CLOSING CLIMATE CHANGE BELIEF GAPS

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Table of Contents

Introduction	1
Scientific Background	8
Assessments & Projections	18
Beliefs & Opinions	29
Influences	39
The Power of Doubt	54
Carson's Legacy	61
Works Cited	71

Introduction

On June 24, 1988, the ABC Evening News with Peter Jennings opened with a segment highlighting the extreme hot weather and destructive droughts impacting wide parts of the country. "It is in the Midwest and the South where the heat holds the people, the animals and the land in its grip" stated Jennings. In some places, the sustained conditions were so bad according to the broadcast, that one despondent citizen was quoted telling their congressman, "God is against us." The news report went on to show dramatic footage of the shrunken Ohio and Mississippi rivers where some of the lowest recorded water levels had stranded barges. The television audience was told that the Army Corp of Engineers were having to build barriers at the lower portion of the Mississippi to prevent salt water from creeping up stream and contaminating drinking water. In another segment, a reporter interviewed small, private hydroelectric dam operators who were losing money because of a lack of water to generate electricity. The weather was the top story at ABC and at other networks on a day when the Palestinian and Israeli conflict, the President's AIDS Commission final report, the Pope's visit to Austria and the approaching election between George Bush and Michael Dukakis all received second billing.

The June 24, 1988 edition of *The New York Times* also featured a story about the drought and the impact on food prices. But the article above that, above the fold on the front page, the one featuring a large scientific chart printed directly below the paper's motto, "All the news that's fit to print," was about a more ominous and larger scale condition than the heat wave impacting the United States. The lead story that day was: "Global Warming Has Begun, Expert Tells Senate" (Shabecoff).

The day before, on June 23, 1988, NASA scientist James Hansen made one of the first public arguments about the need for action based on overwhelming evidence supporting climate change. His audience was the Senate Committee on Energy and Natural Resources. Dr. Hansen shared charts documenting temperatures covering periods of history going back over 100 years. He explained the interaction of carbon dioxide and other man-made gasses on the greenhouse effect, and he pointed to alarming warming trends and projections. According to *The New York Times* article: "If Dr. Hansen and other scientists are correct, then humans, by burning of fossil fuels and other activities, have altered the global climate in a manner that will affect life on earth for centuries to come" (Shabecoff).

Since the birth of the United States, explorers, environmental advocates and philosophers have expressed concerns about man's incessant exploitation of the land and insatiable drive for growth. It only took a hundred years for the population to move from east to west and increase from a few million to nearly one hundred million. With demand came deforestation, species exploitation and industrial pollution that eventually gained the attention of influential citizens. They championed early actions to protect undeveloped land, clean up the water and air, and save animals from extinction. Later, in the twentieth century, the United States government and international institutions took broader action to institutionalize protections to the environment and health of citizenry. Henry David Thoreau, Theodore Roosevelt, Rachel Carson, Senator Gaylord Nelson and many others played important roles in changing man's relationship to nature along the way.

In the three decades since Dr. Hansen raised the first alarms around global warming, the growing research, analysis and environmental trends have bolstered earlier scientific claims and predictions. Today, the overwhelming majority of scientists – depending on the

poll, greater than 97% – accepts and believes in the realities of climate change and the connection to human activity. Recent polling among the population in the United States indicates that most Americans believe the earth is warming, but less than half say humans cause it. And there is an interesting misperception about the research; only half of Americans say there is agreement among scientists. "There's a huge gap between what is understood by the scientific community and what is known by the public" according to NASA scientist James Hansen. Scientists appreciate the delicate balances of ecosystems on local and global levels. They demonstrated the links between pollution and acid rain. They developed weather modeling in the 1950's that help cities regularly prepare for anything from heavy snows to hurricanes and tornadoes. Sustainability and preserving the future is a driving motivation for most scientists and policy makers who care about avoiding a large-scale version of a "Tragedy of the Commons." Yet, in the year 2014, if the polls are to be believed, there are large gaps in the public's trust and faith in science.

The information age has both enlightened populations and contributed to muddling of what previously would have been considered unequivocal evidence. Easy access to vast resources of information has created social networks and intentional processes, some politically motivated, to counter experts, exploit outlier views and seed doubt. The media plays an important role in enabling the creation of doubt and mistrust. Attempts to balance reporting and giving each side similar airtime, regardless of the weight of evidence and facts, can be partly attributed to this effect. There is also a more direct route: bolstering one side by direct marketing. There is a reason energy companies spend millions of dollars on advertising directed at painting overly positive perspectives on oil and gas exploration and

development. These media campaigns are based on economics as public opinion influences policymakers who make decisions about regulations.

When Rachel Carson's book, *Silent Spring,* began to grow in popularity and take hold in the American environmental conscience, the industries that produced the chemicals she was demonizing spent significant sums to discredit her and the research from which she based her arguments. For decades the tobacco companies also fought tirelessly and invested heavily in their attempts to poke holes in the growing evidence of health problems caused by smoking. Their goal, especially after their internal research confirmed the health threats from first and second-hand smoke, was to create doubt to the extent that the general public could not be completely swayed to accept what was by then, scientific fact. The pro-tobacco campaigns were creative, manipulative and later proven to be dishonest. They were also highly effective in skewing public opinion.

Misinformation on environmental issues is an important piece of the equation in diminishing the credibility of experts and disrupting belief systems. Developing a better understanding of those entities promoting anti-science, their motivations, and their strategies is equally important to appreciating political spheres of influence and economic stakeholders. The big shifts in environmental policy over the years happened at the hands of politicians. Their personal beliefs and backgrounds have often played a role in policy development, good or bad, depending on one's perspective. For those who have balked in the face of arguments supporting climate change and global warming, there must be some common themes. Do they represent a resistance to learning science, contrarian religious beliefs or the inability of policymakers to take a stand based on core party ethos and financial ties to industry? And why are some realms of science acceptable and

noncontroversial where others are not? How can an individual compartmentalize an appreciation and trust in the medical community's consensus on cancer research or astrophysicists' understanding of planetary movements, or energy experts' explanations on nuclear power, yet discount the vast research and body of evidence about climate change? There must be ways to address this illogical gap in science acceptance that would create opportunities for resolving major societal challenges facing this and future generations on the planet. These are the questions and issues this paper focuses on.

Twenty-six years after Dr. Hansen's testimony, the science and troves of evidence behind climate change have become irrefutable. In his State of the Union address on January 28, 2014, President Barack Obama stated emphatically: "…the debate is settled. Climate change is a fact." He went on to make the case that future generations are depending on us to take action now to leave "a safer, more stable world." Unfortunately for the planet, the opinion on "fact" is not as widely shared as it is among the scientific community. For scientists, however, the message is clear: "science isn't a democracy. It's a dictatorship. Evidence does the dictating" (Reisman). Why the heavily researched theory that global warming is caused by human activity does not also attract near unanimous consensus, is something that will be explored further as it has created imbalance in the perceived debate.

Until the public belief gaps are narrowed, until policy makers are compelled to move the needle on their positions, the debate will go on. And populations will continue to grow along with their demands for energy and food. The consequences of inaction on climate change are predicted to be global, significant and perhaps, irreversible. Somehow, the

public and governments must be persuaded to think differently about this existential threat.

The goals of this paper are to clarify the background of climate science, to analyze current thinking on all sides of the debate, to highlight the roots of public doubt, and to identify possible approaches to effect change based on previous environmental movement successes. In Section I of the paper I will provide more details about the science involved in climate change as well as current analysis around the latest research and projections for the near and long-term. Section II will focus on beliefs and opinions in the American public on climate issues and what influences contribute to various belief gaps. The final section will cover the role of industry in creating doubt, the rise of the modern environmentalism and what lessons can be applied toward advocating the best approaches to cause shifts in public thinking and action at the federal level.

While it would be naïve to believe that changing course can happen easily, there must be a rapid evolution in thought and strategy. What can be done in the near term to create an atmosphere that enables governments to change their approach to save the planet and millions of human beings? This movement cannot take as long as it did to enact Civil Rights laws or even to change attitudes about tobacco, which in both cases took decades. Scientists warn that an environmental tipping point is near and time is running out to do anything that can reverse climate change trends. Any workable solution to changing beliefs and attitudes must be measurable in months and years, not decades and generations.

Finally, it could be argued that in the face of a daunting situation like climate change, when one fully embraces the science and the projections, pessimistic and even fatalistic

attitudes can prevail. But only an optimistic perspective that it is not too late will garner the level of support where people choose to take action. As with fundraising, people want to know their gift, their action, however small, is going to have an impact. If the goal seems so out of reach that "$50 won't make a dent" or that "home recycling doesn't matter," then fewer people will choose to contribute. A smaller percentage of the population will embrace the mission. Like any SMART goal, the end game has to be measurable and attainable. The challenge is how to accomplish that when many may not be alive to see the changes and thus appreciate the collective impact that could save "the commons" known as earth.

Scientific Background

Humans have been observing their environment for thousands of years. A critical motivation for this was survival; hunters and gatherers utilized primitive resources to gain an appreciation of what plant life was edible and how to track and kill prey. The historical record is filled with examples of these kinds of observations. From prehistoric cave paintings in Europe to hieroglyphics on Egyptian monuments, they show a growing refinement of understanding about their world. This intensified as humans explored the planet and searched for answers about the unknown and the natural world around them. Humans began to decipher the movement of the planets, the evolution of animal species and even decode the tiny building blocks of all matter. Observation is key to the discovery process and it is the starting point of the scientific method. As questions or problems present themselves, scientists conduct research with whatever resources they have available at the time to collect information. After building a base of data, next comes the formation of a hypothesis to suggest a possible theory for what is being observed and predicted. Testing through experiments can reinforce the theory or poke holes in it, which leads to the conclusion. This is the process most children are taught in grade school science classes. It is elementary, it is simple and yet it has led to the greatest discoveries and advances in science.

The lead-up to NASA scientist James Hansen's seminal report to the United States Congress about the warming planet and more recently, the Fifth Assessment Report on Climate Change by the IPCC (Intergovernmental Panel on Climate Change), can be traced to a long history of scientific exploration dating to the late 1800's. Svante Arrhenius was a Swedish scientist who is credited for being one of the first people to credibly argue that

increases in atmospheric carbon dioxide correlated with a rise in global temperatures (White 37). At the time, his theory derived from attempting to explain the ice age. He projected that emissions from human activity could cause warming in the future. The 1950's brought advances in the study of pollutants in the atmosphere and further understanding of weather patterns. At an elevation of 11,000 feet, the Mauna Lau Observatory in Hawaii became ground zero for the monitoring of carbon dioxide concentrations by a team of students and scientists led by Roger Revelle, Director of the Scripps Institution of Oceanography. After only a few years of measurements, they were able to document an increase in carbon dioxide levels. Their work validated findings by scientists at the North and South Poles. From 1880 to 1989 when Hansen addressed Congress, there had been a 20% increase in atmospheric carbon dioxide, which is measured in parts per million (ppm) (White 37).

Around the same time that Roger Revelle was analyzing concentrations of carbon dioxide in the air, John von Neumann and Jule Charney at Princeton "were changing weather prediction from art to science" (White 38). They used digital computers to explain weather in mathematical terms. Jule Charney would later co-author one of the first scientific studies, published in 1979, on carbon dioxide and climate. The work Neumann and Charney did at Princeton provided the foundation for the Geophysical Fluid Dynamics Laboratory that was set up under NOAA (National Oceanic and Atmospheric Administration) in 1963 to model the atmosphere. The first climate models soon followed and in 1975, scientists Syukuro Manable and Richard Wetherald calculated that a "doubling of the carbon dioxide content of the atmosphere would produce a global climate warming of about 5 degrees" (White 38). The rest of the 1970's and the following two decades saw

immense work and coordination by scientific organizations, governments and individuals toward a better understanding of human caused, also commonly referred to as anthropogenic, pollution and predictions about the climate.

For the purposes of this project, I will primarily refer to what are widely considered the most definitive sources for climate research and climate tracking: the IPCC and NOAA. In 1988, given the growing body of evidence linking pollution to climate change and the heightened concerns about a lack of coordinated efforts between nations to deal with the threat, the World Meteorological Organization and the United Nations formed the IPCC "to prepare…assessments on all aspects of climate change and its impacts, with a view of formulating realistic response strategies" (IPCC). This new entity was essentially charged to gather and assess the known science on the subject, to study what could happen on a societal and global level based on various modeling available and to provide guidance for the United Nations and its members. Given the state of the science in 1988 and the multitude of gaps in the research and the scope of the challenge, this was no small undertaking. The resolve was built-in however, and through five assessment reports (1990, 1995, 2001, 2007 and 2013) the evidence has created a very strong consensus.

Today the mission and functioning of the IPCC is sophisticated. The reports include hundreds of authors, thousands of experts from around the world and a careful process for peer-review. Three different working groups are tasked with "defined mandates" (IPCC). Working Group I focuses on the physical science basis, Working Group II addresses climate change impacts, adaptation and vulnerability, and Working Group III studies the mitigation of climate change. Another element of the IPCC is the Task Force on National Greenhouse Gas Inventories with an objective to "develop and refine a methodology for the calculation

and reporting of national greenhouse gas emissions and removals" (IPCC). Governments and organizations select experts who then pick hundreds of lead authors on various topics. They in turn recruit hundreds of co-authors who help produce three drafts; the first two are shared and reviewed by other experts around the world in an open forum to encourage in depth, critical analysis. Dissenting opinions are included in the final reports, a reflection of the transparent process and the nature of scientific discovery.

The fifth report of the IPCC was published in October 2013. If there is a single takeaway from the assessment it is this: the scientific evidence for anthropogenic climate change has never been stronger. "Warming of the climate system is unequivocal, and since the 1950's, many of the observed changes are unprecedented… The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased" (AR5). Earlier IPCC assessments, and even the pre-IPCC 1979 report from the Ad Hoc Study Group on Carbon Dioxide and Climate out of Woods Hole Research Center, also pointed to heating trends, but they were unable to make confident predictions due to gaps in data and advanced tools for modeling. The confidence articulated by scientists in the fifth IPCC report published in 2013 is unmistakable. What is the science behind these conclusions and what has changed in the past three decades that explains the growing consensus?

The greenhouse effect is a natural phenomenon that has been known to scientists since the 1800's. The earth gets its energy from the sun in the form of solar radiation. As that radiation reaches the planet, the atmosphere and the earth's surface reflect some, but most of the radiated energy stays in the atmosphere or is absorbed by the land and ocean. This absorption warms the surface of the planet. The planet also radiates its own energy in

the form of infra-red radiation. Some of that energy or warmth escapes the atmosphere and some is reflected back by greenhouse gasses, which also helps to further warm the earth's surface. The natural greenhouse effect provides insulation to the planet. Without the greenhouse effect, the surface of the planet would be too cold for most life forms. Greenhouse gasses include water vapor, carbon dioxide, methane, ozone, nitrous oxide and chlorofluorocarbons. What scientists have primarily been concerned about is the impact increased concentrations of these gasses will have and the potential to "enhance the greenhouse effect, resulting on average in additional warming of the Earth's surface" (FAR). The term "radiative forcing" is used to describe this energy imbalance in the climate system. But measuring the total energy output, global release of gasses and the effect on the planet is complex and has proven challenging.

For thousands of years humans had a moderate impact on the planet's atmosphere. That changed quickly and dramatically with the onset of the industrial revolution. Massive amounts of fossil fuels were beginning to be burned to power development around the world. Fossil fuels like coal, oil and natural gas powered factories, nearly every form of transportation and provided the energy for modern living. That demand and growth in emissions correlated with an accelerated increase in carbon dioxide concentrations. "Over the last 150 years, humans drove up carbon dioxide concentration in the air from 280 ppm to more than 385 ppm – a value that is 38% higher than the highest value measured for over the previous 800,000 years" (Kennedy). How do scientists know the history of carbon dioxide levels of the planet's atmosphere and why is the increase so concerning?

There have been three primary ways that scientists have gathered information on atmospheric concentrations of carbon dioxide. The most consistent has been the sampling

of air, primarily at the Mauna Loa Observatory in Hawaii. In March of 1958, Charles Keeling, as part of a larger research project, had perfected a method for sampling carbon dioxide in the air. In search of the best place to get the least amount of atmospheric variation, he chose Mauna Loa due to its altitude, remoteness and lack of human activity close by. He began taking samples in March of 1958 and providing them to the SCRIPPS Institution of Oceanography (Krier). Prior to this project, scientists assumed that industrialization and the burning of fossil fuels was increasing carbon dioxide in the air. They also understood that plants and the oceans were absorbing large quantities of the gas. Keeling not only documented that carbon dioxide levels fluctuate throughout the year, but that they were growing year over year. He proved that the earth was not able to absorb the gasses human activity was creating (Krier). Data gathered from other locations sampling air quality and concentrations of greenhouse gasses have only reinforced these findings over time.

Two other ways scientists have documented historic concentrations of carbon dioxide are through tree rings and ice cores. Because trees take in carbon from the air during photosynthesis, and because trees create rings reflecting consistent time frames, the composition of carbon isotopes from each time period can be measured. Those isotopes are not the same as atmospheric carbon, but what scientists are able to do is show that the carbon ratio in "tree ring changes will track the atmospheric changes" (Realclimate.org). Tree ring records go back thousands of years and can be compared with periods of warming, cooling and known increases in atmospheric carbon concentrations like the start of the industrial revolution. In parts of the world where snow has been accumulating for thousands of years, like Greenland and Antarctica, scientist can drill core samples of the ice

and analyze layers in a similar way that one would look at tree rings. Each layer contains bubbles of air and other particles that are tested for gas molecules, concentrations of those gasses and elements. The result is a very accurate historical picture of the atmosphere. Through the core samples, scientists could show natural variations in the greenhouse gas concentrations that coincided with events of "rapid heating and cooling" over hundreds and in some cases, thousands of years (Alley). High and low concentrations of methane were consistently linked to rapid climate changes.

A final strong indicator of increasing global concentrations of carbon dioxide can be found in the feature that dominates the planet: the ocean. Scientists have known for some time that the oceans act as a sink and absorb up to 30% of anthropogenic carbon emissions. Over time, this has changed the ocean chemistry and contributed to a dramatic increase in acidification, or a decrease in the pH. Scientists estimate that today's oceans are 26% more acidic than before the start of the industrial revolution (igbp.net).

Together, the air and ocean testing and ice cores and tree rings samples leave no doubt in the scientific community that anthropogenic emissions are directly responsible for the global increase in atmospheric carbon dioxide concentrations. Predetermined critical thresholds of 350 ppm and 400 ppm have now been breached. Combined with research tracking the release of other greenhouse gasses like methane, the scientific argument is that there is overwhelming evidence demonstrating that higher concentrations of greenhouse gasses are having a warming effect on the planet.

For the past 130 years consistent surface and air temperature measurements have been taken around the world. It is possible for scientists to analyze this data and develop accurate global averages over a long period of time. According to the Fifth Assessment

Report from the IPCC, "each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850" (AR5, 3). 2013 was one of the warmest years on record, tied with 2003, and not far behind the year 2010, which was the warmest year. Since 1880, the ten warmest years have all occurred since 1998. Data indicates an average of 0.85 °C increase in surface temperature since 1880. The warming was not isolated to certain regions or hemispheres; nearly the entire planet reflected the heating trend.

Scientists have not consistently measured ocean temperatures on a similar scale to land and air readings, but "it is *virtually certain* that the upper ocean (0-700m) warmed from 1971 – 2010 and it *likely* warmed between the 1870's and 1971" (AR5, 6). The estimate of the warming is 0.11 °C. Since so much of the energy created in the climate is stored in the upper layers of the ocean, it makes sense that it would display changes over recent history. Ice sheets on Greenland, the Arctic and Europe have been in retreat for decades and the ice loss has been accelerating. Satellite records coupled with regional measurements and observations show an annual decrease in ice cover of 12% in each of the past three decades (Parks). The Greenland ice sheet loss alone has "quadrupled over the past two decades" (Straneo). The most current research suggests that the ice loss is being caused by a combination of warmer air and warmer oceans that lead to surface melt and submarine melt. Ice cover in the North Atlantic has experienced such extreme loss in the summer that new passages have opened that had not existed in recorded history. Overall, more ice is melting during the summer months and less ice is forming in the winter months. This is also true for regions covered in permafrost where it has been melting and

measured to be less thick due to increases of up to 3 degrees Celsius since the 1980's (AR5, 7).

Melting sea ice and glaciers are also partly responsible for a rise in sea level. With high confidence "The rate…since the mid-19th century has been larger than the mean rate during the previous two millennia" reports the Fifth IPCC Assessment. Another factor influencing rising seas is that water expands as it warms. Similar to carbon dioxide concentrations, surface warming, and retreating ice, the sea rise has been increasing decade over decade. To be clear, the total amount of water on Earth is not increasing; it is the volume of water in the oceans that is increasing due to melting ice and warmer water (Dahlman). The most recent data gathered from tidal records and satellite altimeter readings show that the average sea level rise between 1993 and 2010 was 3.2 mm a year (AR5, 9).

Advances in science and technology have played a crucial role in improving the understanding of the Earth's climate. One process in particular that has transformed the accuracy of climate science is modeling. Where weather modeling was perfected in the 1950's and 1960's and shown to make reliable predictions over short time periods, meteorologists would eventually have the ability to make seasonal predictions based on known cycles and atmospheric variations. Recreating the Earth's climate values in its current state and modeling to show the climate state decades or a century into the future could be considered "modeling on steroids." It involves a myriad of complex mathematical calculations based on how the air, land, ocean and sea ice interact and influence the overall climate system. A coupler component starts and ends the time of each simulation, and more importantly, it receives and sends information between the atmosphere, land, ocean and

sea ice components. Early climate models did not have the computational power to properly factor all components, systems and fluctuations to recreate “present day climate” (Gent 8). In 1996 a Community Climate System Model was built at the National Center for Atmospheric Research and attained wide attention in the scientific community due to a “300 year present day control simulation that showed virtually zero drift” (Gent 9). In other words, these models applied historical data to accurately predict global climate averages for the present time, as well as other times in history, thus confirming the reliability of complex climate modeling.

Because scientists know that increased concentration levels of carbon dioxide in the air influence climate and create additional feedbacks, including the further melting of sea ice and raising atmospheric temperatures that quicken the release of methane from Arctic tundra, it is a variable that has to be accounted for in climate models. Earth Systems Models (ESM) that leverages the power of supercomputers, represents some of the latest advancements in climate science projections research. They “enable the carbon cycle in the land, ocean, and atmosphere to be predicted” (Gent 10). Ultimately, the goal is to accurately project global and regional physical conditions, not local weather in a given time period, for policy makers and the public to understand the potential impacts to the planet due to climate change.

Assessments & Projections

We are fortunate to be living in a time when the pace of discovery and advances in nearly every scientific field continues to accelerate. This is a process that, thanks to dedicated researchers coupled with investments by both the public and private sector, contributes to improving overall knowledge and the application of ideas to solving problems, big and small. Humans can observe and problem-solve at a level like no other species on the planet. Send a man to the moon and back? Done. Cure Polio and halt the spread of many communicable diseases? Yes. Design a car that can travel 100 miles on a gallon of gas? It took some time, but now achieved. Sequence the human genome? This also took a while, but now complete. Grow pest resistant plants? Sure. Shrink computers to empower humans to do previously complicated tasks with a few swipes on a smart device? Billions of active hand-held devices are being utilized every day. These are just a few examples of complicated problem solving at work in the twentieth and twenty first century.

Humans and science do have limitations. Where are all of the flying cars we were promised in the 1950's and 1960's or the robots assisting us with household work? But for every missed prediction, scientists did make profound statements about how our world would develop in the future. Author and biochemist, Isaac Asimov, in a now popular article he wrote for the *New York Times* about his trip to the World's Fair in August 1964, illustrates the kind of vision possessed by man. He compared how the 2014 World's Fair would differ from the one in 1964. His predictions about the miniaturization of computers, automation of "kitchen gadgetry" and "moving walkways" were quite accurate; as were his statements about unmanned missions to mars, "wall screens" replacing "the ordinary (television) set" and the elimination of electric cords for appliances due to long battery life

(Asimov). Beyond the advances Asimov foresaw in technology, he also demonstrated an appreciation of a growing population, which he suggested could be 6,500,000,000 in 2014, and the potential impact on the environment. “One thought that occurs to me is that men will continue to withdraw from nature in order to create an environment.” Asimov was no environmentalist, though. His observations did not show deep concern for what people would “withdraw” from the environment or how it could impact the planet and the billions he predicted would be living on it.

Climate scientists are very much ingrained in the prediction game. This dispersed group of physicists, atmospheric scientists, geologists, chemists, hydrologists, meteorologists, and biologists have been working to more accurately determine what man’s influence on the environment will be in the years, decades and millennia ahead. In 1990, climate science was in its adolescence and that was reflected by what scientists were saying and predicting. The First Assessment Report from the IPCC consisted of many ”best estimate” and “likely” qualifiers, yet predicted an average temperature increase of 0.3° Celsius a decade or 1° above 1990 and 4° above preindustrial levels by 2025. The report also stated that even if emissions stabilized to 1990 levels the temperature would keep rising by at least 0.2° “per decade for the first few decades” (FAR XI). Increased precipitation for certain regions was projected as well as the melting of sea ice. This was all couched under a “business as usual” approach. The ranges also varied due to different scenarios based on unknown “climate responses” (FAR XXIII). There would be some variability of extremes in weather and climate, but overall the report predicted that there would be more warm days and fewer cold days in most regions of the planet.

It has been twenty-five years since that first IPCC report was published and the media, public and governments began to take note. Through five reports the research has greatly improved, thousands more scientists are involved, the evidence has mounted and the consensus is stronger than ever. The overall regional climate change assessment of the 2013 report states: "Continued emissions of greenhouse gasses will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions" (AR5, 17). Scientists predict with "high confidence" that atmospheric temperatures will keep rising and by the year 2100 will be in the range of 1.5° to 2° Celsius higher compared with the year 1900. With equal confidence the projections show more intense and longer heat waves, higher mean warming in arctic regions, and some cold weather events throughout the 21st century. Similar to the temperature increases and global variations, precipitation is expected to change over the short and long term. Generally, the Fifth Assessment Report predicts it is "likely" that "high latitudes and the equatorial Pacific Ocean (will) experience an increase in annual mean precipitation" and "in many mid-latitude and subtropical dry regions, mean precipitation will likely decrease" (AR5, 21). Generally, regions that are already considered wet will become wetter and regions that are dry or trending that direction will become drier. Systems like monsoons and hurricanes will carry more precipitation as a result of increases in moisture in the atmosphere leading to more extreme weather events.

The role of oceans in absorbing heat and carbon dioxide has been well documented. Scientists are predicting that the oceans will continue to warm at all depths and that eventually this will have an impact on current systems. Depending on the scenario, the first

100 meters could warm 0.6° to 2° Celsius by the year 2100 and between 0.3° and 0.6° Celsius in the same time period (AR5, 22). There is less confidence about the impact on ocean currents. The report states that is it "very likely" certain currents will weaken, anywhere from 11% to 34% but indicate that it is "very unlikely" these currents will "undergo an abrupt transition or collapse" (AR5, 22).

Consistent with recent historical trends, sea ice, snow cover and volume of glaciers are all projected to continue decreasing. Using two critical months as a measuring point – September and February – the report references ice range reductions from 43% to 94% and 8% to 34% respectively (AR5, 22). This will be most evident in the northern hemisphere where it is "likely" the Arctic could be consistently ice-free in September. Scientists are not as confident about projections for decreases in Antarctic sea ice, but with "medium confidence" project glacier volume loss to range from 15% to 55% in the best-case scenario and between 35% and 85% in the worst-case scenario (AR5, 23). In fact, overall Antarctic sea ice expanded more than usual during the 2013 winter. These gains were not consistent throughout the region and were small when compared with the dramatic Arctic sea ice losses. Snowfall in the northern hemisphere is a vital source of water for people and agriculture. By the end of the 21st century, scientists project with "medium confidence" that spring snowfall could decrease between 7% to and 25% (AR5, 23). Even the presence of permafrost in the northern hemisphere is certain to see dramatic decreases due to global warming. The Fifth Assessment Report projects that the range of permafrost could decrease by 37% to 81%.

As previously mentioned, sea levels are predicted to continue rising for the remainder of the century and scientists are certain that the rate will "very likely exceed"

what has been observed in the last 40 years (AR5, 23). The range of scenarios includes a rise of 0.52m on the low end to 0.98m on the high end. The significant confidence expressed in the report comes from advances in modeling and "because of the improved physical understanding of the components of sea level" (AR5, 23). Scientists now better understand the relationship of ocean warming and thermal expansion as well as the influences of melting ice on land and sea. Thermal expansion can account for up to 55% of the rise in sea level where glacier melt contributes up to 35%.

Some clarification about the ranges mentioned in the IPCC Fifth Assessment Report could be helpful here. The climate modeling done to determine projections were based on four scenarios called Representative Concentration Pathways (RCPs). These included ranges from low to high accounting for anthropogenic emissions and "total radiative forcing in year 2100 relative to 1750" (AR5, 27). In other words, scientists used a set of parameters tied to all sources of data and modeling to provide baselines of what could happen if greenhouse emissions were cut, stabilized (in two scenarios) or continued to increase. The goal was to provide policy makers with information that related to potential action or inaction by governments to mitigate climate change. The ranges are not there to represent guesswork or a hedge on projections. In all cases they represent the results of combining "integrated assessment models, simple climate models, atmospheric chemistry and global carbon cycle models" (AR5, 27).

To further complicate projections, there are several unknowns regarding the impact of positive feedbacks in the climate system. One example includes the melting of snow and ice. Not only does this lead to an increase of water vapor in the atmosphere, which is a greenhouse gas, but it also means more heat energy is absorbed by the surface of the planet

instead of being reflected back out of the atmosphere. Snow and ice also serve as a natural reflector of the light energy coming from the sun. Both the increase of water vapor and higher absorption of heat energy would amplify anticipated warming of the atmosphere, the surface of the planet and the oceans. Another feedback example involving melting is the potential release of huge quantities of methane from retreating permafrost in the arctic. And there is the potential for the steady drying of regions currently made up of forests and rainforests. In a scenario where precipitation decreases lead to disruption of forest ecosystems, less carbon dioxide would be absorbed by plant life, something that could accelerate the warmer and drier the regions become. Where ocean feedbacks are concerned, the warmer the oceans get, the less carbon dioxide they are able to absorb. These positive feedbacks and others are difficult for scientists to predict, but it is understood that their impact would certainly amplify climate change trends.

What the Fifth Assessment Report from the IPCC concludes is that for the rest of this century and future centuries, concentrations of greenhouse gasses will keep rising, the climate will continue to heat up, ice will continue to melt, and oceans will continue to warm and rise. All of this occurs even if emissions were cut to zero today. “A large fraction of anthropogenic climate change resulting from carbon dioxide emissions is irreversible on a multi-century to millennial time scale, except in the case of a large net removal of carbon dioxide from the atmosphere over a sustained period” (AR5, 26). The results of climate change are having real and measurable impacts around the planet and as the report makes clear, it can be anticipated those will persists and grow in the years ahead. How does that translate at the regional and local level?

It is difficult to avoid over-stating the possible impacts of climate change. Numerous studies have attempted to highlight how the effects of a warmer planet will manifest in a variety of ecosystems. One concern is how changing weather patterns will alter growing cycles, ranges and distribution of plant life and how that in turn will impact the animals that depend on the vegetation to survive. “Large climatic range contractions can be expected, amounting to a substantial global reduction in biodiversity and ecosystem services by the end of this century” concluded a group of scientists after analyzing emissions projections and climate change models (R. Warren et al). Their analysis was contingent on delayed climate change mitigation efforts. If global greenhouse emissions peaked earlier in the century, instead of large segments of animals and plants potentially losing more than 50% of their current climatic ranges, that loss could be cut nearly in half (R. Warren et al). It would also allow species and ecosystems more time to adapt to climate change.

As ocean levels rise, cities and people occupying islands, coastal areas and just about any land mass hovering one to four feet above current sea level will be effected. So too will the animals and plants that rely on those regions, especially marshlands, coral reefs and mangroves. With the increase in sea levels already realized there are signs of impacts to come. Where images of a flooded Venice have been common in the past, the degree of coastline erosion seen today coupled with inland flooding from higher than normal storm surges are also becoming common annual sights. According to a report by Climate Central, in the United States alone roughly 5 million people live “less than 4 feet above high tide” (Strauss 2). Billions of dollars in municipal and federal infrastructure as well agricultural assets also lie within that low zone and would be impacted. Large cities like New York,

Boston and Miami are especially vulnerable as are international cities including London, Tokyo and Hong Kong. In Australia, 80% of the population lives on the coast (Mulkern). By 2030 it is estimated that 50% of the global population will live 100km from the coast. And of the 180,000 islands on Earth where 20% of the world's biodiversity exists, the threats to habitat destruction are significant (Bellard, C. et al).

Increases in carbon dioxide are causing the oceans to warm, expand and rise; those increases are also changing ocean chemistry. Acidification due to carbon dioxide absorption has been a known phenomenon for many years, but only recently have serious studies begun to assess the impact and potential damage to ecosystems. According to a 2013 report from the National Research Council, acidity of the oceans has increased by 30% since the industrial revolution and may end up 150% higher by the end of the century (Zeller). Every day millions of tons of carbon dioxide end up in the oceans. Of great concern is the resulting lower pH and concentrations of calcium carbonate, which is a key building block for coral and all orgasms with shells, including oysters, urchins and plankton. With less calcium available, these organisms cannot properly develop and some signs of this have already been observed. A collapse in this segment of the food chain could be catastrophic for ocean life.

There is both scientific evidence and regional observations from the fishing industry that ocean warming is affecting distributions of fish and that it has been going on for over four decades. By measuring the mean temperature preferences of various species when they are caught on an annual basis, scientists can track the movement of fish (Cheung, W. et al). They found that many fish typically found off the northeast coast of the United States had moved further north to deeper and colder waters. In their place, fish found in warmer

regions were showing up in fishing nets. This also translated to “fewer marine species and reduced catches in the tropics” (Cheung, W., et al). When hundreds of millions of people rely on the oceans to supply a significant portion of their diet, any changes to the abundance and availability of fish poses a serious threat.

On land, climate change also threatens sources of food. There is growing concern that variability in precipitation and persistent droughts, rising sea levels threatening low-level crops and pest distribution, will heighten food security issues. “Vulnerable areas are expected to experience losses in agriculture productivity, primarily due to reductions in crop yields” reports Pradeep Kurukulasuriya and Shane Rosenthal (Kurukulasuriya 3). Those vulnerable areas will primarily be found in tropical regions. Other areas will most likely experience an uptick in food production due to longer growing seasons. But the harder hit regions will impact mostly developing countries and consequently, the large poor populations that are dependent on agriculture for their livelihood. “With lower technologies and capital stocks, the agricultural sector in such poorer developing countries is unlikely to withstand the additional pressures imposed by climate change without a concerted response strategy” (Kurukulasuriya 4).

An increase in extreme weather events around the planet has been predicted in every IPCC climate change report since the IPCC’s first assessment was released in 1990. While it is impossible to point to specific weather events and claim climate change “gotcha” moments, scientists do warn that what the planet is experiencing – from more powerful tornados to more powerful hurricanes and higher storm surges, to severe droughts and even the recent temperature dips from the polar vortex – are connected to the changing climate systems. The devastating flood damage in New York City last year from Hurricane

Sandy that submerged much of the Manhattan transportation system was the worst the city had ever seen. According to a recent weather related insurance report from Allianz Global, one of the world leaders in the insurance industry, "Volatility is increasing significantly" and it is "impacting how people live, what they buy, where they go and how their business performs" (Allianz 6). The report goes on to deflect doubt about climate change and instead, site the facts about insurance claims due to weather. In 2012, worldwide financial losses due to weather extremes were estimated at $150 billion compared with average annual costs of $15 billion between 1980-1989 and $40 billion a year between 2000 and 2009 (Allianz 6 & 7). Aside from large-scale events, the economies of most nations are also tied to weather in many other ways that result in annual losses. Disruptions in climate can negatively impact agriculture production, transportation, energy and tourism.

Robert White, in a July 1990 article that appeared in Scientific American, stated with some degree of optimism: "Fortunately, time may for once be on our side. Governments generally act only when threats become real… The effects of a global climate warming are likely to take 30 to 50 years to become serious, and this is a long enough span in which actions to adapt to these changes should be possible" (43). Have the necessary adaptions and actions by government been taking place? By most measures the answer is no. For years, the consensus in the scientific community was that if global temperature increases relative to 1750 did not exceed 2° Celsius, greater problems like a dramatic rise in sea level could be avoided. The speed at which things are changing now has no historic human civilization comparison. Even this January, which many might claim to be colder than normal, turned out to be the 4th warmest in the historical record based on global average surface temperatures (NOAA). And increasingly scientists worry that the impact from

feedback loops loom large in the not-too-distant future. Imagining islands without land, coral reefs without coral, rain forests without rain and ski resorts without snow are not delusional or fictional thoughts. Scientific projections on climate change are being realized as air, surface and ocean temperatures gradually heat-up, as oceans rise and acidify and as extreme climate variations grow in frequency and intensity. Since 1990, it could be argued that general awareness about climate change is much higher and that some steps are taking place by governments around the world to address this existential threat. Many in the scientific community, however, would argue that people and nations have not acted on or fully embraced the multitude of possibilities that lie ahead. Tad Pfeffer of the University of Colorado at Boulder warns, “The public and policy makers should understand how serious a sea-level rise of even 60 to 70 centimeters would be. These creeping disasters could really wipe us out” (Carey).

Beliefs & Opinions

For most adults in the United States and other developed countries, formal science education ends in high school. Of course, many colleges have a minimum requirement of science and math credits for all students. And there are a multitude of advanced disciplines that are either based in science or rely on scientific principles, from chemistry and medicine to agriculture and engineering. Those in the STEM (science, technology, engineering and math) fields have a deep understanding and appreciation of problem solving. They are familiar with testing, analyzing and evaluating data, and applying proven methods to practice. An inherent principle of those in STEM related professions is the desire, in a general sense, to make or do things better. But regardless of education background or formal training, there is no shortage of resources to further one's understanding and appreciation of any number of science related subjects. Books, magazines, mass media, and the internet; friends, colleagues, and family members – all can have influence on what people come to understand and appreciate about the world. As a result, what the public knows and more importantly, *embraces* about science is varied.

As previously stated, one of the goals of this project is to advocate for specific approaches to address climate change by getting the public and policy makers to think differently about the issue. Reviewing historic and current polling data related to science is a first step to help identify not only where people stand on science and the environment, but to also highlight trends, causalities and belief gaps in populations. Thankfully there are several reliable sources of data in this regard. Organizations like Gallup and the Pew Research Center (hereafter, Pew) conduct public opinion polling on a wide range of subjects, including the environment and global warming. Gallup has been exploring

attitudes and behaviors in the United States and abroad for over 75 years. They consult with the public and private sector to provide targeted research and advice. The Pew Research Center is a subsidiary of the Pew Research Charitable Trusts and in addition to polling, works to provide research on demographics and media content. Neither organization is structured to take a side in any given debate; they only seek to provide information that can help inform the public and private sectors to make strategic decisions. Some academic institutions like Yale University and George Mason University have established projects and centers on Climate Change Communication where polling the public about climate change has been a key focus. Together, the data from these organizations and universities will provide the context for the discussion on belief gaps and attitudes in this paper.

Can polling data be trusted and how accurate are the results? The answer to this question may depend on what sides of a particular issue a person or entity sits. Publicly, politicians are reticent to acknowledge any helpful guidance they receive from reviewing survey data. In fact, they are often critical of the media about polling. The truth is quite the opposite. Polling and focus groups are very important in educating politicians. They rely on them much like private companies do, and it explains why so much money is spent on pollsters. Methodology for polling has, like many other functions, adapted and improved over the years. Today most organizations conducting surveys rely on telephone calls to landline and cellphone numbers and complement calls with online surveys.

No poll claims 100% accuracy; there are always stated margins of error rates and there is the potential for bias. According to FiveThirtyEight, the pollster run by Nate Silver through the *New York Times*, “there were roughly two dozen pollsters that issued at least

five surveys in the final three weeks of the (2012 presidential) campaign" (Silver). He calculated the average error rate of each polling organization as well as the average statistical bias. Error rates ranged from 0.9% to 7.2%, which at first glance appears to be wide, but the vast majority of those pollsters – representing over 225 published polls – had less than a 3% margin of error. Most surveys did have a bias for the Republican candidate. But considering that over 124,000,000 votes were cast, this example simply demonstrates that polling, more often than not, does reflect fairly accurate real-time beliefs and attitudes of the constituency that is surveyed.

Addressing where the public stands on climate change can start with analyzing what people know about science in general. In March 2013, the Pew Research Center in conjunction with Smithsonian Magazine tested Americans about their knowledge of science and technology through a brief quiz (Pew, April 2013). There were questions that related to science in the news and questions related to what would have been taught through school textbooks. Eighty-three percent correctly selected "ultraviolet" as the radiation that sunscreen protects against and 58% properly identified "carbon dioxide" as the gas believed to cause rising temperatures across the planet. Just over half, 51%, understood that natural gas is extracted by fracking, as opposed to coal, diamonds or silicon. Seventy-eight percent of the public knew that red blood cells are primarily responsible for carrying oxygen throughout the body. It should not be surprising that those with more education, college graduates or those with some college experience, scored significantly better on every survey question than those with only a high school degree (Pew, April 2013).

Even though personal knowledge of science varies among the American public, "more than eight-in-ten Americans (84%) say they view science as having a mostly positive

impact on society" according to a November 2009 Pew survey. The same survey found that 70% of Americans believe scientists "contribute a lot to society" (Pew, Nov. 2009). Americans have historically been in favor of environmental protection, a tendency that comes out of the environmental catastrophes of the 1960's and 1970's where new science and public pressure eventually led to groundbreaking policy changes. A September 2010 Pew poll found that 81% of Americans believe in tougher environmental laws and regulations (Pew, Sep. 2010). Surprisingly, this high favorability was reflected across political parties and religious affiliation. But fewer Americans are concerned about the environment when weighed against other issues. In that same 2010 Pew poll, 90% of Americans said that the economy was "very important" compared with 57% who stated the environment was "very important." This illustrates one of the key debates involving the environment and public supported efforts for action, especially when it could result in any negative impact to the economy.

Gallup conducted a survey in March 2013 where they provided respondents two statements to read and select the one that they most agreed with. One statement read: "protection of the environment should be given priority, even at the risk of curbing economic growth" and the other stated, "economic growth should be given priority, even if the environment suffers to some extent" (Saad, 3 April 2013). At 48%, Americans chose economic growth over environmental protection versus 43% who favored the environment. This represents the fifth year in a row that the economy has trumped the environment in this Gallup poll, although the gap has narrowed since the height of the economic downturn. But the long-term trend – Gallup began this survey in 1984 – shows sharp declines in how people prioritize the environment overall. In 1990 and 1991,

Americans supported protection of the environment at 71% over economic growth at 20% (Saad, 3 April 2013). This represented the high water mark in the last 30 years of the poll. The lowest support for the environment versus the economy was measured at 36% to 54% in March of 2011. One might anticipate that livelihood trumps most other issues in challenging economic circumstances. Does the same hold true for the much bigger threat of climate change?

In late 2013, Yale University and George Mason University published two reports based on the *Climate Change in the American Mind* survey conducted in November and December of that year. The first report focused on American's beliefs and attitudes about global warming which had several key findings. Do Americans believe global warming is happening? A majority, 63%, agrees that it is happening and less than a quarter of the population, 23% do not believe global warming is taking place (Leiserowitz, et al. Climate Change). The number of undecided, those who claimed they did not know, dropped to 14% from 20%, since the prior survey in the spring of 2013. Are humans causing global warming? A little less than half of all Americans, 47%, see human activity directly related to global warming and 37% attribute changes to natural causes. Overall, roughly half of Americans are either "somewhat" or "very worried" about global warming. When will global warming impact Americans? Thirty-eight percent say they will personally be impacted while they are alive, but a much larger percentage, 65%, believe future generations of people, plants and animals will be more effected (Leiserowitz, et al. Climate Change).

The trends in beliefs and opinions about global warming in the Yale and George Mason survey also align with similar Gallup and Pew polls. Since 1989, Gallup has been

asking the question: “How much do you personally worry about global warming?” The results from a March 2013 survey show that Americans are increasingly concerned compared to how they felt as recently as 2011 (Saad, 8 April 2013). Fifty-eight percent of those surveyed worry “a great deal” or a “fair amount” about global warming and 43% worry “only a little” or “not at all.” At 50%, 1998 was the year Americans expressed the least concern about global warming and the year 2000, at 72%, was the peak of people claiming they worried “a great deal” or a “fair amount” about the issue. Similar to the Yale and George Mason survey, Gallup asked questions about when global warming would happen. Fifty-four percent of Americans believed it had already started, 27% said it would start at a future date and 15% believe there will be no effects from global warming. What is causing climate change? A little more than half, 57%, believe human activity is causing global warming versus 39% who attribute changes to natural causes according to the same Gallup poll (Saad, 8 April 2013). It should be noted that Gallup’s poll result is 10 points higher for those who attribute temperature increases to human activity, compared with the Yale and George Mason results, which were produced the same year.

The media has reported on gaps in consensus between the public and the science community. In the same 2013 survey on global warming beliefs, Gallup asked respondents to weigh-in on scientific consensus. They were asked if they thought: A) “most scientists believe that global warming is occurring,” B) “most scientists believe global warming is NOT occurring” or C) “most scientists are unsure about whether global warming is occurring or not.” A majority of Americans at 62% believe there is consensus, while 28% believe scientists are “unsure” and only 6% say scientists do not believe global warming is happening at all (Saad, 8 April 2013). The actual consensus in the scientific community,

specifically among climate scientists, is in fact very high relative to what the public perceives. This will be covered in greater detail in the following section of this paper.

It would be easy to get lost in the details of the polling data. There is a lot to digest. From a broad perspective, the Pew, Gallup and George Mason and Yale surveys all suggest that most Americans know enough about basic science to appreciate its positive role in society and understand the general implications of global warming. By clear majorities Americans believe in environmental protection, but in recent years, not at the expense of economic growth. And just over half of people worry about global warming to the extent that it is currently happening and impacting their lives. The surveys do align in many of their peaks and valleys. It would appear that awareness and concern related to the environment and global warming peaked around 1990 and again in 2000, then hit a low point between 2010 and 2011. The trends seem to show that concern is growing slightly and that fewer people are undecided about the issues. In poll after poll, Americans have indicated they respect the work of scientists and yet, only half or less depending on the poll, feel there is consensus in the scientific community about global warming. A slim majority believes what scientists have indicated about anthropogenic causes of climate change: that human activity is responsible.

Like many polarizing issues, where people land on the political and religious spectrum can be an accurate predictor of opinions and beliefs about climate change. A March 2012 Gallup survey addressed the question: to what extent do Democrats and Republicans worry about global warming (Newport). Thirty-four percent of Republicans worry “a great deal” or “fair amount” compared with 74% of Democrats. On the other hand, 40% of Republicans are not concerned at all about climate change where only 10% of

Democrats share this opinion. Those who identified themselves with the Tea Party were even less likely than Republicans in general to be worried about global warming. The differences between those who identify with the two major political parties also carries over into the debate between environmental protections versus economic growth. In a 2013 Gallup poll, 55% of Democrats favored environmental protection over economic growth, but 68% of Republicans favored economic growth over environmental protections (Saad, 3 April 2013). For anyone who tracks the news on a regular basis, none of these findings should be particularly shocking. Republicans and conservatives tend to favor economic policy generally and have consistently expressed skepticism about the validity of climate science. Identifying and understanding these varying perspectives will be explored further in this paper.

The role religious affiliation has on views about the environment and global warming has been studied by Pew over the years with some interesting results. A 2010 survey about a variety of issues showed that majorities of Protestants and Catholics in the United States, like the general public, favored tougher environmental laws and regulations (Pew, Sep. 2010). The 85% of Hispanic Catholics and 81% of white mainstream Protestants represented the groups with the strongest support for the environment while white evangelicals, at 73%, represented the weakest support. It should be noted that the degree of white evangelical support and opposition to environmental laws and regulations are nearly identical to the opinions expressed by Republicans on the subject. The group with the largest support of environmental laws and regulation were those Americans with no religious affiliation. The same poll also asked about influences religion had on environmental policy. At only 6%, it turned out religion had a very small relative impact on

how people think about the environment compared with 29% who credited education and 26% who credited the media when forming their environmental beliefs (Pew, Sep. 2010). Majorities of those represented by the major religious groups believe "there is solid evidence the earth is warming" according to a 2008 Pew survey. The largest belief gaps regarding the global warming poll are found in what people think is causing the climate to change. Fifty-eight percent of those without a religious affiliation attribute the warming to human activity, but 48% of white mainstream Protestants and only 34% of white evangelical Protestants believe humans are behind climate change (Pew, 16 April 2009). Once again the evangelical position mirrors the majority of Republicans.

Are there other demographic factors impacting beliefs and opinions about climate change? Not surprisingly, younger people, those 18 – 49, worry more about global warming than Americans 65 and older. And education also impacts beliefs. Fifty-eight percent of Americans with a high school degree or less education are worried about global warming. Of their more educated peers, those who have a college degree, 51% worry "a great deal" or "fair amount" (Newport). This result seems to imply that while education may better inform an individual about science, it does not necessarily translate to one's opinion about global warming.

With all of the polls about the environment and global warming, with the detailed breakdown of beliefs and opinions of groups and sub-groups, it is possible to create a historical and current snapshot of Americans' positions. This is only a two-dimensional picture, however. What is needed to build a three-dimensional panorama of climate change in the American mind are the causes and influences that foster the variety of perspectives that exist. Only then can a proper analysis be undertaken that may lead to possible

approaches to create new dynamics in the general discourse and more importantly, in changes to climate policy.

Influences

Philosophers have been exploring the nature of human thought since ancient times. Explaining how people think and process, and what they do based on external factors is important to many constituencies today. FBI profilers, intelligence officials and even local detectives are armed with training in psychology and practice it daily, whether it is to understand motive or to help predict and pre-empt a criminal act. The business community employs marketers who have access to extensive research about human tendencies related to buying habits so that they may apply those to strategic advertising. Lawyers work to build a strong case, to eliminate doubt on their side and poke holes in the other side, using evidence, targeted language and questioning in a display of mental gamesmanship. Lobbyists leverage money and psychology to push for their causes; politicians leverage knowledge, charisma and honed debating skills to win-over the hearts and minds of the public. Even parents employ a combination of psychological tactics to convince their children to think in certain ways. The point is that whether individuals are aware or not, they are being constantly influenced by external forces that shape what they think, how they rationalize their position and how they react to a variety of issues.

Surveys cited in the previous section of this paper demonstrate that large majorities of the American population have for many years now believed in science and trusted scientists. A modest majority currently agrees that the climate *is* changing. Some across the country know this even without experts telling them as they are experiencing greater weather extremes first-hand and believe those to be tied to global warming (Leiserowitz, et al. Extreme Weather 5). In general, Americans have hardened their positions in the global warming debate. Sides have been chosen. After decades of information saturation through

the media and politics, few people now remain undecided on whether climate change is happening and if it is due to human activity. How might these beliefs and opinions have developed then, and why in the end is this important to the discourse or to those who advocate for policy changes?

From the perspective of scientists and especially those who study climate change, the evidence is overwhelming, the consensus is clear and this has been well documented. In a 2005 study that contacted 986 climate scientists based on published articles on climate change, 94% of the 468 respondents could "say with great certainty that global warming is a process that is already underway" and 88% could "say with great certainty that human activities are accelerating global warming" (Rosenberg 4). These results came prior to the 2007 and 2013 IPCC Assessment Reports where the evidence grew more compelling. Peter Doran and Maggie Kendall Zimmerman (Doran, Zimmerman 22) at the University of Illinois at Chicago conducted a similar poll of 10,257 earth scientists in 2008. They posed two questions: 1. "When compared with pre-1800s levels, do you think that mean global temperatures have generally risen, fallen or remained relatively constant?" and 2. "Do you think human activity is a significant contributing factor in changing mean global temperatures?" Of the 3,146 participants responding to the two questions, 90% agreed that temperatures had risen and 82% agreed that humans were a significant factor. There were 79 climate scientists who participated; all agreed the planet was heating up and 75 believed human activity was to blame (two did not answer the second question). It may seem like a small sample of climate scientists, but this group was responsible for nearly 50% of the peer-reviewed articles published on climate change in the preceding five years.

Analyzing publications related to climate change is another method for dissecting consensus in the scientific community. A research paper published in 2013 reviewed climate abstracts with “global climate change” or “global warming” topics appearing in 11,944 articles between 1991 and 2011 (Cook). The goal was to identify positions on anthropogenic global warming. Sixty-six percent of the articles did not claim a position on human activity, but of the 35.5% that did, 97.2% “endorsed the consensus” that humans were responsible for global warming (Cook 1). Furthermore, nearly all mainstream American and international scientific organizations have fully endorsed the assessment reports from the IPCC. From the U.S. National Academy of Sciences to the American Medical Association and The American Meteorological Society, and hundreds of worldwide organizations, all believe in anthropogenic causes of climate change.

In other areas of science and research, it could be argued that this kind of demonstrated consensus would be more influential and would be reflected in closer alignment of public beliefs and opinion. Instead, only a plurality of the public acknowledges the climate change consensus among the scientific community. In fact, the debate about the scientific *consensus* has been as intense and widespread at times as the debate about climate change in general. Case in point: the hacked email exchanges among scientists that led to what was dubbed in the media as “Climategate” and later proven to be misguided (Climate Change Corrective). Why has the strong case for global warming as demonstrated by those with the greatest expertise and evidence not translated to greater support and concern from the public and politicians?

One explanation may be linked to priorities. Societies throughout history have often times struggled to address and prioritize long-term challenges. The focus tends to be on the

immediate; human nature, political cycles and economics all playing a role here. In the decision-making process leaders and governments can fail to properly assess the bigger picture or they simply rationalize focusing on the present situation, knowing how difficult the path may be to rally support to tackle long-range issues. On an individual level, one's personal and family welfare will almost always trump the welfare of the group or society. This is reflected in recent surveys that focused questions on prioritizing the environment or the economy. Since the 2008 financial crisis, Americans have clearly indicated that for politicians and the president, the economy and jobs should be priority number one. In the year 2000, public concern about global warming peaked, with 72% personally worried about the issue (Saad, 8 April 2013). But in the years immediately following the September 11, 2001 terrorist attacks, concerns about climate change and the environment fell off quickly. More recently, when given a list of priorities for Congress and the President to address, Americans rank "new climate change policies" behind deficit reduction, immigration reform and gun legislation (Pew, Jan. 2014). Another way to view the handling of priorities is in light of natural disasters. When Hurricane Katrina struck in 2005 attention was directed to saving lives first, providing basic needs to the population second, then cleaning-up and finally, addressing long-term solutions to secure and rebuild the levee system. It seems logical that the way people and governments perceive potential impacts of climate change is influenced in part by many competing issues that may overtake large, long-term seemingly existential threats.

The prevalence of news sources beyond the traditional channels has saturated communication with a variety of messages that cater to every constituency and viewpoint. Twenty-four-hour cable news channels, internet-only news companies, blogs and social

media, as well as short and long form journalism through papers and magazines have come to define the "information age." Escape from this onslaught of messages is practically impossible, unless a person lives an "unplugged" lifestyle far from the reach of televisions, computers or radio. Most people choose to engage in the world of mass media for entertainment and information. Due to the variety of perspectives and the way organizations approach programing, they are certain to appeal to and reinforce particular viewpoints. For those who seek the most balanced of news, it is difficult not to be exposed to varying levels of bias and thus, some degree of influence.

The programing related to climate change over the years highlights one of the challenges of accurate reporting. Even as the scientific evidence has mounted, even as global warming has taken hold, and despite the fact that the vast majority of experts side with contemporary projections as articulated through the IPCC assessment reports, news venues continue to provide the other side of the "debate" a disproportionate amount of coverage. There is a strong tendency to cover all viewpoints, even when the facts very clearly support one side versus the other. This is not necessarily a case of intentional misleading, however. In an effort to avoid the appearance of bias, media outlets can distort the true nature of the story. Journalists can be partly blamed for this failure. For starters, they are not generally trained in scientific fields. Journalists are under pressure to write quickly and as a result, must rely on other sources and stories that they may not always have the ability to validate. Some of the sources they rely on are themselves inherently biased such as "industry-funded think tanks and advocacy groups" who "make claims about global warming and renewable energy" while giving the perception that they are

independent organizations (Negin). Journalists typically do not clarify the nature of these groups or where their funding comes from.

Even major news periodical editorial boards have reinforced this theme by supporting contrarian positions that do not stand-up to scrutiny. In January 2012 the *Wall Street Journal* published a controversial letter titled "No Need to Panic About Global Warming" which the editors at the time endorsed by noting it was "signed by 16 scientists" in order to lend more legitimacy to the position (Allegre). The letter was directed at political candidates in the United States suggesting that the scientific consensus about climate change and the warnings about inaction were not accurate, and it advocated a wait-and-see approach. In addition to attracting wide readership and attention, the letter turned out to be factually incorrect on many scientific points including an overly used claim that the climate has not warmed in the past decade, according to MacArthur Fellow and National Academy of Sciences member, Peter Gleick. The reality on that point is that 2005 and 2010 were the warmest years on record and the decade was once again well above historic averages. The letter also completely misinterpreted the work of Yale economist William Nordhaus about costs versus benefits for policy action and of the 16 scientists who signed the letter, many of their credentials would not appear to show expertise in climate science. As Peter Gleick mentioned at the end of his letter in *Forbes* emphasizing the serious negligence by the *Wall Street Journal* in promoting a letter by 16 random scientists on an issue with potentially huge and lasting repercussions to society; "understand that every national academy of sciences on the planet agrees with the reality and seriousness of human caused climate change" (Gleick).

In addition, "reporters are subject to certain pressures that can be explained by the economics of the news business. Controversy, exaggeration, and scandal sell; stories about the gradual deterioration of our environment do not" (Ehrlich 191). This can play out in the amount of coverage for a specific issue or the *way* in which it is covered. Story titles are designed to grab the reader's attention and are not intended to relay the full context or nuances of the article. Gallup has tracked how much Americans perceive news about global warming to be exaggerated. Since 2008, the trend has shown a significant split between those saying the news is "generally exaggerated" – 41% in 2013 – compared with those Americans who say it is "generally correct" – 24% in 2013 (Saad, 8 April 2013).

It would be safe to assume too that certain news stories ebb and flow over time. During episodes of intense heat, drought or other extreme weather related events, the number of stories about connections to climate change rise. The public sees this across the spectrum of environmental coverage. Destruction of the Amazon in the 1990's was covered extensively in mainstream media, spikes in shark attacks every few years has inevitably led to a heavy volume of attention-grabbing headline stories, and even the recent news about the mass killings of African elephants for their ivory saw significant worldwide coverage. These examples and others would validate the notion that stories highlighting "controversy, exaggeration and scandal" do appeal to the public. And the fact that surveys indicating many Americans believe climate stories to be exaggerated would imply that mass media does play a role in influencing the public's attitude and beliefs.

Ideology appears to have one of the most significant roles in determining what Americans believe about climate change. Gordon Gauchat used a long-term study of public trust in science, from 1974 – 2010, to see what changes have taken place in group attitudes.

Liberals' and moderates' trust in science remained relatively stable for the 25 years measured, but conservatives shifted from having the highest trust in science among the three groups in 1974 to having the lowest trust in science by 2010 (Gauchat). Education was not found to be a strong correlation as conservatives had as much education and even more in some instances than the sample of liberals and moderates. Church attendance did prove to be a factor in that those who attended more often tended to have less trust in science overall. In his conclusion, Gauchat suggested, "one interpretation of these findings is that conservatism in the United States has become a cultural domain that generates its own knowledge base that is often in conflict with the cultural authority of science" (Gauchat 179). In terms of the political implications, his findings also highlight connections between the degree to which the dominant party, most recently Democrats, embraces science and regulatory policies and the effect it has on entrenching the position of the opposite party.

This example of political polarization is not new in American politics. Party platforms in recent years have reflected the ideological divide of the two parties as they relate to climate change. The Republican platform for the most recent presidential election made no mention of addressing climate change. It did endorse investments in clean energy and pollution controls, but advocated private sector approaches and increased scrutiny of regulations. The Republican platform put heavy emphasis on finding new ways to tap into the country's fossil fuels. Contrary to the drops in conservative attitudes on the issue, science was recognized as a way to "advance environmentalism" and establish "costs and benefits" of policies (GOP 18). This represented a shift from the 2008 Republican platform; one that attempted to address rising greenhouse gasses. The 2012 Democratic platform,

while toned-down from their 2008 platform, recognized climate change as "one of the biggest threats of this generation – an economic, environmental and national security catastrophe in the making" (Democrats 2012). Their position also endorsed efforts to cut pollution, ensure government investment in renewable energy, protect the environment and preserve ecosystems. Where the Republicans did not address climate change and pushed for private sector solutions to nearly all environmental problems, the Democrats fully embraced the science of climate change, the eminent threat it posed and pushed for government action to address challenges.

Party platforms may have influence in political circles on issues, but they do not generally reach the masses directly. What the public tends to hear and see the most are those messages coming straight from individual politicians. And more and more, those tend to have an anti-science bias. Whether it is evolution, anthropogenic climate change, or vaccines, most Republicans and Tea Party politicians in recent election cycles either expressed doubt or opposition to the popular scientific position. As author Shawn Otto explains, "partisans at both ends of the political spectrum have been guilty of science denialism. But the Republican version is particularly dangerous because it attacks the validity of science itself" (Otto). His argument is that this is a particularly tenuous and odd place for American society based on the historical positive and productive impact science and technology has had in the country. For conservatives who view many issues through an economic lens, this is also somewhat contradictory since "scientific innovation has been the leading driver of U.S. economic growth since World War II" (Otto).

Complicating the belief gap narrative is the position held by most Americans on investment in alternative energy and pollution controls. Eighty-three percent of Americans

"say the U.S. should make an effort to reduce global warming, even if it has economic costs" according to a 2013 survey from Yale University and George Mason University (Leiserowitz et al. Public Support 4). And clear majorities of those polled believe in funding renewable energy research, retaining subsidies for renewable energy industry, regulating carbon dioxide as a pollutant, giving tax breaks to individuals who buy electric or hybrid vehicles and solar panels. Even 59% of respondents thought the United States government should eliminate "all subsidies for the fossil-fuel industry" (Leiserowitz et al. Public Support 5). Clearly there is recognition among the public that a problem exists and the United States should take some action. However, when action involves government regulation, another divisive issue is exposed. Libertarians and conservatives often blame government for getting in the way of economic progress due to overburdening laws and regulations. Liberals on the other hand are typically advocating for even greater regulations and government action to solve problems.

Overall though, it is the extreme partisan nature of current politics that does more to reinforce existing ideology and belief, than it does to present well-informed sides to any of the scientific debates, including climate change. "This is because ideology, by definition, is relatively stable. Facts become less important than the political affiliation of the source of the facts" (Hindman 59). Most of the public is not in a position to analyze and verify scientific findings and they end up leaning on those sources that reflect their core beliefs for interpreting information. By default, confirmation bias is a standard tool in the human psyche toolbox. People tend to align and trust those sources that most often validate or confirm their personal position on a wide range of issues. In the process, narratives are created that consciously or unconsciously, provide back up to ideology and go-to responses

when there is any information presented that challenges one's position. A possible reason for the existence of confirmation bias around science related issues is the overwhelming amount and variety of information that is written, broadcast and generally available with a few keystrokes on a computer. Alice Bender from the American Institute for Cancer Research (AICR) suggested that this information "overload" could be the reason that for the first time in almost ten years, Americans' "awareness of … well-established lifestyle-related risk factors" for cancer fell significantly according to a 2013 AICR survey (AICR). Less than half of the respondents correctly indicated that obesity, alcohol, diets high in red meat and inactivity increased one's risk of cancer. Since 2005 the percentage of those who were aware of the tie between these risk factors and cancer had been steadily going up year after year.

The timing of the drops in cancer awareness follows recent trends among those who do not believe in or trust the benefits of vaccinations. When a group of doctors from Dartmouth College designed a large survey experiment in 2011 to address this issue, the results were alarming. In the survey they attempted to convince parents of the importance of vaccinations and dispel the alleged connection between measles-mumps-rubella and autism. Some parents were provided information about the lack of evidence of a connection, others were provided information reinforcing the dangers affiliated with communicable diseases, another group was given pictures of children who had contracted the various diseases and the last group of parents was provided "a dramatic narrative about an infant who almost died of measles" (Nyhan, Brendan et al). The doctors discovered that "none of the interventions increased parental intent to vaccinate a future child." Not only were the variety of approaches ineffective, but there was evidence it even

hardened the position of some parents who did not believe in vaccinations. How can this be explained other than attributing it to ideology and confirmation bias? Interesting enough, the vaccination issue does not correlate with how Americans feel about their health care providers. The same year the survey was conducted on parents about vaccination messaging, Gallup polled Americans about their faith in medical practitioners. Seventy percent rated medical doctors "high" or "very high" in terms of their honesty and ethical standards (Gallup). Only nurses, pharmacists and teachers scored higher in the poll. At the other end of the spectrum, 8% of respondents rated Congress as having "high" or "very high" honesty and ethical standards, which was slightly ahead of lobbyists who came in last at 6% (Gallup). It is paradoxical to imagine that someone can trust their doctor and at the same time, not believe in something he or she may advocate for, like a vaccination.

Is it possible that the human brain is programed to resist changing a specific narrative and if so, does this have to do with avoiding displays of weakness? Maybe by admitting to being wrong it translates to personal insecurity or surrender. When people do not understand things, there is an attempt to reframe them or reshape them into a paradigm that they can comprehend. Not everyone in the United States or any society for that matter could be expected to deeply understand all realms of science or specific complex issues like how immunology works or nuclear reactors function or planets rotate. Nor can a person be an expert in all fields and disciplines. Every day the public relies on specialists trained to do everything from build roads to practice law to provide emergency services and protection. All of these functions operate under a social contract with government and between people where trust and good faith provide the glue to well being. Reliance on others at some level is required by nearly everyone in their daily lives. This

does not mean the public abdicates responsibility or the right to question, investigate and explore alternative services or perspectives.

Public confidence and trust in science may be compromised in other ways including oscillating opinions or evidence. Americans have been bombarded over the years with science reporting that suggest something is bad or good, and then years later that assumption changes. One example related to diet and nutrition is how for decades people were raised to believe eggs and milk were healthy and nutritious. Beginning more than ten years ago, concerns developed around cholesterol and fat, which promptly altered breakfast eating and drinking behaviors of many Americans. Very recently, those concerns have abated with studies suggesting the cholesterol found in eggs is not as bad as originally thought and that natural fat, like that found in milk, has many positive attributes including evidence that it leads to a lower risk of obesity (Aubry).

Religion's role in influencing opinions on climate change has not been discussed much in this paper because of its close connection with ideology and politics. Similar to the general population in the United States, those claiming a religious affiliation believe in strong environmental protections. Church attendance was demonstrated to be a predictor for belief gaps in global warming, but most again aligned with other Americans in agreeing the climate is changing. There are other relevant scientific issues though, that elicit strong feelings and serious debate among a broad spectrum of those with religious convictions. The theory of evolution, a scientific concept with even more consensus than climate change, is a contentious subject for many religions and their followers. In her book *Betrayal of Science and Reason*, author Anne Ehrlich argues that "the rise of creationism has prevented a majority of Americans from understanding the origins of *Homo sapiens* and

numerous public issues with biological underpinnings, including many health issues" (26). The difficulty then in changing one's opinions and beliefs may also lie in the complex nature of issues that are interconnected. If religion is influential in determining how people think, compartmentalizing a belief in evolution, global warming or vaccines would be challenging and most likely lead to further confirmation bias, depending on a person's viewpoint.

Finally, empirical evidence and first-hand experience, similar to the impact of ideology, may be one of the greatest influences when it comes to embracing scientific theories. For years the United States had a creeping problem with pollution. The air was compromised with high levels of various particulate matter to the point that the average person could see it in the form of haze and smog. Lakes and rivers were clogged with trash, chemicals and dead fish. And if people could not see that, it was hard to miss noticing a river catch on fire due to extreme pollution, which happened to the Cuyahoga River in 1969. On land, pollution could and still can be seen across the country. "Seeing is believing" as the saying goes and with pollution, those effects that can be seen garner public outcry and government action more than what cannot be observed by the average person. There is also a disconnect between understanding the big picture of vast environmental systems and the impacts humans have on them. "A major part of the problem, of course, is that all of us have difficulty perceiving large-scale or slowly developing environmental problems" (Ehrlich 42). "People can't detect the buildup of greenhouse gases by sight, hearing, or smell… Dirty air and dirty water are easy to spot and react to" (Ehrlich 43). A similar analogy could be made about the difference between predicting weather and predicting climate change. One represents a concept within reach of most Americans and the other requires a proverbial leap of faith due to the complexity and scope of the issue. It is that

leap of faith on global warming that many in the American public still have trouble making and this will remain the case until they are convinced to believe otherwise.

The Power of Doubt

Cutting through the noise of modern mass media and politics to express an opinion, advocate for a position or promote a product is not easy. There are countless public relations and advertising companies who specialize in this complicated game to win attention from targeted constituencies and the wider public. Trained lobbyists patrol the Washington DC political establishment as hired point guards to advocate for their clients. Hundreds of millions of dollars are spent on these influencing efforts as they can translate to billions of dollars in economic impact or savings. The return on investment is not guaranteed, but it certainly has proven its value and effectiveness through the years. The ranks of advertising, public relations and lobbying professionals are not shrinking; they are ubiquitous. The simple truth is that the power behind their efforts more often than not comes from the private sector: investments by corporations, entire industry sectors or high net worth individuals with stakes in those entities. Special interest groups who lack this degree of corporate investment, regardless of their base of support and organization, have a hard time competing.

Influencing thought, opinion and action is not necessarily a linear process. This is something that corporations have known for some time. In the human health and environmental cases of tobacco, acid rain and global warming, those companies and industries with the greatest investments at stake have utilized with incredible effectiveness a tactic that has proved vexing for both scientists and public advocates. In their book, *Merchants of Doubt*, authors Erik Conway and Naomi Oreskes argue that the tactic employed was using counter-science to create enough doubt and uncertainty to "deflect attention from the main event" (Conway 19). The reason these campaigns of doubt over the

years were so effective is due to the nature of scientific research. The process of trying to prove a hypothesis involves any number of observations, testing and analysis that is vetted with other scientists through peer review. By nature, scientists are "healthy skeptics" and challenge each other's work, which is of course the best way to objectively solve a problem and advance the field of study. "But it also makes science vulnerable to misrepresentation, because it is easy to take uncertainties out of context and create the impression that everything is unresolved" (Conway 44).

This is exactly what happened over nearly half a century as tobacco companies colluded to discredit science proving that smoking was harmful to human health. The earliest indications of cancer tied to smoking came from German scientists in the 1930's. The German government went so far as to run effective public awareness campaigns about the harmful effects of smoking throughout the 1930's and 1940's. It was not until research from the Sloan-Kettering Institute in 1953, which demonstrated mice who were "painted" with tobacco tar developed cancer, that the attention of tobacco companies and health advocates in the United states was elevated (Conway 20). Not long after that research was made public, the major tobacco companies met with notable public relations and advertising firms to develop a plan "to deceive the American public about the health effects of smoking" (Conway 21). For the next four decades, these tobacco companies, their public relations partners and lobbyists, worked tirelessly to challenge the evidence that smoking was harmful. And they did this under the guise of science and balanced reporting.

Early in their fight the tobacco companies spent millions to recruit medical professionals and sway journalists to their side. In the 1950's and early 1960's, this played out in television ads featuring doctors who endorsed smoking and articles in the press that

gave nearly equal weight to arguments for and against smoking. All along, scientists and researchers were building a stronger case linking smoking to lung cancer, heart disease, emphysema and other degenerative health conditions. These scientists included those employed by tobacco companies who by the early 1960's came to the same conclusions about the harmful effects of smoking. At the same time they were able to link nicotine with addiction, a fact that did not enter the public discourse until the 1980's (Conway 28).

Following the Surgeon General's report in 1964, which endorsed the consensus among scientists that smoking caused cancer, smoking habits among the American public and especially medical professionals began to drop (Conway 32) (Gallup, Smoking). It was around this time that the tobacco companies began to ramp-up their efforts to create doubt in the science. With the threat of impending legal action from individuals and the United States government, in 1979 R. J. Reynolds gave a grant of $45 million to fund research on those diseases tied to smoking. They hired Fred Seitz, a physicist with a successful academic career and experience working with corporations, to lead the research efforts. Documents would later show that the grant's purpose was to generate good data to be used "in defending the industry against attacks" (Conway 19). Fighting science this way played out in courtrooms over the next 20 years and in most cases the tobacco companies prevailed in exploiting the tiniest uncertainties in the connections between smoking and diseases. They did not lose in measurable ways until the early 2000's as one after another, individuals, states and the federal government, proved the companies deliberately deceived the public and its customers.

Similar to the progression of the evidence connecting smoking tobacco to cancer, when scientists first hypothesized and proved the causes of acid rain in the 1960's and

1970's, there was no indication of the organized backlash that would follow from private industry. This time the fight came from energy companies. American, Canadian and Norwegian scientists used isotopes found in carbon dioxide and sulfur to establish that the acid rain falling in many parts of the country were originating in power plants. " Sulfur and nitrogen emissions from electrical utilities, cars and factories could mix with rain, snow, and clouds in the atmosphere, travel long distances, and affect lakes, rivers, soils, and wildlife from the source of the pollution" (Conway 81). While the Carter administration supported the opinion of the scientists, the Reagan administration was resistant.

William Nierenberg, a physicist who worked on the Manhattan Project and later co-founded the conservative George C. Marshall Institute, was known to be a science skeptic. The Reagan administration placed him in charge of the Acid Rain Peer Review Panel to analyze reports by the EPA that called for government regulation to control sulfur emissions (Conway 100). He recruited another scientist, Fred Singer from the conservative Heritage Foundation, who had been consulting with the tobacco companies to discredit the research behind second-hand smoke. Authors Conway and Oreskes suggest that together, Nierenberg and Singer, worked to weaken the scientific arguments of the acid rain panel and claim that any mitigation efforts would not be economically prudent. Other scientists on the panel disagreed with Singer's positions and later charged that he softened language in reports to shield the Reagan administration from criticism (Conway 112). Not surprisingly, the Reagan administration took no action on acid rain, claiming over and over "we don't know what's causing it" (Conway 118). In the end, the scientists were vindicated on their positions. Actions taken by subsequent United States administrations showed that

regulation of power plants was effective in decreasing acid rain and that achieving this did not over-burden customers or the companies involved (Conway 121).

Some of the same scientists who created doubt at the behest of tobacco companies and later questioned the science behind acid rain, namely Fred Seitz and Fred Singer, would be front and center of dismissing the growing evidence of global warming (Conway 12). Their scientific credentials gave them coverage in liberal, conservative and mainstream media outlets, and a vehicle to make their claims, even though their positions were not accurate or based on peer-reviewed research. In this scenario, the media served as enablers in the name of providing balanced reporting. Fred Singer wrote letters in scientific magazines and newspapers like *Science* and the *Wall Street Journal* where he was free to criticize not only the research, but also the climate scientists who were authors of the IPCC reports. In 1996 he suggested Ben Saunter, then a lead author for the 1995 IPCC Assessment Report, had changed results to give the report better alignment with the climate change projections of the time (Conway 231). Saunter had in fact changed the report, but this was following the peer-review process and research protocol where other authors had weighed-in on certain data and hypotheses. What may have sounded subversive to the general public, that Saunter was somehow cooking the books to his liking, was actually how scientists react to cross analysis and input. In this case the input was from hundreds of contributors who were working together on the final report. It was incidents like this that despite the growing scientific consensus led to how "the mass media presented global warming and its cause as a major debate" (Conway 242).

Anti-science in all three of these cases was an effective delay tactic for industries. The small group of contrarian scientists, a group that did very little original research in the

time they were employed by private companies and conservative think tanks, used their pedigree to lobby and alter public opinion (Conway 14). However much sway a few scientists have had in the pubic debate, it can hardly compare to the amount of effort and money now in play to contradict the scientific consensus around climate change. Since 2000, spending by energy companies, conservative foundations and think tanks, has reached epic proportions. The $600,000 contributed by Exxon Mobil between 1998 and 2006 to the Heartland Institute, a non-profit that focuses its efforts on "debunking the science of climate change", may at first seem substantial (Davenport). But according to a December 2013 study conducted by Robert Brulle at Drexel University, between 2003 and 2010, the 91 most prominent climate change counter-movement (CCCM) organizations had "an annual income of just over $900 million" (Brulle). A majority of that income was contributed by 141 foundations. They funneled $558 million to the CCCM groups during the same time period. Some, like DonorTrust and Donors Capital, operate as third-party pass-through foundations, which protect the privacy of high wealth donors (Fischer). In his research, Brulle found that the various CCCM organizations that include conservative think tanks, trade associations, and advocacy organizations "not only played a role in confounding public understanding of climate science, but also successfully delayed meaningful government policy actions to address the issue" (Brulle).

On the other side of the climate change spectrum, environmental advocacy groups attempted to capitalize on the Democratic majorities in Congress and the White House following the 2008 election cycle. Spending by pro-environmental groups peaked in 2009 when they spent a combined $22.4 million on federal lobbying (Mackinder). At the time, it was a record investment and more than double the average expenditure in the eight years

prior. The efforts saw some early momentum behind climate change legislation in 2009. Opponents of potential laws and regulations to help mitigate global warming were also quick to act. In addition to spending tens of millions of dollars to support conservative candidates in 2008, energy companies alone spent $175 million on lobbying in 2009 (Mackinder). This was eight times what the pro-environmental groups spent that year. In the words of one environmental organization representative, "the opposition outspent us and they took it to a new level this time" (Mackinder). With the 2014 and 2016 elections looming, more than likely spending by all parties will only increase in the years ahead. Already one significant donor, the founder of the political organization, NextGen Climate Action, has pledged to spend up to $100 million advocating for climate change action by targeting resistant politicians at the state and federal level. The goal is to try and compete with what Charles and David Koch are doing funding anti-climate change organizations and politicians (Confessore). There is a concern though that individuals like these, on both sides of the climate change issue, are promoting and sustaining a form of advocacy that greatly distorts the democracy that was intended by the Founding Fathers. And similar to the evolution of the science, advocacy and action associated with the tobacco and acid rain cases, it appears that regardless of the scientific consensus, there are many years left where doubt and uncertainty created by a false "debate" will contribute to a lag in necessary action by governments and corporations to mitigate the impact of global warming.

Carson's Legacy

In *Silent Spring*, her watershed book about society's negative impact on the environment and by extension, human health, Rachel Carson expressed concern for a perceived lack of interest on the part of her country to take action and change the relationship between man and nature. "Have we fallen into a mesmerized state that makes us accept as inevitable that which is inferior or detrimental, as though having lost the will or the vision to demand that which is good" (Carson 29)? Her accessible writing style helped people understand complex science and how reactions between man-made chemicals and animal cells could have devastating effects. She also made the case for ecosystems; how humans and development could impact not just a specific species, but also an inter-connected web of life. Chemicals do not start and end with one animal or insect, she argued, they can be passed on from one individual to the next and distributed throughout the food chain. And she created a paradigm shift around the way people considered the human body and its susceptibility to harmful chemicals. Carson's writing and messages were so effective that many would argue they spawned the modern-day environmental movement. "The book synthesized many of the concerns of earlier conservationists and preservationists with the warnings of newer environmentalists who worried about pollution and public health" (Shabecoff 101).

Her work was not only popular with the public; it was quickly disseminated by the Kennedy administration and would later be credited in part with the passing of the historic National Environmental Policy Act that established the Environmental Protection Agency in 1970. That same year also marked the first Earth Day, a celebration that was the culmination of a long series of events beginning more than 160 years earlier when Lewis

and Clark made their trek across the United States. The expedition set a baseline for what was known about nature in the country. As population and development growth moved west over the next 100 years, there was awareness that it carried some problems. "By the end of the (19th) century… there was a growing body of information about the harm that was being done to the natural world and some new ideas about how to set things right" (Shabecoff 37). People like George Grinnell, an early nature writer, warned in 1886 that entire bird populations were at risk of being "wiped-out", something that drew the attention of nature lovers and politicians such as Theodore Roosevelt. Together they would establish an organization that began with the goal to "end the slaughter of big game animals" and later became the National Audubon Society (Shabecoff 41).

In 1872, Congress created Yellowstone National Park; Yosemite followed in 1890. John Muir founded the Sierra Club in 1892. And in 1905, the Forest Service was formally established (Shabecoff 60). By the early 1900's the wheels were well in motion for protecting the natural resources of the United States. It was an effort that was widely supported by the public and all levels of government. When attention began to slide in the middle part of the century and nature was once again under threat, groups like the Sierra Club, the Environmental Defense Fund and the Natural Resources Defense Council took issues to the courts where they perfected litigation on behalf of the environment. In that same time period, Rachel Carson's publication of *Silent Spring* in 1962 provided a springboard for the government to establish the first federal environmental laws. In rapid succession, the Clean Air Act, the Clean Water Act and the Endangered Species Act were passed between 1970 and 1973. All of this led to a change in attitudes and practice around

pollution, regulation and enforcement. It became standard operating procedure in terms of how states and local governments responded to address environmental issues (Shabecoff).

Those who advocated for the environment had real victories to point to by the late 1970's and 1980's. National treasures like the bald eagle and bison were saved from extinction. The quality of the air improved with cuts in sulfur and lead. Waterways and lakes made dramatic recoveries. The health of northeastern forests improved with acid rain mitigation. These were not easy accomplishments as industry fought regulation and worked to discredit scientists, including Rachel Carson, at nearly every step.

While much has been accomplished, it seems the stage has been set for an even more dramatic confrontation in the next few years. The political landscape has altered and so have the entities actively lobbying for and against environmental protections. Perhaps Americans have also changed and as Rachel Carson warned in 1962, have again "fallen into a mesmerized state" about the threats to nature and society. On a routine basis of late there is no shortage of articles about oil spills in waterways, air pollution in urban areas, worsening droughts and declining populations of animals. Even the honeybee has not been spared as colony collapse disorder, a mysterious condition that is killing bee populations, puts essential crops at risk for lack of pollinators. The threat of climate change, however, overshadows all of these.

With all that this country has invested in to ensure against future threats on a local, regional and global scale, why not take more serious and large-scale action on climate change? In the view of this author and the vast majority of those with first-hand knowledge of the science, the hypotheses have been proven beyond any reason for hesitation. The human population, economic development, energy and food demands; all are increasing at

precipitous rates. Taking significant steps now on many fronts, including investing heavily in efforts to cut United States and global carbon dioxide emissions, will payoff in the future. In his 2008 study "A Question of Balance," William Nordhaus, an economics professor at Yale University, wrote about the "net benefits from acting now rather than waiting 50 years" (Nordhaus). In his calculations, the costs of waiting decades into the future could be well above $4 trillion in today's dollars. Is this country willing to risk the possible long-term costs of inaction and projected irreversible impacts for mankind and the planet?

The scenario brings to mind Aesop's Fable of the ant and the grasshopper. While the grasshopper sang all summer long, the ant worked hard to save food for the winter. This lesson of hard work and planning for the future is simple, timeless and feels entirely relevant to the existential threat of climate change. Countries around the world have benefited greatly from exploiting natural resources and pumping massive quantities of carbon dioxide and other greenhouse related gasses into the atmosphere. This economic growth in the developed world has come at a cost as the science has clearly demonstrated the effects of human activity on global warming. In the United States preparing for the future, like buying insurance, is commonplace. Trillions of dollars have been spent building and sustaining a nuclear weapons capability that serves as deterrence to the country's enemies. Hundreds of billions of dollars are spent every year by individuals, companies and public entities on a variety of insurance coverage programs, knowing that the likelihood of making a claim is relatively small. People save for retirement and the government helps them through Social Security. More recently, the changes in health care it has been argued will pay dividends in the future through prevention efforts, standardized costs, and lowering premiums for all. In a variety of ways, individuals and large entities make regular

investments in future planning without the ability to accurately account for current tangible, economic benefits.

It would be fair to state that government and the private sector in the United States are making some progress on climate change. The renewable energy market has expanded in recent years, the rate of carbon dioxide emissions have slowed and there have been significant investments in new energy saving technologies. The scale and scope of these efforts according to the IPCC 2014 Working Group II report are simply not nearly enough to have substantive global impacts.

For those who believe in the climate change science projections, and advocate for action on a global scale, their mission may seem daunting. And it *is* given the money being spent to discredit science and block intent by the government to pursue meaningful mitigation efforts. In the last century, the change in the modern American environmental movement from one that was focused on protecting the beauty of nature and preserving land to the more aggressive actions taken by the government in the form of regulation, "was the manifestation of a crucial realization that unrestricted commercial activity was doing damage… It was the realization that pollution was global, not just local" (Conway 265). That realization still exists today, but the issues, influences and players make it complicated. There are simply no silver bullets to addressing a challenge this large. With that in mind, it would be appropriate to end this paper with some thoughts about next steps for efforts to close belief gaps and create a new environmental paradigm shift among the United States public and government.

According to surveys on global warming perceptions, Americans express lower concern than countries across Europe, Latin America, Asia, Africa and even the Middle East

(Pew, Dec. 2009). Several reasons previously discussed may account for this, chief among them being ideology. With all of the data available, education is still needed to improve awareness and grow the consensus in the American public. The good news is that most people agree that the earth is warming and that acknowledgement is a vital first step to incremental change. Grass roots education and advocacy efforts must continue, they do have an impact, but the vast spending by energy companies makes this difficult. One academic researcher is advocating for an obvious approach to improving science education. In his study, "Seeing and Believing Science," Iwan Morus writes about a "visual culture of the sciences" that existed in the 19th century and its impact on the general public (Morus). Scientific performances across the country "such as magic lantern shows, optical illusions and public experiments" helped inform the public about science. The challenge in today's world is cutting through the noise of mass media and the variety of opinions that are not always factually based. The new Cosmos series, "A Spacetime Odyssey" with scientist Neil deGrasse Tyson, is proving capable of drawing a wide audience despite the competition on cable television. Its creative use of technology, charismatic narration and lack of politics is refreshing at a time and in a culture that does not accept science as readily as it once did. This new brand of programing could provide a blue print for future programs about the environment and specifically, climate change.

Young adults are a key constituency to target as they can play a bigger role in public advocacy now and in the short-term. However, putting a disproportionate amount of focus on educating younger children about climate change, those who are in elementary school for example, requires too long of a wait for them to age, mature and get involved. The most important group to target are the adults who work in state capitals and in the United States

Congress. Serious changes to address global warming in the near future will require actions from these leaders, which is why the messaging and discourse over the next two voting cycles is pivotal. Those advocating for politicians to accept the science and take action have to consider an approach that is not ideologically driven. Demonizing someone for not believing in the science will not be effective. Instead, novel tactics that deflate the typical defenses on the issue will have to be employed.

With such a polarized atmosphere in Washington DC, one way to appeal to political leaders directly may be to organize special trips to take them to strategic locations to see climate change firsthand. These would not be publicized events. In fact, providing as little fanfare as possible may provide needed cover to those who are in opposition to climate science. The goal would be to do everything possible to make the trips non-political experiences focused entirely on real-time impact. This kind of quiet advocacy may be more effective in changing minds than public rebukes and criticism. A similar trip proved effective for the former South Carolina Republican congressman, Bob Inglis. In 2009 under pressure from his son about his positions on the environment, Congressman Inglis began "educating himself on climate issues" and after a moving trip to Antarctica and the Great Barrier Reef where he saw what was happening due to climate change, he "got convinced of the science" (Davenport). Could it be possible to facilitate and coordinate these kinds of experiences on a large scale so that most congressmen could see the reduced arctic ice fields or degrading coral reefs, and meet people dealing with coastal erosion or drought? With the right leadership and under the right conditions, this could be accomplished.

The case for future negative economic impact should also be more aggressively advocated for. Politicians on all sides agree that this country's success hinges in large part

on financial wellbeing. And there are many examples in history where strategic investments have paid-off. There is ample research and evidence to suggest that making large investments now to mitigate climate change will be realized as greatly beneficial by future generations. Appealing to these sensibilities, advocates should focus on renewed efforts to push forward policies that put a higher price on pollution. Simple logic would suggest that these actions would force energy companies and private industry to innovate, it would raise revenue to help with mitigation and adaptation, and an across the board tax would be the most efficient and fair way to handle the core issue of insuring against future climate change impacts. The energy industry and their advocates have fought a carbon tax for years and will continue to do so. But the timing might be right for a pragmatic solution in the face of growing scientific evidence.

Twenty-six years after the first headline in the *New York Times* about climate change brought awareness to the issue, the March 30, 2014 edition featured another front page article: "Panel's Warning on Climate Risk: Worst Is Yet to Come" (Gillis). The dangers are clearer than ever according to the latest IPCC report. "Climate change is already having sweeping effects on every continent and throughout the world's oceans…the problem is likely to grow substantially worse unless greenhouse emissions are brought under control" (Gillis). The primary message of the report is that the impact and damage to people will be worldwide and begin sooner rather than later. Outside of the United States, the science and predictions are widely accepted. Countries that face the biggest threats are pushing the advanced countries of the world to help them since it was their development and pollution that enabled their growth. The 2014 main report from the IPCC suggests that as much as

$100 billion a year will be needed to help poorer countries deal with the impact of climate change.

There are some reasons for optimism. The first scientific paper about global warming was published in 1979. The 35 years represented since that report was released, is about how much time it took for the public and politicians to embrace the science on smoking tobacco and to heavily regulate its use. Proportionally, energy companies and other special interests have spent far greater sums to deflect the science on global warming. Eventually though, the science becomes undeniable and that point, if not already reached, is very near. Some large influential companies understand this and have started preparing for an energy shift. Exxon Mobil has begun to purchase interests in natural gas and renewable energy anticipating a future where carbon is taxed. Surprisingly, their position on climate change published in a 2013 energy development report was in-line with mainstream science: "The risk of climate change exists; it's caused by more carbon in the atmosphere; the risk is growing; and there's broad scientific and policy consensus on this" according to company spokesman, Alan Jeffers (Davenport).

The United States military is openly planning for the projected impacts of a warming planet for national security purposes. According to members of the Center for Climate and Security advisory board commenting on a 2014 defense review report, "it correctly links climate change to energy, water and food security, rising sea levels, and addresses (the issue) as one of the primary global dynamics of the 21st century" (climateandsecurity.org). To drive home the point, they added, "This is the adult way to think about climate change." Many large cities under the leadership of progressive mayors are already engaged in preparation for global warming. Instead of waiting on the slow wheels of the federal

government, they may be better positioned to take action in the short term which in the process educates large constituencies and tests a range of strategies. New York City is spending hundreds of millions of dollars to prepare for rising oceans and future storm surges. That city and others across the country are also investing significant resources to address pollution and air quality.

In the end, there are many loud voices raised in the arguments against addressing and preparing for climate change. The better path is for the United States and other world leaders to take responsibility, put strategic plans in place based on the best known science and worst case scenarios, and act on them unequivocally. It will not be an easy road, but in the words of Rachel Carson, it may "offer our last, our only chance to reach a destination that assures the preservation of our earth."

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