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Public preferences of the Great Lakes Environment : a Lake Michigan pilot study

Fangming Liu
Michigan Technological University

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THE PUBLIC PREFERENCES OF THE GREAT LAKES ENVIRONMENT: A LAKE MICHIGAN PILOT STUDY

By

Fangming Liu

A THESIS

Submitted in partial fulfillment of the requirements for the degree of

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APPLIED NATURAL RESOURCE ECONOMICS

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This thesis, “The Public Preferences of the Great Lakes Environment: A Lake Michigan Pilot Study,” is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN APPLIED NATURAL RESOURCE ECONOMICS.

School of Business and Economics

Signatures:

Thesis Advisor	______________________________ Associate Professor William S. Breffle
Committee Member	______________________________ Assistant Professor Daya Muralidharan
Committee Member	______________________________ Richard P. Donovan, PhD (external)
Dean	______________________________ Darrell Radson
Date	______________________________

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Abstract: The Great Lakes watershed is home to over 40 million people, and the health of the Great Lakes ecosystem is vital to the overall economic, societal, and environmental health of the U.S. and Canada. However, environmental issues related to them are sometimes overlooked. Policymakers and the public face the challenges of balancing economic benefits with the need to conserve and/or replenish regional natural resources to ensure long term prosperity. From the literature review, nine critical stressors of ecological services were delineated, which include pollution and contamination, agricultural erosion, non-native species, degraded recreational resources, loss of wetlands habitat, climate change, risk of clean water shortage, vanishing sand dunes, and population overcrowding; this list was validated through a series of stakeholder discussions and focus groups in Grand Rapids. Focus groups were conducted in Grand Rapids to examine the awareness of, concern with, and willingness to expend resources on these stressors. Stressors that the respondents have direct contact with tend to be the most important. The focus group results show that concern related to pollution and contamination is much higher than for any of the other stressors. Low responses to climate change result in recommendations for outreach programs.

Keywords: Great Lakes, carrying capacity, environmental stressors, ecological services, public preferences, focus groups

Chapter 1: Introduction

The Great Lakes contain about 23,000 km^3 (5,500 cu. mi.) of water; cover a total area of 244,000 km^2 (94,000 sq. mi.); and account for 90% of the United States' surface fresh water (which is roughly 22% of the world's fresh surface water). The Great Lakes watershed (see Figure 1.1) is readily identifiable as viewed from space because it extends from east to west for nearly a thousand miles across the heartland of the United States and Canada. The watershed drains almost 200,000 square miles, has a nearly 10,000 mile long shoreline, and includes 35,000 islands. Its watershed includes part or all of eight U.S. states (Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York) and the Canadian province of Ontario. It is home to over 40 million people.

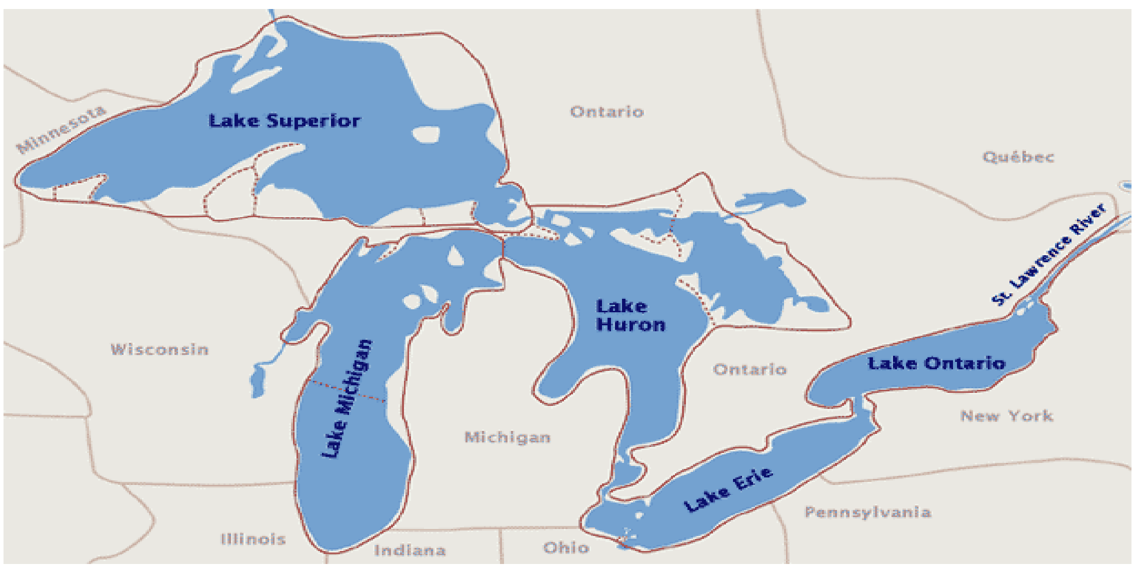

Figure 1.1 The Great Lakes watershed

At $3.7 trillion, the non-farm economy represents 30% of the value of the GDP in the US and Canada combined while employing 43.4 million people. Agriculture alone contributes $53.4 billion in Canada and the U.S. (Krantzberg and de Boer, 2006). Forestry remains as a locally-important industry throughout much of the watershed. For example, in Wisconsin in 2000, pulp, paper, wood products manufacturing, and other forest products industries employed 74,000 workers and generated more than $18 billion in shipments (Union of Concerned Scientists, 2003). Like forestry, shipping is a relatively small percentage of the overall economy but critically important to virtually every aspect of the Great Lakes economy. Grain, soybeans, coal, iron ore, and other goods and commodities worth billions of dollars from the Midwest and Canada are shipped to markets worldwide. If the Great Lakes watershed were a country it would rank third behind the Japanese and U.S. economy with a total population ranked twelfth in the world. The watershed contains 20% of all U.S. timberland and 20% of all U.S. manufacturing (58% of cars made in the U.S. and Canada are made in the basin). In addition, the Great Lakes support a $1-billion-plus recreational fishing industry (Krantzberg and de Boer, 2006).

Though the Great Lakes are one of America's most important natural features, and they are important to the economy of both U.S. and Canada, environmental issues related to them are sometimes overlooked. However, the healthy functioning of ecosystems in the Great Lakes region and the services they provide are important. The health of Great Lakes ecosystem is important to the overall economic, societal, and environmental health of the U.S. and Canada. Unfortunately the complexity of the interactions between the environmental services provided by the ecosystem and the societal demands upon that ecosystem tend to obscure the importance of tending to the significant impact that over 40 million people are having on this ecosystem.

Clearly, agriculture, forestry, tourism, and outdoor recreation rely directly on the vitality of both natural and managed ecosystems (such as tree plantations, farms, and ranches) and the plant and animal communities they harbor. Other ecological processes supply vital support services such as air and water purification, flood protection, pest control, and soil renewal. Human activities, such as urban sprawl, land use change, discharge of pollutants into air and water, and shipping that introduced the zebra mussels and other damaging nonnative, invasive species into the Great Lakes, have put increasing pressure on the ecosystem.

Policymakers and the public face the challenge of balancing economic benefits with the need to conserve and/or replenish regional natural resources to ensure long term prosperity. This challenge is significant because of the following reasons:

1. There is a perception that natural resources are publicly owned and therefore available for everyone to exploit. While profits from such exploitation may lead to regional economic growth, a growing population and unregulated usage can lead to rapid depletion of the resources leading to the well-known "tragedy of the commons" (e.g., non-point source runoff).
2. It is often perceived that environmental regulation and promotion of economic growth are conflicting objectives requiring significant tradeoffs. As a result, it is difficult to build consensus between multiple stakeholders who are directly impacted by such decisions.

3. The region is impacted by diverse pollutants resulting from direct human activity. Analyzing the impacts of all of them comprehensively in relation to each other, and establishing limits to land use and/or economic activity is difficult. The associated scientific literature is fragmented and often difficult to implement.

Given these challenges, the goal of this thesis is to introduce a framework that can be used by policymakers to ensure that the overuse or misuse of natural resources by current generations does not have significant negative impacts on the regional economic or environmental health in future. It provides a method to identify regional stressors and to elicit public perceptions of environmentally-related problems. The objective is to analyze interactions between natural resource usage and stakeholder preferences. The goal is specifically to identify the preferences associated with economic benefit and natural resource conservation. The proposed method was used to identify nine regional stressors, and public perceptions of the environmental damage from such stressors were elicited through a focus-group study.

The significance of this research is that it uses a holistic approach that studies natural resource usage within the context of public preferences. It acknowledges the importance of stakeholder preferences in shaping public policy. The study focuses on the western shores of Lake Michigan encompassing the urban areas of Muskegon, Traverse City, Benton Harbor, Holland, Grand Rapids, and Kalamazoo. This region was chosen not only because of its proximity and familiarity, but also because it is an area significantly impacted by human-induced stressors. The resources in this assessment area are important to numerous entities including federal, state, local, and tribal agencies, private sector firms (e.g., paper companies and agricultural producers), and environmental advocacy groups such as the West Michigan Environmental Action Council.

There are two main sections in this paper. In Section 2, a comprehensive search of literature relevant to carrying capacity in the Great Lakes Environment (GLE) is conducted. The search identifies seminal scholarly contributions that describe the key stressors that affect the Great Lakes carrying capacity. A discussion of the information gathered through the literature review was conducted with local and regional Great Lakes NGOs, non-profit environmental groups, and governments. Nine important human stressors emerged from these discussions. There was consensus that the set of nine stressors include all stressors that are considered to be highly important, and no stressors that are considered to be of no importance or only marginally important. The most important stressors identified from the literature review and discussion with stakeholders became the key topics discussed in subsequent focus groups.

In Section 3, a framework is developed to elicit stakeholder preferences using focus groups. The objective of the focus group study is to provide information on people's attitudes toward and preferences for a broad range of ecological purposes, across social, professional, and geographical demographics. Focus groups provide guidance on environmental and ecological services that are of most value to people, and likewise, those perceived to have little importance or interest.

Chapter 2: Defining Carrying Capacity and Identifying Human-use Stressors

2.1 Carrying capacity definitions

Conceptually, carrying capacity is defined as the population and/or the standard of living that a region can support sustainably. For a given habitat, carrying capacity is a function of available natural resources and the preferences for resource consumption of the population. In the presence of population growth and increased economic activity, limits to carrying capacity can be tested and potentially exceeded. This can lead to environmental degradation and overexploitation, thereby reducing the quality of life of humans who rely upon the natural resources, including future generations. The significant environmental impacts of increasing economic activity and the critical role of economic activity in maintaining a high standard of living for people have created serious challenges with respect to managing natural resources and environmental amenities available to society. Hence, the concept of carrying capacity can be used to characterize the dynamics of complex interfaces between humans and the natural environment.

Carrying capacity has come to have many meanings, and it is important to place this study in the context of appropriate definitions of carrying capacity. Generally the definition differs depending on the research field and application. For example, in engineering it is defined as efficient use of resource bases, and a constant overall ratio of resources going in and coming out (Arrow et al, 1995). In biology, it has been defined several different ways. Burns (1971) defines it as the biomass per unit of surface area; Doshi (2006) defines it as the amount of development and activity a body of water can support before it begins to deteriorate; Jiang et al (2005) defines it as the amount of outside influence that can be introduced into an area before it significantly affects the food web; and Daily et al. (1992) describe it as a measure of the amount of renewable resources in the environment in units of the number of organisms these resources can support. In agriculture, the definition given by the Australian Department of Primary Industries (2005) is the units of output per hectare that can be sustained through normal (non-disaster) years. In recreation, it has been defined as the number of visitors an area can sustain without degrading natural resources and visitor experiences (Prato, 1999). Cohen (1997) gives a multi-faceted definition based on population: it is the amount of people an area can support given the area's economic, biological, and physical limitations. Meyer et al. (1997) give a more Malthusian definition: a ceiling of available resources that human population runs into which can be raised by technological growth. For this study, the general definition of Great Lakes carrying capacity is the amount of human activity the assessment area can support before the ecological services provided by the Great Lakes begin to deteriorate or disappear.

2.2 Human-use environmental stressors

The groups that provided assistance in identifying stressors included: Green Grand Rapids; the Grand Rapids Department of Parks & Recreation; the Alliance for the Great Lakes; the Council of Great Lakes Governors; and the Great Lakes Commission and National Wildlife Federation.

Through discussions with key local and regional stakeholders, a list of nine stressors was developed and investigated as the core element of the investigation: (1) pollution and contamination; (2) agricultural erosion; (3) non-native (invasive) species;

(4) degraded recreational resources; (5) loss of wetlands habitat; (6) climate change; (7) risk of clean water shortage; (8) vanishing sand dunes; and (9) population overcrowding.

2.2.1 Pollution and contamination

Point-source pollution (contamination that comes directly from affixed outlets either in the water or in the air) and non-point-source pollution (pollution that generally results from agricultural production and vehicle operation) are both affecting the GLE (Interlandi and Crockett, 2003). For example, polychlorinated biphenyls (PCBs) are in the Fox River, Green Bay, and Lake Michigan as a result of activity by paper companies (Harris et al, 1990; Breffle et al, 2005a). Agricultural and urban development has led to the degradation of natural buffer zones (e.g. forests and wetlands) and reduced resistance to running water (Austin, 2007; de Groot et al, 2002; Progressive AE, 2005). This loss of retention, coupled with the use of fertilizers and pesticides to maximize harvest yield, leads to a runoff of chemicals and animal wastes into lakes, rivers, and streams (Harris et al., 1990).

Toxic pollutants have impacted the Great Lakes region in several ways. For example, polychlorinated biphenyls (PCBs) have made their way into food sources of fish (especially fish that feed at the benthic level) and have caused fish consumption advisories (Bunt and Bier, 2007); pollution has also decreased water clarity, which has fundamentally changed the habitats of fish species that are harvested for consumption. The same chemicals have decreased the amount of dissolved oxygen in the water, which makes it harder for large numbers of fish to live in an area (Bunt and Bier, 2007).

There are key differences between point-source and non-point-source polluters that need to be understood when conducting regulatory analysis and control of pollution. Point source pollution is relatively easier to measure and assign blame. Therefore, relative to non-point source pollution, it is straightforward to determine the amount of damage done by point-source polluters. Non-point source pollution, however, is much more difficult to measure, as there are multiple polluters that may be in motion, and each agent's pollution often joins together with other polluting agents, thus making the damage assessment for each individual rather difficult (Austin, 2007; de Groot et al, 2002). In either case, assigning the value for damage done based on the volume of pollution is a complex task of bridging scientific knowledge to social justice (Breffle et al., 2005a). Generally speaking, economists have known for a long time that point-source pollution tends to be overregulated and non-point-source pollution tends to be underregulated.

Releases of targeted bioaccumulative toxic chemicals in the Great Lakes region have declined significantly from their peak period in past decades and, for the most part, no longer limit the reproduction of fish, birds, and mammals. Concentrations of regulated contaminants such as PCBs, dichloro-diphenyl-trichloroethane (DDT), and mercury have generally declined in most monitored fish species over the last three decades. However, there are emerging areas of concern for chemicals associated with flame retardants, plasticizers, pharmaceuticals, personal care products, and pesticides. In addition, in spite of the general decrease of contamination in the Great Lakes region, the lakes continue to be a receptor of contaminants from many different sources such as municipal and industrial wastewater, air pollution, contaminated sediments, and runoff. The conditions vary by lakes and are different in the near shore waters compared to the offshore waters (EPA, 2009).

2.2.2 Agricultural erosion

Land use/land cover changes associated with urbanization and population growth have affected the Great Lakes, especially in the nearshore zone. For the period 1992 to 2001, approximately 800,000 hectares or 2.5% of the Great Lakes basin experienced a change in land use (Wolter et al, 2006). The bulk of the change consisted of forested and agricultural lands converting to high or low intensity development, roads, or early successional vegetation. More than half of these changes are considered to be irreversible (EPA, 2009). Figure 2.1 summarizes the land use/land cover change in the Great Lakes basin from 1992 through 2001. The pace of land use/land cover change in the Great Lakes, particularly in urban and suburban areas, exceeds that predicted by population growth alone (Wolter et al, 2006). The most common land use changes from 1992 through 2001 fall into three general categories: (1) agriculture to developed [210,068 hectares (519,089 acres) or 26.3%], (2) forest to early successional vegetation [180,690 hectares (446,495 acres) or 22.6%], and (3) forest to developed land [154,681 hectares (382,225 acres) or 19.4%]. Agricultural conversion showed the greatest change (decreased by 2.24% between 1992 and 2001). This trend is common throughout the Great Lakes region.

Johnston et al. (2007) mapped land use/land cover change for a 100 km^2 area covering portions of Erie Township, Michigan, and Toledo, Ohio on the western end of Lake Erie (these areas are generally representative of the geography and geomorphology of the Great Lakes basin). Geographic information system analysis was used to quantify changes in anthropogenic pressures on coastal ecosystems from 1940 and 2003. Agriculture was and is the main land use in the study site, constituting 78% and 55% of upland area in 1940 and 2003, respectively. Of the 3,571 hectares of cropland that existed in 1940, about one-third was converted to non-agricultural uses by 2003. Commercial and industrial development was a minor land use in 1940, but by 2003 increased by 246 hectares. In addition, commercial development supplanted 172 hectares of agriculture land, and population increases caused residential development to double from 353 hectares in 1940 to 717 hectares in 2003. Moreover, climate change in general is expected to have a significant impact on land use/land change as well. While Global Climate Models (GCMs) do exhibit variability relative to initial conditions, they are in agreement with regard to overall effects.

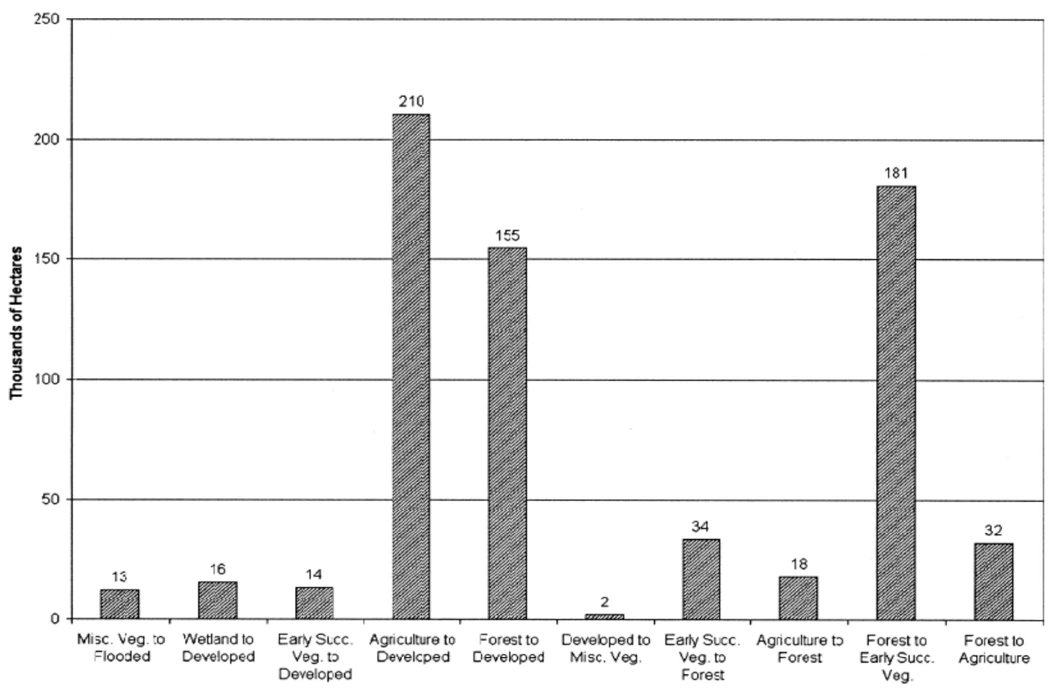

Figure 2.1 Land use/land cover transitions: U.S. Great Lakes basin. 1992-2001. (Source: Wolter et al., 2006)

2.2.3 Non-native (invasive) species

Pejchar (2000) defines an “invasive species” as one that is non-native to the ecosystem being studied and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Within the Great Lakes, invasive species are causing losses in biodiversity, changes to ecosystems, and negative impacts to agriculture, forestry, fisheries, power production, and international trade. Most of these species in the Great Lakes watershed are aquatic plants, fish, algae, mollusks, and crustaceans which were transported into the ecosystem primarily through shipping. In addition, the roles of canals, online purchase of aquatic plants, and the aquarium and fish-bait industries are also receiving increasing attention (EPA, 2009).

Table 2.1 (Mills, et al., 1994) summarizes the history and impacts of invasive species. Currently, 185 aquatic and at least 157 terrestrial invasive species have been discovered in the Great Lakes. Given that non-indigenous species interact with the ecosystem in unpredictable ways and that within the Great Lakes, at least 10% of non-indigenous species are considered invasive, there is a strong potential for negative impacts on the ecosystem health. For example, invasive species can be linked to many current ecosystem challenges including the decline in the lower food web’s Diporeia populations, fish and waterfowl diseases, and excessive algal growth. Economic impacts can also be significant. The sea lamprey’s attack on native lake trout populations has resulted in millions of dollars in damages and losses to commercial fisheries. Similarly during late 1960s, the large buildup of alewife populations accelerated the collapse of whitefish and bloater populations, adversely affected yellow perch and other native species, and caused significant economic losses to lakeside communities in the watershed (Krantzberg and deBoer, 2006).

The invasions of zebra mussel, sea lamprey, and eurasian ruffes have received a great deal of attention in the last several years with good reason. Zebra mussels entered the Great Lakes via ships traveling from Europe. After the first sighting of the zebra mussel in the Great Lakes (in the Canadian waters of Lake St. Clair) in June 1988 they dispersed rapidly and were found in all of the Great Lakes by 1990. By the following year, they had spread from the Great Lakes to the Illinois and Hudson rivers. Since 1992, populations of zebra mussels spread rapidly throughout the eastern United States and parts of Canada.

Table 2.1
Exotic species having substantial impacts on the current Great Lakes resources

Organism	**Date**	**Impact**
Sea lamprey	1830s	Causes decline of native lake trout populations
Purple loosestrife	1869	Competes with native plants causing loss of habitat for waterfowl
Alewife	1873	Suppresses native fish species; became important prey fish for salmon
Chinook salmon	1873	Preys upon Great Lakes fishes; became valuable sport fish
Common carp	1879	Destroys habitat of favored fish species and waterfowl
Brown trout	1883	Preys upon Great Lakes fishes; became a valuable sport fish
Furunculosis	1902	Infects Great Lakes fishes
Coho salmon	1933	Preys upon Great Lakes fishes; became a valuable sport fish
White Perch	1950s	Competes with native fish
Eurasian watermilfoil	1952	Competes with native plants; affected recreational use of water
Glugea hertwigi	1960	Parasitizes native fishes
Eurasian ruffe	1986	Competes with native fishes
Zebra mussel	1988	Competes with and alters habitat of native species
Source: Mills, 1994		

The zebra mussel is a hardy, aggressive species. Through over-colonization they greatly reduce the food and oxygen available in the water, threatening the survival of other native species such as mussels, clams, and snails. In addition to changing the light and nutrient environment substantially through filter feeding, they bioaccumulate toxins that end up in fish and birds that people eat. They coat beaches, boats, and docks, cutting the feet of bathers (Hogan, 2007). By clogging water intake pipes at water filtration and electric generating plants, this rugged species has had significant direct economic impact (Krantzberg and deBoer, 2006). For example, the U.S. Congress Office of Technology Assessment (OTA) reports that the New York Seas Grant Extension Service estimated the costs of the zebra mussel to the power industry alone were as much as $800 million for plant redesign, and a further $60 million annually for maintenance. Shutdown due to fouling of cooling or other critical water systems in power plants can cost upwards of $5,000 ($US 1991) per hour for a 200-megawatt system (OTA, 1993).

The sea lamprey is an aggressive parasite normally present in the Atlantic Ocean that attacks its prey by attaching itself to the flesh and boring a hole into the body. Introduced in 1921 through the Welland Canal, they have driven down the size and numbers of whitefish and lake trout throughout the Great Lakes. Control of this species has been effective but expensive. The Great Lakes Fishery Commission's sea lamprey control program (mainly through introduction of chemicals like 3-trifluoromethyl-4-nitrophenol [TFM] into the water) has reduced populations by 90% and has cost the United States and Canada more than $12 million annually for more than a decade (Krantzberg and de Boer, 2006).

The eurasian ruffe is a small spiny perch capable of explosive population growth that threatens the Great Lakes fishery. The ruffe was first collected in Duluth Harbor in fish surveys conducted in 1986. It is presumed to have arrived via ballast water from ocean-going vessels and competes with native fish for food and habitat. High reproductive rates, feeding efficiency across a wide range of environmental conditions, and other characteristics that may discourage would-be predators such as walleye and pike make it a formidable economic and environmental challenge.

The magnitude of the invasive species problem is beginning to capture the attention of the public and policymakers. Today, the global movement of ships' ballast water is widely accepted as the largest transfer mechanism for aquatic invasive species. The Great Lakes are not alone in battling this problem. Worldwide, a diverse and successful "cohort" of invasive species is being transported and discharged in ports around the world (Ruiz and Reid, 2007). Simple and questionably effective solutions such as mid-ocean ballast water exchange (BWE), by which vessels exchange their coastal ballast water with oceanic water, are currently the only approved treatment option available for commercial and military ships to combat this problem.

With regard to the Great Lakes, the effectiveness of BWE is very much an open question. For example, studies conducted by Grigorovich et al. (2003) and Holeck et al. (2002) suggesting that ballast water exchange has been ineffective at reducing the introduction rate of species have been challenged as insufficient by Drake (2005). However, Costello et al. (2007) urge patience based upon a new model for assessing the efficacy of these policy instruments. The model identifies and accounts for several features of the invasive species introduction-detection process that complicate interpretations of monitoring data. In their study they show that even if BWE were 100% effective, the results of the policy would not be detectable for several years under the current monitoring regime. The one point that most agree on is that better monitoring is needed to establish the efficacy of ballast water exchange and other policy instruments.

2.2.4 Degraded recreational resources

The combined surface area of lakes and reservoirs (25,000 square miles) and the Great Lakes (95,000 square miles) constitute about a quarter of the earth's fresh surface water. According to a five-year participation survey conducted by the U.S. Fish and Wildlife Service (1996), more than 11 million anglers 16 years old and older fished both inland and Great Lakes waters in 1996. The Great Lakes region, including inland lakes, accounts for more than 36% of the national figure. These anglers account for about 160,000 days of fishing, with the Great Lakes alone at 15% of the total. According to the Great Lakes Waterways Management Forum (2000), the Great Lakes sport fishery alone draws about $7.5 billion annually to the region ($US 2000). The national survey of fishing shows that in 2001 Great Lakes anglers spent $1.3 billion on fishing trips and equipment.

For decades, recreational fishing services provided by Lake Michigan fisheries have been impaired by the presence of polychlorinated biphenyls (PCBs) and other chemicals released primarily by paper companies, which have resulted in severe fish consumption advisories (FCAs) warning against the eating of Lake Michigan fish. PCBs accumulate in the fatty tissue of fish and are carcinogenic to humans. Two large-scale studies were conducted to estimate the monetary damages associated with these FCAs for the past and for various future remediation scenarios. For the Kalamazoo River environment (Stratus Consulting, 2004 and 2009), total recreational fishing damages were estimated to range from $19 to $40 million ($US 2009). For the lower Fox River and Green Bay (Breffle et al., 1999), total recreational fishing damages were estimated to range from $106 to $148 million ($US1999), with the Wisconsin share ranging from 76% to 79%, and the rest is accruing to Michigan's Upper Peninsula. Hundreds of thousands of recreational fishing days are estimated to be spent at these sites annually, and satisfaction from these fishing outings is impaired because of PCB-caused FCAs. Furthermore, thousands of fishing trips are foregone or substituted to other sites due to PCBs and FCAs, causing inconvenience and added trip cost to anglers. See also Breffle et al. (2005a), Breffle et al. (2005b), Breffle and Rowe (2002), Morey and Breffle (2006), and Morey et al. (2006). To date, total settlements for the Green Bay natural resource damage assessment, for all services and for remediation costs as well as past and interim damages, are in excess of $170 million ($US 2005).

Recreational boating provides over 125,000 jobs and contributes approximately $9 billion annually to the U.S economy (Great Lakes Waterways Management Forum, 2000). Michigan, with its considerable Great Lakes coastline, leads the region with nearly one million recreational boats, 42% of which belong to people residing in its coastal counties. In 1999, the Great Lake states led the country in numbers of recreational boats with 985,732. According to 1998 data (Great Lakes Commission, 2000), the eight Great Lakes states combined have 131 recreational boat manufacturers, or roughly 12% of the national total for the industry, employing more than 10,000 people throughout the region. 1,262 boating-related retail establishments in these states account for nearly one quarter of all recreational boat retailers in the United States. The retail establishments employ nearly 9,000 additional people and generate an annual payroll approaching a quarter of a billion dollars. The National Marine Manufacturers Association estimates that retail expenditures for recreational boating in the region exceed $2.6 billion and constitute slightly less than one-third of U.S. national expenditures in this category. Boating is clearly an important industry in the Great Lakes watershed. However, the aesthetic quality of this activity is negatively affected by eutrophication and resulting odorous algae blooms.

Besides fishing and boating, beaches along the Great Lakes are also valuable recreational resources. Studies indicate that on average an individual derives approximately $35 of value per day at the beach with a total seasonal value of $800 million to $1 billion for visitors to Great Lakes beaches (Krantzberg and de Boer, 2006). However, water quality issues associated with urban growth industrial and agricultural pressures are creating serious public health and economic issues. For example, at the South Shore beach on Lake Michigan, water quality advisories were issued 62%, 47%, 68%, and 24% of days during the 76-day swimming seasons in 2000, 2001, 2002, and 2003, respectively (Scopel, 2006). Pathogens associated with fecal pollution on beach areas pose a direct risk to human health. Testing to determine fecal indicator bacteria (FIB) such as total coliform, enterococci, and Escherichia coli are commonly used to determine unhealthy concentrations of human and livestock fecal waste and subsequently to serve as the basis for beach closings. The U.S. EPA’s currently recommended standard, subject to state and local policy, for freshwater is either a single sample of 235 E. coli colony-forming units (cfu) per 100 ml. or a geometric mean of 126 E. coli cfu/100 ml. over five samples taken within the past 30 days.

2.2.5 Loss of wetlands habitat

The nearly 40 million people living within the Great Lakes basin and their associated agricultural practices, urban development, and industrial endeavors have dramatically degraded the landscape in a variety of ways (Steedman and Regier, 1987). In particular, development in the Great Lakes basin has resulted in the loss of more than half of the region's wetlands. More seriously, some populated areas such as western Lake Erie have lost over 95% of their wetlands (Seilheimer, 2009). These wetlands and habitats play a critical role in maintaining local ecosystems, as well as the social and economic vitality of the region; thus repairing and protecting them is very important (EPA, 2009). Reyer et al. (2009) give a detailed list of benefits of wetlands, which include: maintaining water quality; reducing erosion; protecting from floods and storm damage; providing a system to process airborne pollutants; providing a buffer between urban residential and industrial sectors; maintaining a gene pool of marsh plants and providing examples of complete natural communities; providing aesthetic and psychological support for human beings; producing wildlife; controlling insect populations; providing habitat for fish and other aquatic organisms; and producing food, fiber, and fodder.

The complexity and importance of the Great Lakes coastal wetlands make their management one of the great ecological challenges of society. They are created and maintained by interaction between coastal landscapes, water-level regimes, open-lake circulation processes and patterns, and nearshore coastal processes. These domains are connected at large and small time and space scales through pathways that are not fully understood. They are dominated by large lake processes such as water level fluctuations, wave actions, and wind tides, and span a diverse geographic range, including freshwater estuaries, lagoons, and deltas. The Great Lakes coastal wetlands cycle critical nutrients and organic material from the land into the aquatic food web while sustaining large numbers of common or regionally rare bird, mammal, herptile, and invertebrate species, including land-based species. Most of the lakes' fish species depend upon them for critical elements of their life, migratory birds rely on them for staging and feeding areas, and they provide a diverse array of other services such as protecting shorelines, stabilizing water supplies, and reducing chemical loads in polluted runoff (Great Lakes Coastal Wetlands Consortium, 2009).

In response to the needs of increasing industrialization, Great Lakes nearshore areas have been altered to maintain commercial navigation and protect property threatened by coastal erosion. It is now an established fact that construction of large structures to protect harbors and adjacent commercial infrastructure, dredging of channels to maintain commercial and recreational navigation, and the emplacement of erosion-control structures to protect both private and public property results in significant coastal degradation. These structures typically serve their direct design function but often result in the reduction or elimination of beaches and barrier systems, the loss of nearshore sand substrates, and an increase in lakebed down cutting and water depths in nearshore areas. These changes directly threaten the Great Lakes ecosystem by impacting coastal marshes and wetlands, reducing water quality, altering habitat heterogeneity, and impacting fish spawning and nursery habitats (Kelso et al., 1996; Brazner and Beals, 1997).

Many scientists and regulators around the Great Lakes have begun work to develop key indicators in order to focus monitoring and improve model accuracy. For example, recent research has tested the use of wetland vegetation as an indicator of ecological condition (Cole 2002; Wilcox et al.2002). Johnson et al. (2007) evaluated plant taxa in 90 U.S. Great Lake coastal-emergent wetlands as potential indicators of physical environment health. The studies showed that using canonical correspondence analysis, the 40 most common taxa indicate that water depth and tussock height explained the greatest amount of species-environment interaction among ten environmental factors. Indicator-species analysis was used to identify species-environment interactions with categorical variables of soil type (e.g., sand, silt, clay, and organic) and hydrogeomorphic type (e.g., open-coast wetlands, river-influenced wetlands, protected wetlands). They conclude that a fuller understanding of how the physical environment influences plant-species distribution will improve the ability to detect the response of wetland vegetation to anthropogenic activities.

Fish community indicators have also been tested. For example, Uzarski et al. (2005) developed a fish-based index of biotic integrity. The relative importance of Great Lake eco-region, wetland type, and plant zonation in structuring fish community composition was determined for 61 Great Lakes coastal wetlands sampled in 2002. These wetlands, from all five Great Lakes, spanned nine eco-regions and four wetland types (open lacustrine, protected lacustrine, barrier-beach, and drowned river mouth). Fish were sampled with fyke nets to determine physical and chemical parameters of inundated plant zones in each wetland. Fish community composition within and among wetlands was compared using correspondence analyses, detrended correspondence analyses, and non-metric multidimensional scaling. They found within-site plant zonation was the single most important variable structuring fish communities regardless of lake, eco-region, or wetland type. In addition, fish community composition correlated with chemical/physical and land use/cover variables.

The valuation of wetlands' ecological services is a relatively recent phenomenon that is hampered by the lack of a "market" for which complex interacting services can be evaluated. The measure of their values can only be obtained through non-market valuation techniques and the effectiveness of these techniques is dependent upon several factors. Brander et al. (2006) collected over 190 wetland valuation studies, providing 215 value observations, in order to present a more comprehensive meta-analysis of the valuation literature that includes tropical wetlands (e.g., mangroves), estimates from diverse valuation methodologies, and a broader range of wetland services (e.g., biodiversity value). They find that socioeconomic variables, such as income and population density, are important in explaining wetland value. Of the various wetland services that they identified, water quality improvement was found to be valued the highest.

In sum, for the Great Lakes ecosystem, wetlands are a crucial component, and there has been progress in how to monitor their quantity and quality and evaluate their economic value. The lack of maturity in the evaluation approaches seems to indicate that social and natural scientists working in this field need to further refine and validate these techniques in order to provide more accurate information.

2.2.6 Climate change

It is scientific consensus that the global warming observed over the past 50 years is due primarily to human-induced emissions of heat-trapping gases. These emissions come mainly from the burning of fossil fuels (coal, oil, and gas), with important contributions from the clearing of forests, agricultural practices, and other activities (U.S. Global Change Program, 2009). Global climate change is having a profound effect throughout the Great Lakes region. Great Lakes temperatures have increased at nearly double the increase in the rest of the country (1.26 degrees from 1895 to 1999), the ratio of snow to total precipitation has decreased, annual snow cover has shrunk, and the freezing of the lakes has started occurring later in the year (Internal Joint Commission, 2003).

Although some caution should be employed when interpreting the results of Global Circulation Models with respect to length scales inherent to modeling the Great Lakes watershed (Xu, 2000; Shackley et. al., 1998; McCormick and Fahnenstiel, 1999; Kumar and Hoerling, 1995), observations are consistent with model predictions for the region that project warmer and probably drier weather during the twenty-first century. The International Joint Commission (2003) has predicted higher spring temperatures (by 9.0 degrees) and summer temperatures (by 7.2 degrees), and associated evaporative increases are to be expected by 2050. Mean annual lake surface evaporation could increase by as much as 39% due to an increase in lake surface temperatures. Evaporative losses will also be affected by predicted declines in the duration of winter ice. Consequently, under future warmer and drier conditions, Great Lakes residents could become more vulnerable to water supply and demand mismatches.

Climate change has influenced both Great Lakes water levels and water quality. Dynamical system effects are likely to accentuate these impacts as a recent study of Lake Superior summer surface water temperatures has shown (Austin and Coleman, 2007). This study shows that over the past 27 years the water temperatures have increased about

4 degrees and are increasing faster than regional air temperatures. Declining winter ice cover, early onset of water stratification (i.e., absence of mixing between surface and deep waters) that lengthens the period over which the lake warms during the summer months, and increased air temperatures are likely causes. Based upon historic records and an adjusted version of Great Lakes Environmental Research Laboratory's large basin runoff model, Croley and Lewis (2006) predict that lake levels in Lake Michigan and Lake Huron could drop to the point that they become terminal lakes (no outflow) through predicted combinations of decreased precipitation and increased air temperature.

The predicted lower water levels and higher temperatures associated with climate change will affect the water chemistry in ways that will likely reduce quality. Higher temperatures will promote more intense and longer duration algae blooms. Lower levels in storage will increase pollutant and waterborne disease concentration, while lower levels in flows will increase local concentrations by reducing transport processes. The net effect is difficult to quantify precisely but most researchers agree that warmer conditions will increase the cost of meeting mandated water quality goals (International Joint Commission, 2003).

Climate-change-associated low lake levels and rising temperatures will likely impact fisheries, wildlife, wetlands, and shoreline habitat in the Great Lakes region (Magnuson et. al., 1997). The associated economic impact is potentially large. Size, quantity, distribution, and range of all current species are likely to change under the effects of model forecasts. Warming water may result in temperatures beyond which certain species can survive. Coldwater species such as lake trout, brook trout, and whitefish, and cool-water species such as northern pike and walleye, could decline. A recent EPA study found that a warming of 4.5 degrees over the next 70 years could cut the habitat of brook, rainbow, and brown trout by one-fourth to one-third throughout the U.S. chum, Chinook salmon, and Coho salmon would experience similar habitat losses (Krantzberg and de Boer, 2006). Warmer temperatures, lower storage, and lower flows will also exacerbate invasive species problems. Warmer temperatures would provide a much more welcoming habitat for zebra mussels because Lake Superior's generally colder water temperatures will increase due to climate change. In addition, with the warming trend, the duration of summer stratification should increase, adding to the risk of oxygen depletion and formation of hypolimnetic anoxia. Higher temperatures over longer periods with shorter periods of colder weather provide adverse conditions for a host of aquatic organisms. This was evident between 1999 and 2002 when a significant outbreak of type E botulism occurred in the eastern basin of Lake Erie (Alben et al., 2006).

Tourism and recreation will also be severely impacted. Lower water levels expose more shoreline, diminish aesthetics, and reduce enjoyment of recreational property. Winters with less ice on the Great Lakes increase coastal exposure to damage from storms. In addition, as lake levels drop, shipping costs in the Great Lakes are likely to increase, along with costs of dredging harbors and channels and of adjusting docks, water intake pipes, and other infrastructure (Kranzberg and de Boer, 2006). The Great Lakes Carriers Association estimates that with a one-inch drop in lake level, a 1,000-foot ship loses 270 tons of cargo capacity (Quinn, 2002). Stepped-up dredging of channels and harbors is often used to increase ship clearance in times of low water, incurring both direct economic costs and environmental costs. Furthermore dredging often stirs up buried pollutants, which may impose additional costs on society. The estimated dredging costs ($US 2000) for a two- to-five-foot drop in water level range from $75 million to $125 million (Great Lakes Regional Assessment, 2000). There will also be significant cost for extending water supply pipes, docks, and storm-water out-falls to the new waterlines.

Climate change and weather variability also pose more direct threats to human health. For example, heavy rainfall has been associated with water-borne disease outbreaks throughout the United States where combined wastewater systems service both public wastewater and drinking water. During periods of heavy rainfall, these systems discharge excess wastewater directly into surface water bodies used to provide public drinking water. Patz et al. (2008) demonstrate the potential effects by using climate models from the U.N. Intergovernmental Panel on Climate Change (IPCC) to simulate the precipitation rate of the 10 wettest days in southern Wisconsin. Their study projects that extreme precipitation events will become 10% to 40% stronger in southern Wisconsin, significantly increasing the potential for the waterborne diseases that often accompany high discharge into Lake Michigan. Using 2.5 in. of daily precipitation as the threshold for initiating combined sewer overflow into Lake Michigan, they expect the frequency of these events to rise by 50% to 120% by the end of this century.

In sum, based on the existing literature, climate change may lead to lower lake levels and water quality, impacts on fisheries and wildlife, changes in Great Lakes shorelines, threats on human beings, and economic cost to tourism and shipping industries. Though uncertainty remains about specific ecological and economic changes that climate change will bring to the Great Lakes region, existing findings can help to guide policy makers to act now and to be better prepared for the future.

2.2.7 Risk of clean water shortage

Over 25 million people in the U.S. rely on the Great Lakes for their drinking water (EPA, 2009). However, water withdrawal in the United States has decreased since 1980 due in large part to improved industrial efficiency. In 2004, water withdrawn from the Great Lakes basin was at a rate of 164 billion liters per day, with 95% being returned and 5% lost to consumptive use. Of the total withdrawals, 83% was for thermoelectric and industrial users and 14% was for public water supply systems (EPA, 2009). Less than 1% of this supply is renewed annually through precipitation, run-off, and infiltration. The net basin water supply is estimated to be 132 billion gallons per day, which is equal to the discharge into the St. Lawrence River.

During the 20th century, Great Lakes water levels have been influenced by several factors including climate variability. Typically, lake levels dropped most dramatically after especially hot years. For example, lake levels dropped dramatically (after achieving record highs in 1986) due to the 1988 drought (International Joint Commission, 2003). Most climate models predict that because of the Great Lakes' significant volatility (increased frequency and duration of low water events), water levels will drop during the next century (Union of Concerned Scientists, 2005).

Groundwater is also an important source of drinking and irrigation water in the region contributing more than half of the flow of streams discharging to the Great Lakes. The predicted increased frequency of droughts and heavy precipitation can reduce recharge in aquifers (especially shallow aquifers). Even if the net precipitation remains the same, the predicted increase in heavy precipitation events can reduce aquifer levels because more of the water will go to runoff before it can percolate into the aquifer (Croley, 2006). In summary, climate change will dramatically affect the Great Lakes and other water resources in the Great Lakes region. It may contribute to lowering lake levels and reducing the surface area of the Great Lakes. Groundwater will also be impacted; aquifer levels and recharge rates are expected to drop.

There are several region-wide policy tools available to manage water resources in the Great Lakes watershed. The 1986 Water Resources Development Act (WRDA) was designed to protect the Great Lakes from diversions within the United States. The statute requires the unanimous approval of the Great Lake States' governors for a proposed diversion and requires unanimous approval of the governors before any Federal agency can even study the feasibility of a Great Lakes diversion. The intent of the law is to leave Great Lake diversion decisions to the states, but it does not provide any policy guidance nor does it have provisions for judicial remedy for challenging governors' decisions (Loe, 2004).

The 1985 Great Lakes Charter has developed into an effective tool to bridge the policy gap of the WRDA. It was originally signed by the Great Lakes states and provinces in 1985 and contains individual commitments to a cooperative process for Great Lakes water management. The key components are: (1) the commitment of the states and provinces to manage and regulate new or increased consumptive uses or diversions of Great Lakes water greater than 2 million gallons per day; (2) the prior notice and consultation procedure with all of the states and provinces for new or increased consumptive uses or diversions of Great Lakes water greater than 5 million gallons per day; and (3) the commitment of the states and provinces to gather and report comparable information on all new or increased withdrawals of Great Lakes water greater than 0.1 million gallons per day. The original conception of the Great Lakes Charter was not sanctioned by the individual state legislatures, and thus had limited legal value. In 2001, the Great Lakes governors and premiers signed an annex to the Great Lakes Charter, commonly referred to as Annex 2001. Annex 2001 reaffirmed the commitments of the 1985 Great Lakes Charter and sets forth a new commitment to develop an enhanced water management system that will incorporate several notable new principles. Among these new principles is the important concept of return flow; that is, requiring diverted water to be returned to its source watershed.

Further, Annex 2001 recognizes that comprehensive water management requires protection of all water-dependent natural resources in the basin, not just the Great Lakes themselves. As a voluntary agreement, Annex 2001 itself is a promise by the states and provinces to develop binding agreements and has no binding legal effect. With climate change and its pressure on water resources, the Great Lakes region needs a more comprehensive water policy for water conservation and aquatic habitat protection.

2.2.8 Vanishing sand dunes

The geomorphologically unique Great Lakes sand dunes are the world's largest collection of freshwater dunes and are home to endemic, rare, endangered, and threatened species; and encompass globally-significant shore-bird habitats. The glaciers and other forces, which brought together stretches of uninterrupted sand with freshwater beaches, grasses, mature forests, and wildlife, will likely never return to recreate this unique environment. They support a variety of plant communities that are used to classify them into four general zones: beach, foredune, trough/swale or interdunal pond, and backdune forest. Nowhere else in the world are there quartz dunes of the size and extent found around the Great Lakes. The temperature of the sand can reach over 100 degrees in the sun, and plants that can survive in such heat must also be able to withstand abrasive winds and the infamous Great Lakes winters.

The Great Lakes sand dunes are ecologically and economically valuable to the region (Lake Michigan Federation, 2009). Ecologically, the dunes are home to diverse and unique wildlife and plant species, proximity to freshwater, and a variety of microclimates. For example, Lake Michigan dunes currently are home to many important plants and animals including: the Piping Plover, a federally endangered bird species that relies on the shoreline for nesting; Houghton's Goldenrod, which is very rare and exists only along the northern shores of Lake Michigan and Huron; Pitcher's Thistle; and the Dwarf Lake Iris, which is Michigan's state wildflower. The dunes also provide shelter for neighboring coastal marshes and the plants and animals that live in them, assist in providing a high quality of life for shoreline communities, and moderate winds and weather from the lake.

Economically, the dunes are significant international attractions that play a large role in maintaining the Lake Michigan region's tourism economy. For example, in 1998 a little over a half a million people visited the lakeshore dunes park P.J. Hoffmaster State Park in Muskegon County. Farther north, Sleeping Bear Dunes National Lakeshore has attracted over a million visitors each year for the last five years. The economic benefits of maintaining ecologically stable sand dunes along the shores of the Great Lakes were documented in a report, *Vanishing Lake Michigan Sand Dunes*, sponsored by the Lake Michigan Federation now the Alliance for the Great Lakes (Alliance for the Great Lakes, 2009). Monetary benefits included total sales in excess of $30 million at Sleeping Bear Dunes National Lakeshore and Indiana Dunes National Lakeshore, with $128 million of annual regional cash flow derived from nearly 2 million visitors per year during the 1990s (Michigan Federation, 2009).

However, Great Lakes sand dunes have undergone significant declines over the past 100 years, as a result of sand dune mining, shoreline development, habitat destruction, and recreational activities on the dunes and adjacent beaches. Great Lakes coastal dune systems are fragile coastal landforms held together by dispersed vegetation that is easily damaged (Peach, 2006). Activities that damage or destroy vegetation on the dunes can initiate an erosion process that can undermine the integrity of the dunes. A study of the effects of pedestrian traffic on the vegetation of Lake Huron sand dunes at the Pinery Provincial Park documented the impact of trampling throughout the dunes (Peach, 2006). It was determined that in the absence of a recovery period, dune species can be seriously affected by prolonged exposure to pedestrian traffic. Invasive species such as Mustard Baby's Breath (eastern Lake Ontario Dunes) on Lake Michigan can also rapidly spread if not controlled in dune areas. In areas where sand is less abundant such as eastern Lake Ontario, dunes are threatened by sand starvation. According to the Lake Michigan Federation's report, sand dune mining is a significant threat to the dunes. Mining the dunes is not complicated and has a permanent and devastating effect on dune ecosystems. Foundries account for 95% of sand mined from Lake Michigan, and the remaining 5% is used for other commercial purposes -glassmaking, concrete products, sandpaper and other abrasives, drywall, snow and ice control, and for use in golf courses.

Currently, Michigan's Sand Dune Protection and Management Act of 1976 is not enough to protect dunes (Lake Michigan Federation, 2009). For Lake Michigan, there were 15 active mining sites, totaling 3,228 acres in 1976. In 1999, active mining sites increased to a total of 20, covering a total area of 4,848 acres. Dunes continue to disappear at a rapid rate, with a total of 46.5 million tons of sand extracted since the law was passed. In addition, the mining cost for most dune sand is for just $5-to-$10 a ton despite the fact that the dunes are an irreplaceable natural resource and contribute significantly to Michigan's tourist economy (Lake Michigan Federation, 2009). Thus, the cost of the sand does not reflect the true value of the beaches to society, and therefore is inefficiently over-mined.

2.2.9 Population overcrowding

In recent years, the Great Lakes Basin population has seen very little growth relative to the rest of the U.S. and Canada. While the combined population of the U.S. and Canada grew by 22% from 1970 to 1990, rising from 225 million to 275 million, the population (Canadian and U.S.) of the Great Lakes Basin grew by less than 1%. This indicates redistribution in regional economic activity with older, industrialized regions losing population to newer, expanding regions (primarily the south and southwest.) Climate-influenced retirement moves have added to the outbound numbers (EPA, 2009).

Urban population growth in the Great Lakes basin is faster and shows consistent patterns in both the United States and Canada. From 1996 to 2006, the population of

Canadian metropolitan areas of the Great Lakes basin grew from over 7 million to over 8 million, an increase of 16.3%. From 1990 to 2000, the population of United States metropolitan areas of the Great Lakes basin grew from over 26 million to over 28 million, an increase of 7.6%. The resulting urban sprawl is placing a strain on infrastructure and consuming habitat in areas that previously tended to have healthier environments than those in urban areas. This trend is expected to continue (EPA, 2009) and is an important point to consider. Even though the overall population of the Great Lakes region may be stabilizing, this increasing urbanization coupled with a society that is trending toward over-consumption may lead to significant stress on natural capital. This notion is a likely direction for future study into methodologies through which debit for the depletion of natural resources can be included in important economic measures such as Gross Domestic Product.

2.3 Discussion

It bears repeating that the Great Lakes and associated watershed are one of the most recognizable geographic features in the entire world, and a unique and valuable resource. It is also clear from decades of research that the region is ecologically, economically, and socially complex. This size and complexity challenges our abilities to capture data, process information, and model the interactions between the ecology, economy, and society. It also represents a unique opportunity. There are very few places on the earth where the forces that drive these complexities are more prevalent. The pristine beauty of the upper peninsula of Michigan, the muscular industry of places like Chicago, Illinois, and the effects of global climate change are all reflected in the waters and ecosystems of the Great Lakes basin. The following chapter is aimed at establishing a methodology and framework through which this complexity can be understood and managed.

Chapter 3: Focus Groups: Development, Implementation, and Results

3.1 General overview of focus groups

Focus groups are discussions held with small groups of people of a specific type; in our case, members of the general public living in Grand Rapids, a medium-sized city in Michigan.[1] This study only investigated the western shore of lower Michigan and the associated natural resources of Lake Michigan. There were four focus groups with a total number of 46 individuals participating. Our focus groups had four objectives. The first was to obtain qualitative and some quantitative information regarding environmental stressors, especially the public's attitudes, concerns, and preferences towards them. The second was to prioritize environmental and ecological services that are valued by the public. The third was to develop criteria for evaluating the future development of the assessment area's natural resources by policymakers and government agencies. The final objective was to assess the effect of any action on the quality of life of the public as expressed by carrying capacity.

However, there are several points about focus groups that should be mentioned before beginning the discussion of the results. This is a pilot study, and as such the sample size is relatively small. Therefore, opportunities for statistical inference and hypothesis testing may be limited. Moreover, statistically significant differences in variable values and the importance of covariates may not be detected, whereas a much larger sample size might reveal statistical differences. The focus group sample is not

[1] The protocol approval number for a study involving human subjects from the Office of Research Integrity and Compliance at Michigan Technological University is M0349.

random in a rigorous sense, but is not intended to be so. Although the survey research firm that recruited the sample ensured that it was highly diverse in terms of key socioeconomic and demographic variables, the sample is not truly random in the statistical sense. Therefore care must be taken in extrapolating results to the population. Finally, the study is a pilot study that examines one small part of the Great Lakes Environment. The focus-group results reflect the attitudes, awareness, opinions, and preferences of the residents of Grand Rapids. If the study were repeated in Detroit, or in another city in another state, there would probably be significantly different results. In spite of these limitations, this study provides an excellent starting point for similar survey efforts conducted on a larger scale.

3.2 Implementation of focus groups

A professional survey agency in Grand Rapids MI, Advantage Research, Inc., was enlisted months in advance to recruit the sample, comment on draft final focus group materials, and organize the implementation of the focus groups. The information from the focus groups was gathered using a repeated format. First, visual material was presented for respondents to consider. Next, written responses were solicited from them; and finally, oral discussions followed. This format was repeated multiple times with written materials (presented in the Appendix) and verbal protocols, which are simply formal ways of asking and following up on specific questions. Raw data from those written instruments were coded electronically, and statistical and other analyses were conducted with over a hundred numerical and textual variables. The team also reviewed videos of the focus groups on DVDs to identify key themes that might not be immediately evident by only examining the written data.

3.3 Analysis of focus group data

Written material was organized into five parts based on the objectives. Part A assessed the relative importance of environmental and non-environmental policy topics. Part B explored direct, active uses of natural resources through recreational experiences. Part C investigated public awareness of environmental stressors in the assessment area. Similarly, Part D investigated public concern and willingness to act through financing projects in the assessment area. Lastly, Part E collected typical demographic and socioeconomic information. Therefore, the results from the survey reflect the attitudes, awareness, opinions, and preferences of the public.

3.3.1 Part 1 – Important policy issues

Respondents were asked an open-ended question about the most important environmental issues in their area. Results reported in Table 3.1 represent the number of times each stressor was reported at each rank level. Although this question was asked before any respondents were exposed to the list of nine stressors, all nine were mentioned at least

Table 3.1 Question: Please list three or four of the most important environmental issues in your area, and rank them in order of importance.					
Category	**First**	**Second**	**Third**	**Fourth**	**Total**
Clean water depletion	20	5	2	1	28
Pollution	5	8	10	1	24
Agricultural degradation	5	6	2	1	14
Recycling	3	6	4	0	13
Energy	4	3	2	1	10
Recreational degradation	2	3	3	0	8
Loss of wetland	3	4	0	0	7
Climate change	0	1	4	0	5
Trees	1	0	2	2	5
Population	2	2	0	0	4
Invasive species	1	1	0	0	2
Fishery	0	1	0	0	1
Vanishing sand dunes	0	0	1	0	1
Noise	0	0	1	0	1

once by respondents. This consistency reflects considerable alignment between the preferences of the public and formal natural resource stakeholder groups. The top two stressors, clean water depletion and pollution, were listed by over half of respondents. Even though the environment may not be as important as other policy issues, respondents are nonetheless able to meaningfully discuss and rank the importance of environmental stressors.

3.3.2 Part 2 – Recreational activity

Respondents were asked about the frequency of doing each of activities listed in Table 3.2 within a one-hour drive of their homes. Over half of the sample respondents participated in all of the above activities at least "a few times" in 2009, except hunting,

Table 3.2 Question: How often do you personally do each of the following activities within a one-hour drive of your home?					
Category	**Frequency[a]**				
	1 Never	**2 A few times**	**3 Once a month**	**4 Once a week**	**5 Several times a week**
Fishing	43%	35%	11%	2%	9%
Boating	37%	22%	13%	20%	9%
Bird watching	7%	33%	7%	11%	43%
Picnicking	30%	28%	24%	7%	11%
Hunting	82%	7%	2%	4%	4%
Walking	2%	11%	9%	17%	61%
Driving	2%	36%	27%	20%	16%
Participating in winter sport	17%	30%	20%	22%	11%
Other	9%	28%	12%	16%	35%

Question B2: Specific activities included in "other" and times listed.					
Visiting park	Swimming	Camping	Shooting	Playing ball games	Visiting beach
11	15	8	2	13	9

a. Detail may not sum to 100% due to rounding.

which is seasonal and gear-intensive. Non-extractive activities, where the respondent does not take anything from the environment, were the most popular with 61% of the sample walking several times a week, 43% participating in bird watching, and 35% participating in other non-extractive activities. Approximately 57% of the sample fished at least "a few times" while over 10% fished at least "once a week."

The respondents who are avid recreationists have much direct experience with the natural environment through these activities. There is weak positive correlation between recreational activity levels and awareness of all stressors (0.08) and between activity levels and concern for all stressors (0.04); there is weak positive correlation between recreational activity and awareness of stress on recreation resources specifically (0.05), but a much higher and statistically significant positive correlation between recreational activity and concern about the stress on recreational resources specifically (0.24). Not surprisingly, awareness and concern tend to be higher for stressors that affect resources with which the public has direct contact, and for stressors where changes in policy will have an immediate effect on the public.

3.3.3 Part 3 – Awareness

Respondents were asked a question about whether or not they have heard, seen, or read about each of the nine stressors in their areas as shown in Table 3.3. This is the first time respondents were presented with the list of nine stressors. The responses to the list shows their relative awareness of the nine stressors. For most stressors, most respondents have “never” or only “maybe” heard of them. There is highest awareness of pollution/contamination and invasive species, which were “definitely” heard of by about two-thirds of the respondents. At the same time, the lowest awareness is of risk of vanishing sand dunes, clean water shortage and population overcrowding, which were “never” heard about by over half of the respondents.

However, most people mentioned “clean water depletion” as the most important environmental issues in Table 3.1, which is an apparent inconsistency. We infer that people are afraid that water is going to be “mined” by an outside source, even though the threat has not emerged yet; this was supported by oral comments during the focus groups, so the apparent inconsistency is not really an inconsistency. The top number shown in

Table 3.3 Question: Have you heard, seen, or read about any of the following issues in your area?						
		Frequency[a]				
Stressor category	NOBS[b]	1 Never	2 Maybe	3 Definitely	Mean	Standard Error
Pollution and contamination	45	9%	22%	69%	2.60	0.097
Non-native species	43	19%	19%	63%	2.44	0.121
Agricultural erosion	42	19%	29%	52%	2.33	0.121
Climate change	45	16%	36%	49%	2.33	0.110
Loss of wetlands habitat	45	18%	44%	38%	2.20	0.108
Degraded recreational resources	44	39%	41%	20%	1.82	0.114
Vanishing sand dunes	45	53%	27%	20%	1.67	0.119
Risk of clean water shortage	46	57%	28%	15%	1.59	0.110
Population overcrowding	46	57%	33%	11%	1.54	0.102
a. Detail may not sum to 100% due to rounding. b. Number of observations.						

each cell of Table 3.6 (p. 47) shows that awareness varies significantly across the nine stressors based on comparisons using two-sample tests of means.[2]

Moreover, the respondents were asked about their preferred media for getting information about environmental issues. Results show that respondents get information

[2] A two-sample test of means (using sample standard distributions and t-statistics) tests the null hypothesis that the means of two independent random variables are the same and come from the same underlying distribution. In these survey questions, the probability density functions of response variables cannot be normally distributed because there is a finite number of responses categories in each of them (e.g., the integers one through five), and the domain of any normally-distributed variable is negative infinity to positive infinity. However, under standard probability theory, with sufficiently large sample sizes, conditions for the central limit theorem (CLT) to hold usually exist. One of the key assumptions is that the distribution of the mean is identical across the nine stressors for each question type. If the CLT holds, the mean of independent draws of a random variable, such as the mean response to a survey question, will be approximately normally distributed. The two-sample tests of means in this chapter assume normality. Whether the sample size (NOBS=46) is "sufficiently large" may come into question, but it is assumed that the CLT holds here anyway.

about environmental stressors from all major media sources, including newspapers, television, radio, Internet, and magazines. They also get information from family, friends, and colleagues. Respondents are mostly satisfied with the availability of current outlets, but over half of the respondents would prefer to get more information about the natural environment, and almost a fifth would "maybe" prefer to get more information.

3.3.4 Part 4 – Concern and Actions

One of the questions in Part 4 is about how concerned people are about the nine stressors. The results are shown in Table 3.4. For most stressors, most respondents are not very concerned and reported "not at all" "slightly" or "moderately" concerned. However, the highest concern is for pollution/contamination: over three-fourths were "very" or "extremely" concerned. This is consistent with people's awareness. At the same time, the lowest concern is for risk of clean water shortage, vanishing sand dunes, and population overcrowding, which over half of the respondents are "not at all" or "slightly" concerned.

Again, for the clean water shortage, we find an apparent inconsistency with the results shown in Table 3.1. This result is possibly because respondents do not think the risk of clean water shortage is an immediate problem for them, but may emerge as a serious problem due to ongoing discussions in the media that non-Great-Lakes states would like to use the Great Lakes as a source of potable water.

Climate change is a very important stressor according to the literature review; however, it receives much less concern in the results of the survey than might be expected. Many people do not understand how their present and future lives are related to the influence of the climate change, especially when effects are far into the future, or they

Table 3.4 Question: How concerned are you about any of the following environmental issues?								
		Frequency[a]						
Stressor category	**NOBS[b]**	**1 Not at all**	**2 Slightly**	**3 Moderately**	**4 Very**	**5 Extremely**	**Mean**	**Std. error**
Pollution and contamination	44	2%	7%	15%	54%	22%	3.91	0.120
Agricultural erosion	40	4%	13%	30%	41%	11%	3.41	0.148
Non-native species	37	11%	16%	18%	37%	18%	3.34	0.192
Degraded recreational resources	43	4%	24%	24%	38%	9%	3.22	0.159
Loss of wetlands habitat	43	7%	16%	40%	27%	11%	3.20	0.158
Climate change	42	11%	23%	25%	20%	20%	3.14	0.202
Risk of clean water shortage	41	28%	20%	22%	22%	9%	2.63	0.197
Vanishing sand dunes	36	20%	31%	29%	16%	4%	2.53	0.167
Population overcrowding	44	41%	15%	33%	9%	2%	2.15	0.167

a. Detail may not sum to 100% due to rounding.
b. Number of observations

do not believe that their personal actions can make a difference. Moreover, many people still do not believe that the climate change is even happening. As such, their concern, and their willingness to act in the next section, seem relatively low for this stressor. This study is certainly not the first to find such a conclusion. For example, based on a 2010 survey conducted by Pew Research Center among a national sample of 2,251 adults who live in the continental United States, the group who believes anthropogenic climate change is occurring (34%) is almost identical in size to the group who believes that there is no global warming at all caused by any sources (32%). Also, the trend over time in this study going back to 2006 is that fewer people believe each year in most scientists' conclusion that human-caused climate change is occurring now, and will ultimately have devastating impacts on the natural environment. Educating the public about climate change should be a top priority for outreach efforts by stakeholders.

The middle number in each cell of Table 3.6 indicates that statistically, concern varies significantly across the nine stressors. This is based on comparisons using two-sample tests of means, the same way and with similar results as the top number on awareness.

Table 3.5 and the bottom number in each cell of Table 3.6 report the preferences for allocating financial resources to address environmental issues. Not surprisingly, awareness and concern scores tend to be higher overall than responses to questions including a monetary element. Again, preferences vary significantly across the nine stressors based on comparisons again using two-sample tests of means. Most respondents think that the same amount or more money should be spent on most stressors. The highest willingness is to take action for pollution/contamination; 89% of respondents think financial resources should be allocated to address this stressor. Meanwhile, the lowest willingness is to take action for population overcrowding, which 41% of respondents think resources should "never" be allocated to address, and 50% think that resources should only "maybe" be allocated to address. Again, these results match the results for awareness and concern, although awareness and concern ratings tend to be more extreme.

Another question in Part 4 also asks about who is responsible to pay for addressing environmental issues. Most respondents (25 out of 46) accept accountability for helping to pay for reducing environmental stress. However, an even larger number, at least 27 out of 46, believe that local, state, or federal governments should pay. Moreover,

Table 3.5 Question: If money were available, actions could be taken to address these environmental issues. However, there will never be enough money to do everything. Please tell us your preferences on the following actions?						
Stressor category	**NOBS**[b]	**Frequency**[a]			**Mean**	**Std. error**
		1 Do less, spend less	2 Do the same as usual	3 Do more, spend more		
Pollution and contamination	44	2%	9%	89%	2.86	0.062
Agricultural erosion	40	10%	33%	58%	2.48	0.107
Degraded recreational resources	43	2%	47%	51%	2.47	0.084
Non-native species	37	3%	49%	49%	2.43	0.091
Loss of wetlands habitat	43	5%	56%	40%	2.35	0.087
Risk of clean water shortage	41	22%	41%	37%	2.15	0.119
Climate change	42	24%	52%	24%	1.98	0.105
Vanishing sand dunes	36	25%	56%	19%	1.92	0.102
Population overcrowding	44	41%	50%	9%	1.66	0.092

a. Detail may not sum to 100% due to rounding.
b. Number of observations

companies who cause pollution are mentioned frequently. Twelve out of forty-six respondents made comments about placing the responsibility on industry.

In Table 3.6, the figures in the top, middle, and bottom of each cell show the t-statistics for two-sample tests of mean of differences in awareness, concern, and willingness to take action respectively. A positive value means the column stressor mean is greater than the mean of the row stressor while a negative value means row stressor mean is greater than column one; the larger the absolute value of each figure, the more difference there is between the two stressors. A value of two or higher in absolute value indicates a statistically significant difference. Consider pollution/contamination, for example. All of the column values are positive, which means pollution/contamination is more important than any of the other eight stressors when comparing people's awareness, concern, and willingness to take action. The largest absolute value, 21.1, is the result of the comparison of pollution and population overcrowding in terms of taking action. Also, a value of 13.2 in the cell that tests the mean of pollution and climate change indicates climate change is much less important. Additionally, most of the figures in the climate change row (second from the bottom) are positive, which means most stressors are more important to people than climate change, emphasizing the need for more understanding on the part of the public with respect to climate change if significant action is to ever be supported by the public.

3.3.5 Part 5 – Socioeconomic and demographic variables

The results from Part 5 show that there is considerable variation across respondents in terms of age, income, education, employment, political affiliation, gender, and ethnicity. The distribution of our demographic variables demonstrates that the sample is representative of the population.

Moreover, each respondent in the focus group was given some sticky dots with different colors depending on their educational background. They were asked to put the dots in the stressor field that they cared about most. The results show that regardless of education background, reducing pollution and contamination is what they considered to be the most important stressor to address first. These results are consistent with the previous findings. However, respondents who are better educated (those who have received their master's degree or higher) care more about controlling invasive species while others care more about protecting wetlands and wildlife habitat. Again, climate

Table 3.6

T-statistics for two-sample tests of means of differences in <u>awareness, concern and willingness to take action</u> across stressors (mean from Table 3.3, Table 3.4 and Table 3.5)[a]

	Pollution and contamination	Risk of clean water shortage	Loss of wetlands habitat	Agricultural erosion	Non-native species	Population overcrowding	Degraded recreational resources	Climate change	Vanishing sand dunes
Pollution and contamination									
Risk of clean water shortage	9.784[b] 4.535[b] 9.051[b]								
Loss of wetlands habitat	8.329[b] 3.387[b] 9.741[b]	-5.382[b] -1.861 -2.062[b]							
Agricultural erosion	2.394[b] 2.392[b] 5.799[b]	-5.957[b] -2.684[b] -2.843	-1.088 -0.958 -1.466						
Non-native species	1.405 1.236 8.362[b]	-6.775[b] -1.951 -2.803	-1.958 -0.740 -1.170	-0.799 -0.156 0.482					
Population overcrowding	11.152[b] 7.790[b] 21.063[b]	0.369 1.564 4.776[b]	6.247[b] 4.152b 9.220[b]	6.809[b] 5.279[b] 9.044[b]	7.674[b] 3.506[b] 10.156[b]				
Degraded recreational resources	7.401[b] 3.159[b] 7.946[b]	-1.942 -1.925 -3.343[b]	3.282[b] -0.093 -1.711	4.022[b] 0.853 0.119	4.833[b] 0.676 -0.487	-2.494[b] -4.217[b] -11.178[b]			
Climate change	2.601[b] 2.675[b] 13.211[b]	-6.446[b] -1.337 1.491	-1.179 0.207 4.354[b]	0.000 0.944 4.888[b]	0.865 0.760 5.184[b]	-7.383[b] -3.040[b] -3.542[b]	-4.355[b] 0.278 5.906[b]		
Vanishing sand dunes	8.325[b] 3.871[b] 13.734[b]	-0.637 -0.106 1.891	4.348[b] 1.537 4.827[b]	4.952[b] 2.258[b] 5.179[b]	5.725[b] 1.705 5.620[b]	-1.058 -1.462 -2.739[b]	1.183 1.595 6.348[b]	5.352[b] 1.114 0.558	

a. A positive value means column stressor mean is greater than row stressor mean; a negative value means row stressor mean is greater than column stressor mean.

b. Indicates means are different at a 5% level of significance.

change did not get much attention, and results did not vary by education or other socioeconomic variables.

3.4 Discussion

Education about environmental issues leads to awareness, concern, and ultimately value of the Great Lakes environment for the public. Natural resource managers should consider this when undertaking outreach efforts. Respondents seemed to care about future generations in their verbal comments, but also seemed to lack a complete understanding of how current stressors affect the future. As a result, climate change received as little concern as population overcrowding, although both of these stressors are linked to many others, and can seriously exacerbate them, especially over long periods of time.

Based on respondent comments, respondents are most concerned about stressors that may affect their direct, active use of the resources, specifically through pollution/contamination, but also including recreation degradation. Meanwhile, there is a pervasive lack of concern for problems that are not perceived as immediate, or for which immediate action does not lead to immediate results, including climate change.

Pollution/contamination is clearly the most important stressor, based both on the survey results and the literature. In the literature review, we see that PCBs have made their way into food sources of fish, and runoff has seriously affected the Great Lakes water clarity. The government has already taken some measures to solve the problem; however, the Great Lakes is still a receptor of multiple pollutants, and work over a long period is necessary to address this. People can see the influence of pollution in their daily lives the most clearly.

Following completion of this pilot study, a large-scale survey could be undertaken, on the basis of focus group results, which would consider a larger geographical area than Grand Rapids and the western shores of Lake Michigan. A larger-scale survey would be designed to be random with a substantially larger sample in order to be statistically defensible and sufficient for hypothesis testing. This survey effort would focus on environmental stressors that are of most importance to the public as well as important to specific natural resource stakeholders. The study would examine how regional preferences may differ from those in this study's assessment area. A utility-theoretic model could be developed with the goal of estimating marginal utilities for programs of different types and scales, and thus the public's marginal rate of substitution between the programs. That simply means that, using econometrics, the rate at which people are willing to trade off environmental programs (or willing to pay for programs) can be measured statistically. The ultimate goal would be to propose suites of programs that would have the largest net benefits for society while keeping with the programmatic goals of natural resource managers and Trustees.

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Appendix: Survey instruments

Handout A
Introduction

A1 I'd like to get your opinion on some issues affecting Michigan and your area. How important to you are these following actions that could be taken in your area?

	Not at all important	Slightly important	Moderately important	Very Important	Extremely important	Not sure
Make state and local government more efficient	1	2	3	4	5	9
Encourage economic growth and jobs in your area	1	2	3	4	5	9
Management of environmental resources in your area	1	2	3	4	5	9
Improve schools in your area	1	2	3	4	5	9
Reduce crime in your area	1	2	3	4	5	9

A2 Which **<u>ONE</u>** of these actions is most important to you, and why?

____

____

____

We will be asking questions about the management of the natural environment within a one-way one-hour drive from your home in order to enhance your quality of life. You don't need any special knowledge or expertise - everyone's opinion is important, so please answer the questions to the best of your ability.

A3 Please list three or four of the most important environmental issues in your area, and rank them in order of importance (1=most important, 2=second most important, etc.)

____

____

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(Please Wait for Further Instructions to Continue)

Handout B
Recreation Experience

In this section we want to learn more about your interest in and experience with natural resources within one-way one-hour drive of your home.

B1 In 2009, how often have you personally done each of the following activities within a one-hour drive of your home? (Circle one for each item)

	Never	A few times	Once a month	Once a week	Several times a week
Fishing	A	B	C	D	E
Canoeing, motorized boating, kayaking, or sailing	A	B	C	D	E
Watching birds or wildlife	A	B	C	D	E
Picnicking	A	B	C	D	E
Hunting	A	B	C	D	E
Walking, biking or jogging	A	B	C	D	E
Car trip	A	B	C	D	E
Winter related activities	A	B	C	D	E
Other outdoor recreational activities	A	B	C	D	E

B2 What are the other outdoor recreational activities you have personally done?

____

____

____

The following questions are about your **<u>FAVORITE</u>** local **<u>OR</u>** regional destination for outdoor recreation within a one-way one-hour drive of your home.

B3 What is your favorite local or regional destination for outdoor recreation? Where and what type of site is this? (Please mark this site on at least one of the maps on the next pages)

____

____

____

B4 What do you do there?

____

____

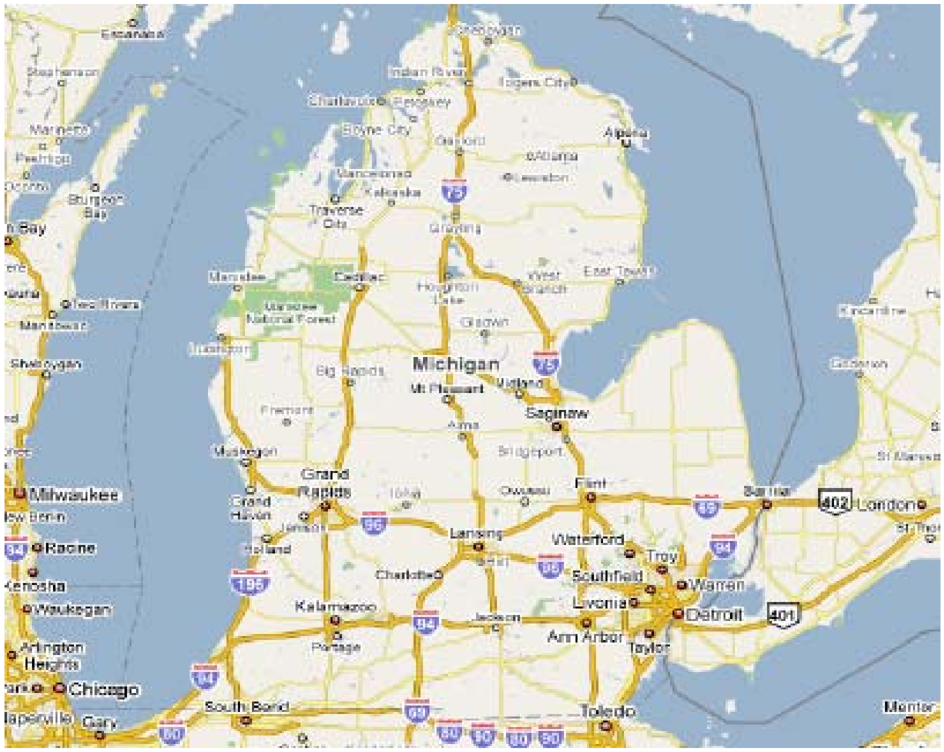
B5 How many driving miles is it one-way from your home?_________________________

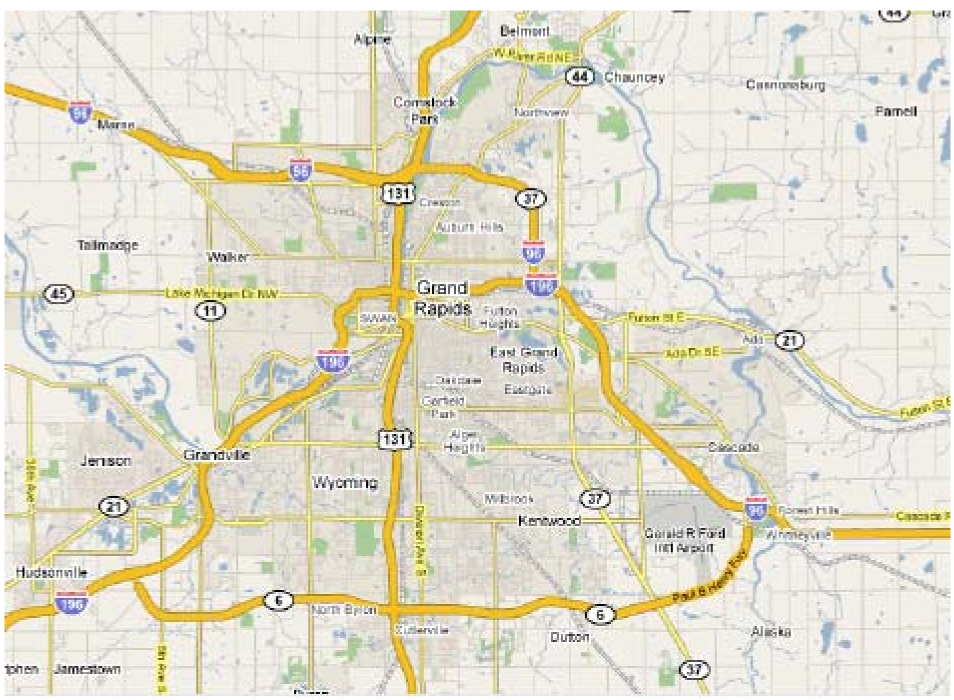
B6 How many times have you been to **<u>THAT</u>** site in 2009 so far?_____________________

B7 Why is this your favorite site?

____

____





(Please Wait for Further Instructions to Continue)

Handout C

Awareness of Environmental Issues

In this section we want to learn more about your awareness of the following environmental issues in your area.

C1 Have you seen, heard or read about any of the following issues in your area? (Circle one for each item)

	Never	Maybe	Definitely
Pollution and contamination of natural resources	1	2	3
Risk of drinking water shortage	1	2	3
Loss of wetlands and wildlife habitat	1	2	3
Erosion or other reduction of productive agricultural land	1	2	3
Non-native animals or plants like zebra mussels	1	2	3
Population overcrowding	1	2	3
Degraded recreational resources	1	2	3
Climate change	1	2	3
Vanishing sand dunes from sand use for industry	1	2	3

C2 Where did you get the information? (Circle all items applied, and specify sources)

1. Newspaper ________________________
2. Radio ____________________________
3. Internet ___________________________
4. Magazine __________________________
5. Friends and family__________________
6. Other_____________________________

C3 Would you like media sources (for example, newspapers or talk radio) to provide more information than you already receive about the natural environment and the stress that can be caused by human use?

1. Yes
2. No
3. Maybe, explain__________________________

C4. If yes, how would you **PREFER** to receive this type of information?

1. Newspaper _________________________
2. Radio _____________________________
3. Internet ___________________________
4. Magazine __________________________
5. Friends and family___________________
6. Other______________________________

(Please Wait for Further Instructions to Continue)

Handout D

Concerns and Actions about Environmental Issues

In the previous section, we learned about your awareness. Now, this section, we want to learn more about your **CONCERN** for these environmental issues in your area.

D1 How concerned are you about any of the following environmental issues? (Circle your best answer)

	Not at all concern	Slightly concern	Moderately concern	Very concern	Extremely concern	Not sure
Pollution and contamination of natural resources	1	2	3	4	5	9
Risk of drinking water shortage	1	2	3	4	5	9
Loss of wetlands and wildlife habitat	1	2	3	4	5	9
Erosion or other reduction of productive agricultural land	1	2	3	4	5	9
Non-native animals or plants like zebra mussels	1	2	3	4	5	9
Population overcrowding	1	2	3	4	5	9
Degraded recreational resources	1	2	3	4	5	9
Climate change	1	2	3	4	5	9
Vanishing sand dunes from sand use for industry	1	2	3	4	5	9

We also want your preferences about management options to address environmental issues.

D2 If money were available, actions could be taken to address these environmental issues. However, there will never be enough money to do everything. Please tell us your preferences on the following actions. (Circle one for each item)

	Do less, spend less	Do the same as usual	Do more, spend more	Not sure
Control invasive species	1	2	3	9
Reduce pollution and contamination	1	2	3	9
Reduce risk of water shortage	1	2	3	9
Protect wetlands and wildlife habitat	1	2	3	9
Enhance the availability of agricultural land	1	2	3	9
Address population overcrowding	1	2	3	9
Maintain the quality of recreational resources	1	2	3	9
Control climate change	1	2	3	9
Stop sand dune mining	1	2	3	9

D3 Please rank the following management actions in terms of importance in your area from one to nine with **<u>ONE</u>** being the most important

	Rank
Control invasive species	
Reduce pollution and contamination	
Reduce risk of water shortage	
Protect wetlands and wildlife habitat	
Enhance the availability of agricultural land	
Address population overcrowding	
Maintain the quality of recreational resources	
Control climate change	
Stop sand dune mining	

D4 Are there any other environmentally related concerns or issues that are not mentioned above but that you think are important?

____

____

____

____

____

D5 Whom do you think should pay for addressing environmental issues? (Circle all items that apply)

1. Taxpayer
   a. Myself
   b. Other people who use the resources

2. Government
   a. Local government
   b. State government
   c. Federal Government

3. Industry
   What companies?____

D6 Why did you answer D5 the way you did?

____

____

____

____

____

(Please Wait for Further Instructions to Continue)

Handout E

Demographic Information

E1 Are you registered to vote in Michigan?

1 Yes
2 No

E2 Which category best describes your age? (Read list and circle the number that applies)

1 18-25 years
2 26-35 years
3 36-50 years
4 51-65 years
5 Over 65 years

E3 Which of the following categories best describes your total annual household income in 2008?

1 Under $24,999
2 $25,000-$49,999
3 $50,000-$74,999
4 $75,000-$99,999
5 $100,000 or more
88 Don't know
99 Refused/confidential

E4 What is your highest level of education?

1. Some school
2. High school graduate
3. Some college
4. Bachelor's degree
5. Graduate studies

If 4 or 5, where did you obtain your highest degree?

____

E5 Last month, were you employed for pay or profit? (Circle all that apply.)

1 Yes — Which category best describes your employment status?
  1 Full time
  2 Part time
2 No — Which category best describes you?
  1 Student
  2 Retired
  3 Homemaker
  4 Looking for work
  5 Other (please specify ___________________________________)

If employed, what is your current occupation and for whom do you work? What kind of work is that?

Occupation:____

Employer:____

.

E6 Are you or any member of your household a member of a labor union?

1 Yes
2 No
3 Don’t know/na

If yes, what is the name of union:____

E7 Generally speaking, do you usually think of yourself as a Democrat, a Republican, an independent or what?

1 Strong Democrat
2 Not so strong Democrat
3 Independent/Lean Democrat
4 Independent
5 Independent/Lean Republican
6 Not so strong Republican
7 Strong Republican
8 Don’t know/na

E8 Did you vote in last November presidential election?

1 Yes
2 No

E9 Have you volunteered time or donated money to a natural resources organization in the last year?

1 Yes What organization?___________________________
2 No
3 Don't know/na

E10 What is your gender?

1 Male
2 Female

E11 Which ethnic group do you identify yourself with?

1 White
2 African-American/Black
3 Asian
4 Latino/Hispanic
5 Other
99 Refused/confidential