FRESHWATER RESOURCES:
AN EVALUATION OF MICHIGAN RESIDENTS' PERCEPTION OF WETLAND ECOSYSTEM SERVICES

By

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ABSTRACT

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Freshwater is an essential natural resource, and the Great Lakes' ecosystem is a natural resource for millions of people. Any ecosystems' health and integrity are dependent upon both water quality and quantity. Pollution, among other anthropogenic activities, continues to threaten these vital water supplies. The unrelenting drainage of wetlands has also exacerbated the problem. Current scientific research has established the crucial role that wetlands play in the overall welfare of the entire Great Lakes region. Environmental concerns regarding wetland abatement have prompted the creation of several national and international protocols to protect wetlands. Even though laws are mandating such safeguards, wetland degradation remains part of a global problem.

Thus, this research serves two purposes: (1), to gather information about Michigan residents' overall knowledge of wetlands ecosystems; (2), to establish whether residents can accurately distinguish between wetland functions and values. Two activities: semi-structured focus group interviews and online digital card sorts were conducted within Chippewa, Huron, and Macomb Counties of Michigan, to evaluate individuals' environmental perceptions of wetland ecosystems.

In the end, these activities revealed that residents do have some knowledge of wetland ecosystems, but the accuracy of participants in differentiating between functions and values was less than optimal, averaging only around 60% accuracy. In closing, this research provides empirical evidence to support, and recommend additional wetland research within the state to address misunderstandings, and educate residents about wetland ecosystems in the Great Lakes region.

This thesis is dedicated to my family, friends, and Michigan residents, who graciously accepted the tasks and challenges throughout the gathering and collating of this research. I am eternally grateful for all your support and kindness throughout this long, and at times, arduous process.

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Though a thesis bears the name of a single student, the overall process that leads to its defense is accomplished in conjunction with the dedicated work of many other people. I wish to extend my deepest appreciation to these people. Starting with my committee chair, Professor Raechel White, for her unwavering support throughout this remarkable experience. She has the patience of a saint and an intellect far beyond my wildest expectations.

In addition, I must recognize my other committee members and offer my heartfelt thanks to them. Professor Nathan Moore and Professor Gail Vander Stoep, both of whom provided continued guidance and encouragement during this incredible journey. I would also like to offer my sincerest gratitude toward Michigan State University, the College of Social Science, and the Graduate College. To the Department of Geography, Environment, and Spatial Sciences for the freedom to pursue my dreams of becoming a Human and Environmental Geographer, who focuses primarily on water resources, sustainability, and biomimicry. With a special salute to Professor Ashton Shortridge for allowing me the opportunity to prove my worthiness, even after missing the application deadline; and to Sharon Ruggles for being kind and patient with my naïveté of graduate school procedures.

I graciously thank the Rose Graduate Fellowship Fund in Water Research for the opportunity to represent their excellence. This Fellowship afforded me the chance to spend additional time in the field gathering vital research data. For this, I will be eternally grateful and always cherish this opportunity to delve into the minds of Michigan residents regarding freshwater resources.

An expression of thanks must be shared with Professor Michael T. Vollbach, who has been my confidante since the beginning of my college career. He has always offered the hard-nosed advice that kept me from surrendering to my insecurities, and for that, I will be indebted to him forever.

I would also like to take a moment to posthumously acknowledge my mentor and greatest ally in my pursuit of education: Professor Chris Mayda, who gave me the confidence to remain bold and push the envelope whenever possible. She showed me that giving up is not an option and that becoming an educator is, and always has been, my destiny. She is sorely missed but will be forever present throughout my educational and professional endeavors.

I owe a major debt of gratitude to every Michigander, who took the time to listen and participate in this thesis research. What a great group of people to have shared this experience with!

Lastly, but, certainly, not least, I must recognize my family, friends, and proofreaders for always supporting me and putting up with my craziness during this tough, but fulfilling journey.

I know there are many others to show my appreciation to, but this would go on and on; nevertheless, thank you all very much! This experience forever changes me.

PREFACE

This thesis is being submitted for a Master of Science in Geography degree at Michigan State University. The research described herein was authorized by the Institution Review Board (IRB) as of July 2016 and was composed under the supervision of Professor Raechel White from the Department of Geography, Environment, and Spatial Sciences at Michigan State University, between July 2016 and July 2017.

This work is to the best of my knowledge, intellectually original and independently completed by the author, Toni Anne Walkowiak, except for where acknowledgements and references are provided for previous work cited. Neither this nor any markedly similar work has been or will be submitted for any other degree or qualification at any other university. This thesis contains less than 30,000 words.

Part of this work is presented for publication online and in print upon its defense.

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KEY TO ABBREVIATIONS

CE – Common (Current) Era

CWA - Clean Water Act

DEQ – Department of Environmental Quality

DNR – Department of Natural Resources

EGS – Ecosystem Goods and Services

EPA – Environmental Protection Agency

ES – Ecosystem Services

ESF – Ecosystem Services Framework

ESV - Ecosystem Services Valuation

GNP – Gross National Product

GIS – Geographic Information Sciences (or systems)

HRPP – Human Research Protection Program

LUCC – Land-Use and Land-Cover Change

NASA – National Aeronautics and Space Administration

NAWMP – North American Waterfowl Management Plan

NIMBY – Not In My Back Yard

NOAA – National Oceanic and Atmospheric Administration

MEA – The Millennium Ecosystem Assessment

PA – Public Act

Ramsar or Ramsar Convention – The Convention on Wetlands

UN – The United Nations

UNESCO – The United Nations Education, Science, and Cultural Organization

US – United States

USDA – United States Department of Agriculture

USDIO – United States Department of the Interior

USFWS – U.S. Fish and Wildlife Service

USGS – United States Geological Survey

WES – Wetland Ecosystem Services

WTP – Willingness To Pay

WWAP – The World Water Assessment Programme of UNESCO

QDA – Qualitative Data Analysis

INTRODUCTION

Anthropogenic forces have begun to alter the North American Great Lakes and the surrounding waterscapes. Seemingly, uncontrollable pollution in tandem with relentless drainage of wetlands has left these vital freshwater resources at a tremendous risk. Human welfare and ecosystem integrity are dependent upon freshwater availability, in combination with reliable water quality. This makes understanding individual's environmental perceptions regarding freshwater resources of the utmost importance (Chapman 1996; Vörösmarty et al. 2010).

Michigan is home to a vast network of amazing waterscapes, unseen anywhere else within the contiguous 48 states ("Surface Water Projects - USGS, MI-WSC" 2017). The present, unique shape of Michigan and the Great Lakes, is a direct result of thousands of years of glacial advances and retreats. These natural phenomena have allowed for meltwater to leave behind a plethora of natural water features (Clayton and Moran 1982; Albert 2003). Michigan is home to more than 21% of the world's, and 84% of North America's, surface freshwater supply (De Pinto, Young, and McIlroy 1986; Brown et al. 2000; Tiner, Lang, and Klemas 2015; "DEQ - Water" 2017; US EPA 2015). Bays, kettles, lakes, streams, and wetlands are among the more predominate freshwater landscape features found within the state. Not to mention the vast network of underlying groundwater, as well as more than 3,200 miles of coastal shoreline (Tiner, Lang, and Klemas 2015; "DEQ - Water" 2017; US EPA 2015). Michigan's relatively low, transitional elevation, together with the Great Lakes, high annual precipitation rates, and climate makes the state suitable for wetland ecosystems to thrive.

The sheer volume of water associated with the Great Lakes region has made these natural resources an essential component of the region's cultural and economic history. For example, commercial and sports fishing are known to harvest around 65 million pounds of fish annually, which equates to more than $4 billion in revenue, directly linked to local wetlands (Graff and Middleton 2001; US EPA 2015). Shipping of raw materials and other staple resources throughout the region have supported countless

employment opportunities as well as over 200 million tons of cargo each year (Graff and Middleton 2001; US EPA 2015). Recreation and tourism rely heavily upon the beauty, tranquility, and versatility of the Great Lakes and other state waterways, with annual profits boasting about $20 billion (Mayda 2013). The Great Lakes and underlying groundwater provide some 40 million people with drinking water (Graff and Middleton 2001; "DEQ - Water" 2017). An essential and supportive role provided by local wetlands.

Native Americans have also lived near and utilized this region's freshwater resources for millennia (Jenks 1901; Prince 1997; Mayda 2013; Tiner 2003). Early American history references numerous types of products that the natives gathered, such as beans, squash, and wild rice (Jenks 1901; Clifton, McClurken, and Cornell 1986; Tanner 1987). Wild rice was considered an essential commodity to native peoples and was harvested each autumn from wetland areas all around the Upper Great Lakes (Jenks 1901; Clifton, McClurken, and Cornell 1986; Tanner 1987). Even earlier than recorded history, natives painted pictures of the almost constant struggle between the Ojibwa (Chippewa) and Dakota (Sioux) Indians for the conquest and retention of the territory (Jenks 1901). In part because of the abundance of wild rice fields associated with the Great Lakes' lacustrine and palustrine wetlands (Jenks 1901). According to Menominee oral traditions, wild rice was a gift to humans from one of the "Underneath Spirits." When the rice was ready for gathering, the Menominee offered tobacco to this spirit to ensure a good harvest (Jenks 1901). The name Menominee was derived from the Ojibwe language, and means "Wild Rice People." In addition to wild rice harvesting, wetlands offered sanctuary for fish and wildlife, which the local tribes became reliant upon for clothes and nourishment (Tanner 1987). Those same wetlands were essential in supplying edible and medicinal plants to native peoples as well (Tanner 1987).

Many of the regional ecosystem services afforded by wetlands are in direct correlation with the health and integrity of the Great Lakes. Even though these unique natural features have provided necessary services for many centuries, they remain in a state of decline.

Plastic debris (e.g., water bottles and resin plastics, et cetera) stand as an increasing environmental concern for the Great Lakes region, as does excessive and dangerous levels of eutrophication induced algal bloom in Lake Erie and elsewhere. With the consensus resting on the belief that agricultural runoff and meteorological events, such as climate change, remain the biggest culprits (Michalak et al. 2013; Kane et al. 2014). Imagine flying over the Great Lakes and peering out the window to see algal blooms that cover more than half of Lake Erie. Figure 1 may well evoke fear or concern for those unaware of what is, and caused, these swirling green masses.

Figure 1. ENVISAT image of Lake Erie

Recent scientific investigations have established that wetlands' natural ability to filter excess nutrients, which, most likely, came from agricultural runoff, would have stopped this from happening (Coveney et al. 2002; Hernández-Crespo et al. 2016; Grasset et al. 2016). Some researchers even suggest that eutrophication can help primary plant production in wetland ecosystems, due to the accumulation of nutrients and sediment (Coveney et al. 2002; Hernández-Crespo et al. 2016; Grasset et al. 2016).

Given mounting ecological concerns regarding natural resources, conservation of wetlands has become of vital interest. This attention was in response to many countries seeking to reverse their historic wetland losses and, in consideration of current encroachment from agricultural enterprises, climate change, and urban sprawl (Dale and Connelly 2012; William J. Mitsch and Gosselink 2015). These viewpoints derive from the growing body of research documenting the essential role wetlands play in sustaining human and ecosystem health and well-being (Dahl, Johnson, and Frayer 1991; Prince 1997; Butchart et al. 2005; Dale and Connelly 2012). Current research also establishes a framework of knowledge that wetlands serve as conduits for several ecosystem services, which directly and indirectly affect the surrounding landscape and waterscape. For instance, wetlands have the unique ability to purify surface water before percolating into the groundwater, which, in turn, directly impacts many lives because it allows for clean drinking water (Chee 2004; Tiner 2003).

Michigan's geography encompasses about 9 degrees of longitude and 9 degrees of latitude, which allows for a diverse mix of wetlands ecosystem types (Fizzell 2014; William J. Mitsch and Gosselink 2015; Tiner, Lang, and Klemas 2015). The Michigan Department of Environmental Quality (MDEQ) and the Michigan Department of Natural Resources (DNR), estimate that at initial European contact, Michigan boasted roughly 11 million acres (~4.45 million ha) of wetlands (Tiner 1984; Dahl, Johnson, and Frayer 1991; Fizzell 2014). According to some research, Michigan has lost an estimated 50% (~6 million acres or ~2.43 million ha) of the state's original wetlands (Dahl 1990; Mayda 2013). However, Tiner (1984) along with Michigan's Department of Natural Resources (DNR) estimates that, after European settlement, roughly 71% of the original wetlands were drained or destroyed. Wetlands once covered approximately 16% of Michigan's land area (Albert 2003; Mayda 2013).

Over the last 30 years, Michigan residents have changed the wetland waterscape mainly because of the growing agribusiness and urbanization within the state. The Saginaw Bay and Thumb regions have seen hundreds of thousands of wetlands acreage losses (Brooks, Ffolliott, and Magner 2013). Similarly,

the Lake St. Clair corridor saw the destruction of wetlands because of urban sprawl (Fizzell 2014). Since the passage of Michigan's wetland protection law in 1979, the rate of wetland losses has diminished. The total decline of wetlands since 1978 is around 41,000 acres. With the speed of drainage slowing between 1978 to 1998 (losses of approximately 1,642 acres per year) and 1998 to 2005 (losses of about 1,157 acres per year) (Dahl 2011; Fizzell 2014). Regardless of the rate of destruction, the remaining original wetlands face continued threats, which, in turn, poses a hazard to the natural environment, especially the Great Lakes and major inland waterways.

The continued deterioration of these essential natural resources may link to generations of people's environmental perception of wetland ecosystems. The idea that wetlands were inhospitable eyesores and environmental annoyance. Also, perceived as smelly wastelands that jeopardized human well-being because they supplied refuge for disease-spreading arthropods, such as mosquitos and flies, can be seen throughout historical records (Tiner 1984; Fretwell et al. 1996; Dahl 2011). Namely, early scientific literature within personal diaries, as well as official reports (e.g., U.S. Census) (Kennedy 1862; Palmer 1915; Prince 1997). The belief that wetlands served no immediate purpose was visible throughout the world as well. The damming of rivers to harness hydroelectric power (Kennedy 1862; Palmer 1915; Dahl 1990; Prince 1997; Dale and Connelly 2012; Newlon 2014). Even over-fishing to feed society, infrastructure projects, such as the highway and railway systems, and drainage for agri-business and urban expansion (Kennedy 1862; Palmer 1915; Dahl 1990; Prince 1997; Dale and Connelly 2012; Newlon 2014). These misunderstandings gave people cause to drain, dredge, and divert wetland for centuries (Dahl 2011; Barbier, Acreman, and Knowler 1997; William J. Mitsch and Gosselink 2015).

To better engage with members of the public regarding the protection of wetlands, it is imperative to understand what the current public knows about wetland management. Thus, the goal of this research is to explore residents' environmental perception of wetland ecosystem services (WES), namely functions and values. Three research questions are being analyzed to meet this objective.

1. How do residents describe wetlands?
2. What types of wetland ecosystem services do residents identify most often?
3. Can residents accurately classify ecosystem functions and values related to wetlands?

Two research activities were conducted to answer these research questions.

- Semi-structured focus group interviews were employed to address question one and two.
- Online closed card sorts were utilized to address the third question.

LITERATURE REVIEW

This section examines the frameworks and vocabulary operationalized for this research, along with some possible alternatives. In addition, research from previous studies of environmental perceptions of wetland ecosystems was utilized.

ENVIRONMENTAL PERCEPTION, VALUES, AND KNOWLEDGE

By understanding an individual's point-of-view, researchers can conceptualize about how people learn and place themselves in the world around them or theorize their worldview. People's experiences shape who they become, and in what way they interact with their surroundings. Ergo, qualitative studies offer the opportunity to delve into a person's environmental perception in practical and unique ways. To accomplish these goals, one must first properly explain the terms and clarify their usage throughout these investigations.

There is no straightforward way to define environmental perception, as the two words, environmental and perception, have depth in their meaning. The Oxford Dictionary explains *environmental* as relating to the natural world; while *perception* is becoming aware of something through the senses ("Perception - Definition of Perception in English | Oxford Dictionaries" 2017). Thus, individuals perceive the environment through their senses: the hepatic (touch), olfactory (smell), auditory (hearing), and visual (sight) (Tuan 1974). Moreover, each person observes the environment through a personal lens that incorporates individual history and experiences, which may also vary due to beliefs, culture, and customs (cultural relativism) (Lemberg et al. 2010). For example, Native American communities saw wetlands as essential freshwater resources, hunting grounds, and providers of many other daily provisions; early European settlers were less inclined to share those same sentiments (Prince 1997). Regardless, ***environmental perception*** is a term used to explain and explore a person's awareness of the environment as a dimension of culture or worldview (Tuan 1974; Ittelson 1978).

Similarly, the multidisciplinary community who investigates environmental values has a difficult time coming to a consensus when asked to define ***environmental values.*** However, from a geographic viewpoint, the emphasis is placed on the intrinsic (fundamental) worth of nature, thus arising from an egocentricity point-of-view (Stratford 2006). In contrast, ***environmental knowledge*** is defined as a cognitive action, or in what way people conceptualize the environment (Arcury 1990; Bögeholz 2010; Cottet, Piégay, and Bornette 2013).

As a result, the purpose of these investigations is to evaluate residents' environment perception of wetland ecosystems, focusing on their perception and knowledge of wetland functions (natural processes) and values (use benefits). Below are some additional definitions:

- **Perception** is the view of understanding something through the senses or having an idea (knowledge) and awareness of a particular subject matter (Tuan 1974; "Perception - Definition of Perception in English | Oxford Dictionaries" 2017). For this research, perception is merged into the expression environmental perception to emphasize the breadth of individual's observation of ecological phenomena.

- **Knowledge** describes information and facts learned through education or a practical understanding of a topic (Suvedi et al. 2000; "Knowledge - Definition of Knowledge in English | Oxford Dictionaries" 2017). The word highlights a person's real-world experiences and familiarity of wetlands and their environmental impact.

- **Values** are the belief that all things have worth or usefulness (Costanza et al. 1997; "Value - Definition of Value in English | Oxford Dictionaries" 2017; Sharma, Rasul, and Chettri 2015; Sumarga et al. 2015). They are one of the primary focuses of these investigations and will be analyzed quite thoroughly regarding cultural perceptions and use-benefits rather than from an economic or worth position.

- **Functions** are also a central component of this research and indicate natural processes that occur without human interaction (Sather and Smith 1984; "Function - Definition of Function in English | Oxford Dictionaries" 2017).

- **Processes** demonstrate a natural succession of actions or events that take place in nature or elsewhere (Costanza et al. 1997; "Process - Definition of Process in English | Oxford Dictionaries" 2017).

- **Ecosystem Services** are the benefits people obtain from an ecosystem, according to the MEA (Alcamo et al. 2003).

In addition to the terms above, the legal definition of a wetland is necessary to articulate the subject matter thoroughly.

Wetlands are diverse ecosystems that established by several factors, including soil type, hydrology, topography, climate, and vegetation. Per Cowardin et al. 1979, wetlands are defined as

> *"Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or shallow water covers the land. Further, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports hygrophytes predominantly; (2) the substrate is predominantly undrained hydric soil; and, (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year" (Cowardin et al. 1979).*

While, the Ramsar Convention accepts a more broadly defined concept of wetlands as,

> *"wetlands include a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as saltmarshes, mangroves, and seagrass beds, but also coral reefs and other marine areas no deeper than six metres at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs" (Ramsar Convention Secretariat 2013, ii).*

Regardless of the breadth of this definition, there are five (5) major types of wetlands recognized by the Convention (Ramsar Convention Secretariat 2013). Table 1 explains the major wetland types found in Michigan:

Table 1. Wetland Types Adopted by Ramsar Committee applicable to Michigan

Wetland Type	**Description**	**Example**
Lacustrine	areas of permanent water and associated with lakes	Pond
Palustrine	an area with either little flow and are permanent or intermittent waters	Bog
Riverine	land periodically inundated by river overtopping	Floodplain

FRAMEWORKS FOR EVALUATING WETLAND ECOSYSTEMS SERVICES

The frameworks available to evaluate and collect data regarding the environmental perception of wetlands are rather new. Perhaps, the reason for this is that wetland protections began to take shape during the environmental movement of the 1960s, with the advent of 1970s programs, such as the Environmental Protection Agency (EPA), the Ramsar Convention, and the United Nations Environment

Programme. Even though earlier international conservation organizations existed, the programs of the 1970s laid the foundation for some major legislation to combat human-made environmental catastrophes. Nevertheless, the commonly accepted and utilized frameworks to assess wetland ecosystem services are from UN Millennium Ecosystem Assessment (MEA), the Ramsar Convention, and the United States Geological Survey (USGS). The MEA is an assessment of exactly how humanity benefits from all types of ecosystems. The Ramsar Convention is an international treaty for the conservation, education, and sustainable use of wetlands. The USGS is a governmental agency of scientists who study landscapes, natural resources, and the natural phenomena that threaten them. The latter two have produced the operational diagrams being utilized throughout this research to highlight WES, namely functions and values.

Ramsar Convention

Once more, the Ramsar Convention is an international treaty (alliance) of 169 countries, with the sole purpose of conservation and education of wetlands since 1971. Their procedural frameworks are policy-laden and are meant to encourage national and international cooperation for the sustainable use of these vital resources. Ramsar's economic values of wetland ecosystem services diagram play a fundamental role in this research. Albeit, the Ramsar Convention categorizes WES regarding economic values (use and non-use), this study applies these values to the resources utilized rather than economically, or for cultural assets versus monetary. In addition, even though the Ramsar Convention classifies wetland functions as indirect use values, this research classifies them as functions or natural processes. Table 2 is an illustration of the Ramsar Convention approach for categorizing WES and is employed throughout this project. This chart offers a holistic perspective of wetland ecosystems and the many services afforded by them.

Table 2. Economic Valuation of Wetland Ecosystem Services as identified by The Ramsar Convention

USE VALUES			**NON- USE VALUES**
Direct Use Values	Indirect Use Values (functional)	Option Value & Benefits	Existence Value
• Fish • Agriculture • Fuel Wood • Fodder • Recreation (Boating, Fauna, Walking) • Transport • Wildlife • Harvesting • Peat/Energy • Education	• Nutrient Retention • Flood Control • Storm Protection • Ground Water Recharge • External Ecosystem Support • Filtration • Microclimate • Shoreline Stabilization	• Potential Future Use (as per direct and indirect use) • Future Value of Information (e.g., medicine and education)	• Biodiversity • Culture • Heritage • Bequest

The economic valuation table is widely accepted and used as a cornerstone of wetland ecosystem research. Thus, the chosen procedural guidelines based on those considerations and validations because the Ramsar Convention is largest international coalition meant for protecting wetland ecosystems.

The National Water Summary on Wetland Resources

The USGS is a governmental agency of scientists who study landscapes, natural resources, and the natural as well as human-made phenomena that threaten them. The USGS, in conjunction with the U.S. Fish and Wildlife Services (USFWS), founded the National Wetlands Research Center (NWRC) in 1975, with the intention to establish and publish scientific data necessary for people to understand the ecological and beneficial aspects of U.S. wetlands (Fretwell et al. 1996). The Wetland and Aquatic Research Center (WARC) formerly the NWRC as of 2015, is also intended to conserve, manage, and restore wetland habitats. The USGS created a well-organized diagram for the National Water Summary on Wetland Resources in 1996/7, which represents wetland ecosystem services, and is meant to illustrate the hierarchical structure of resources for wetland functions and their internal and external values (Fretwell

et al. 1996). Figure 2 is the USGS' operational diagram employed for this research as a visual aid (Fretwell et al. 1996).

Wetland Functions and Values

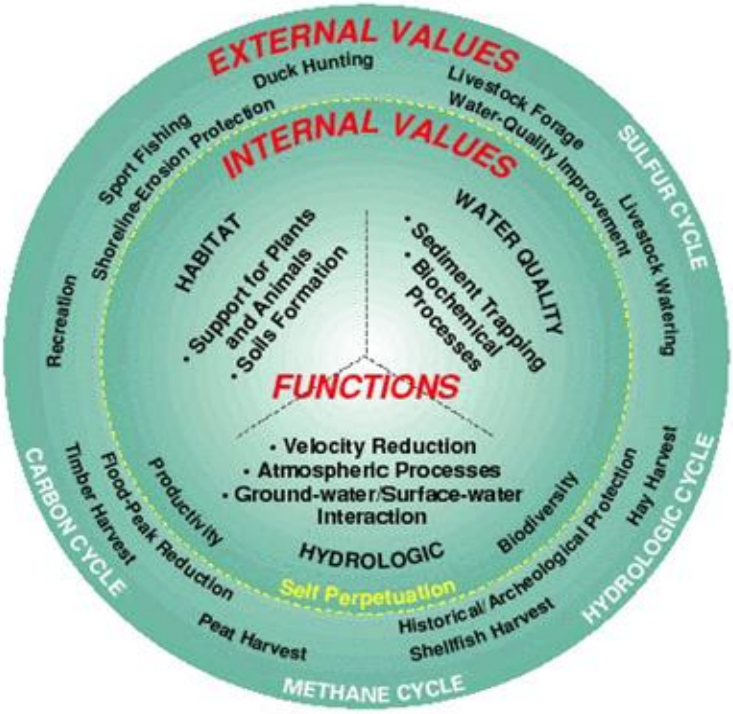

Figure 2. Diagram by The USGS Identifying Wetland Functions and Values as a Relationship to Wetland Ecosystems

In addition to the USGS wetland function and values instructional diagrams, they have created a GIS Social Values of Ecosystem Services (SolVES) application. SolVES is designed to assess, map, and quantify public perceptions of the social values for ecosystem services. *Social values* are the perceived, nonmarket worth that people ascribe to ecosystem services, namely cultural services, such as aesthetics and recreation (Sherrouse and Semmens 2010). This outline offers an initial coding scheme for the qualitative analysis of residents' environmental perception of WES. Table 3 is on loan from the USGS and published with the 2010 Social Values for Ecosystem Services (SolVES).

Table 3. Social Value Types used by the USGS in the SolVES tool

SOCIAL VALUE	EXAMPLE
Aesthetic	I value these ecosystems because I enjoy the scenery, sights, sounds, smells, et cetera.
Biodiversity	I value these ecosystems because they provide a variety of fish, wildlife, plant life, et cetera.
Cultural	I value these ecosystems because they are a place for me to continue to pass down the wisdom and knowledge, traditions, and way of life of my ancestors.
Economic	I value these ecosystems because they provide timber, fisheries, minerals, and/or tourism opportunities such as outfitting and guiding.
Future	I value these ecosystems because they allow future generations to know and experience the forests as they are now.
Historical	I value these ecosystems because they have places and things of natural and human history that matter to others, the nation, or me.
Intrinsic	I value these ecosystems in and of themselves, whether people are present or not.
Learning	I value these ecosystems because we can learn about the environment through scientific observation or experimentation.
Life-sustaining	I value these ecosystems because they help produce, preserve, clean, and renew air, soil, and water.
Recreation	I value these ecosystems because they provide a place for my favorite outdoor recreation activities.
Spiritual	I value these ecosystems because they are a sacred, religious, or spiritually special place to me or because I feel reverence and respect for nature there.
Subsistence	I value these ecosystems because they provide necessary food and supplies to sustain my life.
Therapeutic	I value these ecosystems because they make me feel better physically and/or mentally.

Counterarguments

There has also been an alternative framework created by the U.S. Fish and Wildlife Service (USFWS) for measuring wetland ecosystem services. However, these ecosystem services are organized uniquely and explained regarding the status of knowledge by ***scholars*** (e.g., hydrology, water quality, nutrient cycle, habitat, and socioeconomic) (Sather and Smith 1984). Their research focuses on WES from a scientific perspective. Therefore, a layperson with limited to no previous wetland education could be confused by

the scientific jargon and lost in the explanations. Thus, too verbose and technical for this research's objective.

Additionally, the MEA is an appraisal of human's impact on the environment, called for by the United Nation (UN) Secretary-General Kofi Annan (Alcamo et al. 2003). The MEA also incorporated a report on *Ecosystems and Human Well-being: Wetlands and Water* into the overall assessment. This report was added to provide Contracting Parties (intergovernmental partners) of the Ramsar Convention; and all parties concerned for and involved in, the implementation of the Convention (Alcamo et al. 2003; Butchart et al. 2005). As well as, who is responsible for the future sustainability of wetlands and water resources (Alcamo et al. 2003a; Butchart et al. 2005). The MEA offers another framework for evaluating environmental perceptions of wetlands. Though the MEA measures ecosystem services regarding four (4), broad categories (concepts): cultural, provisioning; regulating; and supporting services. This framework was more intricate with less real-world examples to offer participants. Thus, the Ramsar Convention and USGS organizational diagrams were chosen as a reliable and relatable application instead of the MEA on Wetlands and Water. Nevertheless, the MEA services classifications were selected as part of the final arrangement of codes being used in the semi-structured focus group interview analysis. The initial codes will be consolidated into these broad categories to produce emergent themes and generalized patterns. Table 4 explains the MEA in terms of its four broad ecosystem services categories for wetlands (Butchart et al. 2005).

Table 4. Ecosystem Services Associated with Wetlands

SERVICES	EXAMPLES
PROVISIONING	
Food	Production of fish, wild game, fruits, and grains
Fresh Water	Storage and retention of water for varied uses
Fiber and Fuel	Production of logs, fuelwood, peat, fodder
Biochemical	Extraction of medicines and other materials from biota
Genetic Material	Genes for resistance to plant pathogens, ornamental species, etc.
REGULATING	
Climate	Regulation of greenhouse gases; influence local and regional weather
Water Regulation	Groundwater recharge/discharge
Water Purification & Treatment	Retention, recovery, and removal of excess nutrients and pollutants
Erosion Regulation	Retention of soils and sediments
Natural Hazard Regulation	Flood control, storm protection
Pollination	Habitat for pollinators
CULTURAL	
Spiritual & Inspirational	Source of inspiration, religious significance
Recreational	Fishing, hunting, swimming, etc.
Aesthetic	Beauty and aesthetic value
Educational	Training and information educational opportunities
SUPPORTING	
Soil Formation	Sediment retention and accumulation of organic matter
Nutrient Cycling	Storage, recycling, processing, and acquiring of nutrients

ENVIRONMENTAL PERCEPTION OF WETLANDS RESEARCH CASE STUDIES

Wetlands are unique ecological habitat and in virtually every part of the world. They are designated as the **"kidneys of the landscape"** and **"nature's supermarket"** or, even sometimes, **"the nursery of life"** (Ramsar Convention Secretariat 2013; Mitsch and Gosselink 2015). As a result, civilizations have settled along river valleys and coastal plains for millennia, to reap the benefits of the many services those *wet-lands* offer humanity. Wetlands are amongst the most productive habitats in the world. They offer an array of economic, environmental, cultural, and social benefits or ecosystem services that humanity, as well as the entire ecosystem, rely upon (Costanza et al. 1997; Daily 1997; Brooks, Ffolliott,

and Magner 2013; Mitsch and Gosselink 2015). During the 1970s, scientists, ecologists, and conservationists began to articulate the values of wetlands by evaluating their functions (Fretwell et al. 1996). After the Ramsar Convention (1971), wetlands were finally acknowledged as a vital aspect of the hydrologic cycle (Dugan 1990; Finlayson et al. 1999; Dale and Connelly 2012; Dias and Belcher 2015). The following summarizes some of the most relevant research concerning human perception of wetlands.

The current research about individual's perception of wetlands has been widely administered and assessed outside of the United States with few exceptions. Michael D. Kaplowitz, a professor of environmental law and policy at Michigan State University has conducted many investigations on water resources and wetlands ecosystems within the State of Michigan, as well as Latin America (e.g., Costa Rica and Mexico). Kaplowitz, along with other MSU professors, has individually explored people's perception and knowledge of wetlands. Also, many international scholars have participated in environmental perception research. However, their study focused on the various aspect of environmental knowledge, outside of wetland ecosystems.

Kaplowitz (2001), reported on the use of both focus groups and individual interviews. The research measured local Mexican residents' knowledge and understanding of products as well as services associated with mangrove ecosystems (i.e., estuary wetlands). In total, n=97 year-round seaside residents took part in one of 12 focus groups and 19 in-depth interviews (Kaplowitz 2001). The goal of this research was to aid in future mangrove (wetland) resource management efforts and to explore the relative importance of wood products as a benefit (value) of those ecosystems (Kaplowitz 2001). The findings demonstrated that people discussed provisionary services, such as snail ("chivita" to the natives) and other seafood, during each focus group and interview (Kaplowitz 2001). Additionally, residents mentioned recreation and storm protection as essential services provided by the mangrove colonies (Kaplowitz 2001). However, the collection of wood was rarely stated or offered as a provisioning service, even though wood could be fuel and fiber sources (Kaplowitz 2001).

Kaplowitz, Lupi, and Hoehn (2007), also used focus groups as a tool to offer researchers a "baseline" understanding of Michigan residents' perception, knowledge, and appreciation of wetlands within the state. Altogether, three focus group sessions with 5, 6, and 8 (n=19) participants, respectively were held (Kaplowitz, Lupi, and Hoehn 2007). These interviews illustrated how this information regarding public opinion concerning wetland knowledge, would help policymakers, researchers, and stakeholders make informed decisions about future wetland ecosystem protections (Kaplowitz, Lupi, and Hoehn 2007). Thirteen of 19 participants (68%) cited and discussed how wetlands function as providers of flood control, as people repeatedly acknowledged an appreciation for wetlands' ability to control flooding (Kaplowitz, Lupi, and Hoehn 2007). However, only 32% (6 participants) understood wetlands' relationship to groundwater, with many participants saying nothing about groundwater recharge even when prompted (Kaplowitz, Lupi, and Hoehn 2007).

In contrast, Gollin, McMillen, and Wilcox (2004) conducted a pile sorting (card sorting) study focusing on the environmental perception of Hawaiian residents concerning flora, not wetlands. Nonetheless, this experiment investigated local lay people's awareness and valuations of native and non-native vegetation, in the hope of obtaining a complete understanding of individual's willingness to participate in revegetation or eradication efforts on Oahu, Hawaii (Gollin, McMillen, and Wilcox 2004). In all, n=25 people took part in the pile sorting exercise (Gollin, McMillen, and Wilcox 2004).

Additionally, Nsengimana, Weihler, and Kaplin (2017) presented a case study on perceptions of local peoples in relation to the use of the Nyabarongo river wetland and its conservation efforts, in Rwanda. This paper examined the likely implications of a shift in wetland utilization and management practices and offered preliminary information from a household survey as well as group discussions (Nsengimana, Weihler, and Kaplin 2017). All told, nine participants from eight villages took part in two focus group discussions, where each village had one member, except the village with the largest population had two (Nsengimana, Weihler, and Kaplin 2017). The results showed that any changes to the

use and management of Nyabarongo river wetland pose significant loss for local people in terms of provision of resources, income, and access to the wetland (Nsengimana, Weihler, and Kaplin 2017). Additionally, residents stated how providing food for sustenance was a more appropriate use of the land rather than protecting wetlands for the entire ecosystem's health and well-being (Nsengimana, Weihler, and Kaplin 2017).

These investigations have attempted to fill some of the literature gaps regarding environmental perception and knowledge of wetland ecosystems. They each used a mixture of qualitative methodological tools, namely card sorting, focus groups, and individual interviews, which provides evidence of their *reliability, replicability*, and *reproducibility*. These inquiries found that people seem to misunderstand many ecosystem services afforded by wetlands, such as timber harvest, sediment trapping, and shoreline stabilization (Kaplowitz 2001; Kaplowitz, Lupi, and Hoehn 2007; Nsengimana, Weihler, and Kaplin 2017). However, people were acutely aware of the comestible provisions that wetlands make available (e.g., beans, rice, and snails) (Kaplowitz 2001; Nsengimana, Weihler, and Kaplin 2017). Moreover, livestock foraging and watering were exceedingly important to the Rwandan communities, as those animals also offered comestibles, such as meat and milk (Nsengimana, Weihler, and Kaplin 2017). Each study found that when asked about natural processes, whether related to wetlands or other environmental phenomena, individual perceptions were limited in knowledge. People seemed to focus on their immediate circumstance rather than their knowledge of the overall subject matter and seemed more receptive when they saw cultural value in the ecosystem service. Similarly, when peoples' livelihood and well-being were in direct link to wetland ecosystem services, their willingness to discuss environmental perceptions grew exceptionally.

ECOSYSTEM SERVICES

An ***ecosystem*** is a community of biological organisms working in conjunction with the three other earthly spheres (i.e., atmosphere, hydrosphere, and lithosphere), to exist as one unit; or the organic and

inorganic components operating in tandem to procure and maintain the whole system (Tansley 1935). These holistic systems nurture infinite resources.

The literature shows that the word ***resources*** is applied to describe a source of which assets are available for use, regardless of context ("Resource - Definition of Resource in English | Oxford Dictionaries" 2017). That is, whether discussing academic resources (knowledge), biological resources (production), economic resources (properties), or natural resources. William J. Mitsch, a renowned ecosystem ecologist, who focuses on wetland research, writes that ecosystem services consist of many provisions, such as generic resources (e.g., food, water, or fibers) (Mitsch and Gosselink 2015). Conversely, The National Water Summary on Wetland Resources, a paper for the United States Department of the Interior and the USGS, gives a broad overview of wetland resources, which includes discussions for understanding wetland functions and values in a scientific realm (Fretwell et al. 1996). Interestingly, the report was written several years before the term *"ecosystem services"* took hold in the academic community. Nevertheless, Turner and Daily (2008), discusses the resource space in terms of human welfare benefiting from the ecosystem goods and services, both private and public, generated across a range of temporal and spatial scales. While, Zedler and Kercher (2005), denote wetlands as resources themselves, as they supply beneficial goods, e.g. peat, and complete necessary functions, e.g. sequester carbons, which, in turn, make the peat that becomes useful. In this study, the word *resource* is an umbrella term applied to describe any environmental provision or process, such as an ecosystem service.

Ecosystem Services are the conditions and processes by which the natural environment produces resources that benefit nearby inhabitants, namely humans (Daily 1997; Chee 2004; Alcamo et al. 2003). Other scholars assert that ecosystem services are *"natural capital"* offered to preserve human welfare, by supplying various cultural assets (e.g., biodiversity, clean water, and sustenance) (Costanza, Farber, and Maxwell 1989; Daily et al. 1997; Turner and Daily 2008; Roebeling et al. 2016). Colloquially, ecosystem

services are “the advantages of nature to households, communities, and economies” (Boyd and Banzhaf 2007).

The concept of ecosystem services encompasses a broad range of goods (useful resources). For instance: dietary needs, timber, biomass fuels, pharmaceuticals, and industrial products (e.g., natural fiber) (Chee 2004; Turner and Daily 2008; Costanza et al. 2014). Also, many services (useful resources) that support the maintenance of biodiversities, such as air, soil, and water purification (Daily et al. 1997; Fisher, Turner, and Morling 2009). Not to mention recycling and renewal, intangible aesthetic, and cultural prosperity (Chee 2004; Barbier et al. 2008; Sumarga et al. 2015).

ECOSYSTEM FUNCTIONS

An ***ecosystem function*** is the internal processes and natural interactions, between components throughout or across ecosystems (De Groot, Wilson, and Boumans 2002). While services are the outputs of ecosystems which are beneficial to humans (Costanza, Farber, and Maxwell 1989; Chee 2004; Gómez-Baggethun et al. 2010; Ramsar Convention Secretariat 2013). As a result, people assign economic, ecological, and social values to these ecosystem services based on the usefulness of these services (Richardson 1994).

WETLAND ECOSYSTEM SERVICES

In the past, wetland research has mainly included ecological-economic valuation of goods and services, concerning wetland management practices (Costanza, Farber, and Maxwell 1989; Barbier, Acreman, and Knowler 1997; Wilson and Carpenter 1999; Turner et al. 2000). Furthermore, studies have focused on the cultural value of wetland ecosystems regarding provisions and benefits (Dixon 2005; Cottet, Piégay, and Bornette 2013; Nabahungu and Visser 2013; Greenland-Smith, Brazner, and Sherren 2016; Roebeling et al. 2016). However, much of the cultural research has concentrated on international analysis, such as in Africa, Asia, Australia, and Europe, except a few North American studies that focused on Canada and Mexico. Examinations relating to environmental perception of ***wetland ecosystem services***

have had little emphasis on the United States. More specifically Michigan, the state with more surface freshwater resources than any other, and the state with the second longest coastline of the United States after Alaska ("Surface Water Projects - USGS, MI-WSC" 2017).

Many researchers evaluate wetlands ecosystem services in terms of direct (extrinsic and external), or indirect (intrinsic and internal) functional use and non-use values (e.g., shellfish harvesting and sediment trapping, respectively) (Costanza, Farber, and Maxwell 1989; Acharya 2000). In addition, existing research demonstrates that humanity is extremely dependent upon the services provided by wetland ecosystems (Finlayson et al. 1999; Costanza et al. 2014). Some research states that wetland functions provide resources that humans not only value, but rely upon, such as water quality and seafood harvesting (Brooks, Ffolliott, and Magner 2013; William J. Mitsch and Gosselink 2015; Sandifer, Sutton-Grier, and Ward 2015). Figure 3 displays the association between Wetland Ecosystem Services ("Online Diagram Software to Draw Flowcharts, UML & More | Creately" 2017).

Wetland Ecosystem Services

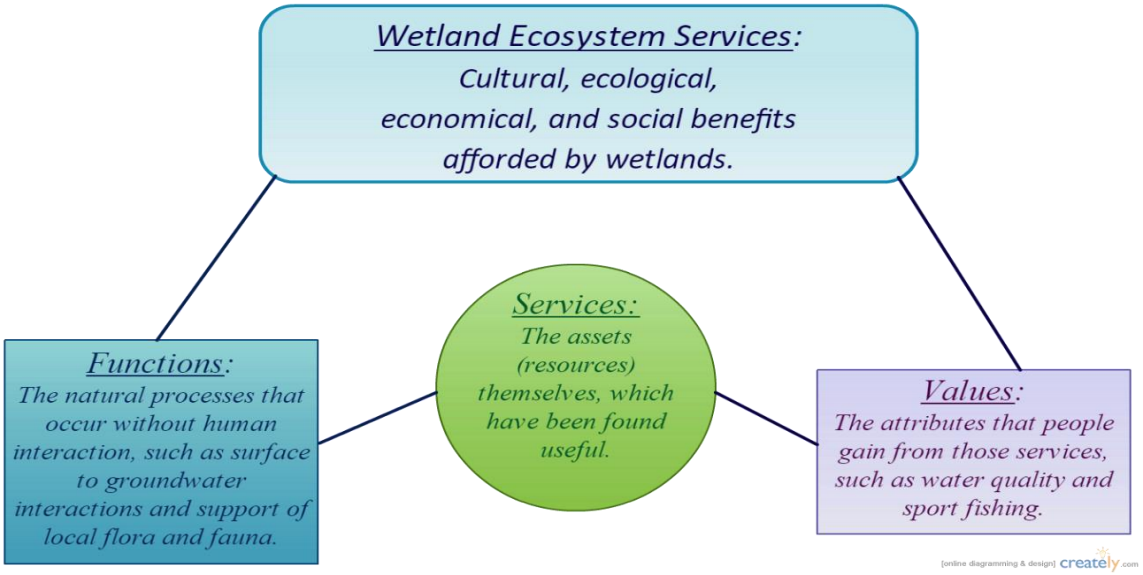

Figure 3. An Illustration of the Connection between Wetland Ecosystem Services

WETLAND ECOSYSTEMS SERVICES RESEARCH

Research about wetland ecosystem services examines them regarding cultural, economic, environmental, and social benefits. Many environmental scientists often asserted that nature has an intrinsic value far beyond an economic value (Turner et al. 2000; Lambert 2003; Chee 2004; Gómez-Baggethun et al. 2010; Farley and Costanza 2010). Nevertheless, much of the literature referencing WES regarding their economic value. Although, some does emphasize societal inequalities and poor distribution of these services; while others examine the cultural relevance.

Costanza, Farber, and Maxwell (1989) ask what if people were to accept the belief that all species have a vital role in the natural ecosystems? Then it would be possible to change individual perceptions to value all ecosystem services as if they were fully informed about the functions of the environment as expressed through their ecological relationships. Even if there is no direct usefulness or appeal to those species, such as mosquitoes and flies (Costanza, Farber, and Maxwell 1989).

Similarly, Kaplowitz (2000), firmly expressed that if Yucatan communities continue to account for the total value of natural resources inadequately, overexploitation and degradation of complex ecosystems, such as mangrove wetlands will remain an ongoing problem.

There are many examples of how WES have measured environmental perceptions. Although the vast majority highlight inequalities, whether from a destruction of indigenous people's ancestral and tribal land, in turn, their cultural identity, or from an unequal distribution of provisions to a complete omission of local peoples from decision-making processes.

Clarkson, Aussei, and Gerbeaux (2013) discussed how the Māori people of New Zealand had suffered greatly from the loss of more than 90% of the original wetlands that once covered the island nation. They appreciated wetlands for their spiritual and cultural significance, as well as vital sources of food and other materials (e.g., timber) closely linked to their identity. The Māori people treasured

wetlands for their ability to offer a safe-haven during wartime, in addition to hiding valuable artifacts, such as canoes (Clarkson, Aussei, and Gerbeaux 2013).

Moreover, Sharma, Rasul, and Chettri (2015) assessed the economic value of WES provided by the Koshi Tappu Wildlife Reserve, the first Ramsar site in Nepal. Their results show that the local people depend heavily on the ecosystem services offered by the reserve for their subsistence and overall well-being.

Adekola et al. (2015), found that local peoples of the Niger River Delta wetlands are rarely considered in the decision-making processes when sustainable development management practices are concerned. Even though they derive nearly 80% of their income (as goods, services, and cash income) directly from the wetlands, and are significantly more dependent upon the delta than other wetland communities in Africa (Adekola, Mitchell, and Grainger 2015).

WETLAND FUNCTIONS

Wetland functions are vital to the health and welfare of any adjacent water body as well as the adjoining landscape (Daily et al. 1997; Ramsar Convention Secretariat 2013; Sandifer, Sutton-Grier, and Ward 2015). Some examples of these functions are ***flood-peak reduction; groundwater recharge and discharge; retention of nutrients; sediment trapping; shoreline stabilization; and, water storage.*** *W*etlands, also ***modify local climate conditions***. Namely, by way of ***evaporation, interception, rainfall, temperature; and, transpiration*** (Richardson 1994; Reddy and DeLaune 2008; Turner et al. 2000; Turner, Georgiou, and Fisher 2008; Keddy et al. 2009; Ramsar Convention Secretariat 2013; Meng et al. 2016).

Wetland functions have protected billions of people from experiencing catastrophic natural disasters for millennia. However, continued wetland destruction places billions more in harm's way. In the end, the literature demonstrates that because people are unaccustomed to recognizing what constitutes a wetland function, they are unable to safeguard them from future losses. (Kaplowitz and Kerr 2003; Dixon 2005; Kaplowitz, Lupi, and Hoehn 2007; Cottet, Piégay, and Bornette 2013).

Patricia M. Manuel and her associates performed on-site case studies within three neighborhoods of Halifax, Nova Scotia during the late spring and summer of 1996-97. These communities were each home to urban wetlands, and this research focused on investigating cultural perceptions or people's awareness of the relationship between themselves and wetlands. Random sampling from civic-directories found 55 households who were willing to participate in the door-to-door questionnaire interviews. A four-section survey was administered, with the third part concentrating on individual perceptions of wetlands (Manuel 2003). The results showed that area residents rarely visited their local wetlands, whether intentionally or on the way to someplace else (Manuel 2003). When asked to describe their local wetlands, locals answered ineptly with regards to structure or size, vegetation and wildlife, wetland condition and water quality (Manuel 2003). Nearly 70% of those polled were unaware if the wetlands had changed in site and situation. However, they were more observant when asked about seasonal variations (Manuel 2003). Aesthetics and naturalness were some of the advantages people mentioned for having wetlands in their neighborhoods (Manuel 2003).

Mitsch and Gosselink (2000), wrote "perceived values arise out of the functional ecological processes… But are also determined by human perceptions, the location of a wetland, the human population pressures on it, and the extent of the resource." Moreover, they claimed that wetland functions and, thus, their use benefits (values) have the potential to last for a very long time (Mitsch and Gosselink 2000). Whereas modern agriculture or industrial activities are largely unsustainable and resource-depleting (e.g., soil, water, and fossil fuels), so the lifetime of these human-based alternatives are rather short-lived. Because once wetlands succumb to development, the loss of their functions and values is often reversible (Mitsch and Gosselink 2000).

In contrast, Lupi, Kaplowitz, and Hoehn (2002) performed a pilot survey of 58 Mid-Michigan residents willingness to accept wetland mitigation as a form of compensation for the destruction or drainage of an existing wetland. The pilot study further explained how Michiganders with higher levels of

educational attainment believe when original wetlands are damaged, more land than the original wetland should be set aside for migration projects, as residents express caring about WES (Lupi, Kaplowitz, and Hoehn 2002).

Kaplowitz and Kerr (2003), found after interviewing more than 1000 Michigan residents from the major geographic regions of the state, most people seem very familiar with wetlands and think protecting them is important. The majority of participants (more than 70%) acknowledged that wetland functions (flora and fauna habitat, flood control, and water filtration) are *very or extremely important* ecosystem services offered by wetlands. Meanwhile, 66% expressed that the existence of wetlands is *very to extremely important* to them (Kaplowitz and Kerr 2003).

Similarly, Kaplowitz, Lupi, and Hoehn (2007) established that 19 people from Mid-Michigan who took part in focus group interviews seem to perceive that wetlands function as wildlife habitats and floodwater retention ponds; yet misunderstand the many other ecosystem services provided by wetlands. When asked, *"what they think of when they hear the word 'wetland,'"* residents gave answers in the form of wetland types (e.g., palustrine or swamps and marshes), or discussed DEQ and DNR regulations (Kaplowitz, Lupi, and Hoehn 2007). Additionally, when asked about wetlands regarding water and other geophysical aspects, participants described stagnant water as well as muddy places (Kaplowitz, Lupi, and Hoehn 2007). Most participants associated wetlands as a refuge for wildlife and wildflowers (Kaplowitz, Lupi, and Hoehn 2007). Nevertheless, there was some skepticism regarding wetlands' ability to stabilize shorelines, and there was an overall lack of knowledge or uncertainty about wetlands' relationship with groundwater recharge (Kaplowitz, Lupi, and Hoehn 2007).

Even though wetlands offer use and non-use benefits all year, people seemed more concerned with the "big-picture" of nature rather than "small" localized ecosystems, such as wetlands (Manuel 2003). Furthermore, most people appear to see wetlands as environmental assets but lack the knowledge to communicate why effectively (Mitsch and Gosselink 2000; Lupi, Kaplowitz, and Hoehn 2002; Manuel 2003;

Kaplowitz, Lupi, and Hoehn 2007). Individuals recognize some wetland functions, such as wildlife habitat and water filtration; however, neglect to mention essential functions like shoreline stabilization and nutrient retention (Kaplowitz and Kerr 2003; Kaplowitz, Lupi, and Hoehn 2007).

WETLAND VALUES

The literature discusses wetland values in several contexts, such as ecological, economic, and social use and non-use values. Wetland valuation is the process of assigning a monetary price to goods and services provided by environmental resources, whether or not market prices are available for comparison (Costanza et al. 1997; Chee 2004; Kaplowitz, Lupi, and Arreola 2012). For example, market prices are not available for services such as flood control, disaster mitigation, and erosion avoidance, et cetera. The value is established by the willingness-to-pay (WTP), for the good or service, regardless if a physical payment is made (Chee 2004; De Groot, Wilson, and Boumans 2002; Costanza et al. 2014).

Conversely, cultural analyses assert that societies utilize wetland ecosystem services as a form of expressing their identity, traditions, and holistic connection to nature (Tuan 1974; Clarkson, Aussei, and Gerbeaux 2013; Greenland-Smith, Brazner, and Sherren 2016). The research points to people's perception of wetland values, in the context of aesthetics, both tangible and intangible (Wilson and Carpenter 1999; Turner et al. 2000; Manuel 2003; Turner, Georgiou, and Fisher 2008; Cottet, Piégay, and Bornette 2013). The ***USGS' SolVES*** further adds social values regarding biological diversity, historical, and learning values, as well as life-sustaining, spiritual, and therapeutic values. Humanity has become reliant upon these values, yet some cultures ignore these values, as wetlands impede plans for land uses and land cover changes (Dahl 2011; Brinson and Malvárez 2002; Nsengimana, Weihler, and Kaplin 2017). Once more, this research analyzes the cultural values offered by WES.

Although wetland functions are essential for the health and well-being of the entire ecosystem, wetland values are equally vital to the welfare of the ecosystem because it is necessary to monitor human use. ***Values*** are the anticipated resources that humanity will utilize because of the functional processes

fulfilled by the wetlands' infrastructure. Examples of some wetland values are **archeological and historical protection; educational purposes;** ***hay, peat, shellfish, and timber harvesting; livestock foraging and watering; medicinal purposes; recreation; commercial and sports fishing.*** Also***, water quality as well as quantity*** (Costanza et al. 1997; Wilson and Carpenter 1999; Reddy and De Laune 2008; Turner et al. 2000; Ramsar Convention Secretariat 2013; Sharma, Rasul, and Chettri 2015; Roebeling et al. 2016)**.**

Ndaruga and Irwin (2003) surveyed 54 primary school teachers from seven provinces within Kenya, who attended a professional training workshop with respect to wetland conservation in January 1999. The teachers were from both rural and urban settings. A combination of questionnaires and interviews techniques were utilized to gather data about how these educators perceived their local wetlands after attending said training workshop (Ndaruga and Irwin 2003). As well as, to reflect on how the in-service training could be applied to promote environmental education teaching about wetlands' and their sustainable use (Ndaruga and Irwin 2003). The results showed that domestic water, water for animals, farming water, and grazing areas were the most fundamental values of wetlands (Ndaruga and Irwin 2003). On the contrary, teachers rated transport, local crafts, the attraction of tourists, recreation, and purification of water as the least relevant services afforded by wetland ecosystems (Ndaruga and Irwin 2003).

Additionally, Greenland-Smith, Brazner, and Sherren (2016) employed unstructured interviews to evaluate 18 males (females declined to participate) Nova Scotian farmers' perceptions of local wetlands and other water bodies, to conserve and protect these natural resources. During the spring and autumn of 2013, a series of questions were asked to identify the farmers' awareness of their wetlands, if they impact their farming or if their farming impacts the wetlands, and if they have altered the wetlands in any way? By using the EGS (Ecosystem Goods and Services framework by the Millennium Ecosystem Assessment), the investigators found that the farmers recognized the provisional services of fresh water utilization and wildlife habitat more often than any other provision, such as food or fuel (Greenland-Smith,

Brazner, and Sherren 2016). Meanwhile, the cultural services mentioned were recreation, tourism, and cultural heritage values, without any reference to the educational services (Greenland-Smith, Brazner, and Sherren 2016). The regulating services ranged from water purification to erosion control, but the farmers neglected to recognize flood control as a vital service because they believed the wetlands caused the flooding of their land (Greenland-Smith, Brazner, and Sherren 2016). Furthermore, only a few farmers noted the supportive services of nutrient retention and primary production with no mention of any others (Greenland-Smith, Brazner, and Sherren 2016).

Nevertheless, as seen earlier, Kaplowitz and his colleagues, Hoehn, Kerr, and Lupi have added to the wetland research within Michigan. Although, they focus on wetland values regarding appreciation versus cultural asset, or how society benefits from the WES regarding use values. Proving the necessity for this Research's exploration of residents, to help close the gap in the literature about the use and non-use ecosystem services provided by wetlands.

Overall, research has shown that residents placed the highest values on services that provide them with immediate use value, such as aesthetics and recreation. However, people see the importance of freshwater but do not recognize the harvesting abilities (food and fuel). Individuals have some knowledge of wetlands' unique habitat, yet they rarely, if at all, mention fishing (sustenance). Once more, this current research evaluates people's knowledge and environmental perceptions of the unique attributes (nonuse functions and use values) afforded by WES. Table 5 offers a slight variation in the working definitions for wetland functions, values, and ecosystem services published by the Ramsar Convention (De Groot et al. 2006; Ramsar Convention Secretariat 2013).

Table 5. Operational Definitions for this Current Research from the Ramsar Convention

TERM	DEFINITION
Function	Activities or actions which occur naturally in wetlands as a product of interactions between the internal processes and ecosystem structure.
Value	The importance of useful goods and services provided by a wetland ecosystem.
Ecosystem Service	The benefits people obtain from wetland ecosystems.

METHODS

The methods chosen for a research project should reflect the types of questions being asked. Qualitative research is often applied to recognize further an individual's or groups' underlying reasons for formulating certain opinions, motivations, and actions (Gollin, McMillen, and Wilcox 2004; Reed et al. 2009). In addition, qualitative analysis concerns itself with evaluating how individuals perceive their surroundings, in an attempt to gather evidence about people's worldview (Brannen 2005; Baxter and Jack 2008). In contrast, quantitative inquiries focus on collecting numeric data to support physical and social phenomena (Morse 1991; Brannen 2005). This research is primarily qualitative because the collection of data, the subsequent analyses, and synthesis of broad patterns and themes are inductive, as there is an end-point; thus, qualitative in approach (Morse 1991; Brannen 2005; Creswell 2013). With the use of exploratory case studies, via participant observations and focus group interviews, this research allows for a different assessment of the research topic. By offering participants the freedom to interact in groups, this allows them to create additional constructs amongst their peers (Tellis 1997; Kaplowitz, Lupi, and Hoehn 2004; Mir and Watson 2000; Creswell 2013). These tools afford the researcher the opportunity to identify themes and investigative patterns within the dialogue.

The methodology behind these investigations are based on conceptualization theory and follow the constructivist point-of-view. Therefore, the truth is relative, subjective, and dependent upon individual experiences and perspectives (Tellis 1997; Mir and Watson 2000; Baxter and Jack 2008; Creswell 2013). These investigations make available empirical evidence of the environmental perceptions of people concerning wetland ecosystems. These activities are easily replicable because of their reliability, replicability, and reproducibility. Even if there is an introduction or replacement of a county, a reduction in sample sizes (for an initial pilot study), or a refinement of qualitative approaches and tools utilized (De Boo et al. 2005). Figure 4 provides a visual aid to articulation the flow of methodologies used for this investigation ("Online Diagram Software to Draw Flowcharts, UML & More | Creately" 2017).

Research Workflow

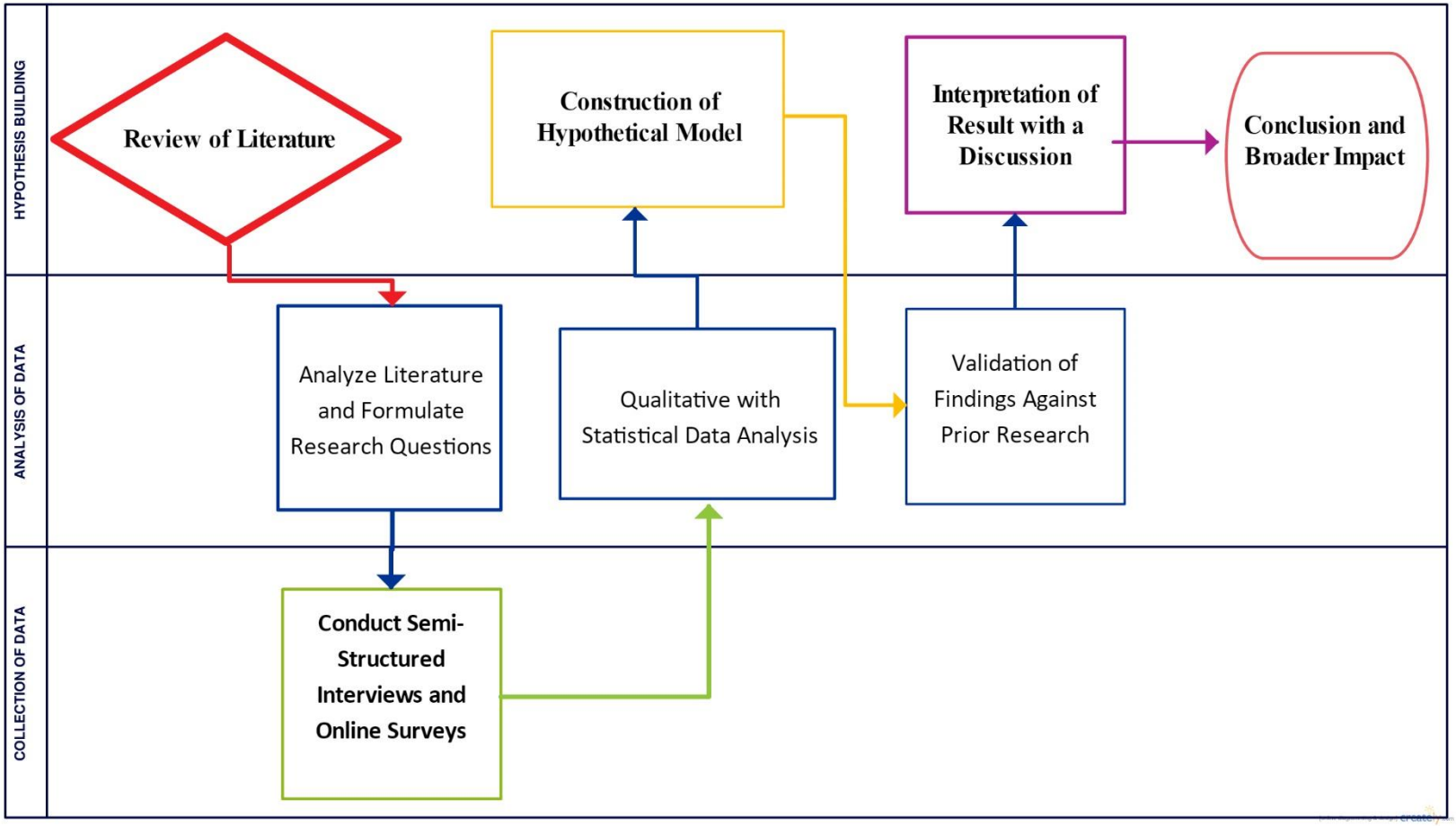

Figure 4. Diagram Explaining the Sequence of Research Methodology

As a result, the goal of this study was to gauge the environmental perception of individuals regarding wetland ecosystems. Primarily concentrating on wetland ecosystem services, collectively referred to as wetland functions (natural processes) and values (useful benefits) for this research. Three research questions were considered:

1. How do residents describe wetlands?
2. What types of wetland ecosystem services do residents identify most often?
3. Can residents accurately classify ecosystem functions and values related to wetlands?

STUDY SITES

Michigan consists of 83 counties, each with a diverse land and waterscape. The scope of this study was limited to three counties: Chippewa, Huron, and Macomb because of time constraints. In addition, these counties were primary focuses for future wetland restoration efforts being led by the U.S. Fish and Wildlife Service, in conjunction with the North American Waterfowl Management Plan (NAWMP) (NAWMP 2012). Figure 5 expresses the up-to-date concentration zones for the said management plan (NAWMP 1998).

Figure 5. Focus Areas for the North American Waterfowl Management Plan (NAWMP 2014)

Study sites were also required to meet two (2) of the following three (3) criteria:

- The county has experienced significant wetland losses in the past 30 years.
- The county has undergone restoration efforts to encourage ecological stewardship.
- The county has a substantial coastline in relation to the Great Lakes.

These sites were to include several lacustrine wetlands and would be representative of a coastal watershed. Appropriate locations were selected after a thorough analysis of official documents detailing status and trend data relating to Michigan's wetlands, as well as scholarly literature (Soulliere and Monfils 1996; Lupi, Kaplowitz, and Hoehn 2002; Fizzell 2014; Fretwell et al. 1996). Figure 6 shows the study site locations.

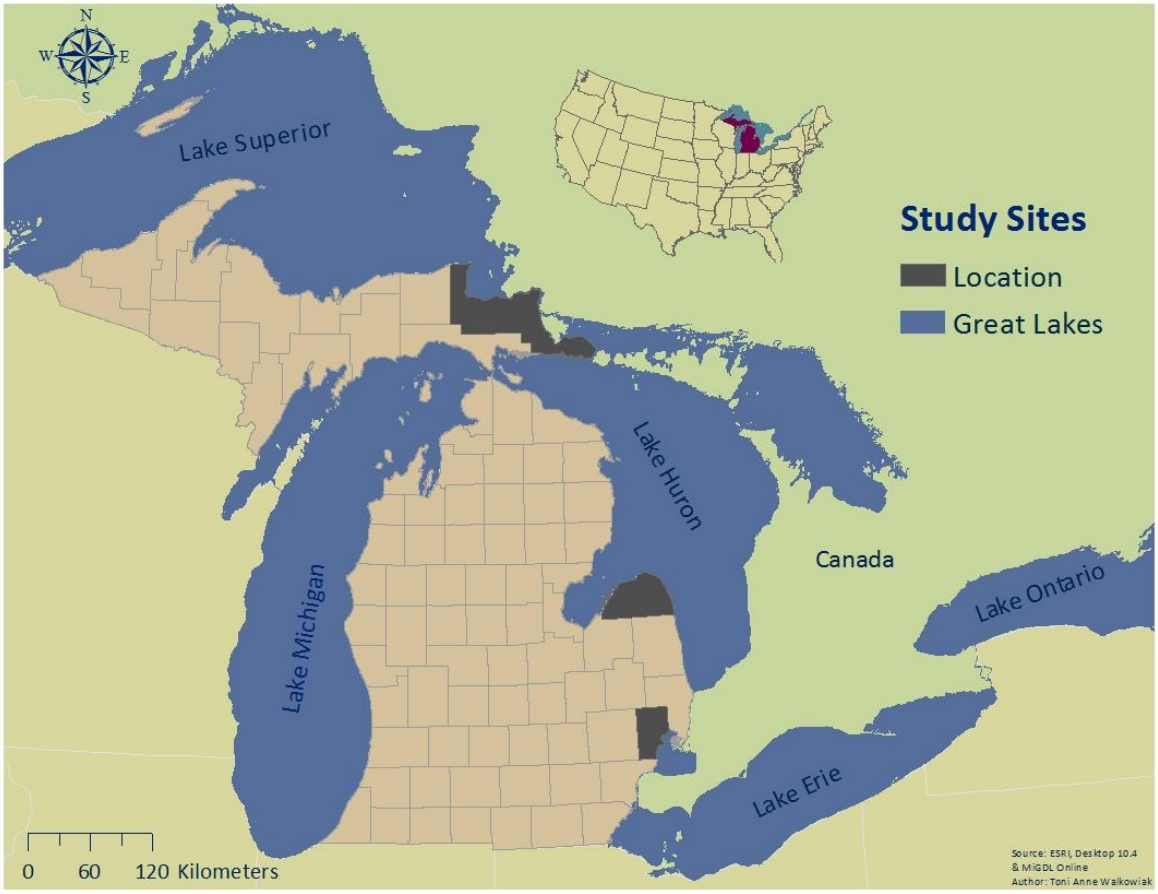

Figure 6. Map of Study Site Locations

Chippewa County

Chippewa County was selected as a research site due to ongoing reclamation attempts in recent decades, with the goal of recovering some of the wetlands lost after European settlement (Munuscong Potholes) (Soulliere and Monfils 1996). Since 1992, these restoration and construction efforts have been remarkably successful (Soulliere and Monfils 1996). The Munuscong Potholes wetland complex was developed to observe which waterfowl returned to this microhabitat, document the geophysical characteristics of these wetlands, and encouraged ecological stewardship. Regardless of the current preservation initiatives, during European colonization, Chippewa County suffered a loss of roughly 30% (145,572 acres or ~59,000 ha) of its original wetlands (Fizzell 2014). Nevertheless, wetlands still cover

343,735 acres (~140,000 ha) or ~20% of the overall land area (Fizzell 2014). The county has experienced zero wetlands losses in the past 30 years, due in part to the recovery efforts (Fizzell 2014).

Chippewa County occupies the northeastern most extent of Michigan's Upper Peninsula. The St. Mary's River runs adjacent to the coastline and separates the U.S. from Canada, and Lake Superior from Lake Huron by a narrow channel. The St. Mary's watershed is a network of waterways found within the Rudyard Clay Lake Plain ecosystem (Silbernagel et al. 1997). Figure 7, the map of Chippewa County offers a glimpse at the investigation sites and wetlands within said county. Figure 8 depicts the Munuscong Potholes, a wetland reclamation effort underway within Chippewa County.

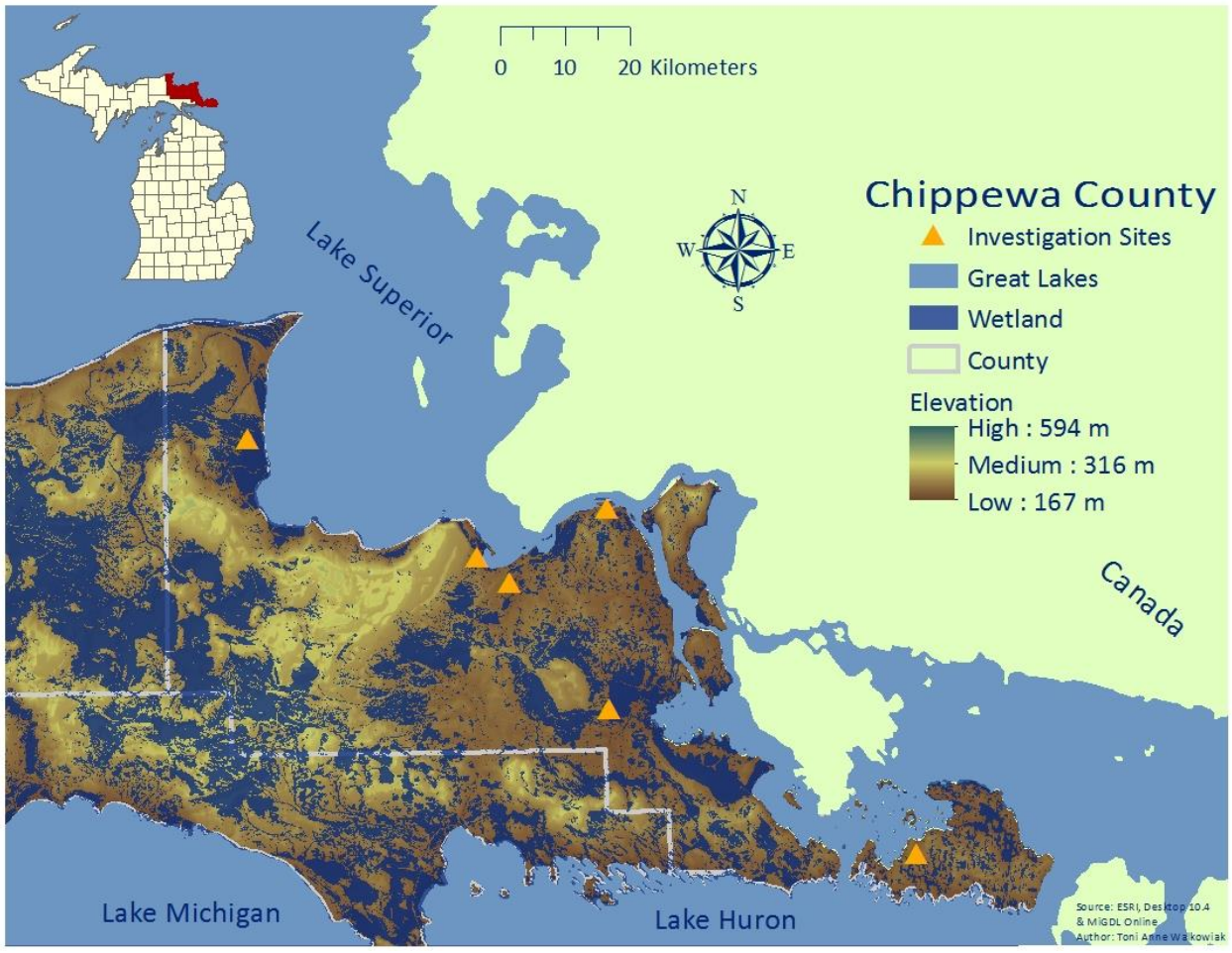

Figure 7. Map of Chippewa County Including Terrain, Wetlands, and Study Sites

Chippewa County's Munuscong Potholes

Figure 8. Munuscong Potholes; Constructed Wetlands by the DNR, NAWCC, Bay Mill Indian Community, Great Lakes Indian Fish & Wildlife Commission, and Ducks Unlimited, Inc. within Chippewa County, Michigan

Huron County

Huron County was selected for data collection, as the county has experienced approximately an 11% loss of wetlands since 1978. In the intervening time since European occupation, the county has lost a bewildering 83% of its original wetlands, some 178,225 acres (~72, 000 ha) (Fizzell 2014). Thus, placing Huron County among the most affected by wetland degradation within Michigan since European settlement, and the only second behind Macomb County in wetland drainage since 1978 (Fizzell 2014). The county still hosts roughly 36,000 acres (~14,500 ha) of wetlands (Fizzell 2014).

Huron County covers the entire tip of Michigan's "thumb" region and surrounded by Lake Huron and Saginaw Bay. The area encompasses the Saginaw Lake Plain ecosystem (Ricketts 1999; Bailey 2009; US EPA 2016). The Pigeon and Willow Rivers are the largest within the county. These watersheds are composed of many, relatively small perennial, intermittent, and ephemeral streams that flow directly into Lake Huron or Saginaw Bay (Bailey 2009). Figure 9 is a map of Huron County and provides a visualization of the investigation sites and wetlands within said county. Figure 10 are images captured while working in Huron County for field research.

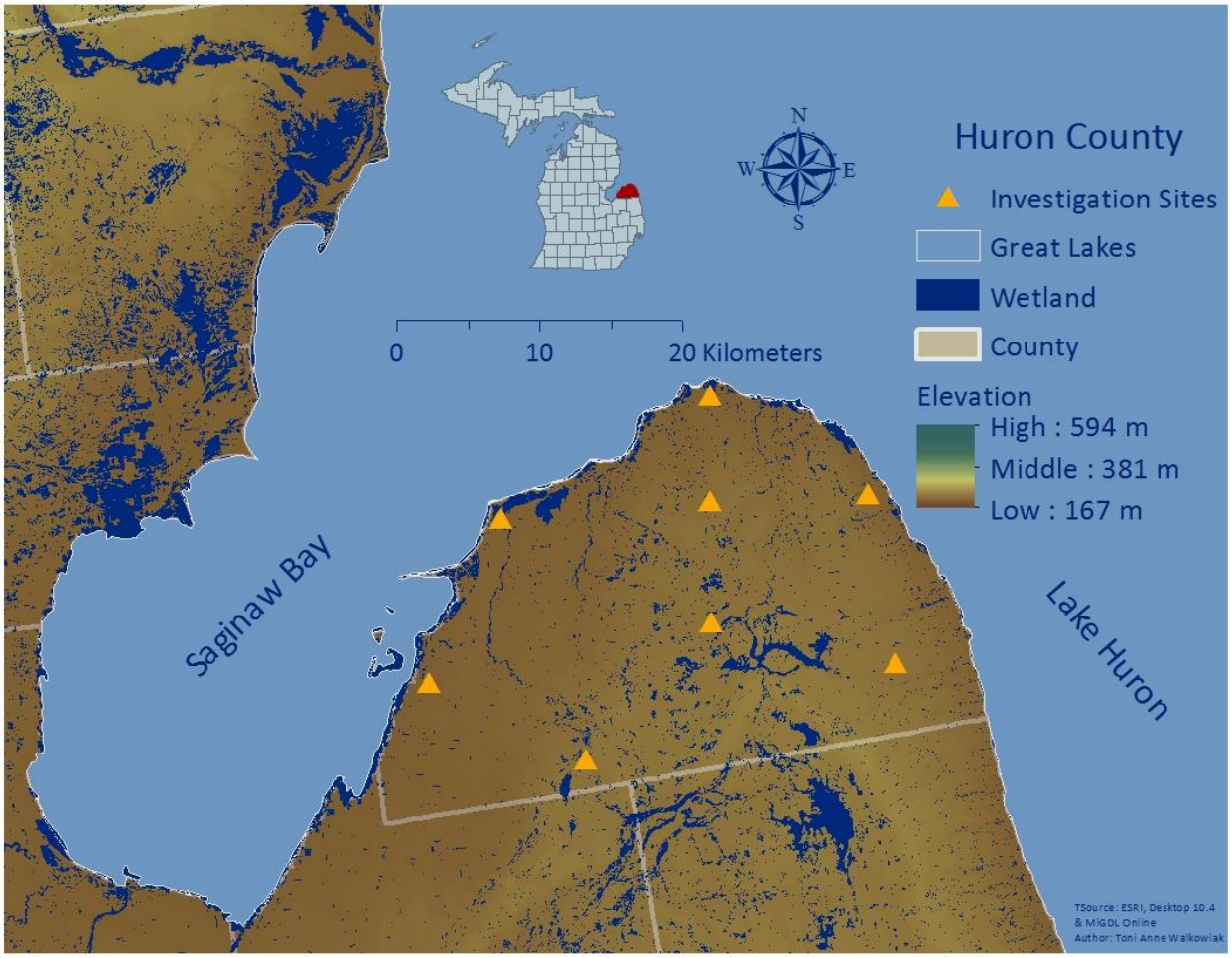

Figure 9. Map of Huron County, Michigan Including Terrain, Wetlands, and Study Sites

Figure 10. Images of a Freshwater Palustrine Marsh (left) and a Lacustrine Wetland adjacent to Lake Huron (right)

Macomb County

Macomb County was elected as the final research site because the county has lost 86%, some 114,927 acres (~47, 000 ha), of the original wetlands, with roughly 17% being drained since 1978 (Fizzell et al. 2015). The county ranks in the top five Michigan counties affected by wetland depletion following the arrival of Europeans, and first amid the most wetland losses after 1978. Macomb County still hosts approximately 17,851 acres (~7,700 ha) of wetlands (Fizzell 2014), most of which are located in Macomb County Metro Park surrounded by Lake St. Clair.

Macomb County is in southeastern Michigan's population corridor and rests upon the shoreline of Lake St. Clair (sometimes called Michigan's 6th Great Lake). Canada is only 10 miles away, just across the lake at it northernmost location. The county is mainly covered by the Clinton River watershed, which flows directly into Lake St. Clair, and is a large part of the Maumee Lake Plain ecosystem (Ricketts 1999; Bailey 2009; US EPA 2016). Figure 11 is a map of Macomb County and affords a graphical view of the investigation sites and wetlands within said county. Also, the images that follow displayed in Figure 12 were captured by Toni A. Walkowiak while in the field collecting research data.

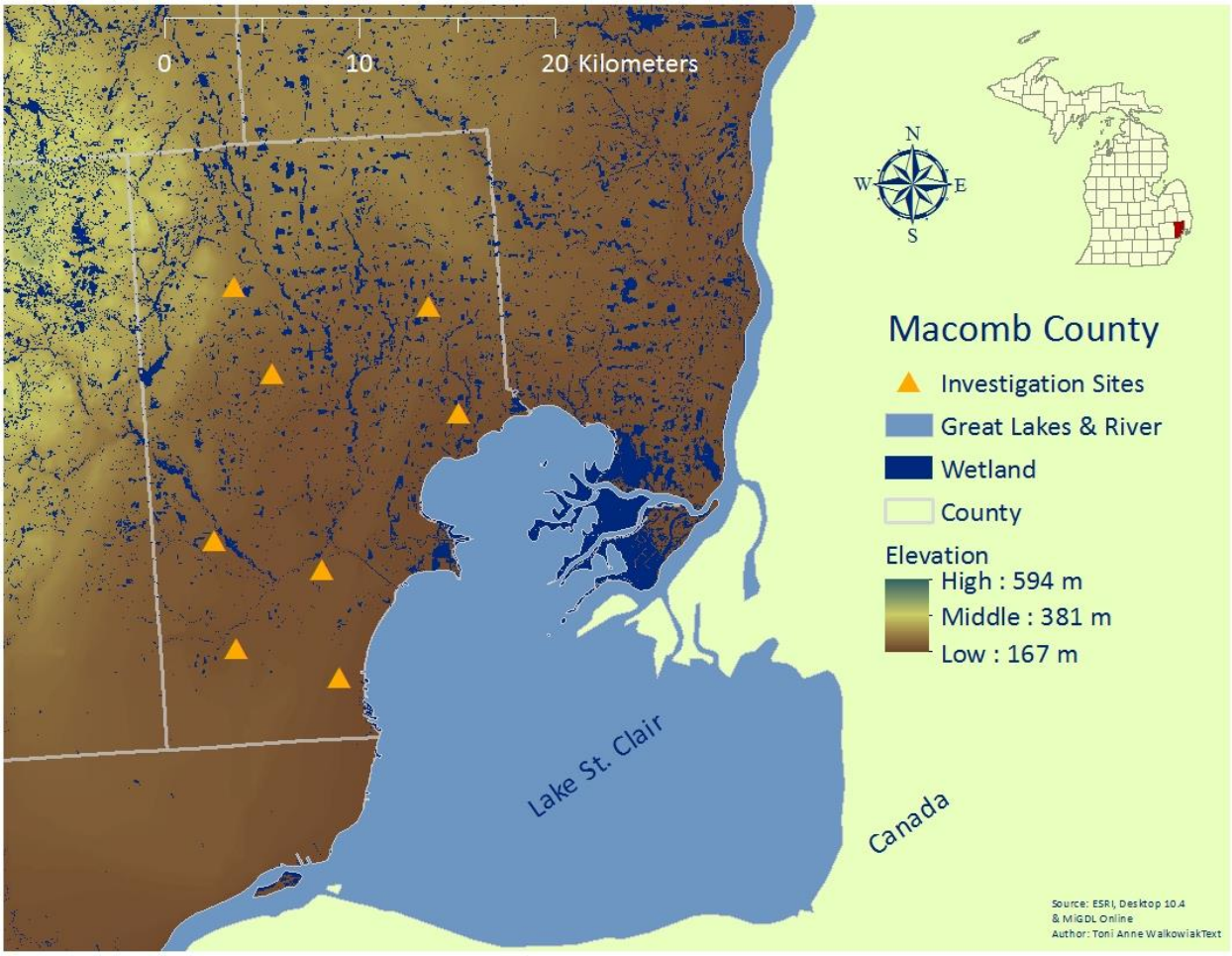

Figure 11. Map of Macomb County, Michigan including Terrain, Wetlands, and Study Sites.

Figure 12. Images of a Freshwater Lacustrine Marsh (left) from Lake St. Clair Metro Park (right).

PARTICIPANTS

Participation was garnered either by door-to-door canvassing or cold calls, to remain in compliance with IRB regulations of random and anonymous selection. The object was to assemble a group of participants that represented a wide-range of demographic categories, which exemplify the county's population (Campanelli 1997; Krueger and Casey 2014; Lowery and Morse 2013).

An opening dialogue was initiated to gain willing participants. Each person was greeted with:

> *"Good day (morning, afternoon, evening),*
>
> *My name is Toni Anne Walkowiak, and I am a graduate student at Michigan State University. I am conducting my thesis research within (respective county) this (week (when in-person) or summer (when cold calling), and I was wondering if you might have a few minutes to speak with me to see if you are interested in participating?" (after agreeing to listen)*
> *"This research project is intended to collect environmental perception data regarding water resources within the state of Michigan, specifically wetlands ecosystem services. "(**Wetland Ecosystem Services** are the natural processes (functions) that wetland perform regardless of human intervention; these functions efficiently and effectively produce resources, which benefit (use and non-use values) nearby inhabitants, namely humans and other wildlife)."*
> *"We are particularly interested in gathering information about residents' knowledge regarding wetlands ecosystems, and how they support the surrounding environment. Also, to discover whether participants can distinguish between their functions (natural purpose/job) and values (use benefits/assets)."*
> *"To collect this information, there are two experiments. One is straightforward and takes roughly 5-10 minutes to complete. The goal of this inquiry is to see whether people can distinguish between wetland functions and values (their ecosystem services). This experiment is an online digital card sorting survey, where each participant sorts thirty (30) cards (with words or phrases that are describing wetland ecosystem services) into two (2) categories: functions and values."*
> *"The second experiment is a tad lengthier but should take no more than 30 minutes. The aim is to collect data about residents' knowledge of wetland ecosystems. This experiment is a semi-structured focus group interview (discussion forum), where each participant answers eight sequential questions regarding wetland ecosystem services with an emphasis on values (use benefits/assets)." (if they agreed to the terms, a consent form(s) was provided (in-person or via email) for authorization of these conditions.)*

In-person interviews were small groups, of no more than five people, who fit into the same stakeholder category (e.g., business owners, employees of local/state/federal/tribal agencies, students, et cetera). In addition, would meet at a designated area, TBD (e.g., local library, city hall, or university conference room) (Kontogianni et al. 2001; Reed et al. 2009). The same remained true for the online activities, except their destination was either at home or the office. These parameters fit the ongoing dialogue amongst scientists who claim that qualitative data collection calls for small sample sizes; with emphasis on abridged groupings, which allows for a broad overview of the regional population's viewpoint (Brown et al. 2000; Olmsted-Hawala 2006; Kaplowitz and Witter 2008; Reed et al. 2009).

The original intention was to assemble five people from each stakeholder category for a sample size of twenty-five individuals per activity, for each county; or 75 participants/study for an overall sample size of 150 residents. Because this research was exploratory, finding willing participants within all stakeholder categories was harder than expected. Thus, this study was deemed a convenience sample or availability sampling. Consequently, demographic data was utilized in place of stakeholder categories.

In the end, 80 individuals took part in the online digital card sort, and 36 people contributed to the semi-structured focus group interviews. Table 6 shows the final number of participants for each county and individual activity.

Table 6. Number of Participants per County for each Research Activity

COUNTY	ACTIVITY	
	Focus Group	**Card Sort**
Chippewa	15	38
Huron	9	20
Macomb	12	22

ACTIVITIES

After the locations had been determined, the step-by-step preparation and protocol for each activity began. Upon arrival to either the in-person focus group interviews or the two online applications

(i.e., FocusGroupIt or OptimalSort), a quick review of the day's agenda, the research objectives, and the operational diagrams being employed for these activities was explained. The italicized text that follows was the verbatim dialogue.

> *"Hello, and thank you for joining me today. I'm just going to give you a little bit of background information on what we're planning to discuss (accomplish)."*
>
> *"Some people are familiar with this, while some people are relatively unfamiliar. Either way, this is the Ramsar Convention's framework of the values of a wetland. Ramsar is the largest wetlands treaty organization in the world. They're based in Iran, and roughly 160 countries are part of this alliance. Their objective is to protect wetlands, and also educate people on wetlands. They mainly focus on wetland values, in terms of direct and indirect uses for economic purposes. Their usage of indirect use values is actually wetland functions (natural processes). And so, these are the topics that I want you all to keep in mind when we get into the focus group questions (or card sorting survey). The fact that people can fish in them. You know, they help with flood control and things of that nature."*
>
> *"Now, this one is from the USGS, and this is a different framework. They break it down into the internal values (essential for the health of the wetland) and external values (cultural attributes that spread beyond the wetland) and functions (natural processes), which is where we are today. We're going to be discussing wetland ecosystem services, paying particular attention to values (internal or external) (card sort: paying attention to the differences between functions and values). Those are the terms that I'm using. Ramsar uses direct and indirect. So, similar, but different. Ok, so, here we go…"*

Focus Group Study

Focus groups are a recognized and reliable method for qualitative examinations regarding wetlands (Kaplowitz and Kerr 2003; Kaplowitz, Lupi, and Hoehn 2007; Reed et al. 2009). This tool incorporated group participation techniques and offers rich text along with efficiency in sampling (Krueger and Casey 2014). Accordingly, semi-structured focus group interviews were utilized to ask a sequence of questions, with the intention of gathering elicit responses and ascertain individuals' knowledge of wetland ecosystems services (Kaplowitz 2001; Kaplowitz, Lupi, and Hoehn 2007; Reed et al. 2009).

The focus group interviews took place in a relaxed environment that put participants at ease. Thus, allowing them to provide thoughtful and meaningful answers (Frey and Fontana 1991; Eliot et al. 2005; Kaplowitz, Lupi, and Hoehn 2007).

Regardless of the location, the online participants seemed to have more brevity when responding (Kitzinger 1994; Schneider et al. 2002). Perhaps due, in part, to the independent nature of this forum (Schneider et al. 2002). Nevertheless, their answers were introspective and offered great insight into the minds of these individuals (Schneider et al. 2002). Then again, the in-person interviews allowed the opportunity for extra dialogue to take place (Kitzinger 1994; Schneider et al. 2002). As such, people took those liberties to delve further into their perceptions and knowledge to share their experiences with other people within the groups.

The focus group interviews addressed two research questions:

1. How do residents describe wetlands?
2. What types of wetland ecosystem services do residents identify most often?

These questions helped to create a "baseline" for future research about Michigan wetland ecosystems, and future wetland management practices (Gollin, McMillen, and Wilcox 2004; Olmsted-Hawala 2006; Kaplowitz, Lupi, and Hoehn 2007). There were eight sequential questions appropriated from previous wetland research, where focus group interviews were the primary activity. (Weiss 1995; Morgan 1997; Kaplowitz, Lupi, and Hoehn 2007). Each question follows the guidelines established by (Eliot et al. 2005), and meet the following conditions:

- Conciseness.
- One dimensional.
- Worded clearly.
- Open-ended.
- Non-threatening or embarrassing (also a condition of the IRB).
- Written to prevent simple "yes" or "no" answers.

In keeping with these parameters, the focus group questions read as:

1. How would you describe a wetland?
2. What are some ecosystem services provided by wetlands?
3. Why are these wetland ecosystem services important to you?
4. What values do you associate with these wetland ecosystem services?
5. Who benefits from these wetland ecosystem services?
6. How are these wetland ecosystem services relevant to your everyday life?
7. Rate these values on a scale from 1-10, where 1 is “mildly important,” 5 is “considerably important,” and 10 is “exceedingly important.”
8. Are there any other issues you would like to address regarding the values associated with wetland ecosystem services?

After a review of the research objectives and guidelines had been explained (*see greeting above*), the activity began. For the in-person semi-structured focus group interviews, the sequence of questions was read aloud one at a time. Allowing participants a few minutes to think about how they wanted to respond or jot down a few words on a piece of blank paper (which was provided). A fifteen-second warning was given, and then people were encouraged to reply at their will. No set order of participant responses was followed for any of the questions. The only caveat was if an individual was unresponsive for too long (more than one question) a non-threatening comment was made by the coordinator encouraging them to express their viewpoints whenever they felt comfortable.

In contrast, the online focus group forum was slightly different due to software constraints. The questions were laid out in the same order, but participants were not given any set time to contemplate their responses. Also, there was no obvious way to nudge someone if they were unresponsive for extended periods because people entered the website at their leisure.

Closed Card-Sort Study

Card sorts methods are used to explore the organic fashion into which people group items together (Campanelli 1997). Thus, card sorts become a tool for collecting data about individual's perceptions related to a set of stimuli; in this example, wetland functions and values (Cataldo et al. 1970; Campanelli 1997; Gollin, McMillen, and Wilcox 2004; Roth et al. 2011).

A close-ended card sort asks participants to classify the subject matter into predetermined categories; an open-ended card sort allows participants to organize the stimuli into their categories and label those groupings as they choose (Jackson and Trochim 2002; Righi et al. 2013).

Open-ended sorts offer a glimpse into the psyche of individuals and reveal how they mentally categorize each card, also what phrases (words) they use to classify each group (Righi et al. 2013). Close-ended sorts help reveal the degree to which the participants agree on which cards belong to a particular category (Roth et al. 2011). Closed sorting is evaluative, and can be used to gauge if a given set of classes offers an efficient way to organize a given set of stimuli. A closed-ended online digital card sorting survey was chosen to gather data about residents' ability to distinguish between wetland functions and values. To that end, this card sorting activity was designed to create a "baseline" for understanding residents' accuracy when asked to categorize those wetland ecosystem services (Gollin, McMillen, and Wilcox 2004; Olmsted-Hawala 2006; Kaplowitz, Lupi, and Hoehn 2007). This portion of the research addressed the question, can residents accurately classify ecosystem functions and values related to wetlands?

Upon arriving at the website, participants entered the secure password specified in the email instructions. Each participant was required to complete the demographic survey, was given the directions for the card sort, and asked to review the WES concepts adopted for this research (e.g., Ramsar Convention and USGS), then the sorting began. As per the directions, the participants were asked to look at the list of cards on the left-hand side of the screen and then requested to sort those cards into the

categories provided on the right: functions and values. At the end of the experiment, participants had the opportunity to add any supplemental thoughts, which a few were compelled to do so.

For this experiment, each participant sorted 30 cards (with words or phrases) into two categories: functions and values. The cards represent both types of WES, i.e. functions and values set forth by both the Ramsar Convention and the USGS operational diagrams. For instance, water quality is a value and retention of nutrients is a function; sports fishing is a value, but water storage is a function (Fretwell et al. 1996; Ramsar Convention Secretariat 2013). Table 7 displays the accurate classification for the 30 digital cards being sorted.

Table 7. Correct Classification of the Cards for The Card Sorting Activity

WETLAND FUNCTIONS	WETLAND VALUES
Atmospheric Processes	Education
Biochemical Processes	Hay Harvest
Fish Sanctuaries	Historical/Archeological Protection
Flood-Peak Reduction	Livestock Forage
Groundwater Recharge and Discharge	Livestock Watering
Local Climate Stabilization	Medicine
Retention of Nutrients	Peat Harvest
Sediment Trapping	Recreation
Shoreline Stabilization	Shellfish Harvest
Storm Protection	Shoreline Erosion Protection
Support Plant and Animal Life	Sport Fishing
Velocity Reduction	Timber Harvest
Water Purification	Water Quality
Water Storage	Water Quantity
Waterfowl Habitat	
Wildlife Sanctuary	

ANALYSIS

Upon completion of the focus groups, some data preparation was required prior to coding (Welsh 2002; Walsh 2003; Leech and Onwuegbuzie 2011). This preparation included the removal of unnecessary clutter from these data, spelling error corrections, deletion of extra spaces, or superfluous columns and rows, et cetera (Walsh 2003; Leech and Onwuegbuzie 2011; “NVivo Plus | QSR International” 2017).

In addition to the information above, some individual data sets required conversion into spreadsheets, such as the demographic surveys and online card sorting data. Further, the focus group demography required that these classifications be entered individually and correctly. Otherwise, they were unreadable within NVivo 11 Plus (Welsh 2002; Walsh 2003; "NVivo Plus | QSR International" 2017).

Qualitative Coding

Qualitative coding is the labeling, compiling, and organizing of data to reveal conceptual patterns. The semi-structured focus group interviews were coded to help organize the data and make sense of textual data. Demographic information, such as age group, educational attainment, gender, and occupation was coded along with participants' responses. Allowing for new themes and patterned relationships to develop within each data set. A list of initial codes pertaining to wetland ecosystems services was developed based on previous research (Kaplowitz and Kerr 2003; Kaplowitz, Lupi, and Hoehn 2007; Lowery and Morse 2013; Greenland-Smith, Brazner, and Sherren 2016). These codes were recognized as descriptive codes to reflect a primary topic seen within the activity notes (Saldaña 2013). Through analysis emergent codes including concepts, meanings, relationships, et cetera (i.e., themes) arose and applied. These codes were more participant-oriented than the pre-set codes (Saldaña 2013). Together, these coding cycles allow for data synthesis to consolidate codes into reliable categories that, when combined, form patterns (Saldaña 2013).

Following the coding cycles set forth by (Kaplowitz 2001; Kaplowitz, Lupi, and Hoehn 2007; Saldaña 2013), several queries were run to further mine through participants response, and amass additional patterns and themes within the data sets (Welsh 2002; Walsh 2003; Saldaña 2013). Thus, serving to interpret further participants' perception and knowledge regarding WES (Basit 2003; Leech and Onwuegbuzie 2011). These queries ranged from code queries, matrix queries, and text queries to compound queries. Queries illustrate whether participants spoke with similar word choices, phrases, and

sentiments or themes. Once more, queries demonstrated if age group, education, or gender played a role in their perception and overall knowledge, and helped in answering the research questions.

Sort Accuracy

The card sorting survey required the organization and synthesis of data to establish patterns within participants' answers. A number of data transformations were performed on the card sort data using Microsoft Excel and the OptimalSort web tools ("Card Sorting Software | Optimal Workshop" 2016).

RESULTS

The objective of this research was to explore how residents of Michigan understand and perceive wetland ecosystem services. As previously stated, most wetland research has focused on their economic value, with an emphasis on best management practices, as well as socio-cultural values, regarding perceived benefits. However, those case studies have focused mainly on international communities located within France, Sweden, or Uganda, along with many others. The cultural investigations that have been conducted within North America have been primarily completed in Canada and Mexico, with a few being conducted in Michigan. Albeit, most of those concentrated on mid-Michigan. This analysis pays attention to the Michigan counties that have experienced significant wetland losses in recent years or have undergone restoration initiatives. Residents from Chippewa, Huron, and Macomb counties were asked to participate in either a semi-structured focus group interview or an online card sorting survey, with some opting to contribute to both activities.

Additionally, this research provides future researchers with some information about the gaps in residents' knowledge about wetland ecosystems. Accordingly, this section focuses on characterizing residents' perceptions of wetland ecosystems services. Next, this section centers on the broad patterns and emergent themes or theories that came from the data analysis itself, with an in-depth look at both investigations, separately. Finally, a discussion of the implications of these discoveries within the broader scope of wetland research for Michigan and the health of the Great Lakes ecosystem.

FOCUS GROUPS

The following presents the results from the focus group interviews. This activity was intended to reveal what wetland ecosystem services were most recognizable by residents. In these interviews, a series of eight questions were asked to elicit responses from participants. These questions were asked sequentially and borrowed from previous research, applied either to focus group or individual interview activities (Morgan 1997; Weiss 1995; Kaplowitz, Lupi, and Hoehn 2007).

Participants

In the end, 36 participants answered the focus group interview questions. There were eight in-person interviews and 28 online interviews. Regardless of the forum, people had the opportunity to communicate with other participants, with the hope of adding further meaning to their answers. Participants, in both forums, did communicate with others and shared experiences. Individuals who contributed to this activity ranged from 19-80 years of age. Children 18 and under were absent from the investigation, due to added parental consent necessary for participation. One participant has lived in Michigan for 3-5 years, while the other n=35 have lived in Michigan for 9+ years, and all of them enjoy recreational activities (i.e., boating, fishing, hunting, hiking, nature walks, and swimming). These demographics were applied to delve further into generational and occupational differences and similarities of knowledge, which offered a unique perspective into the minds of participants, allowing certain themes to emerge. In addition, these demographics were used to discover whether educational attainment and gender played a role in a person's overall environmental perception of WES. Table 8 indicates the gender and age distribution of participants.

Table 8. Number of Participants for the Focus Group Activity Identified by Age and Gender

AGE GROUP	FEMALE	MALE
19-34-years old	5	5
35-44-years old	1	3
45-54-years old	8	3
55-64-years old	5	1
65-80-years old	3	2

Thematic Codes

Qualitative coding using the codes described in the Methods section above were applied to the focus group texts. Personal quotes were coded and utilized to express people's opinions and gave merit to their worldview. For instance, some participants mentioned aesthetics in relation to human refuge and

quality of life; others talked about naturalness in relation to the balance of nature. Additionally, individuals spoke of biodiversity in the context of breeding or flora, and fauna. The coding dictionary applied to the focus group text can be found in Appendix B and C at the end of this document.

Cross Tabulations of Wetland Ecosystem Services

As seen in Table 9, participants with higher educational attainment referenced more wetland ecosystem services than those with less education, at a rate of roughly 30%. However, there was a bias in the sample size of lower education participants, as there were three with a *high school education or equivalent* and one with a *vocation or technical training*. Nevertheless, individuals with *some college* spoke about conservation and education more frequently than the others at 15% and 14%, respectively. Also, people who received their *bachelor's degree* talked about filtration 43% more often than those with other forms of education levels. Again, individuals who have higher educational attainment were better represented, in comparison to other educational categories for these focus group interviews.

Although, when all the WES were consolidated and coded into the Millennium Ecosystem Assessment's (MEA) broad categories: cultural, provisioning, regulating, and supporting, a few informative patterns arose. For example, cultural services were mentioned 2.5 times more often than supporting services, 3.5 times as frequently as regulating services, and a staggering 15.5 times more often than provisioning services. People mentioned provisioning services in terms of a wetlands' ability to offer agricultural services, such as being a food and water sources. The following five tables provide a tabular display of the MEA's four broad categories by demographics, such as educational, generational, occupation, gender, and organizational affiliation (sector), respectively. These visual aids allow thematic patterns within coding schemes to emerge and offers insight into these demographic differences.

Table 9. Cross-Tabulation of Participants' Educational Attainment with the Number of Times the MEA Categories were Mentioned

	MEA CATEGORY			
EDUCATIONAL ATTAINMENT	**Cultural Services**	**Provisioning Services**	**Regulating Services**	**Supporting Services**
Bachelor's Degree	142	10	57	80
High school or equivalent	12	1	5	8
Master's Degree	162	11	33	59
Professional degree (MD, JD, etc.)	4	0	3	6
Some college	145	7	38	38
Vocational/Technical School	19	2	2	4

Aesthetics and conservation were regularly mentioned cultural services when participants were describing wetlands ecosystem services; as one person with a *bachelor's degree* and on with *some college* noted,

> *"They provide a natural place where you can get away from the sights of buildings and cars and the man-made noises."*
>
> *"It's important to have a place where it's still wilderness, and you can actually go out and appreciate that and preserve that ecosystem and see the difference flora and fauna that's there."*

Residents aged *65-80 years old* and *19-34 years old* talked of aesthetics roughly double the number of times than the other groups. In addition, the *19-34-year-old* age group referenced conservation and education 50% more frequently throughout the focus group interviews than any other age group. They also mentioned protections, filtration, and flood control as WES more often as well. The sentiment of recreational space and wildlife were also spoken about at higher rates by people *19-34 years old*. On the other hand, individuals who are *45-54 years old* and *55-64 years old* addressed agriculture, microclimate, and vulnerability when no other age group did. Also, only the participants *35-44 years old* referenced flora and fauna as well as food and water sources as WES.

After consolidating the generational data into MEA classification, and similarly to the more extensive list of WES, people *19-34-years old* referenced all ecosystem services more often than other age

groups. With the exception of provisioning services, which were cited more frequently by individuals who were between *45 and 54-years old*. These two generational groups had more participants than the other three. Compared to the cross tabulation of educational attainment, cultural services were mentioned more often than the other services. However, supporting services pooled a larger number of references during the analysis of age rather than education. For example, one *34-45-year old* explained about wetland ecosystems,

> *"They are often diverse and highly complex ecosystems that are interesting to try and understand. I enjoy the native wildflowers and plants that grow in quality wetlands both for their aesthetics and for the diversity they provide to the natural system."*

Table 10. Cross-Tabulation of Participant's Age Group with the Number of Time the MEA Category was Mentioned

	MEA CATEGORY			
AGE GROUP	**Cultural Services**	**Provisioning Services**	**Regulating Services**	**Supporting Services**
19-34-years old	197	9	70	110
35-44-years old	38	6	37	57
45-54-years old	82	11	43	106
55-64-years old	83	1	33	80
65-80-years old	101	4	41	78

Governmental, municipalities and tribal *employees* spoke of habitat and naturalness in detail, and more regularly than any other area of occupational groups. *Educational support staff* presented an aesthetic viewpoint, with habitat being among the most commonly referenced themes as well. At the same time, students noted conservation at greater rates, but education was also referred to quite often. On the contrary, *stay-at-home moms*, and *primary and secondary school teachers* focused on quality of life, which included air quality and provisions, such as food in keeping with the vital ecosystem services afforded by wetlands. Individuals employed in the *agriculture, forestry, fishing, or hunting* classification, mentioned aesthetics, filtration, habitat, flora, and fauna much more regularly than the other WES. The sole participant who employed in the *construction* field spoke about recreation, flood control, and wildlife

more than the other WES. In the interim, *retirees* expressed contradictory opinions on WES in general. Some believe they are a critical component to the planet's, as well as humanity's, well-being; others think the laws protecting them are too stringent and should be less rigid.

Meanwhile, people who work in the *educational sector*, referenced cultural services at a greater rate than other areas of employment, when examining the MEA categories. Even though, *government and public administration* participants outnumbered the academic segment of the population matrix. On the other hand, *K-12* teachers mentioned provisioning services far more often than others did; and *retirees* talked about the regulating services more frequently than other sectors, as there were only 4 of them. One *K-12 teacher* expressed this of wetlands' provisioning services,

> *"I need oxygen to breathe and food to live. If the plants aren't there, the animals would not have anywhere to live, and people wouldn't have food or oxygen."*

While one *retiree* said,

> *"They are necessary for clean drinking water and also important in purifying our groundwater."*

Table 11. Cross-Tabulation of Participant Occupation with the Number of Times the MEA Categories were Mentioned

	MEA CATEGORY			
OCCUPATION	**Cultural Services**	**Provisioning Services**	**Regulating Services**	**Supporting Services**
Agriculture, Forestry, Fishing, or Hunting	11	4	10	19
Construction	9	1	4	5
Education-College, University, or Adult	56	2	13	31
Education- IT Support	28	2	8	14
Education-Library and Legal Services	13	0	5	8
Education-Primary/Secondary (K-12)	31	7	9	18
Government and Public Administration	43	7	39	47
Homemaker	4	0	4	5
Information	0	0	0	0
Other____ Library	2	0	2	1
Other____ Non-Profit Conservation Fund	6	0	5	9
Religious	3	2	2	1
Retired	27	1	19	22
Scientific or Technical Services	9	3	5	4
Student	32	2	12	9
Unemployed	6	0	1	3

In contrast, female and male participants referenced education, human refuge, and recreational space in equal amounts. Nevertheless, males talked about wetland functions, such as flood control, groundwater recharge, and water filtration more often than females. Conversely, females spoke of aesthetics, biodiversity, and habitat more frequently than males.

On the other hand, when the MEA categories were taken into consideration, both *females* and *males* discussed each ecosystem services group equally. *Males* did reference regulating services at far greater rates and *females* mentioned cultural services much more often. As one *man* stated,

> *"Water Quality, ecological diversity, flood control, groundwater recharge, food (wild rice, water fowl, etc.)."*

And one *female* remarked,

> *"For me, it is the aesthetic beauty. I got myself some boots, and I go out there across from my house. It's that little wetland (redacted) where I go out, and I can see coyotes, beaver, porcupines. I can see raccoons; you know anything that is out there. I see Mallard ducks,*

all the time in the spring on those wet spots. I find their nests. (redacted). The diversity of what's growing out there, the choke cherries and thorn apples and all of the plants and cranberries."

Table 12. Cross-Tabulation of Participant Gender with the Number of Times the MEA Categories were Mentioned

	MEA CATEGORY			
GENDER	**Cultural Services**	**Provisioning Services**	**Regulating Services**	**Supporting Services**
Female	308	18	123	250
Male	203	13	101	181

Word Occurrence

The results for the semi-structured focus group interviews were further mined to explore word count occurrences, or the number of times a certain demographic classification mentioned individual wetland ecosystem services (e.g., retention of nutrients and water quantity). The word frequency query and text search query within NVivo 11 Plus were utilized to establish the rate at which participants spoke about any WES, so unrelated to the MEA broad categories results discussed previously. Each of the following eight tables was normalized as well as converted into weighted percentages, as can be seen in Table 13 and so on.

Table 13. Ecosystem Services Rate of Occurrence

DEMOGRAPHIC VARIABLE	MOST COMMON WETLAND ECOSYSTEM SERVICE	OCCURRENCE (%)
AGE GROUP		
19-34-years old	Habitat	0.67%
35-44-years old	Habitat	0.34%
45-54-years old	Habitat	0.75%
55-64-years old	Habitat	0.53%
65-80-years old	Habitat	0.51%
EDUCATIONAL ATTAINMENT		
Bachelor's Degree	Habitat	1.02%
Doctoral Degree	-	0%
High school or equivalent	Habitat	0.14%
Master's Degree	Habitat	0.86%
Professional degree (MD, JD, etc.)	Habitat	0.12%
Some college	Habitat	0.59%
Vocational/Technical School	Habitat	0.09%
GENDER		
Female	Habitat	1.63%
Male	Habitat	1.20%
OCCUPATIONAL AREA		
Agriculture, Forestry, Fishing, or Hunting	Habitat	0.28%
Construction	Habitat	0.08%
Education-College, University, or Adult	Habitat	0.38%
Education-College, University, or Adult - IT Support	Habitat	0.23%
Education-Library and Legal Services	Habitat	0.09%
Education-Primary/Secondary (K-12)	Habitat	0.18%
Government and Public Administration	Habitat	1.89%
Homemaker	Habitat	0.10%
Information	-	0%
Other _____Library	Habitat	0.02%
Other _____Non-Profit Conservation Fund	Habitat	0.15%
Religious	Habitat	0.03%
Retired	Habitat	0.37%
Scientific or Technical Services	Habitat	0.06%
Student	Habitat	0.17%
Unemployed	Habitat	0.04%
ORGANIZATIONAL LEVEL		
Don't know	Habitat	0.09%
Non-profit	Habitat	0.26%
Other	Habitat	0.10%
Local Government	Habitat	0.02%
Private Sector	Habitat	0.39%
Public Sector	Habitat	1.94%

This table shows that each demographic category spoke about habitat more often than any other ecosystem services. Aesthetics was mentioned more frequently by a few demographics. However, aesthetics represents a USGS SolVES ecosystem service and was not part of the operational diagrams being referenced for this research as a WES. Table 14 provides a list of the top five WES mentioned by the entire sample group (n=36). Once again, these occurrences were normalized and converted into weighted percentages.

Table 14. Top Five Most Mentioned Wetland Ecosystem Services across the Entire Participant Pool

ECOSYSTEM SERVICE	OCCURRENCE (%)
First Most	Habitat at 2.84%
Second Most	Filtration at 0.63%
Third Most	Recreation & Biodiversity at 0.59%
Fourth Most	Water Quality at 0.48%
Fifth Most	Education at 0.45%

In addition to the word occurrences inquiries, a word frequency query was conducted to ascertain which adjectives were cited most often for each of the eight focus group questions. These occurrences were normalized and converted, as well. Table 15 offers a visual aid for these unique noun modifiers.

Table 15. Top Five Most Common Adjectives used to Describe Wetlands

ADJECTIVE	OCCURRENCE (%)
Saturated	2.35%
Wet	1.77%
Low-lying	1.01%
Thrive	0.76%
Natural	0.63%

As can be seen in Table 15, saturated was the most often cited adjective when participants were asked to describe a wetland. Question two offered a slightly different list of adjectives to explain what were some of the WES mentioned by participants. Table 16 brings these word choices into the mix.

Table 16. Top Five Most Common Adjectives used to Reference a Wetland Ecosystem Services

ADJECTIVE	OCCURRENCE (%)
Water(y)	5.79%
Natural	2.13%
Protection	1.22%
Clean	0.61%
Good	0.61%

The adjective *watery* came up more often than any other modifying word when prompted to discuss some WES. "Water quality" was a commonly referenced term, but water, by itself, does not constitute an adjective. On the other hand, when the word frequency query parameters were selected, the option to generate a list of stemmed words was chosen; hence, *watery*. Table 17 illustrates the responses for question three, why are these wetland ecosystem services important to you?

Table 17. Top Five Most Common Adjectives used to Emphasis Importance

ADJECTIVE	OCCURRENCE (%)
Natural	3.07%
Diverse	1.34%
Clean	0.96%
Helpful	0.96%
Useful	0.77%

It was found that *natural(ness)* and diversity were the most common adjectives to explain the importance. Granted, naturalness was neither a WES by the standards of Ramsar, USGS, nor the MEA, but *diversity* was representative of a WES by each of these organizations; albeit, biodiversity. Table 18 gives the responses for question four and offers a glimpse of what adjectives were used to describe the values people associate with WES.

Table 18. Top Five Most Common Adjectives used to Express Values

ADJECTIVE	OCCURRENCE (%)
Natural	1.91%
Important	1.37%
Protection	1.09%
Diverse	0.82%
Helpful	0.55%

Again, *natural* was the top chosen word as well as other similarly frequently referenced words, such as *protection* and *helpful*. Question five asked who benefits from these WES; thus, common adjectives were less emphasized because many people offered one-word responses, like "*everyone*" and "*we all do*." Table 19 offers a set of some newly indicated words that give a sense of how important aesthetics are to people.

Table 19. Top Five Most Common Adjectives used to explain Everyday Life

ADJECTIVE	OCCURRENCE (%)
Like	1.40%
Natural	0.80%
Clean	0.60%
Great	0.60%
Beauty	0.40%

Adjectives, such as *great* and *beauty* were now being referenced when discussing WES and relevance to everyday life.

CARD SORTING

The following presents the results of the online digital card sorting survey. The closed card sorting activity was designed to determine how accurately participants can categorize wetland functions and values. Figure 13 offers a summary of a number of time participants took to complete this activity.

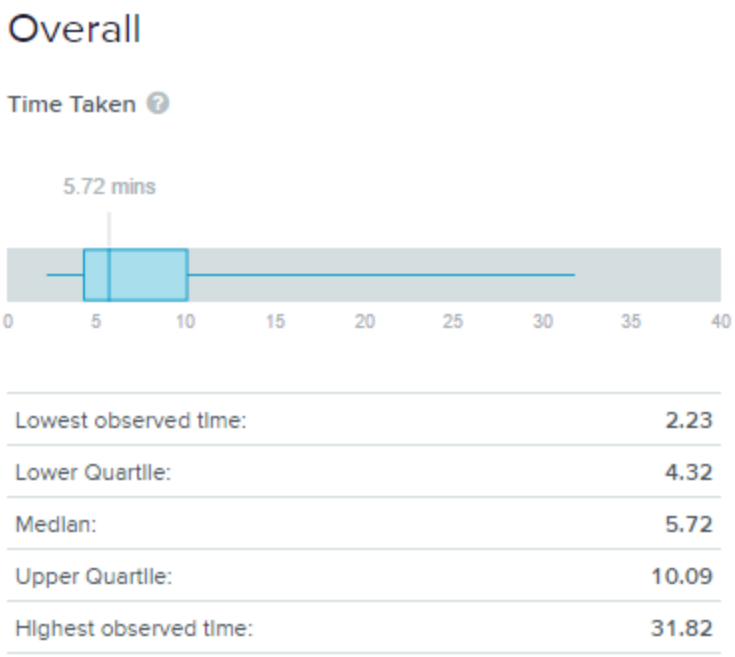

Figure 13. Overview of Time Taken by Participants to Complete the Closed Card Sorting Activity

Demography for the Online Card Sort

Eighty participants completed the card sorting activity. Once again, participants ranged in age from 19-80 years old. Two participants have lived in Michigan for 0-2 years, five for 3-5 years, one for 6-8 years, and the other n=72 have lived in Michigan for 9+ years. Demographic data were used to evaluate potential influences on how accurately individual sorted each card.

Table 20 offers an illustration of the results matrix by age group. The matrix results demonstrate how many times a person sorted each card into a category with no indication of accuracy.

Table 20. Cross-Tabulation of the Results Matrix by Age

	Atmospheric Processes		Biochemical Processes		Education		Fish Sanctuaries	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	24	4	24	4	8	20	14	14
35-44 years old	15	1	15	1	3	13	7	9
45-54 years old	14	2	12	4	4	12	7	9
55-64 years old	10	2	12	0	3	9	4	8
65-80 years old	7	1	7	1	2	6	1	7
Grand Total	**70**	**10**	**70**	**10**	**20**	**60**	**33**	**47**

	Ground-Water Recharge and Discharge		Flood-Peak Reduction		Hay Harvest		Historical/Archeological Protection	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	17	11	20	8	13	15	8	20
35-44 years old	15	1	11	5	8	8	2	14
45-54 years old	12	4	8	8	9	7	4	12
55-64 years old	9	3	10	2	6	6	3	9
65-80 years old	5	3	5	3	1	7	1	7
Grand Total	**58**	**22**	**54**	**26**	**37**	**43**	**18**	**62**

	Livestock Forage		Livestock Watering		Medicine		Local Climate Stabilization	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	14	14	14	14	7	21	14	14
35-44 years old	4	12	6	10	3	13	9	7
45-54 years old	6	10	9	7	7	9	6	10
55-64 years old	6	6	8	4	1	11	9	3
65-80 years old	5	3	2	6	2	6	8	0
Grand Total	**35**	**45**	**39**	**41**	**20**	**60**	**46**	**34**

Table 20. (cont'd)

	Peat Harvest		Recreation		Retention of Nutrients		Sediment Trapping	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	13	15	8	20	18	10	23	5
35-44 years old	4	12	0	16	10	6	12	4
45-54 years old	8	8	2	14	12	4	12	4
55-64 years old	7	5	2	10	8	4	10	2
65-80 years old	2	6	0	8	4	4	6	2
Grand Total	**34**	**46**	**12**	**68**	**52**	**28**	**63**	**17**

	Shellfish Harvest		Shoreline Erosion Protection		Shoreline Stabilization		Sport Fishing	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	14	14	14	14	13	15	10	18
35-44 years old	4	12	7	9	9	7	2	14
45-54 years old	9	7	9	7	11	5	3	13
55-64 years old	6	6	7	5	8	4	4	8
65-80 years old	2	6	5	3	4	4	2	6
Grand Total	**35**	**45**	**42**	**38**	**35**	**45**	**21**	**59**

	Storm Protection		Support Plant and Animal Life		Timber Harvest		Velocity Reduction	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	10	18	12	16	12	16	16	12
35-44 years old	9	7	10	6	6	10	15	1
45-54 years old	13	3	8	8	9	7	10	6
55-64 years old	10	2	6	6	4	8	11	1
65-80 years old	5	3	4	4	2	6	4	4
Grand Total	**47**	**33**	**40**	**40**	**33**	**47**	**56**	**24**

Table 20. (cont'd)

	Water Purification		Water Quality		Water Quantity		Water Storage	
	Function	Value	Function	Value	Function	Value	Function	Value
19-34 years old	17	11	11	17	7	21	16	12
35-44 years old	14	2	9	7	11	5	14	2
45-54 years old	10	6	6	10	7	9	11	5
55-64 years old	9	3	6	6	5	7	7	5
65-80 years old	5	3	5	3	6	6	7	1
Grand Total	**55**	**25**	**37**	**43**	**32**	**48**	**55**	**25**

	Waterfowl Habitat		Wildlife Sanctuary	
	Function	Value	Function	Value
19-34 years old	16	12	13	15
35-44 years old	8	8	6	10
45-54 years old	9	7	9	7
55-64 years old	5	7	4	8
65-80 years old	1	7	1	7
Grand Total	**39**	**41**	**33**	**47**

These matrix configurations illustrated that roughly 36% of people aged 19-34-years old recognized *storm protection* as a function. While, 56% of participants aged 35-44-years old, 81% of 45-54-year-olds, 63% of 65-80-year-olds sorted this service into the functions class. However, the age group 55-64-years old placed *storm protection* in that class 83% of the time. Moreover, individuals aged 65-80-years old categorized *water storage* as functions 88% of the time, as did 67% of residents aged 35-44-years old. Participants' 45-54-years old as well as 55-64-years old sorted this in the function class as well, at a rate of 69% and 58%, respectively. The individuals 19-34-years old placed *wildlife sanctuary* amid the functions 54%, whereas 37% of 35-44-year-olds, 33% of 55-64-year-olds, and 13% of 65-80-year-olds. Nevertheless, 45-54-year-olds situated *wildlife sanctuary* amid the functions 56% of the time.

On the contrary, 92% of people 55-64-years old perceived *medicine* as a value, and so did 81% of 35-44-year-olds. Individuals within age groups 19-34-years old and 65-80-years old cataloged *medicine* 88% and 75%, respectively into the values, while 56% of people 45-54-years old sorted this service into the value category. In addition, participants from 45-80 years of age separated *education* into the value classification 75% of the time, although 19-34-year-olds did 83% and 35-44-year-olds 81% of the time throughout the card sort. *Historical/Archeological protection* was arranged amongst the values 83% by 19-34-year-olds, 88% via 35-44-year old's as well as 65-80-year-olds, and 75% of 45-64-year-olds. In comparison, people aged 35-44-years old, in addition to 65-80-year-olds categorized *recreation* as a value 100% during this activity. Meanwhile, 80% of 19-34-year-olds, 83% of 55-64-year-olds, and 88% of 45-54-year-olds placed *recreation* with the value group.

When considering gender, men positioned *biochemical processes*, *groundwater recharge and discharge,* and *flood-peak reduction* into the function category at a nearly equal rate to women. However, men placed *retention of nutrients* and *fish sanctuaries* with the functions more often than women. In addition, men sorted *livestock water* and *historical/archeological protection* as values to a greater degree than women but classified *recreation* within the value category equally to women. In contrast, women

opted to characterize *sediment trapping* and *atmospheric processes* amid functions, as well as *water quantity* and *hay harvest* along with the values at a greater rate than men.

When educational attainment was inspected more thoroughly, participants, by and large, failed to accurately categorize *fish* and *wildlife sanctuaries* with the functions at a rate of less than 50% throughout this experiment regardless of education. Additionally, the same was true of *water quality* and *shoreline erosion protection* amongst the value classification. *Storm protection* was also sorted alongside the functions less than 50% of the time, except among people who have master's degrees, as they picked this service approximately 90% of the time. However, compared to each of the matrix patterns analyzed previously, people cataloged *sediment trapping* along with *atmospheric* and *biological processes* in the functions at rates of nearly 100% when educational attainment was scrutinized more carefully. At the same time, *recreatio*n was grouped with the values more than 90% during the card sorting experiment. Conversely, when individual educational levels were separated out, people with some college experience chose to place *water quantity* and *medicine* paired with a value 85% during this investigation. Participants who have received bachelor's degrees or attended some college selected *education* and *historical/archeological protection* amidst values nearly 90% of the time.

Accuracy

The accuracy histogram shown in Figure 14 offers data regarding the proportional frequency of times the group (n=80) classified each card into the two categories, correctly. This graphical representation was normalized and weighted similarly to the focus group results. Meanwhile, Table 21 provides the accuracy results regarding average (mean), the minimum, maximum, and standard deviation for the entire participant pool.

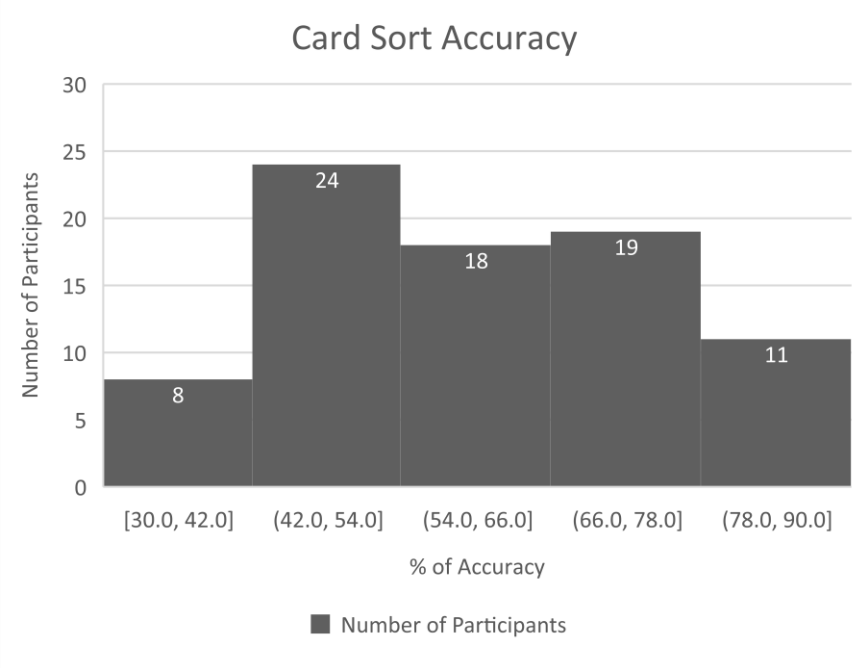

Figure 14. Histogram of the Accuracy Distribution of each Card Sorted by the Group of Participants

The graph demonstrates that 11 (or ~14% of) participants accurately sorted each card between 78% and 90% of the time. Fundamental errs occur thereafter. For instance, eight (10% of) people only accurately classified each WES 30 to 42% of the time.

Table 21. Average, Minimum, Maximum, and Standard Deviation of Accuracy Results for the Entire Participant Pool

ACCURACY	%
Average	60.2
Minimum	30
Maximum	90
Standard Deviation	14.6

In addition, Table 21 shows that there was an average of 60.2% accuracy throughout the entire card sorting survey with a standard deviation of 14.6%. Individuals correctly categorized WES a minimum of 30% and a maximum 90% of the time.

As shown in Table 22, individuals incorrectly categorized *wildlife sanctuary* and *fish sanctuaries as a value* 59% during the card sorting activity, while 41% correctly classified this WES as a function. People

also, incorrectly grouped *waterfowl habitat* with the value category 51% of the time and 49% of participants accurately sorted waterfowl habitat into the functions category. *Shoreline erosion stabilization* was inaccurately classified within the functions class 53% of the time, although 47% of individuals classified waterfowl habitat into the correct WES category. *Supporting of plant and animal life* was split directly down the middle with 50% of people opting to place this WES into the functions category and 50% selecting the values category.

Table 22. Least Accurate Card Sort for Each Card by the Entire Group

LEAST ACCURATE	Function	Value	Correct Answer
Wildlife Sanctuary	41%	59%	Function
Fish Sanctuaries	41%	59%	Function
Waterfowl Habitat	49%	51%	Function
Shoreline Erosion Protection	53%	47%	Value
Support Plant and Animal Life	50%	50%	Function

Table 23 offers an indication as to which cards were sorted with the most confusion. This table does have some of the same cards that were seen in Table 22. However, other cards were added to the confusion pile. For example, *livestock watering* was categorized as a function 49% or nearly half of the participants placed this WES into the incorrect classification. *Hay harvest* and *water quality* were accurately sorted with the value category 54% of the time. Even though 46% of people incorrectly situated these WES into the function group.

Table 23. Most Confused Card Sort for Each Card by the Entire Group

MOST CONFUSED	Function	Value	Correct Answer
Shoreline Erosion Protection	53%	47%	Value
Support Plant and Animal Life	50%	50%	Function
Livestock Watering	49%	51%	Value
Waterfowl Habitat	49%	51%	Function
Hay Harvest	46%	54%	Value
Water Quality	46%	54%	Value

Overall, participants did accurately sort cards into the appropriate category. Table 24 shows how 88% of individuals categorized atmospheric and biochemical processes correctly. Eighty-five percent of people accurately classified *recreation,* 79% sorted *sediment trapping* appropriately, and 78% categorized *historical/archeological protection* properly.

Table 24. Most Accurate Card Sort for Each Card by the Entire Group

MOST ACCURATE	Function	Value	Correct Answer
Atmospheric Processes	88%	12%	Function
Biochemical Processes	88%	12%	Function
Recreation	15%	85%	Value
Sediment Trapping	79%	21%	Function
Historical/Archeological Protection	22%	78%	Value

DISCUSSION

The goal of this thesis was to assess the level of accuracy with which residents could distinguish between wetland functions and values, and to determine the way in which individuals describe wetland and perceive wetland ecosystem services. The data analysis suggests that there are some common misperceptions among Michigan residents with regards to wetland ecosystems. The results demonstrate how personal experiences help to form individual's environmental perception.

The results of these activities demonstrated that prior research involving EP and WES remains true. Kaplowitz, Lupi, and Hoehn (2007) found that many Michigan residents have some experience, knowledge, and familiarity with wetlands ecosystems. For example, those focus groups showed that while some participants have basic knowledge of what defines a wetland (e.g., saturation and type, et cetera), they largely describe wetland functions, such as water filtration and flood prevention (Kaplowitz, Lupi, and Hoehn 2007). In contrast, during these focus groups, participants describe wetlands as wet, low, swampy areas with diverse, native plants and animals that thrive in those ecosystems. People expressed how wetlands are unique, saturated, and valuable environments are part of the hydrological cycle. Some even recognized that wetlands are too wet and thick for urban development, but as a *male college student* explained,

> *"An area of land that is unaltered by man that houses ecosystems that thrive off of the unaltered state that it's in. But, then also I know they're pretty difficult to build things on and stuff like that. Unstable and so a lot of times they're filled in, and a lot of times they're cheap pieces of land because they're hard to build on and they get filled in, and then they get built on top of anyway."*

Kaplowitz (2000), also uncovered how many mangrove (an estuary wetland) ecosystem services had been broadly recognized as vital by scientists, but seem imperceptible to local beneficiaries. Storm protection was among the services that people skirted around in the discussions, as this service was insignificant to them since the mangroves absorb storm surges. In comparison, 59% of card sorting participants accurately identified storm protection as wetland functions (a natural process). Both

Kaplowitz (2000) and this current research had participants who explained that wetlands ecosystems offer beauty (aesthetic) as a beneficial service in nearly all focus groups or individual interviews.

Kaplowitz, Lupi, and Hoehn (2007) also discovered that most people were aware of wetlands' ability to provide animals and plants with sustainable habitats. Nevertheless, those focus groups revealed some significant misperceptions. For instance, some participants believe that "trees don't grow in wetlands" and that "wetlands kill trees" (Kaplowitz, Lupi, and Hoehn 2007). When, in fact, wetlands are known for hygrophyte plants that have roots system which adapted to, and thrive in, these wet environments, such as mangroves, pond cypresses, and sycamore trees (Tiner 1991; Kaplowitz 2001; Mayda 2013). Moreover, these plants make available wood products for building supplies and fuel, two highly critical wetland ecosystem provisioning services that benefit humanity all around the world (Kaplowitz 2001). In contrast, these investigations found that during the focus group activity, n=30 individuals mentioned animals more often than plants when discussing habitat. They spoke specifically of waterfowl for hunting, indicator species for identifying pollution, and breeding-grounds for terrestrial and aquatic animals during spring. Moreover, during this card sorting activity, 50% of people were unable to accurately determine support of plant and animal life as a wetland function. As well as, 53% of participants were unable to identify shoreline erosion protection as a wetland value correctly, and 59% of participants were unable to accurately classify waterfowl habitat and fish sanctuaries as wetland functions.

FOCUS GROUP QUESTIONS SUMMARIZATION

The cross tabulations demonstrated the number of times a participant spoke of particular wetland ecosystem services (e.g., biodiversity, food, or water purification) throughout the entire semi-structured focus group interview process. However, an analysis of each question allowed for a person to illustrate their environmental perception of wetland ecosystems in their own words. In the end, there was very slight variation in the overall content of people's answers, whether analyzing the cross-tabulations or individual questions and **regardless of age, education, gender, or occupation. Even though these data**

were coded the same, the results emphasized various ways the research questions could be articulated, and, thus, generated two unique points-of-view to highlight the findings further.

Description of Wetlands

When participants were asked to describe a wetland, an array of responses was given that characterized wetland types, such as marshes or swamps (palustrine), and they noted that wetlands remain permanently saturated all year. People also mentioned some wetland functional services (e.g., filtration of water, groundwater, and surface water recharge). A few people stated that if wetlands are removed or damaged, specific niche plants and animals will have a difficult time surviving and may even die out. Habitat was spoken about more frequently than any other WES when offering a description. As one *male, retiree* with a *master's degree*, and one *female with bachelor's degree*, who works in *the agriculture, forestry, fishing, or hunting* sector indicated,

> *"They provide a functional habitat for diverse wildlife such as frogs, turtles, snakes, etc. and can be used to hide from predators."*
>
> *"They provide breeding habitat for many threatened or endangered species, aiding in re-establishing the populations."*

Wetland Ecosystem Services

Participants could inventory various wetland ecosystem services when prompted. They focused on air quality, education (e.g., class field trips and research opportunities), habitat, and recreation. A few referenced wetlands' ability to capture runoff, filter water, and produce fodder. As two *males*, one with a *master's degree* and the other with a *high school or equivalent* specified,

> *"Surface water access, groundwater recharge, recreation, wildlife habitat, water quality improvement through filtration, unique vegetation, stable drainage areas."*
>
> *"Drainage areas for surface runoff as well as fertile living and feeding areas for wildlife. Helps to maintain balance with naturally occurring ecosystems in rapidly developing rural and suburban areas."*

Importance

The balance of nature, conservation, and education for children came to mind when people were asked why the wetland ecosystem services they previously spoke about were important to them. Many noted, beauty (aesthetics), filtration of water for consumption, and migratory bird habitats. Along with recreational activities (e.g., duck hunting and fishing), relocation of water, and transportation of goods, such as lumber. Individuals voiced concerns about loss of diversity, natural resources, and quality of life when wetlands were destroyed. As one *female* with *bachelor's degree* and aged *55-64-years old* called attention to,

> *"I think it's important to have areas left untouched by human hands, and wetlands provide a lot of diversity. Because it isn't easy for humans to utilized that area, you hope that some are left alone. Laugh."*

One participant even mentioned Not In My Back-Yard (NIMBY) perspectives,

> *"I have heard people say, well I own this piece of property, and a portion of it has been termed a wetland, but it's mine, and I should be able to do what I want. And then I think about, how people act on ownership. That idea of ownership. Are you a steward of the land or selfish? Can I make money on this?"*

Some farmers voiced concerns of wetlands encroaching onto their fields, the invasive species, and erosion of land because the areas were designated wetlands. Moreover, they reference the invasion of wetland animals (critters), who burrow underground and make the terrain unstable for farming. While others, simply wish the regulations were less stringent where wetlands are concerned. The thought that they must pay for unusable land bothers them greatly. One non-farming, landowner retiree commented,

> *"I own wetlands and am not allowed to disturb them. While I understand and appreciate that, I could really use the land for placement of my well, pit, and septic system. The laws determine how many feet apart these systems must be and I had to get a variance that allowed me to build them closer together. I hope I am not paying taxes on land I cannot use. These wetlands protect an endangered fern that is ugly and brown."*

Values

When questioned about what values people associated with wetland ecosystem services, participants were confused. They asked for clarification. To expound upon values more clearly, two examples were given:

> *Wetlands offer a multitude of fish species and other amphibious life (a function) for animal and human consumption (an external value). Additionally, wetlands afford a wealth of educational opportunities (an external value) because of the biodiversity (an internal value) supplied by the unique habitat (a function).*

Individuals perceived wetland values as being primarily aesthetic and recreational (e.g., fishing, hunting, et cetera). Some made the distinction between being habitats for indicator species, which alert humanity of effects, such as pollution. As one *male* with a *bachelor's degree* and one *female* with a *master's degree*, who both work in *government and public administration* pointed out,

> *"They are home to several indicator species, which by nature react negatively to pollutants faster than other organisms."*

Several participants expressed that wetland values are seen in their ability to provide breeding grounds for countless species, allow commerce for shellfish and timber harvests, as well as offer a measured quality of water for drinking, and an abundance of biodiversity. One *female, aged 19-34-years old* with a *vocation or technical certification* stated,

> *"Any wild habitat has value as a place where wild animals can live without humans bothering them. Wetlands are also valuable because we can go there to hike, or to boat and fish, or just because the plants there produce the very oxygen that we breathe."*

Benefits

Some people replied with broad, succinct statements when asked about who benefits from these wetland ecosystem services. Many immediately shouted,

> *"Everybody."*
>
> *"We all do."*
>
> *"The World."*

Whereas, others responded with,

"They provide Global benefit. Migratory waterfowl can travel thousands of miles on their annual migrations. Fewer wetlands mean higher rates of runoff that carry sediment and pollutants directly to our rivers and streams. Rivers carry sediment and pollutants from high up in the watersheds all the way to their outlets in the oceans."

"I went specific and obvious, people who live near the wetlands would benefit from the services directly. People who sourced their water from those areas would benefit from water filtration. Tourists would come in, and they would use these areas for recreation, hunting, and then the state would get capital from these tourists. DNR would get money from hunting licenses that sort of thing. It would bring money into the state that would be used to benefit hopefully the residents of the state and children would be able to get the first hands-on education about wilderness. And like (redacted), pretty much everything."

Everyday Life

Once prompted to answer how these wetland ecosystem services are relevant to their every day, many participants began the discussion with having the luxury of clean drinking water, recreation, fishing, and hunting. Others expressed just how wetlands help them act more environmentally conscious. Some even claimed wetlands serve as a deterrent to littering and encourage people to take part in local recycling campaigns. One *male* with a *master's degree* and one *female* with a *bachelor's degree* acknowledged,

"We love swimming and recreating in (redacted). We also raise crops and livestock on a small farm. I think of the line from Finding Nemo, "all drains lead to the ocean." Well, that is definitely true and that thought process is important for everyone to understand. Each drop will wind up having an impact. Everyone needs to do their part in ensuring that our water resources are conserved from both quantity and quality standpoint. That way we can enjoy the many great services they provide for generations."

One participant, who works with the DNR expressed that,

"It is my responsibility to maintain the integrity of the wetland ecosystems while managing the lands."

Meanwhile, a participant who works directly with city planning offered this,

"Well for a positive, you get a clean environment. A variety of wildlife etc. etc.. But, in our specific community we have and an overabundance of wetlands, which makes it very difficult to find developable land, and it's hard to even to convince people to come (redacted) to developed property and open businesses. Then you add in the cost and the timelines associated with mitigating wetland impacts, which at this point are more or less unavoidable. It really has an economic impact on the community, which is not a positive one."

Additional Sentiments

The closing question, which asked if there were any other issues people wanted to address. A few groups simply said, no and were done. Whereas, a few statements stood out among the rest.

> *"We don't know what else is in those systems and we haven't even scratched the surface on what they have in them and what we value. We know little of what there is; this is the tip of the iceberg."*
>
> *"Wetlands are important but need to be managed with common sense."*
>
> *"There needs to be more emphasis on the protection of natural wetland areas. I do not believe that it is appropriate for developers to be allowed to destroy a natural wetland area by "creating" a wetland area in another location."*
>
> *"My personal observations and being somewhat aware of what has happened in our (redacted) area, that there should be some way to preserve and increase the (redacted) Lake (Natural Wetland) area to its original state. It has reduced in size tremendously over the past decades because of ditch drainage needed for what is so called "Farm Preservation." Spring and Fall, the shoreline waters of Lake Huron and Saginaw Bay are brown and smelling from silt and manure runoff from farm lands. Our beaches have been closed in the summer, from time to time, because of high e. coli. Please convey this message with other information you gather with your survey as it tries to educate us all as to the importance of wetlands. In closing "Water is life, and without it, there is no life." Thanks*

FOCUS GROUP MISUNDERSTANDING

In due course, these cross tabulations and personal narratives further assisted this research to learn how residents from Chippewa, Huron, and Macomb counties describe wetlands. Also, these analyses revealed that residents can recognize some wetland ecosystems services, and identified some knowledge gaps concerning individual perceptions of wetland ecosystems.

Despite being reasonably aware of WES, most participants fixated on habitat and recreation, with fishing, hunting, and swimming being amongst the most commonly identified forms of recreation. Multiple participants mentioned flood control, groundwater recharge, and filtration of water in conjunction with nutrient retention. One person referenced atmospheric processes (greenhouse effect); one, local-climate stabilization (micro-climate control); and, one, storm protection. On the other hand,

when specifically referring to values, individuals expressed appreciation for having quality drinking water and wilderness areas (habitats). The vast amount of educational opportunities afforded by wetlands was talked about at length, as several people pointed to the biodiversity of flora and fauna as well as naturalness.

Only a few recognized the value of erosion control, shellfish harvesting, and transportation opportunities provided by wetland ecosystems. And, hardly anyone voiced an understanding of how wetlands help to fertilize the surrounding land, nurture the hierarchy of nature's food chains, and preserve nature's bounty. Similarly, a small amount noted their support of livestock foraging and watering, as well as water-quality improvements. When in fact, one person spoke about energy production; another referenced health and welfare.

No one acknowledged wetlands' ability to protect historical and archeological artifacts, form soils, and stabilize shorelines. In addition, participants overlooked biochemical processes, namely carbon sequestration, and evapotranspiration; on top of biological productivity, such as plants (fibers) used for textiles. There was no mention of the countless medicinal applications afforded by local flora and fauna (e.g., bee venom, leeches, maggots, spider webs, et cetera). Participants also failed to reference the various cultural legacies afforded by wetlands. For instance, oral stories of hunting wild game or catching that legendary fish. In the end, Michigan residents offered empirical insight into their perception of wetland ecosystem via a semi-structured focus group interviews.

CARD SORT MISPERCEPTIONS

As with the focus group interview, several misperceptions arose during the online digital card sort. However, no assumption can be made as to why these misunderstandings exist. Regardless, determining whether *peat harvest* was a function or value confused participants. Fifty-seven percent (n=46) of people sorted peat harvest into the value category, while 43% (n=34) believed this service was a function. In actuality, peat harvesting ranks as a value for humanity has benefited greatly from peat and has for

generations. Consider this: the term harvesting means to gather (Van Seters and Price 2001; Reddy and De Laune 2008). Humans gather many plants and crops for consumption or even fuel. Peat is an anaerobic process, which naturally accumulates from decomposed flora or organic matter native to wetland environments and becomes useful for fuel after being dried out properly (Van Seters and Price 2001; Reddy and De Laune 2008). Hence, peat harvest falls into the value class, as humanity utilizes the dried substance to cook and heat their homes.

Similarly, *water quality* perplexed individuals. N=43 people sorted water quality with the value classification, and 46% (n=37) categorized this services as a function. Ponder this: wetlands purify water from sediments and excess nutrients, as well as other pollutants, such as heavy metals (US EPA 2015; Reddy and De Laune 2008; Mitsch and Gosselink 2015). These functions prove essential because wetlands filter water before ever reaching the groundwater (Reddy and De Laune 2008; Mitsch and Gosselink 2015). Not to mention, these functions remain critical for the myriad of fish and other wildlife that inhabit the wetlands and surrounding watersheds (Jude and Pappas 1992; Reddy and De Laune 2008; Mitsch and Gosselink 2015). Given that, water purification is a function that wetlands naturally perform, which is another way of saying that the "water" is ready for consumption. Thus, *"water quality"* is a value because consumption is a benefit afforded by wetlands and measured for humans. In addition to imbibing water, people use filtered water for cooking, irrigation, and many recreational activities. As seen by a few focus group participants when water filtration, purification, and quality were discussed,

> *"Wetlands area are also a local water source for groundwater recharge, which is important for agricultural crops and drinking water."*
>
> *"They help keep the ground water clean." "Value in helping to provide clean drinking water from artesian wells."*
>
> *"They are also important in purifying our groundwater."*
>
> *"In this area surface water filters, back into the ground recharging the aqueducts with clean and usable water."*

LIMITATIONS

The limitations of a study are those characteristics of design or methodology that impact or influence the interpretation of the findings from the research. They are the constraints of applications in practice and usage of results. The various limitations associated with this present research were: the limitation of time; self-reporting; actual sample sizes; and, appropriateness of questions.

The very nature of thesis research limits one's time. Moreover, the challenge of self-reporting creates limitations, as the integrity of the researcher comes into question since the researcher is the only one was conducting the activities, analyzing the data, and reporting the findings.

These activities were exploratory and, therefore, made procuring enough willing participants quite difficult, which makes this a convenience sample. In addition, these findings can neither be generalized to the entire state of Michigan nor do they represent the whole state.

Finally, a few of the focus group questions created some hesitation and confusion. **Question 7** in the focus group interviews seemed to be more complicated than some were able to comprehend. The question read,

> "Rate these values on a scale from 1-10, where 1 is *"mildly important,"* 5 is *"considerably important,"* and 10 is *"exceedingly important."*

Perhaps, poor wording and explanation were to blame, for this question was to ascertain how people rated the values that they had been discussing throughout the entire focus group interview. That is, aesthetics, habitat, and recreation, et cetera. Some individuals were waiting for the researcher to offer examples, while others provided blanket statements with a sweeping 8, 9, or 10.

Having the ability to analyze these responses would have given the researcher the opportunity to see where a person's institutional knowledge of ecosystem services stood overall, as well as provide additional, individual perspectives. Although several people responded with the all-encompassing 8, 9, or 10, a few stated,

> *"No less than 10."*

"Values from my value tab: Water Quality-10, ecological diversity-9, flood control-8, groundwater recharge-10, food (wild rice, water fowl, etc.)-5."

"This is complex. It is a bit of a "chicken or the egg" thing for me. I think the External values listed on the graphic are a 10 because they are essential for life; food, water, shelter. Internal values- 9. Functions- 8. This is consistent with my thought that conservation is a luxury, but is also necessary... So, in general, when considering the graphic, I would put the highest value on the outer ring and a slightly reduced value with each move to the center. But having said that, as noted above, I recognize that the functions listed in the center are critical and the values would not be attainable without the functioning system. They are nearly directly related and have a symbiotic relationship."

"I learned something new. I knew they were a part of our ecosystem, but I wasn't aware of all its role that it plays or how it is affecting me." That's a hard question because if you would have put wetlands on a list with ten other items, we wouldn't have talked about them, and then I would have rated them differently than after our conversation today. In general, having wetlands area 10, as we don't want to lose them. Also, a 10, I like having natural wetlands over mitigated one.

While a few others misunderstood the question altogether and, therefore, proved no ranking for anything. Some were looking for a particular prompt instead of remarking on the values they had been discussing throughout the entire focus group interview.

A few of the other focus group questions may have been better served as one subject versus two or worded another way to obtain more thought-provoking answers. The choice of activities may have altered the results, such as performing individual interviews instead of focus groups, or in-person card sorts rather than online.

DELIMITATIONS

In addition to the limitation, some delimitations were: the use of three counties; activity choice; and, missing age and occupational demographics.

The selection of only three counties was due in part to the time and financial constraints. Having added data from the counties who experienced similar losses during the past 30 years or underwent restoration efforts could have served to add merit to these findings further.

The choice of activities may have altered the results, such as performing individual interviews instead of focus groups, or in-person card sorts rather than online.

This study was unable to obtain a lot of information regarding how different professionals (agribusiness, developers, etc.) perceive wetland ecosystems. The exploratory nature of these activities made it difficult to acquire scores of participants, and, thus, some occupational demographics were limited or left out altogether. Moreover, participants 18 or under were omitted from the demographic makeup because of the additional parental consent necessary to study adolescents.

CONCLUSION

The goal of this research was to evaluate Michigan's residents' environmental perception of wetland ecosystem services, at a county level. With a primary focus on WES, namely functions and values. Once more, providing empirical evidence that environmental perceptions are subjective and that many individuals place themselves apart from the natural world.

Participants are confident in discussing wetland types, such as marshes and swamps, as well as some wetland functions (e.g., habitat and water filtration). During the focus group interviews, people recognized that wetlands serve as facilitators of flood-peak reduction, educational venues, and wildlife habitats. Furthermore, many participants understand wetlands are home to an abundance of native flora and fauna (biodiverse) and relate their knowledge of wetlands to the ones they have seen within Michigan (i.e., lacustrine, and palustrine). Remarking that Michigan's (non-tidal) wetlands have a distinct ecosystem compared with tidal (e.g., estuary and marine) wetlands, as they referenced ice jams and contaminated agricultural runoff flowing into the Great Lakes when wetlands are drained or damaged and not maintained properly. As one participant said,

> *"I see them as the kidneys of the Great Lakes, filtering runoff and reducing pollution to the water we rely on for drinking, recreation, fisheries and another wildlife habitat."*

Throughout the card sorting survey, residents also demonstrated familiarity with wetlands' ability to purify water, perform atmospheric and biochemical processes, as well as serve as recreational hotspots. On the other hand, participants exhibited a lack of knowledge about some important WES, such as timber and peat harvest as well as livestock watering and foraging. Some focus group participants failed to take notice of biochemical processes, medicinal benefits, and shoreline stabilization. Whereas, the card sort saw misperception in distinguishing between whether habitat is a value or a function, as well as if shoreline erosion protection is a value or a function.

The results illustrate that semi-structured focus group interviews and card sorts are useful tools in helping researchers and educators to better understand their audiences' baseline water (natural) resource knowledge and misperceptions. This analysis also shows how focus groups and participant observations are complementary, with each yielding somewhat different perspectives on what individuals understand about wetland ecosystems. Another key message is that one method is no more useful than the other. These two approaches for analyzing environmental perception are equally beneficial.

Each activity provided helpful insight into the institutional (knowledge) gaps regarding people's awareness (perceptions) of wetlands ecosystems. The mixed reviews on whether wetlands offer energy-producing byproducts, such as peat or serve as sinks for carbon sequestration help to expose the underlying misperceptions of wetlands ecosystems. Although people do recognize some WES, there remains a substantial rift between what is known and unknown.

In the end, these investigations suggest that future wetland (even other freshwater resources) research within Michigan are needed. Even though many participants remarked on the numerous educational opportunities afforded by wetland ecosystems, their knowledge gaps further support the notion for future environmental education reforms. Of course, additional research is necessary to approve these suggestions further. Future freshwater research within Michigan can take these findings and build upon them, or even expound upon lacustrine wetlands' impacts on the Great Lakes. For example, investigating the effects of wetlands on the Great Lakes as filters of agricultural runoff, to alleviate or even eliminate the ongoing eutrophication problems plaguing the Great Lakes. In addition, any accumulation of data to provide academia with evidence that links the lack of proper environmental education to the ongoing ecological calamities affecting the global community, can only help to offer sustainable solutions or even resolve the problems in generations to come.

APPENDICES

APPENDIX A. Demographic Questionnaire

1. What is your age group?
    a. 15-18 years' old
    b. 19-34 years' old
    c. 35-44 years' old
    d. 45-54 years' old
    e. 54-64 years' old
    f. 65-80 years' old
    g. 81+ years' old

2. What is your gender?
    a. Female
    b. Male
    c. Fluid
    d. No comment

3. What is your marital status?
    a. Married
    b. Divorced
    c. Widowed
    d. Separated
    e. Never been married
    f. A member of an unmarried couple

4. What is the highest level of education you have completed?
    a. Grammar school
    b. High school or equivalent
    c. Vocational/technical school (2-year degree)
    d. Some college
    e. Bachelor's degree
    f. Master's degree
    g. Doctoral degree
    h. Professional degree (MD, JD, etc.)
    i. Other _____

5. How long have you lived in Michigan, USA?
    a. 0-2 years
    b. 3-5 years
    c. 6-8 years
    d. 9+ years

6. How many hours per week do you USUALLY work at your job?
    a. 35 hours a week or more
    b. Less than 35 hours a week
    c. I am not currently employed

7. Which of the following categories best describes your primary area of employment (regardless of your actual position)?
    a. Homemaker
    b. Retired
    c. Student
    d. Unemployed
    e. Agriculture, Forestry, Fishing, or Hunting
    f. Arts, Entertainment, or Recreation
    g. Broadcasting
    h. Education - College, University, or Adult
    i. Education - Primary/Secondary (K-12)

j. Education – Other_____
k. Construction
l. Finance and Insurance
m. Government and Public Administration
n. Health Care and Social Assistance
o. Hotel and Food Services
p. Information - Services and Data
q. Information – Other
r. Processing
s. Legal Services
t. Manufacturing - Computer and Electronics
u. Manufacturing – Other
v. Military
w. Mining
x. Publishing
y. Real Estate, Rental, or Leasing
z. Religious
aa. Retail
bb. Scientific or Technical Services
cc. Software
dd. Telecommunications
ee. Transportation and Warehousing
ff. Utilities
gg. Wholesale
hh. Other _____

8. Which of the following best describes your role in your industry of employment?
   a. Upper management
   b. Middle management
   c. Junior management
   d. Administrative staff
   e. Support staff
   f. Student
   g. Trained professional
   h. Skilled laborer
   i. Consultant
   j. Temporary employee
   k. Researcher
   l. Self-employed/Owner
   m. Other _____

9. Is the organization you work for in the?
   a. Public sector
   b. Private sector
   c. Nonprofit sector
   d. Don't know
   e. Other _____

10. What are some of your recreational activities? (check all that apply)
    a. Boating
    b. Fishing
    c. Hiking
    d. Hunting
    e. Nature walks
    f. Swimming
    g.

APPENDIX B. Initial Qualitative Codes Applied to The Focus Group Text

CODE	OPERATIONAL DEFINITION
Aesthetic	A set of principles concerned with the nature and appreciation of beauty using the senses.
Agriculture	The science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food and other products.
Balance of Nature	The natural balance or equilibrium of nature (Stevenson 2010).
Biodiversity	The living diversity of ecosystems, natural communities, and habitats, where a variety of flora, fauna, and organisms live in the world (Warf 2010).
Breeding	The mating and production of offspring by animals (Stevenson 2010).
Conflict	Be incompatible or at variance; clash (Stevenson 2010).
Conservation	Preservation, protection, or restoration of the natural environment and its wildlife (Stevenson 2010).
Destruction	The action or process of causing so much damage to something that it no longer exists or cannot be repaired (Stevenson 2010).
Dumping	Deposit or dispose of (rubbish, waste, or unwanted material), typically carelessly or hurriedly (Stevenson 2010)
Ecosystem	The biological community of interacting organisms and their physical environment (WARF 2010).
Educational	Intended or serving to educate or enlighten (Stevenson 2010).
Filtration	The action or process of filtering something (Stevenson 2010).
Flood Control	The prevention of massive overflow or inundations of large amounts of water beyond reasonable limits (Warf 2010).
Flora & Fauna	The plants and animals of a particular region, habitat, or geological period (Stevenson 2010).
Food & Water "Source"	A place or thing from which something originates or can be obtained, such as food or water (Stevenson 2010).
Groundwater Recharge	A hydrologic process where water percolates/infiltrates downward from the surface into the substrate, while purifying the water before flowing to underground aquifers (Warf 2010).
Habitat	The natural home or environment of an animal, plant, or another organism (Warf 2010).
Hydric Conditions	An environment or habitat that contains an abundance of moisture (EPA 2015).
Marshy	Characteristic of or resembling a marsh; waterlogged (Stevenson 2010).
Microclimate	The climate of a very small or restricted area, especially when this differs from the surrounding environment (EPA 2016).
Mitigation	The action of reducing the severity, seriousness, or destruction of something (Stevenson 2010).
Natural	Existing in or derived from nature; not made or caused by humankind (Stevenson 2010).
Natural Resources	Materials or substances that are occurring in nature which can be exploited for economic gain (EPA 2016).
Ordered	The arrangement or disposition of things in relation to each other according to a sequence, pattern, or method (Stevenson 2010).
Pollution	The presence in or introduction into the environment of a substance which has harmful or poisonous effects (Stevenson 2010).
Protection	The action of protecting, or the state of being protected (Stevenson 2010).
Purification	The removal of contaminants from a resource, such as water (Warf 2010).
Quality of Life	The standard of health, comfort, and happiness experienced by an individual or group (Stevenson 2010).
Recreation Space	An area relating to or denoting leisurely time to enjoy outdoor activities (Stevenson 2010).
Refuge	Sanctuary; the state of being safe; sheltered from pursuit, danger, or difficulty (Stevenson 2010).
Saturated	Holding as much water or moisture as can be absorbed; thoroughly soaked.
Swamp	An area of low-lying, uncultivated ground where water collects; a bog or marsh (EPA 2016).
Undeveloped	Not having been developed; in a natural state (Stevenson 2010).
Vulnerability	The quality or state of being exposed to the possibility of being attacked or harmed (Stevenson 2010).
Water Quality	The biochemical, physical, and radiological characteristics of water; the measure of the condition of water relative to the requirements of one or more biotic species (Warf 2010).
Wetlands	Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (EPA 2016).
Wildlife	Undomesticated flora, fauna, and organisms that grow or live in the wild (Stevenson 2010).

APPENDIX C. MEA Categorical Codes Used in the Coding of Focus Group Text

CODE	OPERATIONAL DEFINITION
CULTURAL SERVICES	Nonmaterial benefits people acquire from ecosystems through aesthetic experiences, reflection, recreation, and spiritual enrichment, (Alcamo et al. 2003).
Aesthetic	A set of principles concerned with the nature and appreciation of beauty using the senses (Stevenson 2010).
• Human Refuge	• Sanctuary; the state of being safe; sheltered from pursuit, danger, or difficulty (Stevenson 2010).
• Quality of Life	• The standard of health, comfort, and happiness experienced by an individual or group (Stevenson 2010).
Conservation	Preservation, protection, or restoration of the natural environment and its wildlife (Stevenson 2010).
• Protection	• The action of protecting, or the state of being protected (Stevenson 2010).
• Undeveloped	• Not having been developed; in a natural state (Stevenson 2010).
• Vulnerability	• The quality or state of being exposed to the possibility of being attacked or harmed (Stevenson 2010).
Educational	Intended or serving to educate or enlighten (Stevenson 2010).
Recreation Space	An area relating to or denoting leisurely time to enjoy outdoor activities (Stevenson 2010).
PROVISIONING SERVICES	Products obtained from ecosystems, such food and water (Alcamo et al. 2003).
Agriculture	The science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food and other products (Warf 2010).
Food & Water "Source"	A place or thing from which something originates or can be obtained, such as food or water (Stevenson 2010).
REGULATING SERVICES	Benefits gained from the regulation of natural ecosystem processes, such as climate regulation and disease control (Alcamo et al. 2003).
Filtration	The action or process of filtering or purifying something (Stevenson 2010).
Flood Control	The prevention of massive overflow or inundations of copious amounts of water beyond reasonable limits (Warf 2010).
Microclimate	The climate of a very small or restricted area, especially when this differs from the surrounding environment (EPA 2016).
Purification	The removal of contaminants from a resource, such as water (WARF 2010).
Water Quality	The biochemical, physical, and radiological characteristics of water; the measure of the condition of water relative to the requirements of one or more biotic species (Warf 2010).
SUPPORTING	Supportive services that are necessary to produce all other ecosystem services, which include but are not limited to, nutrient recycling, primary production, and soil formation (Alcamo et al. 2003).
Biodiversity	The living diversity of ecosystems, natural communities, and habitats, where a variety of flora, fauna, and organisms' life in the world (Warf 2010).
Groundwater Recharge	A hydrologic process where water percolates/infiltrates downward from the surface into the substrate, while purifying the water before flowing to underground aquifers (Warf 2010).
Habitat	The natural home or environment of an animal, plant, or another organism (Warf 2010).
Hydric Conditions	An environment or habitat that contains an abundance of moisture (EPA 2015).

Natural Resources	Materials or substances that occur in nature which can be exploited for economic gain (EPA 2016).

APPENDIX D. Card Sorting Accuracy Table of Each Card by the Entire Participant Pool

Table D1. Card Sorting Accuracy Table of Each Card by the Entire Participant Pool

CARD	CORRECT CLASS	FUNCTION	VALUE	ACCURACY
Atmospheric Processes	Function	70	10	88%
Biochemical Processes	Function	70	10	88%
Education	Value	20	60	75%
Fish Sanctuaries	Function	33	47	41%
Flood-Peak Reduction	Function	54	26	68%
Ground-Water Recharge and Discharge	Function	58	22	73%
Hay Harvest	Value	37	43	54%
Historical/Archeological Protection	Value	18	62	78%
Livestock Forage	Value	35	45	56%
Livestock Watering	Value	39	41	51%
Local Climate Stabilization	Function	46	34	57%
Medicine	Value	20	60	75%
Peat Harvest	Value	34	46	43%
Recreation	Value	12	68	85%
Retention of Nutrients	Function	52	28	65%
Sediment Trapping	Function	63	17	79%
Shellfish Harvest	Value	35	45	56%
Shoreline Erosion Protection	Value	42	38	48%
Shoreline Stabilization	Function	45	35	56%
Sports Fishing	Value	21	59	74%
Storm Protection	Function	47	33	59%
Support Plant and Animal Life	Function	40	40	50%
Timber Harvest	Value	33	47	59%
Velocity Reduction	Function	56	24	70%
Water Purification	Function	55	25	69%
Water Quality	Value	37	43	54%
Water Quantity	Value	32	48	60%
Water Storage	Function	55	25	69%
Waterfowl Habitat	Function	39	41	49%
Wildlife Sanctuary	Function	33	47	41%

BIBLIOGRAPHY

BIBLIOGRAPHY

Acharya, G. 2000. “Approaches to Valuing the Hidden Hydrological Services of Wetland Ecosystems.” *Ecological Economics*, SPECIAL ISSUE THE VALUES OF WETLANDS: LANDSCAPE AND INSTITUTIONAL PERSPECTIVES, 35 (1): 63–74.

Adekola, O., G. Mitchell, and A. Grainger. 2015. “Inequality and Ecosystem Services: The Value and Social Distribution of Niger Delta Wetland Services.” *Ecosystem Services* 12 (April): 42–54. doi: 10.1016/j.ecoser.2015.01.005.

Albert, D. A. 2003. *Between Land and Lake: Michigan’s Great Lakes Coastal Wetlands*. Extension Bulletin, E-2902. East Lansing, Michigan: Michigan Natural Features Inventory.

Alcamo, J., N. J. Ash, C. D. Butler, J. B. Callicott, D. Capistrano, S. R. Carpenter, J. C. Castilla... 2003. *Ecosystems and Human Well-Being: A Framework for Assessment*. Washington, DC: Island Press.

Arcury, T. A. 1990. “Environmental Attitude and Environmental Knowledge.” *Human Organization* 49 (4): 300–304.

Bailey, R. G. 2009. *Ecosystem Geography: From Ecoregions to Sites*. Springer Science & Business Media.

Barbier, E. B., M. Acreman, and D. Knowler. 1997. “Economic Valuation of Wetlands: A Guide for Policy Makers and Planner.” Ramsar Convention Bureau Department of Environmental Economics And Environmental Management, University Of York Institute Of Hydrology Iucn-The World Conservation Union.

Barbier, E. B., E. W. Koch, B. R. Silliman, S. D. Hacker, E. Wolanski, J. Primavera, E. F. Granek, et al. 2008. “Coastal Ecosystem-Based Management with Nonlinear Ecological Functions and Values.” *Science* 319 (5861): 321–323.

Basit, T. 2003. “Manual or Electronic? The Role of Coding in Qualitative Data Analysis.” *Educational Research* 45 (2): 143–54. doi:10.1080/0013188032000133548.

Baxter, P., and S. Jack. 2008. “Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers.” *The Qualitative Report* 13 (4): 544–59.

Bögeholz, S. 2010. “Nature Experience and Its Importance for Environmental Knowledge, Values and Action: Recent German Empirical Contributions.” *Environmental Education Research* 12 (1): 65–84.

Boyd, J., and S. Banzhaf. 2007. “What Are Ecosystem Services? The Need for Standardized Environmental Accounting Units.” *Ecological Economics* 63 (2–3): 616–26. doi: 10.1016/j.ecolecon.2007.01.002.

Brannen, J. 2005. “Mixing Methods: The Entry of Qualitative and Quantitative Approaches into the Research Process.” *International Journal of Social Research Methodology* 8 (3): 173–84. doi:10.1080/13645570500154642.

Brinson, M. M., and A. I. Malvárez. 2002. “Temperate Freshwater Wetlands: Types, Status, and Threats.” *Environmental Conservation* 29 (02). doi:10.1017/S0376892902000085.

Brooks, K. N., P. F. Ffolliott, and J. A. Magner. 2013. *Hydrology and the Management of Watersheds*. 4th ed. Hoboken, NJ: Wiley-Blackwell Publishing.

Brown, E., A. Peterson, R. Kline-Robach, K. Smith, L. Wolfson, G. Rinkenberger, and V. Anderson. 2000. “Developing a Watershed Management Plan for Water Quality: An Introductory Guide.” *Institute for Water Research, Michigan State University Extension and Michigan Department of Environmental Quality*.

Butchart, S., E. Dieme-Amting, H. Gitay, S. Raaymakers, and D. Taylor. 2005. “MEA - Ecosystems and Human Well-Being: Wetlands and Water.” World Resources Institute, Washington, DC.

Campanelli, P. 1997. “Testing Survey Questions: New Directions in Cognitive Interviewing.” *Bulletin of Sociological Methodology/Bulletin de Methodologie Sociologique* 55 (1): 5–17. doi:10.1177/075910639705500103.

“Card Sorting Software | Optimal Workshop.” 2016. *Optimal Workshop*. https://www.optimalworkshop.com/optimalsort?gclid=Cj0KCQjw4vzKBRCtARIsAM3l8OCMiHX_8ylWpIeR-tk_Vw84oMP9mOzhrx3HnAtcvTqZLWRX2pegG9oaAtVHEALw_wcB.

Cataldo, E. F., R. M. Johnson, L. A. Kellstedt, and Lester W. Milbrath. 1970. “Card Sorting as A Technique for Survey Interviewing.” *Public Opinion Quarterly* 34 (2): 202–15. doi:10.1086/267790.

Chapman, D., ed. 1996. *Water Quality Assessments: A Guide to the Use of Biota, Sediments and Water Environmental Monitoring*. 2. ed. London: E & FN Spon.

Chee, Y. E. 2004. “An Ecological Perspective on the Valuation of Ecosystem Services.” *Biological Conservation* 120 (4): 549–65. doi: 10.1016/j.biocon.2004.03.028.

Clarkson, B., A. E. Aussei, and P. Gerbeaux. 2013. “Wetland Ecosystem Services.” In *Ecosystem Services in New Zealand – Conditions and Trends*, 182–92. Lincoln, NZ: Manaaki Whenua Press.

Clayton, L., and S. R. Moran. 1982. “Chronology of Late Wisconsinan Glaciation in Middle North America.” *Quaternary Science Reviews* 1 (1): 55–82.

Clifton, J. A., J. M. McClurken, and G. L. Cornell. 1986. *People of the Three Fires: The Ottawa, Potawatomi, and Ojibway of Michigan*. Grand Rapids Publishing. 978-0961770709.

Costanza, R., R. d’Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, et al. 1997. “The Value of the World’s Ecosystem Services and Natural Capital.” *Nature* 387 (6630): 253–60. doi:10.1038/387253a0.

Costanza, R., S. C. Farber, and J. Maxwell. 1989. “Valuation and Management of Wetland Ecosystems.” *Ecological Economics* 1 (4): 335–361.

Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner. 2014. “Changes in the Global Value of Ecosystem Services.” *Global Environmental Change* 26 (May): 152–58. doi: 10.1016/j.gloenvcha.2014.04.002.

Cottet, M., H. Piégay, and G. Bornette. 2013. “Does Human Perception of Wetland Aesthetics and Healthiness Relate to Ecological Functioning?” *Journal of Environmental Management* 128 (October): 1012–22. doi: 10.1016/j.jenvman.2013.06.056.

Coveney, M.F, D.L Stites, E.F Lowe, L.E Battoe, and R Conrow. 2002. “Nutrient Removal from Eutrophic Lake Water by Wetland Filtration.” *Ecological Engineering* 19 (2): 141–59. doi:10.1016/S0925-8574(02)00037-X.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. “Classification of Wetlands and Deepwater Habitats of the United States.” U.S. Department of the Interior Fish and Wildlife Service: Office of Biological Services.

Creswell, J. W. 2013. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 4th ed. Thousand Oak, CA: SAGE Publications, Inc.

Dahl, T. E. 1990. “Wetlands Losses in the United-States: 1780s to 1980s.” Report to Congress. Washington, D.C: US Department of the Interior: US Fish and Wildlife Service.

Dahl, T. E. 2011. “Status and Trends of Wetlands in the Conterminous United States 2004 to 2009.” US Department of the Interior: US Fish and Wildlife Service.

Dahl, T. E., C. E. Johnson, and W. E. Frayer. 1991. *Wetlands, Status and Trends in the Conterminous United States, Mid-1970's to Mid-1980's: First Update of the National Wetlands Status Report*. Washington, D.C: U.S. Dept. of the Interior & Fish and Wildlife Service.

Daily, G. C., ed. 1997. "Chapter 1: Introduction to Ecosystem Services." In *Nature's Services: Societal Dependence on Natural Ecosystems*, 1–10. Washington, D.C: Island Press.

Daily, G. C., S. Alexander, L. Goulder, J. Lubchenco, P. A. Matson, H. A. Mooney, P. E Ehrlich, et al. 1997. "Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems." *The Ecologica Society of America: Issues in Ecology* 2 (1): 1–18.

Dale, P. E. R., and R. Connelly. 2012. "Wetlands and Human Health: An Overview." *Wetlands Ecology and Management* 20 (3): 165–71. doi:10.1007/s11273-012-9264-4.

De Boo, M. J., A. E. Rennie, H. M. Buchanan-Smith, and C. F. M. Hendriksen. 2005. "The Interplay between Replacement, Reduction and Refinement: Considerations Where the Three Rs Interact." *Animal Welfare-Potters Bar Then Wheathampstead* 14 (4): 327.

De Groot, R. S., M. Stuip, M. Finlayson, and N. C. Davidson. 2006. *Valuing Wetlands: Guidance for Valuing the Benefits Derived from Wetland Ecosystem Services*. Gland, Switzerland; Montreal, Quebec, Canada: Ramsar Convention Secretariat; Secretariat of the Convention on Biological Diversity.

De Groot, R. S., M. A. Wilson, and R. O. Boumans. 2002. "A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services." *Ecological Economics* 41 (3): 393–408.

De Pinto, J. V., T. C. Young, and L. M. McIlroy. 1986. "Great Lakes Water Quality.pdf." *Environmental Science & Technology* 20 (8): 753–60.

"DEQ - Water." 2017. Accessed July 7. http://www.michigan.gov/deq/0,4561,7-135-3313---,00.html.

Dias, V., and K. Belcher. 2015. "Value and Provision of Ecosystem Services from Prairie Wetlands: A Choice Experiment Approach." *Ecosystem Services* 15 (October): 35–44. doi: 10.1016/j.ecoser.2015.07.004.

Dixon, A. B. 2005. "Wetland Sustainability and the Evolution of Indigenous Knowledge in Ethiopia." *The Geographical Journal* 171 (4): 306–23.

Dugan, P. J., ed. 1990. *Wetland Conservation: A Review of Current Issues and Required Action*. IUCN.

Eliot, and Associate. 2005. “Guidelines for Conducting a Focus Group.” Duck University.

Farley, J., and R. Costanza. 2010. “Payments for Ecosystem Services: From Local to Global.” *Ecological Economics* 69 (11): 2060–68. doi: 10.1016/j.ecolecon.2010.06.010.

Finlayson, C. M., N. C. Davidson, A. G. Spiers, and N. J. Stevenson. 1999. “Global Wetland Inventory – Current Status and Future Priorities.” *Marine and Freshwater Research* 50 (8): 717. doi:10.1071/MF99098.

Fisher, B., R. K. Turner, and P. Morling. 2009. “Defining and Classifying Ecosystem Services for Decision Making.” *Ecological Economics* 68 (3): 643–53. doi: 10.1016/j.ecolecon.2008.09.014.

Fizzell, C. 2014. “Status and Trends of Michigan’s Wetlands: Pre-European Settlement to 2005.” Lansing, MI: Department of Water Quality.

Fretwell, J. D., J. S. Williams, P. J. Redman, and Geological Survey (U.S.), eds. 1996. *National Water Summary on Wetland Resources*. United States Geological Survey Water-Supply Paper 2425. Washington, D.C: U.S. G.P.O.

Frey, J. H., and A. Fontana. 1991. “The Group Interview in Social Research.” *The Social Science Journal* 28 (2): 175–87.

“Function - Definition of Function in English | Oxford Dictionaries.” 2017. *Oxford Dictionaries | English*. Accessed July 7. https://en.oxforddictionaries.com/definition/function.

Gollin, L. X., H. McMillen, and B. Wilcox. 2004. “Participant-Observation and Pile Sorting: Methods for Eliciting Local Understandings and Valuations of Plants as a First Step Towards Informed Community Participation in Environment and Health Initiatives in Hawai’i.” *Applied Environmental Education & Communication* 3 (4): 259–67. doi:10.1080/15330150490882001.

Gómez-Baggethun, E., R. de Groot, P. L. Lomas, and C. Montes. 2010. “The History of Ecosystem Services in Economic Theory and Practice: From Early Notions to Markets and Payment Schemes.” *Ecological Economics* 69 (6): 1209–18. doi: 10.1016/j.ecolecon.2009.11.007.

Graff, L., and J. Middleton. 2001. “Fish and Wetlands: Catch the Link” Accessed July 7. http://www.habitat.noaa.gov/pdf/fishandwetlands.pdf

Grasset et al. 2016. “Carbon Emission along a Eutrophication Gradient in Temperate Riverine Wetlands: Effect of Primary Productivity and Plant Community Composition.” *Freshwater Biology*.

Greenland-Smith, S., J. Brazner, and K. Sherren. 2016. “Farmer Perceptions of Wetlands and Waterbodies: Using Social Metrics as an Alternative to Ecosystem Service Valuation.” *Ecological Economics* 126 (June): 58–69. doi: 10.1016/j.ecolecon.2016.04.002.

Hernández-Crespo, C., N. Oliver, J. Bixquert, S. Gargallo, and M. Martín. 2016. “Comparison of Three Plants in a Surface Flow Constructed Wetland Treating Eutrophic Water in a Mediterranean Climate.” *Hydrobiologia* 774 (1): 183–92. doi:10.1007/s10750-015-2493-9.

Ittelson, W. H. 1978. “Environmental Perception and Urban Experience.” *Environment and Behavior* 10 (2): 193–213. doi:10.1177/0013916578102004.

Jackson, K. M., and W. M. K. Trochim. 2002. “Concept Mapping as an Alternative Approach for the Analysis of Open-Ended Survey Responses.” *Organizational Research Methods* 5 (4): 307–36. doi:10.1177/109442802237114.

Jenks, A. E. 1901. *The Wild Rice Gatherers of the Upper Lakes; a Study in American Primitive Economics*. Washington, DC: USA.

Jude, D. J., and J. Pappas. 1992. “Fish Utilization of Great Lakes Coastal Wetlands.” *Journal of Great Lakes Research* 18 (4): 651–72. doi:10.1016/S0380-1330(92)71328-8.

Kane, D. D., J. D. Conroy, P. R. Richards, D. B. Baker, and D. A. Culver. 2014. “Re-Eutrophication of Lake Erie: Correlations between Tributary Nutrient Loads and Phytoplankton Biomass.” *Journal of Great Lakes Research* 40 (3): 496–501. doi: 10.1016/j.jglr.2014.04.004.

Kaplowitz, M. D. 2000. “Identifying Ecosystem Services Using Multiple Methods: Lessons from the Mangrove Wetlands of Yucatan, Mexico.” *Agriculture and Human Values* 17 (2): 169–179.

Kaplowitz, M. D. 2001. “Assessing Mangrove Products and Services at the Local Level: The Use of Focus Groups and Individual Interviews.” *Landscape and Urban Planning* 56 (1–2): 53–60. doi:10.1016/S0169-2046(01)00170-0.

Kaplowitz, M. D., and J. Kerr. 2003. “Michigan Residents’ Perceptions of Wetlands and Mitigation.” *Wetlands* 23 (2): 267–77. doi:10.1672/15-20.

Kaplowitz, M. D., F. Lupi, and O. Arreola. 2012. “Local Markets for Payments for Environmental Services: Can Small Rural Communities Self-Finance Watershed Protection?” *Water Resources Management* 26 (13): 3689–3704. doi:10.1007/s11269-012-0097-y.

Kaplowitz, M. D., F. Lupi, and J. P. Hoehn. 2007. “What Does the Public Know about Wetlands in Michigan? Using Focus Groups for Scoping and Exploratory Research.” *Michigan Academician* 37 (1–3): 19–33.

Kaplowitz, M. D., and S. G. Witter. 2008. “Agricultural and Residential Stakeholder Input for Watershed Management in a Mid-Michigan Watershed.” *Landscape and Urban Planning* 84 (1): 20–27. doi: 10.1016/j.landurbplan.2007.06.004.

Keddy, P. A., L. H. Fraser, A. I. Solomeshch, W. J. Junk, D. R. Campbell, M. T. K. Arroyo, and C. J. R. Alho. 2009. “Wet and Wonderful: The World’s Largest Wetlands Are Conservation Priorities.” *BioScience* 59 (1): 39–51. doi:10.1525/bio.2009.59.1.8.

Kennedy, J. C. 1862. *Preliminary Report on the Eighth Census, 1860*. U.S. Government Printing Office.

Kitzinger, J. 1994. “The Methodology of Focus Groups: The Importance of Interaction between Research Participants.” *Sociology of Health & Illness* 16 (1): 103–21. doi:10.1111/1467-9566.ep11347023.

“Knowledge - Definition of Knowledge in English | Oxford Dictionaries.” 2017. Accessed July 7. https://en.oxforddictionaries.com/definition/knowledge.

Kontogianni, A., M. S. Skourtos, I. H. Langford, I. J. Bateman, and S. Georgiou. 2001. “Integrating Stakeholder Analysis in Non-Market Valuation of Environmental Assets.” *Ecological Economics* 37 (1): 123–38.

Krueger, R. A., and M. A. Casey. 2014. *Focus Groups: A Practical Guide for Applied Research*. SAGE Publications.

Lambert, A. 2003. “Economic Valuation of Wetlands: An Important Component of Wetland Management Strategies at the River Basin Scale.” *Conservation Finance Guide, Washington*.

Leech, N. L., and A. J. Onwuegbuzie. 2011. “Beyond Constant Comparison Qualitative Data Analysis: Using NVivo.” *School Psychology Quarterly* 26 (1): 70–84. doi:10.1037/a0022711.

Lemberg, I., I. Kirchberger, G. Stucki, and A. Cieza. 2010. “The ICF Core Set for Stroke from the Perspective of Physicians: A Worldwide Validation Study Using the Delphi Technique.” *European Journal of Physical and Rehabilitation Medicine* 46 (3): 377–88.

Lowery, D. R., and W. D. Morse. 2013. “A Qualitative Method for Collecting Spatial Data on Important Places for Recreation, Livelihoods, and Ecological Meanings: Integrating Focus Groups with

Public Participation Geographic Information Systems." *Society & Natural Resources* 26 (12): 1422–37. doi:10.1080/08941920.2013.819954.

Lupi, F., M. D. Kaplowitz, and J. P. Hoehn. 2002. "The Economics of Wetland Ecosystem Restoration and Mitigation: The Economic Equivalency of Drained and Restored Wetlands in Michigan." *American Journal of Agricultural Economics* 84 (5): 1355–61. doi:10.1111/1467-8276.00402.

Manuel, P. M. 2003. "Cultural Perceptions of Small Urban Wetlands: Cases from the Halifax Regional Municipality, Nova Scotia, Canada." *Wetlands* 23 (4): 921–44.

Mayda, C. 2013. *A Regional Geography of the United States and Canada: Toward a Sustainable Future*. 1st ed. Rowmann and Littlefield Publishing.

Meng, L., N. Roulet, Q. Zhuang, T. R. Christensen, and S. Frolking. 2016. "Focus on the Impact of Climate Change on Wetland Ecosystems and Carbon Dynamics." *Environmental Research Letters* 11 (10): 100201. doi:10.1088/1748-9326/11/10/100201.

Michalak, A., E. J. Anderson, D. Beletsky, S. Boland, N. S. Bosch, T. B. Bridgeman, J. B. Chaffin, et al. 2013. "Record-Setting Algal Bloom in Lake Erie Caused by Agricultural and Meteorological Trends." *Proceedings of the National Academy of Sciences* 110 (16).

Mir, R., and A. Watson. 2000. "Strategic Management and the Philosophy of Science: The Case for a Constructivist Methodology." *Strategy Management Journal* 21 (9): 941–53.

Mitsch, W. J., and J. G. Gosselink. 2000. "The Value of Wetlands: Importance of Scale and Landscape Setting." *Ecological Economics*, THE VALUES OF WETLANDS: LANDSCAPES AND INSTITUTIONAL PERSPECTIVES, 35 (1): 25–33.

Mitsch, W. J., and J. G. Gosselink. 2015. *Wetlands*. Fifth edition. Hoboken, NJ: John Wiley and Sons, Inc.

Morgan, D. 1997. *Focus Groups as Qualitative Research*. Thousand Oaks, CA: SAGE Publications, Inc. doi:10.4135/9781412984287.

Morse, J. M. 1991. "Approaches to Qualitative-Quantitative Methodological Triangulation." *Nursing Research* 40 (2): 120–23.

Nabahungu, N. L., and S. M. Visser. 2013. "FARMERS' KNOWLEDGE AND PERCEPTION OF AGRICULTURAL WETLAND MANAGEMENT IN RWANDA: FARMERS' PERCEPTIONS IN RECLAIMED WETLAND." *Land Degradation & Development* 24 (4): 363–74. doi:10.1002/ldr.1133.

NAWMP. 1998. “Upper Mississippi River and Great Lakes Region Joint Venture Michigan Implementation Strategy (1998 - 2013).” Implementation Strategy. North American Waterfowl Management Plan.

NAWMP. 2012. “People Conserving Waterfowl and Wetlands.” Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales.

Ndaruga, A.M., and P.R. Irwin. 2003. “Cultural Perceptions of Wetlands by Primary School Teachers in Kenya.” *International Research in Geographical and Environmental Education* 12 (3): 219–30. doi:10.1080/10382040308667534.

Newlon, S. R. 2014. “The Past, Present, and Future of Wetlands Permitting in Michigan.” *Michigan Bar Journal*, no. Environmental Law.

Nsengimana, V., S. Weihler, and B. A Kaplin. 2017. “Perceptions of Local People on the Use of Nyabarongo River Wetland and Its Conservation in Rwanda.” *Society & Natural Resources* 30 (1): 3–15. doi:10.1080/08941920.2016.1209605.

“NVivo Plus | QSR International.” 2017. Accessed July 7. http://www.qsrinternational.com/nvivo-product/nvivo11-for-windows/plus.

Olmsted-Hawala, E. 2006. “Card Sorting, Information Architecture and Usability: Adding in Our Users’ Perspective to Re-Design the Census Bureau Web Site.” In, 1:1–11. New York: Institute of Electrical and Electronics Engineers. doi:10.1109/IPCC.2006.320360.

“Online Diagram Software to Draw Flowcharts, UML & More | Creately.” 2017. Accessed July 7. https://creately.com/.

Palmer, B. W. 1915. *Swamp Land Drainage with Special Reference to Minnesota*. Bulletin of the University of Minnesota.

“Perception - Definition of Perception in English | Oxford Dictionaries.” 2017. Accessed July 7. https://en.oxforddictionaries.com/definition/perception.

Prince, H. 1997. *Wetlands of the American Midwest: A Historical Geography of Changing Attitudes*. 1st ed. University of Chicago Press.

“Process - Definition of Process in English | Oxford Dictionaries.” 2017. *Oxford Dictionaries | English*. Accessed July 7. https://en.oxforddictionaries.com/definition/process.

Ramsar Convention Secretariat. 2013. “The Ramsar Convention Manual, 6th Edition.” The Ramsar Convention Manual: A Guide to the Convention on Wetlands (Ramsar, Iran, 1971). Gland, Switzerland: Ramsar Convention Secretariat.

Reddy, K. R., and R. D. De Laune. 2008. “Biogeochemistry of Wetlands: Science and Applications.” *CRC Press*. July 28.

Reed, M. S., A. Graves, N. Dandy, H. Posthumus, K. Hubacek, J. Morris, C. Prell, C. H. Quinn, and L. C. Stringer. 2009. “Who’s in and Why? A Typology of Stakeholder Analysis Methods for Natural Resource Management.” *Journal of Environmental Management* 90 (5): 1933–49. doi: 10.1016/j.jenvman.2009.01.001.

“Resource - Definition of Resource in English | Oxford Dictionaries.” 2017. *Oxford Dictionaries | English*. Accessed July 8. https://en.oxforddictionaries.com/definition/resource.

Richardson, C. J. 1994. “Ecological Functions and Human Values in Wetlands: A Framework for Assessing Forestry Impacts.” *Wetlands* 14 (1): 1–9.

Ricketts, T. H. 1999. *Terrestrial Ecoregions of North America: A Conservation Assessment*. Island Press.

Righi, C., C. Howe, D. L. Day, J. E. Fox, J. Gieber, L. Ruby, and M. Beasley. 2013. “Card Sorting Best Practices.” *Journal of Usable Studies* 8 (3): 69–89.

Roebeling, P., N. Abrantes, S. Ribeiro, and P. Almeida. 2016. “Estimating Cultural Benefits from Surface Water Status Improvements in Freshwater Wetland Ecosystems.” *Science of The Total Environment* 545–546 (March): 219–26. doi: 10.1016/j.scitotenv.2015.12.063.

Roth, R. E., B. G. Finch, J. I. Blanford, A. Klippel, A. C. Robinson, and A. M. MacEachren. 2011. “Card Sorting for Cartographic Research and Practice.” *Cartography and Geographic Information Science* 38 (2): 88–99.

Saldaña, J. 2013. “Chapter 1: An Introduction to Codes and Coding.” In *the Coding Manual for Qualitative Researchers*, 2nd ed. Los Angeles, CA: SAGE Publications Limited.

Saldaña. J. 2013. *The Coding Manual for Qualitative Researchers*. Los Angeles, CA: SAGE Publications Limited.

Saldaña, Johnny. 2009. *The Coding Manual for Qualitative Researchers*. Los Angeles, CA: SAGE Publications Limited.

Sandifer, P. A., A. E. Sutton-Grier, and B. P. Ward. 2015. “Exploring Connections among Nature, Biodiversity, Ecosystem Services, and Human Health and Well-Being: Opportunities to Enhance Health and Biodiversity Conservation.” *Ecosystem Services* 12 (April): 1–15. doi: 10.1016/j.ecoser.2014.12.007.

Sather, J. H., and R. D. Smith. 1984. “AN OVERVIEW OF MAJOR WETLAND FUNCTIONS AND VALUES.” Government. Washington, D.C: US Department of the Interior: US Fish and Wildlife Service.

Schneider, S. J., J. Kerwin, J. Frechtling, and B. A. Vivari. 2002. “Characteristics of the Discussion in Online and Face-to-Face Focus Groups.” *Social Science Computer Review* 20 (1): 31–42.

Sharma, B., G. Rasul, and N. Chettri. 2015. “The Economic Value of Wetland Ecosystem Services: Evidence from the Koshi Tappu Wildlife Reserve, Nepal.” *Ecosystem Services* 12 (April): 84–93. doi: 10.1016/j.ecoser.2015.02.007.

Sherrouse, B., and D. Semmens. 2010. “Social Values for Ecosystem Services (SolVES)-Using GIS to Include Social Values Information in Ecosystem Services Assessments.” Fact Sheet. Social Values for Ecosystem Services (SolVES). Washington, D.C: US Geological Survey (USGS).

Silbernagel, J., S. R. Martin, M. R. Gale, and J. Chen. 1997. “Prehistoric, Historic, and Present Settlement Patterns Related to Ecological Hierarchy in the Eastern Upper Peninsula of Michigan, U.S.A.” *Landscape Ecology* 12 (4): 223–40. doi:10.1023/A:1007946907682.

Soulliere, G. J., and M. J. Monfils. 1996. “Waterbird Use of Constructed Wetland Complex Eastern UP (Year 3).” Wildlide Division 3262. Sault Ste. Marie, MI: Michigan Department of Natural Resource.

Stratford, D. 2006. “Environmental Value.” *Encyclopedia of Human Geography*. Thousand Oak, CA: SAGE Publications Limited.

Sumarga, E., L. Hein, B. Edens, and A. Suwarno. 2015. “Mapping Monetary Values of Ecosystem Services in Support of Developing Ecosystem Accounts.” *Ecosystem Services* 12 (April): 71–83. doi: 10.1016/j.ecoser.2015.02.009.

“Surface Water Projects - USGS, MI-WSC.” 2017. Accessed July 7. https://mi.water.usgs.gov/projects/SWindex.html.

Suvedi, M., D. Krueger, A. Shrestha, and D. Bettinghouse. 2000. “Michigan Citizens’ Knowledge and Perceptions About Groundwater.” *The Journal of Environmental Education* 31 (2): 16–21. doi:10.1080/00958960009598634.

Tanner, H. H. 1987. *Atlas of Great Lakes Indian History (Civilization of the American Indian Series)*. 2nd ed. University of Oklahoma Press.

Tansley, A. G. 1935. "The Use and Abuse of Vegetational Concepts and Terms." *Ecology* 16 (3): 284–307.

Tellis, W. M. 1997. "Application of a Case Study Methodology." *The Qualitative Report* 3 (3): 1–19.

Tiner, R. W., M. W. Lang, and V. V. Klemas, eds. 2015. *Remote Sensing of Wetlands: Applications and Advances*. 1st ed. Taylor and Francis Group.

Tiner, R. W. 1984. "Wetlands of the United States-Current Status and Recent Trends." National Wetland Inventory 3386. Washington, D.C: Department of the Interior: Fish and Wildlife Service.

Tiner, R. W. 1991. "The Concept of a Hydrophyte for Wetland Identification: Individual Plants Adapt to Wet Environments." *BioScience* 41 (4): 236–47.

Tiner, R. W. 2003. "Geographically Isolated Wetlands of the United States." *Wetlands* 23 (3): 494–516. doi:10.1672/0277-5212(2003)023[0494: GIWOTU]2.0.CO;2.

Tuan, Y. 1974. *Topophilia: A Study of Environmental Perceptions, Attitudes, and Values*. Columbia University Press.

Turner, R. K., and G. C. Daily. 2008. "The Ecosystem Services Framework and Natural Capital Conservation." *Environmental and Resource Economics* 39 (1): 25–35. doi:10.1007/s10640-007-9176-6.

Turner, R. K., S. G. Georgiou, and B. Fisher. 2008. *Valuing Ecosystem Services: The Case of Multi-Functional Wetlands*. London; Sterling, VA: Earthscan.

Turner, R. K., J. C. M Van Den Bergh, T. Söderqvist, A. Barendregt, J. Van Der Straaten, E. Maltby, and E. C. Van Ierland. 2000. "Ecological-Economic Analysis of Wetlands: Scientific Integration for Management and Policy." *Ecological Economics* 35 (1): 7–23.

US EPA. 2015. "Great Lakes Facts and Figures." Overviews and Factsheets. *US EPA*. September 18. https://www.epa.gov/greatlakes/great-lakes-facts-and-figures.

US EPA. 2016. "Ecoregion Download Files by State - Region 5." Data and Tools. *US EPA*. March 9. https://www.epa.gov/eco-research/ecoregion-download-files-state-region-5.

"Value - Definition of Value in English | Oxford Dictionaries." 2017. *Oxford Dictionaries | English*. Accessed July 7. https://en.oxforddictionaries.com/definition/value.

Van Seters, T. E., and J. S. Price. 2001. "The Impact of Peat Harvesting and Natural Regeneration on the Water Balance of an Abandoned Cutover Bog, Quebec." *Hydrological Processes* 15 (2): 233–48. doi:10.1002/hyp.145.

Vörösmarty, C. J., P. B. McIntyre, M. O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, et al. 2010. "Global Threats to Human Water Security and River Biodiversity." *Nature* 467 (7315): 555–61. doi:10.1038/nature09440.

Walsh, M. 2003. "Teaching Qualitative Analysis Using QSR NVivo." *The Qualitative Report* 8 (2): 251–56.

Weiss, R. S. 1995. *Learning from Strangers: The Art and Method of Qualitative Interview Studies*. Simon and Schuster.

Welsh, E. 2002. "Dealing with Data: Using NVivo in the Qualitative Data Analysis Process." *Forum: Qualitative Social Research* 3 (2): 1–7.

Wilson, M. A., and S. R. Carpenter. 1999. "Economic Valuation of Freshwater Ecosystem Services in the United States: 1971-1997." *Ecological Applications* 9 (3): 772. doi:10.2307/2641328.

Zedler, J. B., and S. Kercher. 2005. "WETLAND RESOURCES: Status, Trends, Ecosystem Services, and Restorability." *Annual Review of Environment and Resources* 30 (1): 39–74. doi: 10.1146/annurev.energy.30.050504.144248.