LOCAL GOVERNMENT PERSPECTIVES ON THE INTEGRATION OF NATURAL RESOURCE INFORMATION IN LAND USE PLANNING AND ZONING: A MICHIGAN CASE STUDY

By

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ABSTRACT

LOCAL GOVERNMENT PERSPECTIVES ON THE INTEGRATION OF NATURAL RESOURCE INFORMATION IN LAND USE PLANNING AND ZONING: A MICHIGAN CASE STUDY

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The purpose of this project was to determine the extent of local government's use, interest, need, and influences, on natural resource information in land use planning and zoning decisions. A mixed method approach was implemented. A survey was sent to all of Michigan's townships (1,242), counties (83) and regional planning commissions (14) from August to November 2005. A response rate of 70% was received. As a follow-up to the survey, 30 purposeful interviews were conducted from May to September 2006. Due to a relatively small amount of natural resources and designated land area, municipalities were omitted from this study.

Fifteen different types of natural resource information were identified for this project. Results indicate surface water, land cover/land use, soil, wetland and agricultural information are both most commonly used and ranked high in importance. There is a "great need" to know where to access natural resource information. Further, statistical analysis confirmed the use of natural resource information at the township level was highly dependent on the adoption of a Master Plan and Zoning Ordinance. The research concludes with several recommendations for improving the integration of natural resource information in land use planning and zoning such as: the identification of land use goals at the state level, a clearinghouse for natural resource information, educational programs and products for regional planning commissions, and conservation scientists that are involved in the planning and zoning process at the local level.

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INTRODUCTION

The majority of land use decisions in the United States are made at the local unit of government (Nolon and Salkin, 2006). States delegate specific legal authority to local governments to plan and zone. In Michigan, planning and zoning authority has been granted to 1,858 local units of government including 274 cities, 259 villages, 1,242 townships, and 83 counties (MML, 2005: MTA, 2005). In addition, 14 regional planning commissions in Michigan have been granted authority to plan for the physical, social, and economic development of their respective regions. Depending upon the population of a local unit of government, resources such as trained personnel, equipment, technology, and the financial capability to gather information and compensate individuals for their service, range from relatively available to severely limited.

In urban areas, which are estimated to be 6% of the land area in the Michigan (USDA Economic Research Service, 2002a), local governments often have the resources available to hire one or more certified land use planners. Certified land use planners are college educated and familiar with the latest techniques and technologies used to gather and analyze information to make land use planning decisions. But 94% of the land area in Michigan is considered rural and in these communities, resources are often more limited (USDA Economic Research Service, 2002a: MTA, 2003). It is much more difficult to hire trained land use planners, and in these rural areas, land use decisions are made by residents that are elected or appointed to serve on the board or planning commission of the local unit of government.

One of the most significant land use changes of the last half century has been the movement of people from urban to rural landscapes (MSPO, 1995a). Between 1980 and 1995 Michigan's developed areas - those areas of residential, commercial, industrial use and roads - increased by 25%, while population grew by only 3% (PSC, 2001). This 8:1 ratio indicates Michigan's rate of

land conversion to urban-like conditions is greatly out pacing the rate of population growth. This ongoing migration of people from cities to suburban and rural environments had resulted in the loss of agricultural land, forest land, wetlands, scenic views, water quality, biological diversity and fragmentation of wildlife habitat (MSPO, 1995a).

When it comes to natural resource information in the United States, federal and state land management agencies gather and provide the large data sets while county, township and municipal agencies or organizations may disseminate the smaller scale or localized information. Residents in municipalities, townships and counties are charged with making land use decisions that impact the environment far beyond the local political boundary. Information can influence how a local government decides on the types, extent, and arrangement of land uses across the landscape (Environmental Law Institute, 2007). These decisions have a profound impact on the future viability of natural resources.

According to the Environmental Law Institute (2007), high quality natural resource information has been shown to contribute to better land use planning. In fact, high quality natural resource information is needed to defend local decisions. Reducing the rate of habitat degradation and the loss of biodiversity are difficult to achieve without access to good information. Without natural resource information, land use planners may not take such factors into account due to lack of awareness or inability to make informed, defensible decisions. A 2002 survey of Michigan local land use decision makers found that across the state there is a perceived need for better information and planning tools (Suvedi et al., 2002).

Michigan has a diversity of natural resources from agricultural, forestry and mining products, to fish, wildlife, abundant freshwater resources, rare and endemic plants, and unique natural communities found only in the Great Lakes basin (MAES, 1995: Kost et al., 2007). Hunting,

fishing, bird watching, and other wildlife-related activities result in a large influx of dollars into the state's economy. In 2001, state residents and non-residents spent $2.8 billion on fish and wildlife related activities in Michigan (USDI & USDC, 2001). The natural world also provides critical services to our society such as nutrient cycling, clean water, removal of pollutants, clean air, carbon sequestration, decomposition, soil creation, pollination, genetic diversity, transportation networks, improved quality of life, etc. (National Research Council, 2005).

Purpose of the Study

It is generally understood that natural resource information is important in land use decision making, but it is unknown whether information is actually being used and integrated into the land use planning and zoning process, and if it is, to what extent? If it is not, is that because there is a lack of interest, lack of access, lack of awareness, or some other reason? In order to improve the integration of natural resource information in local planning and zoning, one needs to know what type and where training and educational programs should focus. The sheer number of townships, counties and regional planning commissions that may be involved with planning and/or zoning, the increase in the development of rural and suburban landscapes compared to population growth, the commensurate loss of natural resources, contrasted against the need for functioning ecosystems for economic and social well-being, make it important to understand the role and impact local governments play in the sustainability of Michigan's natural resources.

Statement of the Problem

The purpose of this project was to determine the extent of local government's use of, interest in, need for, and influences on, natural resource information in land use planning and zoning decisions. Six general areas were focused on to determine: 1) what types of natural resource information are being used by local governments, 2) how is natural resource information being

used in planning and zoning activities, 3) what types of natural resource information are most important to local governments, 4) what are the challenges and needs of local governments when trying to incorporate natural resource information into planning and zoning efforts, 5) does adoption of planning and zoning techniques influence the use of natural resource information, and 6) does socioeconomic status influence the use of natural resource information.

Justification

In the early 1990's Michigan received a grant from the Environmental Protection Agency to identify and rank Michigan's environmental problems (Rustem et al., 1992). With input from citizens, scientists and state agencies, the Michigan Relative Risk Analysis Project produced a list of 24 environmental issues ranked into four priority categories – 1) high high, 2) high, 3) medium high and 4) medium. One of the six issues identified in the "high high" category was the absence of land use planning that considers resources and the integrity of ecosystems. In addition to the lack of ecologically based land use planning, population growth, population density and population distribution were considered factors that affect virtually all environmental problems in the state (Rustem et al., 1992).

More recently, the Michigan Land Use Leadership Council (2003) acknowledged the negative impact state land use trends have had on biodiversity. In order to better protect the state's natural environment, partnerships between and among federal, state and local governments, natural resource organizations, and the private sector are needed to identify and protect critical habitats while allowing productive uses of the land. Specific recommendations identified for the continued health of Michigan's land resource-based industries included: improved data collection, analysis and access to information, and outreach to the general public and local

policymakers concerning the social, economic and environmental value of natural resources (MLULC, 2003).

Local initiatives that focus on the protection of natural features are not widespread, either nationally or in Michigan (Thomas, 2003). Land use planning that protects critical wildlife habitat, travel corridors, and ecological processes is an essential component of a successful conservation strategy. To prevent wildlife from becoming endangered, state wildlife agencies across the nation identified the threats and conservation needs of wildlife species that have not benefited from conservation attention due to lack of dedicated funding (Association of Fish and Wildlife Agencies, 2006). With input from citizens, land management organizations and agencies, resource experts, and environmental groups, the Michigan Department of Natural Resources created a Wildlife Action Plan that identifies fourteen priority threats against wildlife species and their habitats (Eagle et al., 2005). Seven of Michigan's fourteen statewide priority threats (50%) specifically identified ecologically based local land use planning as a conservation action need. Land use planning that incorporates, improves, initiates, and implements programs and ordinances that protect and enhance natural environments are needed. In order for local governments to implement such ordinances, they must have accurate natural resource information to justify their decisions. For Michigan to maintain the rich diversity of natural resources, the Department of Natural Resources and other land management agencies and organizations must make natural resource information readily available and accessible to local land use planning officials so they can make ecologically informed land use planning decisions.

The U.S. Geological Survey (USDI Geological Survey, 2005) defines natural resources as, "The Nation's natural resources include its minerals, energy, land, water, and biota." In an attempt to encompass the breadth of natural resource information potentially available in Michigan, 15 categories were defined by the researcher for this project. These include: 1) agricultural, 2)

wetland vegetation, 3) upland vegetation, 4) invasive plants, 5) wildlife, 6) invasive animals, 7) endangered and threatened species, 8) geology, 9) surface water, 10) ground water, 11) soils, 12) land cover / land use, 13) topographic, 14) comprehensive green space, and 15) other.

The information gathered in the study will provide important insight into both the current state of the planning process with respect to how natural resource information has been used and integrated, and the future information needs of land use planning entities. Given the very high rate of land being converted from rural to developed in Michigan, there has never been a more acute need for a comprehensive understanding of the role of natural resource information in the planning and zoning process.

Assumptions and Limitations

A decision was made to omit cities and villages from the study population. Of the 1,858 entities with planning and zoning authority in Michigan, 533 were cities and villages, versus 1,339 townships, counties and regional planning commissions (MML, 2005: MTA, 2005). The cities and villages constituted at most 6% (USDA Economic Research Service, 2002a) of the physical land area, but would have increased the sample population by nearly 40%. Though municipalities do have natural resources within their legal boundaries, the percentage of land area that is affected by land use planning decisions and the resulting impact on existing natural resources was considered relatively low compared to townships, counties and regional planning commissions. In addition, survey expenses, time and personnel were limited by project funding.

It was assumed the person who filled out the survey was a planner or individual who is actively involved with land use planning and zoning issues. Due to the fact that there is no comprehensive database or list available with the names and addresses of Planners or Planning

Commission members in Michigan, the surveys were sent to the attention of the township and county Clerk. Results indicated there was high variability in the job title and planning credentials of the person who filled out the survey (Appendix J, Tables 35, 41 and 42).

Surveys were distributed to all townships and counties even though the IPPSR survey (2004) identified which local governments had adopted a Master Plan and Zoning Ordinance two years prior. An assumption was made that local governments may use natural resource information even if they do not plan or zone.

Local governments were asked if they adopted a Master Plan and Zoning Ordinance in both this survey and the IPPSR survey (2004). The results of both are presented later in Table 7 on page 36. If a township has not adopted a Master Plan or Zoning Ordinance but their county has, the county can plan or zone on behalf of the township. There is a possibility that some townships answered the adoption of a Master Plan and Zoning Ordinance question on behalf of the county instead of for their own jurisdiction. In other words, there could be overlap in answers if a township indicated "yes" they plan or zone, when in fact the county plans or zones on their behalf and the county also indicates they plan or zone. For analysis, an assumption was made that local governments were answering on behalf of their own jurisdiction only.

The short non-response survey had a limited set of questions. The non-response survey asked about local government's use of natural resource information in land use planning and zoning, but did not ask if they had adopted a Master Plan or Zoning Ordinance. If a local government did not plan or zone, they may not have returned the non-response survey. Since the IPPSR survey (2004) asked if townships or counties adopted a Master Plan or Zoning Ordinance, it was decided questions related to the government's use of natural resource information would be the focus of the non-response survey.

LITERATURE REVIEW

Michigan's Natural Resources

According to the USDA Economic Research Service (2002b), of the 36 million acres of land available in Michigan, approximately 10 million acres is classified as farmland. This represents 28% of the total land area in Michigan. While 61% of farms are less than 100 acres, the total average farm size is 190 acres, a trend that has been decreasing over time. There are 53,000 farms in the state. Ranked as the second largest industry in the state, Michigan's farm and farm related jobs employ 13% of the workforce (USDA Economic Research Service, 2002b).

Water is an integral part of the Michigan's heritage, economy and quality of life. Four of the five Great Lakes surround Michigan: Lake Superior, Lake Michigan, Lake Huron and Lake Erie. The Great Lakes represent the largest surface freshwater system on Earth. They contain approximately 84% of North America's surface fresh water supply and 21% of the world's surface freshwater supply (USEPA, 2006). In addition to the Great Lakes, Michigan has over 11,000 inland lakes and more than 36,000 miles of rivers and streams, and over 3,200 miles of Great Lakes shoreline (Library of Michigan, 2006). Being centrally located to the largest supply of surface freshwater in the world emphasizes the need for careful and responsible water protection efforts in Michigan.

Michigan's forests cover approximately 53% of the land area in the state (MDNR, 2006: USDA Forest Service, 2006). With the fifth largest timberland acreage in the continental United States, Michigan has 19.3 million acres of forestland, 97% of these forests are capable of producing commercial timber. The private sector owns 63% of the Michigan's forests - 45% by private individuals and 18% by the forest industry. The remaining 37% is controlled by the public sector

- 22% by the state, 14% federal government and 1% by county and local governments (MDNR, 2006: USDA Forest Service, 2006). The introduction of invasive organisms has posed and will continue to pose significant threats to Michigan's forest health. Species such as the emerald ash borer, beech bark disease, eastern larch beetle, gypsy moth, oak wilt and the jack pine budworm have all had impacts on Michigan's native forest ecosystem.

Michigan has an abundance of wildlife including mammals, birds, reptiles, amphibians, mollusks, arthropods and fish. Sixty species of mammals are known to be native since the time of European colonization, (Baker, 1983). Currently, six mammals are listed as endangered or threatened in Michigan (MDNR, 1999). Since colonization, seven species have been extirpated from the state including the: 1) marten, 2) fisher, 3) wolverine, 4) mountain lion, 5) elk, 6) caribou, and 7) bison. Three of these previously extirpated species have since been reintroduced and are doing well: the marten, fisher and elk. According to Brewer, McPeek and Adams (1991), over 215 species of birds are known to breed within the state's boundaries, 21 of which are listed and endangered or threatened (MDNR, 1999). Michigan has 50 species of reptiles and amphibians, of which 6 are listed as endangered or threatened (Harding and Holman, 1990: Harding and Holman, 1992: Holman et al., 1989: MDNR, 1999). Amphibians are particularly sensitive to pollution and other changes in habitat, and reptiles are increasingly vulnerable to road mortality, collection and nest predation pressures as human populations become more suburban (Gibbs and Steen, 2005: USDA Natural Resource Conservation Service, 2006). While often overlooked, insects play a critical role in the food web, especially in pollination and decomposition processes. Nielsen (1999) has identified 159 species of butterflies and skippers, 14 of which are listed as endangered or threatened (MDNR, 1999), and Bland (2003) has identified 137 species of grasshoppers, katydids and crickets in Michigan alone, of which 3 are listed as endangered or threatened (MDNR, 1999).

Because of the surrounding Great Lakes and the large number of inland lakes and streams, Michigan has an abundance of fish. Of the 153 species of fish in Michigan, approximately 30 are pursued for sport (MDNR, 2002) and 15 are listed as endangered or threatened in Michigan (MDNR, 1999). Hunting, fishing, bird watching, and other wildlife-related activities result in a large influx of dollars into the state's economy. The majority of the $2.8 billion spent on fish and wildlife related activities is for equipment (58%), followed by trip-related expenses (35%) and other expenses (7%) such as licenses, contributions, land ownership, and leasing (USDI & USDC, 2001).

In addition to the common fish and wildlife species, Michigan has a number of rare plant and animal species and unique natural communities. The Michigan Department of Natural Resources lists 342 plants and animals as endangered or threatened in Michigan. Of the 342 species legally protected under Part 365 of the Michigan Natural Resource and Environmental Protection Act of 1994, 261 are plants and 81 are animals (MDNR, 1999). In addition to the number of actively protected species, 46 species of plants and 47 species of animals are believed to be extirpated in the state or globally extinct. High quality natural communities are defined as "an assemblage of interacting plants, animals, and other organisms that repeatedly occur under similar environmental conditions across the landscape and are predominantly structured by natural processes rather than modern anthropogenic disturbances" (Kost et al., 2007). Seventy-six distinct high quality natural communities have been identified and are tracked throughout the state (Kost et al., 2007). These include natural communities such as lakeplain wet prairie, pine barrens, alvar, mesic southern forest and inland salt marsh.

One of the many threats to rare species and biological diversity is invasive species. Invasive species are defined as "as species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to

human health" (NISC, 2001). One such negative impact is the tendency to form monocultures at the exclusion of the more desired native plants and animals. In other cases, invasive species may alter hydrology, nutrient cycles, natural disturbance regimes, or the growth and reproduction of native species. Of the 2,729 plant species identified in Michigan, 914 (33.5%) are considered non-native invasive species (Herman et al., 2001).

As far as geologic resources, more than 21 minerals are mined in Michigan making it one of the most diverse mineral producing states in the nation (MSPO, 1995b). According to the United States Geological Survey (USDI Geological Survey, 2004), Michigan ranks ninth in total nonfuel mineral production. Iron ore is the state's most valuable nonfuel mineral commodity. Michigan is first in the production of magnesium compounds and second in iron ore, bromine, peat, and iron oxide pigments. Michigan ranks fourth in the United States in the manufacture of raw steel. There are no active underground metal mines operating in Michigan (USDI Geological Survey, 2004), although, Kennecott Minerals Company was recently approved for an underground nickel-copper mine in Marquette County (MDNR, 2008).

Crude oil and natural gas are two fuel-related minerals found in Michigan. According to the Energy Information Administration (2006), Michigan is ranked 15th in the U.S. in proven crude oil reserves and has the largest residential liquefied petroleum gas market in the nation. Crude oil production occurs mainly from small wells scattered across the Lower Peninsula. In addition to oil, Michigan has substantial natural gas reserves - more than any other state in the Great Lakes region. Ranked 12th in the nation in dry natural gas reserves, the Antrim natural gas fields in the northern portion of the Lower Peninsula are among the largest in the United States (Energy Information Administration, 2006). Michigan also has the most underground natural gas storage capacity and supplies natural gas to neighboring states during high-demand winter months.

Nearly four-fifths of Michigan households use natural gas as their primary energy source for home heating.

It is clear that Michigan's wealth of natural resources provide a remarkable diversity of plants, animals, water resources, agricultural products, minerals, and oil and gas reserves which must be managed carefully. Past, current and future land use planning decisions play a key role in determining the viability of Michigan's natural resources. In order to understand how natural resources information could be influential in local decision making, one must understand how planning and zoning is conducted in Michigan.

History of Planning and Zoning in Michigan

In 1908, in response to rapid population growth from successful industrialization and natural resource exploitation, Michigan adopted a "home rule" provision in the state constitution for cities and villages (Krane et al., 2001; MSPO, 1995c). The principle of "home rule" assumes that local governments are better suited to create regulations and make decisions that affect residents at the local level than state government. Authority to self-rule must be delegated or granted by the state constitution or statute. Virtually all states, including Michigan, provide a limited degree of self-rule to local governments, implementing a mix of both Dillon's Rule - state control over local governments - and home rule authority (Krane et al., 2001).

Land use planning authority was first delegated to cities and villages that had populations large enough to justify regulating. In 1921, Michigan adopted the City and Village Zoning Act which set the standard for state zoning (MTA, 2003). Zoning allows local governments to identify the types of land uses and development densities that will be allowed in certain districts or zones. Zoning regulations are established to protect the public's health, safety and general welfare. It is

a way to avoid land use conflicts between one neighbor and another. For example, residential housing is located in a separate area or district from industrial operations so pollution, noise and traffic do not adversely impact the daily lives of children, families and the elderly. In 1943, Michigan adopted the County Zoning Act and Township Zoning Act which established the regulatory authority for modern zoning in Michigan. Due to inconsistencies between the three separate zoning acts and the confusion it created when one community attempted to consult with another on a zoning matter, or when a developer worked in more than one jurisdiction, the three zoning acts were unified into one Michigan Zoning Enabling Act in 2006 (Michigan Compiled Laws 125.3101-3702) and amended in 2008 (Wyckoff, 2008a).

Soon after the first zoning regulations were instituted, it became clear municipalities needed to anticipate land use conflicts and identify opportunities in communities undergoing rapid development. In 1931, Michigan established the Municipal Planning Act to allow land use planning in villages and cities (MSPO, 1995c). As a result of the need for an agency to coordinate and plan emergency public works and employment projects in the early 1930's, the short lived but proactive State Planning Commission was created and in existence from 1933-1947. This legislative body initiated comprehensive planning that cut across all State departments and focused on achieving integrated and coordinated land use planning for sustained economic development. Comprehensive inventories of State resources, training of local government officials, review and approval of county Zoning Ordinances, and technical assistance to regions, counties and local governments were just a few of the duties of the State Planning Commission (MSPO, 1995c). Interest and requests for assistance soon outstripped the resources available to the Commission. When local governments did not receive assistance they began to question the role of the State in planning. Prior to the dissolution of the State Planning Commission in 1947, the Regional Planning Act and County Planning Act of 1945 was passed and enabled the creation of regional and county land use plans. This allowed counties and

regions to regain a large degree of control over the local planning process. Nineteen years later, the Township Planning Act of 1959 allowed the creation of township planning commissions to regulate and subdivide land. Townships were the last level of local government given authority to implement land use planning in Michigan. Amendments have been passed to improve coordination, notification, content and natural resource protection in all of the planning acts above, although, differences between procedures, public notices, scope of the statutes and authority remain. As a result, the Michigan Planning Enabling Act of 2008 was passed and will go into effect September 1, 2008 (Michigan Compiled Laws 125.3801-3885). This new act will unify all three separate planning acts into one.

Legal Foundations of Planning and Zoning in Michigan

County and township governments in Michigan are not legally obligated to develop zoning. However, if a county has adopted zoning but the township has not, the township is subject to county zoning. If at any time the township adopts its own "Zoning Ordinance," it is no longer subject to county zoning (MTA, 2003). Under the consolidated Michigan Zoning Enabling Act of 2006, if zoning is adopted, "The Zoning Ordinance shall be based upon a plan designed to promote the public health, safety, and general welfare, to encourage the use of lands in accordance with their character and adaptability and to limit the improper use of land, to conserve natural resources and energy, to meet the needs of the state's residents for food, fiber, and other natural resources, places of residence, recreation, industry, trade, service, and other uses of land…(Michigan Compiled Laws 125.3203)." A zoning plan is prepared as a chapter in a larger land use plan or "Master Plan." The zoning plan describes 1) each of the zoning districts, 2) the regulations that describe building height, lot area, bulk, and setbacks by district, 3) the proposed zoning map, 4) the standards or criteria used to consider rezoning, and 5) an explanation of how the land use categories on the future land use map relate to the districts on the zoning map (Wyckoff, 2008b).

Analogous to zoning, counties, townships and regional planning commissions are not legally obligated to develop a "basic plan" or Master Plan to guide future development. Planning at the regional level is completely voluntary. Although, if a township has not adopted a Master Plan and their county has, the township is subject to county planning decisions. If at a later time the township adopts a Master Plan, it must submit a copy to the county or regional planning commission for approval. Once approved, the township would no longer be subject to county planning (MTA, 2003). A Master Plan must address land use and infrastructure issues and may project 20 years or more into the future. Maps, plats, charts and other descriptive materials are included to illustrate the future desired growth and physical development of the local government. The planning commission, appointed by the local governing body, creates and approves the Master Plan (Michigan Compiled Laws 125.3831 and 125.3833). As stated in the statute, the Master Plan must address land use issues pertinent to the future development such as:

> "(a) A classification and allocation of land for agriculture, residences, commerce, industry, recreation, ways and grounds, public buildings, schools, soil conservation, forests, woodlots, open space, wildlife refuges, and other uses and purposes."

The primary difference between planning and zoning is timing. The Zoning Ordinance affects current land use and is a law. Only the Zoning Ordinance can change the use of land or regulations affecting land today. A proposed rezoning changes a described property from one zoning district to another, which affects how that property can be used. The Master Plan refers to future land use and is a statement of policy. It states the principles on which future development will occur and identifies any specific issues affecting development. The Master Plan has no direct legal authority but it is a document meant to be used as the basis for local Zoning Ordinances, subdivision regulations, other local land use regulations, and for ensuring capital improvements are consistent with future desired development. A comprehensive, carefully prepared and regularly implemented Master plan lends credibility to local government decisions

if and when they are challenged in court. Every five years after adoption of a Master Plan, the planning commission must review and determine whether to amend the plan or adopt a new plan (Michigan Compiled Laws 125.3845).

Regional planning commissions bring county and township governments together to identify, administer and provide information, programs and planning at a more economical and effective scale. According to 125.19 of the Michigan Compiled Laws,

> "The regional planning commission may make and coordinate the development of plans for the physical, social, and economic development of the region, and may adopt a plan or the portion of a plan so prepared as its official recommendation for the development of the region. A regional planning commission may conduct all types of research studies, collect and analyze data, prepare maps, charts, and tables, and conduct all necessary studies for the accomplishment of its duties."

There is no mention as to how frequently the regional plan must be reviewed, although, the governor's executive office must review and comment on all regional plans prior to adoption (Michigan Compiled Laws 125.25). There are 14 regional planning commissions that cover the entire State of Michigan.

Status of Planning and Zoning in Michigan

Land use decision making is a difficult balancing act between frequently competing social, economic and environmental objectives. The costs and benefits of local versus regional land use perspectives can also complicate land use decisions. Government's role in land use planning and zoning is to: 1) reduce harm and nuisances, 2) ensure the orderly timing of development and associated services, and 3) protect public values (Dale et al. 2000). One way this is accomplished is through the completion and updating of a Master Plan. Such plans guide planning commissions and local governing body as to the goals and limitations that are desired by residents in a geographic area.

According to a survey conducted in Michigan by the Institute for Public Policy and Social Research (IPPSR) in 2004, 73% of counties and 67% of townships had adopted a Master Plan, while only 29% of counties had adopted a Zoning Ordinance compared to 71% of townships (IPPSR, 2004). The relatively low number of counties adopting a Zoning Ordinance is because in the more urban counties, populations are larger and local units of government at the township and municipal level are more likely to adopt their own Zoning Ordinances. Of the 274 townships that had chosen not to plan or zone, all had fewer than 6,000 persons (USDC Census Bureau, 2000a). The vast majority of townships in Michigan, 707 in total, had adopted both a Master Plan and a Zoning Ordinance. As the population of a township increases, so does the likelihood that it will adopt a Master Plan and Zoning Ordinance.

Michigan's Demographic Trends

Michigan is ranked the 8th most populous state in the nation, with an estimated 10.1 million people in 2007 (USDC Census Bureau, 2000b). This represents 3.4% of the total estimated U.S. population. After World War II, Michigan's population growth peaked with a 22.8% increase in persons from 1950 to 1960 (USDC Census Bureau, 1995). Prior to 1960, most growth occurred in urban areas (CEP and NWF, 2006; MSPO, 1995d). In the 1970's, shifts from urban to suburban and rural areas accelerated. Suburban growth in the Detroit area was partly spurred by forced school integration and the 1967 Detroit riots. In addition to the population moving out of the urban core, population growth slowed substantially between 1970 and 1980 to 4.4% and again between 1980 and 1990 to 0.4% (Table 1) (USDC Census Bureau, 1995).

Table 1. Michigan's population from 1940 to 2000.

Years	Population	Population Growth Rate
1940 – 1950	5,256,106 to 6,371,766	21.2%
1950 – 1960	6,371,766 to 7,823,194	22.8%
1960 – 1970	7,823,194 to 8,881,826	13.5%
1970 – 1980	8,881,826 to 9,262,044	4.3%
1980 – 1990	9,262,044 to 9,295,297	0.4%
1990 – 2000	9,295,297 to 9,938,444	6.9%

The relatively strong growth rate of the 1990's reflected a surging national and state economy. Manufacturing, technology and the housing market were all doing well. Seven of the top ten counties that had the largest increase in population during the 1990's were in the Northern Lower Peninsula (Table 2) (USDC Census Bureau, 1990; USDC Census Bureau, 2000a). In contrast, counties with negative growth rates were mainly in the Upper Peninsula and in the urban core areas of the Southern Lower Peninsula (Table 3). Michigan has consistently ranked in the top ten for home ownership rates for the last century (Hobbs and Stoops, 2002). Home ownership includes not only the primary home, but also secondary or seasonal homes. Due to the abundance of natural resources, access to four Great Lakes, and four distinct seasons, Michigan is a destination for second home development (USDA Forest Service, 1997). The Northern Lower Peninsula is the most popular second home development region in Michigan (USDC Census Bureau, 2000c). Nine out of the top ten counties with the highest number of seasonal homes are in this region. Roscommon County leads the state with 11,091 seasonal homes.

Table 2. Top ten Michigan counties with increasing population: 1990-2000.

County	Population Growth Rate
Livingston	36%
Keweenaw	35%
Lake	32%
Benzie	31%
Otsego	30%
Roscommon	29%
Leelanau	28%
Antrim	27%
Ottawa	27%
Emmet	26%

Table 3. Top ten Michigan counties with decreasing population: 1990-2000.

County	Population Growth Rate
Ontonagon	-11.7%
Iosco	-9.5%
Marquette	-8.8%
Gogebic	-3.8%
Wayne	-2.4%
Bay	-1.4%
Ingham	-0.9%
Saginaw	-0.9%
Iron	-0.3%

Michigan's population is highest in two combined metropolitan statistical areas in the Lower Peninsula of Michigan: the Detroit-Ann Arbor-Flint triangle in the southeast corner of the state has 5.4 million persons, and the Grand Rapids-Muskegon-Holland area on the west side near Lake Michigan has just over 1 million persons (USDC Census Bureau 2000d). Similarly, population density in Michigan is highest in Wayne County followed by Macomb County and Oakland County (USDC Census Bureau, 2000a) (Table 4). Michigan's population is projected to grow slowly in the decades to come. By 2030, the Census Bureau estimates that Michigan will have the 11th largest population with just fewer than 10.7 million people (USDC Census Bureau, 2005). The majority of future population growth is projected to continue in the outer ring suburbs

of the two metropolitan regions above, in addition to the northwestern corner of the Northern Lower Peninsula (CEP and NWF, 2006).

Table 4. Population density of top ten counties in Michigan.

County	Population Density – Persons per Square Mile
Wayne	3,356
Macomb	1,640
Oakland	1,369
Genesee	682
Kent	671
Ingham	500
Washtenaw	455
Kalamazoo	425
Ottawa	421
Muskegon	334

According to Alig and Healy (1987) and Alig et al. (2004), population density and per capita income variables are the primary determinants influencing the increase in "developed land" area in the United States. Developed land is defined by the USDA Natural Resource Conservation Service (2003) as, "A combination of land cover/use categories including: 1) large urban and built-up areas of at least 10 acres, 2) small built-up areas of 0.25 to 10 acres; and 3) rural transportation land which consists of all highways, roads, railroads and associated right-of-ways outside urban and built-up areas." The National Resource Inventory (NRI), which is conducted by the USDA Natural Resource Conservation Service, was the data source for calculations of urbanized and built-up areas on non-federal lands across the United States because it excludes rural land cover (e.g. agricultural crops, forestry, etc.) when it is within an area that is otherwise built-up (Alig et al., 2004). Additionally, the NRI also classifies non-farm built-up uses (e.g. highways, roads, railroads, etc.) in rural areas as developed land.

When considering the primary determinants of developed land are population density and per capita income, the counties with the highest population density (Table 4) and per capita income

(Table 5) are in the Southern Lower Peninsula of Michigan (USDC Census Bureau, 2000a; USDC Census Bureau, 2000e). The natural resources in this region are and will continue to be under the highest threat of development. The scenically beautiful and natural resource rich counties in the northwest Lower Peninsula will also feel the pressure of urbanizing development.

Table 5. Per capita income of top ten counties in Michigan.

County	Per capita income in 1999
Oakland	$32,534
Livingston	$28,069
Washtenaw	$27,173
Leelanau	$24,686
Macomb	$24,446
Midland	$23,383
Clinton	$22,913
Monroe	$22,458
Eaton	$22,411
Grand Traverse	$22,111

Relationship between Land Use Planning and Natural Resources

As human society has advanced in technological and industrial processes, people have migrated from rural communities near essential natural resources to urban environments far removed from vital resources (PSC, 2001: MLULC, 2003). In the 21st century, extensive transportation networks allow people to live on the urban fringe and commute into distant urban environments. These trends have reduced human interaction, knowledge and awareness of critical natural resources and the ecological impact of such land use decisions (Dale et al., 2000). Ecologically based land use planning attempts to reunite humans with their need and impact on natural resources.

Between 1980 and 2000, the United States had a 24% increase in population growth, from 227 million to 281 million persons (USDC Census Bureau, 2007). Between 1982 and 2003,

developed land uses in the United States increased by 48% (USDA Natural Resources Conservation Service, 2003). This 2:1 ratio indicates, at a national level, land is being converted to urban and ex-urban uses at twice the rate of population growth. This is often caused by urban residents moving out to more rural locations on the urban fringe. Michigan undertook a similar analysis looking at current and future land use trends using a Land Transformation Model (LTM) (PSC, 2001). LTM projections between 1980 and 1995 indicate the built areas in Michigan - those areas of residential, commercial, industrial use and roads - increased by 25%, while population grew by only 3%. This 8:1 ratio indicates Michigan's rate of land conversion to urban-like conditions is greatly out pacing the rate of population growth. If current development trends continue between 1980 and 2040, LTM projections indicate the built areas of Michigan will increase by 178%. During the same time period agriculture, wetlands, forest and other vegetation are expected to decrease by 17%, 10%, 8% and 24% respectively. The ability to keep agricultural land or forestland in active production is greatly influenced by the ability of resource producers to compete with increasing land prices as urban sprawl encroaches. While this LTM model reflects an estimate of expected outcomes, the numbers are nevertheless a serious concern to those that rely on land-based industries and the economic output of goods and services provided by the agriculture, recreation, tourism, mining and forestry sectors. The landscape fragmentation associated with a significant increase in the built environment will make resource production and resource conservation much more difficult.

Land use planning can preserve habitat through the use of comprehensive planning, development restrictions and zoning. However, currently this process rarely recognizes the key role ecological systems play in maintaining public health and economic stability. With 67% of the landscape in the continental United States owned by private landowners (Dale et al., 2000), local land use decision can have a tremendous impact on the preserving biodiversity, prime agricultural land, recreational areas, and geological resources necessary for survival and quality of life. Dale et al.

(2000) has identified five principles of ecology that need to be addressed in land use planning to assure Earth's basic ecological processes and biodiversity are sustainable. The five principles are:

1) **Time** – Ecological processes change over time. The full ecological effects of human activities often are not seen for many years because of the time it takes for a given action to transmit through components of the system. Recognizing the impacts of land use on ecological processes over time is critical.
2) **Species** – Individual species and networks of interacting species affect ecological processes. Changes in biological diversity, community composition or total productivity occur when changes in the abundance of a focal species or guild of organisms in one food chain affect the abundance of species or organisms in other food chains. Often it is the processes associated with particular species that are critical to ecosystem functions.
3) **Place** – Each site or region has a unique set of species and abiotic conditions influencing and constraining ecological processes. Land should be used for the purpose to which it is best suited. Houses built on lakeshore dunes, major flood plains or sites prone to fires are extremely vulnerable over the long term. Development should not occur on prime farmland.
4) **Disturbance** – Ecological disturbance is unavoidable and important, with potentially significant impacts on populations, communities and ecosystem dynamics. The effects of disturbances depend in large part on intensity, duration, frequency, timing and spatial impact. Land use policies that are based on the understanding that ecosystems are naturally dynamic in both time and space can often deal with changes induced by disturbances.
5) **Landscape** – The size, shape and spatial relationships of habitat patches on the landscape affect the structure and function of ecological processes. Large patches of habitat generally contain more species and often a greater number of individuals than smaller

patches of the same habitat. Habitat connectivity can limit the distribution of species by making some areas accessible and others inaccessible. The threshold of connectivity varies among species and depends upon two factors: (1) the abundance and spatial arrangements of the habitat, and (2) the dispersal capabilities of the organism.

The Environmental Planning Handbook for Sustainable Communities and Regions (Daniels and Daniels, 2003), which is published by the American Planning Association, defines environmental planning as "deciding how to use natural resources, financial capital, and people to achieve and maintain healthy communities and a high quality of life." The handbook identifies three important land uses which create our environment. They are: 1) **natural areas** which provide environmental services such as habitat, water purification, parks, corridors, alternative transportation routes, and environmental constraints such as floodplains and landslide areas, 2) **working landscapes** provide economic wealth for rural areas and include farms, forests, rangeland, mines, and recreation areas, and 3) **built environments** which provide economic wealth for cities, suburbs and towns and includes all the necessary infrastructure and public spaces. Deciding where, how and when these land uses should or should not change is the primary challenge of planning. Environmental planning helps communities minimize or avoid:

- air and water pollution,
- loss of wildlife, biodiversity and critical habitats,
- conversion of prime agricultural land or prime forestland to development,
- deterioration of existing urban centers,
- cost of natural disaster cleanups.

Research Questions

After an extensive literature review, it was clear the use and integration of natural resource information in land use planning and zoning decisions is critical to improving the economic, social and environmental functions necessary for society's health and well-being. Given this reality, research has not been conducted on local government's use, interest and need for different types of natural resource information. As a result, the following research questions were developed for descriptive or multivariate analysis:

- What types of natural resource information are local governments currently using for land use planning and zoning decisions?
- How is natural resource information being applied to local land use planning and zoning decisions?
- How important is natural resource information for future land use decision-making?
- What are the challenges, barriers and needs of local governments when it comes to incorporating natural resource information into planning and zoning efforts?
- Is the use of natural resource information by townships or counties dependent on the adoption of a Master Plan or Zoning Ordinance?
- Does a township's use of natural resource information depend on per capita income and population density?

METHODS

A mixed method approach was used for this project. The primary data collection method was a quantitative survey followed by qualitative interviews. Secondary data was also collected from the U.S. Department of Commerce, Census Bureau.

Survey Population

To ascertain the natural resource information needs of local governments in Michigan, it was determined the most relevant data would come from a survey of the entire local government land use planning population, minus the municipalities. Because of their relatively high population density, municipalities - cities, towns, or villages - tend to have fewer natural resources remaining or accessible and represent a small percent of the total land area. Therefore, a survey was conducted of all the townships, counties and regional planning commissions in Michigan. A 20-question survey (Appendix A), cover letter (Appendix B, D and E), and postage paid pre-addressed return envelope was mailed to all of Michigan's 1,242 townships, 83 counties, and to the 14 regional planning commissions.

Following the methodology undertaken by the Institute for Public Policy and Social Research in their 2003 survey, *To Plan or Not to Plan: Current Activity within Michigan's Local Governments* (IPPSR, 2004), a survey was sent to the Clerk in the townships and counties. The Planner or Director received the survey in the regional planning commissions. Names and addresses were retrieved from the Michigan Townships Association, Michigan Association of Counties, and Michigan Association of Regions.

Survey Design & Implementation

The survey design and implementation followed Dillman's (2000) Tailored Design Method. Survey recipients were contacted up to five times when necessary through the first questionnaire (Appendix A), a reminder postcard (Appendix C), two replacement questionnaires that were identical to the original questionnaire, and a short non-response survey (Appendix F). Questionnaires were mailed between August and November 2005. The Tailored Design Method is based on the principles of social exchange theory which emphasizes the survey's usefulness and the importance of a response from each person in the sample. Multiple contacts that differ in technique (e.g. cover letter, postcard, short survey) are essential to maximize response rates. The University Committee on Research Involving Human Subjects (Institutional Review Board #05-362) at Michigan State University approved the project design and survey instrument on July 11, 2005 (Appendix I).

Survey questions were measured using a yes/no, multiple choice, fill in the blank, or, three- to five-point Likert scale. Likert scales, developed by Rensis Likert, measure a respondent's level of agreement to a statement (Likert, 1932). The survey has three main sections. The first section of the survey, five yes/no or multiple choice questions in total, identified the respondent's position and duties within the local government they are representing and whether the local government was actively involved with planning and zoning. The second and main section of the survey consisted of eight Likert scale questions, asked about local government's use, satisfaction, importance, and need for natural resource information. Included in this section was a question on the amount of development occurring within the government's jurisdiction, along with a yes/no question asking if the respondent was willing to participate in an interview. The last section had six yes/no, multiple choice, or fill in the blank questions that characterized the

demographics of the respondents. A final open ended question asked for any comments concerning the use of natural resource information in land use planning and zoning.

The first survey and cover letter were mailed to 1,339 local governments in August 2005. A reminder postcard was sent two weeks after the first survey. The second cover letter and replacement survey were mailed one month after the first survey. The third cover letter and replacement survey were mailed one month after the second survey. Local governments that returned a survey did not receive replacement surveys. In an attempt to measure non-respondents bias, a short six-question survey was mailed one month after the third replacement survey. The names of individuals filling out the survey remained confidential.

Survey Analysis

Survey data were entered and analyzed using the Statistical Program for the Social Sciences (SPSS) version 15.0 software. Because of the categorical nature of the survey, results were analyzed using absolute and relative frequencies, cross tabulations, and for one question an index of importance was created. Where appropriate, survey results were stratified by the type of local government (township, county, regional planning commission) and by location in the state (Southern Lower Peninsula, Northern Lower Peninsula, Upper Peninsula).

In addition to analyzing absolute and relative frequencies, the following two research questions were analyzed using Pearson Chi-Square nonparametric statistics (Coolidge, 2000):

- Is the use of natural resource information by townships or counties dependent on the adoption of a Master Plan or Zoning Ordinance?
- Does a township's use of natural resource information depend on per capita income and population density?

In order to analyze these two research questions, it was postulated that the use of natural resource information by counties and townships was dependent on the adoption of a Master Plan or Zoning Ordinance. It was assumed counties and townships answered whether they had adopted a Master Plan or Zoning Ordinance on behalf of their own jurisdiction only. Similarly, if population density and per capita income are the primary determinants influencing the increase in developed land (Alig and Healy, 1987; Alig et al., 2004), it was hypothesized townships with high population density and high per capita income would be most likely to use natural resource information in their land use planning and zoning decisions. In order to use Chi-Square analysis, township's per capita income and population density were stratified by percentile into low (0-33.3%), medium (33.4-66.6%), and high (66.7-100%) categories. The following null hypotheses were used to answer the two research questions:

H1: The use of natural resource information by counties was independent of the adoption of a Master Plan.

H2: The use of natural resource information by townships was independent of the adoption of a Master Plan.

H3: The use of natural resource information by counties was independent of the adoption of a Zoning Ordinance.

H4: The use of natural resource information by townships was independent of the adoption of a Zoning Ordinance.

H5: A township's use of natural resource information was independent of its per capita income and population density.

Interview Population

A purposeful sample of 30 local government officials, or the consultant representing the respective local government, were interviewed to answer research questions and gain additional insight into the use of natural resource information in land use planning and zoning. Interview candidates were chosen from the 283 survey respondents that answered "yes" to survey question #14, "Would you be willing to participate in an interview to further explore the current and potential role of natural resource information, and data products, in your township/county/regional land use planning and zoning activities?" The 30 chosen interviewees were in their position for at least two years, and all but one of the final interviewees were in a position that required making land use planning or zoning decisions/recommendations. The one exception was a local official in an administrative position that did not make daily planning and zoning decisions but who was very familiar with the process and requirements.

Local government officials in a variety of positions completed the survey and indicated they would be willing to participate in an interview. Therefore, the interview population consisted of officials in different positions including directors/managers, supervisors, zoning administrators, planners, clerks, planning commission members, and private consultants. Interviews were geographically stratified across the state with 10 in the Upper Peninsula, 10 in the Lower Peninsula, and 10 in the Southern Lower Peninsula. Within the three geographic areas, a representative sample of local governments was interviewed including one regional planning commission, two counties, and seven townships. This resulted in a total of three regional planning commissions, six counties, and 21 townships being interviewed across Michigan.

Interview Design & Implementation

Topical evaluative interviews were designed as a secondary component to the research project. Topical interviews, compared to cultural interviews, focus on a particular event or process and are concerned with what happened, when, and why (Rubin and Rubin, 1995). The interviews provided an opportunity to follow-up or ask new questions related to local governments use, interest, and need for natural resource information in land use planning and zoning. The interviews were conducted in-person at the local government office or at the consultant's office, with the person that filled out the survey. One exception was a township official that requested the interview occur at his bike rental business, since it was peak bike season. Written consent was received from the participants prior to the interview beginning (Appendix G). Consent was also sought to have the interview digitally recorded. When not allowed to record the interview, extensive notes were taken by hand. A semi-structured interview guide was used during each interview (Appendix H). Interviews ranged in length from 40 minutes to 1 hour 45 minutes, with an average time of approximately 55 minutes. Interviews were conducted between May and September 2006.

The Social Science/Behavioral/Education Institutional Review Board (IRB #05-362) at Michigan State University approved the interview protocol and consent form on April 6, 2006 and the entire project was renewed on June 20, 2006 (Appendix I).

Interview Analysis

The interviews were transcribed verbatim from digital files or from handwritten expanded notes. In lieu of statistical significance, qualitative findings are judged by their substantive significance (Patton, 2002). The interview is designed to be a unique experience with the respondent. Each respondent is in control of the answers they provide. Coding is the act of analysis. Miles and

Huberman (1994) define codes as “tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study.” Codes were applied to the transcribed interviews to identify concepts and themes following Patton (2002) methodology. The unit of analysis was the level of local government – township, county or regional planning commission. Case-based analysis was used to identify codes by township, county, regional government and overall among all local governments. Quotes are provided from local government officials as an example of the common themes and concepts identified.

RESULTS

Of the 1,339 total survey questionnaires mailed to local and regional governments, 994 (74%) were returned. Fifty-four (4%) of the returned questionnaires were blank or had no usable information. The remaining 940 questionnaires (70%) had at least one land use related question that was answered and used in the analysis. Of the 940 usable surveys, 865 were from townships (70% of the townships), 60 were from counties (72% of the counties), and 13 were from regional planning commissions (93% of the regional planning commissions) (Figure 1). Two surveys were returned with the identification number torn off but otherwise had usable information and were included in the overall analysis. Of the 345 questionnaires that were not returned after three contact attempts, 55 (16%) responded to the short non-response survey. The non-respondents did not appear to be different than the respondents.

Of the 283 (35%) survey respondents that agreed to participate in an interview (Table 20), 30 local governments were interviewed (Figure 2) (Table 6). Twenty-eight of the interviews were digitally recorded and two were documented with expanded notes. Officials or representatives in the following positions were interviewed:

- 9 planners
- 6 planning commission members
- 6 zoning administrators
- 3 clerks
- 2 township supervisors
- 2 managers / directors
- 2 consultants representing a local government

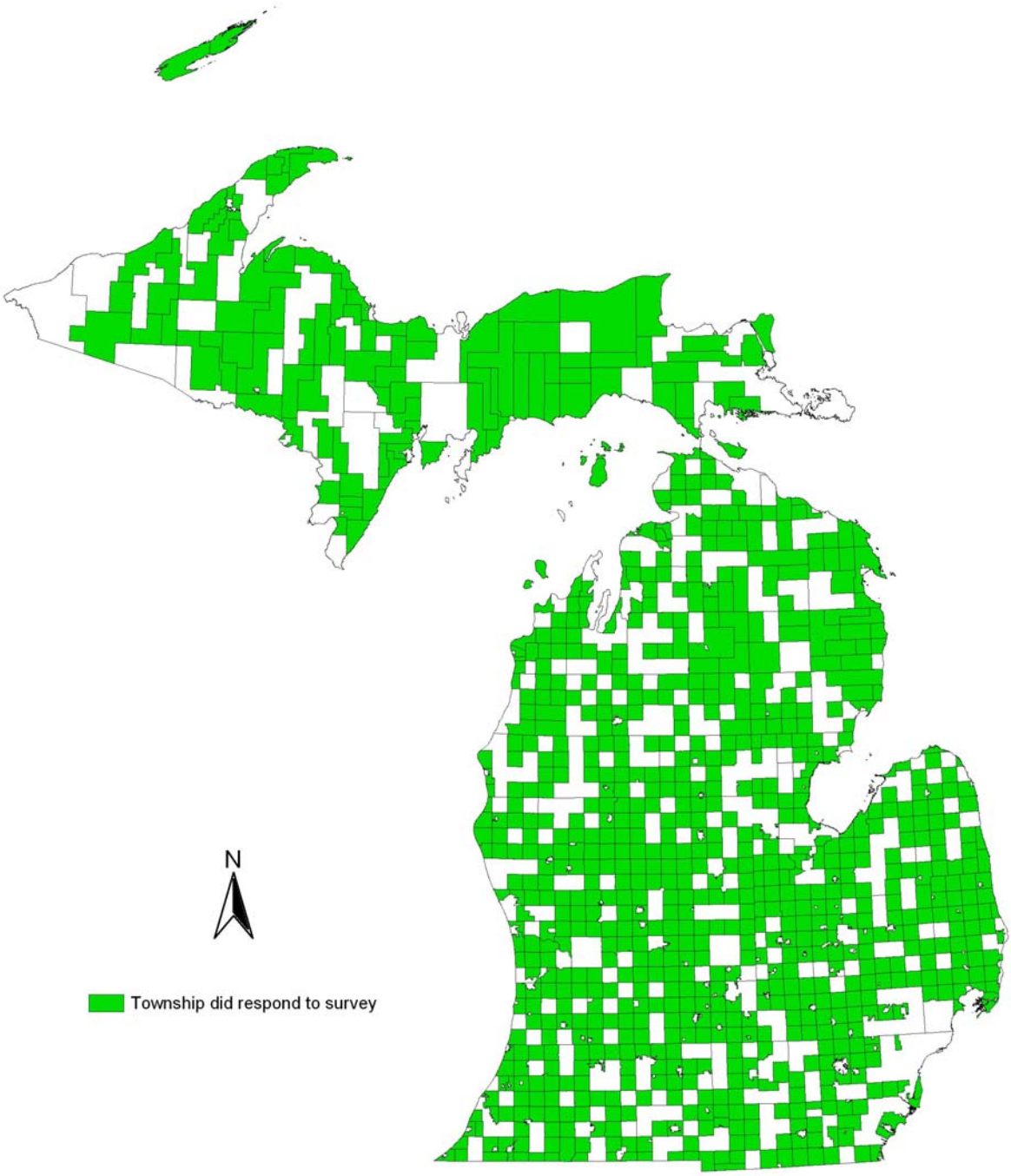

Figure 1. Townships that responded to survey

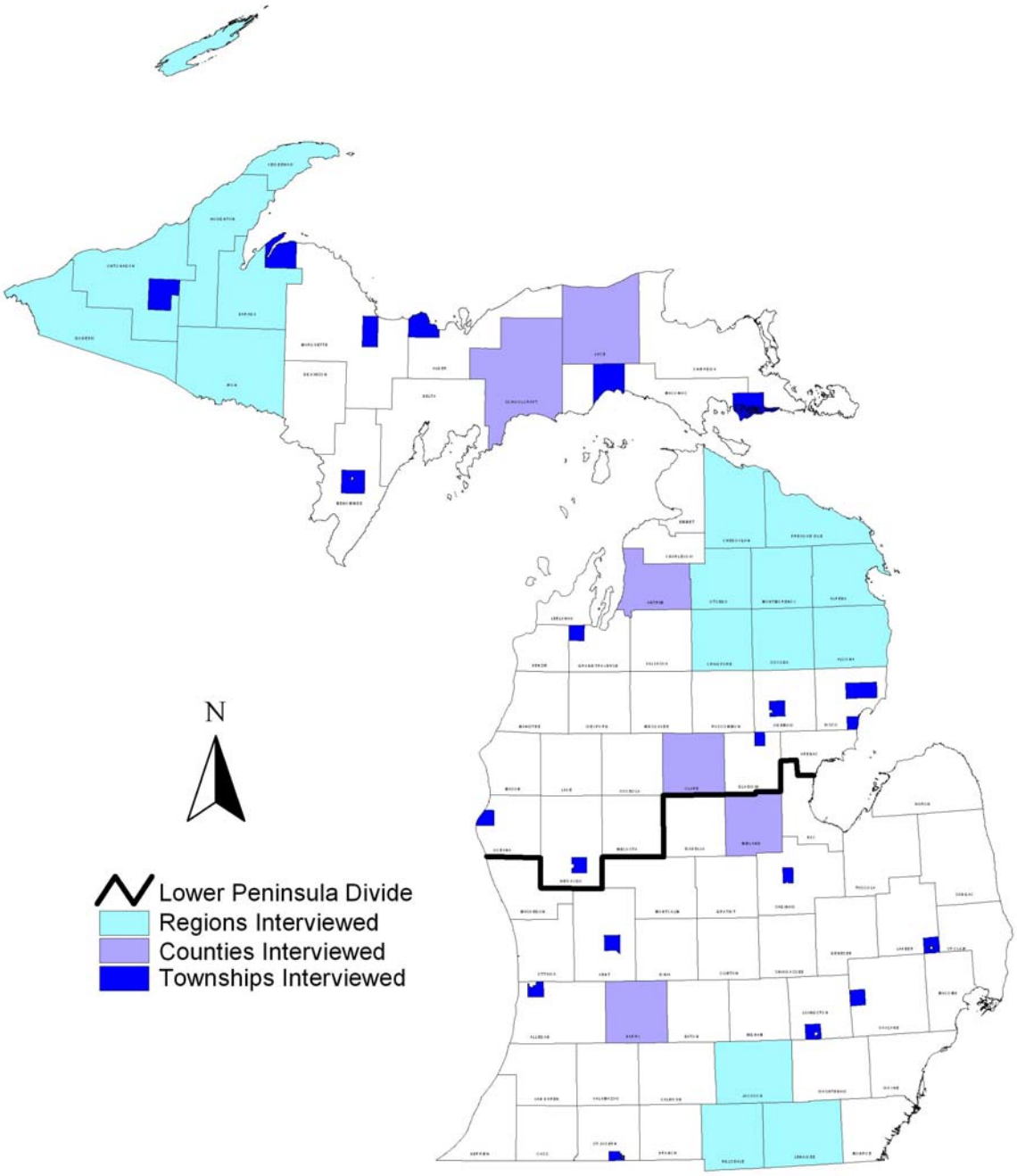

Figure 2. Local governments interviewed in Michigan

Table 6. Local governments interviewed by geographic region.

Local Government	Geographic Region
Western Upper Peninsula Planning & Development Region	Upper Peninsula
Luce County	Upper Peninsula
Schoolcraft County	Upper Peninsula
Arvon Township	Upper Peninsula
Clark Township	Upper Peninsula
Garfield Township	Upper Peninsula
Nadeau Township	Upper Peninsula
Onota Township	Upper Peninsula
Sands Township	Upper Peninsula
Stannard Township	Upper Peninsula
Northeast Michigan Council of Governments	Northern Lower Peninsula
Antrim County	Northern Lower Peninsula
Clare County	Northern Lower Peninsula
Alabaster Township	Northern Lower Peninsula
Brooks Township	Northern Lower Peninsula
Clement Township	Northern Lower Peninsula
Golden Township	Northern Lower Peninsula
Long Lake Township	Northern Lower Peninsula
West Branch Township	Northern Lower Peninsula
Wilber Township	Northern Lower Peninsula
Region 2 Planning Commission	Southern Lower Peninsula
Barry County	Southern Lower Peninsula
Midland County	Southern Lower Peninsula
Ada Township	Southern Lower Peninsula
Almont Township	Southern Lower Peninsula
Fillmore Township	Southern Lower Peninsula
Highland Charter Township	Southern Lower Peninsula
Putnam Township	Southern Lower Peninsula
Sturgis Township	Southern Lower Peninsula
Swan Creek Township	Southern Lower Peninsula

Adoption of Master Plan and Zoning Ordinance

Analysis began by examining the survey results related to local government planning and zoning. Approximately 72% of all townships and 76% of county governments in Michigan adopted a Master Plan, while Zoning Ordinances had been adopted in 76% of townships but in only 37% of counties. These results were similar to the survey results from the Institute for Public Policy and Social Research (IPPSR, 2004) (Table 7), although, these more recent survey results reflect a

higher percentage of townships and counties adopting a Master Plan and Zoning Ordinance than the IPPSR survey. This may indicate an actual increase in the adoption of planning and zoning, or it may reflect the lower response rate of this mail survey (70%) compared to the IPPSR mail survey and follow-up phone calls (93%).

Table 7. Comparison of natural resource survey with the IPPSR survey results[1, 2]

	Township Replies (Total Replies)	% Townships	County Replies (Total Replies)	% Counties
Natural resource survey				
Yes - Master Plan	607 (845)	72%	44 (58)	76%
Yes - Zoning Ordinance	649 (857)	76%	22 (59)	37%
IPPSR survey				
Yes - Master Plan	756 (1124)	67%	61 (83)	73%
Yes - Zoning Ordinance	809 (1138)	71%	24 (83)	29%

Types of Natural Resource Information Used

Survey results indicate the most common types of natural resource information used by local governments are surface water, land cover/land use, soils and wetland vegetation information (Table 8). Regional planning commissions used this information most often, followed by counties and townships. Excluding the "Other Natural Resource Information" category, invasive animal and invasive plant species information were least often used by local governments, although, counties and townships were more likely to use invasive species information than regional planning commissions.

1. Natural Resource Survey questions: Has your township/county adopted a Comprehensive Development Plan, Master Plan, or other similar land use plan? Has your township/ county adopted a Zoning Ordinance? Potential answers: Yes, No, or Not Sure. Frequency analysis was conducted and presented above.
2. IPPSR Survey questions: Has your community adopted a Comprehensive Plan, Future Land Use Plan, General Plan, Basic Plan, General Development Plan, Master Plan, or other similar plan? Has your community adopted a Zoning Ordinance? Potential answers: Yes or No. Frequency analysis was conducted and presented above.

Table 8. Types of natural resource information used in land use plans, zoning ordinances or land use decisions/recommendations[3]

Types of Natural Resource Information	Yes		No		Total # of Respondents
	N	%	N	%	
Surface Water	529	70%	225	30%	754
Land cover/land use	523	69%	233	31%	756
Soils	483	64%	266	36%	749
Wetland Vegetation	472	62%	282	38%	754
Agricultural	451	59%	307	41%	758
Topographic	399	53%	347	47%	746
Ground Water	355	47%	391	53%	746
Geology	327	44%	411	56%	738
Upland Vegetation	305	41%	435	59%	740
Comprehensive Green Space Map	225	31%	504	69%	729
Endangered & Threatened Species	133	18%	604	82%	737
Wildlife Species	124	17%	620	83%	744
Other Natural Resource Information	68	14%	425	86%	493
Invasive Plant Species	107	14%	633	86%	740
Invasive Animal Species	88	12%	651	88%	739

Application of Natural Resource Information in Planning and Zoning Activities

Local governments "always" and most "frequently" used natural resource information when creating or updating a Master Plan (54%), when creating or updating Zoning Ordinances (52%), and when conducting site development reviews (50%) (Table 9). Regional planning commissions (77%) were more likely to always and frequently use natural resource information when creating or updating a Master Plan than counties (60%) or townships (53%). Regional planning commissions (54%) and townships (53%) were equally likely to always and frequently use natural resource information when creating or updating a Zoning Ordinance than counties (38%). The regional planning commissions that used information in Zoning Ordinances must have been contracted to create or update zoning by a county or township since regional planning commissions can not legally zone. An almost equal percentage of townships (50%) and counties (49%) always and frequently used natural resource information when conducting site

3. Survey question: Have you used the following types of natural resource information in your land use plans, zoning ordinances or land use decisions/recommendations? Potential answers: No did not use, or, Yes used. Frequency analysis was conducted and presented above.

development reviews. Regional planning commissions do not conduct site development reviews. Natural resource information was least likely to be used in transportation and utility planning and over 50% of the local governments indicated they do not participate in these activities.

Table 9. Use of natural resource information in land use planning and zoning activities[4]

Planning Activity	Always (100%)		Frequently (~75%)		Sometimes (~50%)		Rarely (~25%)		Never (0%)		Activity Not Conducted		Total # of Respondents
	N	%	N	%	N	%	N	%	N	%	N	%	
Master Plan creation or update	232	31%	172	23%	110	15%	60	8%	33	4%	145	19%	752
Zoning Ordinance creation or update	231	31%	162	21%	119	16%	54	7%	34	5%	154	20%	754
Site Development reviews	198	27%	171	23%	135	18%	53	7%	36	5%	151	20%	744
Planned Unit Developments (PUD's)	167	23%	119	16%	70	10%	54	7%	54	7%	276	37%	740
Preservation Ordinance creation or update	155	21%	105	14%	80	11%	49	7%	53	7%	299	40%	741
Land Division reviews	136	18%	128	17%	140	19%	86	11%	71	10%	185	25%	746
Park and Recreation planning	136	18%	122	16%	81	11%	57	8%	58	8%	290	39%	744
Land Acquisition planning	85	11%	81	11%	78	11%	57	8%	64	9%	372	50%	737
Capital Improvements planning	71	9%	87	12%	110	15%	60	8%	63	9%	344	47%	735
Utility planning	69	9%	70	10%	72	10%	65	9%	69	9%	395	53%	740
Transportation planning	58	8%	65	9%	71	9%	72	10%	71	9%	405	55%	742
Other activities	12	3%	11	3%	8	2%	11	3%	32	8%	324	81%	398

When interviewed, officials indicated natural resource information was most commonly incorporated into Zoning Districts, Zoning Ordinances, or Zoning Maps and to a lesser extent into the Master Plan (Appendix J, Table 21).

4. Survey question: How often do you use natural resource information in the following land use planning and zoning activities? Potential answers: Always, Frequently, Sometimes, Rarely, Never, or Not Applicable - activity not conducted by township/county/region. Frequency analysis was conducted and presented above.

> "We use that information to come up with existing land use. In the city of Jackson we did a conservation overlay to look at riparian buffers on the Grand River and along the wetlands and things like that... We'll use that to help them realize that they have issues to work with. If that translates into their goals and objectives we'll also use that information for the future land use map as well, which then translates into Zoning Ordinance updates. So it goes all the way through." – Region 2

This reflects a slightly different response compared to the survey results, where respondents indicated an equal use of natural resource information in the creation or updating of a Master Plan and Zoning Ordinance (Table 9).

Importance of Natural Resource Information

When asked how important 15 different types of natural resource information are for future planning and zoning decisions, local governments overwhelmingly indicated surface water, ground water, and land cover/land use were "very important" (Table 10). Invasive plant, invasive animal, endangered and threatened species and wildlife information were identified most frequently as "not important" although, an almost equal percentage of local governments indicated they "don't know" enough about these types of natural resource information.

Table 10. Level of importance of natural resource information[5]

Future Importance	Very Important		Somewhat Important		Not Important		Don't Know		Total # of Respondents
	N	%	N	%	N	%	N	%	
Surface Water	568	72%	155	20%	11	1%	54	7%	788
Ground Water	528	67%	183	23%	24	3%	58	7%	793
Land cover/land use	471	60%	236	30%	20	2%	61	8%	788
Wetland Vegetation	453	58%	232	29%	37	5%	64	8%	786
Soils	442	56%	257	33%	21	3%	66	8%	786
Agricultural	415	52%	256	32%	66	9%	58	7%	795
Topographic	368	47%	278	35%	61	8%	76	10%	783
Comprehensive Green Space Map	295	38%	302	39%	64	8%	118	15%	779
Geology	291	37%	313	40%	82	11%	96	12%	782
Upland Vegetation	290	37%	287	37%	107	14%	97	12%	781
Invasive Animal Species	239	30%	256	33%	147	19%	138	18%	780
Endangered & Threatened Species	217	28%	309	40%	125	16%	127	16%	778
Wildlife Species	206	26%	339	43%	116	15%	123	16%	784
Invasive Plant Species	183	23%	291	38%	159	20%	146	19%	779
Other Natural Resource Information	61	16%	79	20%	22	6%	221	58%	383

When forced to choose the top three most important types of natural resource information from among the 15 types provided, answers changed slightly. That is, local governments indicated the "most important" type of natural resource information was agricultural, the "second most important" was surface water, and the "third most important" was soils (Appendix J, Table 22). To identify the overall importance of the 15 types of ranked natural resource information, an importance index was created. The number of respondents identifying a type of information as "most important" was multiplied by three, the number of respondents identifying a type of information as "second most important" was multiplied by two, and the number of respondents identifying a type of information as "third most important" was multiplied by one. The results were then summed and divided by the highest possible score. The highest possible score a single type of information could receive is 2019, or the total # of respondents under the most important column multiplied by 3 (673 * 3 = 2019). This created an index between 0 and 1, with 0 being least important and 1 being most important. An example is provided for agricultural information:

5. Survey question: Please indicate how important each type of natural resource information is for future land use plans, zoning ordinances and land use decisions/recommendations? Potential answers: Very Important, Somewhat Important, Not Important, or Don't Know. Frequency analysis was conducted and presented above.

(179*3) + (45*2) + (46*1) / 2019 = .333. The importance index scores were then ranked. Results indicate surface water information is most important, followed by ground water and agricultural information (Table 11). The index provides an improved measurement of importance versus frequency data alone. For example, soils information improves from sixth most important in the frequency analysis to third most important with the index applied. Endangered and threatened species information moves from 12th in the frequency analysis to 15th or last, with the index applied.

Table 11. Most important types of natural resource information by index score[6]

Future Most Important Information	Most Important	Second Most Important	Third Most Important	Importance Index	Rank
	N	N	N		
Surface Water	107	167	84	.366	1
Ground Water	115	125	80	.334	2
Agricultural	179	45	46	.333	3
Land cover/land use	83	63	86	.228	4
Wetland Vegetation	76	75	53	.213	5
Soils	29	56	93	.145	6
Topographic	10	22	38	.055	7
Comprehensive Green Space Map	10	20	39	.054	8
Wildlife Species	12	16	20	.044	9
Geology	9	15	22	.039	10.5
Upland Vegetation	9	16	20	.039	10.5
Other Natural Resource Information	15	10	10	.037	12
Invasive Animal Species	6	16	21	.035	13
Invasive Plant Species	10	9	16	.032	14
Endangered & Threatened Species	3	5	7	.013	15
Total # of Respondents	**673**	**660**	**635**		

When local officials were asked during the interview what the most important natural resources are in their jurisdiction, local governments mentioned the water resources most often, followed by forests and agriculture (Appendix J, Table 23).

6. Survey question: Of the above natural resource information categories, please rank the three most important types of natural resource information that you would be interested in for future planning and zoning efforts. Potential answers: 15 different categories of natural resource information. Frequency analysis and an index was calculated and presented above.

> "Well, first and foremost, everybody's concerned about the lakes and groundwater. They're mostly tied together." – Highland Charter Township

> "Probably surface water if you were going to ask around that would probably be number one. And then after that, you know wetlands are important because they keep surface water clean. Forest land and farm land." – Antrim County

These local reflections are similar to the importance index results from the survey, although forests ranked lower on the importance index. In the survey, "upland vegetation" was defined as forests, prairies, savannas, etc. The term upland vegetation may not have been well understood or clear to survey respondents even though examples were provided.

Challenges and Needs

During the interview, officials were asked if there was any particular challenge or barrier to integrating their three most important types of natural resource information into future planning and zoning efforts. Local governments indicated the main challenge with incorporating natural resource information into planning efforts was the information lacks accuracy and detail (Appendix J, Table 24). Townships were unsure how to interpret and/or apply the information to land use decisions and feel their decisions are unenforceable. Regional planning commissions would like to see more information available in digital format.

> "Well a lot of the original MIRIS that was done, we end up having to update and manipulate, depending upon what county because it was done really on a county to county, consultant to consultant basis. The lowland and wetland vegetation sometimes is a little bit lacking in its accuracy. Back when the original MIRIS was done, the minimum map unit was 5 acres, so you miss all of the smaller residential uses." – Northeast Michigan Council of Government

> "Well just the uncertainty of, you can't tell by looking. You can't tell by looking at a piece of property sometimes because of potential wetlands, the water table, whatever. So it's challenging just for that reason. People can live next door to each other and one can find something and do something and the other one it just wouldn't work because of the differentials…" – Wilber Township

> "Not everybody on the staff really understands how to manipulate the layers and what the meaning of putting several kinds of information together, what the potential is." – Highland Township
>
> "Soils because it's so difficult to use the paper format. Having that digitally would be a huge help." – Western Upper Peninsula Planning & Development Region

According to the survey results, there was a "great need" among local governments to know where to access natural resource information and to fund the acquisition of natural resource information (Table 12). Regional planning commissions (75%) expressed the greatest need for knowing where to access information, followed by townships (60%) and counties (44%) (Appendix J, Table 25). Regional planning commissions also expressed a great need for funding to acquire information (67%), followed by counties (58%) and townships (46%) (Appendix J, Table 26). Consultation with biologists on the environmental impacts of proposed land uses and the creation of Zoning Ordinances to protect natural resources were in least demand by local governments, although, six of the 12 regional planning commissions (50%) that responded identified both services were of "great need."

Table 12. Need for information or services[7]

Information or Services	Great Need		Somewhat Need		No Need		Total # of Respondents
	N	%	N	%	N	%	
Knowing where to access information	471	59%	273	35%	51	6%	795
Funding to acquire information	363	47%	306	40%	103	13%	772
Interpretation of information	261	34%	407	52%	107	14%	775
Application of information	257	33%	410	53%	105	14%	772
Computer hardware or software information	242	32%	371	48%	155	20%	768
Creation of ordinances to protect natural resources	236	31%	405	52%	133	17%	774
Consultation with biologists on environmental impacts of proposed land uses	173	23%	411	53%	186	24%	770
Other needs	24	13%	30	16%	135	71%	189

7. Survey question: With respect to incorporating natural resource information into land use planning and zoning, how much of a need do you have for the following information or services? Potential answers: Great Need, Somewhat Need, or No Need. Frequency analysis was conducted and presented above.

When asked during the interview what information, tools, training or services would facilitate greater consideration of natural resource information in local planning efforts, local officials expressed the need for natural resource information to be more accessible (Appendix J, Table 27). This included creating an information clearinghouse or centralized website, providing information for free, delivering information through compact discs, pamphlets, newsletters and on-line courses. It was also important that educational opportunities were provided to local officials. These educational efforts should focus on current natural resource issues, the value of natural resources, and the impact of land use decisions on natural resources. In addition, there is a great need for computer and GIS training for local officials.

> "You know what would be really great if you could have a centralized webpage to address these particular issues, and then have direct links from that webpage to these particular areas. That would probably be a real helpful thing because then I could go into just one place and link off of that to whatever I want." – West Branch Township
>
> "If there was ever any free or at-cost information that the provider or a non-profit that uses a lot of it. Might be the Center for Wetland Studies or something that would have an online course to show me all of the sources they've found about wetlands and where it's available. That would be great if we could have that. Developing a clearinghouse and also primers that would let you know how to use the information." – Region 2 Planning Commission
>
> "I think it would be very important for people to understand how things work together. How soil types and different cover types and forest types work together, their ecological value. So that when they make those decisions they know why they're making them. The people making decisions, they are the ones who need to be educated. There are lots of experts who are supposed to work together, but once it leaves our table, the education is lacking." – Luce County
>
> "Probably the biggest tool is the GIS system, that's something that if you asked me two years ago I wouldn't have even brought up. The more I use it the more I like it. It gives me better understanding and the more layers it could have on there to cover this stuff the better it would be. Training, unfortunately most of the people in my position have very little training and don't know what they're doing." – Putnam Township

Approximately 75% of all natural resource information used by local governments has been distributed in hard copy format, while land cover/land use information had the highest percentage of electronic distribution (36%) (Appendix J, Table 28). When asked in what format

the information would be most preferred today, 60% of local governments continue to prefer the hard copy format (Appendix J, Table 29). Townships specifically preferred hard copy information (63%), while counties (76%) and regional planning commissions (92%) preferred electronic information (Appendix J, Table 30). The decrease in the distribution of hard copy information from what has been used in the past to what is preferred currently, indicates local governments are making investments in computers and technology (e.g. GIS), although, a significant percentage of townships still lack the resources, capability or interest in electronically distributed natural resource information.

Adoption of Master Plan and Use of Natural Resource Information

The adoption of a Master Plan and the use of natural resource information by counties were evaluated by using the Chi-Square analysis. Counties that indicated in survey question #6 they used at least one of the 15 categories of natural resource information in land use plans, zoning ordinances or land use decisions or recommendations, were assigned a variable of "1" while counties that had not used any information were assigned a "0." Similarly, counties that indicated in survey question #4 they adopted a Master Plan were assigned a variable of "1" and those counties that had not adopted a Master Plan were assigned a "0."

While 29 counties used at least one type of natural resource and adopted a Master Plan, there was not a significant dependence on the use of natural resource information and the adoption of a Master Plan by the remaining counties (Table 13). It is worth noting that there were only four counties that had used natural resource information but had not adopted a Master Plan. This low number violated one of the assumptions of Chi-Square analysis – there should be a minimum of five participants in any one cell. Based on the data gathered in this survey, the calculated Chi-Square value was not greater than the critical Chi-Square value at $p = .05$. As a result, the null

hypothesis should be retained. The use of natural resource information by counties is independent of the adoption of a Master Plan.

Table 13. County use of natural resource information and adoption of Master Plan[8]

		Used NR Info (at least 1 type)	Did Not Use NR Info	Total
County has adopted a Master Plan	Yes	29 (66%)	15 (34%)	44 (100%)
	No	4* (44%)	5 (56%)	9 (100%)
	Total	33 (62%)	20 (38%)	53 (100%)
Pearson Chi-Square	**1.465**			
critical Chi-Square (*df*=1)	3.84 at *p* = .05			

*1 (25%) cell has expected count less than 5 respondents

Townships that indicated in survey question #6 they used at least one of the 15 categories of natural resource information in land use plans, zoning ordinances or land use decisions or recommendations, were assigned a variable of "1" while townships that had not used any information were assigned a "0." Similarly, townships that indicated in survey question #4 they adopted a Master Plan were assigned a variable of "1" and those townships that had not adopted a Master Plan were assigned a "0."

In contrast to counties, townships were significantly more dependent on the adoption of a Master Plan and use of natural resource information. The majority of the townships (84%) that adopted a Master Plan also used at least one type of natural resource information (Table 14). Adequate responses were received in all of the cells and the calculated Chi-Square value was much greater than the critical Chi-Square value at p = .05. Therefore, the null hypothesis was rejected. The data suggests the use of natural resource information by townships is dependent on the adoption of a Master Plan.

8. Null hypothesis: The use of natural resource information by counties was independent of the adoption of a Master Plan. Chi-Square analysis was conducted and observed values are presented above.

Table 14. Township use of natural resource information and adoption of Master Plan[9]

		Used NR Info (at least 1 type)	Did Not Use NR Info	Total
Township has adopted a Master Plan	Yes	511 (84%)	97 (16%)	608 (100%)
	No	57 (27%)	152 (73%)	209 (100%)
	Total	568 (70%)	249 (30%)	817 (100%)
Pearson Chi-Square	**236.599**			
critical Chi-Square (*df*=1)	3.84 at $p = .05$			

0 cells have expected count less than 5 respondents

Adoption of Zoning Ordinance and Use of Natural Resource Information

In order to conduct Chi-Square analysis on the use of natural resource information and adoption of a Zoning Ordinance, counties that indicated they used at least one of the 15 categories of natural resource information (survey question #6) were assigned a variable of "1" while counties that had not used any information were assigned a "0." Likewise, counties that indicated in survey question #5 they adopted a Zoning Ordinance were assigned a variable of "1" and those counties that had not adopted a Zoning Ordinance were assigned a "0."

Unlike the adoption of a Master Plan, counties appear to be dependent on the use of natural resource information and adoption of a Zoning Ordinance. Although the type of Zoning Ordinance was not defined in the survey, the survey question was designed to answer whether a community had adopted any type of Zoning Ordinance. Chi-Square analysis indicates counties use of natural resource information and adoption of a Zoning Ordinance was significant (Table 15). Sixteen counties (73%) that adopted a Zoning Ordinance also used natural resource information, while 20 counties (54%) that did not adopt a Zoning Ordinance also did not adopt a Zoning Ordinance. The probability the result is due to chance is less than 5% ($p < .05$). Therefore, the null hypothesis was rejected. Analysis suggests the use of natural resource information by counties is dependent on the adoption of a Zoning Ordinance.

9. Null hypothesis: The use of natural resource information by townships was independent of the adoption of a Master Plan. Chi-Square analysis was conducted and observed values are presented above.

Table 15. County use of natural resource information and adoption of a Zoning Ordinance[10]

		Used NR Info (at least 1 type)	Did Not Use NR Info	Total
County has adopted a Zoning Ordinance	Yes	16 (73%)	6 (27%)	22 (100%)
	No	17 (46%)	20 (54%)	37 (100%)
	Total	33 (56%)	26 (44%)	59 (100%)
Pearson Chi-Square	**4.015**			
critical Chi-Square (*df*=1)	3.84 at *p* = .05			

0 cells have expected count less than 5 respondents

Once again, townships that indicated they used at least one of the 15 categories of natural resource information (survey question #6) were assigned a variable of "1" while townships that had not used any natural resource information were assigned a "0." Likewise, townships that indicated in survey question #5 they adopted a Zoning Ordinance were assigned a variable of "1" and townships that had not adopted a Zoning Ordinance were assigned a "0."

The majority of townships (81%) that have adopted a Zoning Ordinance have also used at least one type of natural resource information in their land use and zoning efforts (Table 16). Similarly, the majority of townships that did not adopt a Zoning Ordinance, did not use natural resource information (76%). With 95% probability the two variables are dependent ($p < .05$), the null hypothesis was rejected. Results indicate township's use of natural resource information is dependent of the adoption of a Zoning Ordinance.

10. Null hypothesis: The use of natural resource information by counties was independent of the adoption of a Zoning Ordinance. Chi-Square analysis was conducted and observed values are presented above.

Table 16. Township use of natural resource information and adoption of a Zoning Ordinance[11]

		Used NR Info (at least 1 type)	Did Not Use NR Info	Total
Township has adopted a Zoning Ordinance	Yes	527 (81%)	123 (19%)	650 (100%)
	No	49 (24%)	154 (76%)	203 (100%)
	Total	576 (68%)	277 (32%)	853 (100%)
Pearson Chi-Square	**228.705**			
critical Chi-Square (*df*=1)	3.84 at *p* = .05			

0 cells have expected count less than 5 respondents

Township Per Capita Income, Population Density and Use of Natural Resource Information

Data on per capita income and population density was gathered from the U.S. Department of Commerce, Census Bureau (USDC Census Bureau, 2000a; USDC Census Bureau, 2000e). Per capita income, for the Michigan townships that responded to the survey, had a leptokurtotic frequency distribution with peakedness occurring just on the low side of a normal distribution (Appendix J, Figure 3). Mean per capita income at the township level was $19,654 with a range from $8,505 to $62,716. Similarly, population density had a leptokurtotic frequency distribution with peakedness occurring just on the low side of a normal distribution (Appendix J, Figure 4). Mean population density at the township level was 143 persons per square mile of land area with a range from 0.8 to 4,597 persons. The correlation between per capita income and population density at the township level is .438 and the coefficient of determination (r^2) is .1918, or, 19.18% of the variance is shared by the two variables. A scatterplot of per capita income versus population density can be viewed at Appendix J, Figure 5. Given this relatively weak correlation between the two variables, the variables were considered to be independent of one another and were used in Chi-Square analysis.

11. Null hypothesis: The use of natural resource information by townships was independent of the adoption of a Zoning Ordinance. Chi-Square analysis was conducted and observed values are presented above.

In preparation for Chi-Square analysis, per capita income and population density were initially divided into three numerically equal intervals based on the total range. However, there were less than five participants in 13 of the 18 cells, which violated one of the Chi-Square assumptions. There should be a minimum of five participants in any one cell. Therefore, per capita income and population density were instead stratified into three categories based on percentile (Low 0 – 33.3%, Medium 33.4 – 66.6%, High 66.7 – 100%). A result of the percentile stratification was adequate representation in all of the Chi-Square cells but a broad disparity in the individual ranges among the three categories (Table 17). For example, in order to capture 33.3% of the local governments in the high population density category, the range is from 91 to 4,597 persons per square mile of land area.

Table 17. Per capita income and population density ranges by percentile

Category	Range in per capita income	Range in population density
Low (0 - 33.3%)	$8,505 - $17,228	0.8 - 38.0
Medium (33.4 - 66.6%)	$17,229 - $20,383	38.1 - 90.9
High (66.7 - 100%)	$20,384 - $62,716	91 - 4597.4

As a final step prior to Chi-Square analysis, townships that used at least one of the 15 categories of natural resource information (survey question #6) were assigned a variable of "1" while townships that had not used any natural resource information were assigned a "0." As postulated, townships with High per capita income and High population density were most likely to use natural resource information (87%) (Table 18). On the lowest end, 46% of townships with Low per capita income and Low population density used at least one type of natural resource information in land use planning or zoning decisions. Given a calculated Chi-Square value of 15.51 at $p = .05$, the null hypothesis was rejected. A township's use of natural resource information is dependent on per capita income and population density.

Table 18. Township use of natural resource information and combined per capita income and population density categories[12]

		Used NR Info (at least 1 type)	Did Not Use NR Info	Total
Combined township per capita income & population density categories respectively	High High	160 (87%)	24 (13%)	184 (100%)
	Medium High	60 (82%)	13 (18%)	73 (100%)
	High Medium	54 (73%)	20 (27%)	74 (100%)
	Low High	21 (68%)	10 (32%)	31 (100%)
	Medium Medium	86 (66%)	45 (34%)	131 (100%)
	Medium Low	54 (64%)	30 (36%)	84 (100%)
	High Low	17 (55%)	14 (45%)	31 (100%)
	Low Medium	46 (54%)	39 (46%)	85 (100%)
	Low Low	79 (46%)	93 (54%)	172 (100%)
	Total	577 (67%)	288 (33%)	865 (100%)
Pearson Chi-Square	**84.926**			
critical Chi-Square (*df*=8)	15.51 at *p* = .05			

0 cells have expected count less than 5 respondents

In order to examine the spatial distribution of combined per capita income and population density categories in the state, the results were stratified into three regions: 1) the Upper Peninsula, 2) the Northern Lower Peninsula, and 3) the Southern Lower Peninsula. Both the Northern Lower Peninsula and Upper Peninsula have the majority of the High income / Low population density townships (48% and 39% respectively) and Medium income / Low population townships (46% and 29% respectively) and Low income / Low population townships (56% and 26% respectively), while the Southern Lower Peninsula has the majority of townships in the remaining categories (Table 19).

12. Null hypothesis: A township's use of natural resource information was independent of its per capita income and population density. Chi-Square analysis was conducted and observed values are presented above.

Table 19. Per capita income and population density categories by location in state

		Upper Peninsula	Northern Lower Peninsula	Southern Lower Peninsula	Total
Combined township per capita income & population density categories	High High	0 (0%)	16 (9%)	168 (91%)	184 (100%)
	Medium High	3 (4%)	10 (14%)	60 (82%)	73 (100%)
	High Medium	1 (1%)	18 (24%)	55 (74%)	74 (100%)
	Low High	0 (0%)	7 (23%)	24 (77%)	31 (100%)
	Medium Medium	4 (3%)	34 (26%)	93 (71%)	131 (100%)
	Medium Low	24 (29%)	39 (46%)	21 (25%)	84 (100%)
	High Low	12 (39%)	15 (48%)	4 (13%)	31 (100%)
	Low Medium	4 (5%)	34 (40%)	47 (55%)	85 (100%)
	Low Low	44 (26%)	97 (56%)	31 (18%)	172 (100%)
	Total	**92 (11%)**	**270 (31%)**	**503 (58%)**	**865 (100%)**

Demographic Characteristics

The demographic analysis of survey respondents was as follows. Detailed tables are provided in Appendix J. Just over half of the respondents were male (53%) versus female (47%) (Appendix J, Table 31). Because the survey was mailed to the Clerk in all of Michigan's townships and counties, most of the respondents were Clerks (48%), followed by Supervisors (16%) (Appendix J, Table 32). The majority of respondents were elected (68%) (Appendix J, Table 33) and their position required making land use planning or zoning decisions/recommendations (68%) (Appendix J, Table 34). The average number of years respondents had been in their current position was 10 (mean), with a mode of only one year which indicates a relatively high turn over rate (Appendix J, Table 35). The mean age of respondents was 55.5 years old. The oldest respondent was 87 and the youngest was 22 years old (Appendix J, Table 36). Highest attained education level among respondents ranged from 29% who had some college education to 1% who had less than a high school diploma (Appendix J, Table 37). Only 11% of respondents identified themselves as a Certified Planner or having planning credentials and most of these individuals were county officials in the Southern Lower Peninsula (Appendix J, Table 38 and 39).

DISCUSSION

Methods

One challenge in conducting this survey was locating a source of names and addresses for planning and zoning officials at the county and township level. At the time of sampling, Michigan did not have a central organization that gathers comprehensive planning and zoning contact information. The Michigan Association of Planning (MAP) tracks paying members only, and not necessarily by position, so for those local officials that are not members, their information is unknown. The Michigan Association of Townships tracks the Supervisor, Clerk, Treasurer and Trustee positions. The Michigan Association of Counties tracks the Clerk, Drain Commissioner, Prosecuting Attorney, Registrar of Deeds, Sheriff, Treasurer and County Commissioners. E-mail addresses were not available from any organization. Since the role of a Planner and Planning Commission is to make recommendations to the Board of Trustees on land use planning and zoning issues, it is the Planner or Planning Commission members that are most likely to use and interpret natural resource information. Ideally, a Planner or a Planning Commission member would have received a survey such as this but due to the inability to efficiently contact Planners or Planning Commission members, the researcher chose to replicate the methodology undertaken by the Institute for Public Policy and Social Research in their 2003 survey, *To Plan or Not to Plan: Current Activity within Michigan's Local Governments* (IPPSR, 2004). That is, we sent the survey to the Clerk of the government unit.

The omission of village and cities from the population may have biased the survey results. Though municipalities do have natural resources within their legal boundaries, the corresponding percentage of land area that would be affected by land use planning decisions and the resulting impact on existing natural resources was considered relatively low and survey implementation

resources were limited. This does not mean results gathered from municipalities would not be important or interesting. Municipalities may be more likely to use some types of the natural resource information such as ground water, upland vegetation and comprehensive green space due to the possibility for ground water contamination from industrial and commercial waste, need to identify parks and other green spaces for urban dwellers, and the value of comprehensive green space networks within densely populated areas. Cities, with highly defined organizational structures and resources, could prove to be valuable partners to their adjacent townships in utilizing and integrating natural resource information in land use planning. Future studies should include municipalities' use of natural resource information.

The IPPSR survey (2004), which had a 93% response rate, detailed which counties and townships engaged in planning and zoning activities. This led to the question of whether or not the non-respondents from this quantitative survey chose not to respond simply due to the fact they do not engage in planning and zoning activities. Since the researchers from IPPSR made their raw data available, a simple comparison of the two populations was possible. The IPPSR survey was completed in 2003, and the quantitative survey portion of this project was completed in 2005, so it was assumed most of the subjects would not have changed, i.e. if they didn't plan or zone in 2003, they didn't plan or zone in 2005. This turned out to be irrelevant: Of the 345 non-respondent townships and counties to this quantitative survey, 80 (23%) indicated in the IPPSR survey they did not engage in any planning or zoning activity and 239 (69%) indicated they did plan or zone. Both surveys shared 26 non-respondents. A conclusion to be drawn from this comparison is that not engaging in planning and zoning had little to no connection with not responding to this survey.

Use and Importance of Information

The most common types of natural resource information used by local governments were: 1) surface water, 2) land cover/land use, 3) soils, and 4) wetland vegetation information (Table 8). This may not be surprising since regulatory factors and the required components of a Master Plan and Zoning Ordinance are likely to influence the use of information. Surface water, ground water and wetland activities are regulated under the federal Clean Water Act (CWA). Additional state and local regulations such as Michigan's Right to Farm Act (P.A. 93 of 1981) and County Sanitary Code regulations concerning the construction of septic systems affect the use of agricultural and soils information. Land cover / land use information is a required component of both a Master Plan and Zoning Ordinance.

It was interesting to note that local governments used natural resource information least in transportation and utility planning and over 50% of local governments indicated they do not participate in these activities (Table 9). It is possible most utility and transportation planning is subcontracted out to consultants, engineers, county road commissions and/or the Michigan Department of Transportation. This assumption requires further investigation to know for sure.

When comparing the use of natural resource information to the importance of information, results suggest that information that was frequently used (surface water, land cover, soils, wetland, agricultural) was analogous to the types of information that were identified as "very important" (Table 8 and 10). Natural resource information least used by local governments included invasive animal (88%), invasive plant (86%), wildlife (83%), and endangered and threatened species (82%) (Table 8). Two survey questions provided insight as to why this might be. When asked how satisfied respondents were with the natural resource information they used, 76% to 80% of local governments indicated invasive, wildlife and rare species information were

either “not available or not used” (Appendix J, Table 40). In addition, 16% to 19% of local governments “don’t know” how important invasive plant (19%), invasive animal (18%), endangered and threatened species (16%) and wildlife (16%) information is for future land use planning decisions (Table 10). The use and integration of invasive, wildlife and rare species information in land use planning is critical to the future protection of Michigan’s functioning ecosystems. Educational efforts which target where and how to access invasive, rare species and wildlife information, along with programs that identify how these species impact human society and how planning decisions can exacerbate or diminish negative influences on these species, are imperative.

Needs of Local Governments

Local governments indicated they most need to know where to access natural resource information (Table 12). This is not surprising since natural resource information tends to be scattered among many agencies and organizations. For example, one may need to gather the 14 categories of natural resource information defined in this study from several agencies. At the federal level: the U.S. Department of Agriculture (Natural Resource Conservation Service, Forest Service, Animal Plant Health Inspection Service) U.S. Department of Interior (U.S. Fish & Wildlife Service, U.S. Geological Survey), Department of Commerce (National Oceanic & Atmospheric Administration), Department of Homeland Security (Federal Emergency Management Agency). At the state level: Michigan Department of Natural Resources, Michigan Department of Environmental Quality, Michigan Department of Agriculture, Michigan Department of Information Technology, and Michigan State University Extension. Because of this dispersed network of information, local planning officials confront an overwhelming task to gather this information. For new officials, or local governments with limited resources, learning where to go for natural resource information can be a daunting task. Many counties and regional

planning commissions have gathered and made multiple sources of natural resource information available on their websites or through local offices. Ultimately one location for the storage and dissemination of natural resource information should be created, such as a natural resource information clearinghouse website. If for security reasons or regulatory reasons, some information can not be disseminated from one location then at a minimum, at a minimum a link to the information should be added to the website.

One particular state agency which provides a wealth of natural resource information on their website is the Michigan Center for Geographic Information (CGI). This state run agency, within the Department of Information Technology, has created and made available a Geographic Data Library which contains over 60 statewide datasets. This library serves as the state's repository of digital geographic information. One of the goals of CGI is to "provide for an information geography clearinghouse network" (http://www.michigan.gov/cgi). Data themes are provided at the state, watershed and county level. Eight of the 14 natural resource categories had certain aspects of information available from the CGI website. The remaining six categories of information should also be made available on this website. The final critical step in creating a one-stop location for natural resource information is to advertise its location and purpose to potential users.

When asked in what format natural resource information would be most preferred, regional planning commissions and counties preferred electronic information, while townships preferred hard copy information (Appendix J, Table 30). Preferences are likely related to the technical, financial and personnel capabilities, along with the time available to retrieve and interpret the information. Regional planning commissions and county government generally have more resources available and they are uniquely positioned to customize and make natural resource information available at the township level. By doing so, those townships that prefer hard copy

information would have the ability to easily access the information. Providing grant opportunities for local governments to specifically acquire natural resource information when updating their Master Plans or Zoning Ordinances would also improve natural resource conservation efforts in Michigan. This may include funding the technologies needed to acquire certain types of natural resources information (e.g. computer hardware or software, GIS, etc.).

Because the regional commissions service relatively large geographic areas, it would be most efficient to develop products and educational programs for them. Counties should be the secondary focus, with open invitations to associated townships within the county. Based on the results of this survey, educational programs should focus on where to access, how to interpret, and how to apply natural resource information to land use planning issues. Ecologists, or those with a natural resource background, are best suited to educate and communicate the ecological value of the landscape to members involved and impacted by land use decisions (Dale et al., 2000). To be effective, conservation scientists must understand the local land use planning process and their role in relation to other stakeholders.

Planning and Zoning Influence on the Use of Natural Resource Information

A township's use of at least one type natural resource information appeared to be highly dependent on the adoption of a Master Plan and Zoning Ordinance ($p < .05$) (Tables 14 and 16). This was not too surprising since a Master Plan must address land use issues pertinent to the future development such as the classification and allocation of land for agriculture, recreation, soil conservation, forests, woodlots, open space, and wildlife refuges (Michigan Compiled Laws 125.3833), and a Zoning Ordinance must be based upon a plan designed to conserve natural resources and energy, and meet the needs of the state's residents for food, fiber and other natural resources (Michigan Compiled Laws 125.3203). Separate from the required Master Plan and

Zoning Ordinance contents, communities may identify additional planning and zoning goals and objectives, based on public input, that focus on other important principles and require the use of natural resource information, such as: a rural or open space preservation focus, environmental focus, balanced growth, or growth management strategy (Wyckoff, 2008a; Wyckoff, 2008b).

A county's use of natural resource information was found not to be dependent on the adoption of a Master Plan (Table 13), although a county's use of natural resource information was dependent on the adoption of a Zoning Ordinance ($p < .05$) (Table 15). These findings are a bit surprising since more counties are involved with planning (76%) than they are with zoning (37%) (Table 7). The lack of dependence on a Master Plan may have resulted from an insufficient sample size, only 60 (72%) of the 83 counties responded to the survey, rather than the actual lack of a relationship. Additionally, one cell (county used at least one type of natural resource information but did not adopt a Master Plan) violated an assumption of Chi-Square analysis - when there are only two independent variables, no observed value may be less than five (Table 13). If a higher response rate is received from counties in the future, this analysis should be re-evaluated.

Socioeconomic Influence on the Use of Natural Resource Information

To analyze the relationship between per capita income, population density, and the use of natural resource information, Low / Medium / High categories were created for per capita income and population density. The first attempt divided the total range for each variable into three numerically equal intervals. This method resulted in only five of the 18 Chi-Square cells having a sufficient number of participants. This violated one of the Chi-Square assumptions. Therefore, this method was abandoned. The second attempt divided each variable into thirds by the 33.3 and 66.6 percentile (Table 17). This provided a valid quantity in all 18 Chi-Square cells and a significant result as shown in Table 18.

Both of these methods for dividing per capita income and population density were mathematically based and not rooted in social science. The resulting range of the two variables in each category shows some of the consequences of this decision. For per capita income, the Low category spans $8,723; the High category spans $42,332; while the Medium category has a fairly small span of $3,154 (Table 17). Population density gave similar variable spans: Low 37, Medium 53, and High 4506 persons per square mile of land area. This leads to several questions related to how representative these categories are to actual social conditions. Revisiting these analyses with different stratifications of per capita income and population density based on social or demographic principles (ex. rural, urban, poor, middle class, upper class, educational attainment, etc.) would be interesting but was beyond the scope of this investigation.

When considering the socioeconomic influence on the use of natural resource information, there was a high percentage of at least one type of natural resource information being used in land use planning decisions, especially in the High per capita income / High population density (87%) townships (Table 18). Use was relatively high for even the Low per capita income / Low population density townships (46%). It is interesting that High income / Low population density townships were in the bottom 1/3 of the results table and occurred primarily in the Northern Lower Peninsula (48%) and Upper Peninsula (39%) compared to the Southern Lower Peninsula (13%). Apparently having financial resources among a low population density does not create notable demand for natural resource information. Some level of population pressure must also be needed. Conversely, Low income / High population was the fourth highest ranked category and was located primarily in the Southern Lower Peninsula townships (77%), indicating that population density may be a stronger determining factor than affluence. This is a topic for future analysis.

Another noteworthy result that emerged was the relatively high overall use of at least one of the 15 categories of natural resource information (46% to 87% used at least one) across all economic and population categories (Table 18). This raised the question, what if the minimum number of natural resource categories that were used was increased? Would the overall use of natural resource information decline, and would the range between the High per capita income / High population density and Low per capita income / Low population density narrow or widen? Are there other relationships between the socioeconomic groups and their natural resource data use? Specifically, which categories of income and population were sophisticated enough to use most or all the categories of natural resource information? The researcher speculates that if the types of natural resource information used were increased from two to five, the results would remain similar since the top five types of information (surface water, land cover / land use, soils, wetland, agricultural), used by 70% to 59% of local governments, are either regulated or required in planning and zoning documents. Results may quickly weaken when six or more information types are used because the more obscure types of information were not commonly used by local governments and are not typically required in planning or zoning documents (Table 8). Clearly, this is an area for more analysis. The results from such an analysis would help more clearly focus where products, educational efforts and training could be effectively implemented.

Statewide Comprehensive Planning

Michigan does not have a statewide growth management plan. Studies have shown regional approaches combined with state oversight and local collaboration are vital for growth management success (Richardson, Gough and Puentes, 2003; Bengston, Fletcher, and Nelson, 2004). When local governments are given too much self-government control, they tend to act independently, dealing only with local issues and lack the geographic vision to implement larger scale growth management policies. As Richardson, Gough and Puentes (2003) note, the most

significant growth management efforts in the United States have generally been implemented at the regional or statewide level and several states have enacted statutes that call for comprehensive planning including Hawaii, Vermont, Florida, Oregon, New Jersey, Maine, Pennsylvania, Rhode Island, Georgia, Washington, Wisconsin, Tennessee and Maryland. The State of Michigan should reinstate the State Planning Commission (MSPO, 1995c) or something similar to it. Statewide comprehensive planning would achieve integrated and coordinated land use planning for sustained economic development. By taking the lead on comprehensive planning, the state would provide the goals, guidelines, incentives and tools for regional and local governments to implement planning and zoning that benefits all of Michigan's residents, while still protecting the environment.

CONCLUSIONS

The purpose of this project was to determine the extent of local government's use of, interest in, need for, and influences on, natural resource information in land use planning and zoning decisions. Six general areas were focused on to determine: 1) what types of natural resource information were being used by local governments, 2) how natural resource information is being used in planning and zoning activities, 3) what types of natural resource information are most important to local governments, 4) what the challenges and needs are of local governments when trying to incorporate natural resource information into planning and zoning efforts, 5) does adoption of planning and zoning techniques influence the use of natural resource information, and 6) does socioeconomic status influence the use of natural resource information.

The literature review showed at a national and state level land is being converted from urban to suburban uses at a greater rate than population growth (USDA Natural Resources Conservation Service, 2003: PSC, 2001). Projections indicate this trend will increase in the future and as a result the loss of natural resources will intensify. One of Michigan's most valuable assets is its wealth and diversity of natural resources. Local land use decisions have a tremendous impact on the potential for preserving natural resources and biodiversity. Land use planning can preserve habitat through the use of comprehensive planning, development restrictions and zoning. However, few local governments recognize the key role ecological systems play in maintaining public health and economic stability.

In Michigan, planning may take place at the regional, county, township and/or municipal level, while zoning may take place at the county, township and/or municipal level. If a local government adopts a Master Plan, the document must address land use and infrastructure issues that are expected to be pertinent 20 or more years into the future. Zoning defines what types and

where land use will occur currently and it is considered law. Adoption of a Master Plan has occurred in 72% of townships and 76% of counties. Adoption of a Zoning Ordinance has occurred in 76% of townships but in only 37% of counties.

To assess the use and interest of natural resource information in land use planning and zoning, a mixed method approach was used for this project. The primary data collection method was a quantitative survey followed by qualitative interviews. Secondary data was also collected from the U.S. Department of Commerce, Census Bureau. A survey was sent to all of Michigan's townships (1,242), counties (83) and regional planning commissions (14). Fifteen different types of natural resource information were defined in the survey. Of the 1,339 surveys mailed, a response rate of 70% was received and 30 purposeful interviews were conducted as a follow-up to the survey.

Results show the most common types of natural resource information used by local governments in land use planning and zoning were 1) surface water, 2) land cover/land use, 3) soils and 4) wetland vegetation information. Excluding the "other" category, invasive animal, invasive plant, wildlife, and endangered and threatened species information were used least. When asked how important natural resource information was for future planning and zoning decisions and an index was applied, local governments indicated: 1) surface water, 2) ground water, 3) agricultural 4) land cover/land use, 5) wetland, and 6) soils information were most. When local officials were asked during the interview what the most important natural resources are in their jurisdiction, local governments mentioned water resources most often, followed by forests and agriculture.

Local governments use natural resource information most frequently when creating or updating a Master Plan (54%), Zoning Ordinances (52%), and when conducting site development reviews

(50%). When asked how much of a need local governments have for information or services, there was a "great need" to know where to access natural resource information and to fund the acquisition of natural resource information. During the interview, local governments indicated the main challenge with incorporating natural resource information into planning efforts is the information lacks accuracy and detail. Local officials also expressed the need for natural resource information to be more accessible.

Chi-Square analysis confirmed that a township's use of at least one type of natural resource information was highly dependent on the adoption of a Master Plan and Zoning Ordinance. A county's use of natural resource information was found to not be dependent on the adoption of a Master Plan but was dependent on the adoption of a Zoning Ordinance. A high percentage of townships in the High per capita income / High population density category (87%) have used at least one type of natural resource information in land use planning decisions. Natural resource use was relatively high even for Low per capita income / Low population density townships (46%).

Survey results suggest the types of natural resource information local governments used and the types of information that are important for planning and zoning are very similar. Such findings were not surprising since surface water, ground water, land cover/land use, soils, agriculture and wetland information are either regulated or required in planning and zoning documents. What was notable however, was the finding that invasive animal, invasive plant, wildlife, and endangered and threatened species information are not commonly used and are not as important to local governments. This may be due to the lack of accessibility of these types of information or because local officials have not been educated as to the value or applicability of the information.

Recommendations

Land use decisions must ensure that natural resources and ecological processes are sustainable and available to future generations. Guidance on land use planning goals should be provided on a broad scale. State and regional governments have been identified as key to a successful and effective urban growth management policy (Richardson, Gough and Puentes, 2003; Bengston, Fletcher, and Nelson, 2004). The State of Michigan should adopt state-level land use goals that guide state agencies, along with regional, county and local land use decisions. Regional governments act a liaison between local communities and state government.

Local governments indicated they most need to know where to access natural resource information. One primary location for the storage and dissemination of natural resource information should be created, such as a natural resource information clearinghouse website. If for security reasons or regulatory reasons information can not be disseminated from one location then at a minimum, a link to the information should be added to the website. The Michigan Center for Geographic Information is an existing and logical information clearinghouse for natural resource information. Additional information should be added to this website and advertised as to its availability.

Michigan's natural resources are critical to the economy and contribute to overall quality of life and one's desire to remain and invest in the state. Conservation scientists are best suited to educate and communicate the ecological value of the landscape to planning commissions, local governments, and the public but to be effective, conservation scientists must also understand the land use planning process and their role in relation to other stakeholders (Dale et al., 2000). Ultimately, ecological knowledge will be combined with local human values in order to assess the value of one facet of the landscape relative to another. If ecology is going to guide land use

planners, it must be relevant and clearly communicated to decision makers. This means conservation scientists must become involved in the land use planning process in order to slow or reverse the impact to natural resources.

Because regional commissions service relatively large geographic areas and have adequate resources, it is most efficient to target products and educational programs for them. Counties should be the secondary focus. Educational programs should focus on where to access, how to interpret, and how to apply natural resource information to land use planning issues. Educational programs should also focus on the more obscure but equally significant types of natural resource information such as invasive plant, invasive animal, wildlife and rare species information. Stewards of these less used types of natural resource information need to make greater efforts to create awareness and increase access to the information in order to improve future conservation success. Regional planning commissions and counties could then acquire, customize and make available natural resource information at the township level so those townships that prefer hard copy information could easily access the information. Coordination and cooperation among natural resource organizations will be needed to provide educational programs, technical expertise and informational products to local governments.

Human health and welfare, and ultimately human existence, is dependent on the quality of our environment. Land use decisions, more than any other type of human activity, directly affect water quality, natural habitats, biodiversity, public health, ecological services, socio-economic conditions and community character. Decisions are made based on the best available information and often the accessibility of high quality information is limited. If local officials are to make ecologically sustainable decisions that benefit not only current residents but also future generations, it is essential that natural resource information is available in user-friendly formats, educational training is provided, and state government agencies and conservation scientists

become involved in the land use planning process. An informed citizenry will achieve a better future through coordinated and comprehensive land use planning, access to information, and creative use of new technologies.

Limitations

The main limitation to this study was the resources available in relation to the scope of the project. Although a limited amount of funding was secured for the researcher and volunteers were used when available, the researcher was the only person coordinating, implementing and analyzing an 8-page survey to 1,339 local governments and 30 interviews across the state. The amount of data to be analyzed was at times overwhelming. Because of a limited budget, the number of interviews and the distance to travel to the local government, there was no opportunity to conduct iterative interviews. Interviews involved one visit to the local office. If future analysis is conducted at the same scale, additional funding should be secured to form a project team, including a social scientist and GIS analyst.

The survey covered a tremendous amount of information that had not been asked before, the survey was relatively long (8 pages) and there were many more questions that could have been asked, but to encourage respondents to fill out and return the survey, the length of the survey was limited. Ideally the survey should have been filled out by a Planner or Planning Commission Member but because their names and addresses were not available, the Clerk received the survey. Some counties plan and zone for townships that have not adopted a Master Plan or Zoning Ordinance. It is possible some townships responded on behalf of the county instead of their jurisdiction only, which would result in double counting an answer to a survey question. It is also possible the 15 categories or natural resource information are too technical for many local

officials. There is some overlap between categories and the categories could likely be collapsed in a future study.

A total of 533 municipalities were left out of the research population. It is possible that cities and villages would have responded differently to the survey and interview questions. Due to limited financial resources, the percentage of land area (~6%) that is affected, and the resulting impact on existing natural resources, municipalities were considered relatively low priority compared to townships, counties and regional planning commissions.

Suggestions for Further Study

To further understand the use, interest and need for natural resource information in land use planning the following five suggestions are provided:

1. Is double counting among townships and counties a problem? Analyze whether townships and counties are answering the adoption of a Master Plan and Zoning Ordinance question on behalf of their jurisdiction only, or if they are answering on behalf of other jurisdictions. This could be conducted by comparing and contrasting data from the current survey and IPPSR survey (2004). Also make sure wording in future surveys is clear so that communities answer questions on behalf of their jurisdiction only.
2. Limited analysis of socio-economic factors, such as income and population, showed interesting relationships. Further comparison of additional socioeconomic factors (e.g. rural, urban, poor, middle class, upper class, educational attainment, etc.) along with an in-depth spatial analysis to fully understand the sociological and geographical nuances of the responses in relation to the local condition of the natural resources would be beneficial.

3. Replicate this study for municipalities and compare and contrast results against this study.
4. Increase number of natural resource types used in Chi-Square analysis to test if use remains dependent on the adoption of a Master Plan, Zoning Ordinance, per capita income, population density or other socioeconomic factors identified in recommendation #1.
5. Run logistic regression on the use of natural resource information (one or more types) against the adoption of a Master Plan, Zoning Ordinance, per capita income and population density to determine which independent variables are most important.
6. Investigate who conducts the majority of transportation and utility planning at the local level (municipality, township, county and region) and their use of natural resource information in such planning efforts.

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APPENDIX A: MAIL SURVEY INSTRUMENT

Integration of Natural Resource Information in Land Use Planning

This questionnaire is designed to assist local governments and planning officials in meeting their information and decision-making needs. Results of the survey will assist natural resource agencies, organizations and universities in providing improved data products and services to local governments and regional planning councils. This survey should be filled out by a planner, or individual that actively gathers land use planning and zoning information at the township, county or regional level. For some local governments, this may be a consultant. We ask, if the person receiving this survey is not involved with gathering planning or zoning information, that they please forward the survey to the appropriate individual.

Your views and experience are very important to us. Your response will help determine what type of natural resource information is needed and how information should be delivered to local governments. Please keep in mind that we are interested in everyone's response, from highly populated to sparsely populated townships, counties and regions across the state.

Your response will remain confidential and will never be associated with your name.

Please complete this questionnaire at your earliest convenience. Place the survey in the envelope provided and drop it in any mailbox. Return postage has been provided. The questionnaire should take about 15 minutes to complete. If you choose not to complete the questionnaire, **please return it** with a note on the last question, Question 20. Then simply place the survey in the return envelope and drop it in a mailbox.

If you have any questions regarding this survey, please contact Jennifer A. Olson, Project Manager, by e-mail: olsonje6@msu.edu or by phone: (517) 373-9405.

THANK YOU FOR YOUR ASSISTANCE!

For the purpose of this survey, **natural resources are defined as**: soils, surface and ground water, forests, minerals, air, fisheries, wildlife (common, rare, invasive), plants (common, rare, invasive), wetlands, grasslands, dunes, and other landscape features.

The Township, County, Region and You

1. How would you describe your current **appointment** in relation to the township, county or region receiving this questionnaire? *(Please check only one.)*

   ☐ Elected official

   ☐ Appointed official

   ☐ Hired staff

   ☐ Volunteer staff

   ☐ Consulting firm (please identify): _____

   ☐ Other appointment (please identify): _____

2. Please specify your current **position** below. *(Please check only one.)*

   ☐ Township/County Supervisor

   ☐ Township/County Manager

   ☐ Township/County Clerk

   ☐ Township/County Zoning Administrator

   ☐ Township/County Zoning Board member

   ☐ Township/County Planning Commission member

   ☐ Township/County Planner

   ☐ Planning Consultant (Private Firm)

   ☐ Regional Council/Commission Planner

   ☐ Regional Council/Commission Director

   ☐ Other position (please identify): _____

3. Does your position require making land use planning or zoning decisions/recommendations, such as the placement of utilities, subdivisions, roads, zoning, etc. for the township/county/region? *(Please check one.)*

   ☐ Yes ☐ No

4. Has your township/county adopted a Comprehensive Development Plan, Master Plan, or other similar land use plan? *(Please check one.)*

   ☐ Yes ☐ No ☐ Not Sure

5. Has your township/county adopted a Zoning Ordinance? *(Please check one.)*

   ☐ Yes ☐ No ☐ Not Sure

Integration of Natural Resource Information

6. This question has two parts. Part 1: Have you **used** the following types of natural resource information in your land use plans, zoning ordinances or land use decisions/recommendations? Part 2: If Yes, in what **format** was the information provided? *(Please check up to two responses for each statement.)*

	Part 1			Part 2	
	Types of Natural Resource Information	No, did not use	Yes, used	Information provided in electronic format	Information provided in hard copy format
a.	**Agricultural** (crops, livestock, size, location, etc.)	☐	☐ ⇨	☐	☐
b.	**Wetland vegetation** (marsh, floodplain, shrub swamp, etc.)	☐	☐ ⇨	☐	☐
c.	**Upland vegetation** (forests, prairies, savannas, etc.)	☐	☐ ⇨	☐	☐
d.	**Invasive plant species** (purple loosestrife, Eurasian milfoil, garlic mustard, spotted knapweed, etc.)	☐	☐ ⇨	☐	☐
e.	**Wildlife species** (game and non-game species, nuisance species, health risk species, etc.)	☐	☐ ⇨	☐	☐
f.	**Invasive animal species** (emerald ash borer, zebra mussels, round goby, sea lamprey, etc.)	☐	☐ ⇨	☐	☐
g.	**Endangered & threatened species** (animals and plants legally protected by state or federal legislation)	☐	☐ ⇨	☐	☐
h.	**Geology** (surface and subsurface minerals, oil, gas, bedrock, surface landforms, etc.)	☐	☐ ⇨	☐	☐
i.	**Surface water** (lakes, rivers, streams, drainages, etc.)	☐	☐ ⇨	☐	☐
j.	**Ground water** (aquifers, location, depth, springs, etc.)	☐	☐ ⇨	☐	☐
k.	**Soils** (maps, texture, depth, productivity, erodibility, permeability, etc.)	☐	☐ ⇨	☐	☐
l.	**Land cover/use** (maps, aerial photography, satellite imagery, etc.)	☐	☐ ⇨	☐	☐
m.	**Topographic** (surface contours, steep slopes, etc.)	☐	☐ ⇨	☐	☐
n.	**Comprehensive green space map** (land identified for the long term viability of natural ecosystems)	☐	☐ ⇨	☐	☐
o.	**Other** natural resource information (please identify and rate):	☐	☐ ⇨	☐	☐

7. How **satisfied** were you with the natural resource information that was used in your land use plans, zoning ordinances and land use decisions/recommendations? *(Please check only <u>one</u> response for each statement.)*

	Types of Natural Resource Information	Very Satisfied	Moderately Satisfied	Moderately Dissatisfied	Very Dissatisfied	N/A*
a.	**Agricultural** (crops, livestock, size, location, etc.)	☐	☐	☐	☐	☐
b.	**Wetland vegetation** (marsh, floodplain, shrub swamp, etc.)	☐	☐	☐	☐	☐
c.	**Upland vegetation** (forests, prairies, savannas, etc.)	☐	☐	☐	☐	☐
d.	**Invasive plant species** (purple loosestrife, Eurasian milfoil, garlic mustard, spotted knapweed, etc.)	☐	☐	☐	☐	☐
e.	**Wildlife species** (game and non-game species, nuisance species, health risk species, etc.)	☐	☐	☐	☐	☐
f.	**Invasive animal species** (emerald ash borer, zebra mussels, round goby, sea lamprey, etc.)	☐	☐	☐	☐	☐
g.	**Endangered & threatened species** (animals and plants legally protected by state or federal legislation)	☐	☐	☐	☐	☐
h.	**Geology** (surface and subsurface minerals, oil, gas, bedrock, surface landforms, etc.)	☐	☐	☐	☐	☐
i.	**Surface water** (lakes, rivers, streams, drainages, etc.)	☐	☐	☐	☐	☐
j.	**Ground water** (aquifers, location, depth, springs, etc.)	☐	☐	☐	☐	☐
k.	**Soils** (maps, texture, depth, productivity, erodibility, permeability, etc.)	☐	☐	☐	☐	☐
l.	**Land cover/use** (maps, aerial photography, satellite imagery, etc.)	☐	☐	☐	☐	☐
m.	**Topographic** (surface contours, steep slopes, etc.)	☐	☐	☐	☐	☐
n.	**Comprehensive green space map** (land identified for the long term viability of natural ecosystems)	☐	☐	☐	☐	☐
o.	**Other** natural resource information (please identify and rate):	☐	☐	☐	☐	☐

* Information was not available, or available but not used.

8. How **often** do you use natural resource information in the following land use planning and zoning activities? *(Please check only <u>one</u> response for each statement.)*

	Planning and Zoning Activities	Always (100%)	Frequently (~75%)	Sometimes (~50%)	Rarely (~25%)	Never (0%)	N/A*
a.	**Master Plan** creation or update	☐	☐	☐	☐	☐	☐
b.	**Site Development** reviews	☐	☐	☐	☐	☐	☐
c.	**Planned Unit Developments** (PUDs)	☐	☐	☐	☐	☐	☐
d.	**Land Division** reviews	☐	☐	☐	☐	☐	☐
e.	**Zoning Ordinance** creation or update (map or text)	☐	☐	☐	☐	☐	☐
f.	**Preservation Ordinance** creation or update (wetland, open space, woodland ordinance)	☐	☐	☐	☐	☐	☐
g.	**Land Acquisition** planning	☐	☐	☐	☐	☐	☐
h.	**Park and Recreation** planning	☐	☐	☐	☐	☐	☐
i.	**Transportation** planning	☐	☐	☐	☐	☐	☐
j.	**Utility** planning	☐	☐	☐	☐	☐	☐
k.	**Capital Improvements** planning	☐	☐	☐	☐	☐	☐
l.	**Other activities** (please identify and rate):	☐	☐	☐	☐	☐	☐

* Not Applicable, activity not conducted by township/county/region.

9. How would you describe the **amount** of residential and commercial development occurring in your township/county/region over the past, and anticipated future, five-year time period? *(Please check only <u>one</u> response for each statement.)*

	Time Period	Greatly Increasing	Somewhat Increasing	Unchanged	Somewhat Decreasing	Greatly Decreasing	Don't Know
a.	**<u>Past</u> five years**	☐	☐	☐	☐	☐	☐
b.	**<u>Next</u> five years**	☐	☐	☐	☐	☐	☐

10. Assume the following information is freely available and of high quality. Please indicate how **important** each type of natural resource information is for future land use plans, zoning ordinances and land use decisions/recommendations? *(Please check only one response for each statement.)*

	Types of Natural Resource Information	Very Important	Somewhat Important	Not Important	Don't Know
a.	**Agricultural** (crops, livestock, size, location, etc.)	☐	☐	☐	☐
b.	**Wetland vegetation** (marsh, floodplain, shrub swamp, etc.)	☐	☐	☐	☐
c.	**Upland vegetation** (forests, prairies, savannas, etc.)	☐	☐	☐	☐
d.	**Invasive plant species** (purple loosestrife, Eurasian milfoil, garlic mustard, spotted knapweed, etc.)	☐	☐	☐	☐
e.	**Wildlife species** (game and non-game species, nuisance species, health risk species, etc.)	☐	☐	☐	☐
f.	**Invasive animal species** (emerald ash borer, zebra mussels, round goby, sea lamprey, etc.)	☐	☐	☐	☐
g.	**Endangered & threatened species** (animals and plants legally protected by state or federal legislation)	☐	☐	☐	☐
h.	**Geology** (surface and subsurface minerals, oil, gas, bedrock, surface landforms, etc.)	☐	☐	☐	☐
i.	**Surface water** (lakes, rivers, streams, drainages, etc.)	☐	☐	☐	☐
j.	**Ground water** (aquifers, location, depth, springs, etc.)	☐	☐	☐	☐
k.	**Soils** (maps, texture, depth, productivity, erodibility, permeability, etc.)	☐	☐	☐	☐
l.	**Land cover/use** (maps, aerial photography, satellite imagery, etc.)	☐	☐	☐	☐
m.	**Topographic** (surface contours, steep slopes, etc.)	☐	☐	☐	☐
n.	**Comprehensive green space map** (land identified for the long term viability of natural ecosystems)	☐	☐	☐	☐
o.	**Other** natural resource information (please identify and rate):	☐	☐	☐	☐

11. Of the above natural resource information categories, please rank the **three most important** types of natural resource information that you would be interested in for future planning and zoning efforts.
(Please write one type of information after each rank.)

Most important _____

Second most important _____

Third most important _____

12. If you were to request natural resource information about your township/county/region, in what **format** would the information be most preferred? *(Please check one.)*

☐ **Hard copy format** – paper copies of maps, tables, reports, publications, etc.

☐ **Electronic format** – GIS data layers, web based data, digital info, models, etc.

13. With respect to incorporating natural resource information into land use planning and zoning, **how much of a need** do you have for the following information or services?
(Please check only one response for each statement.)

	Information / Services	Great Need	Somewhat Need	No Need
a.	**Knowing** where to access information	☐	☐	☐
b.	**Computer** hardware or software information (GIS recommendations, minimum requirements, etc.)	☐	☐	☐
c.	**Funding** to acquire information	☐	☐	☐
d.	**Interpretation** of information	☐	☐	☐
e.	**Application** of information	☐	☐	☐
f.	**Creation** of ordinances to protect natural resources	☐	☐	☐
g.	**Consultation** with biologists on environmental impact of proposed land uses	☐	☐	☐
h.	**Other** needs (please identify and rate)**:**	☐	☐	☐

14. Would you be willing to participate in an **interview** (telephone or in-person) to further explore the current and potential role of natural resource information, and data products, in your township/county/regional land use planning and zoning activities? *(Please check one.)*

☐ Yes ☐ No

Background Information

15. How many years have you been in your current position? *(Please write in number of years.)*

_____ Years

16. Are you: ☐ Male ☐ Female

17. In what year were you born? _____ *(Please write in year.)*

18. What is the highest level of formal education that you have completed? *(Please check only one.)*

☐ Less than high school

☐ High school diploma or equivalent

☐ Some college

☐ Associate's degree

☐ Technical / vocational degree

☐ Bachelor's or 4 year degree

☐ Graduate or professional degree (Master's, Doctorate, etc.)

19. Are you a Certified Planner or do you have other specific planning credentials? *(Please check one.)*

☐ Yes, please identify credentials:_____

☐ No

20. Please use the space below for any additional comments you wish to make regarding the use of natural resource information in land use planning and zoning.

Thank you very much for your participation!

APPENDIX B: MAIL SURVEY FIRST COVER LETTER

«RECIPIENT_NAME» August 8, 2005
«RECIPIENT_ADDRESS_1»
«RECPIENT_ADDRESS_2»
«CITY», «STATE» «ZIP»«Next Record»

Greetings! I am writing to ask for your assistance in a study on the integration of natural resource information in land use planning. This study, conducted in cooperation with the Michigan Department of Natural Resources Wildlife Division and Michigan State University Extension, is an effort to identify if, and how, natural resource information is being utilized at the township, county and regional levels in Michigan. The questionnaire is designed to identify your current use and future interest in different types of natural resource information. Results from this study will be used to create new data products and services for local governments and planning officials in Michigan.

This questionnaire is being sent to all Michigan townships, counties and regional councils. We are equally interested in the response from highly to sparsely populated townships, counties and regions. We look forward to hearing from each one of you.

Your answers are completely confidential. A survey identification number is printed at the bottom of the questionnaire so that we can remove your address from the mailing list when it is returned. **Your name will never be associated with your responses in any way and your privacy will be protected to the maximum extent allowable by law.** While your response to this questionnaire and to any of the questions is completely voluntary, you can help us by taking a few minutes to share your views about natural resource information in your area. By completing and returning this survey, you indicate your voluntary agreement to participate in this study.

If you have any questions about this study, please contact Jennifer A. Olson, Project Manager, by e-mail: olsonje6@msu.edu, by phone: (517) 373-9405, or regular mail: Michigan State University, 151 Natural Resource Building, East Lansing, MI 48824. If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Thank you very much for participating in this important study!

Sincerely,

Gerhardus Schultink, Professor
Department of Community, Agriculture, Recreation and Resource Studies

APPENDIX C: MAIL SURVEY REMINDER POSTCARD

In the last two weeks you were mailed a questionnaire seeking your views on the integration of natural resource information in land use planning.

If you already completed and returned the survey, please accept our sincere thanks! If not**, please do so today**. Natural resource agencies, organizations and universities will be creating data products that will help address the needs expressed by townships, counties and regional councils participating in this study.

If by some chance you did not receive the questionnaire, or if it got misplaced, please contact me by e-mail: olsonje6@msu.edu or by phone: (517) 373-9405 and I will mail another one to you.

Sincerely,

Jennifer A. Olson
Project Manager

APPENDIX D: MAIL SURVEY SECOND COVER LETTER

«RECIPIENT_NAME» September 12, 2005
«RECIPIENT_ADDRESS_1»
«RECPIENT_ADDRESS_2»
«CITY», «STATE» «ZIP»«Next Record»

Recently, you received a survey asking for your input on the integration of natural resource information in land use planning. To the best of our knowledge, the survey has not yet been returned. If this letter and your completed survey have crossed in the mail, please accept our sincere thanks for your participation in this study!

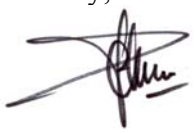
This survey should be filled out by an individual that actively gathers land use planning and zoning information at the township, county or regional level. For some local governments, this may be a consultant. We ask, if the person receiving this survey is not involved with gathering planning or zoning information, that they please forward the survey to the appropriate individual. If the local government you represent is not involved with land use planning or zoning, please return the survey with a note indicating this on the last page (Question 20).

Your views are crucially important, regardless of how often, or if, you currently utilize natural resource information in land use planning. Comments from local governments and regional councils that have already responded indicate there are a wide variety of opinions about the use of natural resource information. Results from this study will be used to help create data products that address local government needs. We hope you will fill out and return the survey soon.

The survey has an identification number so that we can remove your address from the mailing list when your survey is returned. We will not share your personal information with anyone and your name will never be associated with your response. Your privacy will be protected to the maximum extent allowable by law. Your response to the survey and any of its questions is completely voluntary. By completing and returning this survey, you indicate your voluntary agreement to participate in this study. If, however, you prefer to not answer the survey, please let us know by returning a blank survey in the postage-paid return envelope.

If you have any questions about this study, please contact Jennifer A. Olson, Project Manager, by e-mail: olsonje6@msu.edu, by phone: (517) 373-9405, or regular mail: Michigan State University, 151 Natural Resource Building, East Lansing, MI 48824. If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824. Thank you very much.

Sincerely,



Gerhardus Schultink, Professor
Department of Community, Agriculture, Recreation and Resource Studies

APPENDIX E: MAIL SURVEY THIRD COVER LETTER

RECIPIENT NAME
RECIPIENT ADDRESS 1
RECIPIENT ADDRESS 2
CITY, MI ZIP

October 17, 2005

Over the last two months we have sent you several mailings about an important research study we are conducting for the state of Michigan. The purpose of the study is to assist local governments and planning officials in meeting their natural resource information needs.

The study is drawing to a close, and this is the last full survey that will be mailed to Michigan townships, counties and regional councils. We are concerned that people who have not yet responded may have different experiences than those who have responded. **Hearing from everyone helps assure that the survey results are as accurate as possible**. Please send your survey in soon.

This survey should be filled out by an individual that gathers land use planning and zoning information for your township, county or regional planning council. If the local government you represent is not involved with land use planning or zoning, please return the survey with a note indicating this on the last page (Question 20). Your answers are completely confidential and will be released only as summaries in which no individual answers can be identified. A survey identification number is printed on the bottom of the survey so we can remove your address from the mailing list when it is returned. We will not share your personal information with anyone and your privacy will be protected to the maximum extent allowable by law. By completing and returning the survey, you indicate your voluntary agreement to participate in this study.

If you prefer not to answer the questionnaire that is fine. If this is the case, please let us know by returning a blank questionnaire in the return envelope provided. We appreciate your willingness to consider our request as we near conclusion in this effort to better understand the challenges and needs for natural resource information at the township, county and regional levels across Michigan.

Finally, if you have any questions about this study, please contact Jennifer A. Olson, Project Manager, by e-mail: olsonje6@msu.edu, by phone: (517) 373-9405, or regular mail: Michigan State University, 151 Natural Resource Building, East Lansing, MI 48824. If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824. Thank you very much.

Sincerely,

Gerhardus Schultink, Professor
Department of Community, Agriculture, Recreation and Resource Studies

APPENDIX F: NON-RESPONSE SURVEY

DATE

Recently you were mailed a questionnaire concerning the integration of natural resource information at your local government or regional council level. Our records indicate we have not received a response from your local government or regional council and we would like to understand the nature of this non-response.

We are not asking you to fill out anything like the survey we previously sent you. Rather, we have attached a postage-paid, addressed postcard for your local government or regional council to fill out, detach, and drop in the mail. It should take no more than a minute or two to fill out the postcard. We would sincerely appreciate your taking the time to get this back to us soon, as it will provide valuable information for our study.

As before, your response to this questionnaire is voluntary. Nevertheless, your input is important to ensuring planning officials and local governments have the very best natural resource information on which to base decisions. You may be assured of complete confidentiality. The postcard has an identification number for mailing purposes only. Your name will never be linked to your responses. Your cooperation is greatly appreciated. Thank you in advance for taking the time to assist us in this study.

Sincerely,

Jennifer Olson
Project Manager

1. Please specify your current **position** below.
(Please write the title of your position on the line.)

Township _____

County _____

Regional Planning Council _____

Consulting Firm _____

2. Have you **used** natural resource information in your land use plans, zoning ordinances or land use decisions or recommendations?

1☐ No 2☐ Yes

If Yes, in what **format** was the information provided?

1☐ Electronic 2☐ Hard copy

3. How would you describe the **amount** of residential and commercial development occurring in your township/ county/region over the past five-year time period? *(Please check only one.)*

1☐ Increasing
2☐ Unchanged
3☐ Decreasing
4☐ Don't Know

4. Please rank the **three most important types** of natural resource information that you are interested in for future planning and zoning efforts. *(Please write one type after each rank. Ex. Agriculture, wetland, soils…)*

Most important _____

Second most important _____

Third most important _____

5. With respect to incorporating natural resource information into land use planning and zoning, **how much of a need** do you have for the following information or services?

Information/Services	1Great Need	2Some-what Need	3No Need
a. Where to access information			
b. Computer hardware or software requirements			
c. Funding to acquire information			
d. Interpretation of information			
e. Application of information			

APPENDIX G: INFORMED CONSENT

Integration of Natural Resources Information in Local Land Use Planning

Informed Consent Form

You are being asked to participate in an interview as part of graduate research project Jennifer Olson is conducting for her Master's Degree at Michigan State University. The purpose of this research project is to evaluate and improve the integration of natural resource information in local land use planning and zoning activities. The first part of the research project involved a survey of all townships, counties and regional planning commissions in Michigan. Based on survey results, your local government indicated they were willing to participate in an interview to further explore the current and potential role of natural resource information, and data products, in land use planning and zoning activities. The second part of the research project involves conducting interviews based on representative and random samples.

The interview will take approximately one hour. With your permission, the interview will be recorded. Your answers will be transcribed, coded and analyzed for concepts and themes. Information collected during this interview will be kept in a secure location. An interview guide will be used to identify the main questions. You are encouraged to bring up your own topics of interest related to natural resource information and land use planning. Your name will remain confidential and your privacy will be protected to the maximum extent allowable by law. The answers you provide will characterize the local government you represent. We may refer to the answers and the local government you represent in reports and publications.

Your participation in this interview involves minimal risk. You may be unaware of all possible uses of, and interest in, natural resource data by your local government. Potential benefits of your participation in this interview may include evaluating new natural resource data products, sharing your local government's innovative use of natural resource information, and potentially participating in future land use planning and natural resource data projects. Participation in this research project is completely voluntary. If you are asked any question that you are uncomfortable answering, you may refuse to answer the question or discontinue your participation at any time.

If you have any questions about this research project, you may contact - Jennifer Olson, Michigan State University, Department of Community, Agriculture, Recreation and Resource Studies (CARRS), 151 Natural Resources Building, East Lansing, MI 48824, by phone: 517-373-9405 or e-mail: olsonje6@msu.edu.

If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - Peter Vasilenko, Ph.D., Director of the Human Research Protection Program, 202 Olds Hall, Michigan State University, East Lansing, MI 48824, by phone: (517)355-2180, fax: (517) 432-4503, or e-mail: irb@ msu.edu.

Your signature below indicates your voluntary agreement to participate in this study.

_____ _____

Participant's signature Date

Your signature below indicates your voluntary agreement to have the interview recorded.

_____ _____

Participant's signature Date

APPENDIX H: INTERVIEW GUIDE

Interview Guide
Integration of Natural Resource Information in Land Use Planning

Location:
Person:
Position:
Date:

1. How would you describe the natural resource values of the community you represent?

   Is there a natural resource goal stated in any of your local government documents (Master Plan, Zoning Ordinance, etc.)? If so, what is it?

2. What are the most important natural resources in your jurisdiction?

3. How many **full-time** land use planning and zoning staff does your local government have (those individuals dealing with planning or zoning decisions/recommendations)?

   How many **part-time** planning and zoning staff does your local government have?

4. What type of internet service does your local government have (dial-up, cable, DSL-digital subscriber line, wireless, satellite)?

5. Does your local government use Geographic Information Systems (GIS) in its planning efforts?

   If yes, what type of software is used (ArcView, ArcInfo, ArcGIS, other)?

6. If natural resource information has been acquired by your local government, how has the data been incorporated into planning efforts (Master Plan incorporation, Zoning Ordinances, overlay districts, etc.)?

   Was the information useful / not useful? How so?

   How could the information be more useful?

7. Is there an agency, organization, university, website or individual you <u>most frequently</u> contact to obtain natural resource information?

8. In the survey you answered (Question #11), you indicated the three most important types of natural resource information you would be interested in for future planning and zoning efforts. Your answer indicates the most important information was _____, the second most important _____, and the third most important _____.

   Why are these types of NR information desired?

   How would you use this information?

   Have you attempted to acquire this information previously?

   If so, was there any particular challenge or barrier to integrating the information into your planning efforts?

   Of the other types of natural resource information that were not in the top three, can you describe generally why they were not chosen? (Haven't used the information, not interested, no need to use, etc.)

9. For those who preferred hard copy information (Question #12), does your local government have the capacity to receive or retrieve electronic or web based natural resource information?

10. What information, tools, training or services would facilitate greater consideration of natural resource information in local planning efforts?

11. Using a hypothetical situation, let's say you receive natural resource information that was created at the state level, was 20 years old, or was collected with questionable technology or techniques. How does your local government address information limitations such as scale, date and accuracy?

12. Show interviewee an example of a green infrastructure map, potential conservation area map, rare species representation map and/or groundwater related map.
    Would your local government be interested in the above examples of natural resource information?

    Which ones?

    Is there anything you don't like about this information?

13. Any other comments about land use planning and natural resource information in Michigan?

APPENDIX I: INSTITUTIONAL REVIEW BOARD DOCUMENTS

MICHIGAN STATE
UNIVERSITY

Initial IRB Application Approval

July 12, 2005

To: Gerhardus SCHULTINK
310 Natural Resources

Re: **IRB # 05-362** Category: EXPEDITED 2-7
Approval Date: July 11, 2005
Expiration Date: July 10, 2006

Title: INTEGRATION OF NATURAL RESOURCE INFORMATION IN LAND USE PLANNING

The University Committee on Research Involving Human Subjects (UCRIHS) has completed their review of your project. I am pleased to advise you that **your project has been approved**.

The committee has found that your research project is appropriate in design, protects the rights and welfare of human subjects, and meets the requirements of MSU's Federal Wide Assurance and the Federal Guidelines (45 CFR 46 and 21 CFR Part 50). The protection of human subjects in research is a partnership between the IRB and the investigators. We look forward to working with you as we both fulfill our responsibilities.

Renewals: UCRIHS approval is valid until the expiration date listed above. If you are continuing your project, you must submit an ***Application for Renewal*** application at least one month before expiration. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: UCRIHS must review any changes in the project, prior to initiation of the change. Please submit an ***Application for Revision*** to have your changes reviewed. If changes are made at the time of renewal, please include an ***Application for Revision*** with the renewal application.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects, notify UCRIHS promptly. Forms are available to report these issues.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with UCRIHS.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at UCRIHS@msu.edu. Thank you for your cooperation.

Sincerely,

Peter Vasilenko, Ph.D.
UCRIHS Chair

c: Jennifer Olson
2519 Wilson Ave
Lansing, MI 48906

OFFICE OF
RESEARCH ETHICS AND STANDARDS
University Committee on Research Involving Human Subjects
Michigan State University
202 Olds Hall
East Lansing, MI
48824
517/355-2180
FAX: 517/432-4503
Web:
www.humanresearch.msu.edu
E-Mail: ucrihs@msu.edu

MICHIGAN STATE
UNIVERSITY

Revision Application Approval

April 6, 2006

To: Gerhardus SCHULTINK
310 Natural Resources

Re: **IRB # 05-362** Category: EXPEDITED 2-7
Revision Approval Date: April 6, 2006
Project Expiration Date: July 10, 2006

Title: INTEGRATION OF NATURAL RESOURCE INFORMATION IN LAND USE PLANNING

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **the revision has been approved.**

Revision to include an additional interview protocol and consent form, and additional funding from the Land Policy Program at MSU.

The review by the committee has found that your revision is consistent with the continued protection of the rights and welfare of human subjects, and meets the requirements of MSU's Federal Wide Assurance and the Federal Guidelines (45 CFR 46 and 21 CFR Part 50). The protection of human subjects in research is a partnership between the IRB and the investigators. We look forward to working with you as we both fulfill our responsibilities.

Renewals: IRB approval is valid until the expiration date listed above. If you are continuing your project, you must submit an ***Application for Renewal*** application at least one month before expiration. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: The IRB must review any changes in the project, prior to initiation of the change. Please submit an ***Application for Revision*** to have your changes reviewed. If changes are made at the time of renewal, please include an ***Application for Revision*** with the renewal application.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects, notify the IRB office promptly. Forms are available to report these issues.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at IRB@msu.edu. Thank you for your cooperation.

Sincerely,

Peter Vasilenko, Ph.D.
SIRB Chair

c: Jennifer Olson
2519 Wilson Ave
Lansing, MI 48906

OFFICE OF REGULATORY AFFAIRS
Human Research Protection Programs

BIOMEDICAL & HEALTH INSTITUTIONAL REVIEW BOARD (BIRB)

COMMUNITY RESEARCH INSTITUTIONAL REVIEW BOARD (CRIRB)

SOCIAL SCIENCE/ BEHAVIORAL / EDUCATION INSTITUTIONAL REVIEW BOARD (SIRB)

202 Olds Hall
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517-355-2180
Fax: 517-432-4503

www.humanresearch.msu.edu
SIRB & BIRB: IRB@msu.edu
CRIRB: crirb@msu.edu

MICHIGAN STATE
UNIVERSITY

Renewal Application Approval

June 20, 2006

To: Gerhardus SCHULTINK
310 Natural Resources

Re: **IRB # 05-362** Category: EXPEDITED 2-7
Renewal Approval Date: June 20, 2006
Project Expiration Date: June 19, 2007

Title: INTEGRATION OF NATURAL RESOURCE INFORMATION IN LAND USE PLANNING

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **the renewal has been approved**

The review by the committee has found that your renewal is consistent with the continued protection of the rights and welfare of human subjects, and meets the requirements of MSU's Federal Wide Assurance and the Federal Guidelines (45 CFR 46 and 21 CFR Part 50). The protection of human subjects in research is a partnership between the IRB and the investigators. We look forward to working with you as we both fulfill our responsibilities.

Renewals: IRB approval is valid until the expiration date listed above. If you are continuing your project, you must submit an ***Application for Renewal*** application at least one month before expiration. If the project is completed, please submit an ***Application for Permanent Closure***

Revisions: The IRB must review any changes in the project, prior to initiation of the change. Please submit an ***Application for Revision*** to have your changes reviewed. If changes are made at the time of renewal, please include an ***Application for Revision*** with the renewal application.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects, notify the IRB office promptly. Forms are available to report these issues.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at IRB@msu.edu. Thank you for your cooperation.

Sincerely,

Peter Vasilenko, Ph.D.
SIRB Chair

c: Jennifer Olson
2519 Wilson Ave
Lansing, MI 48906

OFFICE OF REGULATORY AFFAIRS
Human Research Protection Programs

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SIRB & BIRB: IRB@msu.edu
CRIRB: crirb@msu.edu

APPENDIX J: ADDITIONAL SURVEY RESULTS

Table 20. Survey: Willingness to participate in an interview

Interview	Frequency	Percent
Yes	283	35%
No	537	65%
Total	820	100%
No response	120	
Total	940	

Table 21. Interview: How natural resource information has been incorporated into planning efforts

Code word(s)	Definition	Twp (n=21)	Cty (n=6)	Reg (n=3)	Total (N=30)
Zoning	Denotes nat res info has been incorporated into zoning districts, zoning ordinances, or zoning maps	18 (86%)	5 (83%)	2 (67%)	25 (83%)
Master Plan	Denotes nat res info has been incorporated into a Master Plan	7 (33%)	2 (33%)	3 (100%)	12 (40%)
Site Plan	Denotes nat res info has been incorporated into a site plan review or building permit	6 (29%)	0	0	6 (20%)
Recreation Plan	Denotes nat res info has been incorporated into some type of recreational plan	3 (14%)	0	1 (33%)	4 (13%)
Watershed	Denotes nat res info has been incorporated into a watershed plan or to reduce pollutants into stream or lake	2 (9.5%)	1 (17%)	0	3 (10%)
Private Landowners	Denotes nat res info has been used to assist private landowners when they have questions	0	2 (33%)	0	2 (7%)
Green Space Plan	Denotes nat res info has been incorporated into a green space or open space plan	2 (9.5%)	0	0	2 (7%)
Purchase Land	Denotes nat res info has been used to direct the purchase of land	1 (5%)	1 (17%)	0	2 (7%)
Maps	Denotes nat res info has been incorporated into maps of some type	0	1 (17%)	1 (33%)	2 (7%)

Education	Denotes nat res info has been use to create educational materials	0	1 (17%)	1 (33%)	2 (7%)
Forest Plan	Denotes nat res info has been incorporated into a forest plan	1 (5%)	0	0	1 (3%)
Suitability	Denotes nat res info has been used to identify suitable soils for development	0	0	1 (33%)	1 (3%)
Manage Property	Denotes nat res info has been used to manage public property	0	1 (17%)	0	1 (3%)
Tax Assessment	Denotes nat res info has been used to generate taxes through green space millage	1 (5%)	0	0	1 (3%)
Infrastructure	Denotes nat res info has been used to direct placement of water and sewer infrastructure	0	0	1 (33%)	1 (3%)

Table 22. Survey: Top three most important types of natural resource information for future planning and zoning efforts

Future Most Important Information	Most Important		Second Most Important		Third Most Important	
	N	%	N	%	N	%
Agricultural	179	27%	45	7%	46	7%
Ground Water	115	17%	125	19%	80	13%
Surface Water	107	16%	167	25%	84	13%
Land cover/land use	83	12%	63	10%	86	14%
Wetland Vegetation	76	11%	75	12%	53	8%
Soils	29	5%	56	9%	93	15%
Invasive Plant Species	10	2%	9	1%	16	3%
Wildlife Species	12	2%	16	2%	20	3%
Comprehensive Green Space Map	10	2%	20	3%	39	6%
Other Natural Resource Information	15	2%	10	2%	10	2%
Topographic	10	1.5%	22	3%	38	6%
Invasive Animal Species	6	1%	16	2%	21	3%
Geology	9	1%	15	2%	22	4%
Upland Vegetation	9	1%	16	2%	20	3%
Endangered & Threatened Species	3	.5%	5	1%	7	1%
Total # of Respondents	**673**		**660**		**635**	

Table 23. Interview: Most important natural resources in jurisdiction

Code word(s)	Definition	Twp (n=21)	Cty (n=6)	Reg (n=3)	Total (N=30)
Water Resources	Denotes several types of water resources that are valued	11 (52%)	6 (100%)	1 (33%)	18 (60%)
Forests	Denotes types of wooded landscapes that are valued	9 (43%)	4 (67%)	0	13 (43%)
Agriculture	Denotes types of agriculture or agriculture in general is valued	7 (33%)	3 (50%)	1 (33%)	11 (37%)
Wildlife	Denotes types of wildlife or wildlife in general is valued	7 (33%)	2 (33%)	0	9 (30%)
Public Land	Denotes types of public land or public land in general is valued	6 (29%)	2 (33%)	1 (33%)	9 (30%)
Green Space	Denotes type of green space that is valued	4 (19%)	1 (17%)	1 (33%)	6 (20%)
Wetlands	Denotes type of wetland or wetlands in general are valued	3 (14%)	2 (33%)	0	5 (17%)
Water Quality	Denotes water quality issues that are important	4 (19%)	0	0	4 (13%)
Native Plants	Denotes native plants or native plant communities are valued	3 (14%)	0	0	3 (10%)
Private Land	Denotes types of private land or private land in general is valued	0	1 (17%)	2 (67%)	3 (10%)
Trails	Denotes trails or non-motorized routes are important	2 (9.5%)	0	0	2 (9.5%)
Mining	Denotes mining or mining related products are valued	0	2 (33%)	0	2 (9.5%)
Viewscapes	Denotes view of landscape is important	1 (5%)	0	0	1 (3%)
Soils	Denotes soils are important	0	1 (17%)	0	1 (3%)
Air Quality	Denotes air quality is important	1 (5%)	0	0	1 (3%)
All	Denotes all natural resources are integrated and important	0	0	1 (33%)	1 (3%)

Table 24. Interview: Challenges to integrating natural resource information into planning or zoning

Code word(s)	Definition	Twp (n=21)	Cty (n=6)	Reg (n=3)	Total (N=30)
Accuracy	Denotes when nat res info lacks detail or accuracy	3 (14%)	1 (17%)	2 (67%)	6 (20%)
Interpretation	Denotes when local government did not know how to interpret or apply natural resource information	3 (14%)	0	0	3 (10%)
Digital Format	Denotes when information was not available in digital format	0	1 (17%)	2 (67%)	3 (10%)
Unenforceable	Denotes when decisions are unenforceable based on nat res info	3 (14%)	0	0	3 (10%)
Time / Money	Denotes when local government lacks time or money to incorporate nat res info	2 (9.5%)	0	1 (33%)	3 (10%)
Local Support	Denotes when there is a lack of local support to incorporate nat res info	2 (9.5%)	0	0	2 (7%)
Where	Denotes when local government does not know where to get nat res info	1 (5%)	0	0	1 (3%)
Current Issues	Denotes when local government lacks knowledge about nat res issues	1 (5%)	0	0	1 (3%)
GIS	Denotes when local government lacks knowledge about GIS	0	1 (17%)	0	1 (3%)
Availability	Denotes when specific types of nat res info are not available	0	0	1 (33%)	1 (3%)
Methods	Denotes when data collection and classification methods are not standard across natural resource data layers	0	0	1 (33%)	1 (3%)
Scale	Denotes how difficult it is to integrate and overlay multiple types of nat res info at the parcel level	0	0	1 (33%)	1 (3%)

Table 25. Survey: Need to know where to access natural resource information by level of government

			Need for knowing where to access natural resource information			
			Great Need	Somewhat Need	No Need	Total
Level of Government	Regional Planning Commission	Count	9	3	0	12
		Percent	75%	25%	0%	100%
	County	Count	20	20	5	45
		Percent	44%	45%	11%	100%
	Township	Count	440	250	46	736
		Percent	60%	34%	6%	100%
		Total # of Respondents	469	273	51	793

Table 26. Survey: Need for funding to acquire natural resource information by level of government

			Need for funding to acquire natural resource information			
			Great Need	Somewhat Need	No Need	Total
Level of Government	Regional Planning Commission	Count	8	4	0	12
		Percent	67%	33%	0%	100%
	County	Count	26	15	4	45
		Percent	58%	33%	9%	100%
	Township	Count	329	285	99	713
		Percent	46%	40%	14%	100%
		Total # of Respondents	363	304	103	770

Table 27. Interview: Information, training or services that would facilitate greater consideration of natural resource information in local planning efforts

Code word(s)	Definition	Twp (n=21)	Cty (n=6)	Reg (n=3)	Total (N=30)
Accessibility	Denotes need for improved accessibility to nat res info	8 (38%)	3 (50%)	2 (67%)	13 (43%)
Educate Officials	Denotes need to educate local government officials about nat res	6 (29%)	1 (17%)	3 (100%)	10 (33%)
Computer / GIS	Denotes need for computer or GIS training	5 (24%)	3 (50%)	2 (67%)	10 (33%)
Applications	Denotes need for training local officials on how to use, apply and interpret nat res info	3 (14%)	4 (67%)	2 (67%)	9 (30%)
Advertise	Denotes need to advertise where and what types of nat res info are available	5 (24%)	0	2 (67%)	7 (23%)
Cheap Training	Denotes need to provide free or low cost training opportunities	2 (9.5%)	1 (17%)	0	3 (10%)
Plan / Zone Training	Denotes need to provide more planning and zoning training, both general and advanced	2 (9.5%)	1 (17%)	0	3 (10%)
Educate Public	Denotes need to educate the public about natural resources	1 (5%)	2 (33%)	0	3 (10%)
Training Locations	Denotes need to provide multiple training locations	1 (5%)	1 (17%)	0	2 (7%)
Accuracy	Denotes need to provide more accurate nat res info	1 (5%)	0	0	1 (3%)
Technology	Denotes need for technology to access and present nat res info	1 (5%)	0	0	1 (3%)
State Laws	Denotes need for training on the state laws related to natural resources and planning and zoning	1 (5%)	0	0	1 (3%)
Scale	Denotes need to use consistent scale on nat res info between agencies	1 (5%)	0	0	1 (3%)

Table 28. Survey: Format natural resource information has been provided in

Types of Natural Resource Information	Electronic		Hard Copy		Total # of Respondents
	N	%	N	%	
Land cover/land use	183	36%	320	64%	503
Topographic	120	31%	262	69%	382
Other Natural Resource Information	19	31%	42	69%	61
Upland Vegetation	83	28%	214	72%	297
Invasive Plant Species	28	28%	72	72%	100
Surface Water	141	28%	361	72%	502
Ground Water	88	26%	249	74%	337
Comprehensive Green Space Map	49	24%	158	76%	207
Wetland Vegetation	108	24%	340	76%	448
Soils	111	24%	358	76%	469
Geology	73	23%	246	74%	319
Wildlife Species	25	22%	90	78%	115
Endangered & Threatened Species	29	22%	101	78%	130
Invasive Animal Species	17	21%	66	79%	83
Agricultural	92	21%	340	79%	432

Table 29. Survey: Preferred future format of natural resource information

Format	Frequency	Percent
Hard copy	476	60%
Electronic	314	40%
Total	790	100%
No response	150	
Total	940	

Table 30. Survey: Preferred future format of natural resource information by level of government

Level of Government	Format information preferred to be in				Total # of Respondents
	Hard copy format		Electronic format		
Regional Planning Commission	1	8%	11	92%	12
County	10	24%	32	76%	42
Township	464	63%	270	37%	734
Total	475		313		788

Table 31. Survey: Gender of survey respondent

Gender	Frequency	Percent
Male	457	53%
Female	411	47%
Total	868	100%
No response	72	
Total	940	

Table 32. Survey: Respondent's current position

Current Position	Frequency	Percent
Township or County Clerk	431	48%
Township or County Supervisor	147	16%
Township or County Zoning Administrator	106	12%
Township or County Planning Commission member	89	10%
Township or County Planner	45	5%
Other position	37	4%
Township or County Zoning Board member	14	2%
Private Planning Consultant	9	1%
Regional Commission Planner	9	1%
Regional Commission Director	3	.5%
Township or County Manager	5	.5%
Total	895	100%
No response	45	
Total	940	

Table 33. Survey: Type of position

Current Appointment	Frequency	Percent
Elected official	609	68%
Appointed official	160	18%
Hired staff	102	11%
Consulting firm	13	2%
Volunteer staff	2	.5%
Other appointment	2	.5%
Total	888	100%
No response	52	
Total	940	

Table 34. Survey: Position requires making land use planning or zoning decisions/recommendations

Land Use Decisions	Frequency	Percent
Yes	598	68%
No	285	32%
Total	883	100%
No response	57	
Total	940	

Table 35. Survey: Number of years in current position

Years in Current Position	
Mean	10.0
Median	8.0
Mode	1.0
Minimum	.5
Maximum	57.0
Missing	73
Number of Respondents	867

Table 36. Survey: Year survey respondent was born

Year Born	
Mean	1950.5
Median	1950
Mode	1947(a)
Minimum	1919
Maximum	1984
Missing	115
Number of Respondents	825

(a) Multiple modes exist. The smallest value is shown.

Table 37. Survey: Highest level of formal education

Education	Frequency	Percent
Some college	249	29%
Bachelor's or 4-year degree	185	21%
High school diploma or equivalent	169	20%
Graduate or professional degree	122	14%
Associate's degree	95	11%
Technical / vocational degree	38	4%
Less than high school	5	1%
Total	863	100%
No response	77	
Total	940	

Table 38. Survey: Respondent's planning credentials

Planning Credentials	Frequency	Percent
Yes	93	11%
No	763	89%
Total respondents	856	100%
No response	84	
Total	940	

Table 39. Survey: Planning credentials by level of government and location in state

		Planning credentials				Total # of Respondents
		Yes	%	No	%	
Level of Government	County	10	21%	38	79%	48
	Regional Planning Commission	2	15%	11	85%	13
	Township	80	10%	713	90%	793
Total # of Respondents		92	11	762	89	854
Location in State	Southern Lower Peninsula	62	12%	436	88%	498
	Northern Lower Peninsula	23	9%	236	91%	259
	Eastern Upper Peninsula	4	8%	48	92%	52
	Western Upper Peninsula	3	7%	42	93%	45
Total # of Respondents		92	11	762	89	854

Table 40. Survey: Satisfaction with natural resource information used

Types of Natural Resource Information	Very Satisfied		Moderately Satisfied		Moderately Dissatisfied		Very Dissatisfied		Information Not Available **or** Not Used		Total # of Respondents
	N	%	N	%	N	%	N	%	N	%	
Land cover/land use	192	26%	268	37%	42	6%	7	1%	219	30%	728
Surface Water	176	24%	306	42%	30	4%	8	1%	206	29%	726
Soils	163	22%	277	38%	42	6%	8	1%	242	33%	732
Topographic	140	20%	224	31%	39	5%	8	1%	303	43%	714
Wetland Vegetation	140	19%	276	38%	43	6%	11	2%	257	35%	727
Agricultural	126	17%	277	38%	34	5%	10	1%	285	39%	732
Ground Water	110	15%	206	29%	46	7%	19	3%	331	46%	712
Geology	106	15%	213	30%	35	5%	9	1%	351	49%	714
Upland Vegetation	96	14%	194	28%	25	3%	7	1%	377	54%	699
Comprehensive Green Space Map	68	10%	137	20%	31	4%	8	1%	452	65%	696
Wildlife Species	36	5%	95	14%	28	4%	9	1%	523	76%	691
Invasive Animal Species	33	5%	67	10%	28	4%	11	1%	549	80%	688
Endangered & Threatened Species	32	5%	89	13%	35	5%	11	1%	524	76%	691
Other Natural Resource Information	25	5%	39	8%	5	1%	6	1%	432	85%	507
Invasive Plant Species	28	4%	87	13%	29	4%	11	2%	533	77%	688

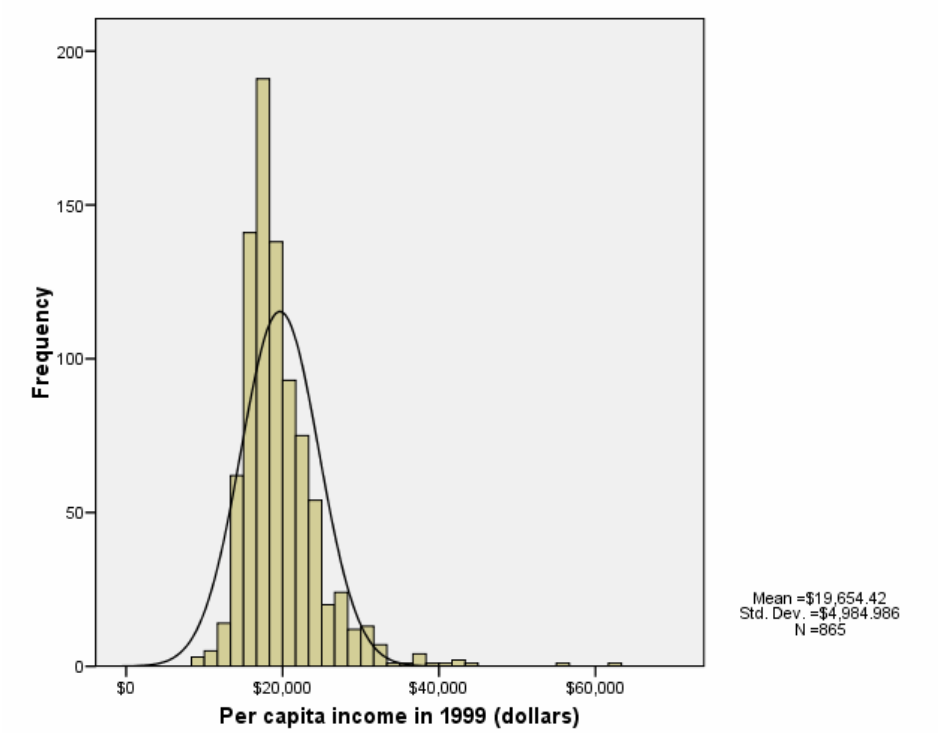

Figure 3. Histogram of Michigan township per capita income distribution

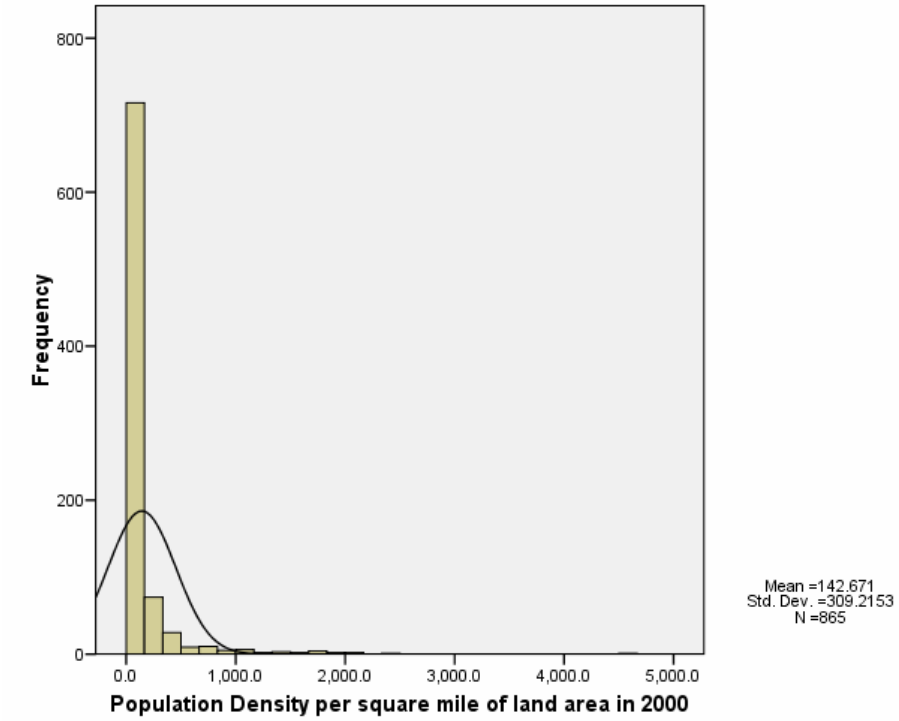

Figure 4. Histogram of Michigan township population density distribution

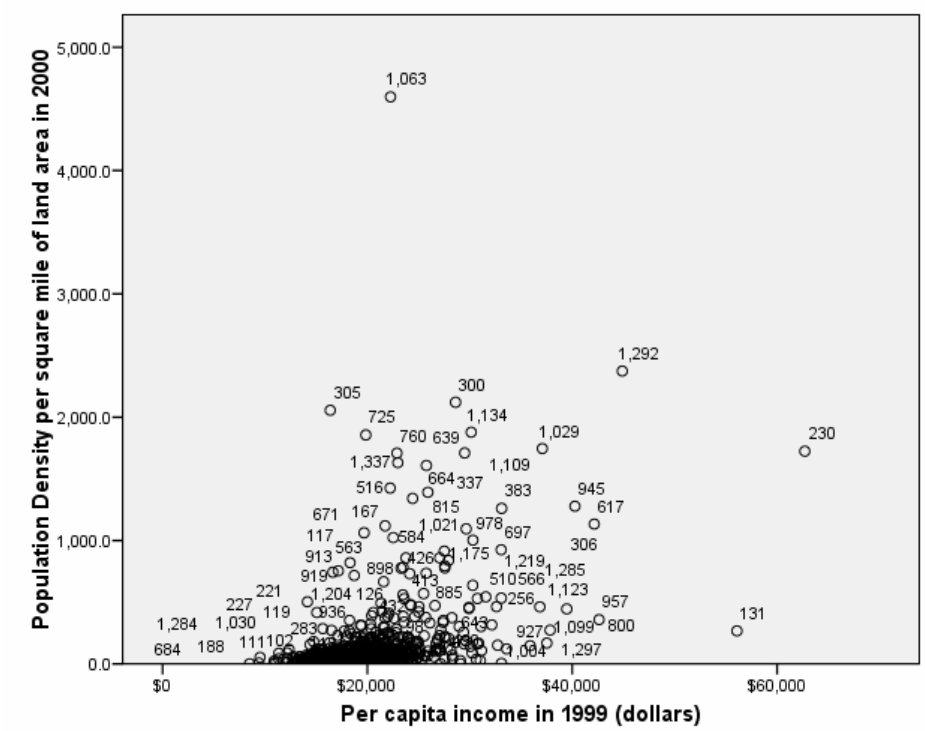

Figure 5. Scatterplot of Michigan township population density to per capita income