Project Number: 46-SWP-9802

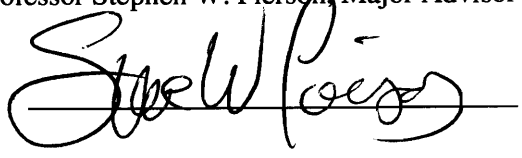
ANALYSIS OF JUNK SCIENCE

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
By

Jon C. Kennedy
William W. Kennerly

Date: May 6, 1999

Approved:
Professor Stephen W. Pierson, Major Advisor



Acknowledgements

We would like to thank our principal advisor, Professor Stephen Pierson, for his patience and his guidance. We know sometimes it was rough, but we believe we all learned a tremendous amount from this experience.

We also thank the Union of Concerned Scientists, especially Nancy Cole. Without them, this project would not have been possible. Nancy gave us so much information, and so many different things to think about, we had no problem keeping busy for three terms.

Lastly, we thank Professor Kent Rissmiller and Professor Wes Jamison for leading the way into unfamiliar social science territory.

Table of Contents

Authorship Page

Chapter 1: Introduction and Objectives: JCK, WWK
- 1.1 Objectives: JCK, WWK

Chapter 2: Literature Review: JCK, WWK
- 2.1 The Problem of Scientific Illiteracy: JCK
- 2.2 The Case for Global Warming: WWK
- 2.3 The Case Against the Problem of Global Warming: JCK
- 2.4 Current Skeptical Groups: WWK
- 2.5 The Union of Concerned Scientists: JCK, WWK
- 2.6 Recent Events: JCK, WWK

Chapter 3: Methodology: JCK, WWK
- 3.1 A Theory of Junk Science Through a Case Study: JCK
- 3.2 Interviewing: WWK
- 3.3 The Update: JCK, WWK

Chapter 4: The Alar Controversy: An Excursion in Junk Science: JCK
- 4.1 The Alar Story: JCK
- 4.2 Analyzing Alar: JCK
  - 4.2.1 The First Element: Public Ignorance: JCK
  - 4.2.2 The Second Element: Media Misinforming the Public: JCK
  - 4.2.3 The Third Element: A Capable Interest Group: JCK
- 4.3 Elements of Junk Science in Global Warming

Chapter 5: Interviewing Results: WWK
- 5.1 Response Summary for the Supporters: WWK
- 5.2 Response Summary for the Skeptics: WWK
- 5.3 Discussion: WWK

Chapter 6: Conclusions and Recommendations: JCK, WWK

Appendix A: Sample Contact E-mail Message: WWK
Appendix B: Interview Questions: JCK, WWK
Appendix C: Interview Notes: JCK, WWK
Appendix D: List of Global Warming Interest Groups We Attempted to Contact, but Did Not Interview (and Why): WWK
Appendix E: "Challengers to the Consensus" Update: JCK, WWK

Abstract

We studied junk science through the "closed" case of the Alar controversy and the "open" case of global warming. To do this, we performed an instrumental case study using Alar and conducted semistandardized elite interviews with global warming interest groups. We formulate a theoretical model of junk science, and use it and the results of the interviews to suggest tactics for the Union of Concerned Scientists to better deal with junk science.

Chapter 1: Introduction and Objectives

Junk science poses a large problem in many policy decisions based on scientific research. Junk science is not simply bad or manipulated research, opinions masquerading as scientific reports, or the media's intentional spin on a scientific issue. Junk science is a complex combination of many factors, and as a result, is difficult to define. Perhaps junk science is one of those concepts that is seen easiest through an example. An interesting case is the following in which a policymaker deferred sound scientific advice from respected research scientists in favor of sweet-sounding political opinion. In 1996, when the House Science Committee was making its final budgetary decisions, the chairman, Congressman Robert Walker (R – PA) consulted the National Research Council (NRC), an independent, non-partisan branch of the National Academy of Sciences. He wanted advice on whether or not to fund the Mission to Planet Earth program for NASA. This program was designed to monitor global climate changes and their potential effects. The NRC is an organization of scientists who strongly recommended full funding for this program. Walker then went to the George C. Marshall Institute, a conservative think tank based in Washington D.C. The Institute publishes "technical assessments of scientific issues with an impact on public policy."[1] Its reports are not based on original research, and are considered by the scientific community as mere opinions. Even the chairman of the Institute has said the reports they publish do not represent fact, but only opinion. The Institute urged Walker to cut funding. Subsequently, Walker decided to cut this program and then cited the advice of the Marshall Institute as reasoning for his action.[2] This is a case in which the influence of a group with a political agenda overrode the advice of research scientists who strongly recommended the program based on its scientific value. This may represent one form of junk science.

One area where junk science seems to be a problem is global warming. The cause for so much disagreement over global warming is that the science of climate change is so complex.

---

[1] George C. Marshall Institute, "About the Institute" <http://www.marshall.org/about.html> accessed on 8 December 1998.

This provides ample opportunity for legitimate scientific debate. This debate is normal, and quite healthy, for any scientific endeavor. Since a justifiable scientific dispute exists, some people (namely, those who believe in the scientific results that predict global warming will not be a problem) do not think global warming is a problem. Those who deem global warming a problem suggest that fixing our environment will require great changes in the structure and practice of industry. Hence, because there is so much at stake for large and powerful industries (such as the petroleum industry) with respect to implementation of corrective measures to global warming, they will want to protect their interests with whatever means available. One potentially powerful method is to exploit the non-scientists' and general public's ignorance of the scientific method by magnifying the existing scientific challenges to the consensus and by producing seemingly scientific reports which introduce a false uncertainty into the debate. As a result, many environmental policy decisions may not be based on legitimate scientific fact, but are driven by an apparent uncertainty in the relevant scientific theory, which can be influenced by an industry's vested interests.

Global warming is an area where the detrimental effects of junk science can have a profound impact. Scientists estimate the effects of global warming could be a three foot rise in sea level over the next century due to the melting of the icecaps. Such a rise "could drown [up to] sixty percent of our coastal wetlands" according to an Environmental Protection Agency (EPA) official. The rise "would inundate more than five hundred thousand square miles of dry land in the United States, an area the size of Connecticut."[3] Others effects may include more extreme temperature bounds and a more dramatic range in the precipitation rate (including more hurricanes and tornadoes). There is also the potential that once some significant warming occurs, a cycle begins in which the warming process begins to speed up. These are obvious environmental concerns, but there may also be directly related socioeconomic after effects.

---

[2] Ross Gelbspan, The Heat is On (Reading, Mass.: Perseus Books, 1998), 3.
[3] Ibid.

Some, perhaps extreme, theorists propose that governments would have to resort to martial law in the wake of homelessness caused by rising sea levels flooding these coastal lands. Disruption of coastal ecosystems could bring about rampant disease outbreaks, food shortages, and in general, economic chaos. To avoid these ends, it is imperative that the public and government be informed on the scientific issues involved. Then they can make proper policy decisions based on accurate scientific information and not on junk science (in its multitude of forms).

Responsible scientists must make sure that the science and the methodology of the science are not corrupted, and that they are well understood by those non-scientists who are in a position to make policy. It may be the responsibility of the scientists to inform policy makers that uncertainty is an integral part of science, and this uncertainty should not detract from the importance of the science in the policy decision. Since a large part of the solution of the potential problem of global warming requires drastic change in the practices of industry, those in power will require existence of a large scientific consensus to expedite legislation mandating these changes. Junk science will act only as a roadblock to an informed consensus.

We believe, as future scientists, that junk science is a major impurity in the science-policy interface. With this in mind, we worked with the Union of Concerned Scientists (UCS) to revise their strategies and develop new ones to minimize the impact of junk science. We developed methods that anticipate the emergence of junk science so it can be dealt with in a more efficient manner.

1.1 Objectives

This project concerns the analysis of junk science and is sponsored by the Union of Concerned Scientists (UCS). Specifically, we worked with the Sound Science Initiative (SSI), a program of UCS, whose goal is to counteract the effects of junk science. To assist the SSI, we:

- Developed a theoretical understanding of the nature of junk science. This is helpful for the members of SSI since junk science is so prolific. They do not have much time to put the problem of junk science in an intellectual framework. A good understanding of junk science is developed, and this revealed fundamental ways to handle its existence.
- Formulated a strategy to deal with the occurrence of junk science which is not based simply on reacting to it but also on anticipating the actions of those who produce it. This is the main objective of the project.
- Updated and added to the UCS information concerning those who challenge the consensus and develop junk science. The background research on the skeptics was conducted by UCS five years ago. Since this is such a dynamic field many changes have occurred during this period. Also, we found new groups of skeptics and ways they get their message out. This provides an independent view of the current state of junk science and the methods that UCS currently uses to minimize its impact.

We accomplished these tasks by working closely with the UCS. We made use of their extensive resources in this area. In the course of studying this problem, the UCS, through the SSI, has compiled a vast database of materials. Some of the materials we used in this project are their files on skeptic groups, articles concerning global warming from periodicals, and communications from a nation-wide network of others concerned with global warming.

Chapter 2: Literature Review

The problem of junk science is very complicated. In the context of global warming, an issue that is itself complex, the problem becomes compounded. To address this complexity, we review here two primary components of the problem of junk science in global warming: the scientific illiteracy of the public, and the science of global warming as viewed by global warming supporter and skeptic groups. What follows is a summary of our findings in these two areas.

2.1 The Problem of Scientific Illiteracy

One of the main reasons for the occurrence of junk science is the existence of a population that is largely illiterate in science. The public is aware that there is something called science and that there exist scientific facts, but they are ignorant of the methods and structure of science. Because of this ignorance there are serious misconceptions as to the very nature of the scientific method. For example, the cause and effect nature of science has been misconstrued by many to mean that science and scientists are narrow-minded and refuse to consider ideas diverging from the consensus. Science is actually dependent on falsifiability. Scientists are continually looking for alternative, better theories and explanations. Junk scientists exploit this scientific ignorance to influence public policy.

It is because of misconceptions such as these that lawmakers and the general public cannot differentiate between good scientific results and junk science messages. This is a very big problem, especially in a democratic system. A large part of scientific funding comes from the government, and so the public and the lawmakers have a major role in directing the scientific pursuits of the country.

An example of a group of politically savvy junk scientists who used the scientific ignorance of the public to their advantage is the creation science movement of the past couple of decades. Members of this movement referred to themselves as creation scientists and relied on the fact that the public would not be able to analyze their cause and determine that they were not

in any way using the methodology of science. But because of their political skill and the ignorance of the policy makers they were successful in attaining their goal, which was to change the public school science curriculum to include the teaching of this so-called creation science.[4]

The creation science movement endorsed two ideas. First, they believed that creation science should be taught and that those in favor of academic freedom should advocate its teaching because only then would a complete discussion of the issues result. The second point was that the teaching of creation science would stimulate critical thinking about the theory of evolution, and this might lead to its revision or rejection.

The definition of creation science given to the general public is the body of scientific evidence for, not the biblical account of, creation, along with inferences drawn from that evidence.[5] However the thoughts of creation scientists differ completely from this definition. Henry Morris, director of the Institute for Creation Research (ICR), the world's leading creationist think tank writes in his book Studies in the Bible and Science:

> If man wishes to know anything about Creation, his sole source of true information is that of divine revelation. God was there when it happened. We were not there... Therefore, we are completely limited to what God has seen fit to tell us, and this information is His written Word. This [the Bible] is our textbook on the science of Creation![6]

He goes on in The Remarkable Birth of Planet Earth to state, "The only way we can determine the true age of the Earth is for God to tell us what it is. And since He has told us, very plainly, in the Holy Scriptures that it is several thousand years in age, and no more, that ought to settle all basic questions of terrestrial chronology."[7]

In the July 1992 issue of *Acts and Facts,* the ICR's journal, a leading creationist and staff member of the ICR Ken Ham states, "Because the Word of God is the only absolute we have, all teaching must be checked against this absolute standard. We here at ICR have always tried to be

---

[4] Michael Zimmerman, Science Nonscience, and Nonsense (Baltimore: The John Hopkins University Press, 1995), 15.
[5] Ibid., 16.
[6] Ibid.

true to Scripture. We put God's Word first; we build our science on God's Word, not on our understanding of God's Word based on science."[8]

Without the Bible there is not much to creation science. In fact, when a curriculum guide was being prepared for the public schools of Columbus, Ohio, in 1981 it was forced to site articles from the *National Enquirer* to back up the scientific claims of the creation scientists.[9] Their theory rested on belief, not on empirical evidence. Creation scientists were not doing science, they were quoting the Bible and then calling themselves scientists.

The proponents of this movement argued that it should be taught in schools because only then would the discussion of this issue be complete. But in reality, if creation science were included in the curriculum then it would represent only the Christian belief and not necessarily the whole discussion. If one truly wanted a complete discussion one would have to incorporate all possibilities from all the religions of the world.

The other component of the creation scientists argument was that without the challenge of creation science there would be no challenge to the theory of evolution.

In 1985 Eugenie Scott and Henry Cole published a study in the *Quarterly Review of Biology* which concluded that creationists have provided no meaningful challenge to the evolutionary sciences.[10] Scott and Cole looked at sixty-eight science journals and talked to the editors about the authors. Their findings are striking. Only 0.01% came from the creationist group and they were written by laypeople, not scientists. It was concluded from this report that the creationists are not doing science. They do not do experiments to test hypotheses and they do not share any findings with the scientific community.

More importantly, the fact that they would make such a claim shows their ignorance of the methodology of science. Science by its very nature is always skeptical of any existing theory

---

[7] Ibid., 17.
[8] Ibid.
[9] Ibid.
[10] Ibid., 19

and is continually questioning the consensus. Scientists do not need outside organizations to tell them they should question their beliefs; that is what they are trained to do. It is the creationists who do not believe in questioning their fundamental beliefs. Nearly all members of the creation science organizations must sign yearly oaths attesting to their beliefs.[11]

Despite this evidence that creation scientists are not scientists at all, and that there is no legitimate science in their creation theory, they were very effective in persuading public schools to change their curriculum and include creationism in their teachings. They were skilled in politically manipulating the policy by exploiting the inability of the public and lawmakers to determine that the creation scientists were not scientists at all. This is just one example to illustrate the problems that this illiteracy can cause and that it is one of the main reasons that junk science exists and is effective.

2.2 The Evidence for Global Warming

The arguments used by scientists to show the occurrence of global warming are supported by a range of types of recorded data and general circulation models (GCMs). Each of these has a different amount of skepticism associated with it. This section will outline a typical argument given for the occurrence of global warming.

There are at least two basic facts about climate science that are rarely, if ever, disputed in the scientific community. One is the accuracy of data concerning the general climate of the earth anywhere from mere hundreds to thousands (as far back as 160,000) of years in the past. These seemingly miraculous claims are substantiated by data obtained from ice cores (long plugs of ice extracted from ice sheets at the poles), tree rings, and coral reefs. For example, the cross section of a tree can be analyzed for this data by looking at the widths of the growth rings. If a particular ring is narrow (relatively), then that is an indication of slow tree growth, and a generally colder climate for that period. A continuous sequence of narrow rings indicates a long period of colder

[11] Ibid., 20.

weather, such as the so-called Little Ice Age, which endured from about 1550 to 1850 AD.[12] Presumably, these natural artifacts can be used for this analysis since they have been around since the periods of old we wish to compare. From an ice core sample, scientists are able to determine the composition of the atmosphere as far back as the ice core has been deposited. Analyzing air bubbles trapped in the ice core from any given period will reveal the gaseous makeup of the atmosphere during that time.

Another important fact that is universally accepted is that certain gases found in our atmosphere have the ability to act as greenhouse gases (GHGs). A gas is termed a *greenhouse gas* if it is one that acts to trap excess heat energy inside the atmosphere of the earth, similar to the way glass panels trap warm air in a greenhouse. This effect was predicted for carbon dioxide (CO_2) as early as 1896 by Arrhenius, the Nobel prize-winning (1903) chemist from Sweden.[13] There are also other accepted GHGs, such as methane, water vapor, chlorofluorocarbons (CFCs), and nitrous oxide (N_2O). The action of CFCs are of particular concern, because not only are they greenhouse gases, but they have been shown to act as catalysts in the decomposition of stratospheric ozone (O_3) by a team of chemists who won the Nobel prize for this research in 1992. Stratospheric ozone protects the earth (and its inhabitants) from the sun. If CFCs are present in the stratosphere, then we retain heat because they can act as a GHG, but they also deplete our protective ozone layer, potentially heating the surface in two different ways.

All of this only says there is a possibility of global warming due to the problematic nature of these gases in our atmosphere. The real business here is that all of these gases (excluding water vapor) are being piped into the atmosphere by anthropogenic devices at an incredible rate, and they have been since the onset of the industrial revolution in the late nineteenth century. Every time wood, paper, oil, coal, or natural gas (all of these are hydrocarbons, a class of

---

[12] Michael Oppenheimer and Robert Boyle, Dead Heat: The Race Against the Greenhouse Effect, (New York: Basic Books, Inc., 1990), 19-26.

[13] Ibid., 34-35.

chemical compounds) are burned in air, carbon dioxide is released in large quantities. Methane is released from decomposing cattle manure and rice paddies. Nitrous oxide is found in automobile emissions. CFCs once enjoyed widespread use as refrigerants and propellants, but their use has been restricted since reasonable substitutes have been found for their purposes. The atmosphere has simply been inundated with this sudden rush ("suddenly" over the previous 120 years) of GHGs.[14]

We now move into the realm of some scientific debate. We will work from the basis that there is a potential for global warming to occur because immense quantities of GHGs are being emitted into our atmosphere. The question is now posed: does the current situation admit that global warming is occurring? In other words, could the amount of GHGs in our atmosphere cause a significant increase in the temperature of the earth (often given in terms of the global mean surface temperature (GMST))? Obviously, evidence of global warming is demanded by all.

One way global warming can be shown is by demonstrating a statistical increase in temperature as it has been recorded reliably over the last 120 years. This data shows that this increase is in the range 0.8 – 1.5 degrees Fahrenheit, as determined by James Hansen of the Goddard Institute for Space Studies. But why the range? This data has been collected over 120 years – a period characterized by a great increase in technological development from start to finish. Consequently, measuring devices and techniques improved over time, which gives some uncertainty to the comparability of today's data to that of yesteryear. In addition, in 1890, only 300 weather stations were around to collect this data. By 1960, there were 1,800 stations, which undoubtedly provides a much more meaningful value for the GMST.[15]

Another source of temperature data is from special satellites, but their use only began within the last twenty years. There is currently debate as to the correct interpretation of data obtained from these satellites. Initially, satellite data showed a cooling at a rate of 0.5 C per

[14] Ibid., 29-50.
[15] Ibid., 51-53.

decade between 1979 and 1995. This data conflicted with the warming of 0.13 C per decade recorded on the surface, so many skeptics used the satellite data to corroborate their arguments. However, some researchers discovered that the data had been analyzed incorrectly due to the omission of some important parameters. When these factors were taken into account, the satellite data showed an increase of 0.07 C per decade.[16]

All of this temperature data, along with a wide range of scientists' knowledge of physics, chemistry, biology, and ecology are incorporated to form a general circulation model (GCM). These models are analyzed using computers; they are constructed by scientists who attempt to understand the intricate mathematical relationships between many different environmental variables that will have an influence on the GMST. Some of these variables might be: tilt of the earth's axis, level of solar activity, ocean currents, volcanic activity, forest fires, and the list could go on and on. These are all natural (non-anthropogenic) causes of temperature change.

Given the number of variables and the fact that we are dealing with a dynamic system with intrinsic randomness, the scientists' ability to predict with any certainty the future of this system is very difficult. To approach an acceptable level of certainty, complicated mathematical models are derived and analyzed on very powerful computer systems.

The actual atmospheric effects of unnaturally high levels of greenhouse gases are unknown at this time: there is no doubt that they could *potentially* trap heat in our atmosphere, but will they actually? If so, is the degree of warming of any significance? This is what the models try to predict, but complications arise when modelers are forced to account for the presence of GHGs.

The main point is that (for instance) CO_2 does not just independently wander around the atmosphere and trap heat inside – it is a dynamical component of our environment. It is the gas on which all vegetation depends for photosynthesis to occur. An important species in this respect

[16] R. Kerr, , "Among Global Thermometers, Warming Still Wins Out," *Science*, v. 281, n. 5385, p. 1948, 25 September 1998.

is the phytoplankton that live in the oceans. They absorb CO_2, but they might not absorb all of the CO_2 released from fossil fuel combustion. Remaining CO_2 may then be left to rise into the atmosphere and cause global warming. Phytoplankton will probably not be able to adapt to an increase in temperature, and may die out. Then a large amount of CO_2 is left unabsorbed by natural causes, and global warming has just accelerated its own severity. This phenomenon is termed *positive feedback*, and is of great concern to ecologists. Needless to say, the problem of ecosystems adapting to possible warming prompted the following statement from the 1992 Earth Summit conference in Rio de Janeiro:

> The ultimate objective...is to achieve...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.[17] (Article 2)

Feedback is also of concern to the modelers, who must be able to (at the very least) estimate the occurrence and magnitude of both positive and negative feedback. The modelers face a stiff challenge: to fully understand natural GMST variations (what would occur without elevated GHG levels), and then to determine the rise in temperature associated with actual and projected GHG levels. Accuracy for this data is a tall demand for any one given model, so many different scenarios have been suggested in an effort to give a broad range of possible increases in GMST over time. The range is 1.8 – 6.3 °F (IPCC, 1992) for the year 2100. A "best estimate" was given of 3.6 °F, which is thought to be a greater increase than given by any natural variation over the last 10,000 years.[18] This is rather compelling evidence of the likelihood and severity of global warming. A broad range of suggested models show a significant warming trend in store for our environment. The use of different scenarios helps to account for the fact that modelers do not

[17] Union of Concerned Scientists, "Climate Change Reference Guide: Policy Briefing," 1998.
[18] Union of Concerned Scientists, "Climate Change Reference Guide Update: The Advancing Science of Climate Change," Spring 1996.

really understand all of the factors going into their models, but skepticism is still widespread about them.

All of this knowledge contributed to the United Nation's Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR) of 1995. This huge attempt to gain understanding on the complex issue of climate change brought together 2,500 scientists from more than sixty different countries. This group was chosen in such a way as to ensure a wide range of scientific opinion. These scientists went through all of the evidence and work previously done, such as the items listed previously, and wrote in the final report that the increase in GMST "is unlikely to be entirely natural in origin" and that "the balance of evidence suggests that there is a discernible human influence on global climate."[19] This provides a rock-steady base for the evidence supporting global warming. Such a large and diverse group of scientists surely provides an adequate consensus to build upon.

2.3 The Evidence Against Global Warming

There is another side to the global warming issue; some people are skeptical that global warming presents a problem. Some argue that global warming is good for the environment. Others argue that global warming is not happening. Some say that the evidence is not strong enough to decide either way. This section will explain these main points that those who believe that global warming is not a problem use to justify their belief.

One of the main arguments that supports global warming as beneficial for life on earth is the idea that increased CO_2 from the burning of fossil fuels and the resulting increase in global temperature will "green the earth." Since most plant life is dependent on CO_2, an increased concentration of this gas along with warmer temperatures will allow more vegetation to grow. This means increased availability of food and denser forests. One of the main proponents of this

[19] Union of Concerned Scientists, "Global warming," <http://www.ucsusa.org/warming/index.html> accessed on 10 December 1998.

theory is the Greening Earth Society. The president of the Greening Earth Society, Fred Palmer, sums up this argument very well:

> "As the human community grows in numbers and as economic activity increases, more and more fossil fuels are used, more and more carbon dioxide is put into the air, with the result of a more vigorous biosphere with higher food production, more productive forests, more vigorous wetlands, increased ground cover, and the like."[20]

This is probably the most popular argument employed by those who believe that global warming is a phenomenon which will enhance the quality of life on the earth. Dr. Sherwood B. Idso, a research physicist with the U.S. Department of Agriculture, is one of the many advocates of this theory. At the Third Annual Kuehnast Lecture of the Department of Soil, Water and Climate, which took place at the University of Minnesota, Dr. Idso stated, "Results from hundreds of laboratory and field experiments demonstrate that increasing the carbon dioxide content of the air helps plants grow faster, bigger and more profusely."[21]

Another big supporter of this argument is the Western Fuels Association. The WFA was the sponsor of a video entitled *The Greening of Planet Earth,* which promoted the idea that the increased CO_2 emissions are beneficial to the planet.[22]

The previous argument in favor of global warming presupposes that the warming of the earth is occurring and that it is mainly anthropogenic. There are some who are not willing to accept this claim based on the present understanding and data. Many claim that natural factors such as cyclical climate forces, sunspot cycles, and volcanic eruptions are the major contributors to global warming, and the human element is negligible. A proponent of this theory is the George

---

[20] UCS internal document
[21] Western Fuels Association, "Western Fuels Association," <http://www.westernfuels.org/truthfr.htm> accessed on 10 December 1998.
[22] Union of Concerned Scientists, "Climate Change Reference Guide: Challenges to the Consensus," Summer 1995, 3.

C. Marshall Institute. The Institute claims that "The earth has warmed by approximately 0.5 degrees C since 1900."[23] Then the Marshall Institute goes on to categorize as fact the statement:

> Most of the half-degree temperature rise since 1900 occurred prior to 1940, but more than half of the additional CO_2 entered the atmosphere after 1940. Greenhouse gases produced by human activities cannot be the cause of a global warming that occurred before these [greenhouse] gases existed. Natural factors, such as an increase in the sun's brightness, must have produced a large part of that earlier warming of 0.5 degrees C. Human activities, such as burning coal and oil, can only account for at most a few tenths of a degree.[24]

The major factor contributing to the difficulty of reaching absolute conclusions on the science of global warming is the extreme complexity. To completely understand the dynamics of a system such as the climate of the earth is to analyze hundreds of variables which may be dependent on one another. To a large extent it is the sheer complexity of the problem and the possibility of excluding an important factor in the analysis of the problem which makes some scientists and policy makers hesitant to take a firm stand on the matter.

As stated before, a standard method in climate science is the use of GCMs. Evaluating the predictions of these models provides fertile ground for debate. The issue here is simple. Many believe that the models are not sophisticated enough, or ignore many important factors which would be necessary components if the models were to accurately predict the future climate situation. Many times a problem will be simplified or idealized in some fashion so as to allow mathematical analysis. Many believe that while simplifying the model to make it workable, the modelers are ignoring important variables. When these variables are ignored, the modelers' critics declare that GCM predictions become invalid.

In any case the final test of any model is how well it corresponds with the data it was designed to predict. Some argue that current models do not agree at all with the actual data. The

---

[23] George C. Marshall Institute, "Global Warming Facts," <http://www.marshall.org/globalfax.html#fax2> accessed on 10 December 1998.
[24] George C. Marshall Institute, "Global Warming Facts," <http://www.marshall.org/globalfax.html#fax2> accessed on 10 December 1998.

Marshall institute is skeptical about the usefulness of computer models and the validity of their predictions. The Marshall Institute justifies its beliefs with statements like the following:

> According to projections by computer models of climate change, a temperature rise of about 0.4 degrees C should have occurred in the last twenty years because of the large increases in CO_2 and other minor greenhouse gases. But temperature measurements from satellites for the period 1978-1997 show no temperature rise at all.[25]

The mathematics required to describe a system as dynamic as the world's climate is very complex. Michael L. Parsons in his book Global Warming: The Truth behind the Myth summarizes a popular position concerning the issue of computer models:

> We are not convinced that the computer models are advanced to the stage that their projections of 50-100 years have sufficient validity to sway an objective scientist to push for governmental action of great consequence, such as making drastic cuts in fossil fuel consumption, or initiating other economically disastrous action. The fact is the earth should already have warmed enough for detection by our current experimental measurement systems if the computer climate models were correct. This warming has not occurred, which is reasonable proof of their inadequacies.[26]

The skeptics on this issue have one final argument which is often presented. The skeptics argue that because of the disagreements listed above there does not seem to be a solid consensus on this issue and therefore no drastic actions should be taken. It would not be beneficial to enforce measures which would disrupt the industrial and economic states of the world if we are not 100% sure that these measures should be taken. They argue that it would be much more prudent to wait and do more research before action is taken. The Marshall Institute is one of many groups who argue this idea. It argues:

> Thus far the climate data have not shown the large temperature increases predicted by the climate models as a result of human-made CO_2. Either the climate models are exaggerating the warming effect of the added CO_2, or the warming is being masked by some other factor. Still, even if fears of a harmful human-caused global warming turn out to be justified – a possibility which finds no support in the scientific data to date – there is no significant penalty for waiting more than twenty years to obtain better information before cutting CO_2

---

[25] George C. Marshall Institute, "Global Warming Facts," <http://www.marshall.org/globalfax.html#fax5> accessed on 10 December 1998.

[26] Michael L. Parsons, Global Warming: The Truth behind the Myth, (New York: Plenum Press, 1995), 238.

> emissions. Since CO_2 emission cuts are expected to have a destructive impact on the U.S. economy, waiting until more information is in hand would seem to be the prudent policy.[27]

In summation, the case for the skeptics of global warming is as follows. Global warming, if it is occurring, has the possibility of providing an improvement of the quality of life through an increase in vegetation. But, one can not be completely sure global warming is occurring because of the complexity of the system, and even if one could be sure it would not be very clear that the cause is anthropogenic. So given this amount of uncertainty, acting dramatically to change the situation would not be the best course of action. It is safer to do more research in the hopes of arriving at firmer conclusions before taking drastic action.

Many of the groups which present the previous arguments belong to a certain industrial class because it is clear that certain industries, such as the oil companies, have a vital economic interest in delaying legislation that attempts to limit the effect of global warming. Often, however, these companies will create front groups that disguise the fact that they are involved. These groups then act to solicit donations and members to support their cause. Listed here are a few of those organizations that are known to lash out against the possibility of global warming problems and related policy. Information about them was provided largely by the UCS.

2.4 Current Skeptical Groups

The Global Climate Coalition (GCC) is composed of many large energy related corporations, such as Shell Oil, Texaco, ARCO, and Amoco. This group tries to dispel hysteria about global warming, and speaks out about the high cost of decreasing CO_2 emissions. It has an active group of lobbyists in Washington D.C. who have worked to stop legislation that would require a reduction in the levels of fossil fuel emissions.

The Science and Environmental Policy Project (SEPP) has stated its goal is to "document the relationship between scientific data and the development of federal environmental policy." It

---

[27] George C. Marshall Institute, "Global Warming Facts," <http://www.marshall.org/globalfax.html#fax3> accessed on 10 December 1998.

is active in putting out information that differs from the consensus on climate change. SEPP is funded by groups such as Bradley, Smith Richardson, and Forbes. Its director, Fred Singer, has received consulting fees from major oil companies.

The Western Fuels Association (WFA) is composed of western U.S. coal companies and has two objectives: "delivering coal at the lowest possible cost to our members and our involvement in the policy debate swirling around coal and energy."

The American Petroleum Institute (API) is a group that represents the oil and natural gas industry. It is against the high cost of implementing reform as it is put forth in the Kyoto Protocol.

The Greening Earth Society (GES) is a "grassroots organization" created by WFA which has as its statement that the group "believes that humankind's industrial evolution is good, and using fossil fuels to enable our economic activity is as natural as breathing." It has produced two videotapes that claim carbon dioxide emissions help to stimulate vegetation growth.

The George C. Marshall Institute is an ideologically conservative think tank. It publishes opinionated reports about climate change that influence policy decisions made in Washington. Its "The Global Warming Experiment" report recommended that legislation be delayed for ten years while more research is done, and that any warming that occurs during this time is, at most, not noticeable.

The Cato Institute is a libertarian institution. To this end, it considers sweeping environmental policy a devastating blow to business and our way of life. It is widely known and quoted in the media, and has published some books and reports on climate change. Its staff climatologist, Patrick J. Michaels, went before Congress in June, 1998, and said that the Kyoto Protocol is a "useless appendage to an irrelevant treaty."[28]

[28] Cato Institute, "What's New at Cato," 29 July 1998, <http://www.cato.org/new/catonew12.html> accessed on 10 December 1998.

2.5 The Union of Concerned Scientists

The Union of Concerned Scientists (UCS) is an organization that bridges scientists and the community to help ensure that in the future, our planet has a livable environment. It does this by focusing on issues that are naturally scientific, where the application of science can have a great impact on the environment. Some of the large issues that UCS studies include developing cleaner energy supplies, cleaner modes of transportation, and environmentally-friendly farming techniques. The UCS has over 70,000 people nation-wide which work on UCS issues and provide financial support.

In the past UCS, has supported many causes. In 1979, UCS called for the shutdown of the Three Mile Island nuclear reactor, along with fifteen others across the nation, because they felt the Nuclear Regulatory Commission (NRC) was downplaying chances of an accident. This was two months before the accident at TMI. UCS has also fought against development of weapons in space. In 1983, it analyzed the Strategic Defense Initiative (SDI) and revealed technical and strategic problems with the concept. In 1985, the UCS's "Appeal to Ban Space Weapons" was signed by over seven hundred members of the National Academy of Sciences (NAS) and fifty-seven Nobel laureates. This document urged the US to ban the development of weapons in space.[29]

The UCS's campaign to prevent climate change was initiated when the "Appeal by American Scientists to Prevent Global Warming" was signed by seven hundred members of the NAS. The UCS's mission in the climate change arena is to reform US energy and transportation policies and increase the public understanding of climate change.[30]

The main program of the UCS that we are concerned with in the analysis of junk science is termed the Sound Science Initiative (SSI). In their own words: "[SSI] is designed to help scientists build public awareness about global environmental issues. The goal is to present

[29] Union of Concerned Scientists, "About the Union of Concerned Scientists," <http://www.ucsusa.org/about/index.html> accessed on 19 January 1999.

accurate, credible information to the media, the public, and policymakers, and to counter misinformation about environmental science."[31] This initiative helps to get scientists involved directly in the policy arena using their field of knowledge which is so crucial to progress on environmental issues. Currently, the SSI includes a network of more than 1,600 scientists in fields such as physics, chemistry, biology, engineering, and environmental science. These scientists receive "action alerts" when some piece of supposed misinformation is put into mass media form. The alert contains instructions on what can best be done to counteract the presence of the junk science – usually encouraging a letter to the editor of a newspaper, or a letter to a member of congress about specific legislative action. The issues covered by the SSI include climate change, biodiversity, population growth, and ozone science.[32] A scientist who cares about one of these issues can gain a wealth of information about how science is used in these important policy areas, and then he can be prepared to shape the future of the environment in a positive way.

The UCS defines junk science as:

> "Junk science" -- results that, while presented as legitimate science, fall outside the rigors of the scientific method and the peer review process. It can take the form of presentation of selective results, politically-motivated distortions of scientifically sound papers, or the publishing of quasi-scientific non-reviewed journals. At its worst, junk science is opinion and speculation being lent undeserved respectability by scientists financially supported by self-interested lobby groups trying to confound the real scientific debate on, for example, global environmental issues.
>
> Defining junk science, however, does not imply that criticism of scientific orthodoxy is illegitimate or inappropriate. Junk science does NOT include well-formulated, testable hypotheses from honest researchers challenging the majority viewpoint, nor peer-reviewed results that don't conform to that consensus. Indeed, these normal scientific inquiries may advance, even alter, the current paradigm and, ultimately, our understanding of environmental science.[33]

---

[30] Ibid.
[31] Union of Concerned Scientists, "Global Resources," <http://www.ucsusa.org/resources/ssi.html> accessed on 17 January 1999.
[32] Union of Concerned Scientists, "Global resources," <http://www.ucsusa.org/resources/index.html?ssi.html> accessed on 10 December 1998.
[33] UCS internal document.

Constructing a definition of junk science is a very difficult task. The UCS definition will provide us with a basis for discerning between junk science and legitimate science.

2.6 Recent Events

There have been several recent events that have helped shape the global warming debate as we see it for the project to come. These are specific events that may play a particularly important role in the content of the project. Because these events are occurring in the present, they will have a greater impact on the direction of the project than things that happened several years ago.

The events with the greatest impact that have occurred recently are large scale conferences involving politicians from all over the world. Towards the end of 1997, such a conference occurred in Kyoto, Japan. This conference was one of a sequence which dealt with similar issues, following meetings in Berlin and Geneva. At the midnight hour, the delegates agreed to continue working on how to cut back GHG emissions in an effort to curb global warming. The details of the actual methods and policies to be used toward this end were not sufficiently clarified during the last minute marathon talks which produced this agreement. There are many issues still to be resolved and agreed upon before actual changes are made. One of the major issues to be resolved before many industrial nations will ratify the protocol is the so-called clean development mechanism (CDM). This is a system which will give industries in developed countries tax credits for carrying out projects which lead to reductions in emissions in developing countries. Another concept developed countries are promoting is the concept of emissions trading. This is a system whereby industrial countries who are already under the projected emission limits can sell unused emissions permits to other countries. The conferences following Kyoto, such as the Buenos Aires conference of November 1998, are designed to resolve these conflicts.

Another recent development, connected with the impetus of the Kyoto conference is the reversal of opinion of Dr. James Hansen, chief of NASA's Goddard Institute of Space Studies, as reported by the Marshall Institute. The relevance of this reversal is that Dr. Hansen, in the summer of 1988, testified before a Senate Committee that "the [human caused] greenhouse effect has been detected and it is changing our climate now..." Dr. Hansen said he was "99-percent confident" that current temperature represents a "real warming trend."[34] Dr. Hansen and other climate scientists indicated that major problems would result from this warming trend and that drastic measures were needed to reduce greenhouse gas emissions. This testimony was a major factor in making global warming a front line issue among policy makers. Now according to the Marshall Institute:

> And now, after ten years, Hansen has taken it all back. In the October 1998 issue of the Proceedings of the National Academy of Sciences he reports that predictions of climate change in the next century are meaningless. According to Hansen and his co-authors, "The forcings that drove long-term climate change are not known with an accuracy sufficient to define future climate change."[35]

There is also a very interesting shift occurring on the industrial side of the global warming issue. Recently, some of the people and organizations who have the most at stake in fighting to downplay the effects of global warming, members of the petroleum industry, have come public saying that global warming is a threat and that the industry should take steps to accept its responsibility. In a 1997 speech at Stanford University, John Browne, group chief executive of British Petroleum, said that in dealing with the problem of global warming, it is time "for change and for a rethinking of corporate responsibility."[36] This remark indicated a very large change in policy for the world's third largest oil company. It should be said that the majority of the petroleum industry is still very skeptical and unwilling to admit that there is sufficient evidence for a major change. However this does represent a landmark fissure in big oil attitudes

---

[34] George C. Marshall Institute, "Global Warming Facts," <http://www.marshall.org/globalfax.html#fax12> accessed on 11 December 1998.
[35] Ibid.
[36] J. Gerstenzang, "Oil Executive Breaks Ranks," *Los Angeles Times*, 21 May 1997.

towards global warming. Large companies in other industries are also coming around, including Ford, General Motors, Intel, DuPont, and the American Electric Power Company.

Chapter 3: Methodology

Our main task was to develop a strategy to minimize the impact of junk science based on anticipating it, not reacting to its occurrence. To accomplish this we synthesized the results of a case study and interviews of global warming interest groups. That is, given a solid understanding of the nature of junk science, and up-to-date information on the role of junk science in global warming, we devised a strategy for dealing with the causes of junk science. Here we discuss the methods used in performing the case study and conducting the interviews.

3.1 A Theory Of Junk Science Through a Case Study

An important element of this project is the creation of a general theory of junk science. To formulate this theory we utilized a procedure known as the instrumental case study (Berg, 1998). In this type of case study, one examines a particular case to develop or refine a theoretical explanation. The actual case itself is used to help the researcher abstract and develop a general theory which models the case being studied and similar situations.

There are a few concerns one must be aware of when conducting an instrumental case study. The first is the question of objectivity. To conduct a case study, one must first select a case and then decide what to take from the analysis. These are subjective decisions. The issue which one must be aware of is whether or not the subjective decisions made by the researcher are going to subtract form the objectivity of his or her results. For many social science researchers the resolution of this concern comes in the form of repeatability. If a second independent researcher, with his or her own biases, can repeat the study and come to the same conclusions, then the study was done objectively.

The second concern is whether or not one can create a general theory on the basis of a single case study. One would hope that when a case study is done properly it should not only fit the event being studied, but it should generalize to give information about similar cases. A justification for this ability to generalize is the idea that rarely is human behavior unique or idiosyncratic. This is an assumption built into almost all behavior science research because

without this assumption, there would simply be no place to start. If this assumption is in place, then one can develop a theoretical model from a single case study and apply this model to similar situations. In our discussion of the Alar controversy, we assume that we can generalize based on our analysis because we assume that the junk science in the story is a typical example of junk science.

With these concerns in mind, we set out to develop a theoretical model of junk science through a case study. The study we chose was the Alar controversy of the late 1980's. We chose this topic for a number of reasons. First, it presented a clean and concise account of a situation where what we think is junk science was a major factor in the policy decision. We believe that the Alar controversy being as clean as it is, helps to ensure that the results of our analysis are objective. Second, the junk science component in the Alar story was particularly effective in persuading the general public to take drastic action. Also, the Alar situation was not as complex as an issue such as the tobacco controversy. In short, we found that the Alar controversy had all the necessary elements of a junk science situation, and at the same time the story was simple enough to allow a complete analysis given our time constraints.

3.2 Interviewing

We wanted a primary source for information about the global warming debate. An obvious resource for this information are global warming interest groups; organized groups of people who work full time to develop and put out a message about global warming. Thus, we decided to interview employees of global warming interest groups to gain first-hand knowledge of this issue from different perspectives (dependent on who is being interviewed). We wanted to find out:

a) basic information about the group's stance on climate change,

b) how the group distributes their message to the public and law makers, and

c) the group's views on the uses and impact of junk science in climate change, as well as what they might do to fight back against the junk science.

Interviewing also gave us information that we used in our update of the UCS "Challengers to the Consensus" sheet.

People from these interest groups, our interviewees, are experts concerning the actions of their group. Interviewing these experts is known as conducting an *elite interview*; the interviewee is an elite individual in the global warming field. Concerns presented by Marshall and Rossman (1995) about this type of interview cover two areas. The first is that since these people are elite, they are generally quite busy and may be difficult to contact. The second concern asserts that the elites are very knowledgeable about the subject, and may be annoyed if your questions are poor, or your knowledge of the matter is lackluster.

We attempted to contact all groups with an initial email message (sample in Appendix A). About half responded to this with follow-up instructions to call or email someone in particular. Those who did not respond by email were contacted by telephone "cold."

We prepared a list of questions in the fashion of a semistandardized interview to elicit information about our above objectives from each of the interest groups. According to Berg (1998), this method follows a standard schedule of questions and topics to discuss, but it is relatively open-ended so that the interviewer and interviewee can freely digress if the need arises. The actual questions we drafted are included in Appendix B. These questions were designed to elucidate responses to cover our three main interviewing objectives.

The raw data of the interviews, the actual notes taken while talking with the representatives, are located in Appendix C. It should be noted that for these interviews, we always represented ourselves as undergraduate students at Worcester Polytechnic Institute conducting a project studying the role of science in the climate change policy arena (See Appendix A). We never mentioned that we were at all connected to the Union of Concerned Scientists. Volunteering this may have come off as a negative, as the UCS is probably seen as a supporter by the skeptic groups, while their only documented goal is strictly to eliminate junk science from the public policy debate.

In addition, for the purposes of this report, the names of interviewees are left intact. Despite ethical considerations discussed by Berg about the general appeal of keeping identities of interviewees confidential in social science research, we feel that his assumptions do not wholly apply in our methodology. The information given by the interviewees is not some kind of private communication or a survey of the popularity of a societal vice: it is a message that these people *want* more people to hear. The listing of names and groups will also provide useful information to any students conducting a follow-up of this project. In addition, the privacy of their messages was never assured or requested.

3.3 The Update

The UCS through the SSI has a bulletin titled "Challengers to the Consensus", which is distributed to scientists in their action network. This document lists major groups which are skeptical about global warming theory as well as short profiles of them. This information has not been updated in approximately five years. Some of the groups that they included in the old report are the Western Fuels Association, Global Climate Coalition, the Cato Institute, and the Marshall Institute. Through are research, we came across some groups that were not included in this report, as well as new information on old groups. This information was found from web sites and also from our telephone interviews. There exists so much potentially useful information that the UCS does not have enough time to process all of it. We wrote a new "Challengers to the Consensus" (see Appendix E) with the new information, but in the same style as the previous version.

Chapter 4: The Alar Controversy: An Excursion in Junk Science

In 1968 a chemical commonly known as Alar, whose active ingredient is daminozide, was registered for use on apples. In the spring of 1989, millions of consumers stopped purchasing apples and apple products because of fear that Alar causes cancer. What would cause people to believe such claims and stop eating one of the most wholesome and nourishing foods? Was the claim well founded, based on sound science and scientific studies? Is this a case of interest groups and government using science to protect the public's health, or is this a case of junk science doing unjust damage by misinforming the public? It is questions like these that need to be answered if one is to understand how science and public policy work together and how junk science can play a major role. The purpose of this study is to analyze a specific case of the science-policy interaction to see how junk science manifests itself in a real issue.

4.1 The Alar Story

In 1973 Bela Toth of the Eppley Institute for Research in Cancer in Omaha published a report which found that 1.1-dimethylhydrazine (UDMH) caused blood vessel, lung, kidney, and liver tumors in mice. UDMH is present in Alar and approximately five percent of the Alar residue on apples is converted to UDMH in the production of apple juice and apple sauce. Toth also found in a later study that mice who were given Alar instead of UDMH also developed tumors.

A small discussion of the processes and methodology of chemical testing is in order before we continue. In order to understand the results of these experiments one needs to know that these results are based on a worst case scenario. Standard operating procedure for testing possible carcinogens is to inject very high doses of the chemical in question into mice. These doses are often many thousands of times higher than the doses to which most human will be exposed. This dosage is extremely high so that weak carcinogens are not over looked.

There are some who disagree that this procedure can identify carcinogens because extremely high levels of anything can act as toxins. The toxins in the body kill cells, and the animal then starts to generate cells at a very rapid rate. When the cells are in this state of rapid growth they are more susceptible to cancer-initiating events. Nevertheless, this is how the testing is conducted and its conservative slant might explain why about half the naturally occurring and synthetic chemicals have been labeled as possible carcinogens.

This procedure is mandated by the EPA, and as a result, the data is obtained from a method which errs on the side of caution. It is important to keep in mind that because these tests are based on an extreme worst case scenario and there is also debate about the legitimacy of such tests; the tests themselves do not always give an accurate rating of the carcinogenic properties of a given substance.

In 1980 the EPA started a "special review" of Alar because of Toth's findings. A special review is initiated when new data is found that was not present at the time the product was approved for use. After private discussions between Uniroyal, the makers of Alar, and the EPA, the review was canceled. But in 1984, the Natural Resources Defense Council (NRDC), through litigation, had the EPA reinstate the review.

The EPA, in this second look at Toth's data, formed a panel of academic experts known as the EPA's Federal Insecticide, Fungicide and Rodenticide Act Scientific Advisory Panel to review the Toth methods data. They found that Toth had made several procedural errors and that she had injected the mice with such high doses, much higher even than the doses administered in the EPA's conservative test, that there was a good possibility that toxicity and biochemical changes could be the cause of the tumors. Their conclusions were that Toth's data was inadequate to serve as a basis for quantitative risk assessment. In 1989 an independent British review of the Toth data reached similar conclusions. With theses findings the EPA announced in January of 1986 that it would allow continued use of Alar, however the Uniroyal company would be required to supply chronic toxicity and residue data .

The data from subsequent studies by the Uniroyal company showed that the mice did not develop tumors with high doses of UDMH. It was shown that the mice did not develop tumors when the maximum dose they could tolerate without experiencing high levels of toxicity was administered. This dosage, 2.9 mg/kg/day (males) or 5.8 mg/kg/day (females), is more that 35,000 times the highest estimate of daily intake of UDMH by preschoolers. It was only when doses of UDMH that were administered far exceeded the amount the EPA would use in its test that the mice developed tumors. With this dosage eighty percent of the male mice died prematurely because of extreme toxicity.

On February 1, 1989, the EPA announced that Alar would be banned as of July 31, 1990. The EPA was forced to take action because the agency had calculated that the use of Alar would result in 45 cancers per 1,000,000 exposed individuals. The EPA forbids the use of any chemical which would result in more than one cancer per 1,000,000 exposed individuals. However, these results were derived from a study where mice were given 23 mg/kg/day of Alar. This is a dosage almost 8 times the maximum dosage that can be administered to male mice before they experience toxicity. Given this fact, there is ample room to argue that the induced tumors were due to toxicity. The EPA press release did note this, saying "it may be argued that the deaths are the result of excessive toxicity, which may compromise the outcome of the study." The public did not hear this line: all they heard was that Alar caused cancer. They were not aware of the details of the study which produced these results and how the main finding, that Alar causes cancer, was based on a very conservative and questionable interpretation of the data.

The Natural Resources Defense Council did not agree with this study. In their report "Intolerable Risk: Pesticides in our Children's Food," they estimated that the number of deaths per 1,000,000 was 240 for average consumers of food treated with Alar and an astounding 910 for people who consumed large amounts of Alar treated food.

The reason for the discrepancy between the NRDC findings and the findings of the EPA is twofold. First, the NRDC used the Toth data. Secondly, the NRDC and the EPA used different

data sets to estimate the number of apples and apple products consumed. The EPA used data from a survey of 30,000 people, and the NRDC used data from a survey of 2000.

There was also a third study performed by the California Department of Food and Agriculture (CDFA). In this study there were some minor methodology changes. This study illustrates how small changes in assumptions and procedure can have dramatic impacts of the outcome of the study. In the CDFA study, the survey data that the EPA used to estimate the number of apple products was used, but the major change was that they factored in the results of previous studies which had found no risk. Using these parameters, the CDFA arrived at a worst case estimate of 2.6 excess cancers per million population. Also, the CDFA calculated a probable lifetime risk of 3.5 cancers per trillion population. These numbers are dramatically different than the estimates the NRDC derived in their report.

To get the message of their report across, the NRDC hired Fenton Communications, a public relations firm, to publicize its report. Fenton offered *60 Minutes* the opportunity to exclusively "break" the story. On February 26, 1989, Ed Bradley used the NDRC's report to warn people that Alar is a chemical which causes cancer and that children are especially at risk because they consume more apple products than adults. Fenton also held conferences and distributed copies of the NRDC's report in thirteen major cities. They also arranged to have Meryl Streep announce the formation of "Mothers and Others for Pesticides Limits" at one of their news conferences.

Because of this reporting many drastic actions were taken by the American public. In February and March of 1989 school systems stopped purchasing apple products and supermarkets were flooded with demand for organic produce. Many people simply stopped buying apples and apple products. Because of this, apple growers reported a loss of $100 million by May. The apple growers demanded that the EPA stop Alar registrations. Finally, Congress did create legislation which banned Alar and Uniroyal announced that it would stop producing the substance.

4.2 Analyzing Alar

The concept of junk science is extremely complicated. It is not simply bad science being performed by incompetent scientists. Nor is it just the media reporting a partial account of a complicated scientific issue. These are merely a few of the elements of what is known as junk science. In the Alar controversy, one sees many of the important components of junk science. The goal of this section is to determine and analyze the major elements of junk science present in the Alar controversy. We have identified three major factors that are of primary importance when one analyzes junk science in the context of Alar. These factors are not independent of one another and it is their complex combination which yields a situation where junk science can exist. The three main factors are public ignorance of the actual science and politics of the situation, the media giving the public partial, one sided information, and an interest group with an agenda. These pieces provide a framework which can be used to understand junk science not just in terms of Alar, but in a general sense.

4.2.1 The First Element: Public Ignorance

The evidence for and against Alar being a carcinogen was generated by a series of scientific studies. The problem of public ignorance is simply that the public is not capable of reading these reports for themselves. This problem occurs whenever a nonscientist needs to make a decision concerning an issue which is based on a scientific report. This problem was a factor in the "creation science" issue and it plays a major role in the Alar controversy. The majority of the general public are not scientists, so they rely on the media to water down the actual science to a level they can understand. When this occurs, the public is making a decision based on the media's translation of the science. Many things, particularly the quantitative aspects and the assumptions built into the science, are lost in the translation. The result is a politically powerful, yet partially ignorant public making an important decision.

In the Alar story, there are many important scientific points which were not conveyed to the public. The media is partly to blame for this, and this is discussed in section 4.2.2. However,

the public is also at fault because even if the science was reported accurately, there would have been aspects of the science that they would not have been able to understand.

The first important piece of information the public was missing concerns the Toth report. The Toth data was the basis for the NRDC report. The American public did not know about the EPA's board of academic scientists which had dismissed the Toth report because of procedural errors, but had they have known their ignorance of the methods of science would have restricted their understanding. The problem here is two-fold. To some extent the media is at fault for not conveying this information, but the fact is that the public is oblivious to the fundamental mechanism of science. That is, they do not understand the existence or importance of the peer review process.

A second problem was that the public did not understand the standard procedure for testing chemicals as possible carcinogens. The public was not familiar with the concept of an extreme worst case scenario. They were also ignorant of the scientific debate about this testing procedure. They did not understand that because the mice were being injected with such huge doses of the chemical that the resulting tumors might not be caused by the carcinogenic properties of the substance in question, but by the animals reaction to toxic levels of the substance.

The public was also ignorant of the quantitative aspects of the studies. They did not know that the experiment which produced 45 cancers per 1,000,000 was produced by giving the mice 23 mg/kg/day of Alar. This dosage is more than eight times the maximum dosage which can be administered before the mice experience toxicity. The public was given a mostly qualitative account of the scientific report, but even if the exact statistics were provided the public would not have completely understood them.

The sensitivity of the algorithms used to calculate the number of expected cancers was yet another aspect of this controversy that the public simply did not understand. This sensitivity can be seen in the CDFA's study. The only difference between this study and the EPA's study was that the CDFA factored in studies which had found no risk. With this slight change the

CDFA calculated a probable lifetime risk of 3.5 cancers per trillion population, which is a dramatic change from the NRDC's report. The public did not understand that a slight change in assumptions and initial data can produce a large change in the study's findings.

In summation, there were many important scientific points in the Alar issue that the public simply did not understand. These subtleties are extremely important because the public was making a decision based on scientific evidence. One of the main reasons that the public was ignorant of these points is that on the whole the general public is ignorant of science and its methods. If the public had the time and knowledge to comprehend the actual scientific papers, then this problem would not exist. A policy decision, based on a scientific study, by a scientifically illiterate public is a major factor in the existence of junk science.

4.2.2 The Second Element: Media Misinforming the Public

The media is the primary source from which the general public obtains its information. In the case of Alar, the media played a major part in misinforming the public. Part of the reason for this is that the media understands that the general public is ignorant of science and its methods and so they reproduce watered-down versions of the scientific report. Additionally, the reporter may not himself understand the issue, and the "watered-down" version of the story may actually be inaccurate. This simply adds to the confusion. The media also has an interest in selling newspapers and television shows. To this end, the media looks for stories with a high dramatic content and sometimes provides the necessary drama by skewing the story. In the case of Alar, the media saw a very dramatic story and then added to its drama by conveying an extremely one sided, slightly sensational story.

The American people learned about Alar the carcinogen primarily from a *60 Minutes* piece because the NRDC hired a public relations firm. To get there message out to the public in a powerful way, the NRDC hired a public relations firm called Fenton Communications. Fenton then simply tried to get the message of the NRDC out in the most effective way possible. They offered *60 Minutes* the exclusive right to the story. Because of this, the American people did not

see the actual scientific paper, and in general, the media was the sole provider of watered-down scientific information.

The *60 Minutes* piece was completely sensational. The opening shot was Ed Bradley sitting in front of a backdrop featuring a skull and crossbones superimposed on an apple. Then a top EPA official informs Bradley that under current regulations a new tolerance application could be denied, but Uniroyal could sue if the EPA immediately canceled the existing tolerances. The next interviewee, Congressman Jerry Sikorski (D-Minn), says "Let them sue. Go to a cancer ward in any children's hospital in this country and see the bald, wasting-away kids and then make a decision whether the risks balance over the benefits." They did not mention that Alar has not been identified as the cause of a single childhood cancer.

The *60 Minutes* report was completely one-sided. There was no mention of the subtleties of the scientific report, no mention of the Uniroyal studies, or of the EPA's rejection of the Toth data, or of the worst case scenario outlook of the models. The show was made as dramatic as possible by only using the NRDC's report.

This story by *60 Minutes* was followed by the official release of the NRDC report. The next day the report was released at major press conferences held in thirteen cities. Fenton also arranged interviews with major women's magazines and arranged for interviews on the Donahue show and other television programs. They also set up other publicity stunts such as Meryl Streep announcing the formation of "Mothers and Others for Pesticide Limits".

It is clear that the media is at fault for misinforming the public in the case of Alar. They gave a completely one-sided story in an attempt to make the situation more dramatic, and thus obtain more viewers. They were very effective in persuading the public to believe that Alar was a serious cancer risk. The media is very important in any junk science situation because it is the primary source of information for the public. The public is not reading peer-reviewed journals. They are watching media sources that are relatively unrestricted in their content, such as *60*

Minutes. The media providing a biased story to heighten drama while misinforming the public is another major factor in junk science.

4.2.3 The Third Element: A Capable Interest Group

The final necessary element for junk science in the Alar controversy was the interest group. The NRDC believed that pesticides were bad for humans and they went out to find the science that supported it. Then they hired Fenton to deliver their message, and the rest is history.

The interest group is of primary importance in a junk science situation. It is the interest group that has a belief and then looks to find a scientific basis for that belief. In the case of Alar, the NRDC believed that they were doing the public a service by bringing the supposed carcinogenic properties of Alar to their attention, and in general the interest group believes that they are doing a service to the community. In reality, it is often the case that by conveying a biased opinion and using only that science that supports it, the interest group is doing a disservice. If the NRDC did not hire Fenton to promote their report then Alar would have never been blown out of proportion and the apple industry would not have taken an unnecessary 100 million dollar loss. An interest group with a belief, and the willingness to exploit science and the media to convey that belief, is an important piece in the junk science puzzle.

4.3 Elements of Junk Science In Global Warming

Now that we have identified through the Alar case what we believe are the three necessary conditions for the existence of junk science, a logical question to ask is whether or not these conditions are satisfied in the climate change arena. We believe that all of the elements are present in the climate change issue, however we also believe that the science and the politics of this issue are much more complicated than in the Alar issue. In what follows, we present a brief discussion of the climate change issue in the context of our model of junk science.

Many of the same points concerning public ignorance of science apply in the climate change issue. The public is largely ignorant of the *methods of science* and therefore it does not matter what scientific issue one is discussing. If the public is ignorant of the methods of science

in the Alar case, they are not going to understand the methodology of the science in the climate change debate. The problem of scientific illiteracy is present in any scientific issue.

One thing which differentiates the issues of Alar and climate change is complexity. The science of climate change is enormously complicated and there is legitimate scientific debate on procedures and results. In the Alar issue the science was not nearly as complicated. Therefore in the climate change issue the problem of public ignorance is much larger. The science is so much more complicated and therefore more information needs to be dropped in order to try and make it understandable to the public.

The media is a large problem in the climate change arena, just as it was in the Alar controversy. However, this problem is magnified in the climate change issue because of the complexity of the science. There are many reporters who are reporting on climate change science who simply do not understand the science. There are also reporters who have a strong bias toward one side of the issue, and that bias can influence their writing. Finally, there is the media's dramatization of the climate change issue. Hence, it is very difficult to believe what the media reports concerning climate change, just as it was in the Alar case.

The existence of interest groups is also a major factor in the climate change debate. There are dozens of interest groups contributing their opinion to this already complicated issue. They also help to confuse the public by providing many different and sometimes conflicting viewpoints. These interest groups can play a major role in influencing climate change policy decisions.

In summation, although climate change and Alar are two very different issues, the three main elements that we have theorized to be necessary for the existence of junk science are common to both. Bearing in mind the assumptions we made before deriving the theory, we postulate that these factors are the essential ingredients in any junk science scenario.

Chapter 5: Interviewing Results and Discussion

The interviews we conducted with the global warming interest groups revealed a tremendous amount of information. The interviews had three important objectives: to determine the group's stance in the climate change debate, to find out how the group distributes it's message, and to see how the group thinks about and deals with junk science. This chapter summarizes the most important results that we obtained based on our interviews of global warming interest groups. Responses to the interviews, which were conducted using methods presented in Chapter 3, can be found in Appendix C.

We received only one interview response from the supporter groups, which was with a scientist at the Environmental Defense Fund. His answers are presented in summary in section 5.1. (The text of section 5.1 is written for consistency's sake in the plural, even though this summary only reflects one person's responses.) We did not receive responses leading to interviews from Greenpeace, the Natural Resources Defense Council, Ozone Action, Physicians for Social Responsibility, and the Sierra Club. An explanatory list of groups contacted, but not interviewed, is provided in Appendix D.

We interviewed five skeptic groups, and they were very responsive to our inquiries and extremely generous with their time. The groups we interviewed were the Heartland Institute, Global Climate Coalition, Oregon Institute of Science and Medicine, American Petroleum Institute, and Western Fuels Association. There were two other groups we contacted, but did not interview: the George C. Marshall Institute and the Science and Environmental Policy Project (SEPP). We received contact phone numbers for these groups, but did not follow up with interviews due to time constraints.

5.1 Response Summary for the Supporters

The supporters view global warming as a serious environmental challenge with far reaching consequences. They believe it is a very challenging problem to solve since we will have to stop using carbon-based fuels in order to repair the damages.

To get their global warming message out, they will use any means available. They spend a lot of their time searching for highly credible scientific information to use in their publications. They publish brochures and booklets to distribute to the public. They hold their employees in Washington D.C. as the most important (as opposed to, say, scientists in New York) since they contact the policymakers.

To "fight" junk science, they try to track down all of the skeptics, including those who embellish the uncertainties in the science. That is, they seek out groups distributing skeptic messages and monitor their behavior.

They feel that the IPCC report is very high quality work. It has been called a role model for work to be done in other interest areas. When skeptic groups criticize the IPCC report, they feel it is the weakest criticism of all. In the IPCC report due out in the year 2000, businesses as well as interest groups will be assured a voice in the write-up.

5.2 Response Summary for the Skeptics

The interviews yielded several distinct but not contradictory stances on global warming maintained by skeptic groups. One of the skeptic groups emphasizes that research on the causes of global warming has to be done in order to ensure which policy should be passed, but a push towards better technology, and technology transfer to developing countries, would be best. One group states that the effects of increased CO_2 appear to be beneficial to plant life according to research currently being conducted, and so it may also be good for the planet Earth. One also informed us that the economy will be ill-effected by mandatory GHG reductions, and that reform required by the Kyoto protocol is the wrong answer to climate change problems. Forcing U.S. industries to decrease GHG emissions will be too costly, and may not even be needed. Another

one states that climate modeling is looked at as a science in its infancy, and these models are much too crude to rely on for good predictions of future temperature trends. Lastly, perhaps a more neutral group (as opposed to being more skeptic) thinks that climate change is happening and may be attributable to humans, but it is unsure if it will be beneficial to humans.

The methods of reaching the public and lawmakers vary greatly from group to group depending on the size and area of interest of it. Some use lobbyists in Washington and send representatives to major international conferences (Kyoto, Buenos Aires, etc.), while others try to contact the public directly via press releases (printed in newspapers, web sites, and television ad campaigns). One group has a service called PolicyFax which legislators use to get information about certain policy areas. The Oregon Institute of Science and Medicine started the infamous petition project; a petition accompanied by a scientific report to find out where the consensus is in the climate change debate. It was signed by ten times as many people (17,000) as who ever signed a supporter's petition. They will publish just about anywhere, noting that national and large regional newspapers and trade journals do nicely.

If some of the skeptic groups see a scientific study that they think is junk, then they will try to determine its validity through independent research. If they determine that the study is really junk science, then they try to address it, but it is often difficult to determine whether something is junk or not. The paper may simply have to be studied and researched further. A couple of the groups indicated that junk science from scientists is not a problem occurring in the climate change arena, but problems do come up when politicians and the media try to deal with the science. An example of this is the Kyoto conference: the science was assumed to be a consensus, so it was not discussed. The attendees only debated ways to fight global warming. One interviewee believes a major cause of what might be junk science is government funded research. This may stimulate a "politicization" in the presentation of research results by scientists who desire to acquire funding over presenting completely honest work.

The skeptic groups said that the public's state of misinformation helps to proliferate junk science to a large degree. The public is not able to make decisions when scary stories about the effects of action either way are offered from both sides of the debate. The details of the science are so complicated, most people cannot understand how it all works. This misinformation-junk science cycle was labeled as a "chicken-and-the-egg" process by one interviewee.

The interviewees indicated that the IPCC is a good summary of the state of climate change research as it is known today. However, they said that the final writers, who only represent a small fraction of the total, were able to manipulate the final wording and the executive summary to imply that global warming is a real and present danger. They believe the actual body of the report stresses the major uncertainties in scientific knowledge. There was some disagreement between the skeptic groups as to the actual number of *scientists* who worked on the report; it varies from 1,100 to 2,500.

5.3 Discussion

The interviews provided us with a large volume of information. We were enlightened on topics that stretched beyond our objectives. This section will bring up these different ideas, as well as elaborate on our preset goals of Chapter 1.

The "eliteness" factor (c.f. section 3.2) apparently presented a problem with contacting supporters. We were only able to interview one of these groups. We attempted to make contact with six of these groups, with varying degrees of success in response (only one interview ensued, however).

In contrast, the elite representatives of the skeptic groups tended to be very helpful and willing to talk to us. Several were called "cold," and were willing to be interviewed by us on the spot. A couple of them talked with us for more than an hour! We postulate that this willingness may be because the skeptics are generally taking the defensive position in the global warming debate. Since they need to justify what many would deem "destroying the planet," they probably

often need to supply swift counter-arguments. Therefore, they are willing to speak with students so that their audience is widened and becomes "educated."

The employee of the Western Fuels Association we spoke with made an important point regarding distributing one's message. He said that the internet, notably the world wide web, is a great way to get your message out since it is directly accessible to many people. It is also desirable because it allows you to communicate without being "filtered" by the media. The organization's own words are always strictly maintained, so there can be no misinterpretation by the media intermediate. Thus, using the world wide web avoids the second basic element of junk science that we presented in the previous chapter.

Another interesting point is the skeptic groups' view on the effect of public ignorance in scientific debates. They all agreed that it is a problem to have a population making decisions that need to be based on science, while they do not understand science and its methodologies. This is exactly what we saw in our case study of Alar (the first element of junk science).

It seems that the skeptic groups present a couple different arguments against global warming. However, they are all based on scientific research (or economic studies). With this, they will often refute ideas given by the supporters. This would tend to befuddle the casual observer. For example, some skeptic groups claim that increased CO_2 levels are beneficial to plant life, thus invalidating the claim that the burning fossil fuels is a bad thing. However, that is only plant life. The benefits for plant life cannot be extended so simply to cover the benefits for the *entire* ecosystem of planet Earth. Thus, although there is science to "help" the argument of an interest group, its simple presence is not sufficient to guarantee absolute validity of its stance. Some of the skeptics' opinion that more research is needed tends to nullify the importance of existing scientific information. If so much more has to be done, then can the limited amount of knowledge clearly dictate what policy path should be taken? Some of the skeptic groups cite this conundrum to bolster their decision to not act, but other skeptic groups seem so vehement in their

stance that they would ignore any future research. In short, it seems that simply the presence of one piece of scientific research does not make much of an argument for any group.

One interesting point that came up a few times in the interviews of the skeptic groups regards the 1995 IPCC report. The skeptics approved of the actual report as an excellent summary of the climate change science done up to the time of the report. However, they said that the executive summary, which is what is usually read by the media, gave a very biased statement: "[the increase in GMST] is unlikely to be entirely natural in origin" and that "the balance of evidence suggests that there is a discernible human influence on global climate."[37] The skeptics claim this statement is biased because (they say) the body of the report stresses the uncertainties in climate change science, and one group even said that the end-authors who wrote that summary were political (as opposed to scientific, we suppose) . However, this quote was read by the media, and has since been used in all forms of literature put out by supporting groups. The interesting part is that we have never heard a counter-argument by the supporters to refute this statement made by the skeptic groups. A natural place to do this would be on their web pages, where two organizations we were involved with had "Myth and Fact" sections about common myths in the global warming debate. These web pages belong to the Environmental Defense Fund[38] and the Union of Concerned Scientists.[39] This is just one minor detail that would help clear up the status of the IPCC report as being a consensus or not in the climate change field.

Junk science is definitely a very difficult presence to deal with. This is evident from our interview responses because no group we contacted has a clear-cut method for dealing with junk science. They may try to confirm the scientific findings by contacting knowledgeable scientists, but it is often just too difficult to find a definitive answer to whether or not a piece of scientific

[37] Union of Concerned Scientists, "Global warming," <http://www.ucsusa.org/warming/index.html> accessed on 10 December 1998.
[38] Environmental Defense Fund, "Global Warming: Facts vs. Myths," <http://www.edf.org/pubs/FactSheets/e_GWFact2.html> accessed on 29 April 1999.
[39] Union of Concerned Scientists, "Gloal warming," <http://www.ucsusa.org/warming/index.html> accessed on 29 April 1999.

work is purely junk. The SSI, it seems by far, has the most organized effort to minimize the *impact* of junk science.

Most groups work on varied ways to loudly distribute their message, which is of course not a junk message from their perspective. Since many groups work on merely getting their message out, and certainly UCS believes some groups are putting out junk messages, then UCS may need to directly refute junk messages. This action is not attacking the core of junk science; the three elements discussed in Chapter 4. The UCS would simply be shouting their message louder than the opposition's message, which may have to be done under appropriate circumstances. We have observed that no one really has any way of attacking the core of junk science.

Thus, it seems that junk science, in its strictest sense, is something that should not be attacked directly. It is simply not feasible to attack what is *outright blatantly falsified* scientific research. This method should not be used because it is much too difficult to determine what studies are junk out of a group of "skeptic" papers – perhaps merely a few junk studies exist out of thousands of legitimate scientific works. It would take a lot of manpower to analyze each and every paper. Instead, the *core* elements of junk science (as seen in Chapter 4) should be aggressively addressed.

Chapter 6: Conclusions and Recommendations

The problem of junk science is very complex. There is no easy way to eliminate the existence of junk science. In this study, we looked at junk science from a variety of angles, and we have reached some understanding of why it exists and effective ways of dealing with it. In this chapter we present the key elements that we have found are necessary for understanding junk science. We also present our recommendations to UCS for dealing with the problem.

We found, by looking at junk science in a variety of cases (most importantly Alar and global warming), that in general there are three necessary elements for the existence of junk science. These are, as noted in chapter 4, public ignorance of science and its methods, the media misinforming the public by generating "junk" stories, and an interest group capable of putting out junk science. These factors all work together in a complex way to generate what we call junk science.

If the UCS wants to successfully counteract junk science, they have two options. They can respond to a junk science story, or they can try to preempt it by addressing some of the fundamental causes of junk science. We have found through our research that the SSI's "action alert" procedure is the most developed and organized way to fight a specific junk science issue. However, this is an after-the-fact measure. We believe that there are other ways to combat junk science which are aimed at preventing its existence. In what follows, we list recommendations for dealing with junk science. Some of these are specific to UCS, and some can be considered more general. We present them in order of increasing difficulty to apply, and the final one can be considered a very aggressive (but ideal) tactic.

Make sure UCS information is readily available. Through casual searches for "global warming" on world wide web search engines, we never found the UCS web site. We feel that this web site is an excellent resource for information about the global warming science and policy arena. However, very few people will ever find it. This avenue of information is so wide, and becoming so increasingly popular, that it would be foolhardy to not maximize the usage of this

resource. Along these same lines, the UCS should be sure to make time for casual telephone interviews. Since so many of the "supporter" groups were lax in responding to us, it seems that someone who would be willing to become a supporter may not do so. On the contrary, all of the "skeptic" groups responded efficiently.

Make sure that reporters are scientifically sound. This is something that can only be done after someone has published a story. We have found that many of the skeptic groups engage in this sort of action to determine the validity of a report. We think that the UCS should interview reporters who publish "suspicious" results and find out what backs up these results, if this is not done already. In short, is the science sound? If the answer is no, then an "action alert" could be taken up against the story.

Continue to make sure promotional literature is scientifically sound. Through observation of the UCS web site and literature, we think that the UCS does a good job in this respect. The basic idea here is to make sure that *any* scientific result that is presented is done so in a manner consistent with the nature of the study that produced it. This includes simultaneously stating with the result any uncertainties in the result. Thus, media sources that present a scare tactic scenario to bolster support for global warming theory is just not good science reporting, and is simply contributing to junk that clutters the climate change arena. We found that the UCS does not do this, but it is imperative to keep this in mind when preparing documents. However, many interest groups (both supporters and skeptics) do engage in these scare tactics. This detracts from all of the good information that some places provide. Additionally, the UCS could encourage other groups to follow their lead

Popularize skepticism among the public. A major component in junk science is public ignorance of scientific methods. The UCS should try to educate the public on these methods so they can better assess any scientific findings rather than blindingly accepting them. A basic tenet that could be pressed would be to emphasize that any scientific study carries uncertainties and assumptions. If these uncertainties are large enough, or the assumptions are unrealistic, than the

scientific study may not be appropriate for application to all cases. Then any policy action based on this study is void of scientific support. If the UCS tries to educate the public on these matters, then the public will become more skeptical when confronted with scientific conclusions. The UCS could try to do this with actual advertising (say, by hiring a public relations firm, as we saw in the Alar case) or by encouraging SSI members to write letters to the editor that would encourage skepticism of scientific findings in general. We believe this would be a very effective way to pre-empt the problems caused by junk science.

Appendix A: Sample Contact E-mail Message

To Whom it May Concern:

I am a student at Worcester Polytechnic Institute (Worcester, Massachusetts) conducting a project to measure the effects of science on public policy. We are specifically looking at the case of climate change. Could you please send me a phone number and name of someone whom I could call to interview at <group> about this topic?

Thank you very much,

Appendix B: Interview Questions

#1 What is your organization's stance on climate change?

#2 How does your organization get their message out to the public and to the law makers?

#3 What news sources do you feel are fair when it comes to reporting, i.e., present both sides of the issue and use credible sources?

#4 What groups do you see as doing or promoting good science in the climate change arena?

#5 How would you define junk science?

#6 How does your organization deal with junk science?

#7 Do you see junk science occurring often and having a major impact in the area of climate change?

#8 What news sources do you feel are most often reporting junk science?

#9 Are there people, who in your opinion, are doing junk science on a regular basis in climate change?

#10 In general, do you think the public is misinformed about the scientific issues involved in climate change? If so, do you see this as a major reason for the existence of junk science?

#11 What is your opinion of the IPCC report?

Appendix C: Interview Notes

This appendix contains the notes taken during the interviews with the elite representatives of various global warming interest group. They are listed in descending order of the date the interview was conducted. The notes are organized by question number. If the numbers are out of order numerically, this indicates that the questions were asked out of scheduled order because it was deemed necessary by the course of the interview. The enumeration of responses is not so strict, so the entire interview must be read to get a broad sense of the interviewee's arguments.

Interview with Dan Miller
Heartland Institute
February 15, 1999

1. The Heartland Institute recognizes that the climate is changing and they believe that it is due to some extent to human activity. They are unsure about the theory that the change in the climate may be beneficial to humans.

2. They have a service called Policy Fax. This is a fax on demand service that legislators can use to obtain information. The legislator can call the service and request documents which will then be immediately faxed or mailed. They also have direct contact with legislators through lobbyists. They also publish original research studies and reports.

3. Did not feel that there really are any truly objective newspapers. Most have some bias and present their stories in that light.

4. Believes that NASA is doing good science in climate change.

5. Defined junk science as assertions based on subjective opinion that masquerade as objective fact.

6. Believe that only way to deal with it is to go to the journalist and ask him or her where they get their facts. They want to talk to journalists and make them do some homework to find out what both sides of the story are. They hope to show the journalists that there are two sides to a story and that the journalist should be careful when they write.

7. They believe that junk science knows no bounds. It is present in many issues and global warming is simply one of them.

8. Yes there are and a good place to find people doing junk science is on the web. Some good web sites are: www.junkscience.com, www.sepp.org, are www.cei.org.

10. The misinformed public is a major factor in the problem of junk science. Not only is the public misinformed but they believe that they have the right information. Many believe they have the right information because they receive it from warm, fuzzy feeling groups such as the Sierra Club.

Interview with Mike Shanahan, ("Public Policy Analyst")
American Petroleum Institute
February 16, 1999

1. There is legitimate scientific disagreement whether there are human effects on climate change; spend whatever it takes to get precise causes of climate change. Believe it is a serious issue which requires policy. Kyoto is not the right solution at this point due to current state of knowledge. Economy will be ill effected; price changes will be too high. No one has a clear answer.

2. API is a member of the GCC – an industry group with public outreach of its own.
   -TV ad campaign before Kyoto and one last fall that stressed:

-No agreement on GHG emissions unless all countries agree; big developing countries are not covered like the USA, so we are hindered. (this was shown graphically)
-Cost effects detrimental
-Letters to editor, op-eds, interviews with experts that are made public.

3. Publish in the NY Times, Washington Post, Wall Street Journal, LA Times, and about a dozen other regional papers (Philadelphia Inquirer, Detroit News, etc.) Quality varies from paper to paper, but there is a change towards more skepticism that fossil fuels are cause of global warming.

4. API funds economic studies and looked at meteorological studies in January. They also look at broad public information, stuff that is widely available.

5. Junk science covers El Niño and global warming, lately. (He had me define junk science.) IPCC led to Kyoto; put final writers under pressure to imply that global warming is a problem. Example: a Harvard study on clean air, ozone, and particulate matter. EPA set new limits on emissions of particulates. API looked at regulations and said they were not necessary because there were no respiratory problems in cities. The researcher at Harvard was being paid (funded) by EPA. He wouldn't offer up his work for public or EPA study. Shanahan's guess is that there is some junk in global warming, but it is hard to say.

6. There are many sincere people, but not much junk. Maybe people are mistaken (e.g., climate models). Al Gore has an agenda; Republicans on Hill think EPA wants to reduced GHG levels without Senate approval, but these are politicians.

7. Gelbspan: "more rhetoric than fact"
We need to distinguish between the paper and op-ed section.

10. Public misinformed due to extreme views from each side, it is a very complicated issue that is not on the hot burner; view get distorted. Shanahan's opinion is that we are not ready for a decision yet on policy; research still needs to be done.

Interview with Art Robinson (Professor of Chemistry, Founder of OISM)
Oregon Institute of Science and Medicine

1. Faculty of OISM have their own "stances". Defines global warming as harmful changes in weather due to increasing CO_2. Says CO_2 is beneficial to the biosphere, does not subscribe to decrease in emissions. No doubt CO_2 is increasing in the atmosphere and the greenhouse effect exists, but not clear that any rise in temperature is attributable to CO_2.

2. OISM is a public foundation (like a University) that takes tax-deductible donations. It cannot legally influence policy. Individually (as a faculty member simply associated with OISM) they can work to influence policy.

Petition project: Art Robinson, along with 2 individuals from Harvard, 1 from Rockefeller University, and 2 more from OISM wrote an eight page paper with cover letter from Fred Seitz to demonstrate there is not a consensus in climate change science (documents available at http://www.oism.org)."Warmers" claim there is a consensus, but ten times as many people signed the petition as did anything on their side. Stresses this is not science, just an effort to show where the consensus is.

Science: 8 page article that is fully referenced, covers environmental effects of CO_2 and data on world temperature and weather over last 200 years. We are at the average temperature (right now) for the last 300 years; we are simply on a rise from the little ice age, and this is blown up in newspapers. Solar activity seems to be the cause. Effects of CO_2 factor in for the last twenty years, climate model not supported (?).

4. Sherwood Idso does good work, there are thousands of papers in literature on effects of elevated CO_2 levels on plant growth. Effects on wheat are shown as providing better wheat. Warmers are scrambling because their position is that fossil fuels are bad.

This research is important because acting to eliminate fossil fuels could be disastrous. Developing countries need fossil fuels (hydrocarbon energy) for now, then they can shift to solar, nuclear, etc. They need this energy *now* to survive. In order for greenhouse gas limitations to be effective, everyone (including developing nations, like China and India) need to cut back. Forcing these nations to cut back on emissions could be deadly. Lives are at stake.

5. In general, not good for science to be involved in public policy. Three types of junk science:

   a) "Nuts"; guys who have screws loose, they belong to fringe group. They could be out to make a quick buck.
   b) Where interpretation of results has major effects Government puts two to four billion dollars into research, some scientists get bought out, but not too many.
   c) The press gets involved – example of DDT. The EPA stated that they saw no reason to ban DDT, but many public sources skewed data (J. Gordon Edwards, Rachael Carlson). DDT was eventually banned. However, DDT was shown to be destroying malaria in third world countries. While it was in use, DDT was estimated to save 500 million lives. This is a case where the science was clear, but the press falsely magnified a problem.

6. AR tries to study reports from the press and non-scientists. Self-correction mechanism of science breaks down when money is involved. Government funding of science is wrong – the science and policy mix is bad. Serious issues imply that scientists need to work hard. Doesn't like Stephen Schneider (he was a global cooler, now a warmer) or the Kyoto conference (no discussion of the science, just the policy; assumed science on climate change was consensus). He likes Seitz and Marshall Nurenburg; prominent scientists fighting warmers.

8. Fear is natural fodder for the news. USA Today and the more liberal newspapers tend to spread it. Generally, the press wants to spread the truth, but they don't understand the facts.

10. The public is misinformed on the truth; they are not trained to make these decisions. It ends up being more of a press and propaganda war. Warmers can give scare scenarios, which scares the public, who show they are scared in polls, which scares the Senate into passing legislation.

11. The IPCC is very conservative. It has been over-represented. It only had 2000 people involved, of that 1100 were scientists, 80 writers, and just a handful to revise it. Revisions took out caveats about uncertainties. It was a careful study of the literature, but it was not what the warmers wanted. The report and summary were never submitted to 1100 scientists for approval. The executive summary was skewed by revisions to give quotes for press that were perhaps not consistent with the 1100 scientists.

Interview with Eric Holdsworth (Deputy Director)
Global Climate Coalition
February 24, 1999

1. Recognizes concern on climate change; supports research and increased funding for research and development for energy efficient technology and "technology transfer" to developing countries. We need a global approach. GCC is opposed to Kyoto; they favor a long term perspective of penetration of technology into the market.

2. Send out press releases to the media, respond to media requests, and try to be included in their stories. They publish studies on climate issues by contracting out reputable firms. GCC represents a "broad spectrum" of industries (incl. Fortune 500) that will be impacted by reform, so their message is based on who they represent. They meet with members of Congress and the administration, DOE, White House, state department. They get involved in international conferences.

3. Doesn't discriminate on where they get published. Feels that the global warming issue is more balanced in media coverage today as compared to ten years ago. Back then the uncertainties in the science were not reported. They also publish in trade magazines for insiders.

4. GCC has concerns about uncertainties in science; science is unclear. Science doesn't support Kyoto. Many people are doing a lot of science. The IPCC is an international body of scientists, but it represents the politicization of science. John Christy/Roy Spencer (NASA) do honest credible work on satellite data. Sallie Bailunas does good work with sunspots. Scientists are credible. We don't hear from most of the good, honest scientists.

11. Wouldn't agree with IPCC since it was a political process. The GCC was involved, but didn't agree with the final language. The report plays on the uncertainties. It is a "good document, [but a] reflection of the process that developed it (political)."

5. When global warmers see junk science, they trash it as being funded by industry. Whether something is junk or not depends on your point of view. It is indicative of funding, can't really say what it means, need a broader sense. Industry are shills for where the money comes from. People need to discredit something to support their cause.

6. They try to address junk science and put out a fact sheet. Action is dependent on the issue and level of importance.

9. (he had me define junk science) All science is somewhat colored. No one is really doing dishonest work, but there is advocacy.

10. Yes and no; coverage is balanced on science side of the issue. Al Gore tends to get reported; public probably not getting the full story. Public needs to know more before policy is passed. Issue has gone beyond environmental, to scientific, to economic, political, and to a development issue. This is why GCC supports more research: to try and understand the situation better. There is more uncertainty then gets played in the media. Trying to convince the public is a major task, so advocates will use science to play up their argument, so "Yes". GCC tries to play up ("highlight") the lack of certainty in science.

Interview with Ned Leonard (Manager of Communications and Governmental Affairs)
Western Fuels Association
February 25, 1999

1. Fundamental belief that apocalyptic global warming is only predicted by computer models, which are not credible, and that the effects of CO_2 on plants are much more credible.

2. WFA active for about 10 years, started after Hansen's testimony in 1988 which attracted headlines to global warming when Hansen said he was 90% sure it was happening. WFA thought this was troubling, and then brought together Pat Michaels, Robert Balling, Fred Singer, and Sherwood Idso (all skeptics) to support the WFA. Idso had written a book CO_2 and Global Change: Earth in Transition, and WFA took this book (written in "turgid prose") and produced a video titled "The Greening of Planet Earth" (1991). They took it to the natural audience of coal companies, Bush administration, OMB, Capitol Hill as well as advertised with an 800 number. They distributed 30,000 copies.

Then they created the World Climate Review, which ran on a quarterly basis for 3 ½ years with a grant to University of Virginia; Michaels was the chief editor. Other people were putting out stuff that was not too credible before the big international conferences. Michael's group, New Hope Environmental Services, put out the "World Climate Report" to environmental journalists and to the right mailing lists. They wanted to get regulators informed on CO_2 issues.

About 3 years ago, WFA put out a compendium of essays called the "State of the Climate Report", which was an annual report distributed to Congress on Earth Day. About 2 years ago, they "seeded" the Greening Earth Society. This group built up membership with their website and exposure on talk radio. GES Decided to make a new video, "Greening of Planet Earth Continues". The premiere of the video was picked up by the NPC by satellite and journalists were allowed to call in and talk to the panel (Bismarck, ND). Now they are making a new video, providing transcripts, contracted with Arizona State's climate task force, which provides ground temperature records from around the world.

WFA will work with the GCC, CEI, National Mining Association, Center for Energy and Economic Development. It also provides more studies (Mark Mills (?)) on the roles of coal fired electricity in the world (cheap and domestic fuel). Sometimes they work independently, sometimes with others, as they see fit.

3. They send out press releases once in a while. Appeared on Dateline (2 years ago), Nightline (3 years ago), NPR, Danish and German TV, Mother Jones, they are profiled by environmental groups. They were covered by Gelbspan (The Heat is On), but he was very misleading about a "cover up". WFA is very frank about their dealings; distributes an annual report with a wide circulation.

4. Quite a number of scientists on both sides are willing to go public, but better scientists just do research and publish. There is US funded (DOE) research on satellites and computer models. There is good stuff funded by DOE, done by USDA, on the effects of CO_2 on plant life (experiments upscaled from greenhouses, to "controlled" open experiments, to fields, to forests, and now looking at "phase" experiments on whole world). This is compelling science (empirical data). Climate models are important, but crude. Should be a long time before a lot of money is spent on this more hypothetical stuff.

5. The term junk science is used pejoratively to attack other side; it is not a useful term. It had its start in case of silicone breast implants. WFA tries not to use it because it has become less and less useful. Science is either good science, or it is not based on peer review. (e.g., Al Gore's rhetoric)

6. Hard to assess if something is junk; sees studies that seem ridiculous (e.g., dying butterflies due to climate change) and goes to scientists for check. Then tries to determine if it is junk or not. People who get money by doing these studies and then meekly suggesting global warming is the cause is a problem. More objective research is not as likely to get funding (for little things). Generally, person who is out on the "issue du jour" will get money. People who or neutral or out to disprove something, not as likely.

7. Before international meetings, global warming stuff comes out. NOAA put out that 1998 was the hottest year first; they had collected ground temperature data with sea temp. data from ships, and also from buoys that were placed in the Pacific to detect el nino, where it should be warmer anyway). They see it a fair amount in the media put out by scientists and universities; press blows it up.

8. Science editors Bill Stevens and Joby Warrick (NY Times, Washington Post, resp.), CNN "can't be brought back". This is why they created GES (Greening Earth Society); the traditional media just doesn't always represent their story. With the WWW, the public can make their own decision.

9. They have an "unintended pernicious effect", not necessarily junk. Global climate research office in White House (GC information project) Task forces in government, often a political statement, not many are independent. The NSF is OK.

10. There is a "chicken-and-egg" effect, WFA tries to figure out which came first.

11. No problem with IPCC process as constituted, i.e., many scientists write a summary on climate change which is "a very noble and ambitious goal". Very good science is in there. The problem is that they create lead authors for each chapter, who are picked for political reasons. 2500 scientists go down to about 25, and then only 20% of these write the executive summary. These final authors are the most political, and the executive summary is spun by them.

Interview with Stuart Gaffin (Senior Staff Scientist)
Environmental Defense Fund
April 17, 1999

1. Global warming is regarded as a very serious environmental challenge that is far reaching. It is very challenging to solve. We need to stop using carbon fuels. This problem was taken on very early be EDF; they started acting on global warming in the early eighties.

2. They use "every means available" to get their word out. The answer queries and find highly credible information to distribute (SG spends much of his time doing this). They publish brochures and booklets for the public. The staff scientists publish in peer-reviewed journals. EDF operates in Washington D.C., also. Policymakers are highest on their list to influence. They will use any media appearance.

3. SG values the NY Times ("excellent") over the Wall Street Journal ("very skewed"). TV and radio were often presenting the debate as a 50/50 split between supporters and skeptics until the late eighties, but it is better now.

4. Generally all research (globally) being done is good (EDF, universities, MIT, Stanford).

5. (SG couldn't really define junk science). He has seen it in the courtroom while serving on the jury. He has also seen it in the case of hydroelectric power; the executives of HEP companies claim it is the best solution to energy problems, while SG thinks otherwise.

6. SG tracks prominent skeptics, aka "uncertainty tweaks". It is very hard to characterize junk science. Global warming has debate (if it didn't, it would be dead) but not necessarily junk. It is not a black and white issue.

10. The public is not well informed because they cannot assess scientific claims correctly. Polls show that Americans are concerned about global warming. One book about this topic is Paul Ehrlich's Betrayal of Science and Reason ("anti-environmentalist rhetoric"). EDF puts out sheets (on web) dispelling common myths about global warming.

11. SG is a lead author for the IPCC report coming out in 2000; the IPCC is very high quality work. SG works on new emissions scenarios. The IPCC has been called as a role model for other issue groups. When other groups criticize the IPCC, SG feels this is the weakest of all their criticisms. In the 2000 report, industries will be heard from as well as groups.

Appendix D: List of Global Warming Interest Groups We Attempted to Contact, but Did Not Interview (and Why):

Supporters:

Greenpeace ("Brian") – Brian talked for a few minutes, but said everyone at the office was too busy for a half hour interview. He requested we submit the interview by email. Several weeks later, we received a

generic email concerning Greenpeace's action in the global warming area. This message was in response to the initial "contact" email.

Hadley Centre – We received an email from Gordon Lupton stating that they were too busy for an interview, and we were referred to various web sites.

Natural Resources Defense Council – We were told, essentially, that they do not conduct interviews.

Ozone Action: No response at all after initial email.

Physicians for Social Responsibility (Sharon Newsome) – Did not feel they could really help us, despite information on their web page that would indicated otherwise.[40]

Sierra Club – Claimed they were too busy and we were asked to submit the interview questions by email. No response was received.

Skeptics:

The George C. Marshall Institute – We were given the phone number of Executive Director Dr. Jeffrey Salmon (202-296-9655), as well as directed to the web site, but we did not attempt to follow up with an interview.

Science and Environmental Policy Project (SEPP) – We were given the home phone number of Policy Research Associate Candace Crandall, as well as the office number of President S. Fred Singer (703-934-6940), but we did not attempt to follow up with an interview.

[40] Physicians for Social Responsibility, "Climate Change and Human Health Homepage -- Physicians for Social Responsibility (PSR) Environment; Health Program" <http://www.psr.org/climate1.htm> accessed on 11 April 1999.

Appendix E: "Challengers to the Consensus" Update

This is a list of several global warming skeptic groups that are active in the climate change arena today. This list could serve as a potential update for use by UCS in their materials distributed to members of the SSI. We wish to note that much of the information on the older document is still valid, but what we have tried to do here is list some of their most recent activity in the climate change arena. We do not have access to some of the "insider" information that UCS has, so they might want to mix this information with theirs for the actual "Challengers to the Consensus" paper they draft.

Cato Institute (www.cato.org)
This is an officially non-partisan (but has a libertarian philosophy) group based on the principle of "promoting public policy based on individual liberty, limited government, free markets, and peace." Perhaps their most recent action in climate change is a policy analysis paper (# 341) that asserts fossil fuels are the best energy resource we have, and "alternative" forms of power are not appropriate for broad use at this time. The "action" of essay writing is common for this group, and this group is often quoted in the media.

Global Climate Coalition (GCC) (www.globalclimate.org)
This is a group which represents many large companies (a listing of which is not available on its web site), as it is a "voice for business in the climate change debate." It seems to concentrate on the negative economic impacts associated with climate change reform. They encourage "technology transfer" to developing nations, and voluntary (as opposed to mandatory) action by businesses to curb greenhouse gas emissions. It has been cited as saying it tries to highlight the lack of certainty in the global warming science to fuel its arguments.

Greening Earth Society (GES) (www.greeningearthsociety.org)
The Greening Earth Society is a creation of the Western Fuels Association. The GES "believes that humankind's industrial evolution is good, and using fossil fuels to enable our economic activity is as natural as breathing." Their message is "that CO_2 is required for life on earth and that the earth is actually getting greener thanks to increasing CO_2 levels." The GES has produced two videos, *The Greening of Planet Earth* and the sequel released in 1998, *The Greening of Planet Earth Continues.* They also publish information for policymakers through the biweekly *World Climate Report* and the annual *State of the Climate Report.*

Heartland Institute (www.heartland.org)
Founded in Chicago in 1984, the Heartland's Institute mission is "to be its customers' fastest, most convenient, most comprehensive, and most reliable source of public policy information." The Heartland Institute operates PolicyFax, a fax-on-demand information service featuring research from over two hundred think tanks and advocacy groups. They also publish Environment News, which reports on global warming, toxic chemicals, public health and regulatory reform.

The Junk Science Home Page (www.junkscience.com)
This web page is maintained by Steve Milloy, an adjunct scholar at the Cato Institute. While claiming to be a site offering up information to combat junk science, with the motto "All the Junk That's Fit to Debunk", it only recommends skeptic groups for quality information in the climate change debate (including most of those listed here). The web page covers all sorts of issues, and Milloy posts articles (from other sources) that he miraculously claims are junk science. He then states on the page as a disclaimer, "Material presented on this home page constitutes opinion of the author." He has authored two short books, Science Without Sense and Silencing Science, which cover the use of junk science in public health debates.

Oregon Institute of Science and Medicine (OISM) (www.oism.org)
This is a research institution that "was founded ... to conduct basic and applied research in subjects immediately applicable to improvements in human life..." Its biggest climate change dealing is the infamous petition project. This was a petition that was passed around the country attached to an eight page paper co-authored by some members of OISM summarizing climate change research, data, and interpretation to date. The petition was signed by about 19,000 people (OISM claims mostly scientists with advanced degrees), which they say is more then ten times the amount of support shown by any petition passed around by the global warming supporter groups.

Science and Environmental Policy Project (SEPP) (www.sepp.org)
Founded in 1990 by S. Fred Singer, SEPP's stated purpose is to "clarify the diverse problems facing the planet and, where necessary, arrive at effective, cost-conscious solutions." SEPP has been very active in publishing articles, press releases and letters to the editor in major newspapers which discredit the issues of global warming, ozone depletion and acid rain.

Since 1995 SEPP has been working to discredit the 1995 IPCC report. SEPP's director Fred Singer attended the IPCC meeting in November 1995 and the following IPCC plenary in Rome in December 1995. He wrote a review of the IPCC report which indicated that the IPCC Policymakers Summary overstated the case for global warming and did not accurately reflect the tone of the main body of the IPCC report. This review appeared in the February 2, 1996 issue of *Science*.

SEPP's Chairman of the Board, Fredrick Seitz, wrote an editorial in the June 12, 1996 edition of the *Wall Street Journal* which alleged that the significant changes and deletions were made to Chapter 8 of the 1995 IPCC report, by the IPCC editors, after the draft report had been approved by the government delegations.

Bibliography

Articles:

"Throwing cold water on a hot debate." *Electrical World*, March 1, 1991, v. 205, n. 3, p. 9.

Bolin, B. "No Deception in Global Warming Report." *The Wall Street Journal*. June 25, 1996.

Gerstenzang, J. "Oil Executive Breaks Ranks." *Los Angeles Times*, May 21, 1997.

Jacoby, J. "Scientists don't agree on global warming." *The Boston Globe*, November 5, 1998.

Kerr, R.A. "Among Global Thermometers, Warming Still Wins Out." *Science*, September 25, 1998, v. 281, n. 5385, p. 1948.

Rodgers, K. "Multiple Meanings of Alar after the Scare: Implications for Closure" *Science Technology and Human Values*, Spring 1996, v.21, n.2

Rosen, J. "Much Ado About Alar." *Issues in Science and Technology,* Fall 1990, v.7, n.3

Schneider, S.H. "Climate reversal." *Nature*, May 30, 1996, v. 381, n. 6581, p. 384.

Seitz, F. "A Major Deception on 'Global Warming'." *The Wall Street Journal*, June 12, 1996.

Shane, S. "Group takes aim at media's dubious statistics." *The Boston Globe*, November 15, 1998.

Stevens, W.K. "Industries Revisit Global Warming." *The New York Times*, August 5, 1997.

Westbrook, G. "After Kyoto, Science Still Probes Global Warming Causes." *Oil & Gas Journal*, January 19, 1998, v. 96, n. 3, p. 40.

Books:

Abrahamson, D., ed. The Challenge of Global Warming. Island Press, Washington D.C., 1989.

Benarde, M. Global Warning... Global Warming. John Wiley & Sons, Inc., New York, 1992.

Berg, Bruce L. Qualitative Research Methods for the Social Sciences (3rd ed.). Allyn and Bacon, Needham Heights, Massachusetts, 1998.

Gelbspan, R. The Heat is On. Perseus Books, Reading, Massachusetts, 1998.

Kuhn, T.S. The Structure of Scientific Revolutions. The University of Chicago Press, Chicago, 1970.

Limbaugh, R. See, I Told You So. Pocket Books, New York, 1993.

Limbaugh, R. The Way Things Ought To Be. Pocket Books, New York, 1993.

Oppenheimer, M. & Boyle, R.H. Dead Heat: The Race Against the Greenhouse Effect. Basic Books, Inc., New York, 1990.

Ornstein, N.J. & Elder, S. Interest Groups, Lobbying and Policymaking. Congressional Quarterly Press, Washington, D.C., 1978.

Parsons, M. Global Warming: The Truth Behind the Myth. Plenum Press, New York, 1995.

Peixoto, J.P. & Oort, A.H. Physics of Climate. American Institute of Physics, New York, 1992.

Marshall, Catherine and Rossman, Gretchen B. Designing Qualitative Research (2nd ed.). Sage Publications, Inc., Thousand Oaks, California, 1995.

Schneider, S.H. The Genesis Strategy. Plenum Press, New York, 1976.

Schneider, S.H. Global Warming: Are We Entering the Greenhouse Century?. Sierra Club Books, San Francisco, 1989.

Zimmerman, M. Science, Nonscience, and Nonsense. The Johns Hopkins University Press, Baltimore, 1995.