INCORPORATION OF CLIMATE CHANGE LEARNING INTO MICHIGAN K-12 SCIENCE AND GREAT LAKES STEWARDSHIP EDUCATION: TEACHERS' PERSPECTIVES

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ABSTRACT

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To enact change that will reduce the Great Lakes region's vulnerability to climate change, it is critical to foster a sense of stewardship and empowerment among current residents. Formal education is a place where individuals can develop the knowledge, skills, and passion to become stewards of this place. The purpose of this research project is to explore the status of climate change teaching and learning within the context of science and Great Lakes stewardship education in Michigan. Within Michigan's current science content standards that guide most teachers with their lesson plans, climate change is addressed sparingly across grade levels and is only explicitly mentioned in the standards three times. Therefore, the degree or frequency that teachers are discussing climate change with their students is unknown.

After in-depth interviews with 15 elementary, middle, and high school science teachers from around Michigan, eight teachers said they had incorporated climate change into their curriculum and six said they had discussed climate change in the context of the Great Lakes with students. Factors such as teachers' perceptions of climate change, access to resources like professional development and teaching materials, teachers' content and pedagogical knowledge, and the context of teacher accountability through student standardized testing all are related to a teacher's decision to integrate climate change into science or Great Lakes lessons. The majority of the teachers are interested in either continuing to educate students on climate change or starting to, and have provided innovative recommendations to do so in the future.

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Introduction

People all over the world are currently experiencing the effects of climate change, whether they realize it or not. Average global temperatures are increasing, sea level is rising, glaciers are shrinking, and the ocean is acidifying (IPCC 5th Assessment – Synthesis Report, 2014). The Earth's climate system undergoes natural fluctuations and the ice ages throughout history are evidence of that. However, the changes that humans are witnessing today in the Earth's climate are not a result of natural fluctuations. In the most recent report from the Intergovernmental Panel on Climate Change, researchers agree that "human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history" (IPCC 5th Assessment – Synthesis Report, 2014, p.1). Since the industrial era of western society began in the 19th century, humans have been adding to the amount of greenhouse gases in the atmosphere, primarily through the burning of fossil fuels (Climate Literacy, 2009). As a result, the average global temperature over the last 100 years has increased 1.4 °F and the projected temperature increase for the next century is greater than any extended warming period over the past 65 million years (Molina, McCarthy, Wall, Alley, Cobb, Cole, Das, Diffenbaugh, Emanuel, Frumkin, Hayhoe, Parmesan, & Shepherd, 2014).

Despite all the evidence on anthropogenic climate change, questions still remain about the reality, severity, and implications it has for the entire human population today and in the future. In a recent national study on public perception of global warming[1], 64% of Americans believe global warming currently exists, and this percentage has stayed relatively consistent over

[1] Global warming is not synonymous for climate change; the first simply means a rise in global average surface temperature while the latter represents long-term changes to the global climate system including changes in temperature, precipitation, and wind patterns. The scientific community prefers to use climate change because it encompasses more than just rising global temperatures (Leiserowitz, Feinberg, Rosenthal, Smith, Anderson, Roser-Renouf, & Maibach, 2014).

the past three years (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Rosenthal, 2014). About half of Americans think that if global warming is happening, it is caused mostly by human activities. However, when surveys ask about both existence and anthropogenic causes of change, only 44% of Americans believe that global warming is both human caused and happening today (Leiserowitz et al., 2014). Despite the disagreement among Americans on the reality and causation of global warming, the majority of climate scientists agree that it exists, is human induced, and is an urgent problem facing society.

In a recent review of over 12,500 climate science articles, 97% agreed upon the reality of human induced climate change (Cook, Nuccitelli, Green, Richardson, Winkler, Painting, & Skuce, 2013). However, according to another recent study, only one in every ten Americans knows that over 90% of climate scientists agree on that reality and cause of climate change (Leiserowitz et al., 2014). This gap in public awareness of climate scientists' consensus can influence the support for policy and efforts to mitigate the United States' current impact on the climate system. If human effort is not made and current greenhouse gas emissions continue to rise at accelerated rates, aspects of the global climate system could be pushed beyond the threshold and into a downward spiral of "abrupt, unpredictable, and potentially irreversible changes" (Molina et al., 2014, p.7).

With the effects of global climate change becoming more and more apparent, governments around the world have taken action toward adapting to and mitigating the present climate trends. National and international entities like the United States Global Climate Change Initiative and the United Nations Framework Convention on Climate Change are presently working toward a brighter future for the entire human population and the planet that supports it. For example in June 2014, the U.S. Environmental Protection Agency, under President Obama's

Climate Action Plan, proposed the Clean Power Plan which was later approved, that will regulate carbon emissions from power plants; these carbon emissions represent one third of U.S. greenhouse gas emissions. In November 2014, President Obama and China's President Xi Jinping announced plans to reduce each respective country's carbon emissions and support developing renewable energy resources for the future, in hopes that they set a precedent for progress to be made at the United Nations Climate Conference in Paris in 2015 (The White House, 2014).

Although there is scientific consensus on the reality of anthropogenic climate change and some plans are being made towards creating a more sustainable future, climate change remains a very real and complex issue facing society today. Any effort to mitigate the impacts of climate change relies on informed decision making at the individual, community, national, and international levels. Being informed means being knowledgeable about a particular topic, in this instance climate change. However, informed decision making is not solely reliant on knowing; it also relies on the ability to translate knowledge into positive action (Climate Literacy, 2009). And, underlying an informed decision on climate change is the notion of interconnectedness between humans and the climate system – understanding the climate's influence on humans as well as humans' influence on the climate (Climate Literacy, 2009).

Recognizing the interconnectedness and complexity of climate change is not something that can be learned overnight. Instead, the learning process requires systems-thinking[2] and interdisciplinary approaches (Climate Literacy, 2009). The United States Global Change Research Program developed a series of climate literacy principles to aid in the development of public understanding of climate change. This program's report states, "to protect fragile

[2] A systems-thinking approach is the ability to recognize and understand the interconnectedness among all the components within the climate system (Climate Literacy, 2009).

ecosystems and to build sustainable communities that are resilient to climate change, a climate-literate citizenry is essential" (Climate Literacy, 2009, p. 3). A climate-literate citizen is one who,

> Understands the essential principles of Earth's climate system, knows how to assess scientifically credible information about climate, communicates about climate and climate change in a meaningful way, and is able to make informed and responsible decisions with regard to actions that may affect climate. (Climate Literacy, 2009, p. 4)

Developing a climate-literate citizenry, that is ultimately able to make informed decisions that benefit society and the environment, begins with the individual.

However, as mentioned before, climate change is a complex, global issue that is often difficult to comprehend in its entirety. Therefore, in order to inspire individuals to become climate-literate and to take action, climate change must be framed in a way that makes sense and is relevant to each individual person. One way of doing this is to focus attention on a specific region or place that people to which are attached and upon which they depend, like the Great Lakes region[3] (Stedman, 2002; Scannell & Gifford, 2013). Demonstrating that climate change poses a threat to the Great Lakes may in turn, ignite a sense of responsibility to protect this resource and desire to make informed decisions that benefit the region and ultimately, the rest of the world. In order to understand the impacts climate change has, or will have, on the Great Lakes, it is critical to first comprehend the larger, global process of climate change.

Throughout earth's history, natural changes in the climate system have occurred whereby the average global temperature experiences cyclical warming and cooling periods, each lasting approximately 100,000 years (Climate Literacy, 2009). These long-term fluctuations in average

[3] The Great Lakes region includes watersheds of the five bodies of water (Superior, Huron, Michigan, Erie, and Ontario) and the bordering states of Michigan, Wisconsin, Ohio, Pennsylvania, New York, Illinois, Indiana, and Minnesota, as well as the Province of Ontario, Canada.

global temperature are attributed to interactions earth's climate has with land, oceans, atmosphere, organisms living on earth, and the sun. For example, the direction of the earth's axis (precession), the tilt of the earth's axis (obliquity), and the earth's orbit around the sun (eccentricity) have been changing throughout earth's history every 26,000, 41,000, or 100,000 years (Lee, 2012). Each of these cycles influence the amount of solar energy the earth receives, which inherently affects global temperature over time. Earth's climate system has also historically been influenced by changing oceanic circulation patterns due to tectonic plate movement and short-term events like volcanic eruptions. While these natural processes are still occurring and influencing the climate system, human behavior has accelerated other changes in the climate system including a rise in global temperatures, a rise in sea level, a loss of biodiversity, the retreat of glaciers, and an increase in the frequency and severity of weather events (IPCC 5th Assessment, 2014).

One way that human behavior has accelerated changes in the climate system is by burning fossil fuels like coal, oil, and natural gas for energy and consequently emitting greenhouse gases in the atmosphere. Greenhouse gases such as carbon dioxide, methane, nitrous oxide, and water vapor naturally occur in small amounts in the atmosphere. They act as "heat-trapping" gases that absorb solar energy reflecting off of the Earth's surface, much like a greenhouse, and are the main reason Earth is habitable for humans (Climate Literacy, 2009). The amount of energy the Earth receives from the sun should equal the amount of energy radiated off of the Earth's surface and back into space, allowing the Earth to have a relatively stable temperature over a given period of time (U.S. Energy Information Administration, 2004). As more greenhouse gases are added to the atmosphere through human activity, the more solar

energy, or heat, that is trapped which contributes to an increase in the average global temperature over time.

The Great Lakes, the watersheds surrounding them, and the livelihoods of resident populations dependent on this resource are already being influenced by increasing surface temperatures and climate change. A study done in 2003 on the effects climate change is projected to have on the Great Lakes region concluded that within the next century, Michigan's temperatures would rise 6 – 10 °F in the winter months and 7 – 13 °F in the summer months (Kling, Zak, & Wilson, 2003). In a recent report by the United States Global Change Research Program, the authors explained the impacts that climate change has already, and will continue to have on the Midwest region such as rising temperatures. Since 1895, average annual temperatures in the Midwest region have risen 1.5 °F (Pryor, Scavia, Downer, Gaden, Iverson, Nordstrom, Patz, & Roberston, 2014). Other impacts of climate change in Michigan are likely to be an increase in seasonal precipitation during winter months, a change in precipitation patterns during summer months possibly resulting in drier conditions, an increased frequency of extreme precipitation events, a decrease in ice cover on inland lakes and the Great Lakes, an extended growing season, and lower lake levels (Kling, Zak, & Wilson, 2003; Pryor et al., 2014).

All of these changes to the climate in Michigan will impact the agriculture, recreation, and tourism industries that are vital to Michigan's economy. For example, Michigan's blueberry production may be significantly impacted by the warming climate as with all other fruit production in Michigan. If spring and warmer temperatures arrive earlier than usual, the blueberry plants bloom prematurely and are at risk of frost damage and the absence of vital pollinators (Garcia-Salazar, 2012). In addition, a decrease in the amount of rainfall Michigan receives could impact groundwater recharge, river systems, and wetland habitats that naturally

improve water quality and provide habitat for many different species (Kling, Zak, & Wilson, 2003). In the final remarks of their 2003 report, the authors stated "it is only fitting that the state whose fate is most closely tied to the Great Lakes themselves should be an exemplary steward of its rich environment and resources in the face of climate change" (Kling, Zak, & Wilson, 2003, p. 4).

To safeguard the quality of the world's largest surface freshwater supply, residents of Great Lakes states like Michigan have the opportunity to learn about climate change, to understand its effects on their surrounding environment, and eventually, to be able to make informed decisions that protect that environment for the future. A logical place for a person to learn about climate change is during the time spent in elementary and secondary education where the foundation for who they are as an individual is built, beliefs and values are shaped, and motivations in life are established. If an individual were to learn about and develop personal opinions on global climate change during their kindergarten through twelfth (K-12) grade years, that individual might then be better prepared to make informed decisions later in life that have a positive influence on the environment.

However, it is important to recognize that knowledge acquisition alone does not ensure informed decision making or a climate-literate citizenry. Instead, climate literacy is a process that includes both knowledge and individual action. The field of environmental education recognizes that manifesting environmentally responsible behaviors, such as those that would reduce vulnerability to climate change, requires both knowledge and the will to take action. The Tbilisi Intergovernmental Conference on Environmental Education in 1977 established five objectives for environmental education; they include awareness, sensitivity, attitudes, skills, and participation (Hungerford & Volk, 1990). Through these objectives, Hungerford and Volk

(1990) define an environmentally responsible citizen as someone with the following characteristics:

> An awareness and sensitivity to the total environment and its allied problems, a basic understanding of the environment and it allied problems, feelings of concern for the environment and motivation for actively participating in environmental improvement and protection, skills for identifying and solving environmental problems, and active involvement at all levels working towards a resolution of environmental problems. (p. 258)

The traditional model for environmental action is a very linear process; the more knowledge one has about an environmental problem, the more aware they will be about that problem and the more likely they will be motivated to take action regarding the problem (Hungerford & Volk, 1990). However, decades of research have demonstrated that a more complex process is involved in one's becoming an environmentally responsible citizen. Hungerford and Volk's (1990) model of responsible environmental behavior includes three critical components: background knowledge of an issue, a sense of ownership or personal investment in an issue, and finally empowerment or the intention to act on the issue (Hungerford & Volk, 1990). Approaching climate-literacy through the lens of this model will result in not only a knowledgeable citizenry, but also a populace that is compelled to act and has the necessary skills to do so.

Statement of Opportunity

In Michigan, the Science Grade Level Content Expectations and the Michigan High School Science Essential Content Standards and Expectations represent the academic standards that frame the state's science curriculum. According to the Michigan Department of Education,

the current K-12 academic standards represent the learning expectations for Michigan students as well as provide a platform for standardized assessments. Within the content expectations for grades K-7, the standards cover four major topic areas and these include: (1) science processes (like inquiry, analysis, communication, reflection, and social implications), (2) physical science, (3) life science, and (4) earth science (Ziker, 2014). A similar structure exists for the high school science content expectations; however, the content expectations delve deeper into the scientific processes, and topic areas are focused on chemistry, biology, physics, and earth science (Ziker, 2014).

A topic of recent debate in Michigan is whether the state department of education should adopt the Next Generation Science Standards (NGSS), a new framework for K-12 science standards that are shaped by three main dimensions: disciplinary core science ideas, cross-cutting science concepts, and scientific practices (NGSS, 2015). The disciplinary core ideas fall within the major science disciplines of physical sciences, life sciences, earth and space sciences, and engineering, technology, and applications of science (NGSS, 2015). Important to acknowledge is the degree to which climate change is specifically addressed in the NGSS and Michigan's current content expectations for science in K-12 classrooms.

Within NGSS, climate change is portrayed as an environmental and societal issue and is addressed throughout the performance expectations for all grade levels. For example, under the earth and human activity performance expectations (K-ESS3-3) for kindergarten within the disciplinary core idea of earth and space sciences, students are expected to "communicate solutions that will reduce the impact of humans on the land, air, water, and/or other living things in the local environment" (NGSS, 2015). Additional performance expectations for elementary students fall within topics areas such as the following: interdependent relationships in

ecosystems, weather and climate, energy, and Earth's systems (NGSS, 2015). Within the middle school performance expectations for earth and space sciences, performance expectations on the topics of history of Earth and human impacts are introduced. In high school, one of the performance expectations within earth and space sciences is human sustainability (NGSS, 2015). It is evident that two common themes within the NGSS are the interdependencies among all species on the planet and human impact on the environment, one impact being human influence on the climate system.

The K-12 science content expectations in Michigan address climate change sparingly across grade levels and most of the content on climate change, or its related topics, is found in the Earth and life science disciplines. Examples of topic areas within the Earth science standards that relate to climate change include weather, weather measurement, natural resources, human impacts, species adaptation and survival, changes in ecosystems, and energy (Michigan Department of Education, 2009). Climate change is mentioned twice within the Michigan science grade level content expectations as an example of human impact on the environment; once in the sixth grade life science standards and once in the seventh grade Earth science standards. Within the Michigan's High School Content Expectations for Science, climate change represents one of the four essential content statements under the standard, Earth in space and time, within the Earth science discipline. In addition to climate change, the other essential content statements falling under the Earth in space and time standard include the Earth in space, the sun, and Earth's history and geologic time (MDE, 2006). Although climate change, and its related topics, is present within Michigan's science standards, the issue of climate change itself is

not a consistent theme as it is in the NGSS, and therefore may not be given as high a priority by teachers operating under these standards[4].

Separate from the formal K-12 science standards in Michigan, agencies in Michigan and around the country have developed curriculum on climate change that is intended for use among educators. For example, the Michigan Department of Environmental Quality developed the Michigan Environmental Education Curriculum Support (MEECS) that offers content and educational resources on seven Michigan-specific units such as land use, ecosystems and biodiversity, water quality, energy and resources, and climate change. The MEECS unit on climate change provides an opportunity for teachers to explore the knowledge and pedagogy necessary to teach students about the scientific facts behind climate change as well as its societal implications. In addition, other state-wide and national agencies are developing climate change curricula and learning tools designed to make climate change, as well as other environmental issues, understandable and relevant for adult and youth learners alike. Some examples of these agencies include the Great Lakes Stewardship Initiative (GLSI), the United States Environmental Protection Agency (U.S. EPA), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA). However, whether or not these climate change curricula and learning tools have been incorporated into lessons is unknown, especially in states like Michigan that have not adopted NGSS and therefore may not prioritize teaching climate change within the science curriculum.

Purpose of the Research

The purpose of this research project is to explore the status of climate change teaching and learning in Michigan K-12 science and Great Lakes education, to identify barriers and

[4] Global climate change is addressed in Michigan's Grade Level Content Expectations for Social Studies under the standard, Global Issues Past and Present, and is referred to as a contemporary potential investigative topic for teachers to explore with students when covering this standard (MDE, 2007).

facilitators to climate change teaching and learning, and to obtain recommendations from teachers on how they think climate change can be best incorporated into science and Great Lakes education. Prior research has identified factors that influence implementation of environmental education, and more specifically, climate change and Great Lakes education (Ham & Sewing, 1988; Samuel, 1993; Fortner, 2001; Fortner & Corney, 2002; Gayford, 2002; Ko & Lee, 2003; Kim & Fortner, 2006; Wise, 2010; Monroe, Oxarart, & Plate, 2013). However, this study takes the existing body of scholarship one step further by providing an in-depth, qualitative investigation of these different factors as well as the role climate change currently has in science and Great Lakes education from the perspective of Michigan teachers. Very minimal research exists on the extent to which climate change is being taught in classrooms, and the studies that do exist are predominantly quantitative and largely focus on students. Although it is important to focus attention on the students within education research, it is of even more importance to acknowledge and learn from the perspective of the individuals responsible for educating students.

Research Questions

Teachers are the backbone of the formal education system in the United States. They cultivate knowledge, foster curiosity, and guide intellectual growth in children and teenagers during the early years of their lives. The immense responsibilities teachers have in educating the future generations of society result in an unending demand for their work. Within the Great Lakes region of the United States, teachers have the unique opportunity to instill a sense of stewardship within their students to protect the Great Lakes and all that they offer the region and rest of the world.

To be stewards of the Great Lakes, students need to first learn about the phenomena that are affecting the quality of the environment surrounding them, then to be able to critically reflect on their own and others attitudes, and then to translate that knowledge into action that benefits and protects the environment. Informed decision making, based on both expert and personal knowledge developed throughout education, is essential for the sustained quality of the Great Lakes. In order to have an informed and engaged citizenry in Michigan, all issues and topics relevant to citizens' livelihoods should be addressed in K-12 classrooms, including climate change. This study offers insight on whether climate change is included in science and Great Lakes education in Michigan, and it has also begun a conversation about how to connect such a complex, global topic to the environment with which students are most familiar. The following research questions have guided and oriented the research project:

1) To what extent are teachers educating students about climate change, specifically in how it relates to the Great Lakes?
2) What are the internal and external factors that influence whether a teacher incorporates climate change into their lessons or not?
    a) What barriers do teachers identify that inhibit teaching about the Great Lakes and climate change?
    b) What facilitators do teachers identify that already support, or are needed for, teaching about the Great Lakes and climate change?
3) How do or would teachers educate students about climate change in general and within the context of the Great Lakes region?

The overarching aim of this research is to learn from the participating teachers' varied perspectives on climate change teaching and learning, understand how they perceive its role in

science and Great Lakes education, and identify the real or foreseen factors inhibiting or supporting their ability to educate students on the topic. Beneficiaries of this research include other Michigan teachers, curriculum advisers, professional development planners, school administrators, nongovernmental organizations, extension and outreach groups, federal and state agencies, and those generally interested in the advancement of climate change teaching and learning. The information gained from this study could inform and improve teacher professional development on climate change education and ultimately provide greater learning opportunities for Michigan K-12 students. The insight the teachers provide in this study deepens and advances the conversation about both climate change education and the next generation of science standards in Michigan.

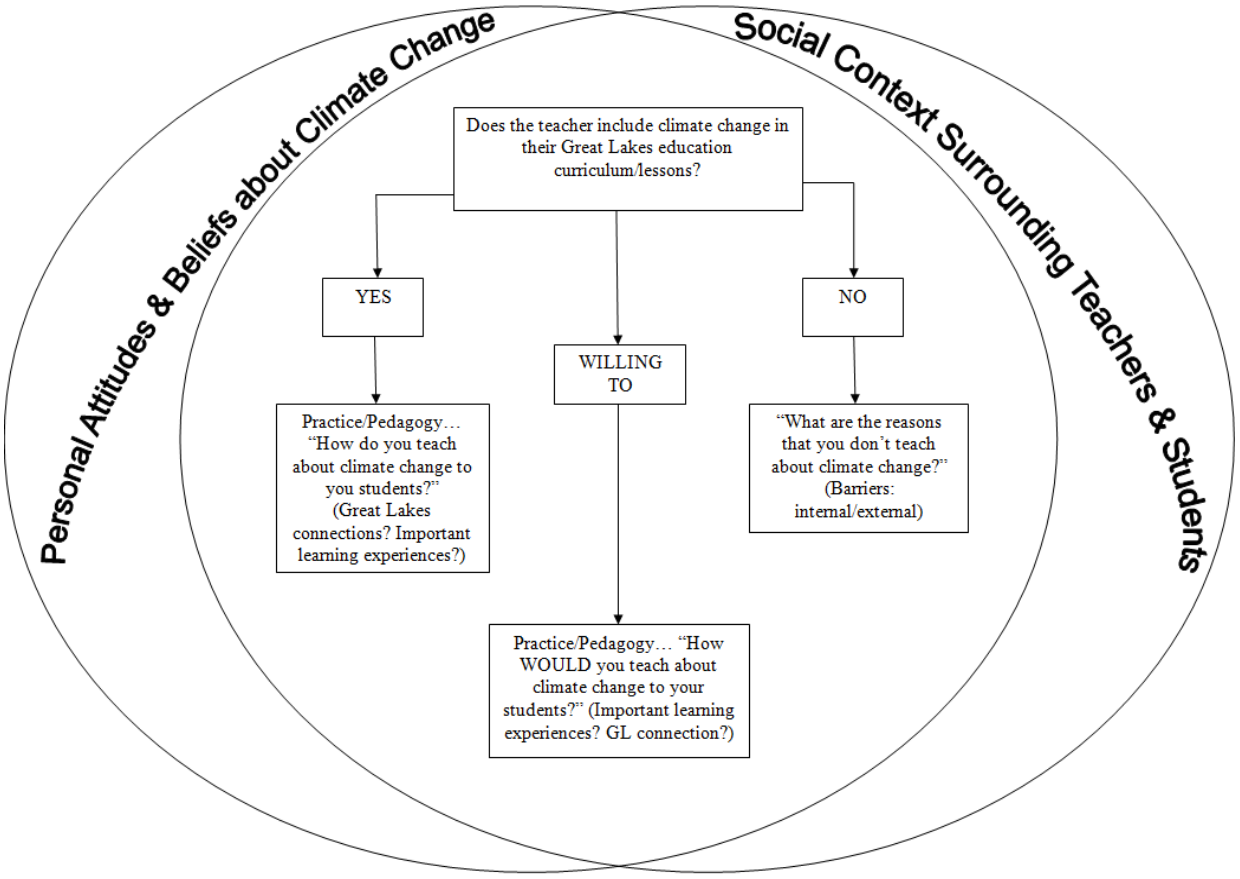

Figure 1 – Initial Conceptual Framework

Initial Conceptual Framework

Maxwell's (2010) interactive model of qualitative research design consists of five key elements, one of which is the conceptual framework. Figure 1 represents the initial conceptual framework underlying this research. Staying true to the emergent approach of this qualitative study, the initial conceptual framework evolved throughout the project as the researcher was informed by the conversations with teachers. The initial conceptual framework demonstrates the decision a teacher makes on whether to include climate change in his or her lessons. It was assumed that both the teacher's personal beliefs about climate change as well as the social context surrounding them and their students influence their decision. The degree of influence and more specific barriers that fall within these broad categories were explored through this study.

Chapter 2 – A Review of the Literature

History of Environmental Education

Environmental education and the principles by which it is founded upon have been evolving since its emergence in the late 1940s. Experts in the field have debated, discussed, and conducted many research projects that explore the avenues and opportunities environmental education offers people of all ages and cultural backgrounds. Many of the world organizations that exist today, like World Wildlife Fund and the United Nations, have contributed to the growth of environmental education into school curricula and beyond. However, environmental education today does not necessarily mean what it did to the world several decades ago, when it was a fairly new phenomenon. Throughout its history, the recognized definition of environmental education has undergone several revisions to reorient the focus to the needs of the time. This chapter section explores definitions of environmental education and the way it has changed over time to become the field it is today.

Environmental education first became popular in the 1960s as both scientists and citizens around the world began realizing the consequences of human behavior for the environment. Areas of concern included the increasing world population, the depletion of natural resources, and the overall quality of land, air, and water on Earth (Gough, 2006). Prior to this international realization, environmental organizations had already been established like The Nature Conservancy and the International Union for the Conservation of Nature and Natural Resources (IUCN), both founded in 1949 (Palmer, 1998). The members of these organizations and scientists around the world recognized that environmental problems could not be resolved solely with science and technology. Thus emerged the need for an educational paradigm for people, at

all levels, to become aware of environmental problems the world faces and develop skills to discuss and establish personal concern for the environment.

It is evident that the 1960s were an important decade for environmental education and that many world organizations were created and then met during these years to continue developing the new field. At first, during the 1960s, environmental education focused on nature study, or examining biotic and abiotic systems, and exposure to fieldwork (Palmer, 1998). However, in 1968 the United Nations Educational, Scientific, and Cultural Organization (UNESCO) held a conference in Paris, France where the world first recognized environmental education as an important topic (Palmer, 1998). The conference discussed the lessons and skills that were considered important for environmental education to teach students. According to the UNESCO conference, the important components of environmental education at the time included "the development of curricula materials relating to studying the environment for all levels of education, the promotion of technical training, and the stimulation of global awareness of environmental problems" (Palmer, 1998, p. 5). It can be argued that this era of environmental education encouraged a broad understanding of environmental problems but on a generalized level.

The 1970s marked an important decade for environmental education, and it was during this time that it was moved to the forefront of the environmental debate. In 1970, the IUCN and UNESCO held a conference in Carson City, Nevada where members discussed environmental education curricula and devised the first official definition of the field. The definition is as follows:

> Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-

> relatedness among man, his culture, and his biophysical surroundings. Environmental education also entails practice in decision-making and self formulation of a code of behavior about issues concerning environmental quality. (Palmer, 1998, p. 7)

Key components of this definition that differentiate it from what was considered environmental education in the 1960s include the development of attitudes/personal beliefs regarding the environment and understanding the relationship between humans and their environment. The IUCN definition emphasizes the importance of individual investment in the environment, something that was not necessarily deemed important in the 1960s. However, the push for environmental education in the 1970s did not stop there.

The 1972 Stockholm Conference on Global Environment witnessed an important realization among the conference attendees – that policy recommendations made during the conference would be difficult to implement without greater public understanding of the need for a change in human behavior (Blackburn, 1983). As a result, the International Environmental Education Program (IEEP) was formally established in 1975 by UNESCO and the United Nations Environment Program, a group created solely for implementing the recommendations that came out of Stockholm. Immediately after its establishment, the IEEP began to research the existing environmental education programs and formulate ideas for new interdisciplinary approaches to environmental education that included both formal and informal education and acknowledged all members of the public (Blackburn, 1983; Gough, 2006).

To begin this process, the IEEP administered an international survey to determine the needs and priorities of environmental education. The IEEP also asked 14 experts in the field to write research papers identifying the trends in environmental education among various levels of education including formal, informal, life-long learning, community education, and university

level education (Blackburn, 1983). Later that same year, the IEEP held a meeting in Belgrade, Yugoslavia to discuss the results from the survey and trend papers with various experts from around the world. This meeting is now referred to as the Belgrade International Workshop for Environmental Education (Gough, 2006). The workshop's discussion led to the unanimous adoption of what is known as The Belgrade Charter, a document that supports a new global ethic that called for "changes which will be directed towards an equitable distribution of the world's resources and will more fairly satisfy the needs of all peoples" (Blackburn, 1983, p. 271).

At Belgrade, three objectives for environmental education programs were developed and they are:

> To foster clear awareness of and concern about economic, social, political, and ecological interdependence in urban and rural areas; to provide every person with opportunities to acquire knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment; to create new patterns of behavior of individuals, groups, and society as a whole towards the environment. (Palmer, 1998, p.8)

The Belgrade workshop not only set the standards for environmental education programs, but it also introduced the idea of politicians and governmental representatives being included in the discussion. As indicated in the objectives, it was important for environmental education to present a holistic view of the world by examining environmental issues from various perspectives like public policy and economics instead of solely from the scientific disciplines.

The curriculum objectives and ideas set forth by the Belgrade workshop in 1975 were further developed at the 1977 Intergovernmental Conference on Environmental Education in Tbilisi, Georgia, USSR (Palmer, 1998). The Tbilisi conference reinforced the objectives made at the Belgrade conference and enacted the desire for including governmental delegates from

various countries among the NGOs already involved. The conclusions reached at the Tbilisi conference were followed for many years by organizations like the UN and UNESCO (Gough, 2006). A particularly effective summary statement from the Tbilisi Declaration, the document created from the meeting, is as follows:

> Environmental education, properly understood, should constitute a comprehensive lifelong education, one responsive to changes in a rapidly changing world. It should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to play a productive role towards improving life and protecting the environment with due regard given to ethical values. (UNESCO, 1977)

There are several key words in this statement that accurately portray the mentality surrounding environmental education in the 1970s. It was important for environmental education to be a lifelong process, one in that an individual adapts and learns as his or her environment changes. This notion was not necessarily considered in early views of environmental education where the focus was on the current state of a biological or physical element of the environment. The Tbilisi conference also reiterated the importance of instilling a holistic world view in students, encouraging them to use various lenses or perspectives to address and analyze the environmental problems in society. In prior environmental education practices, students were instructed to look through one scientific or biological lens to explore an environmental problem. Similar to the Belgrade Workshop, the recommendations that came out of the Tbilisi discussions focused more on quality of all aspects of life rather than solely environmental quality (Blackburn, 1983).

The Tbilisi conference attendees also generated a list of five learning objectives for environmental education, and these were awareness, knowledge, attitudes, skills, and

participation (Gough, 2006). According to the Tbilisi Declaration, environmental education should provide opportunities for developing awareness of and acquiring knowledge about environmental problems, should assist in the development of attitudes and/or concerns about the environment, and finally, generate skills and the ability to actively participate in solving environmental problems (UNESCO, 1977). The progress that environmental education made in the 1970s to becoming a highly discussed topic among world organizations influenced the changes that came to the field in the next two decades.

The 1980s and 1990s reflected a time when the environmental movement experienced a major shift towards sustainability and this shift was reflected in environmental education. In 1980, the IUCN, the United Nations Environmental Program (UNEP), and the World Wildlife Fund developed the World Conservation Strategy (Tilbury, 1995). This strategy "sought to protect essential ecological processes, life-support systems, and genetic diversity, as well as the sustainable utilization of natural resources" (Tilbury, 1995, p.197). The World Conservation Strategy's definition of environmental education differs from previous definitions by how it describes environmental education as being much more valuable to the human population in environmental, social, and economic ways. This perspective of environmental education built itself off of the "holistic philosophy" of the 1970s (Tilbury, 1995, p. 196). During this time, environmental education continued to become more and more important as quality of human life all over the world began to be questioned. Tilbury (1995) noted that the World Conservation Strategy made the relationships between poverty, development, and the environment apparent and that education was the resolution for problems within these relationships.

In 1987, the World Commission on Environment and Development (WCED) released a report that continued the conversation on global sustainable development titled, "Our Common

Future" also known as the Brundtland Report. The Brundtland Report defined sustainable development as when it meets the needs of the current population without compromising the ability of future populations to meet their needs (Brundtland, 1987). This report connected all the common challenges facing global society including population growth, food availability, energy demand, and human right to quality of life and recommended strategies for how to sustainably approach these challenges (Brundtland, 1987). The Brundtland Report also called for "a vast campaign of education, debate, and public participation" and that building public awareness is essential for progress to be made towards a sustainable future (Brundtland, 1987).

Sustainability gained popularity and in the 1990s, it became a central theme within environmental education. In 1992, the United Nations Conference for Environment and Development was held in Rio de Janeiro, Brazil where government officials, delegates, and NGO officers came together to discuss and eventually create what became Agenda 21 (Palmer, 1998). Agenda 21 is a major document consisting of 40 chapters covering topics such as poverty, deforestation, role of business and industry, and the management of radioactive wastes (UNCED, 1992). Chapter 25 of Agenda 21 is titled, "Children and Youth in Sustainable Development", and it emphasizes the necessary inclusion of youth in environmental and development strategies and/or decisions. Section 25.12 states, "The specific interests of children need to be taken fully into account in the participatory process on environment and development in order to safeguard the future sustainability of any actions taken to improve the environment" (UNCED, 1992, p.277). Section 25.2 further states that it is "imperative that youth from all parts of the world participate actively in all relevant levels of decision-making processes because it affects their lives today and has implications for their futures" (UNCED, 1992, p. 275). Agenda 21 confirmed the definition of environmental education for sustainability by demonstrating the

collaboration of environmental and human developmental efforts into one common goal for a sustainable future. The use of the environment and its natural resources is inextricably tied to human quality of life in the present and for the future. Environmental education for sustainability recognizes this relationship and seeks to inform and inspire people to feel empowered and able to create change.

Environmental education for sustainability (EEFS) is an effective and timely approach to environmental education today. EEFS centralizes learning around the relevance of topics to the student. These topics must invite students to establish relationships between themselves and the environmental/developmental problems they are exploring (Tilbury, 1995). EEFS also aims for students to embrace multiple disciplines while exploring a problem and not rely solely on for instance, scientific or economic perspectives. EEFS emphasizes a holistic approach to environmental and developmental problems, allowing students to come to their own understanding and environmental ethics that will guide them in the future (Tilbury, 1995).

The definition of environmental education has evolved through time to ultimately become what is known as EEFS. However, within the realm of EEFS, there are remnants of each phase of environmental education. They all contribute to the field that exists today. Environmental education can be viewed as a cycle; "developing environmental awareness, knowledge, values, concern, responsibility, and action" (Tilbury, 1995, p. 207).

Approaches to climate change education in the United States. The modern environmental movement in the United States sparked a shift in perspective among many Americans; the belief that humans and the environment are interdependent and that human actions have degraded the natural resources most vital to life on Earth. Throughout the 20th century, issues regarding water and air quality received significant attention from policy makers,

and regulations on pollution and waste were enacted in an attempt to improve the environment's conditions for the future. The United States, and the rest of global society, finds itself in a similar predicament today. However, the greatest issue facing today's society is climate change, and it encompasses much more than water and air quality concerns.

According to the U.S. EPA, climate change is defined as "any substantial change in measures of climate (such as temperature or precipitation) lasting for an extended period (decades or longer)," and these changes are as a result of natural processes like changes in Earth's orbit or ocean circulation *and* human activities that alter the atmosphere, land, and water on Earth (2014, p. 3). Global warming, often inaccurately conflated with climate change, refers to "an average increase in the temperature of the atmosphere near Earth's surface" which contributes to changes in the global climate system (U.S. EPA, 2014, p. 3). It is also important to define weather, since it is often confused with climate. Weather represents the conditions of the Earth's atmosphere over a short period of time (e.g. amount of sunshine, rain, snow, cloud cover, humidity, and atmospheric pressure on a given day, week, or month); whereas climate represents long-term averages of these same variables for a specific region or part of the world (NASA, 2005).

With regard to climate change education in the United States, several organizations have developed curricula and learning tools to make a climate literate citizenry a reality in this country and around the world. The Next Generation Science Standards (NGSS), a new curriculum framework designed to redefine what it means to be proficient in science, incorporate climate change content across all grade levels and portray it as a high-priority topic (2015). Apart from the NGSS, other climate change curricula have been created; for example, the U.S. EPA developed an interactive website for young students to learn about global climate change through

facts, games, activities, and short videos. Also, on this website, are educator resources and tools for teaching about global climate change. Other organizations that have developed climate change curricula include NASA, The National Wildlife Federation, NOAA, and The U.S. Global Change Research Program. The U.S. Global Change Research Program developed a series of seven climate literacy principles that provide a framework for climate change education and have guided much of the development of climate change curricula. These seven principles provide the foundation of knowledge necessary to begin establishing a climate literate citizenry that makes informed decisions in favor of improving the environment. In 2010, the Climate Literacy and Energy Awareness Network, or CLEAN, (2015) was launched and it provides educators with access to hundreds of educational resources that have been reviewed by scientists and educators to ensure quality and that are aligned with the seven climate literacy principles.

According to the U.S. Global Change Research Program, climate science literacy is "an understanding of your influence on climate and the climate's influence on you and society" (Climate Literacy, 2009, p. 3). The seven climate literacy principles[5] include:

- The sun is the primary source of energy for Earth's climate system;
- Climate is regulated by complex interactions among components of the Earth system;
- Life on Earth depends on, is shaped by, and affects climate;
- Climate varies over space and time through both natural and man-made processes;
- Our understanding of the climate system is improved through observations, theoretical studies, and modeling;
- Human activities are impacting the climate system;

[5] The climate literacy principles are supported by the content within the National Science Education Standards and the American Association for the Advancement of Science Benchmarks for Science Literacy.

- Climate change will have consequences for the Earth system and human lives.

(Climate Literacy, 2009, pp. 9-15)

These seven principles represent the fundamental concepts to understanding the Earth's climate system and how it is being influenced by human behavior. However, understanding these principles will not guarantee a change in human behavior that will reduce the vulnerability of society to global climate change. Instead, generating a climate literate citizenry that takes action requires knowledge, ownership, and empowerment (Hungerford & Volk, 1990). In their environmental behavior model, Hungerford and Volk (1990) argue that the combination of background knowledge of an environmental issue, a sense of personal investment in that issue, and the intention to take action on that issue are all necessary to enact responsible environmental behavior. Therefore, climate change education must build a foundation of knowledge but also foster a connection between the learner and his or her environment so that they feel empowered to do all that they can to protect it for the future.

Michigan's place-based and Great Lakes stewardship education. When looking at a satellite image of North America, the state of Michigan is easily identifiable because of its iconic mitten shapes surrounded by the largest system of surface freshwater on Earth. Michigan has approximately 3,126 miles of Great Lakes shoreline, over 11,000 inland lakes, and over 36,000 miles of rivers and streams (Michigan.gov, 2015). In addition, the name "Michigan" is derived from a Native American word that means "large lake." From the day it was granted statehood in 1837, Michigan's identity has been and will continue to be based on the Great Lakes and an abundance of freshwater.

The Great Lakes have afforded Michigan's residents, all 9.9 million of them (U.S. Census Bureau, 2012), unique opportunities for industry and recreation throughout the course of

history. For example, the industries of agriculture, tourism, manufacturing, logging, mining, shipping, and most recently hydraulic fracturing have all had an impact on Michigan's economy at one point or another. These industries are supported by the natural resources available in Michigan. However, weakly regulated consumption and use of natural resources has a direct impact on the quality and sustainability of the natural and human systems. Great Lakes literacy, a concept similar to climate literacy, is defined as "an understanding of the Great Lakes' influence on people and our influence on the Great Lakes" (Laporte, Ariganello, Samples, & Diana, 2013, p. 1). The Great Lakes literacy principles were developed by educators within the COSEE (Centers for Ocean Sciences Education Excellence) – Great Lakes and the Great Lakes Sea Grant networks (Great Lakes Literacy, 2010). These principles represent eight fundamental concepts to understanding the interrelationship between people and the lakes. A Great Lakes literate person can understand these fundamental concepts, accurately communicate them to others, and most importantly, make informed decisions that support the wellbeing of the Great Lakes and those living within the watershed (Great Lakes Literacy, 2010). The Great Lakes literacy principles are a central tenet to the water resource-based, place-based education occurring in Michigan today.

Place-based education is defined as "learning that is rooted in what is local – the unique history, environment, culture, economy, literature, and art of a particular place" (Rural School and Community Trust, 2003 as cited in Gruenewald, 2005, p. 264). In place-based education, the community provides the context for students' learning experiences. Place-based schools partner with their community and establish a mutual relationship whereby the community provides schools with resources and local knowledge, and students address the interests or issues of the community. According to the Great Lakes Stewardship Initiative (2015), place-based

education is more than just field trips; it encourages inquiry-based, hands-on learning through which students address real-world issues. After incorporating place-based education practices, teachers see significant improvements in their students' academic and behavioral performances (Great Lakes Stewardship Initiative, 2015).

In an article proposing a shift in science education towards more issue-based curriculum, Hodson (2003) advocates that students should be "getting a feel for the environment – building a sense of ecological relationships through powerful emotional experiences in the field" (p. 664). His issue-based curriculum framework is designed to cultivate activism among students; much like the Great Lakes Stewardship Initiative seeks to foster stewardship in students. Hodson (2003) also states that it is well-documented in the literature that informal learning experiences, such as place-based education, are more effective than traditional school experiences on the basis that they bring about more awareness of issues, shifts in attitudes, and empower students to take action. The essence of place-based education is captured effectively when Hodson (2003) says,

> We should aim to give all students the opportunity to experience the silence and majesty of the forest, mountains and seashore. By learning to be sensitive to the spirituality of the caves, volcanoes, and trees – rather than seeing them merely as products of erosion, the outcome of geothermal activity and resources for making paper or furniture – children can recover what many indigenous peoples around the world have never lost: *a sense of unity between humanity and the environment*. (p. 664)

Place-based education is not formally integrated in the Michigan state curriculum; however, opportunities like the Great Lakes Stewardship Initiative (GLSI) provide teachers with the resources and training to begin making the transition towards more place-based learning. In the years since it began in 2007, the GLSI has worked with approximately 938 teachers from 215

schools across the state of Michigan and more importantly, has provided place-based education experiences for more than 50,000 students in kindergarten through twelfth grade (Great Lakes Stewardship Initiative, 2015).

Factors Influencing Public Opinion on Climate Change

The effects of climate change can be seen and felt by humans across the globe, and yet the number of skeptics and nonbelievers regarding climate change in the United States continues to grow. The average temperature on earth is gradually warming, sea levels are rising, extreme weather events are occurring more frequently and biodiversity of the planet is being lost. People living in the United States may not yet notice these adverse effects of climate change or acknowledge them as a serious problem, but people living in other parts of the world certainly do and are acting on their concerns. The question to ask, then, is why does this gap in beliefs on climate change exist in America?

United States government officials and policymakers have been unable, collectively, to recognize climate change as a legitimate problem that deserves attention. Similarly, Americans are divided on climate change, and various sectors of the public have failed to come to agreement on how to mitigate these changes. Percentages representing the American publics' concern over climate change, their certainty that it is happening and their belief in scientific consensus have fluctuated over time and recently decreased in the United States. And yet, scientific understanding of climate change has become more sophisticated over time, including the ability to predict future climatic shifts more accurately.

To address this disparity among Americans, scholars and researchers from disciplines such as environmental sociology, psychology, political science, and natural sciences have studied public opinion on global warming and climate change and identified the societal and individual

factors that perhaps influence those opinions. It is the goal of this section to examine prior research on peoples' perceptions of environmental issues like global warming and climate change, identify the factors influencing these perceptions, and discuss the implications this has for climate change education in K-12 schools. According to prior research in this field, political orientation including political ideology and party identification, sources of information and trust, perceived scientific agreement, risk perception, weather experiences, and place attachment are all contributing factors to whether a person believes climate change to be a real and occurring phenomenon or not. Additional demographic factors such as gender, educational attainment, race, socioeconomic status, and age have also been studied in this field of research.

Political orientation. The political polarization in the United States regarding climate change has been heavily researched by many disciplines, all seeking to understand why this disparity about climate change exists among political elites. However, the effect political orientation has on a person's perspective and understanding of climate change has not been researched nearly as much. The current literature illustrates the growing interest in studying public opinion on climate change as it relates to political orientation. Several theories and hypotheses have been proposed to provide explanations for the political polarization in the United States, and these include reflexive modernization, information-processes theory, elite cues hypothesis, and "party sorting" theory (Wood & Vedlitz, 2007; Fiorina & Abrams, 2008; McCright, 2010; McCright & Dunlap, 2011). There have also been relationships identified between educational attainment, climate literacy, and belief that climate change is a legitimate problem. The research done on political polarization among Americans offers interesting advancements to this field and to understanding the climate change debate in the United States.

Ideology is defined as "any abstract, internally coherent system of belief or meaning" and first was discussed by philosophers in the late 18th century (Jost, Nosek, & Gosling, 2008, p. 127). An ideology is a belief that either supports the current social system or revolutionizes against it (Jost, Nosek, & Gosling 2008). In today's society in the United States, two major political ideologies dominate the scene: liberals and conservatives. Throughout history, political ideologies have shifted in accordance with the times and status of society (Jost, Nosek, & Gosling, 2008). However, what has shown to hold true about political ideologies is that one extreme supports social progress towards equal opportunity for all and the other advocates maintenance of the status quo, regardless of the inequalities that may exist (Jost, Nosek, & Gosling, 2008). The spectrum of political ideology, liberals to conservatives, has been found to contribute to public opinion on issues like climate change.

Prior research on environmental concern has concluded that self-identified liberals and Democrats are more pro-environmental than self-identified conservatives and Republicans (Jones & Dunlap, 1992). Similar research done specifically on climate change public opinion has found comparable effects of political orientation on peoples' beliefs and attitudes regarding climate change. The notion that exists and that is being reinforced by research today is that liberals and Democrats are more likely to be concerned about and believe in the *science* behind climate change than conservatives and Republicans (McCright, 2010). Although the findings in this research are still being examined, the theory of reflexive modernization provides an interesting explanation for the political polarization regarding climate change.

Reflexive modernization was developed by European sociologists (e.g., Ulrich Beck and Anthony Giddens) who argue that Western society is now in what they call a reflexive modernity age. This age is defined by "critical self-confrontation with the unintended and unanticipated

consequences of industrial capitalism of the earlier modern era" (McCright, 2010, p.3). Industrialized societies we think of today became the nations that they are because of increased consumption and production of energy from fossil fuels. A consequence of this intensive use of fossil fuels is an increase in greenhouse gases in the atmosphere, among other things, which ultimately leave us where we are today: in a society being affected by anthropogenic climate change (McCright, 2010). Reflexivity is supported by the environmental movement and climate scientists who recognize the threat of climate change and support action to mitigate it. There is also a phenomenon called anti-reflexivity which is the antithesis of reflexive modernization. Anti-reflexivity consists of the need to defend the industrial capitalist regime by negating any and all threats to its dependence upon resource extraction and consumption, a major threat being anthropogenic climate change. Anti-reflexivity supporters mainly come from industry, the conservative movement, and a handful of "contrarian" scientists who reject climate science (Dunlap & McCright 2011, p.158). The differences between reflexivity and anti-reflexivity illustrate a similar debate occurring between liberal and conservatives in both politics and the American public on climate change.

The United States' efforts to mitigate climate change thus far have created this dichotomy among the American citizens of the believers and non-believers of climate change. In 1997, the United States signed the Kyoto Protocol which was an agreement to reduce carbon emissions as a country. Some conservative elites began to question the motives of this agreement and consequently began to question the scientific evidence behind global warming (Dunlap & McCright, 2008). The literature suggests that conservatives dislike change and uncertainty, which are two inevitable features of climate change (McCright & Dunlap, 2011). Furthermore, McCright and Dunlap (2011) argue that it is conservative, white males in the United States that

deny the existence of climate change and global warming more than any other group. Called the white male effect, this phenomenon describes those who are more accepting of a wide range of risks and therefore do not see climate change as a viable threat (McCright & Dunlap, 2011). Flynn (1994) describes how this phenomenon stems from socialization of white men throughout history.

> Perhaps white males see less risk in the world because they create, manage, control, and benefit from so much of it. Perhaps women and nonwhite men see the world as more dangerous because in many ways they are more vulnerable, because they benefit less from many of its technologies and institutions, and because they have less power and control. (p. 1107)

It is when these climate change "deniers", conservative white males and others enter into the public sphere that opinions are swayed and policy on climate change moves further out of sight.

Cultural theory describes the process by which individuals shape their perceptions of risk based on their cultural worldview and the in-group with which they identify (McCright & Dunlap, 2011). The conservative elites, or public figures involved in politics, media, and the fossil fuel industry, first began to question the scientific evidence of climate change. It was then that the denialists' information began to disseminate among Americans and to resonate with others. Motivated reasoning, or when someone seeks information that is consistent with their beliefs, links perceptions of climate change and political ideology (Myers, Maibach, Roser-Renouf, Akerlof, & Leiserowitz, 2012). The "evidence that is consistent with the desired attitude is accepted at face value, while conflicting evidence is ignored, dismissed, or subjected to critical review" (Myers et al 2012, p. 343).

Skepticism has continued to grow among conservatives in the United States regarding the media's portrayal of climate change, scientific consensus about climate change, and the observations that climate change has been accelerated because of human activities (Dunlap & McCright, 2008). Researchers have observed that self-identified conservatives are more skeptical of climate change science, while self-identified liberals are more concerned about climate change and willing to support policy to mitigate it (Marquart-Pyatt, Shwom, Dietz, Dunlap, Kaplowitz, McCright, & Zahran, 2011; McCright & Dunlap, 2008).

Several other theories have been developed to explain why political orientation is such a strong predictor of peoples' concerns about climate change. One of these theories is the information-processing theory proposed by Wood and Vedlitz (2007). The information-processing theory posits that people's values and experiences form the foundation of how they view and interpret issues. This theory is especially prevalent when people are exposed to unclear information and therefore will not have very in-depth knowledge about a topic such as climate change. These individuals will instead process information about climate change through their values, ideologies, and experiences, namely their political orientation (Dunlap & McCright, 2011). Another explanation for why political orientation is significant in this research is the elite cues hypothesis, which specifically applies to complex, highly debated topics such as climate change that are represented in the public as a two-sided issue. According to the elite cues hypothesis, people seek information about a controversial topic like climate change from elites in politics or media whom they trust. People are then exposed to different opinions and facts, either valid or invalid, about climate change based on their political affiliation and the information outlets that they most trust or to which their values align most (Dunlap & McCright, 2011).

A third theory that is thought of as the primary explanation for political polarization in the American public is the party sorting theory (e.g., Fiorina & Abrams, 2008). This theory argues that "political party activists drive a process of conflict extension among political elites, which then leads to party sorting within the general public" (Dunlap & McCright 2011, p. 163). Party sorting is a hierarchical process, beginning with the political elites who decide on how the issue will be viewed within the political party, then these views trickle down to their voting constituency. Information-processing theory, elite cues hypothesis, and party sorting theory offer explanations for why political orientation has such a profound effect on peoples' views and understanding of climate change. However, political orientation is not the only variable being studied that effects Americans' polarization on climate change and these variables will be discussed based on work by Hamilton (2010; 2013).

Hamilton (2010) conducted a study examining data from two telephone surveys, one in New Hampshire and the other in Michigan's Upper Peninsula. He was interested in investigating educational attainment in relation to political orientation and its effect on public environmental concern. Hamilton (2010) also studied age and gender as potential predictors of environmental concern. The study found no significant relationship between peoples' understanding of climate change and their perceived threat. However, what Hamilton (2010) found when he separated his sample by political party was something different. He found, understandably, that liberals or Democrats who claim to understand or are knowledgeable about climate change, are more likely to perceive it as a threat. Interestingly though, Hamilton (2010) found that conservatives or Republicans who claim to understand or are knowledgeable about climate change, are *less* likely to perceive it as a threat. This filtering of knowledge that conservatives undergo, as McCright (2010) asserts, relates back to the reflexivity debate for two

reasons. One is that conservatives have greater system justification tendencies, meaning that they desire to maintain the status quo, avoid change to the dominant social paradigm, and deny or negate any threat to industrial capitalist society, even if it means disregarding their own knowledge about a topic. Similarly, conservatives are also less comfortable with uncertainty and more likely to respond uniformly to all problems, regardless of their individual complexity, in order to maintain the status quo.

Sources of information and trust. Other factors that researchers have found to contribute to public perceptions of climate change are 1) the media sources individuals use to get their information, and 2) the level of trust they have in those sources. Climate change is a complex issue, one that is not easily understood by most people unless they are directly involved in the scientific research (Marquart-Pyatt et al 2011). People instead rely on sources of information that they deem credible, that they can trust, and with whom they can align their own beliefs, regardless of whether the information is accurate about climate change or not (Malka, Krosnick, & Langer, 2009). There is also the notion of agenda setting in the media, where media sources choose the amount of coverage or attention given to a particular issue (Krosnick, Holbrook, Lowe, & Visser, 2006). Some studies have also shown that it is not only the coverage the media gives an issue like climate change, but also the content they choose to associate with the issue that influence how the public interprets media messages (Krosnick et al., 2006). As climate change has become a topic for political debate, so too has its presence in the media. Similar to a study done on the topic of evolution in the media, Akerlof et al. (2012) state that as "the topic moved from the science pages to political and opinion pages, reporters were less likely to emphasize evolution's scientific evidence and more likely to stress the controversy" (p.649).

The ambiguity and uncertainty of climate change are common descriptors in climate change denial media. Despite the strength of the climate change denial machine (Dunlap and McCright, 2011), media that support climate science and policy do exist and maintain a devoted audience within the United States. Researchers have identified two different sources of information that people generally use to learn about climate change. The first group of sources includes the natural scientists of the Intergovernmental Panel on Climate Change, environmental advocacy groups, and democratic figures; all who believe that climate change is real and deserves societal attention. The second group is comprised of other scientists, advocacy groups, and conservative figures in politics and the media, all who are skeptical of climate change and suggest it is not as important as other issues of today (Malka, Krosnick, & Langer, 2009). "The media serves as an important interface between the public, the scientific community, and decision makers, and contributes to public understanding of environmental issues" (Boykoff, 2009 as cited in Marquart-Pyatt 2011, p. 41).

The people in the public that are most susceptible to the media's representation of climate change are the individuals with the least-grounded opinions on the issue. Media that frame climate change with fear or uncertainty are likely to continue undermining policy or action if not mediated. Whitmarsh (2011) suggests that improvement in climate change communication towards already skeptical or dismissive groups will not be effective, because their views of new information will be based on already existing beliefs that deny climate change. It is instead the people in the middle of the spectrum who are ambivalent about climate change, who should be the target audience of future political campaigns on the issue of climate change. Trust in climate science is another factor considered in the literature, because it is inherently related to the types of media sources that individuals seek out. Malka et al. (2009) argue that political orientation,

specifically party identification, contributes to whether an individual trusts climate change science or not. Similar to Hamilton's (2010) findings regarding political orientation's effect on self-reported knowledge, exposure to mainstream climate science for a Republican who is already skeptical about climate change may not instill a sense of belief or trust as it would in a liberal or Democrat. Once again, political orientation has a moderating effect on climate change public opinion, in that people seek information from media sources or public figures that they trust and who have similar belief systems and political views as they do.

Perceived scientific agreement. A recent addition to the literature on climate change public opinion is perceived scientific agreement among members of the American public. A major objective in the climate change denial machine is to debunk climate change science, delegitimize it as a major problem, and create a false perception that the majority of scientists do not agree on climate change's existence and anthropogenic causes. McCright, Dunlap, and Xiao (2014) conducted a study building upon prior research done in 2011 and 2013 on the effects perceived scientific agreement has on global warming beliefs and support for green policy. The prior studies found that a misperception of scientific agreement on anthropogenic climate change is associated with lower levels of support for green policy (Ding et al., 2011; McCright et al., 2013). Their study, conducted in 2014, used nationally representative survey data from the Gallup Polls in 2006 and 2012; these years were chosen because they represent time before and after a significant increase in public support for the climate change denial movement. McCright et al. (2014) also included political orientation in their study to see if the resurgence of the climate change denial movement was demonstrated in peoples' perceptions of scientific agreement as well as support for government policy.

The results found that self-identified Democrats and liberals are more likely to perceive scientific consensus about climate change than their political opposites and are more likely to support government policy. Also, the most powerful predictor for global warming beliefs about the timing, cause, and consequences was perceived scientific agreement. Global warming beliefs were also found to be the strongest predictor for support of government policy (McCright et al., 2014). Lastly, in regards to the effect political orientation had on support for government policy in 2006 and 2012, the effects of party identification were stronger in 2012. This last result confirms the climate change denial movement's ability to reach the public and influence their opinions of climate change.

Risk perception. Risk perception is another area in the literature that has been studied relating to people's attitudes and behaviors associated with environmental problems like climate change. An individual's knowledge and understanding of climate change and how it relates to them influences whether or not they see the problem as a personal and/or societal risk. Milfont (2012) states that "individuals have a fundamental need to comprehend their physical and social environments, and uncertainty rises when understanding is inaccessible or constrained" (p. 1004). The ambiguity and uncertainty that surrounds future impacts of climate change is difficult for many people to understand, and it is therefore not seen as a prominent risk to society (McDaniels, Axelrod, & Slovic, 1995; O'Conner et al., 1999; Whitmarsh, 2008). People often are unsuspecting of the effects climate change has because of temperature and precipitation changes they experience as a result of the four seasons (Whitmarsh, 2008).

Recent research in risk perceptions has shown that knowledge about the causes and/or personal experience with an effect of climate change is in fact positively related to an increase in concern about the issue (Milfont, 2012; Whitmarsh, 2008). This is contrary to what prior

research has assumed about the relationship between knowledge and risk perception of climate change (Kellstedt, Zahran, & Vedlitz, 2008). However, what this finding does not consider is the effect that political orientation has on the strength of self-reported knowledge as a predictor of concern (Hamilton, 2010).

People of low socioeconomic status, of racial minority, and of younger age have also been found to perceive climate change as a greater risk. People of minority specifically see climate change as a greater risk because, it is argued, they are disproportionately exposed to the negative effects of climate change (Kellstedt et al., 2008). Milfont (2012) observes that an increase in knowledge about the causes and effects of climate change will result in greater concern as well as greater willingness to act on those concerns. Effective risk assessments regarding climate change require both top-down and bottom-up approaches; in other words, both regulatory policies from government and grassroots efforts are important in promoting environmentally-conscious behaviors (Milfont, 2012).

Weather experiences. Personal experiences with weather and severe storms have also been found to influence perceptions of climate change. Realizing that increasing frequency of severe weather and increasing temperatures are evidence of climate change is more difficult for some than others (Berrang-Ford, Ford, & Paterson, 2011). The lack of immediacy of climate change and its consequences acts as a barrier to policy, because people have the uninformed mindset that climate change has not and will not influence them. However, the literature suggests that those people who have personally experienced severe weather and noticed increasing temperatures or dryness are more likely to accept climate change as a legitimate problem (Borick & Rabe 2010). Prior research in this field has demonstrated that "personal experiences with the environment (e.g., witnessing negative environmental events) affect

attitudes toward environmental protection" (Borick & Rabe 2010, p. 785). Personal experiences with climate change provide people with a much stronger argument than what they see presented in scientific articles or in the news (Myers et al, 2012).

There is a domino effect within these findings: the less an individual perceives climate change as a personal threat to them, the less they are engaged with the issue and the less they are willing to take action through public policy (Myers et al, 2012). It is important, in any research study in this field, to gauge whether an individual thinks climate change is influencing them personally or not and how they came to know that. Hamilton (2013) also studied the influence weather patterns have on the climate change perceptions of those not necessarily at either end of the political spectrum, but rather those individuals in the middle. Hamilton (2013) found that politically independent peoples' concerns about climate change are most likely to be swayed one way or another based on short-term temperature fluctuation over two-day periods.

Place attachment. Another factor influencing public opinion of climate change that the literature has identified is sense of place or place attachment. Place attachment is defined as the cognitive and emotional bond an individual has with a particular place (Vaske & Korbin, 2001; Stedman, 2002; Scannell & Gifford, 2013). Engaging the public with climate change in policy campaigns is difficult because many people understand it as a distant problem and cannot relate it to their own lives (Scannell & Gifford, 2013). However, people who live in places to which they feel a strong emotional connection may feel more inclined to protect that environment. "We are willing to fight for places that are more central to our identities and that we perceive as being in less-than-optimal condition" (Stedman, 2002, p.577). Stedman (2002) asserts that this is even truer when the place is threatened by change. In order to increase the personal relevance of climate change, the messages people are seeking for information must also be relevant to the

local environment (Scannell & Gifford, 2013). As personal relevance increases, so too does an individual's interest and effort in understanding how climate change is influencing the local environment.

Demographic factors. Climate change is an abstract and complex issue that is debated by experts, politicians, and everyday citizens in America. There is a spectrum of attitudes, from alarmed to dismissive, that people have about climate change (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013). It is the goal of many researchers to identify why people have these perceptions and from where they originate. Apart from political ideology, media sources, weather experiences, place attachment, and risk perceptions, there are demographic factors that have been studied in this area of research. These include gender, educational attainment, race, socioeconomic status, and age.

Many research studies on environmental concern, environmental risk perceptions, and environmental behaviors have evaluated the significance of gender as a contributing factor to these phenomena (Arcury, Scollay, & Johnson, 1987; Bord & O'Conner, 1997; Hunter, Hatch, & Johnson, 2004; Dietz, Kalof, & Stern, 2002; McCright, 2010). Gender socialization throughout history has created conflicting societal roles for men and women. In the western world, men typically have been socialized as the breadwinners, industry leaders, and technology advancers of society (Arcury et al., 1987). A male mentality has developed that emphasizes economic growth regardless of the environmental costs and resource use that accompanies it (Arcury et al., 1987; Hunter et al., 2004; Marshall, 2004; McCright, 2010). Women have been socialized throughout history to be the nurturers, the caregivers, and focused on the maintenance of life and the relationships that are important to them (Arcury et al., 1987; Hunter et al,, 2004; McCright, 2010). However, some literature argues that it is the life experiences of an individual rather than

the explicit gender roles or stereotypes attributed to them that provide modest evidence for relationships between gender and environmental concern (Mohai, 1997; McCright, 2010).

Studies have also been done comparing gender and pro-environmental behaviors (Hunter et al., 2004). Women have been found to perceive the world as more 'risky' and therefore participate in environmental action to reduce those risks. It has been hypothesized that as a result of gender socialization, men participate more in public environmental behaviors, like protests and public meetings, while women engage more in private environmental behaviors, like recycling and buying organic, local foods (Hunter et al., 2004). However, what was found in a cross-national study on gender variations is that both men and women engage in more private rather than public environmentally friendly behaviors that can be done within their daily routines (Hunter et al., 2004). Another interesting result from this study was that in the countries with higher gross national income, like the United States, Japan, and Norway, the hypothesis that women engaged in more private environmentally-friendly behaviors than men was confirmed (Hunter et al., 2004).

A positive relationship has also been found in previous research between environmental concern and environmental knowledge. However, McCright (2010) studied this assumption with gender included. He found that women expressed both slightly greater knowledge and concern about climate change than men. Even though women were found to have slightly greater levels of accurate scientific knowledge about climate change, they were also found to underestimate their level of knowledge more so than men (McCright 2010). Women have also been found to have more health and safety concerns regarding local environmental issues, like toxic waste or polluted groundwater (Davidson & Freudenberg 1996; Greenbaum 1995; Mohai 1992; McCright 2010). Dietz et al. (2002) found that the value of altruism, or the concern for the welfare of

others, was significantly stronger in women than men in that environmental problems pose threats to others. This relates back to the socialization of women and their experiences as nurturers and caregivers within their community. There are many assumptions in the literature that suggest relationships between gender and environmental concern and behaviors. The extent to which these relationships have been proven to be significant varies across studies, but it is agreed upon that gender does seem to have some impact on environmental concern, knowledge, and behaviors.

As mentioned earlier, climate change is a difficult issue for many people to comprehend because the scientific evidence for it is primarily represented by computer-generated climate models, which many times are falsely portrayed in the media as confusing and unbelievable (Akerlof, Rowan, Fitzgerald, & Cedano, 2012). Some research has suggested that better education on the issue is the solution to seeing beyond these misconceptions found in the media. Others in the field believe that a person's perceptions about climate change lie deeper in their attitudes, beliefs, and environmental values. Nevertheless, educational attainment is a common demographic variable included in research on climate change and environmental issues. O'Conner et al. (1999) found that educational attainment was the only demographic variable to demonstrate a significant relationship with voting intentions in favor of climate mitigation strategies.

Race and ethnicity are also important when evaluating public opinion on climate change because it is often minority populations that experience the consequences of climate change or other environmental hazards (Marshall, 2004). Socioeconomic status, including household income, is sometimes included in this field of research. One argument in the research is that economically disadvantaged populations show less interest in environmental agency because

their main priority lies in achieving economic stability and fostering financial growth (Buttel, 1975). Mirroring Maslow's hierarchy of needs, as a person's basic needs of food, water, and shelter are met, they are then able to move attention elsewhere, like caring for the environment. This argument assumes that people of low economic status or living in developing countries are incapable of having concerns for the environment because they are preoccupied with meeting their basic needs. However, what is missing from this argument is the fact that many times, people in poverty or those living in developing countries are often most impacted by the negative consequences of climate change. It is important to not discount any voices regarding environmental issues because it is not just wealthy, Western societies that are aware of and concerned about these issues.

Socioeconomic factors, in conjunction with social context, have also been found to influence environmentally-friendly behaviors like recycling. Berger (1997) did a study examining what contextual factors influence pro-environmental behaviors and found that socioeconomic status played a significant role. She concluded that an individual participating in recycling via a collection program in a higher income suburban neighborhood was less of a burden and more feasible than for an individual living in an urban, one bedroom apartment where the extra effort is necessary to take recyclable materials to an additional location to be processed (Berger, 1997). Berger (1997) asserted that it is the socioeconomic status that underlies the decision to participate in pro-environmental behaviors.

Age is another demographic variable that has been considered in climate change and environmental issues research. It has been noted that younger people tend to be more concerned about environmental issues and climate change (Kellstedt et al., 2008; Malka et al., 2009; Wood & Vedlitz, 2007). Interestingly, however, O'Conner et al. (1999) observed that it is older,

typically better educated men, who are more likely to take action and support government policy to regulate carbon emissions or other climate mitigation methods. Education attainment, race, socioeconomic status, and age are all realistic and applicable variables to this study, since some or all of them have been included in the majority of the climate change and environmental research to date.

A review of the literature ultimately concludes with an interesting and complex question: what do we do now? Researchers have suggested better education and climate science resources, while others think the solution lies in fair media coverage of the issue. There is not one, all-encompassing solution to climate change. However, it is research like what these and many other scholars are doing, that will get us closer and closer to understanding why people believe what they do about climate change and what can be done to reduce the polarization among Americans on the issue.

The divide that exists within the American public on the issue of climate change is a significant barrier to government policy looking to moderate the release of greenhouse gas emissions from burning fossil fuels and land use changes. Marquart-Pyatt et al. (2009) outline four recommendations for next steps in climate change public opinion research. First, there is a call for high-quality longitudinal data that would allow researchers to examine more factors that influence public opinion over time. The context in which any study is conducted is important to consider; however, with a longitudinal data series, the influence context and/or societal 'climate' have on the responses would be lessened. Secondly, more research is needed on trust, including where audiences get their information, what media sources they trust or align most with, and what media sources people distrust. Gaining more insight on trust would possibly improve

climate change communication and identify where misconceptions or misguided evidence are being disseminated by the media.

Thirdly, Marquart-Pyatt et al. (2009) recommend that more research be done on how the media and peoples' family/friend networks influence their opinions on climate change and how to mitigate it. Lastly, and most importantly, more research needs to be done examining how climate change public opinion transforms into individual action, behavior changes, and policy. After all, behavioral change and policy enactment are the ultimate goal in order to begin slowing the effects of climate change and paint a different picture for the future of human society.

Known Barriers to Environmental, Great Lakes, and Climate Change Education

The previous section in the literature review discussed research on the factors that influence people's perception of climate change. Those influencing factors either act as a barrier or facilitator to climate change education, depending upon whether the teacher believes climate change is a serious issue requiring attention or not. There has also been significant research done on the influencing factors, or barriers, specifically to environmental, place-based, and climate change education.

Barriers to environmental education. Early research on barriers to environmental education has categorized barriers into four broad groups: conceptual barriers, logistical barriers, educational barriers, and attitudinal barriers (Clark, 1975; Hungerford, 1975; McCaw, 1979; Langseth, 1982; Tewksbury & Harris, 1982). Conceptual barriers "stem from a lack of consensus about the scope and content of environmental education" (Ham & Sewing, 1988, p. 17). This includes the misconceptions that environmental education is only appropriate within the science disciplines or that environmental education is a separate subject in addition to the existing curriculum. Logistical barriers to environmental education include a perceived lack of

funding, lack of resources like instructional materials, lack of transportation, large class size, safety concerns, and time. The barrier of time is divided into three different categories: planning time needed to integrate environmental education into the curriculum, preparation time to organize materials and lesson plans, and finding class time to actually incorporate environmental education (Tewksbury & Harris, 1982). Educational barriers arise when teachers are not confident in their content or pedagogical knowledge for teaching environmental education. Attitudinal barriers stem from a teacher's general attitudes about environmental education and science.

Through a qualitative research study exploring the barriers to implementing environmental education, Ham and Sewing (1988) found that the strongest barriers to implementing environmental education for the interviewed teachers were lack of time in the school day, lack of preparation time, lack of environmental education teaching resources, lack of funding for field trips and teaching materials, and lack of teacher content knowledge. Four of these five top barriers to implementing environmental education were logistical barriers and more specifically, two of the five top barriers involved lack of time. Ham and Sewing (1988) suggest that addressing the misconception that environmental education has to be a completely separate subject on top of the traditional curricular subjects would reduce the perceived lack of time for teachers.

Samuel (1993) added to the literature and identified four additional types of implementation barriers by doing a case study at an "environmental immersion" high school: conceptual problems, poorly defined school philosophy and goals, difficulties in coordinating the program throughout different departments in the school, and inconsistencies between administrator and teacher expectations. The conceptual problems included teachers not having

access to professional development or teaching resources, resulting in their individual knowledge of environmental issues being very basic. She also found that the school's poorly defined school philosophy and goals hindered the success of the environmental immersion program. Samuel (1993) described "the lack of discussion among teachers about what these [the goals] might mean in practice, resulted in vagueness in direction, with everyone talking at cross-purposes rather than complementing each other with new ideas" (p. 28). She also indentified lack of coordination and communication among different teachers in different departments as well as lack of communication between teachers and the administration. Good communication is essential for implementing environmental education, especially if it is a school-wide initiative.

Pedagogical content knowledge (PCK) is a phenomenon of education that has not yet been extensively researched within environmental education. Baxter and Lederman (1999) assert that PCK is determined by "what a teacher knows, what a teacher does, and the reasons for the teachers' actions" (p. 158). Measuring the level of knowledge a teacher has about a specific topic or area of interest is just as important as understanding how the teacher transforms that knowledge or content into lessons for students. Pedagogical content knowledge has been associated with experience of teachers; the longer the teacher has been in practice, the more pedagogical knowledge or general wisdom for teaching that individual has (Driel, Verloop, & Vos, 1998).

Hwang (2011) states that to understand teaching practices, one must not only consider the teacher's knowledge but also their personal experiences and reflections that ultimately shape their thought processes and pedagogy. Jones, Gardener, Robertson, and Robert (2013) add that "teacher knowledge is embedded in the lived experiences of teachers" (p. 1757). Reflecting on these experiences, whether personal or group reflection in professional development workshops

can change the way a teacher thinks about a topic and how they translate that topic into the classroom (Jones et al., 2013). Personal interactions with the natural world could prove to be a significant indicator of the teachers' content and pedagogical content knowledge regarding environmental education.

The barriers to environmental education frequently mentioned in the research studies above or in other literature are relevant to this research study, and these include lack of time as a result of existing curriculum requirements, lack of content knowledge, lack of training in environmental education, limitations as a result of in-classroom setting, and that positive attitudes about the environment are not always indicative of implementation (Ko & Lee, 2003; Kim & Fortner, 2006).

Barriers to Great Lakes-based education. The majority of the barriers to environmental education are also barriers to Great Lakes-based education. However, a few studies have been done that are specific to education in the Great Lakes region and are therefore mentioned. Fortner and Meyer (2000) found that a high priority among teachers for issues regarding freshwater resources did not necessarily result in high levels of knowledge about these topics. Another variable to consider is teacher attitudes towards the environment and how these influence knowledge and/or priority. Researchers have found that positive attitudes about the Great Lakes are positively related to content knowledge about the Great Lakes (Fortner, Mayer, Brothers, & Lichtkoppler, 1991). Similar relationships have been identified in this study regarding the teachers' attitude towards the environment and their priority for Great Lakes, place-based education. Fortner and Corney (2002) state that the "health of the Great Lakes ecosystem may depend upon the effectiveness with which we transmit critical information about the characteristics of the system and its natural processes, changes that have occurred with

human intervention in the system, and individuals' responsibility for environmental stewardship" (p. 3-4).

As with any research, it is important to examine the broader context in which the group or phenomenon being studied operates. However, it is especially important in education, because there are many levels of operation (e.g., administration, teachers, national standards for education, students) that are present and interconnected. In this case, the larger context is everything from the education system in the Great Lakes region to individual school culture, all of which influence behaviors and outcomes of both teachers and students. Meier (2011) argues that "the school environment is consequently guided by norms, values, beliefs, rituals, symbols, ceremony and collective stories that all contribute to the persona or culture of the school" (p. 806). Postholm (2012) adds that social surroundings within an education setting, such as the classroom and school culture or faculty relational dynamics, are inherent to how an individual learns and develops. The location of the school, the standards-based assessments that are required every year, funding, and flexibility of curriculum are all contextual factors that can influence the behaviors of teachers. Understanding how these contextual factors influence a school is extremely important to teachers and how they operate within the classroom (Meier, 2011).

Barriers to climate change education. Again, many of the barriers to both environmental education and Great Lakes-based education apply to implementing climate change education. However, some additional insight specific to climate change is offered by the literature. Kim and Fortner (2006) studied barriers specific to teaching certain environmental issues like global climate change in the classroom. They found that low coverage of certain issues like habitat destruction, distribution of water, and solid waste disposal within textbooks

acted as a barrier to teachers implementing these issues into lessons. Kim and Fortner (2006) also found that the values underlying issues like global climate change and its controversial nature acted as barrier. Kim and Fortner's (2006) study also supports Ko and Lee's (2003) research finding in that a teacher's positive attitude towards an environmental issue like global climate change does not necessarily predict that he or she already incorporates it into the curriculum. Instead, positive attitude towards an issue like climate change may suggest that they are merely more open to the idea of incorporating it into the curriculum.

A quantitative study was done in 2010 that surveyed K-12 teachers in Colorado on integrating climate change into the curriculum (Wise, 2010). The results from the survey suggested that patterns of instruction on climate change were highly variable among the participants and dependent upon influential factors such as student interest, whether or not it aligns with existing curriculum requirements, whether or not there was enough time within existing curriculum to incorporate it, content knowledge on climate change, disciplinary divisions within schools, and enrollment patterns (Wise, 2010). In her analysis, Wise (2010) found that a common public misconception on climate change, that substantial disagreement still exists between climate scientists about the causes of climate change, was reinforced by approximately 50% of the participating teachers. She also found that the controversial nature of climate change was more likely to affect the content of a teacher's lesson on climate change rather than to discourage them from teaching it at all. According to Wise (2010), "the most prevalent reason for teachers excluding climate change was that 'it does not fit in my curriculum or standards', indicating that concerns over authorization and time currently drive patterns of instruction about climate change across different science subjects" (p. 306).

Additional research specific on climate change education has identified other influential factors, one being whether climate change instruction meets other learning goals or targets identified by state agencies, administrations, or parents (Monroe, Oxarart, & Plate, 2013). In a quantitative study on secondary science teachers' interest in incorporating climate change into the curriculum, the participants were asked to rank the top educational goals that they thought were most important while teaching about climate change. The goals include "connecting science to everyday life, emphasizing critical thinking, analyzing skills, choices regarding sustainability, and systems thinking skills" (Monroe, Oxarart, & Plate, 2013, p. 8). This study provides insight for the types of learning objectives identified by educators that are thought to be achievable through climate change education and potentially provide incentive to incorporate it. In her article titled, *Climate change in school: where does it fit and how ready are we?* Fortner (2001) concludes that with the overcrowded curriculum in today's education system and the lack of interdisciplinary training, "teachers may be reluctant to infuse information about a topic that is inherently intangible and uncertain" (p. 28). The known barriers within the environmental education, Great Lakes-based, and climate change education literature are all addressed in varying degrees by the participating teachers within this qualitative study.

Chapter 3 – Methods

Overview of Research Approach

An emergent, qualitative research design guided the methodological decisions for this project. An emergent approach to a study involves a research design and set of assumptions that are malleable, meaning that they evolve throughout the study as more is learned about the phenomenon being investigated. Maxwell (2012) describes how he approaches qualitative research designs in an emergent manner through what he calls an interactive model of research design. Maxwell's (2012) interactive model is comprised of five components that he deems are vital to a successful qualitative research design. The five components include goals or purpose, conceptual framework, research questions, methods, and validity. It is important to have consistency and fluidity among the five components throughout the entire research study and have all decisions be driven by the research questions being asked. If consistency exists between the purposes of the study, the conceptual framework guiding the work, and the research questions being asked, then the decision for what methods to use is clear.

Data Collection

Purposive selection of study participants. This research project was primarily qualitative in nature and used semi-structured, in-depth interviews as the principal means of data collection. All protocols for human subject research were reviewed and approved by Michigan State University's Institutional Review Board (Appendix A). Prior to interviews, I used an online survey in the early phases of the project as a means to recruit diverse interviewees. I selected participants using a purposive sampling strategy referred to as maximum variation (Miles & Huberman, 1994). According to Miles and Huberman (1994), maximum variation

"documents diverse variations and identifies important common patterns" and embraces heterogeneity of participants (p.28).

In order to achieve this diversity of interviewees, the Great Lakes Stewardship Initiative (GLSI) was the means for purposively seeking participants in this study. The GLSI is a statewide network for Michigan K-12 teachers and schools who wish to provide hands-on, project-based learning experiences for their students by connecting with community partners and learning about environmental problems and assets within their community. The GLSI consists of nine hubs around the state of Michigan, each focusing on three main strategies for fostering stewardship of the Great Lakes among students: place-based education, sustained professional development for K-12 teachers, and establishing and maintaining school-community partnerships (Great Lakes Stewardship Initiative, 2014).

The schools and community partners within each hub all have the similar goal of educating their students and teachers about the Great Lakes and creating a sense of environmental stewardship among them for the future. This was the rationale for choosing to recruit participants through the GLSI. I knew that GLSI teachers are all, in varying degrees, educating their students about the Great Lakes and integrating place-based education into their classrooms. This was the lens through which I wanted to explore climate change education and therefore chose to use the GLSI as my access point to those teachers.

Desired heterogeneity of study participants. In order to achieve heterogeneity among the participants of this study, I developed a set of criteria that guided the purposive sampling process. The principle goal of the online survey was to gather information from teachers based on these criteria in order to identify potential interviewees. One criterion was to evaluate each participant based on their beliefs regarding global warming to ensure that a range of perspectives

on the issue would be represented in the data. To determine the teachers' beliefs on global warming, a survey instrument called "Global Warming's Six Americas" was used. It is a widely- known survey created by researchers at Yale University and George Mason University that has been used in national studies comparing Americans' attitudes and beliefs about global warming (Maibach, Leiserowitz, Roser-Renouf, Mertz, & Akerlof, 2011). The Six Americas survey contains 15 questions that focus on global warming beliefs and knowledge, including views on policy for global warming mitigation, behaviors related to environmental awareness, and beliefs about implications global warming has for the future. An individual's responses to the Six Americas survey placed him or her along a spectrum of belief categories about global warming; these categories include *alarmed, concerned, cautious, doubtful, disengaged,* and *dismissive*. (Appendix B provides a more detailed description of each Six Americas category.) Having the teachers take the Six Americas survey provided insight regarding their general beliefs about global warming and acted as the primary criterion for selecting teachers to be interviewed.

It is recognized that the focus of the this study is on the issue of climate change education and the Six Americas survey uses the term global warming in the questions. Three recent studies done regarding the use of the two terms concluded that global warming and climate change are not synonymous among Americans and that they "activate different sets of beliefs, feelings, and behaviors, as well as different degrees of urgency about the need to respond" (Leiserowitz, Feinberg, Rosenthal, Smith, Anderson, Roser-Renouf, & Maibach, 2014, p.4). In order to have the most accurate designation of a teacher within a Six Americas category, the term "global warming" was used in the survey because global warming is the term most people are familiar with and the one that they are more likely to use in conversations. However, during the in-depth

interviews with the teachers, global warming was referred to as one aspect of climate change, similar to how it is defined within the scientific community.

Table 1 – Selection Criteria for Study Participants

Selection Criteria	Six Americas Category	Teaches Science	Gender (½ female, ½ male)	School Classification (urban, rural, suburban)	# of years a GLSI member	# of years a teacher in MI	Grade Level
Criteria Instructions for GLSI Hub Directors		X	X	X	X		X
Criteria for Desired Diversity of Interviewees	X	X	X	X	X	X	X

Apart from the Six Americas category designation, the teachers were selected based on several other criteria (Table 1). It was important to recruit teachers based on these different characteristics, because this process allowed for more diverse interviews and, therefore, more diverse data to analyze and from which to draw inferences. The focus of my study is on the incorporation of climate change specifically into science and Great Lakes related education; however, it is recognized that climate change is not limited to science education and can be addressed in other subject areas such as social studies, language arts, math, and writing. Additionally, it was important to try to have an equal, or close to equal, representation of both male and female teachers because gender has been shown to have some important implications on individuals' perspectives of global warming and climate change (Arcury, Scollay, & Johnson, 1987; Bord & O'Conner, 1997; Hunter, Hatch, & Johnson, 2004; Dietz, Kalof, & Stern, 2002; McCright, 2010).

Teachers were also recruited based on their geographic location in the state as well as within their respective region such as working in an urban, rural, or suburban setting. It was also

important to select teachers with different teaching experiences regarding time spent in the GLSI network, number of total years spent as a teacher in Michigan, and the grade level(s) they currently teach, because these characteristics could have implications regarding each teacher's perspective on teaching climate change and Great Lakes topics. Just as demographics are fundamental to survey research, it is important to learn the background and teaching context from which each teacher draws their experiences, values, and beliefs.

Contact protocol with GLSI hubs and potential teacher interviewees. In total, five GLSI hubs were contacted and asked to participate in the project, and these included the GRAND Learning Network based in Lansing, the Northeastern Michigan Great Lakes Stewardship Initiative based in Alpena, the Grand Traverse Stewardship Initiative based in Traverse City, the Lake Superior Stewardship Initiative based in Houghton, and the Discovering PLACE Initiative based in Flint. These five hubs were selected because of their diverse geographic locations and the potential for heterogeneity on the criteria of school classification such as urban, rural, and suburban. Initially, the goal of 15 total interviews would have meant 3 teachers from each of the five hubs. The rationale behind this number was again, maximum heterogeneity in the participants. Having three teachers from each hub would have resulted in an equal, or close to equal, representation of elementary, middle, and high school teachers as well as representatives from urban, rural, and suburban school locations. However, only the hubs from Lansing, Alpena, Traverse City, and the western Lake Superior region demonstrated strong interest in participating in this project and were therefore pursued more intently by the researcher.

Each GLSI hub has a director who interacts with the teachers in the hub on professional development, project planning, and connecting them to community partners. The first phase of

data collection consisted of contacting the GLSI hub directors and asking them to recommend teachers from their hub based on the corresponding selection criteria shown in Table 1. Each hub director was contacted and asked to recommend 15 to 20 teachers from their GLSI hub that might be interested and willing to participate in the study.

The hub directors were provided the set of selection criteria intended to guide their recommendations of teachers with the specific characteristics desired for this study (Table 1). See Appendix C for the introductory email and recommendation table sent to each hub director. The selection criteria given to the hub directors included characteristics such as gender, years spent as a member of the GLSI hub, classification of the teacher's school as rural, urban, or suburban, grade level, and whether they teach science. The hub directors were encouraged to recommend teachers that they knew had differing backgrounds, experiences, and personal investment in the GLSI. Again, the purpose of the selection criteria was to achieve maximum heterogeneity among the participating teachers. In order to make the recommendation process easy and efficient for the hub directors, a table in Microsoft Word was created for them to enter the teachers' information and email back to the researcher.

As a part of the purposive sampling used for this project, some teachers were excluded from participating in the online survey or interviews and the justifications for these decisions should be addressed. The delimitations for this study include those teachers who are not actively teaching in Michigan, those who do not teach some science content, and those teachers who are not a part of the GLSI network in Michigan. In addition, those considered to potentially be a part of the study must have been teaching in formal K-12 education at the time of the study; this includes public, private, charter, and Montessori institutions. It is possible that other Michigan K-12 science teachers are doing place-based education apart from those in the GLSI. However,

the GLSI represents an accessible network of teachers throughout the entire state who are actively involved in some sort of place-based education.

After each hub director returned the completed list of recommended teachers including names and email addresses, each teacher was sent an introductory email with a link to the online survey embedded in the text (Appendix D and Appendix E). At the beginning of the online survey, respondents were informed that, by completing the survey, they indicated their consent and willingness to have their responses included in any subsequent data analysis. The online survey consisted of two main sections; the first consisted of questions intended to learn more about the teacher and his or her teaching contexts. In this section of the survey, each teacher was asked what grade level(s) he or she currently teaches, the number of years as a teacher in Michigan, the GLSI hub of affiliation, the number of years as a participating teacher in that hub, what Michigan teaching endorsements are held, the science topics or disciplines currently taught, and gender. The second section of the survey consisted of a brief introduction to the Six Americas survey and the 15 corresponding questions (Maibach et al., 2011).

The last question of the online survey asked the teachers whether they were willing to continue their participation in the study through an in-person interview. If the teacher was willing, he or she was asked to provide contact information including name, preferred phone number, preferred email address, school mailing address, and their preferred time of day to be contacted. The teachers were also given the opportunity to indicate whether they wanted to receive an educational resource packet on climate change and the Great Lakes as a token of appreciation for participating, regardless of whether they agreed to be contacted for an interview. If interested in the educational resource packet, the teacher was asked to provide name and mailing information. If the teacher was willing to be contacted for an interview, he or she was

automatically guaranteed to receive an educational resource packet. Any final comments or questions a teacher had after completing the survey could be entered into a text box on the last page of the survey.

The introductory email was personalized to the teacher by addressing each of them by name. One week after the introductory email was sent to the teachers, a follow-up email with similar information and a link to the survey was sent again. One week after the follow-up email was sent, a final reminder email was sent to the teachers who had not yet responded. This implementation process was modeled after the survey design and implementation suggested by Dillman, Smyth, and Christian (2009). As the survey responses came in, the data were entered into an Excel spreadsheet based on a data entry key that can be found in Appendix F. The Six Americas survey responses were computed based on syntax (available at http://www.climatechangecommunication.org/global-warmings-six-americas-screening-tools) created by the researchers at Yale and George Mason Universities (Maibach et al., 2011).

Once the final reminder email was sent and no more responses were being received, the teachers who were willing to be interviewed were compiled into a table and again, compared

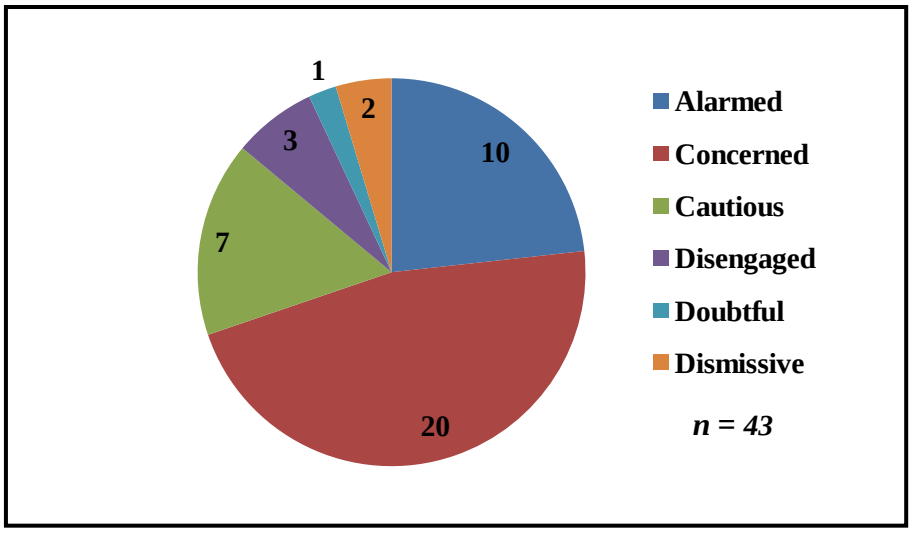

Figure 2 – Survey Respondents' Six Americas Results

using the selection criteria displayed in Table 1. Similar to the hub directors' recommendation process, heterogeneity among the participants was the driving factor in selecting which teachers to interview from each hub. The teachers' Six Americas category designations were weighted heavily in the interviewee selection process as well as the number of years they had been a teacher in Michigan, the number of years as a member of the GLSI, the grade level(s) taught, the scientific disciplines they taught, and gender. 70 percent of the survey respondents were in the *alarmed* and *concerned* categories on the Six Americas spectrum (Figure 2). Because 30 of the 43 respondents fell into these two belief categories, it was even more important to place a higher priority on selecting teachers to be interviewed who were categorized in one of the other four audience segments.

The selection criterion that was not weighted as heavily was school classification as urban, rural, or suburban, because some regions of the state, such as the northeast, were classified as entirely rural, so this criterion was not applicable in that instance. Table 2 displays the resulting responses from the hub directors and the online survey as well as the time frame during which the contact protocol took place. The Lake Superior Stewardship Initiative, although some teachers responded to the online survey, did not have enough teachers who were willing to be interviewed in order to continue with that hub for the remainder of the project. However, the teachers who responded to the online survey were included in the data gained from the survey. The Discovering PLACE hub in Flint did not respond to the initial hub director request made in January 2015. Because only three hubs had sufficient response rates to the online survey, I decided to interview five teachers from each hub rather than three which was the number originally proposed. It was also intentional to stagger the contact dates for the hub directors and teachers so that the researcher could learn from the interview process and adjust

accordingly. For example, the first five interviews with the GRAND Learning Network teachers informed the interview guide for the remainder of the interview. This iterative process of reflection and evaluation after each interview demonstrates the emergent research design of the project.

Table 2 – Resulting Responses from Contact Protocol

GLSI Hub	When Hub Director was Initially Contacted	Dates in Contact with Teachers	Initial # of Recommended Teachers	# of Survey Responses	# of Teachers Willing to be Interviewed	# Actually Interviewed
GRAND Learning Network	11/14/2014	12/8/2014 – 2/13/2015	15	8	5	5
Northeast Michigan GLSI	11/14/2014	1/30/2015 – 3/10/2015	20	15	9	5
Grand Traverse Stewardship Initiative	1/26/2015	2/16/2015 – 3/21/2015	13	11	7	5
Lake Superior Stewardship Initiative	1/26/2015	3/2/2015	20	9	1	0
Discovering PLACE	1/26/2015	-	-	-	-	-
Contact Totals	-	-	**68**	**43**	**22**	**15**

Protocol for in-depth interviews. The teachers from the GRAND Learning Network represented the first five interviews, followed by five from the Northeast Michigan Great Lakes Stewardship Initiative and the lastly, five teachers from the Grand Traverse Stewardship Initiative. The interviews were conducted over a three-month period, from January to March of 2015. Once the five teachers from each hub were selected, they were contacted first by email and then by phone if necessary, to schedule an interview date and time. Prior to beginning each interview, the teacher read and signed a consent form indicating their permission to have the

interview audio-recorded as well as their general consent to participate (Appendix G). Once the consent form was signed, the interview could begin. Each interview lasted between 30 and 75 minutes and they were all audio-recorded on a digital recording device. Each interview followed a set of questions developed prior to the first interview but that evolved throughout the project as the researcher learned more from the teachers (Appendix H).

The study's 15 interviews were modeled after what qualitative researchers call responsive, semi-structured interviewing. Responsive interviewing, as Rubin and Rubin (2012) describe it, is interviewing that "emphasizes searching for context and richness while accepting the complexity and ambiguity of real life" and embraces the evolutions that the research design may have throughout the study (p. 38). Interviews were chosen as the primary method for data collection, because it is during these conversations that the interviewer was able to dive deeply into the teachers' experiences and views to understand the factors that influence their teaching practices and decisions. During the interviews, teachers were asked questions on their beliefs and attitudes about climate change, whether they recognize a connection between climate change and the Great Lakes, their perspective on climate change learning and whether they think it is important, contextual factors they experience that may inhibit or foster climate change learning in their classrooms, and how teachers actually educate (or would educate) students about climate change.

The interview guide used for this research was semi-structured, meaning it contained key questions and topics that the researcher wanted to cover that relate directly to the research questions (Appendix H). According to Rubin and Rubin (2012), a researcher doing semi-structured interviews "has a specific topic to learn about, prepares a limited number of questions in advance, and plans to ask follow-up questions" based on the flow of conversation (p.31).

After each interview, the teacher was presented with a packet containing several different educational resources on climate change and the Great Lakes. It was important to provide the interviewed teachers with resources relevant to our conversation but also expose them to teaching resources they might not have known about otherwise. The interviews were transcribed, and each teacher was given a pseudonym to ensure their confidentiality.

Validity

In Maxwell's (2012) interactive model of research design, validity is one of the five critical components and is especially important to address in qualitative research where validity does not have the same meaning as it does in quantitative research. Some criticisms of qualitative research are rooted in the fact that it is not seen as classical science, or that it is not inherently refutable and replicable (Anfara, Brown, & Mangione, 2002). Questions surrounding conclusions drawn from qualitative research studies include: what does the researcher mean by saying, themes emerged? How did the researcher come to these conclusions? This dissonance between quantitative and qualitative researchers sparked a debate on whether or not qualitative research can be valid. Indeed it can, however validity within a qualitative research study should be based on trustworthiness criteria such as credibility, transferability, dependability, and confirmability rather than the traditional validity criteria of internal/external validity, reliability, and objectivity used in quantitative research (Anfara, Brown, & Mangione, 2002).

In order for a qualitative research study to meet the trustworthiness criteria, Creswell (1998) suggests that the researcher employ at least two verification strategies and be exceptionally aware of providing the audience with full disclosure of the research processes. Examples of the verification strategies for qualitative research include triangulation, prolonged engagement or observation, disconfirming evidence, researcher reflexivity, member checking, an

audit trail, and providing a rich, detailed description of the evidence (Creswell & Miller, 2000). For this research project, three verification strategies were employed to establish trustworthiness and to give credibility to the researcher's study design. The first verification strategy included providing an audit trail for how the researcher came to the conclusions that she did. The audit trail for this research study includes summary memos for each interview (an example of a summary memo is found in Appendix I), the final code book used for analysis (Appendix J), and any other memos written to document decisions made regarding the research process (Appendix K) (Creswell & Miller, 2000).

The second verification strategy employed was to provide readers with rich, detailed descriptions of the data. Denzin (1989) emphasizes the utility in this strategy by stating, "thick descriptions are deep, dense, detailed accounts….Thin descriptions by contrast, lack detail, and simply report facts" (p. 83). Providing detailed descriptions of each interview and the context in which each teacher works will give the reader a unique lens through which to understand the interviewee's perspective.

The third verification strategy employed was triangulation, where the researcher seeks "convergence among multiple and different sources of information to form themes" (Creswell & Miller, 2000, p. 126). To ensure that the Six Americas category designation for each teacher accurately represented their beliefs about global warming and climate change, the researcher asked interviewees to define what climate change means to them personally and/or whether they think it is an important issue in today's society. All except one Six Americas designation accurately represented each teacher's perception of global warming and climate change, demonstrating that the Six Americas survey was a successful selection criterion for this project. It is important to note that a fourth verification strategy, member checking, was attempted by the

researcher. However, the teachers responded by saying that they trusted the researcher and did not have to read through the transcripts to verify that their thoughts were captured accurately. It is important to acknowledge that it is not the goal of this study to generalize the results to the entire population of Michigan teachers; rather, it was to conduct in-depth interviews and acquire detailed information from a willing and interested group of Michigan teachers. The hope is that this study will provide detailed insight but also inspire future, more generalizable research on the topic.

Qualitative (Interview) Data Analysis

Since this study is rooted in an emergent process, data analysis occurred concurrently with the process of data collection. The raw data consisted of verbatim transcripts from audio recordings of the interviews, field notes taken by the researcher during the interviews as supplementary material, and the information gained through the online survey. The first five interviews were transcribed by the researcher; the remaining ten interviews were professionally transcribed by a transcription company called Scribie (https://scribie.com), an online platform for transcription services. After each interview was transcribed, the researcher read through the text carefully while listening to the audio recording to ensure the text matched exactly what the teacher said. Some of the transcriptions were edited to meet proper grammar and spelling requirements, but nothing that was said during the interviews was altered in any way. Each teacher was also given a pseudonym, as promised in the consent form, to protect anonymity and ensure confidentiality. In addition, anything that was said during the interview that would make the teacher identifiable was removed from the transcript and replaced with a blank space.

The first time through each transcript, important themes or concepts that emerged during the conversation and that were relevant toward answering a research question were highlighted.

A summary memo was written after each initial coding to document these themes and concepts. Once all the interviews were completed and transcribed, a full commitment to the data analysis began. The codes were categorized according to the research question they helped answer. For each code, a rule and definition were written that delineated when and when not to apply a particular code to the data. See Appendix J for the code book used for analysis. The codes were entered into an analytical computer program, QSR International's NVivo 10, and this helped the researcher organize the data into individual documents that housed all the evidence found for each code.

Memos were written throughout the analysis process, documenting ideas for modifications to an existing code or the need for a new code. After each transcript had been coded and the code book was finalized, the second stage of data analysis began. This stage consisted of reducing the raw data by code and summarizing the information across and within the different interviews. For example, all of the evidence for the code *Teacher's Perception of Climate Change* was separated into one document and a summary statement was written to explain how this code answered the following research question: what are the internal and external factors that influence whether a teacher incorporates climate change into lessons or not? However, this code was also analyzed by looking at how teachers' perceptions of climate change differed across the three regions and whether this provided any additional insight towards answering the research question. This process allowed the researcher to be fully engaged with the data and analyze it multiple times through various lenses (Rubin & Rubin, 2012).

The third and final stage of data analysis was the creation of displays that visually summarize and organize the evidence for each research question. The displays simplify the process of drawing inferences and writing the narrative for the discussion section of this study

(Miles & Huberman, 1994). Applying these three stages of data analysis required the researcher to be fully immersed in the data throughout the entire project. In order to have meaningful summary statements for stages two and three, the researcher had to be well versed in what was being said in the data. Consistent interaction with the data resulted in deeper levels of understanding about teachers' perspectives on climate change learning within science and Great Lakes stewardship education.

Chapter 4 – Results

Maxwell's (2012) interactive model of research design suggests that a qualitative study's research questions are the center or the heart of the study. He argues that the research questions "not only have the most direct influence on the other components, but are also the component most directly affected by the others; they should inform, and be sensitive to, all of the other components" (Maxwell, 2012, p. 4). The other components within Maxwell's (2012) interactive model include the study's goals or purpose, the conceptual framework, the methods, and validity; all of which interact with and inform one another throughout a qualitative research study. For the results chapter of this report, the research questions operate as the foundation on which the conclusions have been built. Each research question has been addressed by analyzing the interview data using the codes developed over the data collection and analysis stages of this project. Below, each research question has its own section with subsections based on the corresponding codes. Evidence for each code that addresses a research question has been provided in either direct quotation from the interview or in a paraphrased format. However, prior to the results of the interview analysis, it is important to provide a brief overview of the results from the online survey.

Results from the Online Survey

The ultimate goal of the online survey was to evaluate the respondents based on the selection criteria in order to achieve maximum heterogeneity in the interviewees. The results indicate that both the hub director recommendation process and online survey were successful in achieving heterogeneity across the respondents. In total, 43 out of 68 teachers responded to the online survey, a 63% response rate overall (Table 2). Of the 43 survey respondents, 22 indicated their willingness to be interviewed (51% of those responding). The range of teaching career

length across the 43 teachers was from one year of teaching experience to 30 years of teaching experience.

The teachers' grade level(s) were categorized by elementary (kindergarten through fifth), middle (sixth through eighth), high school (ninth through twelfth), or as a hybrid across elementary and middle or middle and high school. Seventeen teachers who responded to the online survey represented elementary school, 9 represented middle school, 10 represented high schools, and 7 represented a hybrid. As for whether or not they teach science content to students, only one teacher responded that they do not. The specific scientific topics or disciplines and the corresponding number of teachers that teach them include: earth or environmental science (33), chemistry (7), biology or life science (28), physical science (23), environmental problems (33), weather and climate (23), and the Great Lakes (24). A wide-range of Michigan teaching endorsements was provided by respondents and this range illustrates the diversity in their pre-service training and content knowledge. Regarding gender, 10 males and 33 females responded to the online survey; for reference, 28 males and 40 females were recommended by the hub directors.

Research Question 1: Incorporation of Climate Change into K-12 Curriculum

The first research question that guided this project was: To what extent are teachers educating their students about climate change, specifically in how it relates to the Great Lakes? This research question sought to discover whether or not science teachers in Michigan incorporate climate change into their lessons, and specifically into their place-based lessons. The two codes used to identify data that addressed this research question were incorporation of climate change in general and incorporation of climate change in the context of the Great Lakes (Appendix J for final code book). They are both discussed in greater detail below.

Incorporation of climate change in general. The definition of this code is the degree to which the teacher incorporates climate change in a broad sense, referring to global climate change as an issue, into their lessons. Eight of the 15 teachers who participated in this study have intentionally incorporated the issue of global climate change into a lesson. The extent to which climate change is addressed in these lessons varies by teacher and is dependent upon contextual factors that will be discussed later in this chapter. Four of these eight teachers have taught or currently are teaching entire units on climate change, ranging from one to nine weeks in length. For example, Ms. Belle teaches a month-long unit on climate change in her high school ecology class and Mr. Linte teaches a nine-week unit on climate change with his fourth and fifth grade students. Three of the eight teachers incorporate global climate change into an existing lesson on related topics such as renewable vs. non-renewable energy sources, energy transformations of fossil fuels, the carbon footprint of food production, and human impact on the environment.

The eighth teacher, Mr. Pryor, incorporates global climate change into lessons but does so differently than the other teachers participating in this project and in a way that is not consistent with the definition of climate change education as outlined in the climate literacy principles (Climate Literacy, 2009). Mr. Pryor, for various reasons that will be explored later, is skeptical of climate change science because of the government's involvement in the issue. For example, he expressed much disdain for Al Gore's, former vice president of the United States, movie *The Inconvenient Truth,* and has only exposed his students to perspectives from the dissenting side of the climate change debate. He concluded by saying that climate change remains a debatable topic among his students, but that he will remain skeptical until he feels he is no longer being manipulated by the government to believe in climate science. The remaining

seven teachers who said they do not incorporate global climate change into their science lessons have various reasons for not doing so, such as lack of content or pedagogical knowledge specific to global climate change. However, some of these teachers do teach their students about human impact on the environment and/or related topics to climate change such as weather, pollution, and water conservation.

Incorporation of climate change in the context of the Great Lakes. The definition of this code is the degree to which the teacher makes the connection between climate change and the Great Lakes and incorporates this within their lessons. Six of the 15 teachers provided examples of lessons that illustrate the connection between climate change and the Great Lakes region. Mr. Linte, for example, described a fourth/fifth grade science lesson where he connected climate change to the Great Lakes region by looking at regional weather data with his students. He said,

> We looked at the weather patterns from NOAA, from 1979 to 2009, that 30-year period. And it was pretty striking the changes that were occurring as far as depletion in overall snowfalls, and overall rain, and the increase of warmer climate.

Another teacher, Ms. Riccona, described how she and a few students participated in an informal lunch conversation about how another staff member had noticed changes in the regional climate over time and how a late ice storm in the spring really damaged her fruit trees. Ms. Riccona said her students were really intrigued by this person's story and wanted to learn more. Ms. Honald has talked about the impact climate change, specifically warming temperatures, is having on Michigan bird species and their migration patterns.

A major criterion for selecting these teachers as participants for this study was that they are a part of the Great Lakes Stewardship Initiative and practice place-based education with their

students. With that, the teachers described the various place-based lessons and projects they do with their students such as Salmon in the Classroom, an ROV (remotely-operated underwater vehicle) program, water quality assessments in the lakes and river systems, and an adopt-a-beach program. However, as described above, only six teachers intentionally connected their place, the Great Lakes region, with climate change during a lesson.

Research Question 2: Factors Influencing Incorporation of Climate Change into K-12 Curriculum

The second research question that guided this study was: What are the internal and external factors that influence whether a teacher incorporates climate change into their lessons or not? The codes used to answer this research question include teaching context, teacher's career background, teacher's personal connection to the local environment, the teacher's perception of climate change and whether that perception in anchored in recent weather experiences, and a teacher's observations of changes in their regional climate or environment. Each of these codes, and their degree of influence, are discussed in greater depth and detail below.

Teaching context. The definition for this code is the conditions under which the teacher is working, and this has been categorized as an external factor potentially influencing a teacher's ability or decision to teach about climate change. A teacher's teaching context could include the characteristics of their student population, the level of administrative support they receive, the level of interaction between school and community, level of adherence to the state curriculum standards, and characteristics of the local community. During each interview, the teacher was asked to describe their working environment and school culture, so the range of answers to this question was very broad. However, if a teacher needed guidance in order to answer the question, they were given probes such as the examples listed above. The evidence for teaching context

provided below will be referred to throughout the remainder of the results chapter as it pertains to teaching or not teaching about climate change. However, it is important to offer a brief description of each interviewee's teaching context as a way to introduce them to the reader (Table 3).

Ms. Worthington is a middle school teacher in the GRAND Learning Network (GLN), the first GLSI hub represented by the participating teachers. She described her school as having students from a wide-variety of socioeconomic backgrounds. She also described how from an environmental, place-based education standpoint, it is difficult because some of her students rarely leave their neighborhoods in mid-Michigan to experience the Great Lakes or nature in general. Ms. Applebaum is an elementary school teacher in the GLN and described her school as, "very small, community-oriented" and that "if somebody says they have an idea, it's

Table 3 – Interviewee Teaching Context Overview

Interview #	Pseudonym	GLSI Hub[1]	Grade Level(s)	School Type
1	Ms. Worthington	GLN	Middle School	Public
2	Ms. Applebaum	GLN	Elementary	Public
3	Ms. Eisenhower	GLN	High School	Public
4	Ms. Honald	GLN	Elementary	Public
5	Ms. Erekson	GLN	Elementary	Public
6	Ms. Laskey	NEMI	Elementary	Public
7	Mr. Plisinsky	NEMI	High School	Public
8	Mr. Linte	NEMI	Elementary	Public
9	Ms. Ackerman	NEMI	Middle School	Public
10	Mr. Olson	NEMI	Hybrid (MS-HS)	Public
11	Ms. Belle	GTSI	High School	Independent[2]
12	Mr. Pryor	GTSI	High School	Public
13	Ms. Riccona	GTSI	Middle School	Independent[2]
14	Ms. Feldman	GTSI	Hybrid (EL-MS)	Independent[2]
15	Ms. Sonance	GTSI	Elementary	Independent[2]

1. GLN = GRAND Learning Network; NEMI = Northeast Michigan Great Lakes Stewardship Initiative; GTSI = Grand Traverse Stewardship Initiative

2. Independent School = private, charter, or Montessori

supported." She also said that the school's neighboring community is very involved and collaborates often to maintain their partnership. Ms. Eisenhower is a high school science teacher in the GLN and said she has relative freedom from the standards, or "wiggle room" within her environmental science class to teach the content she thinks is most appropriate. The same cannot be said for her general biology class, which is much more tied to the state standards and has a common final exam. Ms. Eisenhower also described her student population as an "interesting demographic that's been shifting over the last ten years", including more free and reduced lunch[6] students than ever before.

Ms. Honald, an elementary school teacher in the GLN, described her school's administration as very supportive of new curriculum or project ideas so as long as it is connected to the state standards. She also mentioned that her school district strives towards providing students with opportunities to learn through technology. Ms. Erekson is an elementary school teacher in the GLN and said her student population is almost 70% on the free and reduced lunch program, indicating that there is a high rate of poverty at her school. She also mentioned that her school has both a Title 1 and focus school designation. Being a Title 1 school means there is a high percentage of students living in poverty and so therefore, the school receives more state funding but also more regulation and accountability to support the at-risk students. Focus school designation means that there is a wide gap between the school's highest achieving students and lowest achieving students, based on standardized assessments. Ms. Erekson described it as, "there's certain criteria that they [the state] say you have to have and they can come in and take over, you know, fire people and set up their own administration." Two other teachers' schools

[6] The free and reduced lunch designation is a part of the National School Lunch Program, through which students or families apply to receive federal assistance to provide low-cost or free lunches at school (U.S. Department of Agriculture – Food and Nutrition Service, 2015). This statistic is often used as a metric describing the economic status of school district populations.

are deemed as focus schools, and this designation acts as an added pressure on them and their school administration to boost standardized assessment scores, often achieved by teaching to the state standards in English/Language Arts and Math as these two subjects are more heavily tested.

Ms. Laskey is a middle school teacher in the Northeast Michigan Great Lakes Stewardship Initiative (NEMI), the second GLSI hub represented by the participating teachers, and her school's approach to the state standards is fairly flexible. She said her school's curriculum director restructured the standards 10 years ago and "what gets taught in fifth grade at _____ is not necessarily what gets taught in fifth grade at different schools in Michigan." Mr. Plisinsky, a high school science and social studies teacher in NEMI, works at a focus school, and 50% of his students are on the free and reduced lunch program. Mr. Plisinsky, however, does not think the focus school designation is appropriate as he described,

> I personally think that speaks more to the great quality of education that we can provide students here between AP [advanced placement] classes, dual enrollment, advance classes and other connections like _____ [a class he teaches] with our community partners....We also have a very large special education population that drag down our test scores and put us in a weird spot of being a focus school.

Mr. Plisinsky also commented that his school's funding ability for special programs and projects were improving. Mr. Linte, an elementary school teacher in the NEMI, described his school as being very collaborative and forward-thinking in terms of education. He is also a part of a team of teacher leaders who are developing an entirely place-based, STEM (Science-Technology-Engineering-Mathematics) curriculum to be used in his school.

Ms. Ackerman, a middle school teacher with the NEMI, has students from a wide range of socioeconomic backgrounds because her school is the only middle school in the entire rural

county. She said she collaborates often with her teacher colleagues and feels as if she has flexibility with the science standards. Mr. Olson is a middle and high school level teacher in the NEMI. He teaches science to sixth and eighth graders, and chemistry to upper-level high school students. Mr. Olson said, "I think we're a small town, more than just a small district….I also think we have probably a stronger than normal connection to the Great Lakes, the watershed here because we are so close." Ms. Belle is a high school science teacher at an independent school (private, charter, Montessori) and is a member of the Grand Traverse Stewardship Initiative (GTSI), the third GLSI hub represented by the participating teachers. The majority of Ms. Belle's students are international and because it is an independent school, Ms. Belle stated that she is not bound to the standardized assessments; instead, her students take the SAT (Scholastic Aptitude Test) and TOEFL (Test of English in a Foreign Language).

Mr. Pryor, a high school science teacher in the GTSI, teaches in a rural community where his students are very passionate and connected the region's natural resources. He teaches an environmental science class, general biology, and an elective class called wilderness leadership. Specifically in the environmental science class, Mr. Pryor has a lot of freedom and enjoys teaching what students are interested in such as raising Shiitake mushrooms or aging white-tailed deer based on jawbones. Ms. Riccona is a middle school teacher at an independent school and is a member of the GTSI. Her school prioritizes environmental and project-based education, through which all subject areas are integrated into the lessons. Ms. Riccona refers to the Michigan and Common Core standards for lesson planning, but she said "the cool thing about project-based learning is you can design these really meaty informational projects for the kids and the standards kinda just fall in, you don't have to stretch for it."

Ms. Feldman is a kindergarten through seventh grade teacher at an independent school (private, charter, or Montessori) and is a member of the GTSI. Her school has a very strong sense of community, and teachers there do use the state standards, because their students will move on to a traditional, public high school setting where they will be expected to know certain information. Ms. Sonance is an elementary school teacher at an independent school and is a member of the GTSI. She described her school as "very different" and that she only has 20 students across first, second, and third grades.

In total, this study gives voice to six elementary teachers, three middle school teachers, four high school teachers, and two teachers crossing grade level boundaries; one with kindergarten through seventh grade students and the other with sixth, eighth, eleventh, and twelfth grade students (Table 3). Three Great Lakes Stewardship Initiative hubs were represented: five teachers from the GRAND Learning Network (GLN), five teachers from the North East Michigan Great Lakes Stewardship Initiative (NEMI), and five teachers from the Grand Traverse Stewardship Initiative (GTSI). Overall, the teachers said they are well-supported by their school administrations, and their level of adherence to the state science standards varied; often, the type of school (public or independent) as well as whether the school was a designated focus or Title 1 school influenced the emphasis on standards and assessments. For example, all four of the teachers from independent schools (private, charter, or Montessori) claimed they were not required to teach according to the state standards. This, as well as the other contextual factors described by the teachers, will remain relevant throughout the remainder of this chapter as they provide insight for the lesson planning decisions a teacher makes.

Teacher's career background. This code is defined as a teacher's career experiences that provide insight regarding their teaching practices and motivations. Evidence for this code

came up at various times during the interviews. The range in length of teaching career was 3 years to 30 years as a practicing teacher (Table 4), with the average career length being 16 years. Some teachers have switched school locations and grade level assignments during their careers, while others have remained at the same school or in the same grade level for their entire career. Also under this code are any teaching endorsements that each teacher has, offering insight to content knowledge in science as well as other subject areas and specializations. A teacher's

Table 4 – Interviewee Teaching Career Overview

Interview #	Pseudonym	Length of Teaching Career	Prior Grade Levels Taught	Teaching Endorsements
1	Ms. Worthington	19	1st-6th	N/A
2	Ms. Applebaum	30	preK-2nd	Early Childhood
3	Ms. Eisenhower	20	K-12 Curriculum Specialist	Biology, Chemistry
4	Ms. Honald	16	K, 3rd	K-5 All Subjects, 6-8 Science, Early Childhood
5	Ms. Erekson	20	1st	Elementary Ed., Language Arts
6	Ms. Laskey	16	1st, 4th, 6th	Elementary Ed., Math
7	Mr. Plisinsky	15	N/A	History, Earth Science
8	Mr. Linte	25	1st, 3rd	Elementary Ed.
9	Ms. Ackerman	19	preK, K, 1st, 4th, 5th	PreK, K-5 All Subjects, 6-8 Science and Language Arts
10	Mr. Olson	13	N/A	Chemistry, Math, General Science
11	Ms. Belle	3	N/A	Licensed in Ohio, M.A. in Education
12	Mr. Pryor	15	7th	Biology, Science
13	Ms. Riccona	3	N/A	Integrated Science, Language Arts
14	Ms. Feldman	15	Special Ed., 1st	M.A. in Curriculum and Teaching, K-12 Special Ed., K-12 Elementary Ed.
15	Ms. Sonance	10	N/A	M.A. in Education

career background is similar to teaching context in that it represents an external factor that potentially influences teaching practices and motivations for teaching certain topics or issues, like climate change.

Personal connection to the local environment. This code represents an internal factor and is defined as a personal attachment one has to their local environment because they believe it is special and/or something worth protecting and was applied to instances when the teacher described incorporating place-based education into lessons and/or why they think this providing this type of learning experience for their students is important. The level of connection a teacher has to their local environment provides insight for the individual's emphasis on place-based education as well as how attuned they might be to the adverse impacts of climate change on the local environment. This code arose during the interviews as we talked about the teachers' investment in GLSI and place-based education as well as their motivations for providing their students with this type of learning experience. For this code specifically, the geographic region of each teacher was compared to the level of connection to the environment because communities more inland from the lakes may not be as directly tied to them as coastal communities.

It is recognized that these teachers are expected to practice place-based education as a part of their involvement with the GLSI; however, some teachers have incorporated passions of their own into their place-based lessons. For example, Ms. Honald incorporates place-based elements within her curriculum, and specifically, she and her students sometimes go birding in a natural area near their school grounds. She is also connected with the Audubon Society and does an activity called, The Great Backyard Bird Count in which the students observe and track the different bird species that they see in their backyards. Ms. Honald refers to these types of

activities as her "pet projects", because they don't necessarily have a set curriculum but they are of interest and importance to her as an educator.

Another teacher who has combined her passion with her place-based education is Ms. Laskey. She has a Lake Sturgeon in her classroom and incorporates it into lessons on animal adaptations and invasive species. Her students are responsible for feeding it, something she said they enjoy very much, and also releasing it into the river in the spring. She said, "I've always liked fish. I've always had fish tanks, but just tropical fish. I've never done anything like this before." Mr. Pryor considers himself a steward of the land, someone who is very connected to his place in the Great Lakes region. He believes his goal as an educator is "to get them [his students] out of this classroom and experiencing their resources first-hand. 'Cause otherwise, they are not going to have a passion for it." His deep connection to his local environment is demonstrated in the place-based education he employs in and outside of his classroom.

Looking more closely at the evidence for teachers' personal connection to their local environment, geographic location was not as influential of a factor as originally thought. Largely because of the GLSI and the opportunities this network provides, teachers even in mid-Michigan, get students outside and connecting with their local environment. Ms. Erekson and her elementary students in mid-Michigan participate in Annie's Big Nature Lesson, a week-long GLSI place-based education workshop where students spend the entire school day outside. In describing this experience she said, "that place-based learning is probably the most important; I would say that learning sticks with them so much more than what we talk about in the classroom.…We want them to become naturalists, you know, we want them to love nature." This was similar to comments made by other teachers; taking students into nature or bringing

nature into the classroom provides a profound learning experience in which students begin to develop a connection to their place as many of these teachers already have.

Teacher's perception of climate change. This code, in addressing research question 2, was defined as a teacher's beliefs about climate change. The teachers' personal beliefs about climate change were revealed through the interview questions, how do you define climate change or what does climate change mean to you personally? This question marked a transition in the interview, from focusing on Great Lakes and place-based education to focusing on climate change. The results from the Six Americas section on the online survey provide supplementary information to the interview data for this code and can be seen in Figure 3 (Maibach et al., 2011). The Six Americas survey categorized 7 of the 15 interviewed teachers as *alarmed* about global warming, meaning that they "are very certain global warming is occurring, understand that it is human-caused and harmful, and strongly support societal action to reduce the threat" (Leiserowitz et al., 2013, p.5).

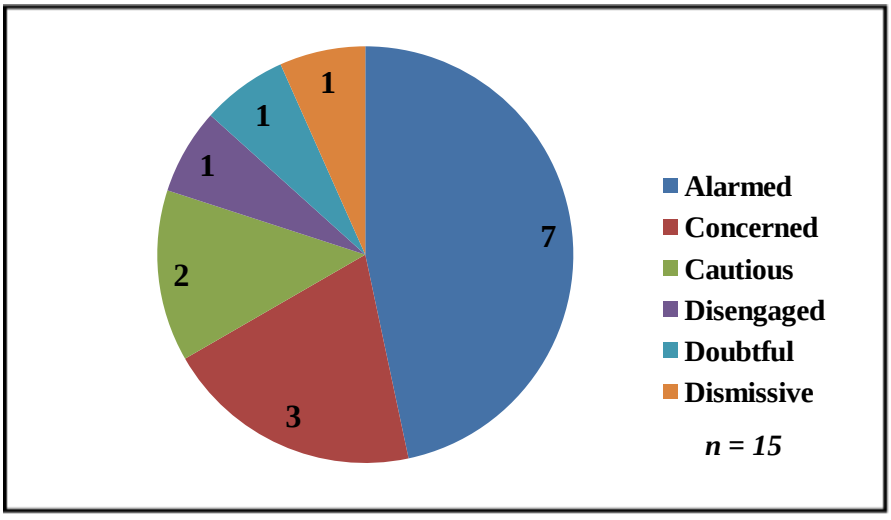

Figure 3 – Interviewees' Six Americas Survey Results

Three of the 15 teachers interviewed were categorized as *concerned* about global warming, which also happened to be the largest audience segment in both the online survey

results (Figure 2) as well as for a recent national study using the same survey instrument (Appendix B) (Leiserowitz et al., 2013). Two interviewed teachers were determined to be *cautious* about global warming, meaning that they "are likely to believe that climate change is real, but are not certain, and many are uncertain about the cause….They have given little thought to the issue" (Leiserowitz et al., 2013, p.5). The remaining three interviewed teachers each represent the three more dissenting perspectives on the Six Americas spectrum; ranging from *disengaged* with and *doubtful* of the issue to completely *dismissive* and strongly believing global warming does not exist. It is evident that more in-depth insight was gained about each teacher's perception of climate change through the interview process. However, it was important to include the Six Americas results in order to fully represent each teacher's beliefs on the issue to the best of my knowledge.

Fourteen of the 15 teachers' Six Americas designations matched their perception of climate change that was revealed during the interview. The *alarmed* teachers demonstrated their knowledge about climate change when defining what it meant to them during their interviews. For example, Ms. Applebaum believes that climate change is a human-induced global issue that is evident through the extreme weather patterns that are increasingly occurring, the drought in California, the growing season moving northward, and the receding glaciers. Ms. Eisenhower, who was also knowledgeable about the issue, said,

> I find it of great concern because of the number of things it seems to impact and I'm worried that it's at a point right now where it's those amplifying feedback loops have gotten us to almost a point of no return. Where it's going to be really hard to rein it back in and not just, I don't know. I feel like we keep breaking records we shouldn't be breaking.

Two characteristics of today's climate change that makes it inherently different from Earth's natural climate change are its rate of change and that it is human-induced. Mr. Linte, another *alarmed* teacher, acknowledged both of these characteristics in his definition of climate change. He said,

> Well, climate change isn't really anything new if you look at the history of the Earth. What's new about this is the rate at which we're creating climate change and the predictable adverse consequences of not changing our usage of fossil fuels.

Often associated with, and sometimes inaccurately used as a synonym, to climate change is global warming. Although the *alarmed* group of teachers often mentioned rising global temperatures in their definitions, they also recognized that global warming is just one impact of human-induced climate change.

The *concerned* and *cautious* group of interviewed teachers, totaling five, offered similar information in their definitions of climate change. Mr. Plisinsky, designated as *concerned* by the Six Americas survey, is in fact very concerned about climate change and considers himself "a more engaged member of the public." However, where he differs slightly from other teachers' perceptions is that he thinks less attention should be given to the predicted impacts of climate change over the next century. Instead, Mr. Plisinsky believes more conversations need to occur addressing the question, what are we going to do about it? Another teacher, Ms. Belle, expressed similar beliefs in stating, "There's no question to whether it's happening or not happening….It's what are we going to do?" One of the teachers categorized as *cautious*, Ms. Erekson, admitted that climate change is something she just doesn't think about very often. She said, "I'm not a panic-type person….I don't ignore it but it's not, I don't necessarily believe all the panic about

it." However, Mrs. Erekson does believe that climate change and human impact on the environment are worthy of concern.

The least represented Six Americas categories were *disengaged*, *doubtful*, and *dismissive*; there was one teacher interviewee to represent each of these categories. Ms. Worthington, categorized as *disengaged*, claimed that climate change is something she does not think about on a regular basis. However, when she does think or talk about climate change, she defines it as patterns over a long period of time and that it is connected to farming, the economy, and animal populations. Ms. Laskey, categorized as *doubtful*, is aware of climate change but has little trust in the information because of the political aura surrounding the issue. She stated, "It could be true. But I don't believe it…I'm considering the source." Ms. Laskey also recognized that there has been a warming trend in the Earth's temperature and that this possibly is related to human activity.

Mr. Pryor, categorized as *dismissive* about global warming and climate change, provided evidence to support this categorization. As mentioned earlier, he considers himself a steward of the land and is cognizant of the impact human activity can have on the environment. However, his argument on climate change was, "I don't buy the fact that it's anthropomorphic. Our climate is changing and it's changing all the time. Our most valuable resource of Michigan is the Great Lakes and that's why they're here, because the climate has changed." Mr. Pryor described the issue of climate change today as very politically-driven, and encouraged me to "follow the money." For example, Mr. Pryor told a story about how he went to buy a new tractor and was faced with a $2,000 tax because of the carbon emissions the tractor would produce. He said, "when we start pushing to pay taxes on CO_2 [carbon dioxide] and calling it a pollutant, that makes me a little uncomfortable because I think it's manipulative."

Mr. Pryor is also very skeptical of the science supporting climate change and believes there is too much misrepresentation of the data to reverse that skepticism. It was very important to have a perspective like Mr. Pryor's represented in this study, because his *dismissive* views on global warming are shared with 8% of the American public (Leiserowitz et al., 2013). Finally, it is also important to acknowledge that Ms. Sonance, categorized by the Six Americas as *cautious*, admitted during the interview to not knowing anything about climate change or global warming other than what she hears about in the news. Based on our conversation, I would categorize Ms. Sonance as *disengaged* with the issues of global warming and climate change (Appendix B).

Teacher's perception of climate change is anchored in recent weather patterns. This code is defined as a teacher's beliefs about climate change being influenced by recent weather patterns in Michigan; this was only observed during one interview. However, it is important to acknowledge because this finding provides additional insight towards understanding this teacher's overall perception of climate change. During the conversation with Mr. Pryor (categorized as *dismissive*), several times he mentioned how cold the past couple winters have been, to the point of saying, "if I really did think I could warm the place up by driving my car around, I would've drove my car and left it running all day and all night." He continued by saying, "it was cold; really, really cold this year…all of these things factor into the fact that I'm skeptical." The distinction between weather patterns and climate change will be addressed later; however, Mr. Pryor's, as well as many other peoples' perception of climate change is influenced by the daily weather patterns experienced.

Teacher's observations of changes in the climate or local environment. This code is defined as a teacher's observations of changes in climate or in the local environment over time and was applied to data that describe a memory or experience through which a teacher observed

change that either reinforced or dissuaded their beliefs on climate change. The majority of the evidence for this code reinforced teachers' beliefs on climate change. Ms. Honald, for example, described this observation: "Well I think about last winter, my dad lives two hours north and we both had big flocks of Indigo Buntings and typically, he hasn't seen them around and I haven't seen them." Indigo Buntings normally would only be in Michigan during the summer breeding months; however, Ms. Honald argued that bird migration patterns are shifting, possibly as a result of climate change. Other observations teachers have made that support their personal beliefs about climate change include a noticeable decrease in lake levels, new vegetation growing on otherwise sandy beaches, decrease in overall precipitation, changes in lake ice, and differences in the four seasons as well as the intensity of storms.

One teacher, Ms. Laskey, had a childhood experience through which she witnessed the lake's water level significantly fluctuate over a few years. She said,

> We had a cottage on the Straits of Mackinac. Well, the water rose. The Straits rose to the point where, on a rough day, the water, the waves were washing into our front porch. So my dad and neighbor…they built a break wall. The neighbor on the right, who graduated from MSU, and said 'It's cyclical. It's going to go down, just give it a couple years. You'll be fine.'….And sure enough, it's cyclical and it went down.

Ms. Laskey has noticed changes in the ice cover on the lakes as well as less precipitation and believes that these would be worthwhile to bring to students' attention. If a teacher notices a change in the local environment that is consistent with the changes likely to be observed as a result of climate change, then that individual may be more likely than others to believe that it is something that needs to be addressed. Ms. Laskey was categorized as *doubtful* about global

warming and so her past experience with observing the lake level fluctuations potentially reinforces her beliefs in that climate change could be attributed to natural cycles or fluctuations.

Level of importance for teaching about climate change. This code is defined as whether a teacher thinks it is important to teach students about climate change. Six of the 15 teachers interviewed explicitly said that climate change is an important topic to cover with students. However, only two of these teachers are actually incorporating climate change into their curriculum. The other four teachers think it is important, but for reasons that will be explored later, have not taken steps to incorporate it. For example, Ms. Riccona said she was frustrated by the fact that she does not discuss climate change very often with her students because of how important of a topic she thinks it is. Mr. Olson, a teacher who incorporates climate change into his science curriculum, emphasized the importance of students knowing "what we think is causing it, that they understand the science behind what the greenhouse effect is, and how burning fossil fuels could potentially increase it. And they know what we're trying to maybe do to prevent it, some actions that are out there." Ms. Laskey made a similar remark in that she thinks it is important to teach students the facts of climate change; but she also emphasized not including information coming from political sources or arenas.

Research Question 2a: Barriers to Incorporating Climate Change into K-12 Curriculum

This study explored the internal and external factors that influence a teacher's ability or decision to incorporate climate change into their science and/or Great Lakes-based curriculum. Research question 2a specifically explored the disincentives to teaching about climate change and is as follows: What barriers do teachers identify that inhibit teaching about the Great Lakes and climate change? Some of the barriers the teachers mentioned during the interviews are supported in existing literature on barriers to environmental education. However, other barriers

teachers mentioned were unique to their own experiences and represent potential extensions of this study into future research. The barriers identified during the interviews include lack of exposure to the environment in both students and adults, the standards driven accountability era within education today, science education is not seen as a priority, a lack of resources, lack of content and pedagogical knowledge, weather is not covered consistently across grade levels, teacher concern about parent/family influence on student beliefs, distrust of climate science, individuals' lack of buy-in regarding the issue of climate change, and barriers specific to climate change such as that it is abstract, not observable on a daily basis, and too political. These barriers will be discussed in greater detail and depth below.

Lack of exposure to nature or environmental problems. This code is defined as when an individual does not see or experience the natural world around them often, if at all. This code was applied to teachers' perceptions of this in both students and adults. For Ms. Worthington and Ms. Erekson, both teachers in mid-Michigan, lack of exposure to the environment is connected to the socio-demographics of their student population. Ms. Worthington teaches a wide-range of students at her school, some of whom are able to travel and have frequent exposures to nature, while others rarely leave their neighborhoods. Specifically, she described the difficulty in trying to get those students to understand the sheer size of the Great Lakes, and because many of them have never seen a Great Lake, it is hard for them to conceptualize. Ms. Erekson directly correlated lack of exposure to the environment, in both her students and their parents, with poverty. She described an experience with a parent during a week-long outdoor learning session with her class:

> I had a lady who, when we were at _____ Nature Center…there's wild turkeys there. She was like, 'what is that?' I'm like, 'that's a turkey.' She said, 'that doesn't look like a

> turkey.' And I'm like, 'it's a wild turkey." And then they were like right there, and she's scared. She was like 'I've never been that close to a turkey except in the freezer section at Meijer.' That's my favorite story about why we do it.

Ms. Erekson believes that students do not have enough exposure to the nature and this is her main motivation for doing programs where students are outside for an entire school week learning about their place.

Ms. Feldman described how her students, as a more affluent population, have lack of exposure to environmental problems or issues. She said,

> They're not starving, they're comfortable; they're not cold, they're not too hot. If it's too hot they have air conditioning; if it's too cold, they have heat, all sorts of clothes, they have access to food all the time. They're not suffering from droughts or floods….they just don't see it.

Ms. Feldman described growing up near a landfill and being very aware of waste disposal. She doesn't believe her students have those same exposures. She argued that her students need to be exposed to people and/or places that have been impacted by climate change or other environmental issues. Otherwise, students will have a difficult time understanding and visualizing climate change's impacts on the Great Lakes region and the rest of the world.

The accountability era. This code is defined as when a teacher does not have enough time apart from current curriculum requirements to address climate change and/or has lost motivation as an educator because of the standards/assessment-driven mentality, sometimes referred to as the accountability era of education today. This barrier was frequently mentioned by teachers during the interviews; in total, 9 of the 15 teachers spoke to how a standards/assessments-driven mentality in education inhibits their personal teaching practices or

practices of teachers in general. Several of the interviewees remarked that teachers run out of time to teach anything apart from what is in the standards and assessments. Ms. Laskey said, "I can just tell you with the way things are going right now in education, if it's not in the form of a learning target from the state, you just don't have time." Ms. Ackerman described how if she was not able to tie the place-based project, Adopt-a-Beach, to a specific standard, her administration would not allow her to do that field-day with her students.

Two other teachers discussed how the standards/assessments-driven approach encourages memorization and not scientific inquiry or critical thinking, two skills that are fundamental to science as a discipline. Ms. Honald, referring to a new science curriculum/textbook she is required to use, said the difficulty with science textbooks is that "science is really about more critical thinking and, you know, it's not about them learning really even the organs in the body; it's just that the systems are working together and how are those working." Ms. Honald continued to say, "Science is more about the investigation and the curiosity and you know, scientists don't just memorize terms." Ms. Worthington described the standards/assessment-driven approach to education as "everything is a fact in a box," and she believes this approach is not conducive to promoting scientific inquiry in students.

Apart from teachers not having time or being restricted to facts in boxes, Ms. Eisenhower and Ms. Feldman think teachers have lost motivation and their sense of purpose as educators because of the accountability era in education today. When Ms. Eisenhower returned to her teaching position after being a K-12 curriculum specialist for five years, she described how her colleagues had changed. She said, "When I look around, at the people that I work with, people are exhausted….they're not innovating and changing the way they were ten years ago because they [are] kind of, more surviving and doing whatever it takes to get along." Along the same

sentiment, Ms. Feldman said "we've driven a lot of teachers out of teaching and we've brought in a lot of people who could probably be really good accountants. They're very good at keeping records….good at checking the facts and passing on their requirements." And it is not just the standards and assessments that are tiring teachers, but also the pressure from teacher evaluations that are often, based on student performance on the assessments rather than teaching practices and approaches to foster learning among students. Ms. Eisenhower described how she is less likely to take time to do a lab activity outside of the classroom that may not be directly tied to a standard, because she knows that her teaching evaluation is based on her students' end of year assessments.

Mr. Pryor is very adamant about place-based education in which students learn from outside the classroom and away from textbooks. His reaction to the accountability era of education today was,

> …our voices have been taken away. So we're afraid to speak out about this testing mentality. I mean, everything has kind of closed us into a book, in[to] tests, in[to] one-dimensional assessments. And it's embarrassing….We all know that we learn from our experiences, we all know that we learn from our adventures, and it is really hard to do that in a classroom.

Ms. Feldman shared similar thoughts, arguing that the national standards and assessments are moving teachers away from using the learning opportunities in the own community or region, in other words, making it difficult to do place-based education. She said, "there are always problems to be solved. And these kids are hungry to be able to do that, to explore and to wonder and question…and by taking it and making it into just one national standard, we're not allowing them to do that." The accountability era of education today that strongly emphasizes standards

and assessments is a barrier to climate change and place-based education because, as these teachers perceive, it does not allow the time to teach topics that are not explicit in the standards, it marginalizes science education to merely memorization, and it deflates the creativity and innovation in teachers that once motivated them to join the profession.

Science education is not a priority. This code is defined as when science, particularly in elementary and middle school, is not viewed as a priority subject because of the heavy emphasis of schools on reading and mathematics skills on the standardized assessments. This barrier was identified by four elementary and two middle school teachers, because it is in the early grade levels that students learn to read and write. All six teachers said that science is not a priority within their curriculum, and that the time allotted for science education has been steadily diminishing. Ms. Honald described the structure for her daily curriculum and said, "the thing with science is that it tends to be what gets cut out at elementary because you have your hour of math and your hour and half reading block. And then they have an hour of creative arts." Ms. Honald said her school is unique in that they allot 40 minutes of science education at the end of each school day; whereas, other schools, in her opinion, are typically only given 40 minutes of science education every other day. Because of this minimal time devoted to science, she tries to integrate science into other subjects within her curriculum.

Ms. Erekson is determined to provide her students the opportunity to participate in a week-long outdoor learning experience every year because of how little time she is given for science education. She said, "We do it [week-long outdoor learning experience] very early in the year so we connect it with everything we do for the rest of the year." It is important to her to give her students that outdoor exposure because she believes it resonates with them so much more than what they are able to learn during the short time periods of science education in the

classroom. The barrier of science education not being a priority in elementary and middle school is related to the accountability era barrier, because it all comes back to teachers not having enough time to teach topics that they think are important for students to learn, such as Great Lakes or climate change. That is why opportunities like those presented through the GLSI are so important to teachers, because they provide educators with an avenue to integrate place-based education despite these barriers.

Lack of resources. This code is defined as when a teacher has little or no access to resources that would help incorporate climate change into lessons such as professional development, funding, and curricular materials. This barrier was not overwhelmingly reported by the teachers interviewed; however, what was mentioned most often was the lack of monetary resources in order to get curricular materials or transportation for field-trips. Also, Ms. Worthington described how typically for a teacher in an urban setting, it would be difficult to do any sort of place-based education because of the resources required. The GLSI, however, makes it possible for her to do it. Teachers also mentioned that they apply for grants in order to get funding to do their place-based projects, and so more opportunities need to be made available to assist teachers in writing grants or finding funds to incorporate place-based and climate change education.

Lack of content knowledge. This code is defined as when a teacher self-identifies that they are not knowledgeable or as knowledgeable about science and/or climate change as they feel they should be. Lack of content knowledge is a barrier that has also been identified in existing literature on environmental education and climate change education. Regarding content knowledge on general science, Ms. Worthington stated that science is the subject with the least content knowledge and understanding for elementary or middle school teachers who are

responsible for teaching multiple subjects. Similarly, Ms. Ackerman who is a middle school teacher, stated, "I don't have a tremendously strong science background….I'm a K-8 certified teacher so most of my school [training] was actually about how to teach" and not necessarily specialized in a content area.

Specific to content knowledge on climate change, Ms. Sonance admitted to not having any knowledge on the issue. She also recognized that although she believes climate change is something students should be learning, she must first educate herself on the topic prior to teaching her students about it. Ms. Eisenhower, a high school biology and environmental science teacher, admitted she could probably know more about climate change. She also acknowledged that a teacher's level of content knowledge for science, and/or topics like climate change, is largely dependent on where and when the teacher was trained as well as where they are currently getting their information. Unlike her experience in college, other teachers may not have been exposed to teaching and/or learning about general science topics or more specifically, climate change.

Lack of pedagogical knowledge. This code is defined as when a teacher self-identifies that they are not proficient in strategies for teaching about climate change or as proficient as they feel they should be. Similar to lack of content knowledge, lack of pedagogical knowledge is a barrier already identified within the environmental education and climate change education literature. However, there was not a significant amount of evidence for this barrier among the interviewees for this study. Only three teachers mentioned this as a barrier to climate change education. Ms. Worthington referred to her pedagogy as having a "bag of tricks," something she feels as if she has for reading and writing but does not have for science and more specifically, climate change education. She said, having "the awareness that that concept [climate change] is

out there and that I can integrate it into other areas of my teaching. That's key." Mr. Olson and Ms. Ackerman both agreed that climate change is a difficult topic to teach. Mr. Olson said, "I haven't found a lab or anything that you could do to demonstrate it very well….It's difficult to demonstrate in a small environment." Ms. Ackerman said that curriculum kits or lesson plans on climate change need to include both content and pedagogical knowledge to help teachers who are not necessarily comfortable with open-ended activities where students are making the conclusions. Without knowledge on *how* to teach about climate change, content knowledge can only get a teacher so far.

Weather is not covered consistently across grade levels. Weather is often confused with climate, and so it is important to teach about the difference. However, some teachers in this study claim that it is not clear when and to what extent students are learning about weather. Only three teachers mentioned this barrier during the interviews; however, it is important to include in the analysis, because if weather is not being taught consistently or effectively, it will be more difficult to teach students about climate change and alleviate the misconceptions between weather and climate. Ms. Honald stated, "I don't think we do a very good job with weather, at all….there are little bits and pieces of it at most of the grade levels." The other two teachers made similar remarks. Ms. Erekson teaches her students about weather during the water cycle unit but majority of her weather curriculum was moved out of her grade level requirements. The distinction between weather and climate is fundamental to climate change education; if students are not learning that distinction, they will have greater difficulty grasping the concept of climate change.

Parent/family influence on student beliefs. Parents are a student's first teachers and their beliefs are often imprinted on their children. This code was applied to data that described a

teacher's experience with parents influencing their children's beliefs on environmental issues or when a teacher refrained from teaching climate change because of potential parental backlash. Eight of the 15 teachers interviewed mentioned parental influence on their students' beliefs or perspectives regarding topics like science and climate change. The conversations between parents and their children as well as the behaviors modeled at home influence students' beliefs. Ms. Ackerman described how the students who are more likely to understand the impacts humans are having on the environment are also the students whose parents drive hybrid cars or use electrically efficient light bulbs. Ms. Erekson, referring to struggling to get her students to understand the distinction between weather and climate, said, "maybe the ones that do get it have had more family conversations about it. And it's just like anything with kids in poverty; they don't have conversations with their parents about academic things."

The teachers expressed how students come to class with preconceived ideas about climate change, most often from their parents. Ms. Laskey said,

> What I find is what's spouting out of their [students'] mouths is what their parents said, and their parents got the information from the news; from the political party….I can't say that I've ever had a student that wasn't just regurgitating what their parents had said. They weren't thinking for themselves.

Ms. Riccona described how it is difficult to get her students to think for themselves on topics like climate change. She said, "Whatever notions and preconceptions they're coming to school with are a little more ingrained [than] in a climate change talk that we might have for four weeks." This is why she and Mr. Plisinsky believe that it is difficult to gauge whether their students are influenced by the lessons or discussions on climate change. Mr. Plisinsky described how he is

unsure of whether the emphasis on climate change during his classes influence or change the preconceived notions his students bring to class from their parents.

Mr. Linte had a direct experience with a parent being upset because of his discussions on climate change with students. Mr. Linte said,

> In fact, I had one of my friends, known the guy for a long time, a farmer in the area who, this year, wanted to know why I'm filling his son's head full of nonsense about the problems farming is causing….And my argument was, 'You guys might be doing higher yields right now, but over the long course of time, you're not doing a sustainable growth pattern.' And I'm not telling them one thing or another. I'm saying, 'Look at it.'….I said, 'Marv, I'm not putting ideas....I guess I am putting ideas in their head, but the ideas I'm putting in their heads are ideas for them to do inquiry-based thinking about, is this sustainable over a long period of time?'

At a previous school, Ms. Riccona received similar parental backlash regarding teaching students about evolution, and she fears that similar backlash could be experienced again with teaching about a similar politically controversial topic like climate change. The conversations had at home as well as the amount and type of exposure students have to an issue like climate change impact their beliefs and maybe their ability to see the issue from a different perspective. This presents a challenge for teachers who teach about climate change or for teachers who would like to but are hesitant because of potential parental backlash.

Distrust of climate science. This code is defined as when a teacher does not trust the science behind climate change for various reasons or acknowledges the public distrust of climate change science/publications. Six teachers mentioned distrust of climate science during their interviews but in three different contexts. Two teachers, one categorized as *doubtful* and the

other as *dismissive* on the Six Americas spectrum, claimed they do not trust climate science because of the political polarization of climate change, influencing their overall perception of the issue. Mr. Pryor said, "I feel that we are being manipulated. I would feel that way if any government official was trying to convince me of something before a scientist." He described the skepticism he felt after receiving Al Gore's *The Inconvenient Truth* and people arguing that the "science is in." Mr. Pryor continued,

> Al Gore says that a lot, that ICP or the Intergovernmental Panel on Climate Change, they say that a lot when they're doing their interviews. A lot of times it will be like, 'These amount of scientists or climatologists agree that global warming is anthropomorphically caused.' But, fine, let's look at the evidence. Why is CO_2 preceding or the warming preceding the CO_2 measurements in the ice cores? Why is the temperature warming on Mars? Okay, so those kinda things, is it caused by humans? Well CO_2 you're telling me now is a pollutant. Too much CO_2 is causing our planet to warm unnaturally. The oceans are supposed to rise, all these things. People are going to die, all this bad stuff is supposed to happen. I mean red flags are going. This sounds like religion.

The distrust of climate change science, especially for these two teachers, stems from the political atmosphere surrounding the issue and is consistent with their perception on the issue as made evident through the Six Americas survey and the interviews.

Two other teachers described how making climate predictions or providing inaccurate data is dangerous and fuels the public distrust of climate change science. Mr. Plisinsky referred to two reports found containing inaccurate climate data and that the agency removed the bad data without proper explanation, one coming from NASA (National Aeronautics and Space Administration) and the other from the IPCC (Intergovernmental Panel on Climate Change). Mr.

Plisinsky said, “We have to have good data….we can’t have these political games going on where if NASA took the data down? NASA is the government, man. There are a lot of people that don’t trust the government.” Along the same lines, Mr. Olson believes that sometimes climate scientists overemphasize how quickly the negative impacts of climate change are going to become reality because when these predictions are inaccurate, people are less likely to believe in them. Mr. Olson and Mr. Plisinsky both agree that climate is very difficult to predict because of all the influencing factors, and that distrust of climate science can result from inaccurate predictions. Mr. Olson said that in the classroom, he tells his students “don’t always try to predict exactly what's going to happen until you’ve made some observations and done some things.”

The final two teachers with evidence supporting this code are frustrated by the fact that there is still distrust of climate scientists. Ms. Belle compared it to the medical field; she argued that society trusts the medical researchers when they say a new drug or procedure is a remedy for an illness, so why doesn’t society trust scientists with evidence supporting the reality of climate change? Regardless of whether a teacher distrusts climate science themselves, is leery of climate predictions or bad data, or is frustrated by those who do not trust climate science, distrust of climate science is a barrier not only to climate change education but also to general public buy-in to the issue as something that needs to be addressed.

Lack of buy-in. This code is defined as when teachers perceive that people either do not care about climate change or are unwilling to make the necessary lifestyle changes that would reduce human impact on the environment. This phenomenon was mentioned by two teachers when referring to their students or the general public. Mr. Plisinsky argued that a lot of people do not care enough about climate change or have bigger problems to worry about within their

lives. Ms. Feldman, a teacher at an independent environmentally-oriented school, recognizes a gap between what her students are learning at school and their behaviors outside of school. She said,

> …it blows my mind because you're paying money to go to a school that has a huge focus on Earth to table….you still don't get the buy-in from them. The kids are coming to school and they're doing all this stuff, but then they're going home and not doing it at all.

Ms. Feldman went on to describe how she has observed students approach the recycling area during lunch where they are supposed to recycle the appropriate materials, compost food waste, and discard whatever is left. She said students will walk up, look around to see if anyone is watching them, and throw everything into the garbage can. She then stated, "You can't just model it and talk about it. There's something that we're missing that they're not making the connection with how important it is to their lives…. [That] their choices are affecting the environment." A lack of student buy-in acts as a barrier to climate change and place-based education because without it, cultivating stewardship of the environment is very difficult to achieve because students do not understand the importance behind their individual choices and actions.

Climate change is abstract. The next three codes are specific to climate change as an issue and were identified as barriers to incorporating it in a lesson. This first code, climate change is abstract, was applied to data where a teacher described climate change as being too abstract or complex for themselves or their students to fully understand. Climate change is a complex phenomenon that has several driving factors, both human and natural, and many consequences. Nine of the 15 teachers discussed this barrier during the interview and some provided specific examples of how climate change is too abstract or complex for students to

understand. Ms. Honald described how the interconnectedness of the driving factors and resulting impacts of climate change are very complex to consider. She said, "you're tying in the temperature and the weather and how its impacting vegetation… how storms are related to the water level rising because of what we're doing….it's a lot. I mean for me it's a lot to think about."

Other teachers described how climate change is difficult to put into context for students because it is inherently a global or planetary issue. Ms. Laskey, in describing a lesson on the greenhouse effect with her students, said that without walking into a greenhouse and feeling the difference in temperature, her students would have a hard time understanding the concept. Ms. Riccona thinks that, especially with a topic like climate change, it is difficult to help students to understand a phenomenon or process through a two-dimensional textbook. She compared it to a lesson on the Great Pacific Garbage Patch, an area of the Pacific Ocean in which litter and plastic debris has built up over time because of the oceanic currents; she said, "We watched a video on it and the kids are like, 'Oh, that's what it is? Oh, that's what it looks like?' In their head, they're only imagining this little thing." Specifically for her younger students, Ms. Sonance believes that climate change is too abstract because their idea of the world is often only as big as their town or state.

In addition to the science behind climate change being abstract, the social, cultural, and economic factors also make it complex. Mr. Plisinsky said climate change is not a simple problem to solve because of all the different elements of society that it influences such as cultures, economies, and politics. The science and social implications of climate change make it a very complex, and abstract issue; one that is sometimes difficult for people, and students, to understand.

Climate change is not observable on a daily basis. Climate represents long-term patterns in meteorological variables such as precipitation and temperature for an area. Therefore, changes in an area's climate, whether human-induced or natural, are difficult for one to observe on a daily basis. Eight of the 15 teachers mentioned this as a barrier to climate change education, because K-12 students' frame of reference is not very long (between 5 and 18 years of age) and weather patterns are often misinterpreted as climate patterns. Ms. Worthington said how she does not think her elementary students would be able to understand that climate is changing because it is something that they simply do not notice. She said, "I don't know maturity wise whether elementary students have enough experience to see the difference between [weather and climate]. Their long period of time is just a year." Ms. Riccona agreed, in that the stories she has heard about the climate changing are all from older people who have lived in that area for their entire lives. She said, "I think when you talk about climate change to a 10-year old, they don't have a frame of reference; they've only been on the planet for 10 years and what happened in 10 years? The temperature rose to a tenth of a degree, whatever the case may be."

Something that students do feel and see every day is the weather. Teachers expressed how their students are often confused by climate change and global warming because what they see and feel doesn't necessarily match what they expect when learning about climate change. Ms. Ackerman recognized this confusion, saying "I think the fact that is was called global warming for so long, and then we're having these record-breaking cold winters and our summers have been cold, that is definitely an issue." Mr. Olson has also noticed that his students, when they do realize that the climate is changing, think that Michigan is going to turn into Florida. He described how he tries to inform them that small changes in temperature can have significant impacts on the climate system and that, "We're still going to have winter, it just might not be the

same winter we saw all along." It was argued by one teacher that bringing climate change into the local context is important to do in lessons because this could help students notice changes in their area.

Climate change is too political. Climate change is a frequently debated topic among political parties in the United States, and this is seen as off-putting by some individuals. This code was applied to data that described a teacher's discomfort with climate change being viewed through a political lens. As made evident through the analysis of previous codes, the politics of climate change significantly influenced two teachers' perceptions on the issue. Because of the political debate on climate change, Ms. Laskey chooses to not get involved in the conversation. She is very skeptical of the information on climate change that is present in the news, because often, the source has political affiliation or biases. It is not just the issue of climate change, but more so politics in general that Ms. Laskey does not believe in investing her time.

Mr. Pryor is skeptical of climate change science because of the political debate and investment in the issue. He said, "If you follow the money, it comes back to political motivation. I mean, when in all of history has a politician, who we should be programmed to be skeptical and distrustful of, been able to send every science teacher *The Inconvenient Truth*?" As we have seen over the course of the entire analysis, the political atmosphere surrounding climate change has made people skeptical of the information and less likely to believe in it because of perceived instances of data misrepresentation and inaccuracies. In addition, there are also many people in the United States who do not support government action at all, and so the polarization on the issue of climate change continues to grow.

Research Question 2b: Facilitators, or Needs, for Incorporating Climate Change into K-12 Curriculum

This study included consideration of the internal and external factors that influence a teacher's ability or decision to incorporate climate change into their science and/or Great Lakes-based curriculum. Research question 2b specifically explored the facilitators to teaching about climate change and is as follows: What facilitators do teachers identify that already support, or are needed for, teaching about the Great Lakes and climate change? The facilitators and needs identified during the interviews include the GLSI (Great Lakes Stewardship Initiative), resources on climate change, connections with the community, a presence in the curriculum standards and assessments, student-friendly data and resources, teacher autonomy, increased dialogue about climate change, whole school/community buy-in, teacher empowerment, and a paradigm shift in science education towards more inquiry-based, place-based learning. These facilitators and needs will be discussed in greater detail and depth below.

Great Lakes Stewardship Initiative (GLSI). This code is defined as teachers who are involved in the GLSI and believe their teaching has improved because of it. Every teacher interviewed is a member of the GLSI through his/her respective hub across the state. The range of membership among the teachers is one to seven years, and their individual investment in the program varies. However, common among them all is the incorporation of place-based education in their instruction. Overall, the involvement in the GLSI for these teachers is highly-valued and beneficial for their teaching practice. The GLSI has facilitated place-based education by providing teachers with professional development, curricular resources, funding, networking opportunities among other teachers, community partner connections, and ideas for place-based projects they can do with their students. Ms. Worthington, for example, said, "The professional

development that comes with it [GRAND Learning Network] through the GLSI is very helpful. Even in just being able to find materials, watching a lesson, figuring out how you can adapt it to your class needs." Several teachers mentioned how helpful it has been to network and learn from other educators in the GLSI during meetings or workshops. Mr. Plisinsky said, "I definitely think it's helped me to up my game. It's connected me with some really cool professionals who are doing some really important and good quality place-based education projects with their students that can provide me a model to follow."

Idea generation was another way that the GLSI has facilitated place-based education for these teachers. Examples of the place-based projects or project ideas mentioned by the teachers include Annie's BIG Nature Lesson, an ROV (Remotely-Operated Underwater Vehicle) program, rain gardens, Adopt-a-Beach project, Salmon in the Classroom, Lake Sturgeon in the Classroom, and school-ship programs. The GLSI has been a very positive facilitator for the teachers interviewed for this study and their place-based education initiatives. As far as being a facilitator for climate change education, the GLSI recently applied for funding through the NOAA Environmental Literacy Grant Program to incorporate climate change into Great Lake's place-based programming.

Resources on climate change. This code is defined as when a teacher recognizes the need for resources such as professional development or already has access to resources that helped them incorporate climate change into lessons. Nine of the 15 teachers interviewed said access to resources such as professional development would help incorporate climate change into the curriculum. Mr. Plisinsky explained how the only professional development he receives through his school is on how to not be a designated focus school anymore. He said, "I have a lot of professional development but it all tends to be in the education mode, not the content mode."

Ms. Belle thinks that professional development is most helpful when it is relevant and adaptable to any classroom. She said, "The best professional development…gives me new ideas, something that I can use right then and ideally time to actually work on adapting it to my classroom." Ms. Sonance suggested that a teaching website on climate change would be helpful to her as well as affordable experiments and age-appropriate lesson plans on climate change. After our conversation was over, I shared with Mrs. Sonance a list of existing teaching websites on climate change and encouraged her to look at them. This raises another potential need in that teachers are not certain of where to look for the resources on climate change that already exist. With increased access to teaching resources on climate change, teachers may be more inclined to incorporate it into their curriculum. Many of the teachers appreciated the educational resource packet given to them for participating in the project because it not only gave them several resources to use immediately but also direction for where to look to for more.

Connections with the community. This code is defined as when a teacher recognizes the need for community connections through partners, experts, and field trips, or the teacher already has established these connections and has seen the benefits to their students. Six of the 15 teachers described how beneficial their existing connections within the community are for the students. These connections consist of community partners that help with the place-based projects or programs that the teachers do, as well as experts that visit the classroom or field trips where the students visit the expert. Mr. Linte is very active in place-based education and has many community partners to assist him and his students with their projects such as Michigan Sea Grant Extension and the Saginaw Basin Land Conservancy. Ms. Riccona's school also has many community partners that she believes are very beneficial to her and her students. She also

identified a need for inviting local experts into the classroom to talk about their observations of the changing climate. She suggested,

> I think it'd be really cool to have those people that I talk to, older people who have been here for years and years, come in and talk to the kids, like, 'Hey, when I was a kid, this lake used to freeze and now it doesn't,' or 'We used to ice-fish on this, and now we can't'.

She continued to say that making those connections with long-time residents within the community would help put climate change into perspective for students. The value of existing community connections is clear among the teachers. Ms. Sonance believes bringing experts into the classroom who are knowledgeable and passionate about a topic encourages her students to become passionate about that topic too. She also said that these community connections make learning fun and exciting for her students, and that more opportunities seem to arise because of her connections.

Climate change needs to be in the standards or on the tests. This code is defined as the need for climate change to be a larger presence in the curriculum standards for Michigan or put on the standardized tests, or else it will not get taught. This need was identified by 5 of the 15 teachers and could become a facilitator of climate change education if made a reality. As a result of the standards/assessments-driven educational system in play today, Ms. Feldman said, "unfortunately, one of the biggest things that would help it happen is if you put it in the core curriculum." She explained that if climate change is put on an assessment, it will get taught, because teachers have to teach the content covered on the assessments. Otherwise, teachers do not have time to teach anything else besides what is on the assessments. Ms. Laskey offered additional insight on this when she said, "Remember, it needs to be in a learning target, or it just needs to be on those standards somehow; and maybe a standard that's already there but just

needs to be rephrased to include it [climate change]." If climate change is not put in the standards, Ms. Honald said a curriculum on climate change at the very least needs to align with the current standards such as Next Generation Science Standards or Common Core. Teachers would then be able to easily demonstrate the alignment of climate change to a particular standard, especially if lesson plan approval by the administration is required.

Student-friendly resources and data. This code is defined as the importance of having student-friendly resources and data on climate change or related topics, meaning that the content is framed so that youth or non-technical people can understand it. Two teachers identified this as a need for incorporating climate change into the curriculum. Mr. Olson said that he would like to have access to more longitudinal, raw weather and climate data. He argued that, "it doesn't have to be all processed for the kids….My students can figure out those relationships themselves and its more powerful, sometimes, if they do." However, Mr. Olson does think the raw data needs to be framed in a way that makes sense, not just to students but to non-technical people too. He said,

> I always laugh at it when they say, 'Well, regular people don't seem to believe in climate change quite as much.' And I'm like, 'have you read some of the things you guys write? ....We're not talking about uneducated people. We're talking about people who just aren't scientists.

More access to student-friendly resources and data is a facilitator to climate change education because these data sets allow students to explore real scientific evidence of climate change and to draw their own conclusions about what the data mean to them. Again, student-friendly, non-technical resources on climate change exist; the need lies in that teachers may not necessarily

know where to look for them or that these resources need to be made more available to teachers for educational purposes.

Teacher autonomy. Teachers need or desire autonomy within their classrooms to have a say in what they teach students; whereas traditionally, the curriculum standards dictate what is taught. The evidence supporting this code comes from two teachers who have autonomy in their classrooms. Ms. Eisenhower, a high school environmental science and biology teacher, expressed that she thinks she is in the minority, as far as teachers having autonomy within their classrooms to add or remove lessons however they deem appropriate. Ms. Belle, a high school science teacher at an independent school, also has a lot of autonomy in her classroom, saying that she does refer to the Next Generation Science Standards as a framework but is able to pick and choose the topics she focuses on with her students. It is important to note that both of these teachers incorporate climate change into their curriculum. Ms. Eisenhower thinks that in order for teachers to be able to incorporate climate change, they need to have autonomy or more control over what they teach. The more autonomy a teacher has, the more freedom they have in lesson planning and the more able they are to incorporate topics like climate change.

Increased dialogue about climate change. This code was applied to data that described the need for more dialogue about climate change, among teachers as well as with students, and/or how increased dialogue is beneficial. Three teachers mentioned increased dialogue about climate change as a need, both in the general public and among educators. Mr. Plisinsky described a conversation at a conference where educators were talking about evolution and how to best teach it to students. He said, "Something similar should happen in terms of global climate change….I think educators need to take charge of that debate and probably address it." Ms. Belle emphatically believes that climate change is something that needs to be talked about

more often, period. She said, "We need to talk about all facets, and it's not just carbon dioxide that matters." An increase in dialogue about climate change would improve teacher understanding of the issue, albeit the content of the dialogue is accurate, and encourage sharing ideas on how to effectively teach students about climate change.

Whole-school/community buy-in. This code is defined as the benefit of having the whole school or community on board with incorporating climate change and/or Great Lakes education. Three teachers described how their schools and surrounding communities support their school initiatives and that this is very beneficial towards achieving their goals of place-based or environmentally-focused education. The community that Ms. Applebaum's school is in has always been very proactive with environmental stewardship and initiated the recycling program that now exists at the school.

Mr. Linte's school district is striving to be the first entirely STEM-based K-12 school in the state, and he said his school district has always been progressive in terms of education. He, and several other colleagues, are currently developing a STEM-based curriculum focusing on place-based and project-based learning. Mr. Linte said, "it's starting to become an expectation that you're going to be doing it….we've written it into our school improvement program that we will be moving towards place-based education. We've got a lot of support from the administration and the school board." This collective buy-in and support from the entire school district has made the goal of providing students place-based, STEM-based education a reality. Ms. Riccona also acknowledged the benefit of whole school or community buy-in regarding climate change education, but she is not certain on how to achieve this.

Teacher empowerment. As a result of the accountability era within education today, Ms. Feldman argues that teachers have lost their motivation as educators and that there is a dire

need to empower them again. Ms. Feldman was the only teacher to mention this as a need, not just for climate change or Great Lakes-based education but for education in general; however, as is the purpose of this study, it was important to give her a voice. She said, "Teachers need to be empowered to know that they can use teachable moments, that they can go on field trips, that they can go outside, that they can bring in speakers….What's been taken away from them is the real world of teaching." Ms. Feldman continued to say that majority of teachers enter into the profession because of "a love for the future" and the belief that they are going to help the world in some way. However, she believes the emphasis on standards and assessments has hindered teachers' ability to be creative and to take advantage of learning opportunities like field trips or simply taking students outside for a lesson. If teachers' sense of empowerment is restored, then they may be more likely to take risks and incorporate place-based education or topics like climate change in their curriculum.

Paradigm shift in science education. Eight teachers identified that there is a need, across all grade levels, to shift away from science textbooks and assessments towards more inquiry-based, experiential learning practices like those afforded in place-based and project-based education. The teachers already employing place-based, experiential learning recognize the value in this approach to science education. Ms. Ackerman's motivation to continue providing her students with place-based education is that "it just makes it really interesting and gives them [students] a great connection to collect your own data as opposed to looking at what someone else collected, and this canned question in your science book." Mr. Olson actively tries to transform his science education to be more inquiry-based and exploratory. He said, "we try to do as many lab activities, try to apply more of what we're doing, try to investigate a little bit more….where students get to do a little bit of the question asking, as well as answering.

Discover some things on their own." Teachers who are already shifting towards more inquiry-based, place-based education typically may have enough autonomy and support from administration to do so.

Other teachers who have not yet made the shift recognize the importance of inquiry-based education, especially in learning about a topic like climate change. Ms. Worthington explained that an overarching theme of science education is to look for and identify patterns or changes in whatever is being observed. She then described how her middle school students do not come into her classroom prepared for this type of learning; she said, "They're not looking at patterns and questioning on their own." Ms. Worthington continued, "I've been a lower elementary teacher, we spend a lot of time just identifying things but then we don't do anything with it….we don't foster that questioning and analysis." She believes that in order to successfully educate students about a topic like climate change, the foundation for learning through observing patterns or changes, questioning, and analyzing must be developed early on in a student's education career.

Research Question 3: Recommendations for How to Teach about Climate Change

The final research question that guided this study is as follows: How do or would teachers educate students about climate change in general and within the context of the Great Lakes region? Because of the emergent nature of the study and the emphasis on giving the participating teachers a voice, every example and suggestion provided for climate change education was considered important and a part of the analysis even if it was only supported by one teacher who said it. Therefore, only one code was used to tag evidence that answered this research question and that code was "recommendation." This code is defined as an example or

suggestion a teacher provides that describe how they already do, or would, teach about climate change. The suggestions and examples will be discussed in greater detail and depth below.

Suggestions for teaching about climate change. The following represent all of the suggestions that the interviewed teachers provided to successfully incorporate climate change into the curriculum. Beginning with the most frequently mentioned suggestion, 7 of the 15 teachers recommended that climate change be incorporated as a K-12 progression through which student perspectives expand as they move up in the grade levels. Teachers referred to this as a scaffolding or spiraling effect, meaning that new content being learned builds from prior knowledge. Ms. Erekson suggested,

> they [students] have to have multiple exposures…they can't have it in one grade…it needs to spiral for them and they need to have some exposure to it every year so it becomes like, 'I'm not just hearing this right now; I've been hearing this message since I got into school. This matters.' And I think if they hear it enough and we have this background knowledge to scaffold so that when they do get old enough to understand it and to care about it more…I just think it's one of those things you can't start too young.

Teachers suggested that this K-12 progression on climate change begin with human impact on the environment in younger grade levels, becoming more and more complex as students grow up, and eventually reaching internalization of climate change as a critical issue that requires civic action in high school.

Another suggestion made by six teachers is that climate change be cross-curricular, meaning that it is seen as an interdisciplinary topic that can be connected to many subjects besides science. Other subject areas teachers recommended include social studies, economics, tourism, recreation, English or language arts, chemistry, geology, social issues, and current

events. Ms. Belle said, "[If] we think about climate change as this separate topic, then it's going to be hard to get it in. But if you're thinking about climate change in the sense that its part of everything, then I think it would be easier." A third suggestion made by five teachers is to bring climate change into the local context for students so that it is not so far-removed from where they live within the Great Lakes region. For example, Ms. Riccona suggested bringing in long-time residents of the area to share stories about how the region's environment and climate have changed over the course of the residents' lifetime. Ms. Honald doesn't think that using the polar bears as an example of a consequence of climate change is useful because it is so far-removed; however, Ms. Ackerman sees her students' interest in animal extinction and thinks that the threat to arctic species would be an effective avenue to grab her students' attention.

Another suggestion from four of the teachers is to make sure students, especially in elementary grades, know what they can do personally about climate change and feel as if they have a voice in the conversation. Ms. Applebaum, an elementary teacher, said, "looking at it in ways that they can be resourceful.…maybe not using as much water, turning it off when brushing your teeth…riding your bike as opposed to using a car…[ways] that they can make a difference." It was also suggested that teachers be aware of how they frame climate change within a lesson; especially with younger students, it was seen as important to not focus solely on the "gloom and doom" of climate change. In addition, Ms. Riccona suggested that teachers provide students with an explanation for a certain environmental behaviors like recycling. She said,

> It's never framed in a way that's interesting for them [students]….I think there's a way that we could make it more impactful, but I don't think just talking about it is going to do anything. It's the framing of, 'if I'm engaged to do something, I'm more likely to do it'.

Another suggestion made by four teachers is to focus on the facts behind climate change when incorporating it into a lesson and not necessarily the politics involved in the issue. Ms. Laskey thinks climate change is important to talk about with students but that the political debate and propaganda should be left out of those conversations. In addition, Mr. Olson stated,

> I think ultimately what we want, I would think, out of climate change education is to understand how we think it's happening from the science standpoint, and then to understand what we think we could do about it. I don't know if focusing on the effects is as important.

Ms. Riccona also suggests that students be encouraged to base their statements about climate change strictly on facts and scientific evidence; as opposed to basing statements on feelings which is what she argues predominantly occurs within the public debate on climate change.

Another suggestion made by three teachers is to integrate various skills and subject areas into lessons on climate change. Ms. Eisenhower thinks it is important that while students are learning new content, they are also practicing other skills like working with technology, graphing data, or making observations. One way to use graphing within a lesson on climate change, as two teachers recommended, is by presenting a graph showing the Earth's climate fluctuations over time. Ms. Worthington suggested that graphs or other visual representations could help "lay the foundation of the historical sequence of climate change" for students.

Additional suggestions made by one or two teachers include: breaking climate change down into specific issues and encouraging students always to be skeptical. Ms. Feldman provided the phrase, "go in through the back door," meaning that teachers need to find ways to indirectly connect students' interests with climate change or else they may not care. She suggests breaking climate change down into more specific questions like, "How do we manage

our waste? How do we get energy? How do we sustain energy?" Ms. Erekson, an elementary teacher, suggested that, especially with younger students, the smaller a topic like climate change is broken down, the better. She described how her students understand that choices have consequences; she said,

> If they punch someone, they're going to get a timeout, and if you run, you might fall. If we continue to pollute and emit and if we continue to do all these things without thinking about the consequence, I think they can understand their impact.

Mr. Pryor suggested that encouraging students always to be skeptical and asking questions is important for education on climate change. Although he himself is skeptical of climate change, that is separate from his suggestion. He is more focused on making sure students leave his classroom being able to think and reason on their own. Mr. Pryor said,

> …that's the whole goal of a science classroom, is being able to think and reason on your own and have the tools to do your own research or share your own evidence, and how you make that claim based on your evidence and your reasoning. I mean that's what being a scientist is, and they should be able to use that every day.

All of these suggestions are important to consider for education on climate change in general and within the context of the Great Lakes region.

Examples of teaching about climate change. The following are specific examples of how some of the interviewed teachers have incorporated climate change into their curriculum and/or connected climate change to the Great Lakes region. One example of connecting climate change to the Great Lakes was provided by Ms. Honald. She does The Great Backyard Bird Count with her students, where students observe and record the different bird species they see in

their backyard over a given time period. She has incorporated climate change into this project by how it is impacting bird species, their migration patterns, and nesting habitats.

Another example is from Ms. Eisenhower's high school environmental science class. She and her students calculated their school's carbon footprint based on the number of cars in the parking lot. She described the activity in greater detail: "We collected the data and then they [students] looked at it and had to ask a question" such as "Does it matter what kind of car you drive? Does it matter what year the car is? Would the carbon footprint be smaller if more kids rode the bus?" Each student had to create a graphic representation of data and write a short paper answering their question. Ms. Eisenhower also did an interactive modeling activity with her students that created a big map of the effects of increasing global temperature. Each student received a card with an effect on it, and it was up to them to decide whether an increase in temperature would result in more or less of their effect. Ms. Eisenhower described how she wished she could have returned to this activity after a full semester of instruction to see if the students' understanding had changed.

Ms. Belle has done a similar mapping activity with her high school students but over an entire nine-week unit dedicated to climate change. She assigned each student a topic related to climate change such as ocean acidification, meat production, sea level rise, snow pack and glacier loss, migration and pests, the albedo effect, permafrost, and methane release. Each student researched and presented his or her topic to the class, being sure to include how the topic relates to climate change. Ms. Belle then gave each student someone else's topic and, "as a group they basically make a big web of what factors influence each other." The students used arrows to make connections between certain factors and decided what is influencing what.

Mr. Olson, with his middle school students, does an activity comparing the advantages and disadvantages of renewable and non-renewable energy sources. The students do some background research on renewable and non-renewable energy, and then have a discussion about the advantages and disadvantages they have identified. He described the early discussion as "being a lot about, 'well if you have a nuclear power plant you get a lot of jobs,'….And then you start directing it to look a little bit more like, 'what does coal do when you burn it in the environment? It smells bad, or it also creates smoke and it pollutes that way.'" Mr. Olson then said, "Eventually we talk about the fact that coal does produce CO_2, that CO_2 is dangerous because of climate change, and how wind and other sources don't [produce CO_2]."

Two teachers provided examples of how to incorporate the political debate on climate change into the classroom in ways that promote positive learning and better prepare the student to be an informed and engaged citizen after leaving the classroom. Mr. Plisinsky, within his social studies classes, has presented climate change as a debate with his students during which they examined both sides of the issue. Ultimately, Mr. Plisinsky wants his students to "understand the basic science…then be engaged as they leave my class to think about the problem and be…an engaged citizen or an engaged voter, somebody who's at least going to look at both sides, or seek out evidence, and consider the problem when it comes time to deal with it."

Mr. Linte has also incorporated the political aspect of climate change into his classroom, but with a slightly different approach. With his elementary students, he discussed the extreme right or conservative views on climate change and asked, "Does this match up with the science that we're seeing, or is this fact or opinion?" Mr. Linte described how most of his students concluded that a lot of the conservative views on climate change are based on conjecture; "that it's what they want to believe, it's not necessarily what they can prove." For Mr. Linte, the take-

home message for this lesson is that his students are better capable of discerning whether a statement is based on provable facts rather than opinions.

Mr. Pryor has incorporated climate change into lessons with his students but not in the way the other teachers have. He has exposed his students to two videos that present counter-evidence for climate change; one video was an investigative report by John Stossel, a Fox News correspondent, and the other video was titled, "Unstoppable Solar Cycles" that presents the theory that rising global temperatures might be cyclical based on solar cycles. He also said that climate change remains a debatable topic within his classes, and that until he feels that the evidence behind climate change is valid, he will continue to believe he is being manipulated and think that it is a waste of time for students. Mr. Pryor said, "there's a lot more obvious issues of our impact on the environment that are getting put on the back burner because we're trying to convince everyone that CO_2 is a pollutant and we're gonna tax it." For example, he went to Africa last summer and described the water shortage he witnessed there:

> You look at the animals, you look at the Serengeti, and you look at the populations of people that are in need of food and water. And you can bring that stuff into the classroom and you see what, as far as just a well for water for these people, what that would do to. Even for women, a lot of the girls spend a lot of their time hauling water, so those kinda issues are way, way, way more important than something that I think is based on flawed science.

Other teachers provided ideas for lessons incorporating climate change and these include examining how the aquatic food web in the Great Lakes has changed in recent years and whether this is connected to climate change; inviting long-time community members to the classroom to

share stories on how the region's environment or climate has changed over time; and collecting data on the Great Lakes water quality and connecting it to climate change.

Chapter 5 – Discussion, Limitations, and Recommendations

Overview of the Research Study

The overarching purpose of this research study was to explore the status of climate change teaching and learning in Michigan K-12 science and Great Lakes education. Specifically, this study sought to answer the following research questions: first, to determine whether or not K-12 science teachers in Michigan are teaching students about climate change, either as a global issue or within the context of the Great Lakes region; secondly, to identify the internal and external factors, including barriers and facilitators that influence teachers' decisions or ability to incorporate climate change into their science or Great Lakes lessons; thirdly, to acknowledge the participating teachers' recommendations for how they think climate change should be incorporated into lessons, thus giving them a voice in the conversation on the future of climate change education. At the center of Maxwell's (2012) interactive model of research design are the research questions, interacting constantly with the study's purpose, conceptual framework, methodological approach, and validity checks. Embracing the emergent and interactive design for this study, the research questions, as well as the conceptual framework, evolved as I gained insight from the teachers' perspectives. The research questions were also used as the channel through which analysis occurred, each code addressing an individual research question. In this chapter, the results from the interview data analysis will be discussed further, but more importantly I will explore how all the results are connected and the implications for the future of climate change and Great Lakes education.

Discussion

The research questions for this study are interconnected, meaning that evidence supporting research question 1 is influenced by evidence supporting research question 2. The

study's first research question explored whether or not the interviewed teachers have incorporated climate change into their science lessons, and this inherently is dependent upon the influencing factors, such as barriers and facilitators, explored through research question 2. For the purposes of the discussion chapter, the major connections and interrelationships within these two research questions will be identified below but separated into two groups: teachers who have incorporated climate change into their science or Great Lakes lessons and those who have not. Figure 4 represents the conceptual framework that evolved throughout the project and that has been informed by the teachers' perspectives. It illustrates the major factors, including barriers, facilitators, and the teacher's teaching context and perception of climate change, that influence teachers' decisions or ability to incorporate climate change into their science and Great Lakes-based education.

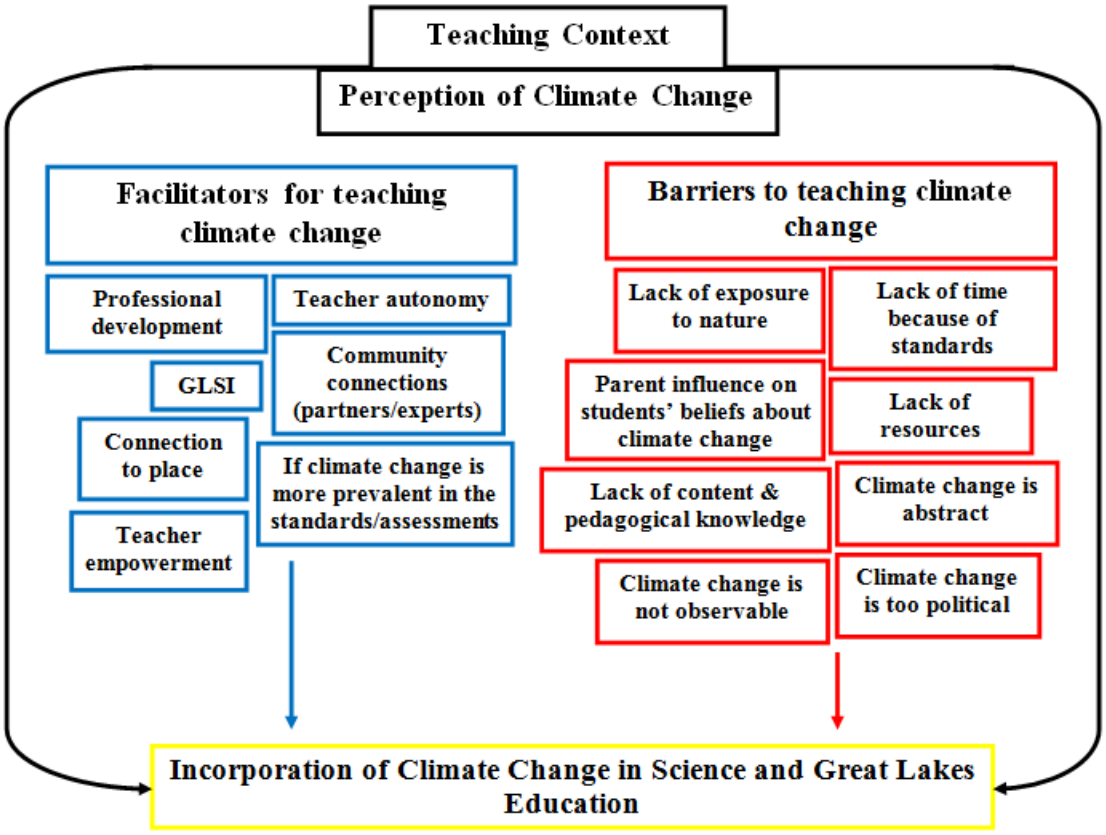

Figure 4 – Conceptual Framework Informed by Study Results

Major influencing factors for teachers who have incorporated climate change.

Seven of the 15 teachers interviewed for this study have incorporated climate change literacy, in a general sense, into a lesson and six teachers have connected climate change to the Great Lakes region within a lesson. In total, 9 of the 15 teachers interviewed have exposed students to climate change in some capacity. It was decided that although Mr. Pryor has incorporated climate change into his curriculum, he is not considered a part of this group because the way in which he incorporated climate change is not consistent with how climate change education is framed in this study by the climate literacy principles[7] (Climate Literacy, 2009). As a result of his personal beliefs, he has only exposed his students to the "denialist" or counter-argument on climate change.

Of these 9 teachers, seven of them are from either the Northeast Michigan Great Lakes Stewardship Initiative (NEMI) or the Grand Traverse Stewardship Initiative (GTSI). This finding implies that schools and/or teachers located on the coast of one of the Great Lakes may be more likely to incorporate a topic like climate change into the curriculum. For these teachers, being in close proximity to either Lake Michigan or Lake Huron affords them more opportunities for student interaction with the lakes but also opportunity to notice change in the lakes, or the entire region, as a result of climate change. Teachers located on, or near the lakes' coasts, may be more aware of changes in their local environment and therefore, more likely to invest time in teaching about climate change. Therefore, the geographic location of a teacher's school is related to the degree to which a teacher incorporates climate change into the curriculum. To

[7] Climate Literacy Principles: The sun is the primary source of energy for the Earth's climate system; Climate is regulated by complex interactions among components of the Earth system; Life on Earth depends on, is shaped by, and affects climate; Climate varies over space and time through both natural and man-made processes; Our understanding of the climate system is improved through observations, theoretical studies, and modeling; Human activities are impacting the climate system; Climate change will have consequences for the Earth's system and human lives (Climate Literacy, 2009).

encourage all Michigan teachers to incorporate climate change into the curriculum, especially as it relates to the Great Lakes, special attention may need to be allocated to teachers in inland and urban communities.

It was also important to explore other factors within teaching contexts that were related to the incorporation of climate change. Of the nine teachers who have incorporated climate change into their curriculum, three are from independent schools (private, charter, or Montessori), three teach at the high school level, three teach at the middle school level, two at the elementary level, and one teacher is a hybrid, teaching at both the middle and high school levels. This finding implies that climate change was more often incorporated into lessons for students in higher grade levels, specifically middle and high school, and suggests that climate change education may be more challenging to offer to students in elementary grade levels. In addition, six teachers claimed that they are well-supported by their administration and five claimed they have flexibility or freedom regarding the state science standards. This suggests that the teachers who were able to incorporate climate change into their curriculum are also the teachers with more administrative support and those with more flexibility regarding the science standards and assessments. For example, three of the four teachers who work with high school students teach environmental science, earth science, or ecology, which were described by teachers as being be more loosely tied to the state standards than other subjects like biology. Thus, these teachers reported more teaching autonomy. If climate change is to be incorporated more often into the science curriculum, teachers may need to be given more freedom from the standards and assessments, and more support from administrations to try new lessons or activities with students.

All of the teachers who claimed to have incorporated climate change into the curriculum were categorized as *alarmed*, *concerned*, or *cautious* about global warming and climate change (according to the Six Americas survey – Leiserowitz et al., 2013). Therefore, this study suggests that the more concerned teachers are about climate change, the more likely they may be to incorporate it into their curriculum. However, several research studies in the field of environmental education (Ko & Lee, 2003; Kim & Fortner, 2006) found that a positive attitude towards the environment does not always predict positive environmental behavior. For example, two other teachers interviewed expressed concern about climate change, and yet they do not incorporate climate change for reasons that will be explored later.

Other factors that facilitated the incorporation of climate change, as suggested by the teachers, include the connections within the community such as classroom guests, community partnerships, and field trips, and whole-school and/or community buy-in or support for place-based education. In addition, involvement with the Great Lakes Stewardship Initiative (GLSI) not only supports the teachers' place-based education practices but also provides a vehicle for some teachers' incorporation of climate change education within the Great Lakes region.

Major influencing factors for teachers who have not incorporated climate change. Six of the 15 teachers have not incorporated climate change into their curriculum before or have not incorporated it as defined by the climate literacy principles, and the major barriers that have been attributed to this are discussed below. Four of the six teachers in this group are elementary teachers, meaning that science is one of the several subjects that they teach, and the fifth teacher is at a middle school, and the final teacher is at the high school level. Specifically, lower-elementary teachers are highly responsible for teaching students to read and write, and this creates a barrier for not only climate change education but science education in general. The

majority of the teachers in this group noted that science education is not a priority within the curriculum. Instead, their instruction is predominantly focused on reading, writing, and mathematics and is strictly bound by the curriculum standards and assessments regarding these three subject areas. The heavy emphasis on the curriculum standards and assessments, especially in elementary grade levels, is debilitating for teachers, because it restricts their instruction and leaves little time for other subjects, let alone topics of special interest to the teacher. In addition, schools are often evaluated based on student standardized test scores. If a teacher's school is a designated focus school[8], like Ms. Erekson's, or is threatened to be classified as such due to low test scores, that school's administration is going to be even more strict in teaching to the English/Language Arts and Math standards so that test scores improve.

The teachers' perceptions of climate change are also indicative of their decision to incorporate it into lessons. Three teachers within this group are categorized as *disengaged, doubtful,* and *dismissive,* according to the Six Americas survey (Leiserowitz et al., 2013). Ms. Worthington, categorized as *disengaged,* claimed that climate change is something she does not think about, and Ms. Laskey, categorized as *doubtful,* does not pay attention to climate change because of the politics often involved in conversations about it. Mr. Pryor, categorized as *dismissive,* has only incorporated climate change in ways that support his skepticism on the issue. It is argued that a major influencing factor for these three teachers is their personal perceptions of climate change.

Another major influencing factor for one teacher in her decision not to incorporate climate change into her curriculum is her personal knowledge of the issue. Ms. Sonance claimed she does not know very much about climate change and feels that before she could teach about

[8] Focus school designation (in the state of Michigan) means that there is a wide gap between the school's highest achieving students and lowest achieving students, based on standardized assessments.

climate change, she must become knowledgeable about it. Although she was the only teacher to admit not knowing hardly anything about climate change, other teachers felt that they should or would like to know more or that more professional development specifically on climate change is needed. This finding suggests that providing teachers with professional development opportunities, specifically tailored to climate change education, would be beneficial and well-appreciated. And it would be important to provide professional development not only on the content or information on climate change but also on the pedagogy or *how* to teach about climate change. Ms. Worthington claimed she did not have a "bag of tricks" for science education, and so providing teachers with tools and techniques for climate change education would support incorporation of it in the future. Overall, the major barriers to incorporating climate change for the teachers in this study were: the heavy emphasis on teaching to the standards and assessments, especially at the elementary level with reading, writing, and math; lack of content and pedagogical knowledge regarding climate change education; and the teachers' perception of climate change and corresponding distrust of climate science.

Recommendations for pedagogy (how to teach) about climate change. The interviewed teachers, regardless of whether they incorporate climate change or not, offered meaningful suggestions and examples for how they think climate change should be approached within science education, Great Lakes education, and beyond. Their suggestions act as the foundation for my recommendations. Many teachers suggested, and I agree, that climate change can be integrated into the curriculum across grade levels, and within multiple subject or topic areas such as social studies, language arts, economics, tourism/recreation, social issues, and current events. For the teachers who claimed that climate change is too abstract for students in lower grade levels to comprehend, my response is that it depends on how climate change in

framed within the lesson. Yes, the larger implications of climate change like ocean acidification may be too complex for first, second, and third graders. However, as some teachers claimed, students at that age level are able to understand individual consequences and human impact on the environment, two critical components to understanding climate change. In addition, Mr. Plisinsky mentioned his nine-year old son and how he wants him to be thinking about climate change now so that he internalizes it and is better prepared to think critically about it in the future. He said, "I think it's absurd to think that there's an age where it's appropriate to teach it to kids. My nine-year old could understand global climate change." It is also important to recognize the teachers who claimed that if climate change were not made more explicit within the state curriculum standards, it would be very difficult to incorporate. Prior to anything else, the current curriculum standards in Michigan need to be revisited to make climate change more prevalent within them or perhaps, as one teacher suggested, put climate change on a standardized test and it will most likely get taught.

More specific on the pedagogy of climate change education, teachers recommended what was referred to as a K-12 progression or a scaffolding of climate change curriculum; meaning that as students move through the grades, the new knowledge on climate change builds from their existing knowledge. Several teachers agreed that multiple exposures to climate change across the grade levels would illustrate to students that climate change is important and not just another question to anticipate on the standardized tests. I also recommend that within these multiple exposures or K-12 progression, climate change is segmented into individual topic areas, much like Ms. Belle did with her high school students during their unit on climate change. Climate change could be presented as a series of interrelated topics that increase in complexity as students move up in the grade levels, eventually resulting in them making a mental map for

climate change. For example, lower-elementary level students would learn about air pollution and where it comes from, then progress in upper-elementary grades to learning specifically about CO_2 emissions, and lastly learning about the amplified greenhouse effect in early middle school, thereby connecting the dots of everything they had learned prior to that final lesson. Also, as recommended by teachers, I think it is important to focus attention on climate science, the implications of this science, and then the actions that can be taken to reduce our vulnerability to climate change. Too often are people caught up in the politics of the climate change debate; as Mr. Plisinsky would argue, we need to move beyond trying to answer the question "Is it a problem?" and instead focus attention on answering the question, "How do we fix it?"

This brings me to my next recommendation which is to make climate change as local as possible for students. All of the teachers interviewed for this study are a part of the Great Lakes Stewardship Initiative and as a result, are also doing some sort of place-based education with students. Combining place-based and climate change education efforts would give students the opportunity to learn about climate change but within the context of their place, which in this case is the Great Lakes region. As a part of this recommendation, teachers suggested having access to more scientific data, specifically regional climate and weather data, for students to analyze, and I think that this would be beneficial in more ways than one. This would connect students to scientific research and data demonstrating potential evidence of climate change within their region, and would give students an opportunity to practice scientific inquiry, critical thinking, and/or problem solving skills, all of which are important as this generation moves forward into a future undoubtedly impacted by climate change. Additionally, these analytical and thinking skills will be receiving attention as Michigan moves to adopt some version of the Next Generation Science Standards (NGSS).

Lastly, teachers need to feel empowered again as educators; as Ms. Feldman so eloquently put it, teachers today are trained to act more like "accountants" or record-keepers because of the heavy emphasis on teaching to the curriculum standards and assessments. Teachers need to feel empowered to take students outside, to provide field trips, and to do place-based learning, all without being fearful of repercussions from their administration. From my conversations with these teachers, the impact place-based and project-based learning has had on students is evident and results in meaningful learning that extends beyond the classroom.

Limitations of the Research Study

There are three limitations to this research study and they all have to do with the sampling strategy for this project. It is important to reiterate that the purpose of this research study was not to achieve generalizability with the data or results. Instead, the intention was to explore 15 teachers' unique perspectives by obtaining rich, detailed data through in-depth interviews with carefully selected teachers. Therefore, the number of subjects in this study should warrant no questions because it was intentional and purposeful. The three limitations to this study do involve the sampling strategy, but not regarding the number of teachers interviewed. The fact that only science teachers were selected for this study could be viewed as a limitation because, as made evident through the interviews, other subject areas, like social studies, apply to climate change education. It is also important to recognize that the adverse reactions to climate data inaccuracies that some teachers felt might have been because they were highly aware of research and data methods as science educators. It is possible that teachers from other subject areas might not have necessarily had those same reactions.

Another limitation to this study is that urban teachers were underrepresented within the interviewed teachers. Only one interviewed teacher was classified as urban; it is possible that the

results of this study would have been slightly different had more urban teachers been interviewed. Lastly, a possible limitation of this study was the use of the Great Lakes Stewardship Initiative (GLSI) as the means for contacting and selecting participating teachers. There is potential bias in that the teachers are already practicing place-based education and that there might not have been an accurate representation of Michigan teachers. However, measures were taken to achieve maximum heterogeneity of participants within the GLSI, and I believe that this was achieved to the best of my ability.

Recommendations for Future Research

The insight gained from the teachers who participated in this study provides the foundation for future research on climate change education, specifically in the context of the Great Lakes region. For example, a possible extension of this research would be to observe teachers who are incorporating climate change into lessons to describe in greater detail the different approaches and techniques, and their impacts on student learning outcomes. It would also be interesting to explore how teachers in other states within the Great Lakes region such as Ohio, New York, or Illinois are educating students on climate change. Curriculum standards vary between states, and the degree to which other Great Lakes states are incorporating place-based and climate change education would be important knowledge to have in moving towards a regional climate literate citizenry who act as stewards of the lakes. Perhaps after a regional study on climate change education, other regions of the country could be explored. For example, it would be interesting to do a similar study in California where they are currently experiencing water shortages; teachers affected by the drought might have greater concern about climate change and greater investment in preparing students to think critically about mitigation strategies for the future. Or, researchers could study teachers in Texas, where oil drilling is a large

industry, to explore how natural resource extraction and CO_2 emission are viewed and whether or not climate change is seen as a human-induced problem.

As mentioned before, climate change is cross-curricular and it would be interesting to explore how climate change is, or could be, incorporated within other subject areas such as social studies or language arts. One teacher hinted at teacher burnout, or the notion that teachers have lost motivation as educators. If teachers have truly lost motivation as educators, as Ms. Feldman and others claimed, then this research recommendation requires immediate attention because it has consequences for all of education, not just science, climate change, or place-based education. Lastly, another important extension of this research would be a more generalizable study exploring the same influencing factors but on a much larger scale so that conclusions could be made regarding all teachers in Michigan.

Recommendations for Practitioners

It is important to provide recommendations for future research and also for practitioners – those who will take the knowledge gained from this research and apply it to their professions. The specific practitioners who benefit from this research include other Michigan science teachers, curriculum advisers, professional development planners, school administrators, non-governmental organizations, extension and outreach groups, federal and state agencies, and those generally interested in the advancement of climate change and place-based education. Three recommendations for these practitioners have been made that are based on the insight gained from the interviewed teachers; these recommendations are intended to be applied to create positive change. First, it is recommended that climate change, both as a global and Great Lakes issue, become more of a presence within the science education standards for Michigan. This is dependent upon whether the Next Generation Science Standards, or some variation of them, are

adopted in Michigan. However, regardless of what science standards become the new framework for Michigan, climate change needs to have a greater presence in the standards so that teachers who are bound by standards and assessments, as well as teachers who have more autonomy, will teach about it.

A second recommendation for practitioners, specifically those working directly with teachers such as administrators, curriculum planners, and extension groups, is to provide teachers with more access to resources and professional development on climate change. The majority of the teachers interviewed for this study said that professional development specific to climate change would be helpful, especially professional development that focuses on content knowledge and pedagogical knowledge, and that provides time to work on adapting the content to their individual classrooms and students. An important part of this recommendation is providing think-time for teachers, during the actual professional development workshop, when they can ask questions and determine how to incorporate climate change in a way that best suits their classrooms, students, and school-community contexts.

It is not just professional development on climate change that is needed, however; also needed are educational resources such as curriculum/lessons plans on climate change, experiments or hands-on activities demonstrating climate change, and interactive technology like websites and applications that engage students with real-time data on climate change. Also, it is not so much that more educational resources on climate change need to be made, but rather that teachers need to know where and how they can access these resources, because it is often the time required to find these materials that deters teachers from searching. During these professional development workshops, teachers should be given content and pedagogical knowledge on climate change, directions for where to look for more information or more

teaching resources, and think-time to ask questions and begin adapting climate change to their classrooms and students.

A third recommendation for practitioners is to integrate climate change into the place-based education initiatives in Michigan, in order to make climate change as local as possible for students. As several teachers indicated during the interviews, climate change should be framed in a local context, so that it is seen as a relevant and present issue for the Great Lakes region by students, and as something requiring attention and action. Organizations already invested in fostering stewardship through place-based education in Michigan, like the Great Lakes Stewardship Initiative, have the potential to have a positive impact in promoting climate change education within the Great Lakes context. For example, during a unit on animal or plant adaptations, the teacher could explain how the distribution of plant species native to Michigan, like spruce trees, is moving northward as a result of warming temperatures and therefore demonstrating one way that climate change is impacting the Great Lakes region; this locally relevant impact is different than referencing the polar bear, an animal that students in Michigan are unlikely to see in the wild, as an impacted species because of warming temperatures and loss of habitat. The integration of climate change into place-based education can be in varying degrees, based on the teacher and the priority within the school, because as learned through this study, teachers operate within the larger context of education in their district and in the state of Michigan. However, the main message of this recommendation is not necessarily focused on quantity but rather quality; when teachers are learning about climate change content and pedagogy through professional development or other trainings, they need to be empowered to make climate change as local as possible for students and given examples for how to do so within their curriculum.

The three overarching recommendations for practitioners include making climate change more of a presence the state standards and assessments, increasing teachers' access to educational resources on climate change like professional development, and when training teachers on climate change education, empowering them to make the issue local and relevant for students. The purpose of these three recommendations is to provide practitioners, or those wanting to take action immediately, with a foundation of ideas based on insight gained from the teachers interviewed for this study. However, these recommendations are not the only ways for climate change education to become a higher priority within science education. This research will continue to evolve as others take the knowledge gained from the 15 interviewed teachers and apply to their own practice, whether they are teachers, school administrators, or a member of the state board of education. My hope is that the teachers' ideas and perspectives given voice within this study are acknowledged as legitimate, and used to inform and inspire action within the climate change and place-based education conversation occurring in Michigan today.

APPENDICES

APPENDIX A:

Michigan State University IRB Approval Letter

MICHIGAN STATE UNIVERSITY

Initial IRB Application Determination *Exempt*

November 13, 2014

To: Shari Dann
147B Natural Resources Bldg.
MSU

Re: **IRB# x14-1131e** Category: Exempt 2
Approval Date: November 12, 2014

Title: Incorporation of Climate Change Learning into Michigan K-12 Great Lakes Stewardship Education: Teachers' Perspectives

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **your project has been deemed as exempt** in accordance with federal regulations.

The IRB has found that your research project meets the criteria for exempt status and the criteria for the protection of human subjects in exempt research. **Under our exempt policy the Principal Investigator assumes the responsibilities for the protection of human subjects** in this project as outlined in the assurance letter and exempt educational material. The IRB office has received your signed assurance for exempt research. A copy of this signed agreement is appended for your information and records.

Renewals: Exempt protocols do not need to be renewed. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: Exempt protocols do not require revisions. However, if changes are made to a protocol that may no longer meet the exempt criteria, a new initial application will be required.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants regarding the risk and benefits of the project must be reported to the IRB.

Follow-up: If your exempt project is not completed and closed after three years, the IRB office will contact you regarding the status of the project and to verify that no changes have occurred that may affect exempt status.

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

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

Sincerely,

H. McGee

Harry McGee, MPH
SIRB Chair

c: Jessica Batanian

Office of Regulatory Affairs
Human Research Protection Programs

Biomedical & Health Institutional Review Board (BIRB)

Community Research Institutional Review Board (CRIRB)

Social Science Behavioral/Education Institutional Review Board (SIRB)

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408 West Circle Drive, #207
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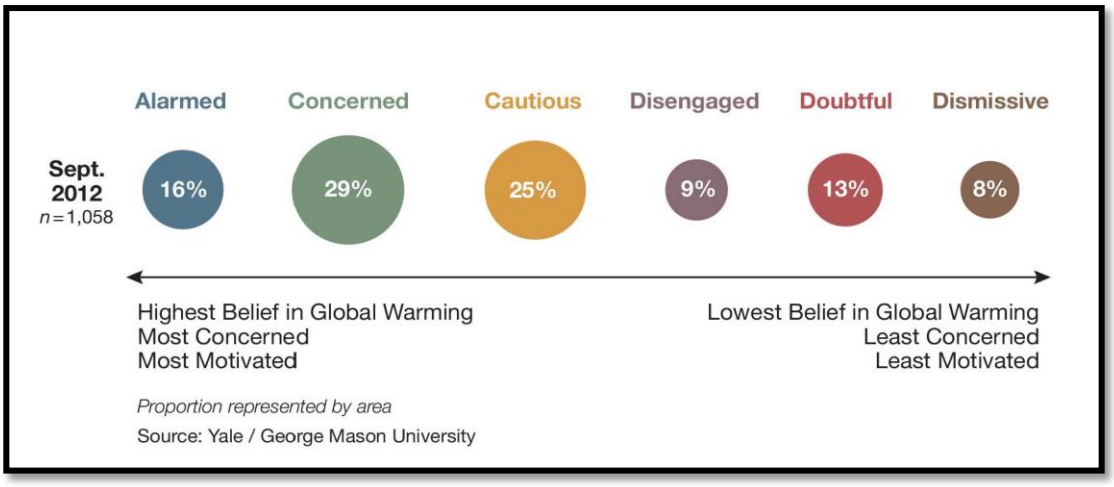
APPENDIX B:

Detailed Description of Six Americas Categories



The Six Americas

ALARMED…"Very certain global warming is occurring, understand that it is human-caused and harmful, and strongly support societal action to reduce the threat. They discuss the issue more often, seek more information about it, and are more likely to act as global warming opinion leaders than the other segments. They are the most likely of the six groups to have engaged in political activism on the issue, although only about a quarter have done so."

CONCERNED…"Moderately certain that global warming is occurring, harmful and human caused; they tend to view global warming as a threat to other nations and future generations, but not as a personal threat or a threat to their community. They support societal action on climate change, but are unlikely to have engaged in political activism."

CAUTIOUS…"Believe that climate change is real, but are not certain, and many are uncertain about the cause….view global warming as a distant threat. They have given little thought to the issue and are unlikely to have strongly held opinions about what, if anything, should be done."

DISENGAGED…"Given the issue of global warming little to no thought. They have no strongly held beliefs about global warming, know little about it, and do not view it as having any personal relevance."

DOUBTFUL…"Uncertain whether global warming is occurring or not, but believe that if it is happening, it is attributable to natural causes, not human activities."

DISMISSIVE…"Very certain that global warming is not occurring. Many regard the issue as a hoax and are strongly opposed to action to reduce the threat."

SOURCE: Yale / George Mason University, Global Warming's Six Americas National Study, September 2012

APPENDIX C:

GLSI Hub Director Email and Recommendation Table

Email Subject: GLSI Hub Director Recommendations

Dear (Hub Director),

My name is Jessica Batanian and I am contacting you today to request your help on my master's thesis project exploring the status of climate change learning within the context of Great Lakes education. Your role in my project would be to recommend a list of 15-20 teachers from your Great Lakes Stewardship Initiative hub who you think would be interested in participating in my study. Prior to recommending the teachers, you do not need to guarantee their interest or willingness to participate; just recommend teachers who you think would participate and then that decision is left up to them.

Your recommendations should be based on a set of criteria that I have purposefully chosen as important characteristics for participating teachers to have. I would like to interview a diverse group of teachers from across the state that have different perspectives and experiences regarding science, Great Lakes, and climate change teaching. Extensive interviews with a diverse group of teachers will allow for more detailed and rich information for me to analyze, learn from, and share with other educators or those interested in the topic.

The set of criteria that I ask you base your recommendations on include the following: teachers' school locations (rural, urban, or suburban), teachers' time spent in the GLSI, and whether they teach science content to students. Additional information that I ask you to include is teacher name, grade level(s) he or she currently teaches, gender, school building/district, and the teacher's email address. Please keep in mind that in order to have as diverse a group of teachers as possible, I ask that you recommend teachers who you know to have differing backgrounds, experiences, and personal investment in your GLSI hub.

In order to make the recommendation process easy and efficient, I have created a table in Microsoft Word in which you can enter the teachers' information and save as a new document to email back to me (see attached document). Once you have sent me a list of recommended teachers, I will then contact those teachers via email with an introductory letter and link to an online survey. The online survey will contain two sections: the first being about teachers' personal characteristics and the second being a widely-used survey instrument asking about views on global warming. This survey instrument, called the Six Americas, consists of 15 questions that focus on global warming beliefs and attitudes and will place him or her along a spectrum of belief categories about global warming; these categories include alarmed, concerned, cautious, doubtful, disengaged, and dismissive.

Having the teachers take the online survey will give me more insight into them as teachers as well as their general beliefs about global warming. Ultimately, the results from this online survey will help me select teachers to interview who have different personal characteristics and Six Americas categories.

Please know that you, and your GLSI teachers, are under no obligation to participate in this project and will not be penalized for declining this offer. Please do not hesitate to contact me with any questions that might you have.

Thank you for your time and consideration,
Jessica Batanian

Graduate Research Assistant
Department of Community Sustainability
Michigan State University
(419)205-7223 or batania2@msu.edu

Teacher Name	Gender	Grade(s)	School District & Building	School Classification (rural, urban, suburban)	# of years in GLSI	Teaches Science? (Yes or No)	Teacher's Email Address

APPENDIX D:

Introductory Email to Recommended Teachers

Email Subject: Michigan State University Research – A Request for Your Help

Dear (Teacher name),

Thank you for taking time out of your busy schedule to learn about this opportunity. My name is Jessica Batanian and I am a graduate student at Michigan State University in the Department of Community Sustainability. I am requesting your help as a participant in a study exploring teachers perspectives on science, Great Lakes, and climate change teaching in Michigan K-12 education. The online survey will take only 10-15 minutes to complete.

Click on this link to access the online survey:
https://www.surveymonkey.com/r/67QZ2GD

This is an exploratory study, through which the insight gained from a select group of Michigan teachers, like yourself, will inform future teacher professional development on Great Lakes and climate change education. Your participation in this study is **voluntary**. If you choose to respond to the online survey, you will be eligible to receive a small educational resource as a sign of my appreciation. If you choose to continue to participate after you have completed the survey, you may be contacted to schedule an interview with me at your earliest convenience and be eligible to receive an additional educational resource. If you choose not to participate, I appreciate your time and consideration.

Your responses to this survey will be kept confidential. You are under no obligation to participate in this research, and you do not have to answer any question that you do not want to answer. By completing this survey, you indicate your voluntary consent to participate in the research and have your responses included in the data set for analysis. If you have any questions regarding this survey or the project, please do not hesitate to contact me by email at batania2@msu.edu or by phone at (419) 205-7223 or my academic adviser, Shari Dann, by email at sldann@msu.edu or by phone at (517) 420-4301.

If you are not satisfied with the response provided by the researcher, have more questions, or want to talk with someone about your rights as a research participant, you should contact the Michigan State University Human Research Protection Program by phone at (517) 355-2180 or by email, irb@msu.edu. The number assigned to this project is IRB# i047056.

Thank you in advance for your time and input.
Sincerely,

Jessica Batanian
Graduate Research Assistant
Department of Community Sustainability
Michigan State University
(419)205-7223 or batania2@msu.edu

APPENDIX E:

Online Survey

K-12 Teaching in Michigan: Science, The Great Lakes, and Climate Change

Thank you for taking time to respond to this online survey. By completing this survey, you indicate your voluntary consent to participate in the research and have your responses included in the data set for analysis.

Research conducted by: Jessica Batanian and Shari Dann, Michigan State University, Department of Community Sustainability

Getting to Know You as a Teacher

I have contacted a select group of K-12 teachers throughout the state of Michigan who are active members within their Great Lakes Stewardship Initiative (GLSI) hub to participate in my study, including you. This section of the survey identifies important characteristics about you as a Michigan teacher. Your responses to the following questions will not be connected with your personal identity in any way.

1. How many years have you been a teacher in Michigan schools?

2. What grade level(s) do you currently teach?

Getting to Know You as a Teacher

3. Do you currently teach science?

- ◯ Yes
- ◯ No

Other (please specify)

4. If answered yes to question #3, please indicate whether you currently teach students about each of the following science topics by marking the appropriate box. Select ALL that apply.

- ☐ Environmental/Earth Science
- ☐ Chemistry
- ☐ Biology/Life Science
- ☐ Physical Science
- ☐ Environmental Problems (pollution, water supply, drought, etc.)
- ☐ Weather and Climate
- ☐ The Great Lakes

Other (please specify)

5. In what areas do you hold Michigan teaching endorsements?

K-12 Teaching in Michigan: Science, The Great Lakes, and Climate Change

Getting to Know You as a Teacher

6. Which one of the Great Lakes Stewardship Initiative hubs are you currently a member of? Please select only one answer.

- ◯ Discovering Place
- ◯ GRAND Learning Network
- ◯ Grand Traverse Stewardship Initiative
- ◯ Groundswell
- ◯ Lake Superior Stewardship Initiative
- ◯ Northeast Michigan Great Lakes Stewardship Initiative
- ◯ Southeast Michigan Stewardship Coalition
- ◯ Upper Great Lakes Stewardship Initiative
- ◯ West Michigan Great Lakes Stewardship Initiative

7. How many years have you been an active member of your GLSI hub?

Getting to Know You as a Teacher

8. What is your gender?

- ◯ Male
- ◯ Female

Your Views on Climate Change & Global Warming

The second section of this survey is a brief questionnaire exploring your views about climate change, specifically global warming. Recently you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result.

This survey has been used in many state and country-wide studies on the topic; however, it is seldom used specifically with teachers and educators. The results of this section will not be seen as a representation of all of Michigan teachers' views about global warming. Instead, the insight gained from this section will help me to get to know you more as an individual and possibly inspire future research.

There is no right or wrong answer to any of the following questions. Please select one answer that most represents your view.

9. What do you think? Do you think that global warming is happening?

- ◯ Yes, and I'm extremely sure
- ◯ Yes, and I'm very sure
- ◯ Yes, and I'm somewhat sure
- ◯ Yes, but I'm not at all sure
- ◯ No, and I'm extremely sure
- ◯ No, and I'm very sure
- ◯ No, and I'm somewhat sure
- ◯ No, but I'm not at all sure
- ◯ I don't know

Your Views on Climate Change & Global Warming

10. Assuming global warming is happening, do you think it is...

- ◯ Caused mostly by human activities
- ◯ Caused mostly by natural changes in the environment
- ◯ Other
- ◯ None of the above because global warming isn't happening

11. How worried are you about global warming?

- ◯ Very worried
- ◯ Somewhat worried
- ◯ Not very worried
- ◯ Not at all worried

Your Views on Climate Change & Global Warming

12. How much do you think global warming will harm you personally?

- ◯ Not at all
- ◯ Only a little
- ◯ A moderate amount
- ◯ A great deal
- ◯ Don't know

13. When do you think global warming will start to harm people in the United States?

- ◯ They are being harmed now
- ◯ In 10 years
- ◯ In 25 years
- ◯ In 50 years
- ◯ In 100 years
- ◯ Never

Your Views on Climate Change & Global Warming

14. How much do you think global warming will harm future generations of people?

- ◯ Not at all
- ◯ Only a little
- ◯ A moderate amount
- ◯ A great deal
- ◯ Don't know

15. How much had you thought about global warming before today?

- ◯ A lot
- ◯ Some
- ◯ A little
- ◯ Not at all

Your Views on Climate Change & Global Warming

16. How important is the issue of global warming to you personally?

- ◯ Not at all important
- ◯ Not too important
- ◯ Somewhat important
- ◯ Very important
- ◯ Extremely important

17. How much do you agree or disagree with the following statement: "I could easily change my mind about global warming."

- ◯ Strongly agree
- ◯ Somewhat agree
- ◯ Somewhat disagree
- ◯ Strongly disagree

Your Views on Climate Change & Global Warming

18. How many of your friends share your views on global warming?

- ◯ None
- ◯ A few
- ◯ Some
- ◯ Most
- ◯ All

19. Which of the following statements comes closest to your view?

- ◯ Global warming isn't happening.
- ◯ Humans can't reduce global warming, even if it is happening.
- ◯ Humans could reduce global warming, but people aren't willing to change their behaviors so we're not going to.
- ◯ Humans could reduce global warming, but it's unclear at this point whether we will do what's needed.
- ◯ Humans can reduce global warming, and we are going to do so successfully.

Your Views on Climate Change & Global Warming

20. Do you think citizens themselves should be doing more or less to address global warming?

- ◯ Much less
- ◯ Less
- ◯ Currently doing the right amount
- ◯ More
- ◯ Much more

21. Over the past twelve months, how many times have you punished companies that are opposing steps to reduce global warming by NOT buying their products?

- ◯ Never
- ◯ Once
- ◯ A few times (2-3)
- ◯ Several times (4-5)
- ◯ Many times (6+)
- ◯ Don't know

Your Views on Climate Change & Global Warming

K-12 Teaching in Michigan: Science, The Great Lakes, and Climate Change

22. Do you think global warming should be a low, medium, high, or very high priority for the President and Congress?

- ◯ Low
- ◯ Medium
- ◯ High
- ◯ Very high

23. People disagree whether the United States should reduce greenhouse gas emissions on its own, or make reductions only if other countries do too. Which of the following statements comes closest to your own point of view?

The United States should reduce its greenhouse gas emissions...

- ◯ Regardless of what other countries do.
- ◯ Only if other industrialized countries (such as England, Germany, and Japan) reduce their emissions.
- ◯ Only if other industrialized countries and developing countries (such as China, India, and Brazil) reduce their emissions.
- ◯ The US should not reduce its emissions.
- ◯ Don't know

Are you interested and willing to be interviewed for this study?

During the interview, you will be asked a series of questions about your teaching practices regarding science, the Great Lakes, and climate change. You will also be asked to share your personal beliefs about Great Lakes stewardship education and climate change learning as well as what you think might hinder or promote teaching about either of these topics. Whether or not you are currently teaching your students about climate change, I am still interested in talking with you about your science teaching practices. If you agree to be interviewed, you will receive an educational resource related to climate and the Great Lakes as a sign of my appreciation. Each interview will last no more than 2 hours. Personal information will not be connected in any way to the content discussed during the interview.

24. Are you interested and willing to be interviewed for this study? If yes, please fill out the information below.

By providing you personal information below, you are giving consent to be contacted potentially for an interview. An official consent form will be sent to you when we schedule an interview.

Name:

Preferred phone number:

Preferred email address:

School mailing address:

Best times of day to be contacted:

25. Regardless of your response to question #23, you are eligible to receive an educational resource related to climate change and/or the Great Lakes as a sign of my appreciation for your participation in this survey. If interested in receiving the educational resource, please fill out the mailing (home or school address) information below.

***None of the personal information that you provide will be connected in any way to your online survey responses.**

Name:

Address:

City/Town:

State:

ZIP:

26. If you would like to provide additional comments about this survey or the topics it covers, please use the space below.

Thank you!

APPENDIX F:

Survey Data Entry Key

Online Survey – Data Entry Key
K-12 Teaching in Michigan: Science, the Great Lakes, & Climate Change

TEACHER CHARACTERISTICS

Q1: Years teaching in Michigan? ---------- # of years

Q2: Grade level(s) currently teaching? ---------- Grade levels

Q3: Currently teach science? ---------- 1=Yes 0=No
99=other

Q4: Science topics they currently teach? ---------- List the topics in separate columns;
1=Yes 0=No

Q5: Michigan teaching endorsements? ---------- List endorsements;
0=none or blank

Q6: GLSI hub? ---------- 1=GLN
2=Discovering PLACE
3=NEMI
4=GTSI
5=LSSI

Q7: # of years in GLSI hub? ---------- # of years

Q8: Gender? ---------- 1=male 0=female

SIX AMERICAS

Q9: Is GW Happening

1 = No, extremely sure. **2** = No, very sure. **3** = No, somewhat sure. **4** = No, not sure. **5** = don't know. **6** = Yes, not sure. **7** = Yes, somewhat sure. **8** = Yes, very sure. **9** = Yes, extremely sure.

Q10: Assuming global warming is happening, do you think it is…

1 = caused mostly by humans. **2** = caused mostly by natural change. **3** = Other. **4** = None, it's not happening

---

Q11: How worried are you about global warming?

1 = not at all worried. **2** = not very worried. **3** = somewhat worried. **4** = very worried.

Q12: How much do you think global warming will harm you personally?

0 = don't know. **1** = not at all. **2** = only a little. **3** = a moderate amount. **4** = a great deal.

Q13: When do you think global warming will start to harm people in the United States?

1 = never. **2** = 100 years. **3** = 50 years. **4** = 25 years. **5** = 10 years. **6** = now

---

Q14: How much do you think global warming will harm future generations of people?

0 = don't know. **1** = not at all. **2** = only a little. **3** = a moderate amount. **4** = a great deal.

Q15: How much had you thought about global warming before today?

1 = not at all. **2** = a little. **3** = some. **4** = a lot.

Q16: How important is the issue of global warming to you personally?

1 = not at all. **2** = not too important. **3** = somewhat. **4** = very. **5** = extremely.

Q17: How much do you agree or disagree with the following statement: "I could easily change my mind about global warming."

1 = strongly agree. **2** = somewhat agree. **3** = somewhat disagree. **4** = strongly disagree.

Q18: How many of your friends share your views on global warming?

1 = none. **2** = a few. **3** = some. **4** = most. **5** = all.

Q19: Which of the following statements comes closest to your view?

1 = it isn't happening. **2** = humans can't reduce it if it is happening. **3** = Humans could reduce it, but people won't change. **4** = Humans could change it, but it's unclear what needs to be done. **5** = Humans can reduce it, and we will.

Q20: Do you think citizens themselves should be doing more or less to address global warming?

1 = much less. **2** = less. **3** = right amount. **4** = more. **5** = much more.

Q21: Over the past twelve months, how many times have you punished companies that are opposing steps to reduce global warming by NOT buying their products?

0 = don't know. **1** = never. **2** = once. **3** = a few times (2-3). **4** = several times (4-5). **5** = many times (6+).

Q22: Do you think global warming should be a low, medium, high, or very high priority for the President and Congress?

1 = low. **2** = medium. **3** = high. **4** = very high.

Q23: People disagree whether the United States should reduce greenhouse gas emissions on its own, or make reductions only if other countries do too. Which of the following statements comes closest to your own point of view?
0 = don't know. **1** = US should not reduce. **2** = only if other developing countries reduce.
3 = only if other industrialized countries reduce. **4** = yes, regardless of other countries

---

Q24: Willingness to be interviewed? ---------- 1=Yes 0=No; provide contact information in separate columns

Q25: Interest in receiving educational resource? ---------- 1=Yes 0=No; provide contact information in separate columns

Q26: Additional Comments? ---------- enter verbatim

Six Americas 15-item Survey Syntax available at:
http://www.climatechangecommunication.org/global-warmings-six-americas-screening-tools

APPENDIX G:

Interview Consent Form

Interview Participant Information and Consent Form

You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Study Title: Incorporation of Climate Change Learning into Michigan K-12 Science & Great Lakes Stewardship Education: Teachers' Perspectives
Researchers: Jessica Batanian, Graduate Student, (419) 205-7223 or batania2@msu.edu and Shari Dann, Associate Professor, (517) 420-4301 or sldann@msu.edu
Department and Institution: Department of Community Sustainability, Michigan State University
Address and Contact Information: Department of Community Sustainability
Michigan State University
Natural Resources Building
480 Wilson Rd., Rm. 151
East Lansing, MI 48824

PURPOSE OF RESEARCH:

You are being asked to participate in a research study that is exploring the status of climate change learning within the context of K-12 Great Lakes stewardship education in Michigan. We are interested in learning what Michigan teachers think about climate change teaching and learning in the Great Lakes region. You have been asked to participate because you are a member of the Great Lakes Stewardship Initiative and have a background in teaching that is important to this study. The method of research that will be used in this portion of the study and that you are being asked to participate in is an in-depth interview that will last no more than two hours.

WHAT YOU WILL DO:

For this study, you will be asked to answer a series of questions pertaining to your beliefs and attitudes regarding climate change, whether you see a connection between climate change and the Great Lakes, your perspective on climate change learning, contextual factors you experience that may inhibit or foster climate change learning, and how you actually teach (or would teach) students about climate change. The questions will be open-ended, allowing for you to answer in whatever way you like or choose not to answer at all. The interviews will be audio-recorded if your permission is granted. Once the interview has been transcribed, you will be given the option to review the interview transcript to ensure that we have accurately documented your words and ideas. You will also receive a copy of the final research report if desired.

PERMISSION TO AUDIO-RECORD THE INTERVIEW: _____YES _____NO

POTENTIAL BENEFITS:

One benefit to you for taking part in this study is that you will receive a gift of an education resource about climate, the Great Lakes, or another related topic for indicating your willingness to be interviewed during the online questionnaire. You are guaranteed to receive this educational resource as a sign of appreciation, even if you opt out of being interviewed after reading through this document. Your participation, more broadly, will potentially benefit the future of climate change and Great Lakes education in Michigan as well as improve teacher professional development on the topics.

POTENTIAL RISKS:

There are no foreseeable risks associated with participation in this study.

PRIVACY & CONFIDENTIALITY:

Your confidentiality is of utmost importance. You will be assigned a pseudonym that will not be associated with your real identity or any other identifiable characteristics you possess. This pseudonym will be used in all written documents where information you share is present. Also, no one besides us will have access to your personal contact information that was obtained through the online questionnaire including your name, phone number, email address, and school address. The information that you provide will be stored in locked files, on a personal computer, and on a digital recording device, and we will be the only people with access to the data. Your confidentiality will be protected to the maximum extent allowable by law.

RIGHTS:

- Participation is voluntary. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled.
- You have the right to say no.
- You may change your mind at any time and withdraw.
- You may choose not to answer specific questions or to stop participating at any time.

COST/COMPENSATION:

There is no cost or compensation for your participation in this study. However, as mentioned before, you will receive an educational resource for agreeing to be interviewed for this study.

CONTACT INFORMATION:

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher,

Jessica Batanian, Graduate Student
Department of Community Sustainability
Michigan State University

Natural Resources Building
480 Wilson Rd., Rm. 151
East Lansing, MI 48824
(419) 205-7223 or batania2@msu.edu

Or the researcher's academic advisor,

Shari Dann, Associate Professor
Department of Community Sustainability
Michigan State University
Natural Resources Building
480 Wilson Rd., Rm. 147B
East Lansing, MI 48824
(517) 432-0267 or sldann@msu.edu

If you have problems, questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 408 W. Circle Drive, 207 Olds Hall, MSU, East Lansing, MI 48824.

DOCUMENTATION OF INFORMED CONSENT:

Your signature below means that you voluntarily agree to participate in the interview.

_____ _____

Signature Date

*You will be given a copy of this form for your records.

APPENDIX H:

In-depth Interview Guide

In-Depth Interview Guide
Project Title: Incorporation of Climate Change Learning into Michigan K-12 Science and Great Lakes Stewardship Education: Teachers' Perspectives

Objective: to explore whether or not the teacher incorporates climate change into his/her science and Great Lakes-based lessons; to explore the factors that inhibit or support the teacher's decision to incorporate CC into their lessons; to explore how the teacher incorporates (or would incorporate) CC into their science and/or GL-based lessons.

Thank you for meeting with me today to talk about your teaching experiences and thoughts about climate change education within Michigan K-12 classrooms. Please feel free to ask me any questions that may arise throughout the interview. Before we begin, do you have any questions for me?

1) Let's begin by talking a little about where you work. How would you describe your school?
   - ….As innovative and forward thinking? Encouraging teachers to participate in GLSI?
   - .... As adequately funded?
   - ….As high-performing?
   - ….As standards/assessment driven?
   - ….Do you feel that there is an adequate emphasis on science education in your school?

2) Do any of the characteristics that you used to describe your school inhibit or support what/how you teach?
   - If yes, in what ways? Your general teaching practices? Specifically science teaching? Great Lakes education?
   - Are you incentivized to obtain specializations or teaching endorsements? Or to become a member of the GLSI?
   - If you had to choose, which of the above factors is the most influential regarding your teaching practices?

3) I would like to hear about your experience as a participating teacher in the Great Lakes Stewardship Initiative. In what ways has this experience influenced how you approach teaching science and topics related to the Great Lakes?
   - Have you noticed any change in your students as a result of your GLSI involvement? How so?

Now that I know more about the school environment that you work in, I'd like to talk more about the science content that you teach; specifically regarding climate change and the Great Lakes. However, before we do that I'd like to learn more about your thoughts on climate change.

4) Think to yourself for a moment and then define "climate change" in your own words.
   - Do you believe that global climate change is a real problem in today's society? Why or why not?
   - Where or whom do you look to for information regarding climate change? Do you have any specific examples? News broadcasts? Political figures? Newspapers?

- Do you think climate change has any impact on you, living here in Michigan? How so?
- Do you find any aspects of climate change confusing or difficult to understand? Explain.

Thank you for sharing. Next, I would like to return to talking about your teaching experiences.

5) Have you ever incorporated climate change into a science lesson? If yes, could you describe it for me?
   - If you have not incorporated climate change into a lesson, would you? If yes, can you think of an example of how you would incorporate it?
   - How did your students react to this lesson?
   - During this lesson, did you connect climate change to the Great Lakes region? If yes, could you describe how you made this connection?
   - How did your students react to this connection to climate change affecting their "own backyard"?

6) Do you think climate change fits anywhere in the current Michigan curriculum and content expectations outlined in the GLCEs or HSCEs, with regards to your grade level(s)?

7) Do you feel as if you have adequate training and education to teach your students about climate change? Specifically, within the context of the Great Lakes?
   - If not, what would help you to feel this way?
   - Can you think of anything else that supports or inhibits you from teaching about climate change?

8) In your opinion, do you think it is important to teach students about global climate change as well as how it impacts the Great Lakes region? Please explain.

9) Is there anything you wish you had access to or made available to you regarding teacher professional development on climate change learning?
   Anything else you think I need to know regarding this topic?

Thank you very much for your participation and I will follow up with you on the transcript of this interview to make sure I captured your comments correctly and clearly. I will provide you with a summary report of this project's findings. Please accept this educational resource as a gift for your participation in this interview.

APPENDIX I:

An Example of a Summary Memo

Research Question 2: What are the internal and external factors that influence whether a teacher incorporates climate change into their lessons or not?

Code: Personal Connection to Local Environment
Definition: A personal attachment one has to their local environment because they believe it is special and/or something worth protecting.
Rule: Apply to data that describe how a teacher incorporates "place" into lessons and/or why they think it is important for students to make a personal connection with their "place" through education.

Evidence

Interview #2
We expose children and have them feel close to where they live on the earth so that they know that they can take care of it and that they have to take care of it. And I think that's something that they can grasp. (p.3)

Summary Statement: She exposes her students to nature [through GLN] so that they establish a connection to it and feel a sense of urgency to take care of it.

Interview #3
My focus has been more about getting kids to just connect with their space and want to protect their space and less about the bigger picture because I was with little kids for so long. (p.3)

I feel strongly that younger kids need to just be outside, in nature, as much as possible. And I do a little bit of that with the big kids too because they spend so much time inside. (p.8)

Summary Statement: She is very passionate about getting students outside during her classes and helping them to connect with their place.

Interview #4
…in the spring, I'll do the greenhouse. We'll start in March and we'll grow some food; lettuce, vegetables for salad and then we grow native plants from seeds we harvested in the fall. So try to keep things ongoing throughout the year. And then we'll grow some native grasses probably again this year and then we'll either put things in the prairie or kids take a lot of stuff home, particularly we grow false indigo and that grows really well so they take that home. And plant some in the courtyard. (p. 2-3)

We talk about the watershed and being in the Grand River watershed part of the Great Lakes watershed. We talk about that with invasive plants and you know the purple loosestrife. And then we pull garlic mustard, just how native plants are helping the watershed. Our prairie is a buffer zone for the wetlands and also a watershed, well a catching area for the lake that's out there. Just improving that, the plants within that watershed to help with the water. (p.3)

We just go right across [the street] and we do some birding over there, we fish there in the spring as part of the PE that Mark Stephens has helped incorporate so all the 5th graders fish in the spring. And they all catch something, it's amazing, it's really well stocked. And so you know, we've done some water sampling out there. Actually, a couple of the retired Grand Learning Network folks came out…was it _____ and ____ who came out...and did water sampling last year with all the 5th graders. I've got deer heart dissections we're doing on February 6th; yea I have a dad that has brought me deer hearts every year. It's a part of the human body but we were a little backed up. But it'll tie into the zoo, because we'll do the zoo. So that's pretty cool. (p.3)

Summary Statement: She does a lot of Great Lakes, place-based education with her students including growing native plants, learning about the Grand River watershed and invasive species, birding, fishing, and dissecting deer hearts as a part of the body systems unit.

Interview #5

There's a real good integration between our social studies and our science. And the science that most connects is our earth science because we do the Battle Creek science lessons, we try to use that as our base and then we springboard off that a lot of course. But the whole, earth, land and water, and then we focus on Michigan and the Great Lakes in general terms. Kids really struggle in second grade to know their place, I mean we talk about communities in social studies…so we talk about the large community and our social studies spirals outward so like in kindergarten it's your family, and in first grade it's more…and every year it spirals outward a little bit. So we do talk about Michigan, I mean second grade is not where the Michigan history curriculum is. It's now in third, used to be fourth, now it's third. They do a lot of Michigan history. But we always talk about the Great Lakes with the kids and try to get them to be able to name them of course and to have some sense of them when we're talking about that. There's an ecology piece in that lesson series where we talk about things like water and water preservation and reservation, and things like that. So we always bring, and you know we talk about them in general terms…that part is not exactly, Great Lakes specifically is not part of our curriculum but…and especially when we go to Annie's we always do at least one day, usually more, where it's like water day. (p.3)

…it's a big model and the kids love that because you put things like coffee grounds and Kool-Aid and whatever in different places and they can see how the water comes and it contaminates, and the whole water cycle and what goes into the ground and how that works. That's a really great place for us to do that and they're out in it. We used to go to _____ Nature Center, I don't know if you've been out there, so fabulous out there. So we'd always go across into the lake park and we'd do a lot of stuff with the river and the naturalist there would always help us, help the kids understand a little bit about the river and how it connects to everything. That place-based learning is probably the most important, I would say that learning sticks with them so much more than what we talk about in the classroom because we don't have a lot for science in the classroom. That's why we always make sure that we preserve that week that we can go and do it all day long for an entire week. We do it very early in the year so we connect it with everything we do for the rest of the year. So it's nice. (p. 3-4)

That's the hope of it all. We want them to become naturalists; you know we want them to love nature. We spend an hour every single day just observing. (p.7)

…what I love about the Annie's because we do a stewardship project every week, as you know. The kids really get into that and this year, and it doesn't have to do with the Great Lakes or even water…but this year, we were at _____ and they had just burned their prairie the spring before. So we did cow patties, or whatever; they planted seeds in the mud and made mud pies that were all full of prairie seeds, native Michigan plants. They threw them out, we went out into the prairie and we had a big ceremony where they threw them out. And then the idea is that they come back and check on their prairie and take ownership of that. (p.7)

Summary Statement: She incorporates most of her Great Lakes content through the Annie's BIG Nature Lesson; she talks about the Great Lakes watershed, water resource protection and conservation, and how rivers connect to the lakes. She thinks that PBE is most important for her students and ultimately wants them to become naturalists who love nature.

Interview #6

We kind of copied that as much as we could because I did Salmon in the Classroom too but see what happened is because you have to have all the permits from the DNR, and I had done it and then I ended up having to teach sixth grade for a year so I lost all my permits and everything and then Sturgeon for Tomorrow was offering this and so I got new permits, obviously, but it was a little different. (p.3)

And we do it while they're, during the Sturgeon run while they're spawning, so they kind of act as that day, you got kids all over the place, nobody's going try and poach or anything that day. That's... They kind of act as a watch in a little ways too. (p.5)

But I think bringing... 'Cause, we started out without the fish, we didn't get the fish till October. So, bringing the fish in the classroom definitely made them more excited about it, and they talk about it. When it's their turn to feed him, 'cause they feed him twice a day, one class feeds him one and the other class feeds him the other time. So when it's their turn to feed him they are to the point of being obnoxious about… (p.6)

That's what I'm going for. I don't... I think that at least our lake sturgeon and then hopefully we'll get some radio, 'cause they tag the fish before they release them so, and then if they swim under those little monitor things then they could just get a hit on that. So we know what the one we released, we know what he's tag is. So after I do this for a couple of years, we should have a couple fish, we should get some hits on some of them. And I'm hoping that getting those hits will help them get more interested in it "Oh, he's flying back up the river today," or whatever. (p.13)

Summary Statement: She has a Lake Sturgeon in her classroom and her hope is that the students will

be excited about it and have an urge to protect Lake Sturgeon in the future.

Interview #7

[Regional maritime-specific class] is a class about Thunder Bay National Marine Sanctuary, its earth science based. We do units on geology, meteorology, a little bit of economics and history, but we also come back around to lake ecology. And then we worked in STEM concepts with technology and how we do research in the water. And I guess, the really the peak of that is we spend some time with our underwater archaeology. So the kids actually go to the pool and everybody gets to try scuba diving and we work underwater... (p.1)

I think that's [excitement about their place] a byproduct of taking the class. I don't think that's the motivation for taking the class. (p.4)

And I was surprised by how much more kids appreciated Alpena after taking the class. One of the quotes that stuck out was a student said that they took Michigan/Alpena History, which is offered in our History Department, and they felt like they learned more about Alpena taking [regional maritime-specific class] than they did taking Michigan/Alpena History. So I shouldn't let _____ hear that, but I was pretty happy with that. So I think they really come to appreciate what Alpena has to offer and what makes it a unique site after taking the class. (p. 4-5)

Summary Statement: His [regional maritime-specific class] class is based on their place and really emphasizes place-based learning; his students have come to appreciate their place after taking the class.

Interview #8

I set up over the summer, wrote a program, wrote the curriculum and we did a water investigation of the Northeast, or the east branch of the Au Gres River system. (p. 4)

And the kids can see... Everyone here knows we're connected very much to the water. Without the water, without a healthy fishing industry, without healthy swimming, without a good recreational base, there won't be this place… (p.8)

Yes, yes. God if they don't, then this has not been worth my effort. I'm trying to... That is... Yeah. And all of us are that's working on the team. _____ and _____, our second grade teacher, the whole idea is to build this stewardship awareness and activism… (p.14)

Summary Statement: He is co-writing an entire place-based curriculum for his school and already practices PBE in his classroom. For example, he does a water quality investigation of the local river system with his students.

Interview #9
Yes, definitely. And my students have a total advantage because we can see where the storm sewers are, and that's where it ends up. I mean, if you pour motor oil down there it's going to be in the beach that you swim at and that the fish that you eat come out of. So, I think my students definitely have a very big advantage in that respect, and it does... It's an advantage, there's another word. They have a closer connection to it because they can see it. It's one thing to be, when you're in East Lansing and the Grand River is going to flow somewhere that is kind of abstract to you, but we drive over the river all the time that goes right into the lake. So, they definitely have a more literal aspect of it maybe than some kids. (p 3-4)

Summary Statement: As a result of her adopt-a-beach project, her students feel a greater sense of urgency to protect the beaches and water resource because they can directly interact with them and see how easily they can be compromised by humans.

Interview #11
Ecology is very place-based. But in biology, we're covering a lot of topics. We have salmon in the classroom. (p.4)

Summary Statement: Her ecology class is place-based and she also participates in the salmon in the classroom project.

Interview #12
…this book right here is on invasive species of Florida. So like the gopher tortoises, like the keystone species in Florida, these kids have never seen a gopher tortoise. And so it's difficult because you get them, like the passion that kids have when you talk about their fishing in the Great Lakes, is way more meaningful to them than the gopher tortoise in Florida. And that's my whole MO after school. We're fishing, we're cleaning, we do the Boardman River Clean Sweep, so they're cleaning the river. There's a sportsman's show this weekend. They're on the rivers canoeing in the UP and here. So they're constantly taking advantage of the unique resources of Michigan. And then when they are fishing with their parents and their family goes hunting and I mean, and how that's all connected is really important. Then in our water... I mean, I've traveled all over world, and our fresh water here, they don't realize what a resource that is. (p.4)

…so to try and get them to see that they're sitting on a gold mine and what they need to do, the foresight especially, what they need to do to protect that resource is really important to our state and to all of us. Yeah, I think it's the most important thing, resource use. (p.4)

I consider myself a steward of the land, but I'm not buying this CO_2 thing. I drive a big diesel truck and I didn't buy the emissions control unit for my tractor. I bought the last year's model. So, but if you wanted to tell me about composting or how to... Not using Round-up or chemicals that can get into my groundwater or what's going on with the honey bees, and I mean all that stuff,

I'm very connected to the environment. I hunt, I fish, I have bees, I'm an organic farmer. I try to do non-GMO. I raise pigs, chickens, ducks. I have horses. All those things I try to do the best with environmentally the most sound principles. (p.8)

I would say, the number one most important thing to me as a science teacher, is to get them outside, experiencing and being part of these resources. One of the most powerful things that we do is the Boardman River Clean Sweep. So those kids, every kid I can guarantee you, that does Boardman River Clean Sweep and spends the day cleaning up the river, I mean they have smiles on their face and they will never in their life probably litter in that. I mean, they are always gonna be having awareness. And then, when you catch a trout, or let's say raise salmon in the classroom, or you do like have... Go out on this school-ship program out on the Manitou, and you see how complex and how fragile these ecosystems are, you learn about these evasive species and how they all interact. It creates awareness where they're going to respect their resources. It's really, really hard to create that passion out of a book in a classroom. (p.12)

I think my goal is to get them out of this classroom and experiencing their resources first-hand. 'Cause otherwise, they are not gonna have a passion for it. (p.12)

Summary Statement: He considers himself a steward of the land and thinks the most important thing to him as a science teacher is to get students outside and experiencing their environment because it is really hard to create the same passion inside a classroom with a textbook.

Interview #13

I think it's kind of engrained into what we do every day. So I guess I don't really see like a... I don't know, I guess I've never really... I'd have to think about the reaction, but I would say kids are really excited to be outside; they love the macro invertebrate studies because they're in the creek. Everything that we do is really hands-on, so I think it's much more preferable to sitting and reading from a textbook, or doing a worksheet on something, and it's just more valuable, in general. (p.3)

Of course you have a lot of kids that are really interested in that, but I think the kids who seem disengaged when they're in middle school, I've seen a lot of those kids come back and say, "Oh my gosh, I didn't realize, like, how awesome that was!" So I think it's that delayed gratification part of it where it's just like, they might not see the value in it, but everyone that's come back or has thanked all of us and said, "I learned so much here, I just wanna be back here," but in the moment, they might not realize it. (p. 3-4)

If kids are familiar with that recreation aspect I think it makes it a lot easier to have those conversations. Because then you got the kid that says, "Hey, I noticed this with my dad!" And it ups the accountability, I think, too, for kids to think and share stories like that. (p.12)

Summary Statement: Place-based education is embedded in her school's mission and the type of education they provide their students. She thinks

that PBE is much more preferable by the students and valuable, more so than reading a textbook or doing a worksheet inside.

Interview #14

…I felt like our connection to the... You kind of skipped... You go straight to the global community instead of going to our local community. So that's something that I think, in the last couple years we've realized and started to tap into. Which is important because it allows them to be able to apply what they learn right away, instead of having it be abstract. (p.4)

In education, it's probably more important for us to focus on living sustainably and in harmony with our environment. (p.5)

I think our job is to really expose kids to, just to the environment, just to the outdoors. Because if they don't find a love for it now, they're not going to have any interest in doing anything. They have to be out there, they have to be working in the mud and in the water, and finding bugs and seeing seeds grow and bringing in really big squash. They need to be doing that stuff so that they care. Because if they're not out there who cares? (p.5)

Summary Statement: She has been trying to bring place-based learning into her school to have her students connect with what they can readily see and experience. She also thinks that exposing students to the environment is important because that's how they become interested in doing something to protect it.

<u>Grand Summary Statement:</u> Place-based education is viewed as a strategy to get students to appreciate and care about their place, the Great Lakes. The teachers employ place-based education in varying degrees, some incorporating it through their GLSI projects and others it is an integral part of their daily curriculum. For example, Mr. Linte's entire school is moving towards place-based, project-based STEM education whereas Ms. Laskey fosters a sense of personal connection to place by having a Lake Sturgeon in her classroom. The level of personal connection a teacher has to their place as well as how they incorporate place-based learning in the classroom has implications for whether they recognize the impacts climate change is having on the Great Lakes.

APPENDIX J:

Final Code Book

RQ 1. To what extent are teachers educating students about climate change, specifically in how it relates to the Great Lakes?				
CODE	**TAG**	**DEFINITION**	**RULE**	**EXAMPLES**
Incorporation of climate change in general	**INCORP.**	The degree to which the teacher incorporates climate change in a broad sense into their lessons.	Apply to data that indicates whether or not the teachers incorporates climate change in a broad sense into their lessons and/or specific examples of them doing so.	"That it changes? And patterns? No. No I haven't. We do talk about weather and climate, and we talk about similarities and differences in different regions and in different parts of the world. But not specific to climate change." (Int. #1)
Incorporation of climate change as it relates to the Great Lakes	**INCORP. GLS**	The degree to which the teacher makes the connection between climate change and the Great Lakes and incorporates this within their lessons.	Apply to data that indicates whether or not a teacher incorporates the connection between climate change and the Great Lakes into their lessons and/or examples of them doing so.	"I also teach an environmental science class and we have a whole unit around the Great Lakes and we come back to climate change over and over again. And we talk about feedback loops and it's a big emphasis in that class." (Int. #3)

RQ 2. What are the internal and external factors that influence whether a teacher incorporates climate change into their lessons or not? (*can positively or negatively influence a teacher's decision to incorporate climate change)				
CODE	**TAG**	**DEFINITION**	**RULE**	**EXAMPLES**
Teaching context (external)	**CONTEXT**	The conditions under which the teacher is working.	Apply to data that describes the conditions under which the teacher works; for example, characteristics of the student population; the level of administrative support; interaction among school and community; adherence to the state standards; characteristics of the community.	"We are a small _____ school, public. We focus on environmental education and project-based learning, with a little bit of Montessori influence." (Int. #13)
Teacher's career background (external)	**BACKGROUND**	A teacher's career experiences that provide insight regarding their teaching practices and motivations.	Apply to data that describe a teacher's career background as an educator.	"I was a biology teacher for a decade, plus-ish. Then they pulled me out to be a K-12 curriculum specialist" (Int. #3)
Personal connection to the local environment (internal)	**CONNECTION**	A personal attachment one has to their local environment because they believe it is special and/or something worth protecting.	Apply to data that describe how a teacher incorporates "place" into lessons and/or why they think it is important for students to make a personal connection with their "place" through education.	"We expose children and have them feel close to where they live on the earth so that they know that they can take care of it and that they have to take care of it." (Int. #2)

Teacher's perception of climate change (internal)	**PERCEPTION**	A teacher's beliefs about climate change.	Apply to data that describes a teacher's beliefs about climate change.	"Well, climate change isn't really anything new if you look at the history of the Earth. What's new about this is the rate at which we're creating climate change and the predictable adverse consequences of not changing our usage of fossil fuels" (Int. #8)
Teacher's perception of climate change is anchored in recent weather patterns (internal)	**ANCHORED**	A teacher's beliefs about climate change are influenced by recent weather patterns in Michigan.	Apply to data that mention weather events or patterns from recent years that, in their mind, negate or support the existence of climate change.	"I mean it was cold really, really cold this year. So I mean all of these things factor into the fact that I am skeptical." (Int. #12)
A teacher's observations of changes in the climate or environment (internal)	**OBSERVATION**	A teacher's observation of changes in climate or in their local environment over time.	Apply to data that describe a memory or experience through which a teacher observed a change in the climate or their local environment over time and/or whether that reinforces or dissuades their beliefs on climate change.	"…we both had big flocks of indigo buntings and typically, he hasn't seen them around and I haven't seen them. And so, you know, you get eruptions of birds but I think it's interesting how the migration pattern is changing." (Int. #4)

Level of importance for teaching about climate change (internal)	**IMPORTANCE**	Whether a teacher thinks it is important to teach students about climate change.	Apply to data that describes the level of importance a teacher places on teaching climate change to students, both in general and as it relates to the Great Lakes.	"I think it's important that they know what we think is causing it, that they understand the science behind what the greenhouse effect is, and how burning fossil fuels could potentially increase it." (Int. #10)

RQ 2a. What barriers do teachers identify that inhibit teaching about the Great Lakes and climate change? (*negative)				
CODE	**TAG**	**DEFINITION**	**RULE**	**EXAMPLES**
Lack of exposure to the environment, nature, or environmental problems.	**EXPOSURE**	When an individual does not see or experience the natural world around them.	Apply to data that describe a lack of outdoor/nature experiences, both in students and adults.	"If it's too hot they have air conditioning, if it's too cold they have heat, all different sorts of clothes, they have access to food all the time. They're not suffering from drought or floods. I don't know. They don't see it, they just don't see it." (Int. #14)

The heavy emphasis placed on teaching to the standards to increase performance levels on assessments	**ACCOUNTABILITY**	When a teacher does not have enough time apart from current curriculum requirements to address climate change and/or has lost motivation as an educator because of the standards/assessment-driven mentality.	Apply to data that describe teachers not having enough time or motivation to address climate change, as well as other topics of interest, as a result of the "accountability era" of standards and assessments.	"…to the point, where in my fifth grade room, my fifth grade classroom, 10 years ago, we would do some kind of art project on Friday afternoons. We don't have time to do anything on Friday afternoons, because we have to get all of this in." (Int. #6)
Science education is not seen as a priority	**NOT A PRIORITY**	Particularly in elementary and middle school, science is not seen as a priority subject because of the heavy emphasis of reading and mathematics skills on assessments.	Apply to data that describe science not being as high of a priority subject as reading or math.	"And sadly science is not one of the, at elementary anyway, a high priority. When you're teaching kids to read, that's really the priority…reading and writing." (Int. #1)
Lack of resources ($, PD, curric.)	**RESOURCES (-)**	When a teacher has little or no access to resources that would help incorporate climate change into lessons.	Apply to data that mention a teacher having little or no access to resources such as funding, professional development, and teaching materials that would ultimately help them bring climate change into lessons.	"…finding money is probably one of my biggest challenges." (Int. #7)

Lack of content knowledge	**KNOWLEDGE**	When a teacher self-identifies that they are not knowledgeable or as knowledgeable about science and/or climate change as they feel they should be.	Apply to data where the teacher states they are not knowledgeable about climate change or that they would like to have more knowledge about climate change.	"I know nothing about it... I mean, I truly don't. So I would think that I would have to start seriously at the kindergarten, first grade level, and then work my way up to educate myself before I even taught my children." (Int. #15)
Lack of pedagogical knowledge	**PEDAGOGY**	When a teacher self-identifies that they are not proficient in teaching about climate change or are as proficient as they feel they should be.	Apply to data where the teacher states that they do not know how to teach about climate change in the classroom or feel as if they need to know more.	"I'm very good at writing; I'm very good at teaching reading. I've got all kinds of strategies and things that I can do to get kids hooked and I just don't feel like I have that for science." (Int. #1)
Weather is not covered consistently within curriculum	**WEATHER**	Weather is oftentimes confused with climate and so it is important to teach the difference; however, some teachers claim that it is not clear when and how to teach weather to students.	Apply to data that describe confusion about where weather is covered in the curriculum or the extent to which it is covered.	"I don't know if they've taken some of that weather and just grabbed the little parts and threw it all in. I don't know, but right now we don't teach any weather." (Int. #6)

Parent/family influence on student belief systems	**PARENTS**	Parents are a student's first teachers and their beliefs are oftentimes imprinted on their children, specifically regarding environmental issues.	Apply to data that describe a teacher's experience with parents' influence on their students' beliefs and/or refraining from teaching climate change because of potential parental backlash.	"I think that's one of the struggles with talking about climate change is whatever notions and preconceptions they're coming to school with is a little bit more ingrained in a climate change talk that we might have for four weeks" (Int. #13)
Distrust of climate science	**DISTRUST**	When a teacher does not trust the science behind climate change or acknowledges public distrust of climate science/predictions.	Apply to data that describes distrust of climate science for various reasons such as misrepresentation of data and political agendas.	"I don't trust a lot of people that seem to have a ton of information. I don't trust the source." (Int. #6)
Lack of buy-in	**BUY-IN**	People either just don't care or are unwilling to make the necessary changes to their lifestyles that would reduce human impact on the environment.	Apply to data that describe unwillingness to make behavioral changes or a lack of care about climate change.	"…they know that it's expected that they're going to recycle the plastic, the cardboard, and they're going to compost the food. But they look around to see if someone's watching first and then just dump it in the trash." (Int. #14)

Climate change is abstract	**ABSTRACT**	Climate change is a very complex phenomenon that has several driving factors, both human and natural, and many consequences.	Apply to data where a teacher describes climate change as being too abstract or complex for themselves or students to fully grasp.	"…how big of a topic it is. So you're tying in the temperature and the weather and how its impacting vegetation and then how that's impacting, again just how all of its related. So how the storms are related to the water level rising because of what we're doing. I just think that, it's a lot. I mean for me it's a lot to think about." (Int. #4)
Climate change is difficult to observe on a daily basis	**NOT OBSERVABLE**	Climate represents long-term patterns in meteorological variables such as precipitation and temperature for an area; changes in climate, human-induced or natural, are difficult to observe on a daily basis.	Apply to data where a teacher describes climate change as being difficult to observe on a given day or that it is often times conflated with changes in weather.	"…it's not an immediate…They can't see it right away….And I think when you talk about climate change to a 10-year-old they don't have a frame of reference, they've only been on the planet for 10 years and what happened in 10 years?" (Int. #13)

Climate change is a very political issue	**POLITICAL**	Climate change is a frequently debated topic among political parties in the United States and this is seen as off-putting by some.	Apply to data that describe a teacher's discomfort with climate change being viewed through a political lens, possibly resulting in them not paying attention to it at all.	"I don't really spend a lot of time in it, because I feel that we are being manipulated. I would feel that way if any government official was trying to convince me of something before a scientist." (Int. #12)

RQ 2b. What facilitators do teachers identify that already support, or are needed for, teaching about the Great Lakes and climate change? (*positive)				
CODE	**TAG**	**DEFINITION**	**RULE**	**EXAMPLES**
Great Lakes Stewardship Initiative	**GLSI**	Teachers that are involved in the Great Lakes Stewardship Initiative and believe their teaching has improved because of it.	Apply to data that describes the influence the GLSI has had on a teacher's teaching and/or their approach to Great Lakes or climate change teaching.	"…the professional development that comes with it through the Great Lakes Stewardship initiative is very helpful. Even in just being able to find materials, watching a lesson, figuring out how you can adapt it to your class needs." (Int. #1)
Resources on climate change	**RESOURCES (+)**	When a teacher recognizes the need for resources such as professional	Apply to data that mention the influence resources like professional	"I think resources for sure, and educating teachers with things like

		development or already has resources that have helped them incorporate Great Lakes and/or climate change into lessons.	development has had on teaching or the need for more resources on Great Lakes and/or climate change.	things we do at a small level with the Grand Learning Network and the GLSI. I think that's really important, to get more teachers involved in that themselves because they're the ones that are going to impact the students directly." (Int. #5)
Connecting with the community – experts, field trips, partnerships	**COMMUNITY**	When a teacher recognizes the need for community connections through partners, experts, and field trips or already has established these connections and has seen the benefits to their students.	Apply to data that mention already having strong partners within the community that connect students to their place or the desire for strong community partnerships.	"…because they're obviously more knowledgeable and passionate. When someone is passionate about something in front of those kids, they are too." (Int. #15)
Climate change needs to be in the standards or on the standardized tests	**STANDARDS**	The need for climate change to be explicitly addressed within the science standards for Michigan or put on the standardized tests, or else it won't get taught.	Apply to data that describes the need for climate change to be in the science standards or on the tests.	"I would just say, remember, it needs to be in a learning target, or it just needs to be on those standards somehow, and maybe a standard that's already there just needs to be rephrased to include it" (Int. #6)

Student-friendly resources and data	**STUDENT-FRIENDLY**	The importance of having student-friendly resources/data on climate change or related topics, meaning that the content is framed so that youth and/or non-technical people can understand it.	Apply to data where a teacher describes the need for student-friendly resources and data on climate change or related topics.	"I would say the one that I can think of is probably more data. More weather related, climate related data that kids could look at." (Int. #10)
Teachers need autonomy	**AUTONOMY**	Teachers need or desire autonomy within their classrooms to have a say in what they teach their students; whereas traditionally, the standards dictate what's being taught.	Apply to data that describe a teacher's desire for autonomy or the benefits from having autonomy in their teaching practices.	"It's incredible with the level of autonomy that I have. I do use the NGSS as my standards that I go to, but I really get to choose what I want to focus on and how to go about that." (Int. #11)
Increase in dialogue about CC	**INCREASED DIALOGUE**	People, specifically teachers, need to be talking more about climate change to spread awareness and begin to decide how it is that we will handle the issue.	Apply to data that describe the need for more dialogue about climate change, among teachers as well as with students, and/or how increased dialogue is beneficial.	"…there was a big push to have educators take charge of the debate about evolution and creation or something. And so probably, something similar should happen in terms of global climate change or climate disruption. I think educators need to take charge of that

				debate and probably address it." (Int. #7)
Whole-School/Community Buy-in	**WHOLE-SCHOOL**	Having the whole school or community on board with incorporating climate change and/or Great Lakes education is helpful.	Apply to data that describe the need or benefits from having the whole school or community on board to incorporate more climate change or Great Lakes place-based education.	"Now, it's starting to become an expectation that you're going to be doing it, and it's just great. That's a big change. We have written it into our school improvement program that we will be moving towards place-based education." (Int. #8)
Teachers need to feel empowered as educators	**EMPOWERMENT**	A lot of teachers have lost their motivation or craft in teaching; there is a need to empower them again. (a result of the standards/assessments and accountability era)	Apply to data that describe the need for teachers to be empowered again as educators, returning to the craft or art of teaching.	"Teachers need to be empowered to know that they can use teachable moments; that they can go on field trips; that they can go outside; that they can bring in speakers. And that's, I think... What's been taken away from them is the real world of teaching." (Int. #14)

A paradigm shift is needed in science education that is integrated across the grade levels	**PARADIGM SHIFT**	There is a need, across all grades, to shift away from science textbooks/assessments and more towards inquiry-based, experiential learning practices like place-based and project-based learning opportunities.	Apply to data that describe a teacher's desire to move away from science textbooks and assessment/standards driven teaching or the benefits of doing more inquiry-based, experiential, and project-based learning.	"I can tell you sixth graders don't come thinking that way. They're not looking at patterns and questioning on their own. Lower elementary, and I've been a lower el teacher, we spend a lot of time just identifying things but then we don't do anything with it." (Int. #1)

RQ 3. How do or would teachers educate students about climate change in general and within the context of the Great Lakes region?				
CODE	**TAG**	**DEFINITION**	**RULE**	**EXAMPLES**
Recommendations (suggestions or examples) for how to teach about climate change	**RECOMMENDATION**	Examples or suggestions a teacher provides that describe how they do, or would, teach about climate change.	Apply to data where teachers provide examples or suggestions for how to effectively teach students about climate change.	"I think, too, that there's an appropriate way to frame it and there's also, just depending on the age level that you are, I think engagement has a lot to do as far as the effectiveness of the conversation." (Int. #13)

APPENDIX K:

Additional Memos

Data Collection Memos – Contact Protocol

11/14/2014

Today I sent the GRAND Learning Network hub director, Mark Stephens, and the Northeast Michigan Great Lakes Stewardship Initiative hub director, Brandon Schroeder, the hub director teacher recommendation request.

12/8/14

Today I sent the first wave of emails and online surveys to the 15 teachers recommended from the GRAND Learning Network. The subject line read "Michigan State University Research – A Request for Your Help". I copied the approved letter into the email body and adjusted the addressee accordingly. The link to the survey is embedded in the email.

12/15/14

Today I sent a reminder email to those who had not responded to the online survey as of yet (11 emails were sent). 4 additional responses were gathered as a result of the reminder email (final response received on 1/7/15).

1/12/15

Today I analyzed the GRAND teachers' Six Americas responses in SPSS. I then created a new table called "Teacher Candidates Interview" that compares the data collected regarding only the teachers who agreed to be interviewed, including their Six Americas segment. It is from this table that I compared and determined which 3 teachers from the 5 candidates who I will contact to schedule interviews. However, with the rate at which I am receiving teacher recommendations from other hubs, I may contact the remaining 2 teachers for interviews if I do not have sufficient numbers from other hubs.

Email Subject: Michigan State University Research: Scheduling an Interview. I sent 3 emails to the selected teachers for scheduling interviews. Reasons for selecting these 3 teachers include:

- Each teaches at a different school location/characterization (sub., urban, rural)
- Different 6 Americas segments; includes range of extremes (Alarmed-2 & Disengaged-1)
- 1 elementary, 1 middle, 1 HS
- Different numbers of years in GLSI

Possible limitations include: all experienced teachers (Range = 19-30 years); all female; none of them explicitly stated they teach students about "weather and climate" or "chemistry" content areas.

1/19/15

As of today, I have three interviews scheduled with GRAND teachers. I also sent a final reminder to the remainder of the GRAND teachers on the recommended list in order to acquire more responses, more 6 Americas data, and additional interview candidates. I also sent a thank you email to the two interview candidates not selected to thank them for their willingness but to also be aware that I may contact them if more interviews are needed further along in my project.

1/26/15

I received one more response for the online survey from the GRAND teachers. I also sent emails to the hub directors for the Traverse City, Flint, and Houghton GLSI hubs.

- Joan Chadde, Education Program Coordinator, Mich. Tech., jchadde@mtu.edu 906-487-3341
- Kristen Grote, Program Coordinator, Grand Traverse Stewardship Initiative @ the Grand Traverse Conservation District; kgrote@gtcd.org 231-941-0960
- Leyla Sanker, Community outreach coordinator, Discovering PLACE - UM Flint lsanker@umflint.edu 810-424-5477

1/30/15
I received the teacher recommendation list from Brandon Schroeder in the Northeast MI GLSI hub. Sent the first round of surveys to the 20 teachers he recommended.

2/9/2015
A total of 4 responses came in from the first round of surveys sent to the NEMI teachers. I sent a second round, reminder email, this morning to the remaining teachers. Shortly after being sent, three more responses came in; making the total number of responses (as of 10:00am) 7 with 6 teachers willing to be interviewed. I will send the final reminder next Monday, February 16th. I also hope to get another teacher recommendation list this Friday February 13th from the Grand Traverse Stewardship Initiative hub director (Kristen Grote).

2/16/2015
As of now, I have received 13 survey responses from NEMI teachers with 9 of them willing to be interviewed. Today, I sent the final reminder email to the NEMI teachers (9 total emails). I also sent the first round of emails to the Grand Traverse teachers (9). Kristen Grote said she would add to the list if more of her teachers show interest. I will send the first reminder email to the Grand Traverse teachers on Monday, February 23rd.

Circumstances for the project have changed; I will now try to interview five teachers from three hubs (GLN, NEMI, and GTSI) and hope for a few phone interviews from the UP. I have five interviews done and transcribed from the GRAND Learning Network. I will try to schedule five interviews from the NEMI hub and same for the Grand Traverse hub, totaling 15 teachers.
The five teachers that I have selected from the NEMI hub have diverse characteristics desired for my project and include:

- 5 teachers spanning entire eastern coast of the state, north of the Saginaw Bay.
- 3 males, 2 females
- Six Americas = 2 Alarmed, 1 Concerned, 1 Cautious, 1 Doubtful
- All rural
- 1 Elem., 2 MS, 1 MS/HS, 1 HS
- All science teachers with variety of content areas covered

2/17/2015
I sent a scheduling email to the 5 selected teachers from the NEMI hub this afternoon. Once I receive responses, I will begin to plan the trip north accordingly. Hopefully, I can find a group of days that works for all 5.

2/18/2015
Today I received four more teacher recommendations from the Grand Traverse GLSI hub. I added them to the existing list and sent the survey email.

3/2/2015
I sent the final reminder to the remaining GTSI hub teachers (4). I also sent the initial email to the LSSI (Lake Superior Stewardship Initiative) hub today. I also plan to contact Grand Traverse teachers this week to schedule interviews.

I received 10 responses from GTSI teachers (out of 13 recommended teachers). Seven of the ten said they were willing to be interviewed. I chose the following five teachers based on these criteria:

- From a variety of locations around northwest Michigan
- 4 females, 1 male
- Six Americas = 2 Alarmed, 2 Concerned , 1 Dismissive
- 1 Elem., 1 K-7, 1 MS, 2 HS
- All science teachers; some with special interests (wilderness survival and agriculture)
- Teaching careers range from 3-15 years; involvement in the GTSI relatively low across all 7 teacher candidates so no significant diversity regarding this criterion

Memo – Data Analysis Thoughts (as of 4/7/2015)

- The level of importance felt towards teaching climate change, regardless of whether they do or don't
- Students are desensitized to global warming and climate; to this generation, there are just terms that they hear frequently
- Professional development as a part of a general need for resources on climate change
- Recommendation = historical sequence/geologic timescale of climate change is important for understanding how human-induced climate change is different
- Modeling environmental behaviors in class to integrate climate change; maybe it's not about addressing climate change specifically but in smaller, more demonstrative ways that relate better to students.
- Decision to only code for examples of teaching about climate change and/or suggestions for how to teach about climate change instead of individual recommendations; these will be categorized in the analysis but it is important to not omit some ideas just because they are only mentioned once.
- Needs = time, autonomy, increased dialogue about climate change among teachers
- Barrier = weather is not covered very well in any grade; unless that particular school makes it a point to cover weather
- The need for solid/good science = science that is based on solid evidence and not misrepresented in its presentation (like the NASA data set on the book cover or Al Gore's false data in his movie)
- Need = whole-school buy-in to teaching about climate change would help teachers integrate it better; having a community behind you is easier than trying to do it by yourself

- Lots of additional time invested by teachers creating an entire place-based curriculum for their school
- What is weather, what is climate change? Misunderstanding between global warming and weather patterns that contradict the predictions of climate change/global warming = therefore, need more clarity about the terminology of this topic
- It needs to be something that doesn't add to the existing work that teachers have – something that can be easily integrated or replace existing curriculum
- There is a greater pressure to teach from the science textbook than from the standards or administration (Int. #9) – wishes she could do away with them
- Climate predictions, when wrong, create distrust
- Distrust of science – broken down into distrust of the sources of information (political figures, biased websites) and distrust of the actual information/predictions
- The phenomenon of climate change is difficult to demonstrate in a classroom
- Int. #12 – shows students two videos = John Stossel, Fox News Correspondent and a short video called, "Unstoppable Solar Cycles' by Izzit
- Paradigm shift = shift away from textbook driven mentality in teaching today
- Feelings vs. facts – students needs to justify their opinions with facts and evidence; so much of this climate change debate is based on feelings and emotions
- Combine paradigm shift with need for PBE/project-based opportunities?
- Level of student interest is challenging, some don't want to do whatever is necessary to reduce carbon footprint..they are weighing the costs and benefits of this green behavior
- Desensitized to CC – "Whatever, give me my Twinkie" mentality; lack of care, lack of buy-in by students
- Within accountability, the lost art of teaching – teachers are more like accountants today
- Teachers need to feel empowered again to be the teachers they were trained to be – opposite of this is accountability era code…Int. #14's stories about her experiences in other schools demonstrate the accountability era nicely

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