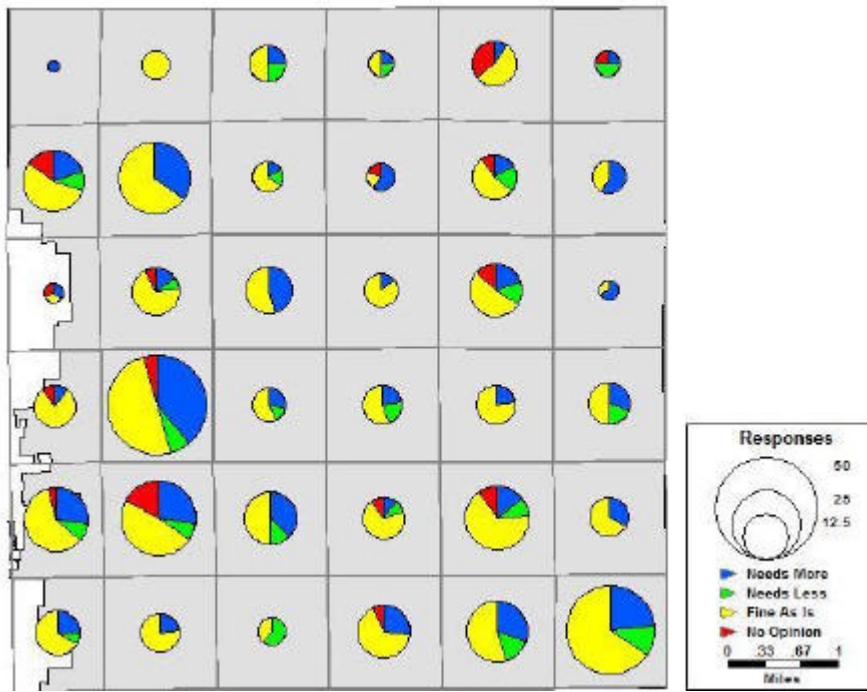


Figure 4. Number of respondents by survey section on key issue regarding the future commercial growth

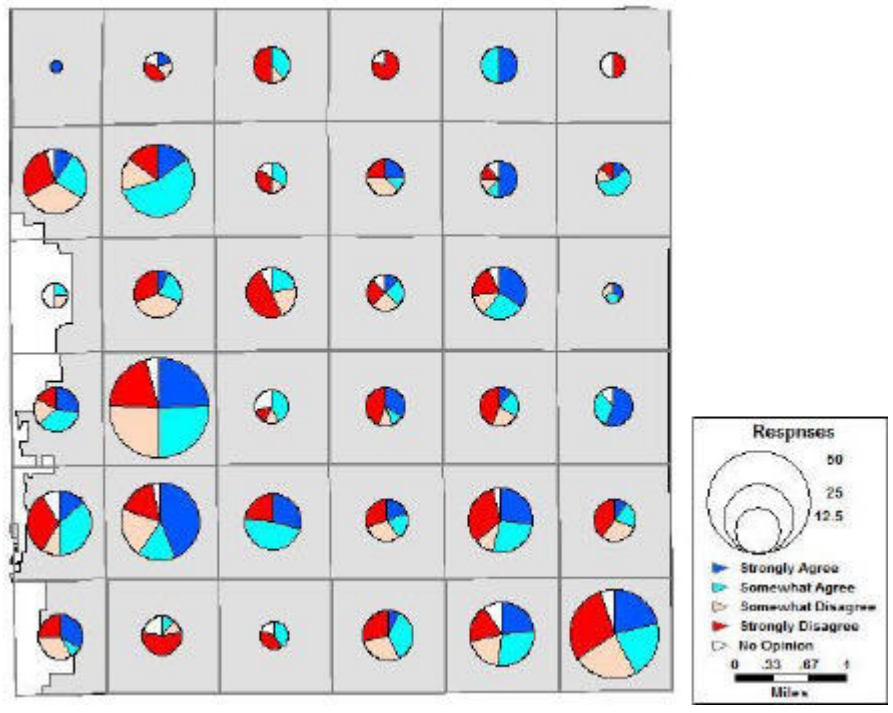


Figure 5. Number of respondents by survey section on key issue of the enforcement of aesthetic standards in the community

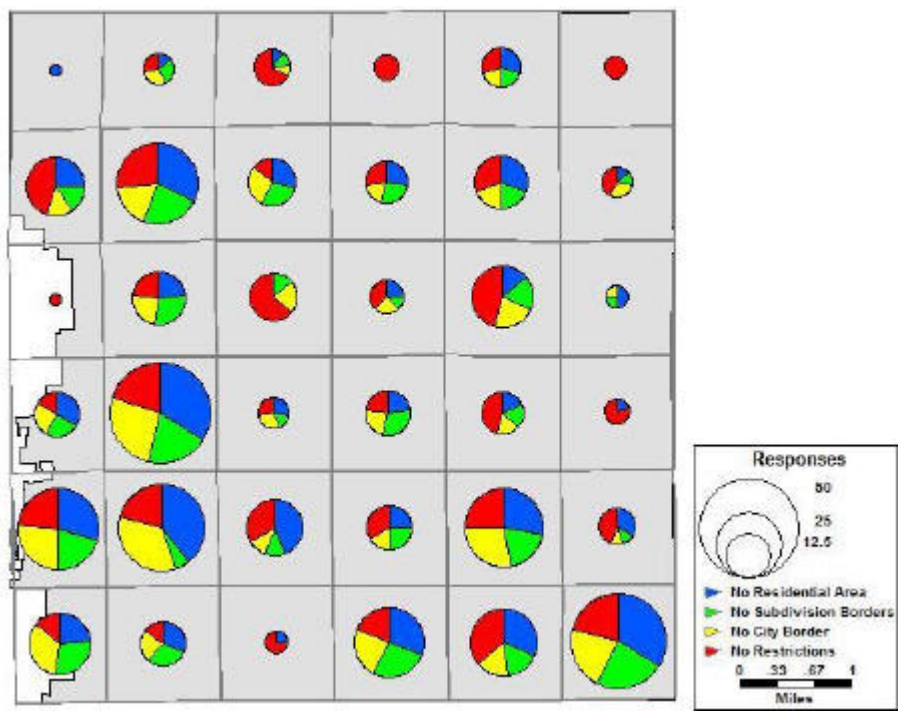


Figure 6. Number of respondents by survey section on key issue of rifle hunting in the town limits

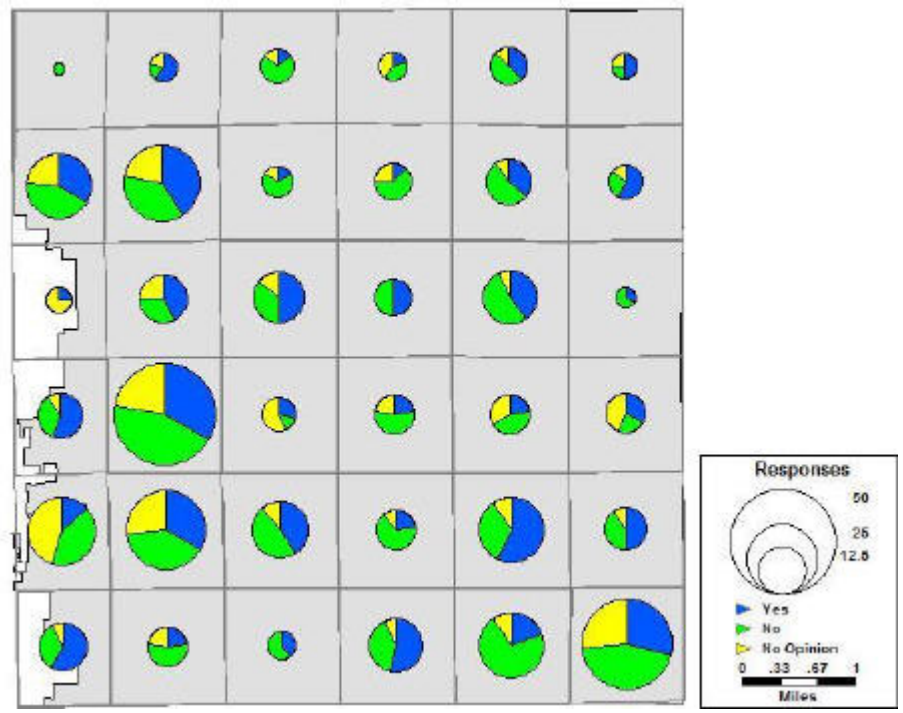


Figure 7. Number of respondent by survey section on key issue of banning certain dog breeds within town limits