

**COMMUNICATING CARBON CAPTURE AND STORAGE TECHNOLOGIES:  
OPPORTUNITIES AND CONSTRAINTS ACROSS MEDIA**

A Dissertation

by

ANDREA MARIE FELDPAUSCH-PARKER

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2010

Major Subject: Wildlife and Fisheries Sciences

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## **ABSTRACT**

Communicating Carbon Capture and Storage Technologies: Opportunities and  
Constraints across Media.

(August 2010)

Andrea Marie Feldpausch-Parker, B.S.; B.S., Michigan State University;

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In 2003, the U.S. Department of Energy created regional joint government-industry partnerships as part of a larger incentive to develop carbon dioxide capture and storage (CCS) technologies to address the issue of climate change. As part of their missions, DOE and their partners are responsible for creating and distributing public outreach and education materials discussing climate change and CCS technologies.

In this dissertation, I sought to evaluate processes for communicating CCS to the public by examining different pathways including direct communication through DOE and regional partnership websites (Chapter I), news media from states with energy projects proposed or underway (Chapter II), and alternative strategies for communication such as an online educational game for youth (Chapter IV). My study also included focus groups in communities where CCS technologies have been piloted to determine public knowledge and acceptance of CCS (Chapter III). In Chapter I, a critique of DOE and partnership websites, I found authority to be a dominant theme throughout DOE and partnership website content, often incorporating technical jargon beyond laymen

understanding and, in many cases, targeting industry audiences over the intended public. In Chapter II, I analyzed newspaper articles from the states of Massachusetts, Minnesota, Montana and Texas using Luhmann's social theory and the SPEED framework to determine how CCS has been framed by the media. Findings indicated that political, legal, economic and technical frames dominated, with emphasis on benefits, rather than risks of adoption. I also found that CCS reporting increased dramatically as pilot projects started to come on line. In my study of community acceptance of CCS in the American Southwest, Chapter III, I found that participants focused their conversations on industry and government knowledge, risks and unknowns of CCS and processes for decision-making. These topics also provided an impetus for caution. Skepticism and distrust of government entities and corporations influenced participant willingness to accept storage risks to mitigate for CO<sub>2</sub> emissions. After open discussion of pros and cons associated with the technology, however, participants were more willing to consider CCS as an option, indicating a need to talk through the issue and to come to their own conclusions. Finally, in focus groups used to evaluate of an online game titled *The Adventures of Carbon Bond*, I found that it was difficult for participants to discuss environmental issues with students that are viewed as contentious (i.e. climate change and CCS), but that gaming was a valuable tool for addressing such sensitive subjects.

Overall, these four chapters demonstrate that communication of CCS has only reached portions of the public and has not consistently connected with those potentially impacted by the technology. They also show that CCS must overcome numerous barriers to deployment, foremost of which is public acceptance.

## DEDICATION

*I would like to dedicate this research to my husband, Israel, who has been my rock throughout this whole process from beginning to end. I would also like to thank my parents, Regina and Larry, and siblings, Renee and Loren, who have helped me through the rough patches and cheered me on through my successes. Thank you.*

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Next I would like to thank my co-authors and colleagues from other labs, departments and universities. I have learned much from these experiences and plan to put these lessons to use in future collaborative efforts. I also would like to acknowledge the staff of both the Department of Wildlife and Fisheries Sciences and the Institute of

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Finally I would like to extend a large thank you to all my fellow graduate students for their support and guidance through both my masters and Ph.D. and all of my project participants who shared their life experiences and knowledge, which allowed me to write something which, I hope, will be useful and meaningful.

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## CHAPTER I

### INTRODUCTION

#### BACKGROUND

##### **The Ascension of Science**

The study of science has played a pivotal role in our development as a species. Scientific inquiry has advanced all facets of understanding, including medicine, astrophysics and space travel, war, ecology, and human social constructs. Though scientific knowledge has suffered from losses and setbacks, such as after the fall of the Roman Empire, during the French Revolution, and even recently with the editing of scientific documents for political purposes, it is considered a sacred knowledge. This knowledge has allowed humanity to overcome the obstacles that plague other species, creating an arrogance of invincibility marred only by the occasional tremor of uncertainty that is often quickly forgotten (Feldpausch & Peterson, 2007). Science became the anvil upon which whole belief systems found themselves suddenly tested. The appearance of scientific inquiry shocked civilizations with new thoughts, ideas, and perspectives that had to be incorporated into existing cultures. Scientific concepts such as evolution and the birth of galaxies and solar systems challenge faith-based knowledge and the belief in the supernatural, naturally leading to conflicts still extant today.

Science, as a discipline, focuses on empirical studies involving experience and experimentation to gain knowledge (Morrison et al., 2008). The concept of truth in the

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This dissertation follows style of the journal of *Applied Environmental Education and Communication*.

positivist philosophy of science is often seen as one without the taint of the subjective. This philosophy seeks truth through objectivity and logical empiricism; an attempt to rise above human flaws (Romesburg, 1981; Lincoln & Guba, 1985; Morrison et al., 2008). Though the positivist paradigm is still alive and well in the scientific community, many scientists have since embraced the postpositivist philosophy of science (Romesburg, 1981; Lincoln & Guba, 1985). This paradigm attempts to rectify the problems of the positivist paradigm by recognizing an absence of a single, shared reality. As a result, the scientific method has gone through many incarnations (i.e. inductive, deductive, and retroductive reasoning) to the now widely accepted hypothetico-deductive method, the scientific approach developed by Karl Popper (1902 to 1994) which includes developing a hypothesis, usually through the process of retroduction, and testing it to determine if it can be falsified (Morrison et al., 2008). With an ever more rigorous approach to conducting research, scientific findings are more difficult to dispute by those outside the field and are therefore given higher value in decision-making processes. This tendency towards trust by outsiders does not, however, eliminate political debate or general speculation (Cox, 2006).

### **Science as a God Term**

In 1859, Charles Darwin published *On the Origin of Species*, a seminal work with a provocative message: “man had not been created with special care in the image of God; therefore, he is one with all other species in a universal brotherhood of living and dying, which he denies only at the risk of cutting himself off from his psychic and biological roots” (Worster, 1994, p. 180). Gone are the days of studying nature to reveal

God's divine order (Worster, 1994; Jutro, 2007). The Theory of Evolution and later the Big Bang Theory put into question the presence of an omnipotent being. For some scientists, this meant the death of God(s) and the possibility of supernatural influences. For others it meant a revised interpretation of previous beliefs (i.e. creation of Earth, the existence and timeline of the dinosaurs, and our implied separation from the animal kingdom). The role of science took on a new meaning as ethics and morals were no longer dictated just by faith-based practices and social norms. Cloning, genetic engineering, and stem-cell research have all come about because of a stronger reception to what science is capable of, even with a sometimes uneasy general public (e.g. stem-cell research). Science has gone beyond previous limits, inspiring further exploration in hopes to benefit humankind, right past mistakes, and gain additional knowledge about the natural world.

This new science has expanded human boundaries to levels previously thought unattainable or even mystical. This idea of science and what is now achievable reflects Kenneth Burke's definition of the God term: terminology that serves as a synonym for or an extension of God (Burke, 1970). Historically, humanity has turned to God(s) to explain the otherwise unexplainable. According to Burke (1969, p. 299; 1970, p. 40) "God" includes "the ground of all possibility; substance; nature; history; society; necessity; mind; consciousness; self-consciousness; truth; genius loci; efficient cause" whereas man is "the symbol-using animal, inventor of the negative, separated from his natural condition by instruments of his own making, and goaded by the spirit of hierarchy." For most of human existence people have accredited divinity and its

intervention with, among other things, the creation of celestial bodies, the birth of man and nature, and the vagaries of war. Today, science and logic have discredited many of these beliefs, thus resulting in a partial transference of the unexplainable or awe-inspiring from God(s) to science and technology. Science has become something ethereal, even though it is conducted and studied by man, or as Burke says, the “rational animal.” The rigid methodology of science is the attempt to inject perhaps the most important aspect of godhood into human thought, the elimination of fallacy, the taint of humanity. Though science has not entirely replaced traditional religion – hardly a town can be found that lacks a house of worship for instance – science has acquired a certain amount of reverence from its followers. Now when faced with a problem, humans turn to science and technology intermingled with an exhortation (expectation?) of divine intervention. Climate change and its ramifications provide a perfect exemplar of this new philosophical paradigm. Scientifically and logically, climate change can be addressed through more efficient energy use, alternative energy sources, carbon dioxide sequestration, and other green technologies. Spiritually, religions around the world are embracing climate change as an ethical test of humanity’s earthly stewardship, and have called for people to lower their carbon footprint.

### **The Position of Science in Society**

Although our culture holds science in great esteem, as exhibited in federal agencies’ attempts to use the “best available science” in decision-making processes, it is still but a single component of a complex society (Cox, 2006). The role of science is one highly motivated by the needs, interests, and concerns of a culture (Latour, 2004; Jutro,

2007). Case in point: funding received and research conducted generally is influenced by the social and political climate. For example, the issue of global climate change is receiving more attention than ever before and as a result, the number of projects related to climate change mitigation and adaption has increased precipitously. Science therefore lacks the autonomy it is believed to possess (Burke, 1969). Luhmann (1989) hypothesized about these social complexities and what it means for environmental action. He described late modern society as being defined by six major interconnecting function systems that use binary codes formed when information obtains a value and a respective counter-value. These function systems include economy, law, science, politics, religion, and education, though additional function systems may also exist. According to Luhmann, science, as one of the six major systems, is connected to the other systems. This connection allows for resonance between systems even though the systems retain their autonomy from one another as well as the natural, material world.

An interesting facet of this theory of resonating function systems is the use and abuse of science due to motives linked to other systems. One can envision fields of study as a metaphor for a battlefield, science can be considered the battleground for two different forms of argumentation: those within a field of study (i.e. competing ideas or paradigms) and those between scientists and the lay public (people outside a specific field of study). Both types of arguments have a common ground: the scientific method, though the similarities tend to end there. Arguments between scientists generally consist of, but are not limited to, defending opposing findings, attacking research methods or scientific approaches, and debating the validity and currency of ideas. These arguments

exist between what can be referred to as insiders, or those “in the know” (Killingsworth, 2005). Though they have the ability to span multiple fields or divide fields into separate camps of thought, these arguments still remain in the realm of the academic such as the past battle between geneticists and naturalists over the process of evolution or the current disagreement between physicists over String Theory (Ceccarelli, 2001). Debates between scientists and the general public, however, focus on a different aspect of the scientific method: uncertainty and the definition of scientific fact (though scientists do sometimes involve themselves in the latter arguments, blurring the lines between the two levels of argumentation). Scientific research is understood by scientists and those who work closely with scientists that science cannot provide proof or absolute certainty about the natural world (Cox, 2006). All science has the ability to do is better understand how a system functions, be it an organism, an ecosystem, or a solar system. That does not, however, prevent people, including scientists, from labeling something as a fact.

As part of the scientific process, research goes through the process of testing and validation, in an attempt to weed out false hypotheses. After a certain amount of research has been conducted, the word “fact” is loosely applied. Though the term “fact” can be misleading since nothing can ever be proven beyond doubt (at least in the postpositivist philosophy of science), scientists tend to become more comfortable with the label after the research passes scientific review (Killingsworth & Palmer, 1992; Latour, 2004a). Latour (2004a) suggests, however, that the term “fact” is sometimes used prematurely, obscuring the stages of the scientific process. This allows for a “politicization of the sciences” where people use facts like a rapier, believing them

incontestable. A more or less harmless example of premature fact labeling is the tendency for people to change their diets every time a new study comes out about health and the consumption of certain foods. The use of biofuels as an alternative to fossil fuels, on the other hand, has proven to be more contentious. For example, though it is a fact that plants such as corn and sugarcane can be used to produce ethanol which in turn can run your car without producing CO<sub>2</sub> as a byproduct, it is also a fact that growing biofuels produces more greenhouse gases due to the conversion of forests and grasslands to cropland (Searchinger et al., 2008). This is also compounded by issues of water requirements, fertilizer, increased use of pesticides and the competition for land use and food availability, not to mention that the production of ethanol also produces CO<sub>2</sub>. These facts have now become tools in a political as well as economical debate where climate change is only part of the discussion.

Scientific uncertainty and the lax use of the term “fact” are also used by members of society to halt processes and arouse doubt through the ambiguous labeling of good and bad science, though it should be noted that additional methods also exist. The first tactic, known as the precautionary principle, is rooted in the debate over burden of proof of the possibility or the actuality of something negative occurring due to an action (Cox, 2006). Starting with conflicts over human health and the use of hazardous chemicals, it was once considered the public’s responsibility to compile enough data to prove that an activity or agent caused deleterious effects to a population (e.g. Rachel Carson’s fight against the use of DDT). At the 1998 Wingspread conference, however, the burden of proof was passed over to the proponent of an activity to “take proactive measures to

reduce or eliminate hazards,” though examples of the former still exist today such as illnesses near containment facilities or increased rates of cancer near power plants (Cox, 2006, p. 341). The second tactic is the use of rhetorical tropes of uncertainty. For this method, special interest groups, with or without the assistance of scientists, create and/or nurture doubt about scientific claims that would otherwise lead to actions that could be unfavorable to certain sectors of society (Latour, 2004b; Cox, 2006). A well known example of this tactic is the rhetorical campaign against climate science and its claim that humans are the root cause of recent climate change events.

### **The Identity of a Scientist/Expert**

The term expert or specialist implies an intimate, detailed understanding of a specific subject of research. Experts generally have higher degrees and years of training and experience separating them from the non-specialist that makes up the majority of the general public. Because of this, specialists are given more authority in matters pertaining to their expertise (Killingsworth, 2005). In scientific fields, experts are those who have an in depth knowledge of the natural world and its systems. As experts, it is their responsibility to put aside personal feelings and opinions in order to provide unbiased information to decision-makers, in theory. As mentioned before, science does not exist within a vacuum, and it is not always conducted for the sole purpose of furthering humanity’s knowledge of the natural world. There are outside as well as inside forces acting upon scientific research. For example, Burke (1969) sights the support for nuclear science by governments interested in using nuclear weapons in World War II as an agenda driven application of research. Though the scientists may

not have been fully aware of how their research was to be used, they had no delusions of what they were creating or its potential for destruction. Burke's point from this narrative is that science itself is not moral or value-free. Morality instead is determined by people and how they choose to use or not use science.

Like outside influences, inside influences (i.e. needs, interests, and concerns of researchers, both personal and professional) also impact scientific research. In keeping with the identity of the unbiased, objective researcher, most scientists feel that their research should "speak for itself" as an absolute authority (Killingsworth, 2005). For example, if research shows that climate change is occurring due to increased levels of anthropogenic CO<sub>2</sub> or that industrial activities are responsible for acid rain, then that should be evidence enough for action on behalf of society. It is the impression of many scientists that "sound scientific information can help increase consensus and cooperation and may reduce normative and policy complexities" when it comes to issues of the environment and its wellbeing (Beckers et al., 2007, p. 45). Scientists feel that they should not push for action since change should be understood, but instead influence public understanding of an issue through education; the preferred rhetorical strategy amongst scientists (Killingsworth & Palmer, 1992). Scientists also fear being labeled an advocate, since advocacy implies having a position or bias, which could ruin a career as an objective researcher. This position can cost them in other aspects of their life, focusing on one identity over the other, but is not a risk most are willing to take. Some scientists though, have taken on the role of the advocate in order to raise the alarm when the environment is under siege. Rachel Carson and James Hanson are two good

examples of scientists turned activists when their research indicated severe environmental disturbances due to human activities. Unfortunately both came under heavy fire by interest groups and often fellow scientists for their positions.

### **The Position of the Applied Scientist**

Within the scientific fields, there exists a distinction between the basic or theoretical scientist and the applied scientist. Basic scientists can be categorized as those seeking to contribute to scientific understanding and/or theory without thought to social consequences such as R.H. MacArthur and E.O. Wilson's theory of island biogeography explaining how immigration and extinction determines species richness in island systems or R. L. Lindemann's theory of trophic levels demonstrating the transfer of energy through food chains (Killingsworth & Palmer, 1992; Begon et al., 1996).

Applied scientists on the other hand focus their research on the applications of science (i.e. management and problem solving). Unlike basic scientists, applied scientists tend to engage themselves with the needs and concerns of the public (Killingsworth & Palmer, 1992). For instance, state extension agencies exist for the purposes of conducting applied research and interpreting/transferring basic research results for and educating and assisting the public in issues pertaining to agriculture and natural resources, family and consumer sciences, and community development for both adult and youth audiences.

Regulatory agencies, as an extension of federal and state governments, possess authority due to their position as enforcers of policy and law. In addition to this authoritarian role, agencies also serve as applied scientists. Agencies such as the U.S.

Fish and Wildlife Service, the Bureau of Land Management, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, and the U.S. Department of Energy (DOE) are all tasked with the responsibility of monitoring and managing public resources. Since they possess the authority to make management decisions that impact society, agencies must take into account both socio-political as well as scientific factors when making their decisions. Agencies therefore also serve as problem solvers. When an issue arises, such as the near extinction of a species or the changing climate due to anthropogenic forces, agencies must take steps to prevent or rectify the situation as is the case with the Department of Energy's carbon sequestration initiative for the mitigation of climate change.

### **The Use of Education and Rhetorical Strategies**

When entering into a conversation with a member of the scientific community about issues known to be human caused, chances are good that the solution provided in the end will be one along the lines of "we just need to educate people." For most scientists, advocacy is out of the question as a method for invoking change in society, whereas education is an acceptable strategy if not one that is encouraged. Part of being a scientist is not only to learn, but also to teach others, be it colleagues, students, targeted interest groups, or the public in general. Since scientists are expected to publish their research in peer reviewed journals, their career depends upon the education of others. If the research is novel or socially relevant enough, it may even be published in a popular magazine (i.e. *Science*, *Time Magazine*, and *National Geographic*) or make it onto television, radio, or print and internet press (Killingsworth & Palmer, 1992). These

outlets for education are viewed by many as an unbiased interpretation of results for the benefit of society. It cannot be denied, however, that education usually contains an element of persuasion.

The use of rhetoric by scientists is different from the classical views of rhetoric. According to Killingsworth (2005, p. 15), “in the classical view, rhetoric applies only to cases that cannot be solved authoritatively or scientifically. Rhetoric by definition has to do with things we argue about, not with cases that can be made air-tight.” It is wrong to assume though that scientists do not use rhetoric. Not only do they use rhetoric to settle disputes within their own fields, but they also exercise rhetorical strategies with the public (Ceccarelli, 2001; Killingsworth, 2005). For instance, the climate science website called *RealClimate: Climate Science from Climate Scientists* (<http://www.realclimate.org/>) allows researchers to refute and/or correct misinterpretations of climate science by those they believe misunderstand or manipulate it for their own purposes. Unlike the classical definition of rhetoric, the modern definition includes the more academic arguments such as those used in the *RealClimate* website. This example also demonstrates the use of rhetorical appeals such as appeals to science expertise as well as authority.

The use of appeals is a rhetorical strategy which attempts to please and/or plead with an audience in order to persuade them of a position (Killingsworth, 2005). Scientists tend to use appeals to science and authority when dealing with controversial issues such as resource use and environmental health because of their reputable positions within society. Scientists are viewed as problem solvers and visionaries. Their

credentials provide them with better standing on an issue because it is assumed that they have a better understanding of the problem and would know best how to fix it. The appeal to science and authority is an appeal to superior knowledge. This perceived knowledge imbalance between the layperson and scientist attempts to push the lay public to cede the knowledge high ground to science and the scientist.

### **The Science of Climate Change and Carbon Capture and Storage**

In 1988 the Intergovernmental Panel on Climate Change (IPCC) was created to investigate the climate change or global warming. They concluded the earth's climate was changing at a rapid rate unaccounted for by historical fluctuations. In February of 2007 the IPCC released a report stating with at least 90% certainty, current rates of global warming are due to human activities (Intergovernmental Panel on Climate Change, 2007). The IPCC report also named carbon dioxide (CO<sub>2</sub>) as the most important human produced greenhouse gas contributing to climate change.

In recent years, climate change has taken center stage in global talks as countries race to develop plans to mitigate for and adapt to the changing climate. In 2003, DOE responded to concerns about climate change by creating a series of partnerships between government, industry, universities, and non-governmental organizations to research and develop technologies for CO<sub>2</sub> capture and storage (CCS), also known as carbon sequestration (U.S. Department of Energy, 2009). As a result, seven regional partnerships, covering most of the United States and portions of Canada, were formed. Contracted with the DOE and the National Energy Technology Laboratory (NETL), partnerships are tasked with evaluating available technologies that capture and store CO<sub>2</sub>

within their region. These technologies include both geologic and terrestrial sequestration. Geologic CCS is the capture of CO<sub>2</sub> from point sources such as power plants and factories, and storage in underground geologic formations such as deep saline formations, depleted oil and natural gas reservoirs, and unmineable coal seams. Terrestrial sequestration is the absorption of CO<sub>2</sub> from the atmosphere by vegetation and soil.

According to their contracts, the regional partnerships are charged with the characterization, validation, and deployment of carbon sequestration technologies. In the characterization phase (phase I) partnerships are responsible for the identification of CO<sub>2</sub> sources and sinks in their region and the development of “human capital to support and enable future carbon sequestration field tests and deployments” (National Energy Technology Laboratory, 2008). The validation phase (phase II) focuses on the validation of promising geologic sites within the partnership. These sites are chosen based on industry interest, existing infrastructure, and the site’s injectivity, capacity, and containment. The deployment phase (phase III) is where the partnerships “will demonstrate at large scale that CO<sub>2</sub> capture, transportation, injection, and storage can be achieved safely, permanently, and economically” (National Energy Technology Laboratory, 2008). The partnerships are currently transitioning into phase III with projects injecting upwards of a few million metric tons of CO<sub>2</sub> from natural sources (underground pockets), though some partnerships are also experimenting with man-made sources (i.e. from ethanol plants).

## **JUSTIFICATION**

New technologies such as CCS face challenges with respect to public acceptance because of the obstacles they present to society: uncertainties in implementation (e.g. risks to public health and safety as well as the economy), large-scale changes in infrastructure, and intense government involvement to name a few (Bradbury et al., 2009). As part of their mission, the partnerships are charged with communicating efforts to mitigate human-induced climate change to the general public through the creation and distribution of outreach and educational materials addressing the topics of climate change, CCS, and their respective technologies. These materials incorporate rhetorical strategies such as appeals to science and authority to persuade the public of the safety and viability of carbon sequestration. Though CCS technologies are still in the research and development stage, commercial deployment is expected in the next 5 to 10 years as a means to control industry emissions. Pressure for the implementation of these new technologies is also rising as the Obama Administration along with the House and Senate push for solutions to climate change. The communication of science and science-based policy is therefore important when attempting to gain public acceptance for the purposes of acting on a national as well as global issue.

## **RESEARCH OBJECTIVES**

My dissertation research evaluates processes for communicating science to the public, with a specific focus on CCS as a mitigation strategy for anthropogenic climate change. Understanding that information can be dispersed from multiple sources through various communication mediums, I examine different communication pathways to

determine how messages are crafted, disseminated, and received. My chapters include empirical analyses of: 1) text and images from DOE and carbon sequestration partnership websites (n = 16) for the purpose of evaluating how front pages set the overall tone for websites, 2) newspaper media coverage of CCS technologies, for the purpose of learning how public discourse regarding climate science and related technology is framed, 3) public knowledge and acceptance, using focus groups and interviews with citizens in communities where the partnerships are considering implementation of CCS to discover critical social and cultural issues to be addressed. Having developed and managed a website for the Southwest Regional Partnership on Carbon Sequestration, I included opportunities for internet gaming as an alternative media for communicating climate science and mitigation technologies. For my final chapter I evaluate a narrated story and game titled *The Adventures of Carbon Bond* to determine its effectiveness as an educational tool. Overall, my research examines the communication of objective, science-based solutions to conservation challenges which has the potential to enhance both the quantity and quality of citizen participation in the development and implementation of science policy.

## **CHAPTER II**

### **COMMUNICATING THE SCIENCE BEHIND CARBON CAPTURE AND STORAGE: A CASE STUDY OF THE U.S. DEPARTMENT OF ENERGY AND REGIONAL PARTNERSHIP WEBSITES**

#### **OVERVIEW**

Websites serve as a dominant communication strategy for government agencies. As such, the U.S. Department of Energy (DOE) incorporated websites into outreach efforts for their 2003 carbon dioxide capture and storage (CCS) initiative. In this study I examined rhetorical strategies present within the DOE and CCS partnership websites with a specific focus on the use of science and technology as leverage in influencing public acceptance of CCS. I found institutional authority to be a dominant theme throughout with content often incorporating technical jargon beyond laymen understanding. I also found numerous cases where text targeted industry audiences over the intended public. Furthermore, text reflected perspectives of the fossil fuel industry. Though the professed intent of websites was to inform the public of DOE and partnership activities, in practice, the websites are promoting CCS technologies as a means for continued use of fossil fuels. This disconnect between intended purpose and what was actually presented was produced through 1) reliance on authority of DOE and partners, and 2) speaking to the industry that already advocates the technology.

#### **INTRODUCTION**

New forms of media, such as websites, have become a popular way for government agencies to share information with the masses (i.e. the establishment of e-

government; Eschenfelder et al., 1997; Thomas and Streib, 2003). Though the number and use of U.S. government websites have drastically increased over the last decade, they tend to fall short in their facilitation between agency and public in regards to democratic outreach (West, 2000; West, 2004). In the case of the U.S. Department of Energy (DOE), communication with the public has been tempestuous and reactionary due to the DOE's embrace of the technocratic ethos, contributing to decreasing public satisfaction with the agency. For example, the DOE energy conservation campaigns of the early 1980's were criticized for creating messages too complex for the general public (Weiss & Tschirhart, 1994). Yucca Mountain in south-central Nevada, site of the Yucca Mountain Repository for spent nuclear reactor fuel, has been the center of political unrest for roughly 30 years because of a failed DOE campaign to convince residents of the low risks of a nuclear repository in their community (Flynn et al., 1993). This failure was only intensified by accusations of an unfair process for providing public input (Endres, 2009). DOE is also responsible for the remediation and restoration of roughly 3,700 hazardous waste sites, including chemical and radioactive waste, spanning 34 states (Burger, 1999). Controversies over these sites have forced the DOE to rethink their approach to risk assessment and public involvement (Lowry, 1998; Hamilton, 2004; Branch & Bradbury, 2006). In recent years, this change has included the use of new media as a new and more accessible pathway in reaching the public, predominately through the use of websites.

Having exhibited an already poor communication track record with previous energy campaigns, the DOE has again turned to the internet as a way to build public trust

by attempting to increase accessibility to information on their most recent initiative – the sequestration of carbon dioxide (CO<sub>2</sub>) also known as carbon capture and storage (CCS). Starting in 2003, the DOE and the National Energy Technology Laboratory (NETL), part of the DOE's national laboratory system, employed the use of websites as a means for disseminating information about CCS, an initiative geared toward mitigation for industry's contribution to global climate change. This initiative is based on voluntary participation in one of seven regional joint government-industry partnerships designed to research, develop, and deploy carbon sequestering technologies that would enable the United States and Canada to capture and store millions of tons of CO<sub>2</sub>, the leading greenhouse gas (GHG) contributing to climate change, in geologic formations, and to a lesser extent, terrestrial systems. Partnerships include the Big Sky Regional Carbon Sequestration Partnership (BSCSP), Plains CO<sub>2</sub> Reduction Partnership (PCOR), Midwest Geological Sequestration Consortium (MGSC), Midwest Regional Carbon Sequestration Partnership (MRCSP), Southeast Regional Carbon Sequestration Partnership (SECARB), Southwest Regional Partnership on Carbon Sequestration (SWP) and West Coast Regional Carbon Sequestration Partnership (WESTCARB). Through the use of websites, the DOE and regional partnerships outline the benefits of CCS, provide explanations on how the technologies work and summarize the implementation strategies via use of the regional partnerships.

### **DOE as an Authority on Policy and Science**

As a government agency, the DOE's mission is to “advance the national, economic, and energy security of the United States; to promote scientific and

technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex” (U.S. Department of Energy, 2010a). As such, they are afforded a degree of authority in order to carry out their mission, including having influence over issues pertaining to the production of energy, meeting energy demands and restructuring of the energy infrastructure to account for environmental concerns such as climate change. A product of this authority is the agency’s ability to impact or influence individuals’ actions for the sake of the public good as dictated by law.

In addition to the DOE’s administrative duties, they also serve as applied scientists or intermediaries between theoretical science and industrial practice (Killingsworth & Palmer, 1992). In the DOE system alone there are 21 national laboratories with missions to investigate safer, more efficient means of energy production for an increasingly consumptive public. For instance, the Fermi National Accelerator Laboratory is responsible for “advancing the understanding of the fundamental nature of matter and energy,” the National Renewable Energy Laboratory is in charge of developing renewable energy and energy efficiency technology, and NETL is responsible for assuring that “U.S. fossil energy resources can meet increasing demand for affordable energy without compromising the quality of life for future generations of Americans” (U.S. Department of Energy, 2008a). These laboratories are charged with using the most recent science and technology available to solve the United States’ energy problem – providing more energy for a technology dependant public

while at the same time determining what energy sources to use in order to meet these demands.

With the added responsibility of mitigating for climate change, the energy crunch becomes even more complex and competitive. As Killingsworth and Palmer (1992) argue, government “is devoted to control and to the self-perpetuation of a social system. Scientific understanding is useful only if it empowers government to control and perpetuate the system” (p. 13). In the case of the DOE and recent administrations, this hegemonic process is being used to foster support for the fossil fuel industry and the continued use of coal, oil and natural gas as a major source of energy in America. NETL and the fossil fuel industry are able to defend their rank as the leading U.S. energy producer by solving the problem of CO<sub>2</sub> disposal and pending greenhouse gas legislation: CCS, which allows for the continued use of fossil fuels with less impact to the environment. Because CCS is backed by “the science” and the authority of federal and state governments, it has become one of the United States’ solutions for immediate action on climate change. Even so, CCS must still overcome numerous social obstacles including the hurdle of public acceptance for technologies that favor the fossil fuel industry and an agency with ever fluctuating popularity. As mentioned in a 2004 FE/NETL report on carbon sequestration outreach, public support of this initiative is important because “research and development rarely occurs in a vacuum” and “public disapproval will be very hard to overcome” (FE/NETL, 2004).

As a government agency, the DOE must include public involvement to some degree in their decision making process for the purposes of gaining public acceptance

(Depoe et al., 2004). Mandates within the Comprehensive Environmental Response, Compensation, and Liability Act and National Environmental Policy Act, meant to enforce public outreach by government agencies (Hamilton, 2004), do not, however, exclude the use of persuasion in order to gain the support needed. Killingsworth (2005) defines rhetorical appeals as a strategy attempting to please and/or plead with an audience in order to persuade them of a position. For CCS, the DOE has employed the use of rhetorical appeals focusing on their dual roles as applied scientist and government authority in an attempt to persuade the public of the safety and effectiveness of CCS technologies. Thus, with a focus on websites as a communication strategy for gaining public acceptance, I pose the question following question: can the DOE and their respective partnerships effectively use websites as a communication tool for building public trust or will they relegate websites to their authority-dominated toolbox?

In this study I examined rhetorical strategies present within the DOE and regional partnership websites with a specific focus on the use of science and technological advancement as leverage in influencing public acceptance of a particular mitigation strategy. This study includes 1) determination of dominant rhetorical strategies present in website text, 2) identification of statements of authority and the types of authority present, 3) identification of target audiences for information presented and 4) identification of opportunities for public involvement.

## **METHODS**

For purposes of understanding how DOE, NETL and the regional partnerships attempt to use their knowledge of science and technology to influence public acceptance,

I examined 16 webpages addressing carbon sequestration technologies, including seven DOE and two NETL webpages and homepages from the seven regional partnerships (Table 2.1). Website text including the main body of the webpage, images and side bar content were collected and recorded by site. Webpages were monitored weekly over an 18 month period from February 2008 to July 2009 to capture any content changes during phase II (small scale pilot studies of CCS technologies) and the transition to phase III (commercial scale pilot studies) of partnership projects. At the end of the 18 month period, webpage content was compiled and all duplicate text deleted.

**Table 2.1**

**List of 16 government and partnership websites with web addresses as of February 4, 2008.**

Entity	Website Address
DOE	<a href="http://www.energy.gov/sciencetech/carbonsequestration.htm">http://www.energy.gov/sciencetech/carbonsequestration.htm</a>
DOE	<a href="http://www.fossil.energy.gov/programs/sequestration/capture/">http://www.fossil.energy.gov/programs/sequestration/capture/</a>
DOE	<a href="http://www.fossil.energy.gov/programs/sequestration/geologic/">http://www.fossil.energy.gov/programs/sequestration/geologic/</a>
DOE	<a href="http://www.fossil.energy.gov/programs/sequestration/novelconcepts/">http://www.fossil.energy.gov/programs/sequestration/novelconcepts/</a>
DOE	<a href="http://www.fossil.energy.gov/programs/sequestration/ocean/">http://www.fossil.energy.gov/programs/sequestration/ocean/</a>
DOE	<a href="http://www.fossil.energy.gov/programs/sequestration/terrestrial/">http://www.fossil.energy.gov/programs/sequestration/terrestrial/</a>
DOE	<a href="http://www.fossil.energy.gov/programs/sequestration/">http://www.fossil.energy.gov/programs/sequestration/</a>
NETL	<a href="http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html">http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html</a>
NETL	<a href="http://www.netl.doe.gov/technologies/carbon_seq/index.html">http://www.netl.doe.gov/technologies/carbon_seq/index.html</a>
BSCSP	<a href="http://www.bigskyco2.org/">http://www.bigskyco2.org/</a>
MGSC	<a href="http://www.sequestration.org/">http://www.sequestration.org/</a>
MRCSP	<a href="http://216.109.210.162/">http://216.109.210.162/</a>
PCOR	<a href="http://www.undeerc.org/pcor/default.asp">http://www.undeerc.org/pcor/default.asp</a>
SECARB	<a href="http://www.secarbon.org/">http://www.secarbon.org/</a>
SWP	<a href="http://www.southwestcarbonpartnership.org/">http://www.southwestcarbonpartnership.org/</a>
WESTCARB	<a href="http://www.westcarb.org/">http://www.westcarb.org/</a>

For analysis, I modified Luhmann's theory of modern function systems which describes late modern society as being defined by six major interconnecting systems including economy, law, science, politics, religion and education to incorporate authority

as the main factor of power and influence in these systems (Luhmann, 1989). Because the websites were created for educational purposes, I used function systems to describe the type of information presented. For example, if the authors described a scientific finding or process, it was coded under science. The subject of religion was excluded from web content and thus the analysis whereas time/urgency, as a subset of science, was also made into a category. Education was kept as a category, but was only used when additional educational opportunities and materials were presented such as public information meetings, teacher trainings, etc. To provide consistency while coding, I created a codebook describing each categories' value and respective counter value which evolved during the coding process. I used QSR International's NVivo 8.0 qualitative software for the purposes of coding the main text (excluding images and sidebar content), with sentences serving as the unit of analysis. Coding categories included science/technology, human health/wellbeing, environmental health/wellbeing, time/urgency, expertise, economics, politics, law, education and other (Table 2.2). It should be noted that the same sentence could be coded in multiple categories if it fit category criteria.

**Table 2.2**

**Thematic categories based on Luhmann's function systems including their positive and negative values.**

Thematic Category	Positive	Negative
Economics	1. Technology can save or earn money 2. Financial support is given 3. Technology decreases the cost of electricity	1. Technology costs money 2. No financial support 3. Technology increases the cost of electricity

**Table 2.2 continued.**

<b>Thematic Category</b>	<b>Positive</b>	<b>Negative</b>
Education	1. Training or educational meeting given 2. Additional information provided such as reports, pamphlets, FAQs, Kids Stuff, etc.	1. Site notes a lack of educational material or activities available
Environmental Health/Wellbeing	1. Efforts will mitigate for climate change – reduce CO <sub>2</sub> and other greenhouse gases 2. Measures to protect the environment are taken	1. Efforts will make environmental conditions worse 2. Measures to protect the environment are not taken 3. Risks to the environment presented
Expertise	1. Demonstrates advanced knowledge/experience or adding to the knowledge base 2. Shown to be in a position of authority or has elite status in reference to knowledge 3. In a position to educate others	1. Demonstrates a lack of knowledge/experience – no experts/expertise available
Human Health/Wellbeing	1. Efforts will improve human environments 2. Measures to protect human health and safety are taken	1. Efforts will negatively impact human environments 2. Measures to protect human health and safety are not taken
Law	1. Regulations and procedures are in place and being followed	1. Regulations and procedures are not in place and/or not being followed
Politics	1. Political support is given by politicians and/or interest groups 2. Groups working together such as partnerships, nations, or unlikely allies	1. Political support is not given or they are receiving opposition from politicians and/or interest groups 2. Groups such as partnerships, nations, or unlikely allies suffering from fractionation
Science/Technology	1. Explanations of environmental and/or technical processes provided 2. Demonstrates scientific/technological knowledge 3. Technology/processes being researched or explored – includes both completed work and work in progress	1. Unable to explain environmental and/or technical processes 2. Demonstrates a lack of scientific/technological knowledge 3. Technology/processes not being researched or explored
Time/Urgency	1. There is time to act on climate change or humanity is in the process of acting	1. Humanity is running out of time to act on climate change
Other	1. Positive statements worth noting, but that do not fit in other categories	1. Negative statements worth noting, but that do not fit in other categories

## RESULTS

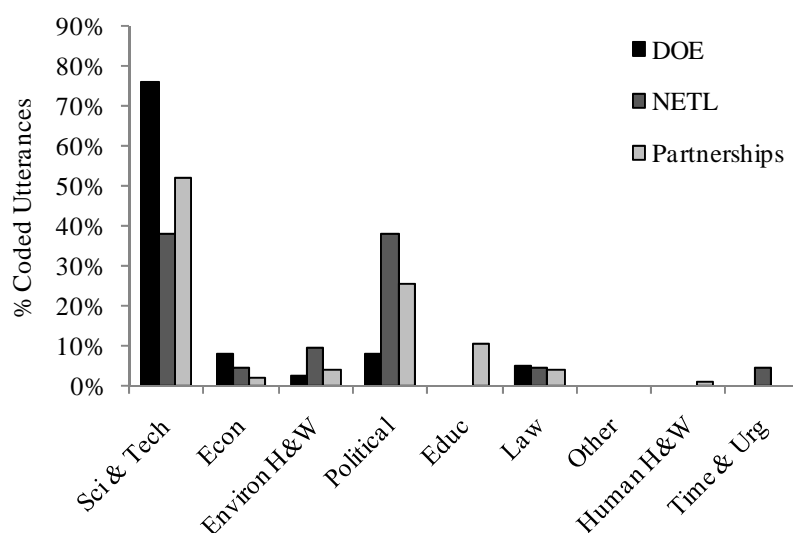
### Rhetorical Strategies and Statements of Authority

The DOE, NETL and regional partnerships' web and homepages demonstrated a heavy reliance on expert authority as an appeal for public acceptance with roughly a quarter of all coded statements referencing a form of expertise (DOE = 27%, NETL = 19% and Partnerships = 22%). This authority included a privileging of knowledge in all categories (with the exception of the 'other' category), especially the subjects of science, technology and politics (Figure 2.1). For example, one DOE carbon sequestration webpage stated that:

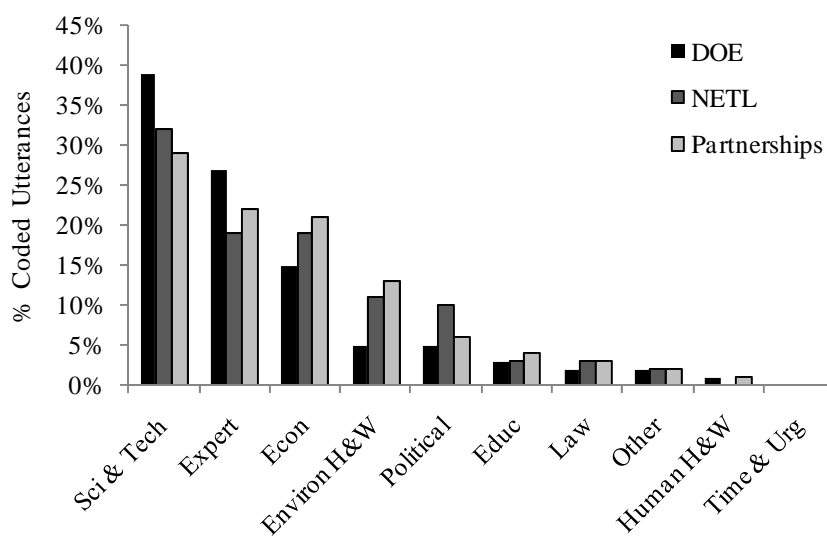
Carbon Sequestration is one of the most promising ways for reducing the buildup of greenhouse gases in the atmosphere. In fact, even under the most optimistic scenarios for energy efficiency gains and the greater use of low- or no-carbon fuels, sequestration will likely be essential if the world is to stabilize atmospheric concentrations of greenhouse gases at acceptable levels." (U.S. Department of Energy, 2005).

This same message, though varying in form and enthusiasm, was repeated throughout the 16 DOE, NETL, and regional partnership websites.

When examining individual entities by thematic category (Figure 2.2), I found that all three groups focused the majority of their content on science/technology (DOE = 39%, NETL = 32% and Partnerships = 29%) followed by references to expertise. Additional themes addressed by the three groups, in decreasing order, were economics, environmental health/wellbeing, politics, education and law. The use of these subjects



**Fig. 2.1.** Categories where expertise is mentioned by the DOE, NETL, and carbon sequestration partnerships.



**Fig. 2.2.** Category use by the DOE, NETL and carbon sequestration partnerships.

varied by entity with the DOE focusing more on the economics of CCS technologies including negative impacts on energy prices and cost of CO<sub>2</sub> capture, retrofitting and the building of new facilities as well as positive benefits such as using captured CO<sub>2</sub> for enhanced oil recovery or the creation of by-products that could be sold as commodities. The NETL and regional partnerships also made references to economics, but were generally more positive in their statements. DOE and their affiliates also highlighted the political positives of CCS, citing both national and international political support for CCS ventures and the partnering of various government agencies with interest groups including environmental NGOs, industry, and for a few of the partnerships, Native American tribes. The partnerships also emphasized education more so than the other two groups due to their outreach requirements, emphasizing public education opportunities and materials such as public information meetings, fact sheets, and updates of partnership progress. Environmental health and wellbeing varied greatly in attention with partnerships and the NETL putting more focus on the benefits of CCS as a means to mitigate for climate change than the DOE who initiated the program. The partnerships and the NETL also placed more emphasis on the legalities of implementing CCS technologies due to their impact on project procedures, both technical and outreach, as well as future commercialization. For example, The MGSC (Midwest Geological Sequestration Consortium, 2008) used their website to announce a Public Notice of Underground Injection Well Permit Hearing, stating that:

The Illinois Environmental Protection Agency has given notice of intent to issue an Underground Injection Control permit to Archer Daniels Midland Co. (ADM) of Decatur. Interested citizens are invited to review

documents of ADM's permit application, Illinois EPA's draft permit and technical fact sheet at the following location...

For the partnerships, overcoming the technical, political and legal obstacles to deployment was more important to showcase due to their immediacy than discussing future challenges such as the commercialization of CCS.

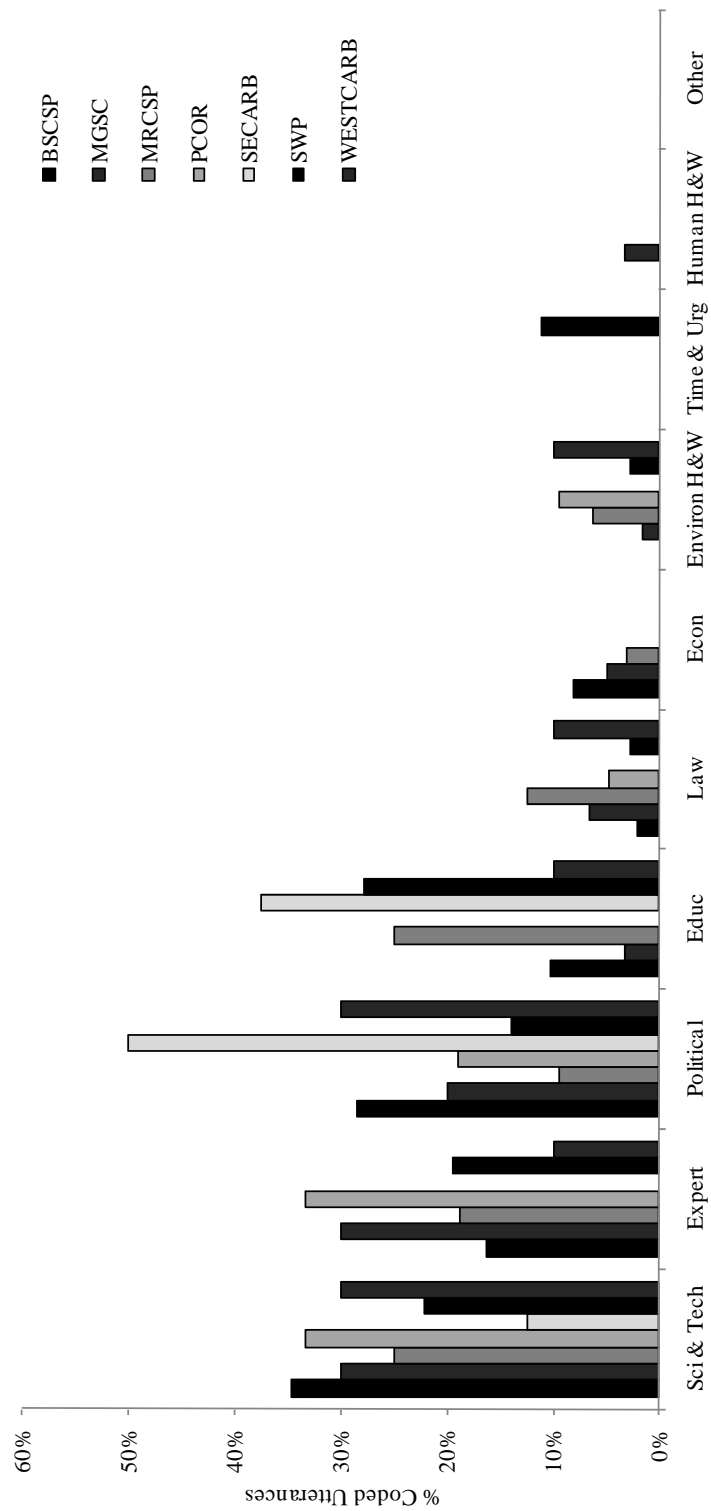
Categories consistently receiving the least amount of group attention were human health and wellbeing (DOE = 1%, NETL = less than 1% and Partnerships = 1%) and time and/or urgency (less than 1% for all groups). The human health and wellbeing category generally included statements about measures taken to ensure public health and safety through the implementation of monitoring systems. Like the CCS technologies themselves, these systems are still in the research and development stage and were therefore downplayed or not mentioned in the main text. Time/urgency was used less than expected, especially considering that the implementation of CCS technologies is to mitigate for climate change; a time sensitive environmental issue.

In a more detailed analysis of the partnerships, I again found a variety in theme and strength of focus. Though science/technology remained a strong focal point for all partnerships due to their research and development status (BSCSP and PCOR taking the most advantage of science/technology), this category did not seem to overshadow the other categories as it did in their combined state. This demonstrated a discrepancy between partnerships in attention given to science/technology (range from 35% to 13%) and broader consideration for appeals outside of this category. Also, not all of partnerships were as heavy handed with references to their expertise. Similar to the

previous category, expertise showed a wide range of attention from PCOR with 33% of statements referring to expertise to WESTCARB with 10% and SECARB with 0% (Figure 2.3). Like PCOR, MGSC (Midwest Geological Sequestration Consortium, 2008) was especially vocal in this category with statements such as:

...the Illinois State Geological Survey provides the citizens and institutions of Illinois with earth science research and information that are accurate, objective and relevant to the state's environmental quality, economic prosperity and public safety. ISGS is one of four scientific surveys affiliated with the University of Illinois...Together they form a unique group of scientific experts in the earth, environmental and biological sciences that is unmatched in the nation. These agencies carry out objective, high-quality, multi-disciplinary scientific studies in service to all the people of Illinois.

SECARB, on the other hand, was an outlier in many respects in comparison to the other partnership homepages because they chose to present an outline to their website as their homepage text instead of providing an overall view of the partnership and their respective activities. Other differences included variations in the discussion of politics, law economics and environmental health and wellbeing, with all four categories receiving minor attention. This result was surprising due to the partnerships' role in deploying the technology, but it may be reflective of their stage within the research and development process (currently transitioning from phase II to phase III which is deployment). Only the SWP used time/urgency as an appeal or justification for the research and development of CCS technologies, whereas MGSC was one of the few partnerships to highlight their efforts in monitoring, mitigation and verification (MMV)



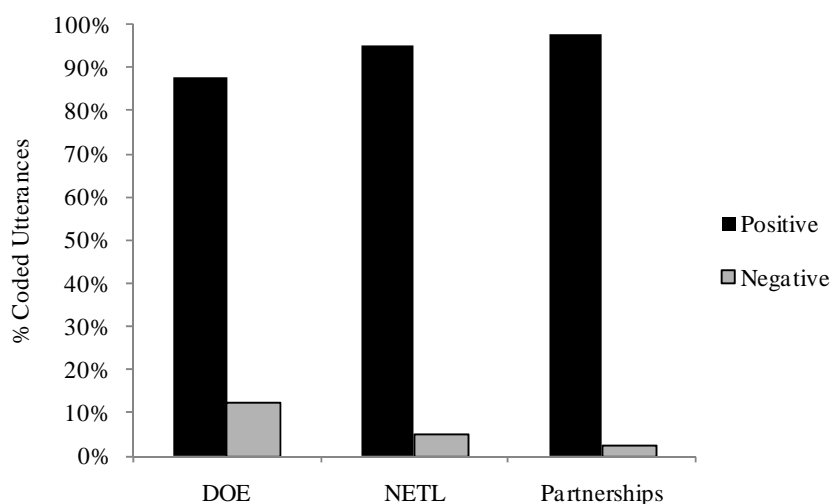
**Fig. 2.3.** Percent coded utterances within individual carbon sequestration partnership homepages by category.

for the purposes of safe and effective CO<sub>2</sub> storage which is more in line with public concerns.

Looking specifically at education, the partnerships fluctuated dramatically in their presentation of educational opportunities and materials. In light of their outreach mandate, this demonstrated a variation in mandate interpretation on the part of the partnerships, especially in consideration of their websites. Excluding SECARB due to their bulleted approach for presenting information which resembled the other partnerships' sidebars more than main text, the SWP ranked highest in their focus on education with MRCSP ranking a close second. These two partnerships differed in their educational focus with the SWP presenting more educational materials in the main text and the MRCSP having a higher number of references about educational meetings. Interestingly enough, PCOR was also heavy in their presentation of educational materials, but did not present any of this information in the main text of their homepage; instead choosing to relegate this information to the sidebars.

An examination of the overall binary values for the 10 themes demonstrated a tendency to focus on the groups' extensive knowledge base and progress in research and development (Figure 2.4). Many statements including the following highlight the groups' demonstration of competency and confidence in their understanding of not only geologic and terrestrial systems, but also other social systems as well:

Tests have shown that the adsorption rate for CO<sub>2</sub> to be approximately twice that of methane, giving it the potential to efficiently displace methane and remain sequestered in the bed (U.S. Department of Energy 2008c).



**Fig. 2.4.** Binary values for all 10 themes by group.

The Plains CO<sub>2</sub> Reduction (PCOR) Partnership is a collaboration of over 65 U.S. and Canadian stakeholders that is laying the groundwork for practical and environmentally sound CO<sub>2</sub> sequestration projects in the heartland of North America (Plains CO<sub>2</sub> Reduction Partnership 2008).

The groups also noted obstacles to deployment which were generally limited to economic barriers and a need for further testing of the technology, though the latter was usually couched with assurances to the knowledge of the scientific process or technical understanding. Time/urgency for climate action, when mentioned, was also a negative trend throughout the web text. Only one webpage alluded to a lack of expertise. The DOE webpage described processes for oceanic sequestration, but it was later removed from the DOE website for unknown reasons.

In addition to the main text, many of the web and homepages included sidebars and images to provide further reading and viewing options. Though many of the DOE

and NETL webpages did not have sidebars explicitly for CCS, being part of a larger website, one DOE webpage did provide additional information including sections on news/updates, project information, key publications, informative links and contact information. Partnerships, on the other hand, focused their sidebars on providing background on climate change and CCS as well as showcasing their partnerships as shown in Table 2.3.

**Table 2.3**

**Carbon sequestration partnership website sidebar content.**

Side Bar Categories	Side Bar Categories
Carbon Dioxide	Activities
Gas emissions calculator	Carbon sequestration
Geologic projects	Climate change
Maps	Contacts
MMV and other technologies	Events
News/updates	Geology
Overview/about partnership/mission	List of partnership partners
Reports/publications/presentations	Materials/activities for kids/educators
Resources/Materials/Links	Partners login
Terrestrial projects	Regional partnerships
What can I do?	Regulatory frameworks

Pictures, for the most part, tended toward the industrial with images of piled pulverized coal, piping and power plants, though some of the partnerships such as the SWP and SECARB chose to highlight the benefits of CO<sub>2</sub> capture and storage including clear blue skies and a pristine image of a butterfly. Some of the partnerships also included maps delineating their region. The DOE site on geologic sequestration even included an interactive model showing both CO<sub>2</sub> capture from industrial sites and its

storage in geologic formations while charting a decrease in atmospheric CO<sub>2</sub> concentrations over time.

### **Target Audiences and Public Involvement**

In a final analysis of the CCS webpages, I examined content in respect to target audiences. Though all of these sites were designed for an indiscriminant readership, content was heavily weighted toward the technical, requiring readers to have an insider understanding of the technology and experience with regulatory operations. Partnerships in particular tended to use their websites as an information clearinghouse for their partners and other parties of interest. This included announcements about professional meetings and project updates in addition to publishing technical reports, presentations, etc., on their sites:

What's New: MRCSP is conducting an additional injection test at the Michigan Basin site near Gaylord, Michigan (March 02, 2009) The MRCSP is pleased to report that, based on the successful injection test conducted in the Bass Island Dolomite formation at the Michigan Basin site near Gaylord, Michigan, the partnership is ... Read More (Midwest Regional Carbon Sequestration Partnership, 2009).

Upcoming Events: Big Sky Carbon Sequestration Partnership's Annual Meeting is October 28-29, 2008 in Spokane, Washington; please visit the conference pages for more information. The meeting is free, but registration is required by October 21, 2008. Register here now! (Big Sky Carbon Sequestration Partnership, 2009).

In addition to insider information, a few of the partnerships also posted information for public viewing such as announcements for public workshops, hearings and informational meetings. Partnerships with these postings included BSCSP who co-sponsored a one day workshop on terrestrial sequestration, MGSC who hosted an informational meeting

as part of a public hearing for their well permits by the Environmental Protection Agency and MRCSP who held an informational meeting to introduce their phase III project to the community of Greenville, Ohio. Besides information only accessible with a partner login and password, much of the insider versus public information was not separated in the text, leaving the reader to sort through and process what they could based on their level of knowledge.

## **DISCUSSION**

Anthropogenic climate change is a problem with highly technical policy issues. As such, scientific expertise has and will continue to play a large role in strategies for dealing with this dilemma. As a means for differentiating one another through occupation, experience, education, etc., identity determines how actors are viewed and provided legitimacy in society (Feldpausch-Parker et al., 2009). Scientific identity often assumes that scientists are ruled by what Prelli (1989) calls the “technical logic of scientific methodology” (p. 3). The purpose of DOE’s involvement in climate change policy is to serve as problem solvers, trouble-shooting the crisis of energy production and reduction of U.S. greenhouse gas emissions, mainly CO<sub>2</sub>. This identity as problem solver also places the DOE within the energy-climate debate itself because of their research, relationships with industry and position within government (Cox, 2006). The complex role of applied scientist and government administrator often leads to conflicts in identity where the objective scientist clashes with the value driven proponent of a specific action. Burke (1969) described this as a loss of autonomy, stating that “The liberal ideal of autonomy is denied them [scientists], except insofar as they can contrive

to conceal from themselves the true implications of their role” (p. 35). This identity crisis between scientist and proponent was played out in the DOE and their affiliates’ web-based presentation of CCS technologies.

This analysis of the DOE, NETL and partnership webpages demonstrates a reliance on institutional authority to persuade various publics of the benefits of CCS technologies as a means for mitigating climate change. Institutional authority is defined as authority dependent on the acceptance and reinforcement of hierarchical division (Giddens, 1984; Peterson, 1988). Entities claiming institutional authority generally are the source of or have immediate access to resources such as knowledge, political ties and funding (Norton, 2007). The heavy use of science and various forms of expertise provided by this authority assumes blanket public acceptance of expert knowledge and thoughtful consideration of the risks and benefits of a technology, thus lending credence to expert argumentation for the implementation of such technologies (Killingsworth, 2005; Waddell, 1997). This form of persuasion, however, runs the risk of being too academic for public consumption and marginalizes public input. Focusing the majority of text on the science allowed the groups to intentionally or unintentionally divert attention from the greater energy debate, and instead focus on the scientific ingenuity of a technology that eliminates an environmental hazard. Furthermore, the use of Luhmann’s social systems demonstrates a claim on the part of DOE and its partners to expertise of systems in addition to the science including policy, economics and law because of their government status and access to specialized partner knowledge including universities, industry and other interest groups. The DOE, NETL and

partnerships also downplayed categories of understanding where public input would be most beneficial in adding to their knowledge base such as human health and wellbeing, local knowledge of politics, economics, etc. This behavior is reflective of their technocratic ethos; presenting a political issue in technical terms (Laird, 1990). As a result, power in the decision-making process is shifted away from the citizenry and given to entities able to participate in a technical debate such as government, industry and special interest groups. Partnership websites especially catered to this latter group in their posting of technical reports, presentations, and even news reports and updates. This technocratic approach alienates the public from the debate, discounting the public's ability to question such authority. According to Hyde (1990):

The “right” of the people to question the legitimacy of authority is one that arose with the birth of classic democratic theory in the eighteenth century. Then, the right was used to challenge the power and influence of the King; now, the right is being used to make “experts” accountable for what they say and do. Open discussion and debate are the means for achieving this goal; they define rhetorical practices that serve to concretize the theory of democratic politics. These practices help to insure that the private motivations and interests of individuals who claim authority will be disclosed to those who, according to classic democratic theory, constitute the sovereign collective known as “the public” (p. 115).

In the case of CCS technologies, a major motivation behind their implementation is the continued use of fossil fuels in light of anthropogenic climate change, though other industries such as cement factories, steel refineries and ethanol plants also benefit from the development of such technologies for their own CO<sub>2</sub> emissions reduction (U.S. Department of Energy, 2008b). Webpage authors made sure to avoid any connotation of CCS as a silver bullet to climate change, but, at the same time, promoted the

technologies as a way to protect current and future energy consumption. As BSCSP (Big Sky Carbon Sequestration Partnership, 2009) stated, “Because energy is not an optional commodity, carbon sequestration will play an important role.” This language thus attempts to establish CCS as more than just a choice, but a necessity to energy security. It also minimizes space for citizen input because the discussion requires specialized knowledge of the energy sector in order to participate. Though the public is granted access to a certain amount of information, they are denied standing and influence in the decision making process (Senecah, 2004). Website content thus failed to take advantage of the opportunity to encourage public participation and instead blurred the line between informing and involving the public in agency activities and promoting a technology to industry as a means to continue the use of fossil fuels in a carbon-constrained world, resulting in the DOE and their affiliates losing sight of their outreach goals: building public trust and acceptance of CCS as a mitigation option. This demonstrates a disconnect between the responsibility on behalf of government agencies to inform the public and their practice of such measures even in the face of public opposition.

This communication disconnect highlights a paradox that exists between scientific expertise, politics and public participation. Weingart (1999) describes the paradox as “the scientification of politics and the politicization of science” (p. 151). The blurring of these two social systems has led to a dependence that threatens classic democracy, only to be replaced with what Weingart calls a democratization of expert knowledge. This blurring also violates the organizational structure of the different

function systems leading to further confusion (Luhmann, 1989). Because of this disruption to the socially agreed upon mode of operation, policy-making is then further complicated by competing expertise, which actually leads to a loss of authority by experts. Even so, the unstable relationships between science and politics persist, and thus continue to ignore the public's place in the debate.

Kinsella (2004) argues that science, and by extension scientific expertise, is value free and cannot therefore replace the values and experiences expressed in public discourse. In order to disrupt the science-politics paradox presented above, Kinsella (2004) suggests the installation of what he calls public expertise, defined as “technical competency acquired and used directly by affected citizens” (p. 85). This expertise includes insights into solving problems within the community context thus forming the connector between expert knowledge and practice. For this reinsertion of the public into political debate to take place, however, the public still requires motive for involvement and access to expert knowledge in order to gain a basic understanding of technical terms and concepts. This access depends on agencies such as DOE sharing the information necessary for this type of participation, such as materials addressing health, wellbeing, and urgency, which goes beyond current outreach efforts.

## **CONCLUSION**

Through the use of websites, DOE, NETL, and their seven regional partnerships used appeals to authority in an attempt to gain public acceptance of CCS technologies. By incorporating websites into their communication strategy, the agency and its partnerships were able to access a greater audience for sharing information about the

benefits and logistics of CCS. The use of websites, however, did not solve DOE's reoccurring communication dilemmas. To improve communication between agency and public, DOE needed to provide content relevant to their readers' concerns and wellbeing, which could be obtained through interactions with the public such as focus groups, meetings, or possibly surveys. Instead they attempted to address these concerns through their authority as scientists and as problem solvers.

By appealing to authority, DOE communicated their expert knowledge of the energy situation, but were generally too vague or too technical in their explanations of the technology. By incorporating the use of technical jargon and multiple assurances of expertise, DOE ran the risk of limiting their argument to an inner audience while excluding the general public from the decision of how best to solve the energy dilemma; a debate that cannot be solved by science alone. They also ran the risk of creating further skepticism of the process, which as Killingsworth (2005) argues "No authority is absolute, no evidence free from questions and counterexamples" (p. 23). If DOE instead chose to use less jargon, address citizen questions and concerns, and provide more detail in order to acquire a layperson's understanding of the process, some of this risk would be eliminated (Shortland & Gregory, 1991).

DOE and the partnerships acknowledge that public acceptance is necessary if a full commercial operation is going to be effective in climate change mitigation. They also recognize the need for extensive outreach efforts in order to gain this acceptance. This understood, the agency now needs to adopt a policy of transparency and willingness to interact with and address public concern (two-way communication) if they want to be

successful in gaining the public's confidence while helping solve some of the world's farthest reaching social and environmental issues.

## **CHAPTER III**

### **SPREADING THE NEWS ON CARBON CAPTURE AND STORAGE: A STATE-LEVEL MEDIA COMPARISON**

#### **OVERVIEW**

Media play a significant role in public awareness and opinions of energy technologies developed to mitigate climate change. To determine how media portray one such technology, we examined newspapers from 4 states with varying degrees of progress in deployment of carbon capture and storage (CCS). We grounded the analysis in an integration of Luhmann's theory of ecological communication and the SPEED framework. Findings indicated that political, legal, economic and technical frames dominated, with emphasis on benefits, rather than risks of adoption. We also found that CCS reporting increased dramatically as pilot projects started to come on line.

#### **INTRODUCTION**

With increasing pressure to reduce greenhouse gas (GHG) emissions, issues of energy production, GHGs and the development of climate policies are receiving increased attention in the news media (Stephens et al., 2009b). This relatively recent swell in coverage follows a brief peak that occurred when climate change first became headline news with U.S. Senate hearings on climate change and the Intergovernmental Panel on Climate Change was established in 1988 (Peterson & Thompson, 2009). Media inattention to climate change was interrupted by brief interludes: one during the Kyoto Treaty negotiations in 1997, followed by another swell in the mid 2000's where events such as Hurricane Katrina and the release of *An Inconvenient Truth* and the *Stern Review*

drove climate change coverage back in the public eye (Boykoff, 2007; Boykoff & Boykoff, 2007; Feldpausch & Peterson, 2007). Political skepticism over climate change has also kept coverage relatively low and focused on the uncertainties of climate science rather than strategies for mitigating the phenomenon (Antilla, 2005; Boykoff & Boykoff, 2007). Now, with many states actively adopting climate policies and development of mitigation strategies well underway throughout the country, news of climate-related activities has once again captured media attention.

As the second largest emitter of GHGs in the world, the United States will need a portfolio of technologies and approaches to significantly reduce its GHG emissions (goal to reduce emissions by 50 to 80% below 1990 levels by 2050; Kyle et al., 2009; Schmitt Olabisi et al. 2009). Carbon dioxide (CO<sub>2</sub>) capture and storage, also known as carbon capture and sequestration or CCS, is one mitigation technology which could allow significant CO<sub>2</sub> emissions reductions while continuing the use of inexpensive fossil fuel and established fossil fuel infrastructure (Intergovernmental Panel on Climate Change, 2007). CCS is of particular interest in the U.S. because of the technology's unique ability to decrease emissions from the coal-dependent electric sector and other industrial sources, allowing the continued use of plentiful and cheap fossil fuels in a carbon constrained world (Stephens, 2006). With 57% of all CO<sub>2</sub> emissions coming from fossil fuel use, particularly coal, and 85% of current U.S. energy production coming from fossil fuels, the potential impact of adopting CCS technologies is substantial (Wilson et al., 2003; U.S. Department of Energy, 2008b; U.S. Department of Energy, 2010b). Commercial deployment of CCS depends on public support, however, both for

developing policies that encourage CCS, and for accepting local projects under people's back yards (van Alphen et al., 2007; Bradbury et al., 2009; Stephens et al., 2009b).

News media, as a source of information and influence on risk perceptions, will play an important role in determining public acceptance (Peterson & Thompson, 2009).

Geologic CCS involves capturing thousands to millions of tons of CO<sub>2</sub> from stationary sources, transporting it, and injecting it deep (>1km) into the subsurface. A suite of new and proven technologies from capture to geologic sequestration must be linked together to form a CCS system (Stephens, 2006; U.S. Department of Energy, 2007; Stephens, 2009). CCS requires an integrated system including 1) the capture of CO<sub>2</sub> from industrial sources including coal-fired power plants, ethanol plants, and cement, steel and fertilizer production facilities using systems that facilitate capture such as pre-combustion, post-combustion and oxyfuel, 2) transportation via pipeline or other means, 3) storage in geologic formations such as depleted oil and natural gas formations and saline formations and 4) monitoring to ensure safe and permanent storage (McMullan et al., 1997; Stephens, 2006; U.S. Department of Energy, 2008b).

In this study, we examine news media's representation of CCS risks and benefits as an emerging energy technology that mitigates for climate change by analyzing newspapers from 4 states (Massachusetts, Minnesota, Montana and Texas) with varying degrees of public acceptance and progress in emerging energy technology deployment. These states represent geographically and demographically diverse regions of the United States (Table 3.1). They are particularly interesting with regard to CCS because of

**Table 3.1**  
**Key state-level indicators and statistics.**

		Massachusetts	Minnesota	Montana	Texas
<b>Econ. and demographic indicators</b>	Population, 2009 (in millions) <sup>a</sup>	6.6	5.3	1.0	24.8
	Population growth, 2000_2008 <sup>a</sup>	2.3%	6.1%	7.2%	16.7%
	Land area (square miles) <sup>a</sup>	7,840	79,610	145,552	261,797
	Person per square mile, 2000 <sup>a</sup>	809.8	61.8	6.2	79.6
	Per capita income, 2008 (U.S. dollars) <sup>b</sup>	33,806	30,090	23,390	24,709
	Economic growth, 2005 <sup>b</sup>	5.5%	2.9%	NA	4.3%
<b>Energy sector data</b>	Energy consumption, 2006 (trillion Btu) <sup>c</sup>	1,479.1	1,822.0	429.1	11,744.4
	Energy consumption per person, 2006 (million Btu) <sup>c</sup>	229.9	353.5	453.2	501.7
	Electricity from coal, 2008 (MWh) <sup>c</sup>	10,628,688	31,755,253	18,331,532	147,131,841
	Electricity from petroleum, 2008 (MWh) <sup>c</sup>	2,107,999	231,617	419,150	1,033,520
	Electricity from natural gas, 2008 (MWh) <sup>c</sup>	21,514,434	2,865,846	65,659	193,247,078
	Net electricity imported, 1999 (TWh) <sup>d</sup>	12	14	--	--
	Net electricity exported, 1999 (TWh) <sup>d</sup>	--	--	14	19
<b>CO<sub>2</sub> source and sink data</b>	CO <sub>2</sub> stationary source emissions (million metric tons per year) <sup>e</sup>	24.6	65.6	45.5	364.8
	Storage capacity in unminable coal seams (million metric tons) <sup>e</sup>	0	0	293	18,538 to 26,469
	Storage capacity in oil and gas reservoirs (million metric tons) <sup>e</sup>	--	0	1,262	47,761
	Storage capacity in saline formations (million metric tons) <sup>e</sup>	6 to 25	--	265,407 to 988,831	533,600 to 2,133,300

Sources: <sup>a</sup>U.S. Census Bureau, 2010; <sup>b</sup>Bureau of Economic Analysis, 2008; <sup>c</sup>U.S. Energy Information Administration, 2009, 2010; <sup>d</sup>Justo, 2006; <sup>e</sup>U.S. Department of Energy, 2008b.

variations in energy resources, electricity production and carbon storage capacities.

Each of these states also has its own unique history and policy with regard to these characteristics. The regional perspectives they represent can thus be applied to a broader understanding of technology deployment in the United States as well as other nations with state or territory-level structures.

Thus, we seek to determine 1) the extent and focus of CCS reporting throughout the four states with specific attention to frequency and type of frames present, 2) how the technology is portrayed through these frames in the form of risks and benefits, 3) differences between newspapers as correlated with their proximity to energy production and/or political centers, and 4) the level of attention given to climate change as a driver for the adoption of CCS technologies. To achieve this, we first outline our theoretical framework which incorporates Luhmann's social theory and the SPEED framework to analyze the benefits and risks to energy technology deployment. Second we explain the methods used to collect and analyze media coverage of CCS. Third we report the results of the study based on the above criteria. Finally we discuss implications for the use of Luhmann's social theory and the SPEED framework as a means for interpreting media framing and the significance of this communication due to media's role as intermediary for public discourse on CCS.

### **Theoretical Framework**

To better understand how society conceptualizes and addresses environmental issues such as climate change, we use Luhmann's (1989) theory of social function systems. Luhmann posits that while society is connected to its environment (e.g.

dependent on resources, living space, spiritual connections, etc.), it cannot communicate directly with that environment (Peterson, 1992). Rather, as is the case with any system, society can respond to its environment only according to its own mode of operation, which, Luhmann argues, is communication (Peterson, 1992). As such, society can only recognize and deal with environmental problems in terms that can be communicated within one of its subsystems. Luhmann (1989) describes late modern society as constructed of distinct function systems that may communicate with each other when the need arises. Environmental perturbations such as rapid climate change may create that need; leading to what Luhmann (1989) refers to as resonance between function systems. Society may respond to the environment, but “Only in exceptional cases (i.e., on different levels of reality, irritated by environmental factors), can it start reverberating, can it be set in motion. This is the case we designate as resonance” (p. 15).

Luhmann (1989) identifies the six major function systems as economy, law, science, politics, religion and education, and notes that additional systems may also be present. Although each subsystem is closed in respect to its organization and mode of operation, all retain the ability to resonate with one another through communication. Luhmann’s social theory, which defines society as a system within an environment, highlights the importance of internal resonance, or communication, as a means of responding to the complexities presented by environmental perturbations. It also suggests that each environmental issue, as a unique phenomenon, will be communicated throughout the social system differently, depending on which social functions it disturbs.

Despite its conceptual relevance to contemporary environmental problems, however, Luhmann's social theory provides an exclusively macro perspective, and offers little guidance for empirical study. We used the socio-political evaluation of energy deployment (SPEED) framework (Stephens et al., 2008), to guide an empirical study of how contemporary society has responded to climate change, which certainly qualifies as an exceptional case of environmental perturbation. SPEED offers a framework for examining technical, economic, environmental, health and safety, political/legal and aesthetic factors influencing decisions on the deployment of emerging energy technologies, particularly as related to perceived risks and benefits of those technologies. With a lack of federal climate policies and unified support at the national level, U.S. climate policy-making currently rests with the states. Incorporating ideas from the transition management, technology diffusion, state difference and risk perception literature, the SPEED framework focuses on state energy systems because of the states' geographical, political and cultural differences, which influence how they approach project siting, finance, and public acceptance. Stephens et al. (2008) explain that, "understanding the mechanisms and patterns of energy technology deployment within and among U.S. states is a critical component for predicting and planning for energy-related greenhouse gas emissions reductions" (p. 1225). In order to analyze socio-political influences on the deployment of energy technologies, they suggest three methods including 1) policy reviews, 2) media analyses, and 3) interviews with key stakeholders. These methods help provide an overall picture of the current condition of CCS deployment and investigate what hurdles are left to overcome in order for

deployment to take place at the state level. In this study, we are focusing on media analyses.

### **The Role of News Media in Public Acceptance**

Mainstream news media play an important role in informing the public of scientific and technological findings, advances and uncertainties associated with climate change and its mitigation (Corbett & Durfee, 2004; Carvalho, 2007). According to Corbett and Durfee (2004), media serves as the main conduit for such knowledge. As intermediaries between the public and political and scientific elites (Manning, 2001), journalists frame problem discovery, how the public interprets problems, and public acceptance or rejection of technologies developed to remediate problems (Stephens et al., 2008; Weaver et al., 2009). In many cases, this framing can determine whether technologies will be considered a scientific breakthrough and benefit to society or a risk too large to warrant continued investigation (e.g. nanotechnology, stem cell research). For environmental issues such as climate change, the news media help frame both the problem and its possible solutions, interacting with multiple sectors of society and integrating past experiences with other issues (Hansen, 1991). News media therefore not only control the flow of information, deciding its newsworthiness, but also influence political agendas by determining focus and framing of information presented (Cox, 2010). This focus and framing includes the perception of risks and benefits (Peterson & Thompson, 2009).

## METHODS

For purposes of analysis, we examined 3 newspapers from each of the states of Massachusetts, Minnesota, Montana and Texas (Table 3.2). These newspapers represent the 1) highest circulated newspaper in the state, 2) newspaper from the state capital or a paper covering a different geographic region in the state, and 3) newspaper covering the area closest to major energy technology activities. Major newspapers with articles highlighting CCS technologies were obtained using the LexisNexis™ Academic search guide. For smaller newspapers not available on LexisNexis™, other search guides and newspaper archives were used. The search criteria included all articles with the terms CCS, carbon sequestration, CO<sub>2</sub> sequestration, carbon capture, CO<sub>2</sub> capture, carbon storage, CO<sub>2</sub> storage, carbon capture and storage, carbon dioxide capture and storage, CO<sub>2</sub> capture and storage, and/or clean coal in the title and/or lead paragraph of an article. By limiting the search to the title and/or lead paragraph, we were able to ensure that the article focus was on CCS, eliminating possibilities of just a mere mention of the technologies in the article. Search dates were from January 1, 1990 to June 15, 2009, encompassing articles coinciding with the publication of the 1990 Intergovernmental Panel on Climate change (IPCC) Assessment Report to the start date for the study. All types of articles were included in the analysis (i.e. news, business, editorials/ opinion pieces, etc). Articles not strictly adhering to the search criteria were manually removed from the retrieved set of articles for each paper. Attributes were recorded for each article and articles were given individual identifiers. Article text was unitized at the sentence level for the purpose of coding.

**Table 3.2**  
**Newspapers included in the news media analysis.**

<b>Paper Type</b>	<b>Massachusetts</b>	<b>Minnesota</b>	<b>Montana</b>	<b>Texas</b>
Highest circulated	<i>Boston Globe</i>	<i>Minneapolis Star Tribune</i>	<i>Billings Gazette</i>	<i>Houston Chronicle</i>
State capital or different region	<i>Springfield Republican</i>	<i>St. Paul Pioneer Press</i>	<i>Missoulian</i>	<i>Austin American-Statesman</i>
Closest to energy technologies	<i>Cape Cod Times</i>	<i>Duluth News Tribune</i>	<i>Bozeman Daily Chronicle</i>	<i>Midland Reporter Telegram</i>

We examined articles using a codebook that was developed through the integration of Luhmann's (1989) theory of social theory and the SPEED framework (Stephens et al., 2008). Frames for analysis were technical, economic, environmental, health and safety, political/legal and aesthetic. An 'other' category was also included for statements that did not fit or were too vague to categorize but still demonstrated a position on the technology. We defined frames broadly, as a set of text that may "supply content and suggest what the issue is through the use of selection, emphasis, exclusion, and elaboration" (Crawley, 2007, p. 318). Each frame examined both the benefits toward and the risks/uncertainties of the technologies and their commercialization. Criteria for each of the six frames along with their respective benefits and risks/uncertainties to deployment were outlined in the codebook (Table 3.3; Fischlein et al., 2010). We used QSR International's NVivo 8.0™ qualitative software to code articles, first individually and then as a team so that all articles were independently coded by at least two people and then corroborated by those individuals to ensure coding consensus. To maintain coding integrity, articles were distributed in such a manner that each coder shared a certain number of articles with each of the other 3 coders to ensure fidelity to the coding protocol and norms. Queries addressing the frequency of various

frames employed over time and by newspapers were run with the corroborated data to delineate salient patterns.

**Table 3.3**  
**CCS media codebook outlining the six frames and their respective risks/uncertainties and benefits.**

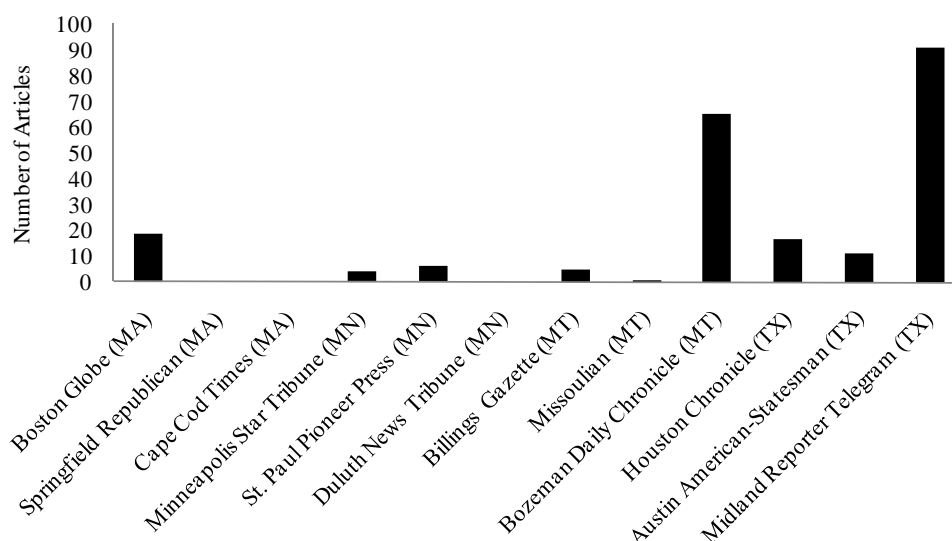
<b>Frames</b>	<b>Risk/Uncertainty</b>	<b>Benefit</b>
Technical	<ul style="list-style-type: none"> <li>- Technology may not work</li> <li>- Historical perspective of negative experiences with technology</li> <li>- Infrastructure challenges</li> <li>- Technical limitations</li> <li>- Technology not fully researched, developed, or demonstrated</li> <li>- Technology not eligible for every location</li> <li>- One aspect of the technology depending on the success of another uncertain aspect</li> </ul>	<ul style="list-style-type: none"> <li>- Technology is advanced, sophisticated</li> <li>- Reliability and operational success</li> <li>- Technology demonstrated</li> <li>- Takes advantage of existing resources</li> <li>- Takes advantage of existing infrastructure</li> <li>- Considered “shovel ready”</li> <li>- People educated on how to do/use technology</li> </ul>
Economic	<ul style="list-style-type: none"> <li>- Technology may be expensive, more expensive than other options</li> <li>- Technology may have indirect costs to economy</li> <li>- Technology may have inconsistent demand or no demand at all</li> <li>- Cannot go commercial or it is uncertain</li> </ul>	<ul style="list-style-type: none"> <li>- Technology may strengthen economy if it still enables use of coal</li> <li>- Technology is cheaper than other options</li> <li>- Technology helps to meet growing electricity demand</li> <li>- Technology can help to further extract oil</li> <li>- Financial support or backing given</li> <li>- Ability to go commercial</li> </ul>
Environmental	<ul style="list-style-type: none"> <li>- Technology may have negative environmental consequences</li> <li>- Allows the continued use of coal and increase non-carbon environmental degradation associated with coal</li> </ul>	<ul style="list-style-type: none"> <li>- Technology may reduce/divert GHGs or carbon emission, mitigate climate change</li> <li>- If technology is referred to as green, clean, pollution-free or environmentally friendly</li> <li>- Helps alleviate “downstream” issues</li> </ul>
Health & Safety	<ul style="list-style-type: none"> <li>- Technology may pose health or safety concerns to local residents</li> <li>- Technology may pose risks for workers, worker safety</li> </ul>	<ul style="list-style-type: none"> <li>- Technology may improve health and safety</li> </ul>

**Table 3.3 continued.**

<b>Frames</b>	<b>Risk/Uncertainty</b>	<b>Benefit</b>
<b>Political/Legal</b>	<ul style="list-style-type: none"> <li>- Attempts of technology deployment have negative political ramifications, image, reputation of state or political leaders</li> <li>- Any mention of comparative state rankings in a competitive way</li> <li>- The political/legal process is difficult to navigate</li> <li>- Public frustration with government or process</li> <li>- Technology could lead to abuse of land-use</li> <li>- Technology is threat to military or political security</li> <li>- Lack of CO<sub>2</sub> regulations</li> <li>- Public official with negative perceptions</li> <li>- Rips prior affiliations apart</li> <li>- Lacks political support</li> </ul>	<ul style="list-style-type: none"> <li>- Technology deployment attempts have positive political ramifications in the state</li> <li>- Technology brings positive political benefits to the US in the global context</li> <li>- Technology deployment brings state closer to meeting established state goals</li> <li>- Technology contributes to energy independence, enhanced national security, energy security, etc.</li> <li>- Legislation is present or being considered that would help or facilitate the technology</li> <li>- Brings unlikely allies together for technology</li> <li>- Public official with positive perceptions Uses the words “win-win” or “game-changer”</li> <li>- The political/legal process is made easier to navigate</li> <li>- Resolves liability issues</li> </ul>
<b>Aesthetic</b>	<ul style="list-style-type: none"> <li>- Technology has negative visual impacts</li> <li>- Technology may have negative impact on cultural, historical or recreational sites</li> </ul>	<ul style="list-style-type: none"> <li>- Technology has positive visual or community educational impacts</li> </ul>
<b>Other</b>	<ul style="list-style-type: none"> <li>- Negative about technology</li> </ul>	<ul style="list-style-type: none"> <li>- Positive about technology</li> </ul>

## RESULTS

In our analysis, we found that only 9 of the 12 regional newspapers surveyed reported on CCS technologies over the 19 year period, resulting in a total of 219 articles. Of those 9 newspapers, only one Massachusetts paper (*Boston Globe*) and two Minnesota papers (*Minneapolis Star Tribune* and *St. Paul Pioneer Press*) published on CCS (Figure 3.1). All three of the Montana and Texas papers, however, had articles focused on CCS technologies at some point during the duration of the study. The majority of this reporting came from regional newspapers closest to energy industrial

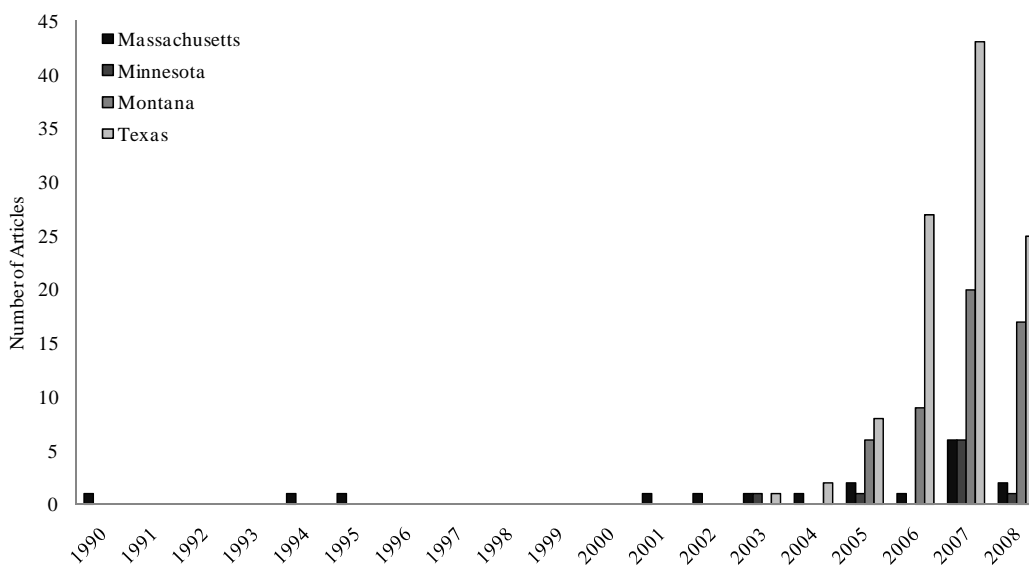


**Fig. 3.1.** Number of articles reporting on CCS from January 1, 1990 to July 15, 2009 by regional newspaper from the states of Massachusetts, Minnesota, Montana and Texas (Massachusetts = 19 articles, Minnesota = 10, Montana = 71 and Texas = 119).

sites or CCS research sites (*Midland Reporter Telegram* and *Bozeman Daily Chronicle*).

Montana and Texas newspapers overall showed the highest frequency of articles on CCS in comparison to Massachusetts and Minnesota.

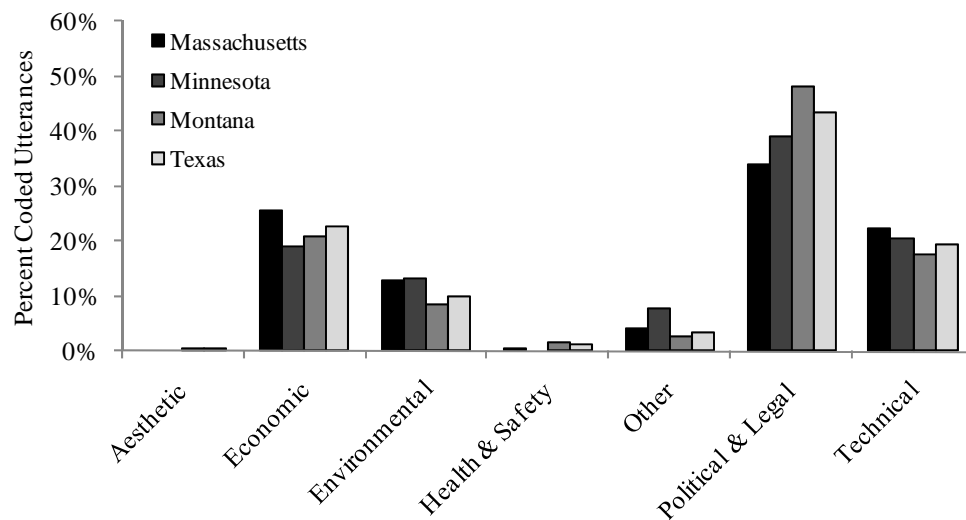
An analysis of reporting between 1990 and 2008 showed minimal and highly sporadic reporting focused on CCS until 2001 (Figure 3.2). More thorough reporting across the 9 newspapers started in 2003 and began to increase in frequency in 2005 with a peak in 2007. Montana and Texas consistently demonstrated the highest rates of reporting from 2005 to the present. This higher incidence of reporting is likely associated with ongoing CCS projects in those states - the DOE Regional Carbon Sequestration Partnerships in both states and the proposed FutureGen project in Texas.



**Fig. 3.2.** Number of articles reporting on CCS from January 1, 1990 to December 31, 2008 by state.

The framing analysis by state demonstrated a strong focus on the political/legal frame; the highest of which was in the state of Montana with 48% of coded material addressed within this frame (Figure 3.3). Montana journalists showed particular interest in the political/legal frame due to proposed legislation on a regulatory framework for underground CO<sub>2</sub> storage including the designation of liability and ownership rights (i.e. surface vs. pore space vs. mineral), and economic incentives for its adoption. Montana's governor, Brian Schweitzer, was a prominent figure throughout the articles as a proponent of coal-to-liquids technology with the incorporation of CCS technologies for reducing GHG emissions. According to the *Bozeman Daily Chronicle* in their May 19, 2008 article titled "MSU's earmark money fund fight against global warming", "Montana's governor is keenly interested in capturing carbon so the state can develop its

vast coal deposits.” This statement demonstrates a linkage between the political/legal and economic frames with one frame driving action within the other. Montana State University also received media coverage as the lead university in the Big Sky Carbon Sequestration Partnership (BSCSP) which is one of seven regional joint government-industry partnerships charged with the characterization, validation, and deployment carbon sequestering technologies. Part of the partnership’s responsibilities includes involving diverse stakeholders in the research and development of CCS technologies not to mention participating in discussions addressing regulatory frameworks.



**Fig. 3.3.** Comparative breakdown of frames by state. Reported as percent of coded utterances (Massachusetts = 161 coded utterances, Minnesota = 179, Montana = 814 and Texas = 2197).

The political/legal frame was also dominant in the other three states. The majority of this attention stemmed from states’ attempts to develop their own legislation, standards, or precedents prior to national legislative efforts in order to establish control

at the state level over CCS regulation. This frame also addressed a high number of projects attempting to navigate the siting and permitting process with varying success, often connecting back to states' attempts at legislated incentives and other actions to encourage technology implementation. Texas newspapers in particular exhibited a high level of reporting on this topic (43% of coded utterances) because of their bids for FutureGen and other near-zero emissions power plants. National level efforts in this frame only received minor attention including references to clean coal and CCS as part of presidential candidate platforms for the 2008 elections, further highlighting discrepancies between regional, state and national efforts in CCS deployment.

Technical and Economic frames were next in level of coverage. These two frames were often reported within the same articles as the political/legal frames because of the relationships between desires to improve the economy, project planning and the creation of a legal framework in which to make it a reality. Most of the projects boasted the creation of jobs in the communities where they were proposed. In Montana and Texas, economic incentives to move forward in project development included taking advantage of the states' non-renewable resources such as coal in Montana and oil and gas in Texas. These two states have the additional benefit of large capacities for CO<sub>2</sub> storage with Texas particularly interested in the implications of cheap CO<sub>2</sub> for the purposes of enhanced oil recovery (EOR), a process for recovering oil from nearly depleted oil fields. Few articles, however, actually reported on the negative implications of such projects except for financial risks to the companies or U.S. tax payers (i.e. for government funded projects) if the project hit any road bumps to construction such as

poor market demand, a fluctuating economy, problems with permitting, failure to receive government incentives, etc. From the consumer perspective, journalists noted that CO<sub>2</sub> capturing technology decreases the efficiency of energy production, thus raising the overall costs of energy. Journalists also reported on the readiness of the technology for commercial deployment, acknowledging doubts that it will go commercial anytime soon. Some journalists went as far as to report the technology as ‘experimental,’ especially in reference to FutureGen. For example, in an interview with the *Midland Reporter Telegram* on the viability of CO<sub>2</sub> storage:

Senior research engineer and associate director of New Mexico Tech's Petroleum Research and Recovery Center at New Mexico Tech, Reid Grigg, said the project is Phase III of a decade-long project to discover if CO<sub>2</sub> can be permanently stored in coal seams...If we're going to sequester CO<sub>2</sub>, we has to prove that we not only [know] where it's going but that it's going to stay there” (November 23, 2008).

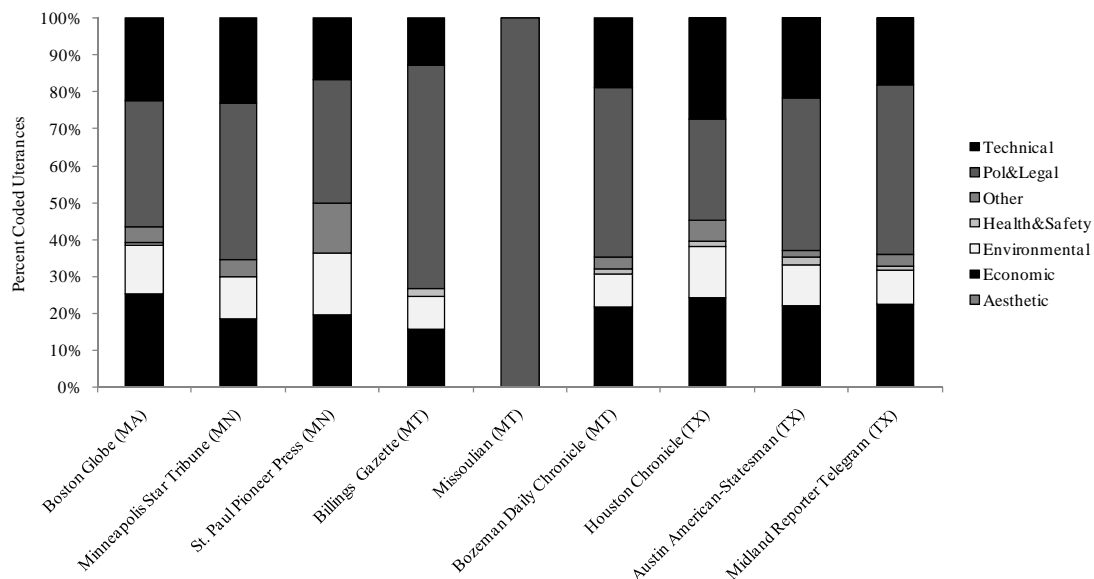
This type of reporting, however, varied by project and specific CCS technology, with some reports featuring aspects of the technology that are well proven such as the gasification of coal for the production of liquid fuels mentioned in a May 6, 2007 article by the *Houston Chronicle*: “The process of converting coal to gas or liquid fuel was developed in Germany and helped power the Nazi war machine during World War II.”

Receiving the least amount of attention from journalists of all four states were the environmental, health and safety and aesthetic frames. These frames represented many of the benefits and drawbacks of climate change and the adoption of CCS technologies. The environmental frame in particular reflected the amount of coverage given to climate change as an issue for mobilization. The majority of statements attributed to this frame highlighted the amount of emissions that could be reduced from the adoption of CCS. It

also encompassed statements about the current state of environmental quality caused from ‘old’ and ‘dirty’ power plants, touting improved quality through the construction of clean coal facilities. The health and safety frame received even less attention than the environmental frame, with minimal attention given to the effects of CCS on public health and safety. When mentioned it often addressed either 1) the possibility of the release of toxic chemicals from a plant failure, CO<sub>2</sub> leaks, minor earthquakes, water contamination and impacts to property rights and/or the safety measures put in place to prevent such occurrences or 2) the ability of CCS to improve air quality. It should be noted that assurances of safety in these articles often came from recognized ‘experts’ in relevant fields or agencies or from acknowledgements of the level of research conducted on such facilities or geologic formations. For instance, the *Bozeman Daily Chronicle* reported that “In its first regulations on the burial of carbon dioxide underground, the EPA on Tuesday unveiled measure to protect drinking water from the gas behind the bubbles in carbonated beverages” (July 16, 2008). Finally, aesthetics received the least amount of attention of all the frames with a reference playing off of the common environmental justice acronym, NIMBY, but instead calling it NUMBY: Not Under My Back Yard (*Austin American-Statesman*, October 2, 2007). CCS was also touted as a way to “preserve our outdoor heritage and break our dependency on foreign sources of energy” (*Bozeman Daily Chronicle*, November, 18, 2008). Unlike technologies such as wind which involves the construction of structures new to people’s viewscapes (Stephens et al. 2009), CCS technologies involve more familiar structures (i.e. power plants, injection wells, etc.) or they are out of site, below ground.

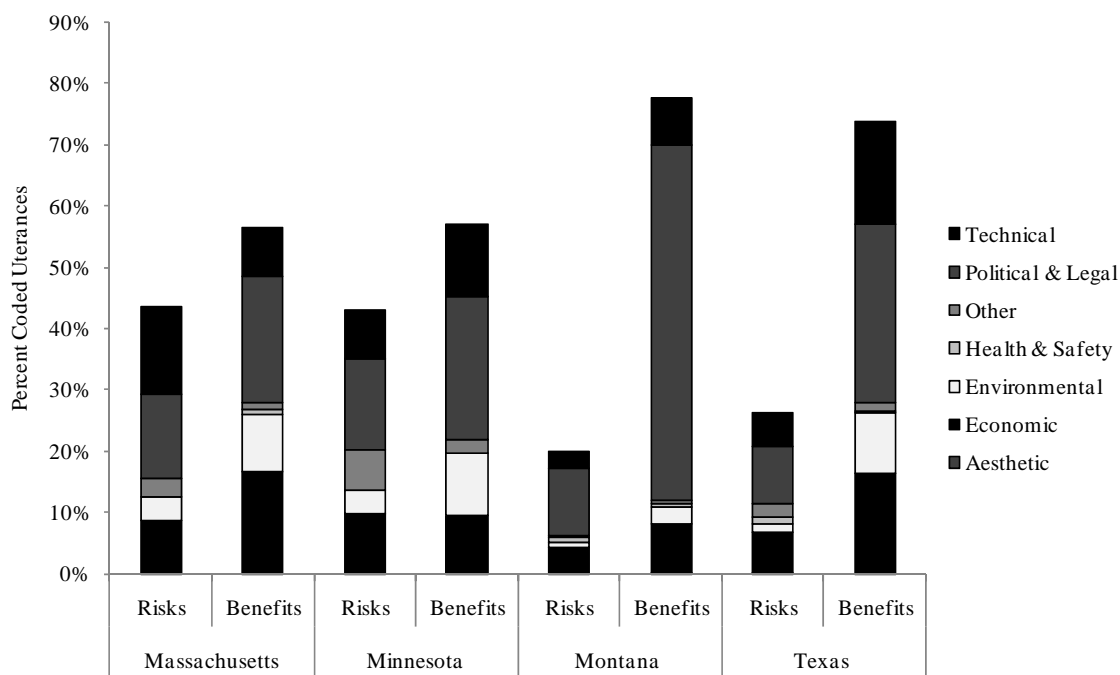
In addition to state differences in framing, regional differences also existed between papers from the same state (Figure 3.4). As demonstrated to a degree above, newspapers closer to project sites focused on frames directly impacting their particular project (i.e. the *Bozeman Daily Chronicle*'s focus on activities of the BSCSP or the *Midland Reporter Telegram*'s heavy coverage of FutureGen). No patterns were evident, however, between the represented regions and their particular demographic with the exception of the *Missoulian*'s single article focused solely on CCS legislation.

A breakdown of frames into their opposing values (i.e. risks/uncertainties vs. benefits) by state showed a mixture of reactions about the deployment of CCS technologies (Figure 3.5). Massachusetts was generally negative toward technological



**Fig. 3.4.** Comparative breakdown of frames by newspaper. Reported as percent of coded utterances (*Boston Globe* = 161 coded utterances, *Minneapolis Star Tribune* = 113, *St. Paul Pioneer Press* = 66, *Billings Gazette* = 101, *Bozeman Daily Chronicle* = 702, *Missoulian* = 11, *Austin American-Statesman* = 162, *Houston Chronicle* = 271 and *Midland Reporter Telegram* = 1764).

readiness of CCS operations; the only state out of the four to focus more on the risks, especially considering the state's lack of capacity for geologic storage. As demonstrated by the "other" frame, general statements of uncertainty and concern were also made throughout Massachusetts' articles. This was reversed in state reporting on political/legal, health and safety, environmental, and economic frames, demonstrating a preference for displaying the benefits of CCS. Minnesota, Montana and Texas journalists largely reported on the benefits to CCS deployment with a few exceptions. Minnesota reported on an even number of risks and benefits for the economic frame and eluded to risks and uncertainty in general statements too vague to place. Montana was



**Fig. 3.5.** Comparative breakdown of specific risk/uncertainty frames and benefit frames by state. Reported as percent of coded utterances of each category (Massachusetts = 161 coded utterances, Minnesota = 179, Montana = 814 and Texas = 2197).

the most positive in their portrayal of the technology except in their health and safety frame. Similar to Montana, Texas was equally positive in all but health and safety and the ‘other’ frame. Therefore reporting was positive overall toward deployment.

In a final examination, the analysis of word frequencies, we found a large overlap in subject matter, with the majority of reporting focused on proposed projects, industrial players/companies, impacts of a new technology on energy resources and power production, legislation and the control of GHG emissions, mainly CO<sub>2</sub> (Table 3.4). The word frequency analysis excluded terms used in the article search process assuming a high frequency of use biased by the search itself. This included the terms CCS, carbon, dioxide, CO<sub>2</sub>, sequestration, capture, storage, clean and coal. Words commonly used throughout the articles, excluding search terms, were general terms addressing a particular facility, project or fossil fuel. Less common terms specific to each state were largely location-based, featuring specific projects or companies such as Xcel Energy’s plan to build a clean coal plant in Minnesota and pipe the CO<sub>2</sub> to Colorado for storage or Texas’ bid for FutureGen which was eventually awarded to Mattoon, Illinois before it was cancelled completely in 2008. Cities of particular significance also ranked high on the list with Bozeman ranking 3<sup>rd</sup> due to its involvement with the BSCSP and Midland ranking 10<sup>th</sup> due to the city’s involvement in a bid for FutureGen. The term “bill” also received a high ranking in Montana because of attention given to legislative acts. Because Massachusetts imports the majority of their energy and lacks the proper geology for CO<sub>2</sub> storage, none of the top 10 terms listed was specific to activities occurring within the state.

**Table 3.4**

**Top 10 most frequently used words in newspaper articles by state. This list excludes search terms used in article acquisition and other words not pertaining to the technology. Words in dark gray are mentioned in all four columns, words in light gray in two or three columns, and words in white are unique to that column only.**

Massachusetts	Minnesota	Montana	Texas
Energy	Energy	energy	FutureGen
Power	Minnesota	Montana	Texas
New	Plant	Bozeman	energy
Gas	Power	state	project
Plant	Gas	power	plant
companies	Percent	gas	oil
Plants	Project	bill	power
emissions	Xcel	plant	site
Oil	Emissions	chronicle	state
technology	Plants	plants	Midland

Few of the newspaper articles focused exclusively on mitigation of climate change as the primary reason for, or benefit to be gained by, deployment of CCS. In the examination of word frequencies, the term “climate” was ranked 19<sup>th</sup> in use in Massachusetts and 41<sup>st</sup> in Montana. Climate, however, did not rank in the top 100 words for either Minnesota or Texas. The words “global” and “warming” received relatively equal attention to “climate” in Massachusetts (ranked 16<sup>th</sup> and 27<sup>th</sup>) and substantially more attention in Montana (ranked 29<sup>th</sup> and 31<sup>st</sup>), Minnesota (ranked 46<sup>th</sup> and 42<sup>nd</sup>) and Texas (ranked 56<sup>th</sup> and 80<sup>th</sup>) indicating a preference for the term global warming over climate change in the public lexicon. Unlike “climate,” “global” and “warming,” “emissions” did receive a top 10 listing in both Massachusetts and Minnesota. This analysis demonstrated an overall higher prevalence of reporting on climate change as part of the topic of discussion in states lacking extensive CCS capacities (i.e.

Massachusetts) compared to states where CCS projects are being proposed or in-progress (i.e. Minnesota, Montana and Texas).

## **DISCUSSION**

In our examination of regional media reporting on CCS, we found very different pros and cons due to regional needs and the perceived appropriateness of CCS use in our study states. For example, in two of our study states, Massachusetts and Minnesota, the presentation of CCS was thin because of limited opportunities for the technologies. Not only did these states lack geologic storage capacity, thus essentially removing their involvement from a portion of operations, but they also were not on the receiving end of large government-funded projects like Montana and Texas. Geologic CCS was therefore more of an abstract discussion or one that involved contact with other states in order to carry out operations (e.g. both capture and storage of CO<sub>2</sub>). However, in Montana and Texas, CCS received more attention by media because of more extensive opportunities for CCS implementation, not to mention benefits such as CO<sub>2</sub> for EOR operations in Texas and the continued use of coal resources in Montana.

In addition to determining the salience of CCS by state, we were also able to 1) better understand delays in CCS reporting, 2) determine why certain frames received more attention than others and 3) investigate connections made between climate change and CCS as a strategy for mitigation.

### **Level of Reporting on CCS by News Media**

Most of the technologies involved in the capture, transport and geologic storage of anthropogenic CO<sub>2</sub> are well established and have been in existence for a while in

some fashion or another (i.e. gasification of coal for the purposes of making fuel during World War II and the injection of CO<sub>2</sub> in geologic formations for enhanced oil recovery since the 1980's; Wilson et al., 2003; Stephens, 2006). First discussed in its current combined form in the early 1990's as a possibility for mitigating climate change (First International Conference on Carbon Dioxide Removal in 1992; Herzog, 2001), it took over a decade before CCS became a truly newsworthy topic. This delay in reporting represents a lag period in public interest of such technologies and its pursuit by public and private interests. Our results showed that steady reporting on CCS did not begin until 2003, coinciding with the launch of the regional carbon sequestration partnerships. Other peaks coincided with proposals for clean coal plants and the bidding war over FutureGen when opportunities and risks become public and private concern. Bradbury and Dooley (2004) found similar results stating that:

The articles showed a strong tendency to group around specific events (i.e., their release was likely triggered by these events). For example, slightly more than 20% of all of the articles appeared in close proximity to the announcements by the DOE of the FutureGen project (February 2003) and the Carbon Sequestration Leadership Forum (June 2003).

Unlike wind and other renewable energy sources whose infrastructure is still in its early stages, CCS takes advantage of existing infrastructure, regulations and legal experience with the fossil fuel industry and waste disposal, and social norms involving the fossil fuel industry, resulting in less immediate attention from news agencies. This lack of attention though is short lived. Nearing the point of commercialization, the various technologies start to gain regional attention because of the necessity for a regulatory framework in deployment as a means for dealing with proposed projects. With these

proposals come recollections of past experiences and discussions of the risks and benefits to communities, regions and the state itself. Crawley (2007) found this to be the case with news reporting on genetically modified crops. Implementation of agricultural biotechnology failed to make national news, but it did receive local attention because the technological risks are localized.

### **Frames and Function Systems**

We found that the political/legal, economic and technical frames dominated text with preferences toward benefits of adoption over risks and uncertainties. Luhmann (1989) notes that “only through limitation does the economy achieve the immense internal complexity of a monetarily integrated system...Limitation, therefore, is the condition of its expansion, and this expansion contains the much deplored consequences for society’s environment” (pgs. 51, 52). We found that newspapers used the economic frame to relay the desire for economic expansion in their communities or regions. For states such as Montana and Texas, CCS was portrayed as means to protect and boost the fossil fuel industry by reducing carbon emissions without reducing use of fossil fuels. For states whose economies are dependent on fossil fuels, a positive perception of CCS was expected so as to continue production of their dominant commodity. Examples of such sentiments include these two excerpts from the *Bozeman Daily Chronicle* and the *Midland Reporter Telegram*:

The reason this bill is necessary is that in order to sell that coal (energy) back east or to California, they want green lemonade,” said Sen. Jerry Black, R-Shelby (Bozeman Daily Chronicle, March 24, 2009).

The success of FutureGen in the Permian Basin will not only help meet strict environmental standards through the use of clean coal technology,

reducing greenhouse gas emissions, but the applied technology will capture CO<sub>2</sub> that can be used to produce more Permian Basin oil ("green oil"). It will produce more jobs, generate more State and local revenue and reduce our country's dependence on foreign oil. I like to think of it as the "Greening of the Oil Patch" (Midland Reporter Telegram, December 9, 2006).

Focusing next on politics and law, Luhmann (1989) argues that “whatever does not fit within the language of prices [the economic function system] has to be expressed in the language of norms. Whatever the economy does not bring about on its own has to be accomplished by politics with the help of its legal instrument” (p. 63). As noted above, the economic and political/legal frames were often mentioned together, especially in articles discussing proposed projects. The political/legal framing was especially dominant in Montana and Texas, representing almost half of the coded statements. Without the proper legal framework in place to address permitting, rights determination and liability, many of the proposed projects cannot move forward, thus preventing the acquisition of jobs and other monetary promises made by project proponents. Current regulatory structures for injecting CO<sub>2</sub> involve a mixture of agencies and regulatory authorities at both the state and national levels (Wilson et al., 2003). Even with a semblance of structure in place, tangled as it is, it still fails to address all of the risks and uncertainties associated with CCS (i.e. liability and ownership), thus requiring additional legislation as discussed in news articles from all four states, or a revisit to existing legislation with new considerations (Wilson et al., 2007; 2008).

Similar to the relationship between economics and politics, politics is often dependent on science to provide research and technology with the hopes of solving environmental problems. Because science deals with truth and falsity in the form of

theoretical paradigms and methodologies (Luhmann, 1989), its overarching drive is the acquisition of knowledge. Thus science as a function system has the ability to alert society of environmental problems such as anthropogenic climate change and create technologies with specific goals in mind. In references to the technology, journalists would use this frame to make claims to the maturity of CCS technologies, deeming CCS experimental or shovel-ready, both of which were used to describe projects such as FutureGen.

Though the environmental, health and safety and aesthetic frames did not receive as much attention as economics, political/legal and technical frames, they were still present in news media reporting. In many respects, articles showed a departure from the debate over the validity of climate change as a human-caused phenomenon and instead moved the argument into the realm of how best to act in order to reduce GHG emissions. This was reflected not only in the use of the environmental frame, but also in the word frequency results, showing higher use of the term emissions than climate change or global warming. The environmental frame was often used by journalists to show technology effectiveness and motive for the construction of new plants. Results for the health and safety frame on the other hand alluded to a knowledge gap not only by journalists as technological laypersons, but also project proponents, having only a few projects worldwide underway serving as a reference for project success at the commercial scale. Aesthetics related to the fossil fuel industry, however, were considered nothing new.

## CONCLUSION

When it comes to environmental issues such as climate change and the reduction of GHGs, news media provide the public with information and political and scientific elites with a window into public discourse. Media also shape how that information is received through the use of frames that help determine future discussions for environmental action. In the case of CCS technologies, news media serve as a gauge for opinions and interests of both the public and political elites. Through examination of newspaper articles from 4 states experiencing varying degrees of public acceptance and progress in the deployment of CCS technologies from 1990 to 2009, we were able to determine how news media interprets and frames CCS projects. The results demonstrate key differences in the framing of CCS deployment throughout the four states with each state representing a contrast in geography and culture, impacted by varying values, economies and geologies. They all, however, had some connection to or capacity for CCS technologies. Media reporting showed that newspapers closest to CCS projects had substantially more articles than the other newspapers surveyed. This was especially apparent in Montana and Texas with a high level of reporting from the *Bozeman Daily Chronicle* and *Midland Reporter Telegram*. All states exhibited a preference for the use of political/legal, economic and technical frames, with intermediate attention given to the environmental frame and minimal attention to health, safety and aesthetics. Benefits also tended to outweigh the presentation of risks and uncertainties, indicating a positive perception on the part of media on CCS technologies and their future implementation.

Though climate change served as the basis for the adoption of CCS technologies, it was somewhat lost in the benefits and risks to implementation, especially in states with proposed or in-progress CCS projects. Journalists often acknowledged climate change in their articles as demonstrated by use of the environmental frame, accounting for 9% to 13% of coding by state, but because it is still considered a contentious issue, focus was kept more on the reduction of emissions and other benefits/risks (i.e. economic, political, etc.) than reducing the impacts of climate change specifically. This may be a strategy on the part of journalists for promoting or acknowledging CCS as more than just an option for climate change mitigation (i.e. benefits to EOR and air pollution standards), but it also brings a global issue to the local in a manner that is easier to discuss and consider than the grander, more overwhelming discussion of how to deal with climate change.

## **CHAPTER IV**

### **PUBLIC PERCEPTIONS OF CARBON CAPTURE AND STORAGE IN THE AMERICAN SOUTHWEST: COMMUNITY KNOWLEDGE AND ACCEPTANCE OF SOUTHWEST PARTNERSHIP PILOT PROJECTS**

#### **OVERVIEW**

As a potential mitigation strategy for anthropogenic climate change, carbon capture and storage (CCS) technologies are being tested around the world, including the American Southwest. The implementation of such technologies, however, depends upon public acceptance, especially by potentially impacted communities. In this study I conducted focus groups across the Southwest to discover how communities near CCS pilot sites perceive the technology and accept the possibility of deployment. I found that participants focused their conversations on industry and government knowledge, risks and unknowns of CCS and processes for decision-making. These topics also provided an impetus for caution. Skepticism and distrust of government entities and corporations influenced participant willingness to accept storage risks to mitigate for CO<sub>2</sub> emissions. After open discussion of pros and cons associated with the technology, however, participants were more willing to consider CCS as an option, indicating a need to talk through the issue and come to their own conclusions.

#### **INTRODUCTION**

Carbon capture and storage, also known as carbon sequestration or CCS, is a technology that is receiving global attention as a mitigation strategy for anthropogenic climate change. According to scientists, including members of the Intergovernmental

Panel on Climate change, CCS has the potential to significantly reduce CO<sub>2</sub> emissions from fossil fuels and other emissions intensive industries (Herzog, 2001; Intergovernmental Panel on Climate Change, 2005; Stephens, 2006). This technology involves the capture and long-term or permanent storage of CO<sub>2</sub> by one of three strategies: geologic, terrestrial and oceanic. The U.S. Department of Energy (DOE) is currently pursuing projects in geologic and terrestrial CCS (U.S. Department of Energy, 2007). Geologic CCS refers to the capture of CO<sub>2</sub> from industrial facilities (capturing 85-95% of CO<sub>2</sub> produced) such as coal-fired power plants, cement factories and steel refineries, and the storage of this CO<sub>2</sub> in geologic formations including depleted oil and natural gas formations, unmineable coal seams, saline formations, organic shales, and basalt formations (Intergovernmental Panel on Climate Change, 2005; Stephens, 2006; U.S. Department of Energy, 2008b). Terrestrial CCS involves the absorption of CO<sub>2</sub> from the atmosphere by vegetation through the process of photosynthesis, converting CO<sub>2</sub> to organic carbon. With geologic and terrestrial pilot projects in various stages of development around the world, including projects in the United States, Germany, Denmark, the Netherlands, Japan and Australia (Ashworth, 2009), the future of CCS commercialization now depends on its acceptance by the general public (van Alphen et al., 2007; Bradbury et al., 2009; Stephens et al., 2009a). This acceptance, however, may not be easily obtained due to its dependence on factors at multiple scales (i.e. local, regional, national and global) and impact on various systems within society.

When it comes to the implementation of new energy technologies, social acceptability depends upon factors such as past experiences with government and/or

industry (impacting trust relations), benefits or costs to the community including but not limited to economics, health and safety, aesthetic changes, and other socio-economic and political factors (Huijts et al., 2007; Bradbury et al., 2009; Stephens, 2009b). Based on studies analyzing public acceptance of renewable energy technologies and CCS, Wustenhagen et al. (2007) describes social acceptance as comprised of three dimensions. These dimensions include socio-political, community and market acceptance. Focusing on the second dimension, they outline procedural justice, distributional justice and trust as the main contributors to community acceptance. Because the impacts of CCS are generally localized (i.e. health, economics and various environmental impacts both above and below ground), community acceptance can serve as a strong indicator for national if not global acceptance of such a technology.

### **Community Acceptance and Procedural Justice**

Past events have shown that concerns of communities living close to energy technology projects have not always received the attention warranted (O'Rourke & Connolly, 2003; Cox, 2010). Public response to the risks of these technologies have often been characterized and dismissed as emotional or irrational (Loewenstein et al., 2001; Kunreuther, 2002; Slovic et al., 2004). Furthermore, it was expedient for experts to ignore public concerns if there were economic or political pressures for an energy technology to move forward (O'Rourke & Connolly, 2003; Endres, 2009). Findings, however, suggest that expert definitions of risk (e.g. probabilities and consequences; Bradbury, 1989; Kunreuther, 2002) are fundamentally different from that of the layperson who is concerned with a more diverse set of uncertainties (e.g., stigma,

economic risk; Otway & Von Winterfeldt, 1982). Dismissing the concerns of the public can also defeat the implementation of new energy technologies even if expert defined risks are low (Endres, 2009). Therefore, process transparency and public involvement in decision-making are integral for ensuring fairness and building trust to gain public acceptance.

Procedural justice literature argues that, when it comes to decision-making, people care about how they are involved in a process and that their input is taken into consideration when decisions are finally made (Borsuk et al., 2001). Lind and Tyler (1988) argue that people are generally more interested in the process than in a specific outcome. Whether or not they approve of the final outcome, people respond more positively to outcomes coming from social processes deemed fair and just than those perceived as biased (Thibaut & Walker, 1975; Lind & Tyler, 1988; Kim & Mauborgne, 1998). Gangl (2003) adds that open debate among competing interests is often “more important than outcomes when it comes to assessments of legitimacy” (p. 136). In addition to creating increased public legitimacy for a decision or outcome, positive assessments of a process “also can lead to more positive assessments of the outcomes produced” (Gangl, 2003, p. 135). In the case of CCS, studies have already shown that the public is currently unaware of technologies being tested in their communities (Curry et al., 2004; Bradbury et al., 2009), and that trust and fairness are impacting their receptiveness to project implementation (Bradbury et al., 2009). In this study, I focus on community acceptance of CCS technologies in the American Southwest; targeting communities near DOE sponsored pilot projects.

## **The Southwest Partnership**

The Southwest Regional Partnership on Carbon Sequestration (SWP) is one of seven regional partnerships developed as part of the DOE's efforts to respond to global climate change. The SWP has been challenged with evaluating available technologies to capture and store CO<sub>2</sub> in the Southwest region of the United States which includes all or portions of Arizona, Colorado, Kansas, Nevada, New Mexico, Oklahoma, Texas, Utah and Wyoming (Southwest Regional Partnership on Carbon Sequestration, 2010). Partnership participants within the SWP include the coal, oil and gas industries, electric utilities, the Navajo Nation, nongovernmental organizations, universities and U.S. federal agencies. The region is viewed as potentially valuable for CO<sub>2</sub> sequestration not only because of its large energy production, diverse geologic formations and large storage capacities, but also because of existing infrastructure such as the CO<sub>2</sub> pipelines spanning from Colorado to Texas. The primary goal of the majority of pilot projects is to understand the behavior and characteristics of geologically sequestered CO<sub>2</sub> and how it interacts with specific geologic formations, with the exception of one terrestrial project. A secondary goal of the partnership is to conduct public outreach at project sites and to characterize any potential social obstacles.

During phase II of the SWP program, three states within the partnership region were conducting pilot projects on various carbon storage technologies (Figure 4.1). Project sites were located in the San Juan, Permian and Paradox basins in the states of New Mexico, Texas and Utah respectively. All SWP sites were chosen primarily for their geological characteristics and economic potential (Southwest Regional Partnership



**Fig. 4.1.** Southwest Regional Partnership on Carbon Sequestration with phase II pilot study sites.

on Carbon Sequestration, 2008). The San Juan basin was selected because it provides an excellent site for studying the use of coalbeds for CO<sub>2</sub> sequestration. Coal has a unique ability to store massive quantities of carbon, and injecting CO<sub>2</sub> into these coalbeds enhances the recovery of coalbed methane, the primary energy source for natural gas. The water produced by the enhanced coalbed methane process is desalinated and used for terrestrial sequestration. With this method, scientists hope to enhance the natural cycle of CO<sub>2</sub> absorption by plants simply by using the desalinated water to irrigate

grasslands for new vegetation growth. The SACROC and Claytonville reservoirs in the Permian basin were the first CO<sub>2</sub> enhanced oil recovery (EOR) operations in the world. EOR is a CO<sub>2</sub> sequestration method which involves injecting CO<sub>2</sub> into an oil well that is no longer producing at an economically viable rate. This strategy allows producers to access the remaining oil from a depleting well and gives researchers an opportunity to study the process of CO<sub>2</sub> injection and storage. Though EOR operations strive to reuse the injected CO<sub>2</sub>, some CO<sub>2</sub> generally remains in the formation, making it a natural laboratory for the permanent storage of CO<sub>2</sub>. The Aneth oil field in the Paradox basin, like the Permian basin site, is also studying EOR operations. Unlike the other two sites which are located on private property, the Aneth site is located on Navajo Nation lands.

Besides the locations' geologic and terrestrial attributes, other characteristics of these project sites have more social implications. In addition to land ownership, these sites are also located in rural areas far from large populations. Communities in close proximity to the project locations include Aztec, New Mexico; Snyder, Texas; and Bluff, Utah (Table 4.1). These communities are also partially dependent upon the energy industry for economic stability and possible growth resulting in a wide range of experiences and opinions of this industry and the government agencies they work closely with including the DOE.

Thus in this paper I seek to address how communities who live near an actual or potential geologic or terrestrial CCS site within the SWP region perceive the technology and to explain how and why their perceptions might differ depending on regional characteristics.

**Table 4.1**  
**Demographics of communities closest to SWP pilot sites (U.S. Census Bureau, 2010).**

<b>Demographics</b>		<b>Aztec, NM</b>	<b>Snyder, TX</b>	<b>Bluff, UT</b>
Population size		6,378	10,783	320
Median household income		\$33,110	\$31,016	\$23,906
Race (highest percentages only)	White, non-Hispanic	69.6%	62.4%	60.3%
	White, Hispanic	19.2%	31.8%	4.1%
	Native American	10.6%	1.0%	35.6%
	African American	0.0%	5.0%	0.0%
Industries (highest percentages only)	Ag. and natural resources use/extraction	12.9%	16.5%	5.6%
	Retail trade	16.4%	12.3%	14.1
	Ed., health & social services	19.4%	26.4%	29.6%
	Art, recreation, food services, etc.	12.9%	6.1%	13.4%
	Finance, insurance, real estate, etc.	5.1%	3.5%	12.0%

## **METHODS**

To determine community knowledge, opinions and concerns about research occurring within their region, I conducted focus groups in four communities near phase II pilot projects in each state (Table 4.2; Peterson et al., 1994). Sites were chosen based on size and proximity to a SWP project site. Site criteria included choosing one community 1) closest in proximity to the pilot project sites, 2) closest in proximity to the pilot project site with an airport (indicating a sizable population), 3) of equal size to the first community, but within a 50 mile radius of the pilot project site, and 4) of equal size to the second community, also within a 50 mile radius. These different locations were chosen in order to gain a range of perspectives from communities of varying sizes and proximities to the pilot sites. Sites were also chosen in this manner with the knowledge

that pilot projects were intentionally placed in sparsely populated areas, resulting in smaller communities in closest proximity to the pilot project site.

**Table 4.2**  
**Focus groups communities in the states of New Mexico, Texas and Utah.**

<b>Community Criteria</b>	<b>New Mexico</b>	<b>Texas</b>	<b>Utah</b>
<b>Community 1</b>	Aztec	Snyder	Bluff
<b>Community 2</b>	Farmington	Sweetwater	Blanding
<b>Community 3</b>	Grants	Midland	Monticello
<b>Community 4</b>	Gallup	San Angelo	Moab

To provide an open forum for discussion about CCS and the SWP pilot projects, I obtained focus group participants through the use of newspaper advertisements, local internet-based community calendars, and word of mouth. I also contacted local city representatives from the chamber of commerce, city hall, and county extension offices to solicit further participation. The four focus groups were planned over a three day period (Thursday through Saturday) in each state. To accommodate for a variety of work schedules, participants were encouraged to attend whichever focus group worked best with their schedules regardless of residence. These focus groups took place over the course of about one year (August 2007 to September 2008).

Focus group design was based on a revised version of a guide developed by social scientists from several of the regional carbon sequestration partnerships. Worksheets and handouts were provided to attendees at the beginning of the session for the purpose of note taking and background information (appendix A). These materials were for the participants' own personal use and were not collected at the end of the

session. Focus group questions were non-directive and open-ended (Patton, 2002), covering the topics of community issues (both environmental and other), climate change, and CCS. Audio recorders were used during the session, and participants were notified of their confidentiality prior to the beginning of the focus group and again when they received their consent forms in accordance with the Texas A&M University Institutional Review Board. Surveys were administered at the end of the focus group, including a demographic survey and an opinion survey with a 5-point Likert scale (appendix A). The length of the focus group sessions varied between a half hour and two hours, though the majority of sessions lasted the full two hour term.

For purposes of analysis, I created thematic categories based on preliminary readings of focus group transcripts (Aronson, 1994; Peterson et al., 1994). These categories included positive and negative thoughts and perceptions on economics, environmental health, human health, knowledge, climate change, the DOE, efficiency measures, renewable energy sources and nuclear, geologic CCS, terrestrial CCS and governmental procedures for public involvement and decision-making. I used QSR International's NVivo 8.0™ qualitative software for the purposes of coding with an utterance (length varying by participant) serving as the coding unit. Sentences fitting more than one category were coded accordingly.

## **RESULTS**

### **Participant Demographics and Focus of Discussions**

Out of the 12 focus groups scheduled, 9 were successfully attended by community members. The San Angelo, Monticello and Moab focus groups were

cancelled due to a lack of attendance. These three cities also happened to be farthest in distance to the pilot projects which could explain lack of citizen interest or knowledge of the projects. Overall, the focus groups resulted in 14 participants in New Mexico (from Aztec, Farmington, Gallup and Grants), 6 in Texas (from Snyder, Midland and Sweetwater) and 7 in Utah (from Bluff and Blanding), with a total of 27 participants.

Focus group demographics showed a mixture of genders in attendance, though participant age was weighted more toward those 46 years and older (Table 4.3). Participants varied in the duration spent in these communities, with the highest number having lived there most or all of their lives. Ethnicity was less diverse with the mass majority of participants identifying themselves as Caucasian, and only a handful as Asian, Hispanic, Native American or other. A wide range of occupations were represented, and the majority of participants were highly educated (e.g. associates degree or higher). When asked where they received the majority of their information, television, local newspaper, internet and radio were listed as top sources.

In an analysis of dominant themes present in focus group dialog, I found that participants tended to talk about certain energy related topics more so than others. For instance, main topics for discussion in the New Mexico focus groups tended to address knowledge, geologic CCS and procedures for decision-making (Figure 4.2).

Knowledge in particular was focused on the knowns and unknowns of the energy industry and proposed deployment of CCS technologies including both CO<sub>2</sub> capture and its storage (storage being the focus of the SWP). Texas and Utah followed a similar

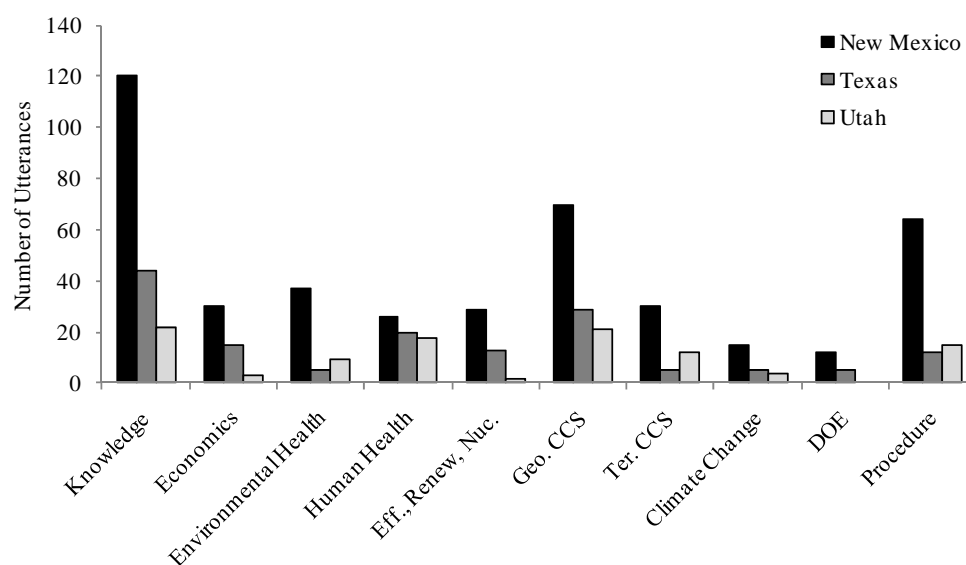
trend, both with knowledge, geologic CCS and human health as their top subjects of debate. Though they were not dominant topics, economics, environmental health,

**Table 4.3**  
**Demographics of the New Mexico, Texas and Utah focus group participants.**

Demographics		New Mexico	Texas	Utah	Compiled
<b>Gender</b>	Male	10	3	4	17
	Female	4	3	3	10
<b>Age</b>	18-45	2	3	0	5
	46-64	9	2	3	14
<b>Children under 18</b>	65 or older	3	1	4	8
	Yes	3	2	1	6
<b>Time in Area</b>	No	11	4	6	21
	6 mo. to 5 yrs.	3	1	2	6
	6 to 15 yrs.	3	2	1	6
	16 to 25 yrs.	1	0	3	4
<b>Ethnicity</b>	26 yrs. to life	7	3	1	11
	Caucasian	10	6	6	22
	Asian	1	0	0	1
	Hispanic/Latino	1	0	0	1
	Native American	1	0	1	2
	Other	1	0	0	1
<b>Occupation</b>	Retired	3	1	3	7
	Agriculture related	1	2	0	3
	Engineer	4	0	0	4
	Educator	1	0	1	2
	News writer	0	1	0	1
	Geologist	0	1	0	1
	Industry admin.	3	0	0	3
	Admin. Assistant	0	1	0	1
	Business owner	1	0	0	1
	Chamber of Com.	1	0	0	1
	Attorney	0	0	1	1
	Did not report	0	0	2	2
<b>Level of Education</b>	High school diploma	1	0	0	1
	Some college (no degree)	2	1	0	3
	College degree (Associate or Bachelor)	7	1	4	12
	Advanced degree (Masters or Ph.D.)	4	2	3	9
	Technical training	1*	0	0	1*
	Primary Info. Source (could choose multiple)	12	2	4	18
	Local newspaper	6	0	1	7
	Radio	7	2	4	13
	TV	12	3	4	19
	Internet	9	2	6	17
	Work	2	1	0	3
	Conferences	1	0	0	1

\* Individual recorded as having an advanced degree in addition to technical training.

alternative energy practices (i.e. efficiency, renewables and nuclear), and terrestrial CCS were also mentioned consistently throughout the focus groups. Receiving the least attention by participants of all states were the subjects of climate change and the DOE, though strong positive and negative views were still present for both subject categories.



**Fig. 4.2.** Number of utterances coded for each category by state.

## Knowledge

Receiving the most attention throughout focus group discussions, participants used their local knowledge of community issues and experiences with the fossil fuel industry, and in some cases professional training (i.e. geology, engineering, business), to discuss current and proposed CCS projects in their region. Though only a handful of participants had even heard about CCS prior to the focus group (4 out of 27 participants), attending in order to learn more about either the CCS process or the SWP

specifically, all of the participants had some in-depth knowledge of fossil fuel (mainly oil and gas) or uranium extraction and/or production. Some examples of this knowledge included the use of seismic testing to map geologic formations, refinery operations and the process and location of CO<sub>2</sub> extraction for EOR. Because these focus groups generally attracted citizens who were already active members of their community or involved in the energy industry, participants were also up-to-date on industrial practices, proposed projects and legislation and regulations in place for such operations. Some of the participants were even involved in watchdog groups such as the San Juan Citizens Alliance and the U.S. EPA funded CARE initiative (Community Based Initiative for Environmental Health), while others were involved in energy project planning including the proposed Desert Rock plant in New Mexico and a bid for the government funded FutureGen project, the first zero-emissions power plant to be built in the United States. When it came to professional knowledge and experience with the energy industry, participants from many of the focus groups were particularly knowledgeable not only in energy operations, but of the various technologies involved in CCS such as coal gasification, EOR operations and processes for CO<sub>2</sub> storage including formation restrictions preventing the migration of injected CO<sub>2</sub>, though they did not always link CCS to these technologies. This lack of connection is most likely due to the fact that CCS is a compilation of new and proven technologies.

Based on this knowledge and past experiences with the energy industry, participants focused on specific concerns as to future activities by this group (i.e. clean coal operations and CO<sub>2</sub> storage). Because of the communities' familiarity with such

operations, health concerns accounted for a large portion of the discussion. Participants from all states mentioned air quality as a major concern. The communities of Bloomfield, Farmington, Gallup, Snyder and Bluff specifically mentioned their current air quality issues stemming from local and regional industry including noted cases of asthma and cancer. As one Texas participant noted, “We have had a lot of calls at the newspaper and I know that for a fact...a lot of calls. ‘Why are people so sick?’ You know and it’s just ... it’s just one of those things...” Residents of Bloomfield, Gallup and Bluff also talked about the visual effects of the pollution, describing the brown or yellow “haze” that diminishes visibility, whereas a Snyder resident noted a constant smell of oil in the air. One resident of Bloomfield, for example, called the region a “sacrifice zone” for energy acquisition in the West.

Another major concern of participants was water quality, but unlike air quality, these concerns were more so related to the geologic sequestration of CO<sub>2</sub> than any other operation (i.e. terrestrial sequestration). This concern for water was brought up in all but one focus group, with at least one participant voicing concerns about ground water contamination either to drinking water or irrigation wells. According to one New Mexico resident, water is a precious commodity in the Southwest and its allocation is already a major point of contention without the additional pressures from CCS operations. Though community concerns included more than questions to health in the form of air and water, these two concerns in particular were remnants of past disputes over practices by the energy industry and thus are attributed to knowledge.

## Perceptions of Climate Change

Overall, residents displayed varying levels of knowledge about climate change, its causes and social relevance. According to one Utah participant:

It's [the climate] changing. They are producing greenhouse gases of all kinds. And something should be done. And one of the major ones, of course, in terms of volume being produced is carbon dioxide. There are others who claim all of this other stuff, like nitrous oxide is eighty times as potent, but we're producing only two hundredths of the amount of that [nitrous oxide] as we are of carbon dioxide...that's a straw-man.

A fair number of participants also expressed skepticism about the science and/or political agendas behind climate change.

Our company can rebut this stuff [climate change] for age on end...I'm not saying that we shouldn't do something about it, but it's really gotten to be a joke around here, because people don't buy it (New Mexico focus group).

Almost all of the participants, however, were concerned about the potential local and national impacts of climate change and its mitigation. These concerns varied from how mitigation strategies will be implemented at the local level to how these strategies will affect the energy industry as a whole. The fact that most of these communities are tied to the energy industry added another level of complexity because of conflicting values such as community health and economics. Many were also confused and/or frustrated with the perceived climate change debate taking place in the media. When asked about how to solve the climate change problem, many responded that a wide range of solutions from nuclear power to conservation measures and renewable energy sources are needed. Main obstacles to these solutions ranged from lack of encouragement from the government to the reluctance by the public and those in power to acknowledge that

climate change is real. When asked about DOE's interest in climate change solutions, many also expressed skepticism regarding its motives and practices, including questioning their use of science and acknowledged relationships with industry.

### **Perceptions of CCS**

Due to the goals of this study, the knowledge of CCS and its perceived pros and cons were a major subject for discussion. Dividing the discussion into pros and cons as well as knowns and unknowns of each set of technologies (i.e. geologic and terrestrial), I found that participants from New Mexico and Utah expressed more risks, uncertainties and negative implications to geologic CCS than benefits (Figure 4.3). A portion of this negative focus can be attributed to participants' newly formed reactions to the technology, but also their past experiences with industry and government agencies and knowledge of project costs, resource needs, etc. These concerns included not only environmental and human health and safety, but also economics and property rights (Table 4.4). For instance, one New Mexico participant points out that an already dwindling water supply would pose problems because of possible contamination issues.

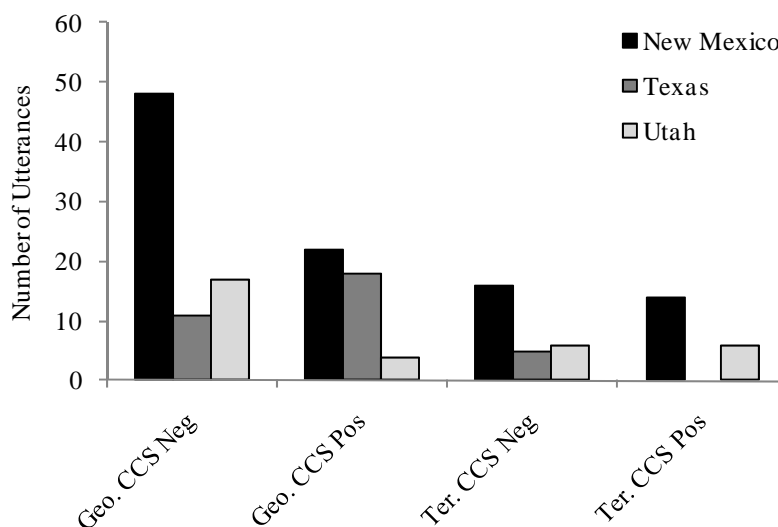
We are pumping from the aquifers...we know they are not refilling fast enough, and we don't know if we are going to get the pipeline from the San Juan River because it is so expensive. So I think that if people heard that something was being pumped in or around the water aquifers that was going to mess up the water, that would be a whole other concern that they haven't even thought of, you know, because they are already concerned. And then if they hear this ...

Another participant from the same focus group voiced concerns about the economics and logistics of such implementation.

Like I said, you build a 1,500 megawatt plant and you put carbon sequestration on it, you're down to 1,033 megawatts...you are burning the

same amount of fuel, the same amount of coal, but the output would be less because it has to help run the sequestration portion.

Residents of these communities also considered high levels of CO<sub>2</sub> as air pollution, and therefore were curious if carbon capture operations would improve local air quality or just add to the region's current air quality problems. Asphyxiation due to localized leakage was also a concern expressed by participants in relation to geologic storage, with one resident bringing up the incident at Lake Nyos where numerous people died due to CO<sub>2</sub> leakage.



**Fig. 4.3.** Number of participant utterances as to the pros and cons of geologic and terrestrial CCS technologies.

Conversely, Texas participants were more receptive to geologic CCS due to their extensive history and good safety record with the process of EOR. As one participant put it, “The first CO<sub>2</sub> enhanced oil recovery projects in West Texas started thirty years

**Table 4.4**  
**Pros and cons of CCS technology according to New Mexico, Texas and Utah focus group participants, 2007-2008.**

Technology	Pros	Cons
<b>All CCS strategies</b>	Stores CO <sub>2</sub>	Current practices cause long-term increase in CO <sub>2</sub>
	Improves atmospheric conditions/air quality	Political strategy/smokescreen
	Natural storage facilities	Not cost effective
	Intermediate/transition technology	Not energy efficient
	Mitigates for climate change	Draws attention from conservation/efficiency measures
	Provides national security by continuing use of U.S. resources	Too many unknowns
	Establishes U.S. as a technological leader	
	Could provide local jobs	
<b>Geologic CCS</b>	Greater storage capacity than terrestrial	Lacking or aging infrastructure
	Easier to measure than terrestrial	Permitting
		Health problems
		Unfair burden on a locality
		Cuts efficiency of electricity production by 1/3
		Equal to storing nuclear waste
		Water and soil contamination
		Cannot store enough CO <sub>2</sub> to make a difference
<b>Terrestrial CCS</b>		Expensive
		Involves unproven and experimental technology
	Greater public acceptance	Limited by location and scale
	More easily attained	Difficult to measure CO <sub>2</sub> uptake
	Cheaper than geologic	Requires water resources
		Term of storage depends on practice
		Deforestation and fires are counterproductive

ago... we need all the CO<sub>2</sub> we can get for EOR projects out here.” Although they shared the distrust in companies representing the energy industry and the federal government, they saw no particular problem with geologic CCS operations. Like New Mexico and Utah, however, residents were equally concerned about water contamination because of

past shortages and allocation disputes. “Well, I mean the big one...well...pretty much everywhere in Texas it’s going to be water. That’s the EVERYTHING.”

Unlike geologic CCS, discussions of the pros and cons of terrestrial sequestration were more balanced in New Mexico and Utah. Participants generally felt less threatened by this strategy because of characteristics such as using environmentally friendly practices and the natural carbon cycle for CO<sub>2</sub> absorption. They also viewed terrestrial CCS as beneficial for reasons beside CO<sub>2</sub> capture and storage. According to a Utah participant:

I’m really interested in this Aztec range or ecosystem enhancement because in the western states, there are literally millions of acres of debilitated rangeland that has lost productivity from either poor management or lack of management or no management or mismanagement, the whole combination of things that need to be restored...A sequestration program that could drive that and fund some of that would be marvelous. We could trap erosion...provide habitat...There would be tremendous benefits to restoration, restoring western rangelands and productivity.

Other participants mentioned benefits to wildlife, water quality improvements, and enhancements to rangeland and other natural areas. Some of the noted drawbacks of implementing this strategy included a limited capacity for CO<sub>2</sub> storage, a need for water, and a need for trees as a natural resource (i.e. building material and fuel). Texas again served as an outlier, focusing the majority of their terrestrial discussion on the cons, with no references to the benefits of such projects. These cons included the unintentional release of CO<sub>2</sub> from forest fires, competition with demand for CO<sub>2</sub> by EOR operations and the need to compensate landowners for the use of their properties. Though this last con is not necessarily a negative, it marks a difference in perception between states

dominated by public lands and those dominated by private. Texas in particular is a state interested in the protection of private property rights, indicating a preference for voluntary, incentive-based programs.

During the discussions of the pros and cons, participants also listed knowns and unknowns of the different strategies. When listing unknowns, participants focused not only on their own knowledge, but on expert knowledge as well. These concerns generally fell into five categories: health and safety, economics, technology, legal and environmental with the vast majority in the technical and legal categories (Table 4.5). Most of these questions addressed technological readiness, including how to carry out such strategies, how to minimize risk and what is to be done if the worst is realized (e.g. who is liable).

### **Perceptions of Trust and Fairness**

As mentioned briefly above, procedures for decision-making were a popular part of discussion during conversations about community issues and the pros and cons of CCS. Participants from all three states expressed some form of past and/or current dissatisfaction with aspects of the energy industry as well as frustration with government agencies and administrations. Few also demonstrated sympathy for the DOE or politicians in decision-making.

Our problems here with oil and gas, with everything ... we have literally been declared a sacrificial area. They could care less about us here. And it doesn't really matter if they're Democrats or Republicans; it's ingrained within the larger government context (New Mexico focus group).

However, this dissatisfaction came from different points of view. As to the adoption of CCS, some participants voiced fears of moving too fast without considering all the risks.

**Table 4.5**  
**Unknowns of CCS technology according to New Mexico, Texas and Utah focus group participants, 2007-2008.**

Health and Safety	Economics	Technology	Legal	Environmental
Water contamination	Adoption offsetting costs	Geologic space required for a ton of CO <sub>2</sub>	Responsibility for monitoring	Cumulative impacts
General safety	Economic viability	Emergency leakage procedures	Responsibility for safety/liability	Technology adding to CO <sub>2</sub> emissions
General health		Amount of vegetation set aside for mitigation	Impact to surface owner rights	Atmospheric life of the CO <sub>2</sub>
		Assurance of the permanence of storage	Responsibility for leakages	
		Pressurization of CO <sub>2</sub>	Ownership of CO <sub>2</sub>	
		Depth and difficulty of injection	Permitting, regulations and legislation	
		Prove technology		
		Overall systemic improvement		
		Water shortages		
		Long-term repercussions		
		CO <sub>2</sub> production vs. ability to offset		

People are really skeptical...I think they're going to ask a lot questions and they want to know before there's one in their back yard. I mean if you want to build one ...in another state far from my house I'm not going to ask questions as [I am] here ...because I feel like a lots been dumped on this area already. We are already carrying a pretty big burden for the nation in terms of environmental cost and ... I'm not sure if I want to be the guinea pig for the next one as well (New Mexico focus group).

Others, however, felt the U.S. was moving too slowly. According to a participant from another New Mexico focus group in reference to technology deployment, "We're standing still, but the politics are driving the science instead of the science driving the

politics. And that's what we're doing [standing still]." A Texas participant had similar experiences, arguing that the DOE throws money at problems without interest in long-term solutions, later calling the DOE a "bureaucratic nightmare."

Though participants did not always agree with the speed of government action, they did agree on the fact that they were not given an opportunity (outside the focus groups) to voice concerns or possible support of such plans and/ or projects. Except for the few individuals who attended the focus groups to discuss the utility of CCS for projects in their own region, many participants were upset yet unsurprised that they had not heard of the pilot projects prior to the focus groups. In response to this reaction, many of the participants expressed a desire to learn more about the technology, so as to be informed and prepared for events to come. They were cautious, however, of the sources. As one New Mexico participant put it:

I think it's quite interesting because it seems like you're coming from a neutral place. Because, and I mean I've been involved in this Desert Rock project and you go to one meeting and it's offered by the company that's going to build the plant and you go to another meeting and it's sponsored by the organizations that oppose it, you go to another meeting and it's sponsored by the government and you're like, okay. So you're trying to filter information from a lot of sources but you never know what THEIR filter is.

In addition to information, participants were curious of additional outreach activities by the DOE and the SWP, hoping for additional opportunities for public conversations on community acceptance of CCS even though they were skeptical of the likeliness of such discussions ever happening.

## Survey Results

At the end of each focus group, following the discussion of CCS pros and cons, participants were administered a questionnaire giving their opinions regarding sequestration (Tables 4.6 and 4.7). Like the data from the discussions, surveys showed that participants generally supported the idea of learning more about CCS, including support for more research into both geologic and terrestrial sequestration. In New Mexico and Utah, participants felt that landowners should be encouraged to engage in terrestrial carbon sequestration activities whereas Texas participants were less convinced. New Mexico and Texas participants were also overall unconcerned that CCS might delay a shift away from fossil fuels, supporting the inclusion of this technology as part of a larger energy strategy. Utah participants, however, showed a preference for higher emphasis on other technologies such as renewables. When offered potential reasons to support research on carbon sequestration, they were fairly supportive of doing so both because it is important to test new technologies prior to deployment and because it would help remove CO<sub>2</sub> from the atmosphere during a transition of the overall energy system. New Mexico and Utah were less certain, however, of whether the support of DOE and relevant industry provided a good reason to conduct research on CCS, whereas Texas was okay, especially in light of their timely bids for FutureGen.

**Table 4.6**

**Mean responses to individual opinion statements by New Mexico, Texas and Utah focus group participants, 2007-2008. Possible responses were 1 = Disagree Completely, 2 = Somewhat Disagree, 3 = Uncertain, 4 = Somewhat Agree, and 5 = Agree Completely.**

Number	Question	New Mexico Mean	Texas Mean	Utah Mean	Combined Mean
1	We should learn more about geologic and terrestrial carbon sequestration -- such as how much would it cost, and is it safe and effective -- and support more research on this topic.	4.9	4.5	5.0	4.8
2	We should encourage landowners to increase the carbon stored in farmlands, forests and open spaces for terrestrial carbon sequestration.	4.3	3.5	4.4	4.2
3	We should not support geologic and terrestrial carbon sequestration because we need to make a major shift away from using emission-causing fuels such as oil, coal and gas. Carbon sequestration will just delay that shift.	2.2	2.3	3.6	2.6
4	Both geologic and terrestrial carbon sequestration should be encouraged as part of a larger strategy that includes more renewable energy, higher energy efficiency and other types of energy sources.	4.5	4.0	3.4	4.1
5	We should encourage both geologic and terrestrial carbon sequestration because there is evidence to suggest that it will be difficult to transition away from our reliance on fossil fuels such as oil, gas and coal, and sequestration provides a way we can keep carbon out of the atmosphere as much as possible during a transition.	3.7	4.3	3.4	3.7
6	We should support efforts to test and develop geologic sequestration because new technologies need to be tried before they can be adopted nationally.	4.4	3.8	3.4	4.0
7	We should support geologic carbon sequestration because it is an approach that the US Dept of Energy and oil / gas / power companies are seriously looking at.	3.0	4.0	2.4	3.0

**Table 4.7**

**Comments to individual opinion statements by New Mexico and Texas focus group participants, 2007-2008. Utah participants failed to provide comments and were therefore not represented in this table.**

Number	Question	New Mexico	Texas
1	We should learn more about geologic and terrestrial carbon sequestration -- such as how much would it cost, and is it safe and effective -- and support more research on this topic.	1. A lot of unknowns. 2. Economic development and national security are dependent on national resources.	
2	We should encourage landowners to increase the carbon stored in farmlands, forests and open spaces for terrestrial carbon sequestration.	1. First, educate them about need. 2. ?? 3. Encourage meaningful incentives - voluntary vs. required.	
3	We should not support geologic and terrestrial carbon sequestration because we need to make a major shift away from using emission-causing fuels such as oil, coal and gas. Carbon sequestration will just delay that shift.	1. Self-sufficient, cost-effective natural resources. 2. I don't believe we can make a major shift away from oil, coal, and gas. These are our best energy sources. 3. It is part of the solution. It can't be a solution for 1-2 hundred years. It is part of the transition from carbon-based economy. 4. Transition takes time. We can develop alternate methods of generating electricity but it will take time.	1. How long? We cannot do this indefinitely.
4	Both geologic and terrestrial carbon sequestration should be encouraged as part of a larger strategy that includes more renewable energy, higher energy efficiency and other types of energy sources.	1. Energy policy. 2. All options should be evaluated to seek balance. 3. This is on the assumption that this technology is going to work and that CO <sub>2</sub> is really affecting our climate. 4. This is assuming sequestration is a viable technology.	1. Need education on this.

**Table 4.7 continued.**

Number	Question	New Mexico	Texas
5	We should encourage both geologic and terrestrial carbon sequestration because there is evidence to suggest that it will be difficult to transition away from our reliance on fossil fuels such as oil, gas and coal, and sequestration provides a way we can keep carbon out of the atmosphere as much as possible during a transition.	1. Impacts?	
6	We should support efforts to test and develop geologic sequestration because new technologies need to be tried before they can be adopted nationally.		1. EOR (CO <sub>2</sub> Tertiary Recovery) has been ongoing in the Permian Basin for 30 years. We need more CO <sub>2</sub> here. Not stored in brine aquifers.
7	We should support geologic carbon sequestration because it is an approach that the US Dept of Energy and oil / gas / power companies are seriously looking at.	1. The brain. 2. Don't know anything about this. 3. How much is the DOE investing in these technologies? How much are private industries investing? Who are the private companies that are actually injecting CO <sub>2</sub> ? Is the DOE or other government agencies involved in each project?	1. Still need to promote EOR CO <sub>2</sub> utilization.

## DISCUSSION

Several themes regarding geologic and terrestrial CCS emerged from dialog with focus group participants, most of which can be explained by participants' views toward trust and fairness. Once they had a basic understanding of the technology and the goals of its implementation, participants were often intrigued and wanted access to more detailed information including entities involved in the research, locations of current and future pilot projects in their region and in-depth descriptions of the various technologies

used. It was generally agreed upon that research into such technologies is a good thing and that a variety of mitigation strategies are needed in order to have enough of an impact on climate change to slow down or halt the changes taking place. For those skeptical of climate change findings, advantages were also seen in CCS adoption such as providing cleaner methods for energy production and/or the economic benefit of cheap CO<sub>2</sub> for further extraction of oil and gas. This said, participants also expressed doubt and concern about the impacts to communities near proposed sequestration sites, due to a history of issues with the energy industry and various government agencies.

In all three states, participants expressed varying levels of distrust of companies representing the fossil fuel industry and/or the federal government. Most focus groups included participants who demonstrated strong reservations regarding anything related to the DOE and/or the fossil fuel industry. The New Mexico and Utah focus groups in particular expressed a lack of control over decisions regarding energy production. These findings were supported by the survey data, with participants completely agreeing with investigations into CCS for mitigation purposes and as a transitional technology, but having less agreement when it came to supporting such research by entities whom they had distrust.

Observations from the Southwest focus groups tend to fall in line with other procedural justice findings. For instance, according to Gangl (2003), “When people deal with third parties and other authorities with which they have little direct contact, their assessments of procedural justice are more strongly influenced by trust in the intentions of the decision makers” (p. 136). Participants from the various focus groups

demonstrated a dwindling of social capital in regards to the DOE, further exacerbating their concerns with CCS and the need for its implementation over other alternatives.

Beierle (1998, p. 8) explains this reaction, stating that “A number of analyses of public trust suggest that it is far easier to lose than to regain. However, one of the most effective ways to regain public trust may be to involve and empower the public in decision making (Slovic, 1993; Schneider et al., 1997).”

Gangl (2003) also divides procedural justice issues into either pragmatic or ethical problems. In pragmatic issues, the outcome matters more than the fairness of the process, whereas in ethical issues, process is more important. In the case of the Southwest focus groups, participants who were persuaded that current rates of climate change are human induced (or at least impacted) viewed CCS as an ethical issue; protecting the Earth for future generations. Thus process fairness in the climate change/CCS debate was more important than decision outcome. For those who believed human behavior has no influence on climate change, ethical (and therefore process) considerations were less important. This differentiation was seen between the Utah and New Mexico focus groups and the Texas focus groups, though this split was not universal by state.

As to specific participant questions and concerns regarding the implementation of CCS technologies, they focused the majority of their discussions on human and environmental wellbeing at the local level, influences on economics and access to information and people (i.e. project proponents, agency people, etc.). For instance, in discussions about safety concerns, most participants claimed that geologic CCS was still

experimental, and that companies and the government were using their communities as testing grounds not only for the technology, but also as a social experiment (Bradbury et al., 2009). Information about monitoring often failed to allay all of their health and safety concerns because of this distrust. Participants also requested access to detailed information from politically neutral sources including materials on the different technologies used in CCS, liability, contact information for liable parties, etc. because of perceived biases from project proponents. To make their point, participants often recounted past frustrations when attempting to communicate their concerns to decision-makers and other authorities. According to Arvai (2003, p. 286), decisions resulting from processes viewed as “fair, reasonable, and amenable to allowing all interested parties an opportunity to voice their feelings and concerns” are more likely to be accepted by the general populous, whereas a lack of citizen voice could lead to dissatisfaction and a dissenting public. Webler and Tuler (2002, p. 182) defines fairness as “what people are permitted to do in a participatory process,” identifying 4 necessary components of fair public participation process: attendance, initiation of discourse, participation in discussion, and participation in decision-making. With past failures at two-way communication with industries and agencies, participants felt that the adoption of a new technology would not change this trend of top-down decision-making without impacted community input. After open discussion of the pros and cons of the different sequestration strategies, however, focus group participants were more willing to consider CCS as a viable option for climate change mitigation than before they had the

opportunity to discuss such advantages and disadvantages, indicating a need to talk through the issue and come to their own conclusions.

## **CONCLUSION**

When it comes to making decisions with far-reaching implications, such as the mitigation of anthropogenic climate change, public acceptance is a mandatory component for moving forward in project planning. In order to receive such overwhelming acceptance, the public needs to either be involved in the decision-making process or have trust in decision-making authorities; that they will be represented and treated fairly. As demonstrated in this study, issues as contentious as climate change and energy production, often lack this level of trust. Skepticism and distrust of government entities and corporations, as well as concerns about health and safety were issues voiced throughout focus group discussions, influencing participants' willingness to accept storage risks to mitigate for CO<sub>2</sub> emissions. Thus, without this trust, citizen involvement is needed for deployment of technologies such as CCS.

According to Arvai (2003), public involvement includes a broad inclusion of stakeholder values and objectives, the ability of impacted citizenry to come to their own conclusions on what is deemed acceptable risk, and fulfillment of democratic norms. "Risk policies that are the product of a participatory decision-making approach may also seem more acceptable because the policy frame changes from an imposed risk to that of a voluntary one" (Arvai, 2003, p. 287). Involving the public in the implementation of CCS technologies alleviates tension and promotes trust because it gives citizens control over a decision (Gangl, 2003; Peterson et al., 2004). "Widespread negative sentiment

toward the political process does not necessarily signify rejection of difficult democratic deliberation. When inclusive, representative democracy in the abstract is put into practice, people do indeed respond more positively” (Gangl, 2003, p. 136).

## **CHAPTER V**

### **THE USE OF GAMES IN PUBLIC OUTREACH: CASE STUDY OF *THE ADVENTURES OF CARBON BOND* NARRATED STORY AND GAME**

#### **OVERVIEW**

In 2003 the U.S. Department of Energy created joint government-industry partnerships to develop carbon capture and storage technologies with the added mission to develop outreach materials describing such technologies. In addition to more traditional forms of public outreach, I developed an internet game geared toward teaching youth about underground CO<sub>2</sub> storage. I piloted *The Adventures of Carbon Bond* using focus groups with teachers and graduate students in scientific fields of study. I found that participants find it difficult to discuss environmental issues with students that are viewed as contentious, but that gaming was a valuable tool for addressing sensitive subjects.

#### **INTRODUCTION**

In February of 2007 the Intergovernmental Panel on Climate Change (IPCC) released a report stating with at least 90% certainty that current rates of climate change are due to human activities (Intergovernmental Panel on Climate Change, 2007). The IPCC report also named CO<sub>2</sub> as the most important human produced greenhouse gas (GHG) contributing to climate change. The report confirmed that the two highest contributors to anthropogenic CO<sub>2</sub> in the atmosphere are fossil fuel emissions (56.6%) and deforestation and the decay of biomass (17.3%). In 2003, the U.S. Department of Energy and the National Energy Technology Laboratory (NETL) created joint

government-industry partnerships to develop carbon capture and storage (CCS) technologies to address the issue (U.S. Department of Energy, 2009). As a result, 7 regional partnerships were formed. These regional carbon sequestration partnerships, covering most of the United States and portions of Canada, are responsible for the characterization, validation, and deployment of CCS technologies within their region.

As a new technology, social acceptability of CCS requires overcoming both social and technological obstacles (i.e. addressing issues of risk, economy, political pressure, suitability, and scale; Bradbury et al., 2009). As part of their mission, the regional carbon sequestration partnerships are charged with communicating their climate change efforts with the general public through the creation and distribution of outreach and educational materials addressing the topics of climate change, CCS, and their respective technologies. Materials included in these outreach efforts consist of websites, roadmaps, atlases, newsletters, communication events, conferences and other outreach activities aimed at the mutual sharing of information about the benefits, logistics and risks of CCS. In addition to more traditional forms of outreach (i.e. pamphlets, newsletters, press releases and websites), I developed an internet game for the Southwest Regional Partnership on Carbon Sequestration (SWP) geared toward teaching youth about climate change and CCS.

In *The Adventures of Carbon Bond*, the internet-based game focuses on the underground storage of CO<sub>2</sub> which makes up a majority of CCS projects in the Southwest. In addition to being a readily available resource in the region, geologic CO<sub>2</sub> storage also happens to be the least understood of the storage strategies by the general

public (Ashworth et al., 2009; Bradbury et al., 2009; Stephens et al., 2009a). The game stars action hero Carbon Bond, a special agent for NETL, and his quest to save the planet from climate change by capturing anthropogenic CO<sub>2</sub> and storing it in the underground formations of the Southwest. In this paper, I describe the game as a means to educate youth ages 8 to 10 on climate change and CCS and determine its usefulness and applicability through focus groups with grade school science teachers and graduate students in the life sciences.

### **Games and Internet-Based Gaming**

The aim of environmental education programming is to produce an environmentally aware and responsible general public (Bogner, 1999; Whitt, 1999; Rovira, 2000; Zint et al., 2002). Many of the environmental issues we deal with today such as climate change, ozone depletion and acid rain are issues with human drivers and therefore social solutions (Firor, 1990; Brklacich et al., 2007). Games can provide a safe starting point for constructive discussion of such issues and opportunities for brainstorming. Additional benefits to using games in environmental education programming include, but are not limited to, 1) energizing a teaching environment by providing a change of pace for students, 2) introducing and reinforcing environmental concepts, 3) promoting collaboration amongst players, 4) allowing for mistakes and turning them into learning experiences, 5) appealing to kinesthetic learners and finally 6) the fun factor (Jacobson et al., 2006; Teed, 2008).

As the next logical step in the creation of environmental games and activities, internet-based games are a means for keeping pace with the growing virtual world

(Squire, 2003; 2006). The internet has become an important source of information with more than 75% of students in the United States having access to computers either at home or in the classroom (Becker, 2000). By incorporating internet games into educational activities, youth are given the opportunity to practice problem solving skills with real world issues in an interactive learning environment (Pange, 2003). Situating games within a narrative also provides youth with a context for the problem, providing them with options for possible solutions as well as alternative actions (Connelly & Clandinin, 1990).

### **Issue-based Gaming**

Environmental education programming exists to inform people about environmental issues that require public support for action (Jacobson et al., 2006). Conflicts over natural resources, such as protection of endangered species, non-renewable resource extraction or water rights, are major drivers of such programs. Often people are unaware of the extent or complexity of an issue until they are given the proper tools for analysis. Issue-based games are therefore an effective way to fill this void in a manner that alleviates anxiety and produces a positive learning environment (Thompson et al., 2008). For example, researchers at the University of Utah created a game known as the Ice Cream Game to initiate discussion about a local urban airshed in the Salt Lake Valley of Utah (Thompson et al., 2008). The board game was used to teach systems thinking during a collaborative learning session given at the beginning of a public workshop series in Salt Lake City. Stakeholders were given a neutral subject, selling ice cream, to study a system through play complete with all the complexities of a

regular system: delays, feedback loops, interconnections between actions and dependency on others. Though game content was detached from the actual issue, the airshed of Salt Lake Valley, players still experienced the frustrations and understood the need for adequate communication in a complex system.

Another example of an issue-based game is FutureSite. This monopoly-like board game was created by the Fernald Citizens Task Force (later renamed the Fernald Citizens Advisory Board – FCAB) to discuss cleanup levels and future use scenarios of the Fernald nuclear weapons site (designated a superfund site by the U.S. Department of Energy in 1989). “Using this game, FCAB members moved chips representing waste on site to see the volumes of waste, transportation alternatives, disposal alternatives, and costs required to achieve various levels of ‘clean’ needed to attain specific future uses” (Hamilton, 2004, p. 75). The benefits to incorporating games such as the Ice Cream Game and FutureSite into education and outreach efforts include the ability to teach about complex problems or systems at a level that can be easily understood by its players (e.g. stakeholders and/or students). Instructors or facilitators can adjust the complexity and/or content of an activity based on the audience such as using neutral subject matter to discuss more controversial issues (i.e. ice cream instead of airsheds). Games can also provide stakeholders or students with an opportunity to practice problem solving skills in an interactive learning environment such as activities involving computer models or simulations (Polman, 2002). Finally, instructors or facilitators can situate an activity within a narrative, giving players some realistic confines for solutions while at the same time opening up the possibility for alternative actions (Dickey, 2005). These 3 elements

of issue-based educational game design, 1) complexity of subject matter, 2) opportunities for problem solving and 3) use of narrative, were all taken into consideration in the development of *The Adventures of Carbon Bond* as an educational tool describing the issue of climate change and a possible mitigation strategy: the capture and storage of CO<sub>2</sub>.

### **The Game**

The main character, Carbon Bond (a.k.a. OOC), is on a mission to save the planet by capturing as many rogue CO<sub>2</sub> molecules as possible and putting them safely behind bars (or down an injection well). Bond's adventures take him from the smokestacks of an Integrated Gasification Combined Cycle (IGCC) power plant, to the stormy coasts of the Gulf of Mexico, and finally to a CO<sub>2</sub> storage facility in the Southern Rockies where the Gang (anthropogenic GHGs) is put away...for life. Youth are encouraged to join Bond on his missions around the world by taking the NETL entrance exam. Tested on their knowledge of the carbon cycle, greenhouse gases, energy production, rock formations, climate change, and actions that can be taken at home, youth can earn carbon credits and eventually their NETL agent badge (earning a badge requires a score of 200+ carbon credits). The goal of this Jeopardy-style game is not only to teach youth about the technology behind CCS, but also about climate change and the difficulties faced by attempting to manage and mitigate for global problems.

In the *Carbon Bond* game there are both scientific as well as moral messages in the narrative, typical of environmental education programming. Specific objectives for the game include the following:

- Science education objectives:
  - Teach youth about climate change science with a focus on greenhouse gases, especially CO<sub>2</sub> and its role in the carbon cycle
  - Familiarize youth with the concept of mitigation or CO<sub>2</sub> offset
  - Teach youth about CCS technology and strategies with a focus on IGCC power plants and underground CO<sub>2</sub> storage
  - Familiarize youth with methods for energy production
- Social awareness objectives:
  - Create awareness about climate change and mitigation efforts
  - Demonstrate how climate change is a social problem, not just environmental
  - Empower youth with ideas to lower their own carbon footprint

## **OBSERVATIONS AND EVALUATIONS OF *CARBON BOND***

To gain input into the content and usefulness of *Carbon Bond*, I conducted focus groups on the narrated story and game with two groups in September of 2008: 1) grade school science teachers (n = 12) from Southeastern New Mexico and 2) graduate students, both Masters and Ph.D. level with backgrounds in the life sciences, at Texas A&M University (TAMU; n = 10). Groups were chosen based on location within the SWP region and expertise in the fields of education and life sciences. Prior to the activity, the New Mexico teachers received a day and a half of training on the subjects of climate change and CCS whereas the TAMU graduate students received 2 hours of training. Participants viewed the narrated story as a group and then divided into smaller groups for the purposes of game play. After participants had an opportunity to play the

game, I conducted a group discussion about the activity including conversations about the use of games to start or continue youth dialog about environmental issues, benefits and drawbacks to *Carbon Bond*, and ideas for future educational materials. Audio recorders were used during the discussions, and participants were notified of their confidentiality and given consent forms in accordance with the TAMU Institutional Review Board.

## **FOCUS GROUP FINDINGS**

### **Environmental Discussions in the Classroom**

In discussions about opportunity and desire to talk about concerns such as climate change and use of issue-based materials, teachers found that the problem was not of desire in teaching the subject, but instead of whether or not their students cared about a specific environmental problem. Indifference and animosity were mentioned as prominent barriers to teachings about issues such as climate change. One teacher in particular mentioned that even her accelerated students were socially unaware if not clueless about environmental issues impacting their daily lives. Teachers also felt students were not exposed to these issues outside the classroom, adding to their open disregard for becoming more informed.

These aren't kids that watch the kind of TV that brings these issues to the forefront. They're spending their time on video games or other sources...and I don't think their parents are having that kind of discussion.

Social pressures were also mentioned as having influence over whether or not students even cared to learn about such problems. Social hierarchies within school were often cited as having precedence over issues outside that particular sphere of reality. One

teacher noted that it was considered “un-cool” to be smart and so students would downplay their understanding unless positive attention could result from the demonstration of knowledge.

Of all the social barriers mentioned, climate change skepticism or more specifically skepticism over the root causes of climate change was considered the biggest problem to overcome for implementing issue-based education. As one high school teacher noted:

I run into students, and I think they probably got this from their families, who don't believe that climate change is happening...And they cite things for example...the ice core data is all false because they found a 1945 World War II bomber [in the ice]...and we've got teachers teaching it!

Teachers found that climate change was still a contentious issue in their communities including amongst some of their contemporaries. This was also made apparent in the TAMU discussions with one graduate student expressing her skepticism by stating that:

You have to be careful about [social] screens that are seen through in the development of a program. I think it would be important to really balance that...regardless of personal perception.

She went on to state that care needs to be taken when designing educational programs so as to avoid perceived bias. As noted by both groups, social pressures impact the reception of activities with an environmental message, even with scientific agreement on the root causes of current climate change events.

Even with the acknowledgement of social hurdles to issue-based environmental education teachers expressed their willingness and desire for materials to address such topics as climate change in their classrooms. “Superintendents and principals and school boards need to come and do this [teacher training] and say ‘Are my kids doing this kind

of stuff? ...Why aren't we doing this?'" They felt that by having the materials created and made available by reputable sources with an understanding of curriculum standards, school administrators would be more willing to pursue this type of learning experience.

### **Benefits of Gaming with a Focus on Carbon Bond**

After receiving training about climate change and CCS and playing the *Carbon Bond* game, both focus groups found the activity to be a fun and useful tool to motivate youth into thinking about climate change and climate change mitigation strategies. As expressed by one graduate student:

Environmental communication is inherently a crisis discipline, talking about the notion of problem solving through creativity...so in something like this [*The Adventure of Carbon Bond*] as a starter tool... already starts putting it in that problem solving frame.

Teachers saw additional benefits to the game since it included curriculum material on subjects such as the carbon cycle and other scientific concepts.

Focus group participants also found the game to be adaptable to different learning experiences and styles of learning. For example, *Carbon Bond* could be played as individuals, in small groups, or as an entire class, broken up into teams complete with a score keeper (a suggestion by one of the teachers). One graduate student pointed out the advantages of games as a way to encourage interaction between students since "it's impossible to passively play a game." Other researchers have also found that substituting lecture with an activity allows youth to use more of their senses, which is especially helpful for non-auditory learners (Jacobson et al., 2006). Many of the graduate students referenced their own positive learning experiences with games such as the *Oregon Trail* and *Where in the World is Carmen Sandiego* where strategy and

investigation were needed in order to earn points. The use of role play or taking on a character in a narrative was also considered a memorable feature to the games because it not only provided context, but also framed the problem and thus the challenge.

### **Drawbacks of Carbon Bond**

Though *The Adventures of Carbon Bond* was well received by the teachers and graduate students alike, both groups found room for improvement. One of the most difficult aspects of the story and game was providing an accurate yet simplistic account of the process of capturing CO<sub>2</sub> from power plants and storing it in underground formations. The purpose behind the creation of the game was to explain this exact method since it is the least understood strategy but has the most storage potential. In reality, this concept is difficult even for adults, which made the transition to youth material all the more difficult.

It is important to remember the audience, because one of the things I thought about when I was watching the intro is it felt to me a little bit complex for 3<sup>rd</sup> to 5<sup>th</sup> graders. But part of that is, carbon sequestration is a really, really complex topic. I mean we're all in the environmental field and a lot of us didn't know much about it and we probably don't understand it as well as we can even now.

Another possible improvement mentioned by participants was adding playability to the story, making it part of the game instead of just a precursor. The TAMU group was especially interested in providing more interactivity, having had their own experiences with both educational and non-educational gaming. Suggestions included more interactivity through the addition of activities such as controlling Carbon Bond's capture of rogue CO<sub>2</sub> molecules and his trip to the underground formation. They felt that it was important for kids to be able to impact the game itself, lending to a better

understanding of the sequestering process overall. The TAMU group also felt that additional game interactivity would encourage repeated play since players would feel challenged to better their score in additional sessions. This suggestion would also eliminate the static feeling of the narrative, making the game more engaging.

In addition to increasing game play, other more cosmetic suggestions were made such as using bright colors and increasing the visual elements of the animations. Though use of a brighter color scheme is an easy change, going from a simple animation to a more complex animation presents a challenge, especially when budgets are concerned since higher quality animation is more costly (i.e. expenses related to software, computers, expertise, and time allocated to game creation).

## CONCLUSION

According to members of both focus groups, *The Adventures of Carbon Bond* is a worthy tool for educating youth about climate change and CCS. As an internet game, *Carbon Bond* has the capacity to reach multiple users, teaching them about a process that is otherwise inaccessible to the public. Due to visibility limitations, underground CO<sub>2</sub> storage is generally demonstrated using 2 or 3 dimensional images or models. Additional limitations include access to CCS project sites and an inability to see processes below the surface operations when site access is granted. *The Adventures of Carbon Bond* provides youth with a glimpse into this process, outlining the basic actions involved in capturing, transporting and storing CO<sub>2</sub>. Though *Carbon Bond* is simplistic in its interpretation as well as cartoonish, it is one of few educational activities for youth attempting to introduce CCS as a possible mitigation alternative for climate change.

Also, though this story and game was created without supplemental materials, it was not intended to be a standalone piece. Like all educational materials, environmental or otherwise, they must fit into the context of lessons within a curriculum in order to be implemented by teachers in a formal education setting. Therefore, in order to provide a place for *The Adventures of Carbon Bond*, a list was created at the bottom of the SWP Kids Stuff webpage containing additional web-based games, printable activities, and lessons (i.e. EPA's Climate Change Kids Site and Environmental Kids Club, The Science Museum of the National Academy of Sciences' Global Warming Facts & Our Future, Atmospheric Radiation Measurement Program's education website for kids and teachers, The Why Files – Global Warming and Virtual Science Interactives, and The Stabilization Wedge Game – Princeton and Keystone Center versions) as well as curriculum focused on either climate change mitigation (The Keystone Center's CSI: Climate Status Investigations) or climate change adaptation (World Wildlife Fund Climate Curriculum for Teachers). Age or grade appropriateness was also indicated where possible to avoid inappropriate use based on developmental level and skills (Bhatt et al., 2005). A division was also made on the web page between activities for youth and educational materials for parents and teachers.

It must also be stated that computer games are only one tool in the educational arsenal. They are an effective way to demonstrate what is otherwise difficult to display or manipulate without real world repercussions. They are also not without their limits. In the case of environmental education, the point is to connect humanity with their environment so as to better understand how to solve environmental issues (Jacobson et

al., 2006). Computer games cannot replace activities that allow for and promote interaction with the environment (Louv, 2006). Carbon dioxide storage in vegetation and soils, for example, is a concept more intelligible and easier to demonstrate through outdoor, hands-on activities such as planting trees and calculating their carbon uptake. Though computer games could simulate this activity, it could lack the same potency.

Finally, the issue of climate change is one of urgency. In order to act, people must have a firm understanding of the options. It is up to the public whether or not CCS will be considered for implementation. Therefore education of such strategies is needed to make an informed decision as to what should be done to slow or halt the effects of climate change.

## **CHAPTER VI**

### **CONCLUSION**

The purpose of this dissertation was to evaluate processes for communicating CCS as a mitigation strategy for anthropogenic climate change to the public. With multiple mediums for communication available, I sought to examine different pathways including direct communication from the DOE and carbon sequestration partnerships via websites (chapter one), newspaper media from states with energy projects proposed or underway (chapter two) and alternative communication mediums in the form of an online interactive youth game (chapter four) in order to better understand the transmission of information from political and scientific elites to the general public. In chapter three I also examined public knowledge and perceptions of the technology to gauge public acceptance by potentially impacted communities as an indicator for nationwide approval of CCS deployment. From these studies I have determined that 1) though information about CCS is readily available on the web, communication of its research and implementation is highly dependent on authority as a means for persuading the public of the need for CCS technologies in a carbon constrained world, 2) only recently has CCS gained the attention of news media and the majority of this attention is from newspapers in close proximity to CCS pilot operations or proposed projects; predominantly interested in the political/legal, economic and technical aspects of these newly recommended technologies, 3) potentially impacted communities of CCS pilot projects are generally unaware of such activities even with their extensive knowledge of other operations related to the fossil fuel industry, leading to further distrust of

government and industry decisions and activities, and finally 4) alternative educational opportunities such as internet games can be a useful method for engaging the public in the climate change-energy debate, especially when used to describe a technology that cannot easily be viewed otherwise. This usefulness, however, is contingent upon a willingness to discuss possibly contentious environmental issues.

Overall, these four chapters show that communication of CCS has only reached portions of the public, and has not consistently connected with those potentially impacted by the technology. These studies also demonstrate that CCS must overcome numerous barriers to deployment, foremost of which is public acceptance, both of the technology and its need. This acceptance is dependent upon factors such as community-level acceptance, a heavier weighting of pros to cons and a high level of political backing. Though science has played a substantial role in preparing the technology for deployment and is still part of the overall discussion, the actual implementation of CCS technologies also now rests on the influence of other social systems to reach fruition.

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## **APPENDIX A**

### **FOCUS GROUP QUESTIONS**

#### **Discussion Topic #1 – Environmental Concerns**

- What would you consider the top 3 issues in your community?
- What would you consider the top 3 environmental or energy issues in your community?
  - This includes health issues

#### **Discussion Topic #2 – Climate Change**

- What about environmental issues related to climate change?
- What do you think about climate change? What have you heard?
- What do you think when you hear or read about climate change or global warming?
- Do you think it is happening?
  - Lets write down some thoughts on the board as to why it may or may not be happening
  - Climate change refers to the sorts of changes that might take place if the Earth's atmosphere warms significantly
- What impacts do you think climate change is having or not having? What are your concerns? What are you not concerned about?
  - Local examples and global examples

#### **Discussion Topic #3 – Carbon Capture and Storage**

So let's switch gears just a little bit and talk about one of the technologies being put forward as a way to manage climate change. Before we started our talk, did everyone

have a chance to read through the handout on carbon capture and storage, also known as carbon sequestration? Does anyone have any questions about either the terrestrial or geologic forms of carbon sequestration?

- What do you think about these methods?
- Let's discuss the opinion survey I handed out earlier
  - Discuss questions 1 through 7
- What do you think are the pros and cons of carbon capture and storage?
  - Please feel free to write down your personal feelings about this on the worksheet during the discussion
  - Please also include your knowns and unknowns about the technology on the back of this sheet
- What about the technologies risks and safeguards?
- What information would you like to receive about carbon capture and storage?
- How would you feel if a geologic storage project was to take place in your community?

## FOCUS GROUP SURVEY

Please rate how well you agree or disagree with the following statements using the scale listed below (fill in one bubble per row).

Question	Disagree Completely	Somewhat Disagree	Uncertain	Somewhat Agree	Agree Completely	Comments
We should learn more about geologic and terrestrial carbon sequestration -- such as how much would it cost, and is it safe and effective -- and support more research on this topic.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
We should encourage landowners to increase the carbon stored in farmlands, forests and open spaces for terrestrial carbon sequestration.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
We should not support geologic and terrestrial carbon sequestration because we need to make a major shift away from using emission-causing fuels such as oil, coal and gas. Carbon sequestration will just delay that shift.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Both geologic and terrestrial carbon sequestration should be encouraged as part of a larger strategy that includes more renewable energy, higher energy efficiency and other types of energy sources.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Question	Disagree Completely	Somewhat Disagree	Uncertain	Somewhat Agree	Agree Completely	Comments
We should encourage both geologic and terrestrial carbon sequestration because there is evidence to suggest that it will be difficult to transition away from our reliance on fossil fuels such as oil, gas and coal, and sequestration provides a way we can keep carbon out of the atmosphere as much as possible during a transition.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
We should support efforts to test and develop geologic sequestration because new technologies need to be tried before they can be adopted nationally.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
We should support geologic carbon sequestration because it is an approach that the US Dept of Energy and oil / gas / power companies are seriously looking at.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

### DEMOGRAPHICS QUESTIONNAIRE

This information is being collected to help in the analysis of the discussions and will not be used to identify individuals. We are not requesting you to complete your name and address. Your responses to all questions, including these, are completely confidential.

1. Sex: (Please circle one)

Male

Female

2. Age: (Please circle one)

18-45

46-64

65 or older

3. Do you have children under 18 years of age? (Please circle one)

Yes

No

4. Occupation: \_\_\_\_\_

5. How long have you lived in this area? \_\_\_\_\_

6. How would you define your ethnicity? (Please circle all that apply):

Caucasian

Asian

African-American

Hispanic/Latino

Native American

Other

7. What is your highest level of education? (Please circle one):

Grade school; high school diploma

Some college (no degree)

College degree (Associate or Bachelor)

Advanced degree (Masters or Ph.D.)

Technical training

8. What are your primary sources of information about local and national news? (Please circle all that apply):

Local newspaper

National newspaper

Radio

TV

Internet

Other (please specify) \_\_\_\_\_

## TYPES OF GEOLOGIC CO<sub>2</sub> SEQUESTRATION ACCORDING TO THE DEPARTMENT OF ENERGY

**Oil and Gas Reservoirs:** In some cases, production from an oil or natural gas reservoir can be enhanced by pumping CO<sub>2</sub> gas into the reservoir to push out the product, which is called enhanced oil recovery (EOR). The United States is the world leader in enhanced oil recovery technology, using about 32 million tons of CO<sub>2</sub> per year for this purpose. From the perspective of the sequestration program, enhanced oil recovery represents an opportunity to sequester carbon at low net cost, due to the revenues from recovered oil/gas.

In an enhanced oil recovery application, the integrity of the CO<sub>2</sub> that remains in the reservoir is well-understood and very high, as long as the original pressure of the reservoir is not exceeded. The scope of this EOR application is currently economically limited to point sources of CO<sub>2</sub> emissions that are near an oil or natural gas reservoir.

**Coal Bed Methane:** Coal beds typically contain large amounts of methane-rich gas that is adsorbed onto the surface of the coal. The current practice for recovering coal bed methane is to depressurize the bed, usually by pumping water out of the reservoir. An alternative approach is to inject carbon dioxide gas into the bed. Tests have shown that the adsorption rate for CO<sub>2</sub> to be approximately twice that of methane, giving it the potential to efficiently displace methane and remain sequestered in the bed. CO<sub>2</sub> recovery of coal bed methane has been demonstrated in limited field tests, but much more work is necessary to understand and optimize the process.

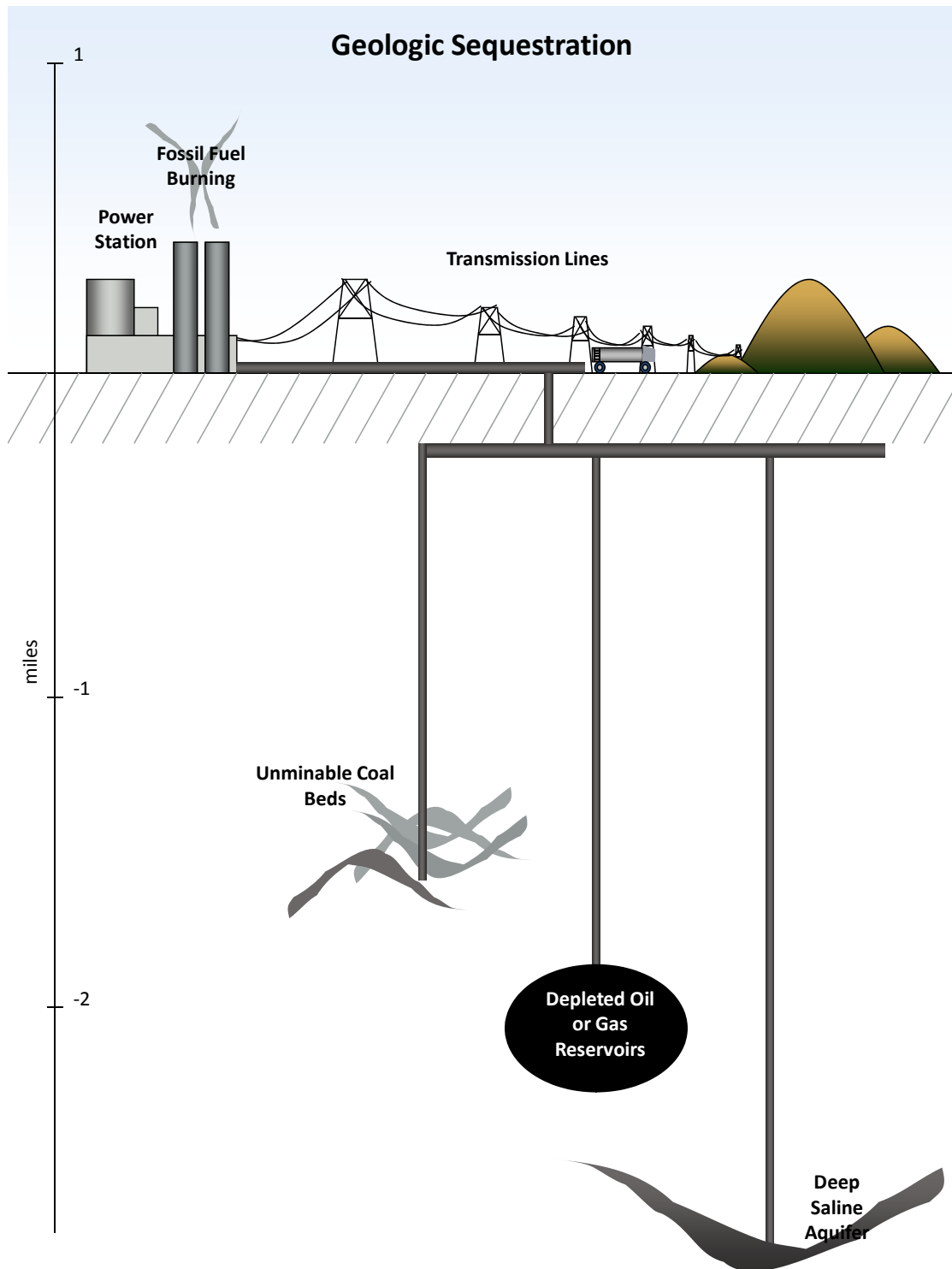
Similar to the by-product value gained from enhanced oil recovery, the recovered methane provides a value-added revenue stream to the carbon sequestration process, creating a low net cost option. The U.S. coal resources are estimated at 6 trillion tons, and 90 percent of it is currently unmineable due to seam thickness, depth, and structural integrity. Another promising aspect of CO<sub>2</sub> sequestration in coal beds is that many of the large unmineable coal seams are near electricity generating facilities that can be large point sources of CO<sub>2</sub> gas. Thus, limited pipeline transport of CO<sub>2</sub> gas would be required. Integration of coal bed methane with a coal-fired electricity generating system can provide an option for additional power generation with low emissions.

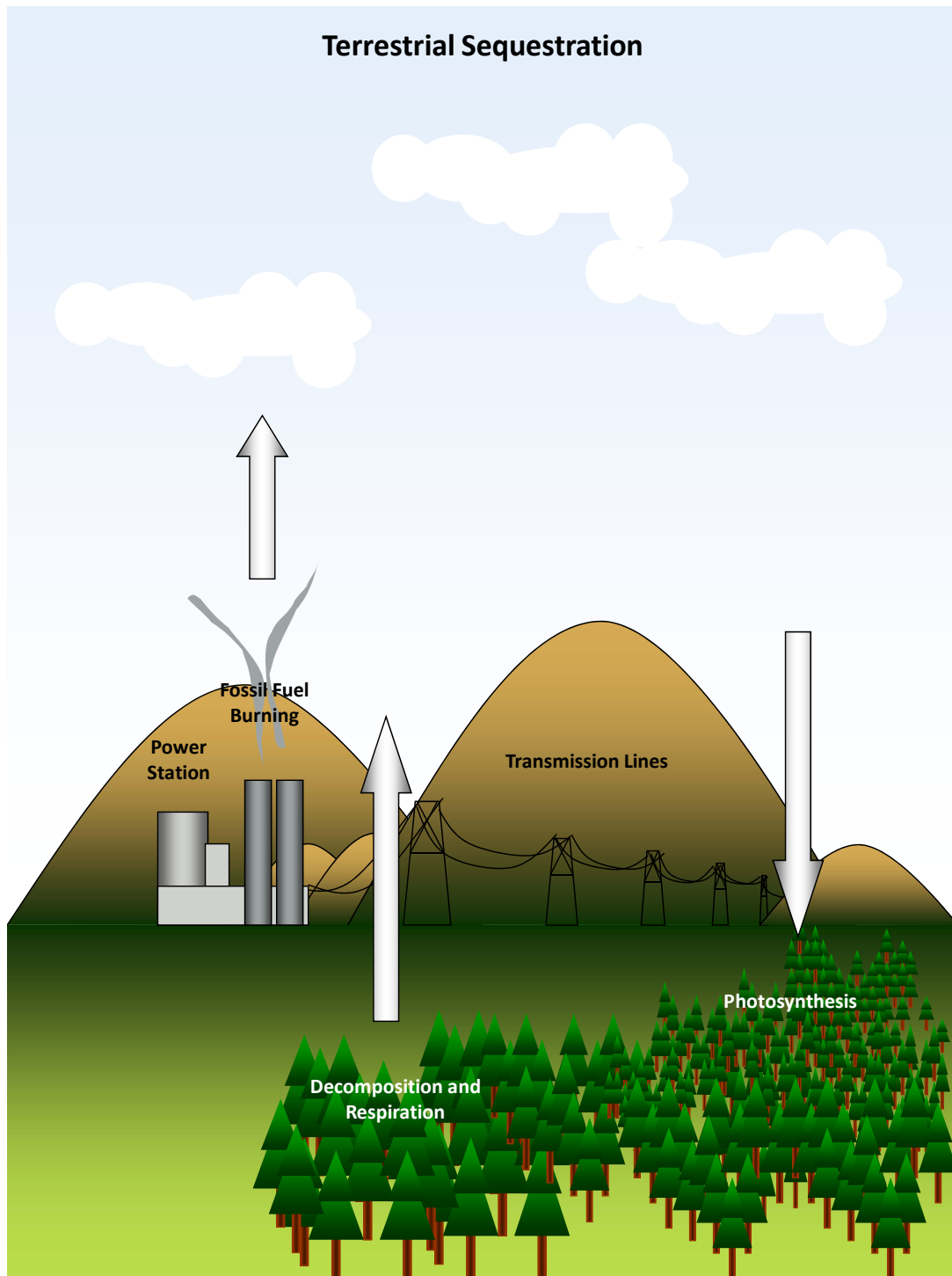
**Saline Formations:** Sequestration of CO<sub>2</sub> in deep saline formations does not produce value-added by-products, but it has other advantages. First, the estimated carbon storage

capacity of saline formations in the United States is large, making them a viable long-term solution. It has been estimated that deep saline formations in the United States could potentially store up to 500 billion tonnes of CO<sub>2</sub>.

Second, most existing large CO<sub>2</sub> point sources are within easy access to a saline formation injection point, and therefore sequestration in saline formations is compatible with a strategy of transforming large portions of the existing U.S. energy and industrial assets to near-zero carbon emissions via low-cost carbon sequestration retrofits.

Assuring the environmental acceptability and safety of CO<sub>2</sub> storage in saline formations is a key component of this program element. Determining that CO<sub>2</sub> will not escape from formations and either migrate up to the earth's surface or contaminate drinking water supplies is a key aspect of sequestration research. Although much work is needed to better understand and characterize sequestration of CO<sub>2</sub> in deep saline formations, a significant baseline of information and experience exists. For example, as part of enhanced oil recovery operations, the oil industry routinely injects brines from the recovered oil into saline reservoirs, and the U.S. Environmental Protection Agency (EPA) has permitted some hazardous waste disposal sites that inject liquid wastes into deep saline formations.





Terrestrial Sequestration		Geologic Sequestration	
Pros	Cons	Pros	Cons

Terrestrial Sequestration		Geologic Sequestration	
Knowns	Unknowns	Knowns	Unknowns

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Bachelor of Science, Environmental Biology/Zoology, Michigan State University, East Lansing, MI USA, May 2003

### **PROFESSIONAL EXPERIENCE**

Graduate Research Assistant (Ph.D.), Department of Wildlife and Fisheries Sciences, Texas A&M University, September 2006-August 2007, June 2008-December 2008, January 2010-August 2010

Graduate Teaching Assistant (Ph.D.), Department of Wildlife and Fisheries Sciences, Texas A&M University, September 2007-May 2008

Graduate Research Assistant (M.S.), Department of Wildlife and Fisheries Sciences, Texas A&M University, September 2004-August 2006

Zoology Assistant, Michigan Natural Features Inventory, Michigan State University Extension, April 2004-August 2004

Seasonal Technician, Michigan Department of Natural Resources, Rose Lake Research Center and State Game Area, June 2003-April 2004