

**PROMOTING
ENVIRONMENTAL STEWARDSHIP
THROUGH EXHIBITIONS:

THE CHALLENGES OF REPRESENTING
GLOBAL WARMING IN SCIENCE MUSEUMS**

by

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TABLE OF CONTENTS

I. INTRODUCTION	4
Research Questions	6
Objectives.....	7
Methodology and Limitations	7
Product Description.....	9
Glossary	11
II. BACKGROUND.....	12
Introduction.....	12
The Dynamics of Climate Change	12
Science Museums, Environmental Education and Advocacy.....	18
Maximizing Visitor Understanding of the Message: Educational Theory and Visitor Research.....	23
Advocacy in Science Museums: The Challenges in Taking an Explicit Ideological Stance.....	29
III. FINDINGS AND CONCLUSIONS	33
Visitor Surveys.....	33
Literature Review Findings.....	35
Interview Findings	37
IV. RECOMMENDATIONS.....	51
V. BIBLIOGRAPHY	58
VI. APPENDICES	62
Appendix A: Visitor Survey Form.....	63
Appendix B: Survey Results	65
Appendix C: Interviewee Contact Information.....	67

I. INTRODUCTION

This master's project examines how medium to large science museums in the United States and Canada are creating socially responsible programming on timely issues specific to environmental degradation, using the subject of climate change (or global warming) as a case study, since it is currently a major scientific and social dilemma. The paper will demonstrate that, due to the pressing nature of global warming, there is a growing need for such institutions to not only present material on the subject, but to act as advocates for corrective action. My project brings to light the creative ways in which these challenges are being addressed by science museums. Partnering between museums and with major environmental organizations is examined as an effective way to bring climate change information to the public, and inspire and equip that public to make a difference.

This study describes, in part, the various aspects of climate change, an environmental topic which has been debated in various arenas, including among scientists themselves, for at least 150 years. However, the controversial nature of this topic has diminished significantly in the scientific community in the last ten to fifteen years with the rapid accumulation of data indicating that the Earth's average temperature is increasing. Moreover, that data has slowly but inexorably pointed to human activities as the main reason (chiefly, deforestation and the burning of fossil fuels), causing a progressive buildup in the atmosphere of greenhouse gases, altering climatic systems worldwide.

Despite the scientific consensus on global warming, the issue is still controversial and confusing for the general public, as the U. S. government and the mainstream media have reported on the problem in such a way as to confuse the general populace about the subject. With only superficial knowledge and unfounded ideas about climate change, U.S. citizens are not in a position to take the steps necessary to stem its progression. However, their involvement is vitally important as they--we--are, after all, active, though often unwitting, contributors to the problem. With often inadequate and misconstrued information coming from the mainstream media, where can the American populace turn for a more accurate account? It seems clear that as long-trusted, authoritative institutions devoted to informal learning and environmental education, science museums are in a unique position to help the public move past the rhetoric to the truth of the matter. But are they equipped to do this? Do they have quick access to the facts, or the internal resources to mount informative programming? Does educational staff have sufficient familiarity with the topic to elucidate its difficult and abstract science to lay visitors so they gain a clear sense of its societal implications? The answers to these questions vary from museum to museum, and are imbedded in their history, their missions, and their educational focus.

Modern science centers have their roots in nineteenth century world fairs and expositions extolling the virtues of the inventions of the Industrial Revolution. These institutions were thus established with their allegiance to industrial and technological progress. They continued to evolve in synchronization with technological industries through the mid 1900s, and functioned mainly as showcases for these new creations.¹ By the 1970s, there was a growing societal recognition of environmental pollution caused by these new technologies. This, coupled with the "space race" and social reforms of that era, brought about new ideas on public education, prompting science centers to rethink their role as solely being exhibitors of scientific objects and facts. More specifically, natural history museums, zoos and aquariums moved away from simply displaying specimens of nature, devoid of their original context, and began informing the public on broader ecological issues. Science museum educators hoped that through this process of learning about the natural world and humanity's impact on it, the populace would become better environmental stewards. In

¹ George E. Hein, *Learning in the Museum* (London and New York: Routledge, 1998), 4.

1970, James A. Oliver, chair of American Association of Museums' ad hoc Environment Committee, believed that the way to reverse environmental destruction was to educate the public about the problem. He saw museums as well equipped for that task.² Modern science centers (including botanical gardens and space and science centers) continue this strong focus on education.

Museum professionals are currently showing interest in the field's self-described responsibility to educate the public on contemporary issues in a timely way. Historically, the museum community has felt that it must share timeless truths and present well-researched facts from its knowledge and authority-based platform. For the past two to three decades, however, this assertion of authority has been questioned, both from within and without the institutions. The inclusion of community voices, and notion of public accountability on current issues, have been accepted as necessary aspects of museum outreach and broad-based education.³ Even when such incorporation of outside voices is at cross-purposes with a museum's efforts, it is usually understood by staff that such tensions ultimately bring balance to a museum's offerings. This dynamic is seen as a reflection of the museum's engagement with the community. Nevertheless, responsiveness to contemporary events and issues has not been embraced to its fullest extent by museums.

What does it mean for a museum to be timely in its public offerings? In a world of increasingly rapid access to information of all kinds, museums may feel it necessary to keep pace through the types of information they provide. At the same time, there is a public need for the meaningful reflection and contemplation that museums can offer. Speed must be tempered with reliability of material and integrated commentary. While museums have not traditionally been geared to respond rapidly to emerging issues (e.g., climate change) or disasters (such as the 9/11 event), some have found a balance between covering a subject quickly and providing a thoughtful context. Examples in the Background section of this paper highlight the efforts of three science museums to exhibit current events and issues. These stories reveal that museum staff felt an ethical responsibility to the public to be contemporary in their programming. A similar effort can be found at the Museum of Science in Boston, through its initiative, the Current Science and Technology Forum. This program was developed in early 2004 to help visitors understand contemporary science and technology through an examination of successes, drawbacks and implications of those disciplines in their own lives and in society. As the program matured, it was merged with other live programs to bring the idea of currency to the rest of the museum.⁴ In April 2005, at the University of Victoria in British Columbia, museum professionals met to address timeliness in order to gain a better understanding of its place in the modern museum. To position the topic's importance, the group noted key concepts pertinent to engaging with the issue, including "The opportunity of a museum is to respond to current life issues. . .," ". . .the obligation of museums is to be responsive, relevant and engaged with the community."⁵ It was agreed that there are a multitude of challenges inherent to exhibiting contemporary issues--e.g., dealing with controversy, involving appropriate external voices, and offering accurate information--all the while ensuring that presentations are accessible, palatable, and engaging for a varied audience. The group also noted the problem of disaffected stakeholders who might accuse the museum of taking sides.⁶ In addressing this, one meeting participant opined, "I don't enjoy being attacked, but it's a whole lot better than being irrelevant."

This project investigates how science museums are stepping up to the task of presenting current and contentious issues, particularly climate change. Some science museums may avoid engaging

2 Adrienne McGraw, "Acting Locally: Community Museums and Grassroots Environmental Organizations In Partnership," master's project, John F. Kennedy University, 27 August, 2001, 55.

3 Joy Davis, et al., "Timeliness: A Discussion for Museums," *Curator* 46, no. 4 (October 2003), 353.

4 *Ibid.*, 357.

5 *Ibid.*, 355.

6 *Ibid.*, 360.

visitors with such a real-world problem, while others may want to better educate the public on global warming but are not quite sure how to proceed. They may have disseminated pertinent information in some form, such as through websites, but are looking for ways to expand their palette of delivery modes. There are also potential hurdles in presenting the climate change message to the public. One challenge is covering the material in such a way that visitors will be motivated to work on solutions, rather than feeling overwhelmed or disempowered by the information and ignoring it. Another difficulty relates directly to the United States being a major market for the world's materials and goods, including oil. Representing global warming and its solutions to a population of committed consumers requires diplomacy and a balanced approach.

This project examines the innovative methods (i.e., especially successful at surmounting the above challenges) used by science centers to interpret climate change, and illustrates their willingness to share their findings and methodologies with sister institutions. Some of these methods include the ample use of visitor evaluations to determine visitor concepts and needs--before, during and after exhibit installation, re-evaluation of the mission statement, and the building of collaborations with similar institutions and/or environmental organizations which are actively dealing with global warming issues.

Science centers reach millions of people each year through exhibits, on-site and outreach programs, floor demonstration, and websites. This paper particularly describes exhibition techniques which the reviewed institutions have found to be successful in imparting motivational conservation messages to their visitors. Due to global warming's broad implications (social, economic, environmental), science centers have a rich mix of facts from which to build creative and persuasive presentations. Additionally, many of the larger institutions house research departments with scientists knowledgeable about climate change who can act as exhibit/program consultants. Most importantly, as in the past, science centers continue to represent scientific findings and technological changes occurring in the world. Therefore, it is their responsibility to provide material which is both timely and relevant to society.

RESEARCH QUESTIONS

I have identified six research questions for this project which have formed the basis for my research and analysis.

1. Are science museums in the United States creating environmental programming which manifests their responsibility to educate the public on socially significant and timely issues?
2. What role does advocacy play in the creation of socially responsible environmental exhibitions? For the purposes of this study, advocacy is defined as the endorsement of a particular action or concept (see Glossary).
3. Do science museums believe they have a duty to develop an awareness in their visitors of the threats posed by climate change and a responsiveness to the problem?
4. What factors may be hindering such museums from creating exhibitions that call for advocacy on the institution's part?
5. Do collaborations between science centers, and with environmental organizations, offer these museums more creative and persuasive ways to present climate change and empower visitors to take remedial action?

6. What do visitor evaluations reveal about public attitudes toward museum advocacy when contentious issues, such as climate change, are at stake?

OBJECTIVES

In conjunctions with the above research goals, I have identified six objectives for this project.

1. Establish science museums' positions on their educational role vis-à-vis climate change.
2. Investigate how climate change has played out in museum discourse and representation, as well as in the popular media and government.
3. Discover what methods science museums have used to manage the challenges of presenting controversial topics, including climate change.
4. Investigate past and present collaborative efforts between science museums and with environmental advocacy organizations.
5. Research the process of visitor evaluation and its effectiveness in promoting visitor uptake of conservation messages and embrace of an activist stance by the museum.
6. Propose ways that science centers can create successful advocacy-oriented exhibitions on climate change.

METHODOLOGY AND LIMITATIONS

For this paper I investigated past and current partnerships and collaborations between science museums and with environmental advocacy organizations to bring climate change information to museum visitors. I reviewed literature on climate change and attended several lectures and seminars on the subject. To gain an understanding of the public's knowledge about climate change, I conducted four visitor surveys at science museums within California. These various methodologies have given me a broad range of information, opinions and insights with which to inform my analysis.

Literature review

I consulted books, scientific journals, formal and informal papers, as well as mainstream periodicals, covering the subject of climate change to understand the extent of social/environmental impacts due to alterations in weather patterns. I did not go back any further than 1990 in this investigative phase, as scientific findings about climate change have progressed significantly since that time due to advances in research methods and technology. The material covered findings on prehistoric and historic alterations in climate, including impacts on humans and the natural world, to provide a backdrop from which to compare the climatic shifts currently happening.

To make a case that science museums should be presenting climate change to the public, I chose authors from the scientific field who are reliable and respected. I tended to avoid information coming from the internet, unless I knew the source, as I have seen so-called "facts" that are inflammatory, incorrect, and worse still, written to mislead the reader. There is also information in popular literature written by special interest groups which uses correct scientific evidence on the subject, but presents it selectively to bolster particular agendas. I have needed to read selectively to fully understand the intent.

I conducted a review of writings from the museum profession to determine the role of science museums in educating the public on environmental topics, and the function of visitor studies in helping museums create exhibits that will inform their audiences and inspire them to action. I additionally studied reports generated by science museum collaboratives, delineating the various methods they are using to bring climate change information to their members.

Interviews

I interviewed ten educational staff and exhibit developers from science-based museums which have exhibited, or will exhibit, climate change material to determine what role they believe science museums have in bringing this information to the public. I questioned them about their institution's views on using advocacy to motivate environmentally responsible behavior in visitors. I also spoke with eight environmental organization staff members, including climate change research scientists, to ascertain their activities relative to global warming issues. I interviewed both groups as to whether they have worked together to present environmental/climate change material within the museum setting. I also consulted project leaders of four science museum collaboratives. Three of these collaboratives consist of science museums on the east coast which were formed, in whole or in part, to educate their visitors about climate change impacts in that area. The fourth group is made up of approximately 50 science museums and other organizations partnering under NASA's new umbrella project Earth Explorers Institute. This project was created to bring NASA research data (including climate change information) to the public through science museum programming. By this inquiry, I wanted to understand how such alliances have made possible, or enhanced, each museum's acquisition of climate change information and persuasive methods of presentation.

All interviews were conducted by phone and e-mail, as opposed to in person, since none of the contacts were local. Most of the phone conversations were limited by the interviewees' busy schedules. E-mail interviews were similarly restrained, with answers given without embellishment, or my being able to spontaneously ask further questions based on responses. Of course, in both these interview modes, there was no visual component, with the attendant important body language, which often makes for a more open exchange. However, these interviews usually afforded insights and opinions more personal than would be the case with only using a written questionnaire. In several instances, I was given leads to other individuals engaged in work pertinent to my topic. Phone conversations especially gave me the closest connection to interviewees, most of whom were open to subsequent interviews, and some of whom volunteered to send me additional information to supplement my research.

I confined my research to medium to large science-based museums in the United States and Canada (those science centers with an annual budget of \$1 million or more), even though I wanted to have a sense of how their foreign counterparts are handling global warming. But attending to such institutions was tedious and took valuable time away from other research tasks. Language barriers also hindered the gathering of information. I additionally restricted my focus in this project to science museums. Other museum types, such as art, history, or children's museums, most probably would have very different goals in presenting climate change to their publics, as it is a broad topic and can be approached from a variety of viewpoints. Finally, while my research has covered several kinds of science museums, it does not look at the smaller, more locally-focused museums. Nor does it investigate activities by local, grassroots conservation groups, even though their concerns and processes around these subjects are, no doubt, similar to those of the larger ones.

There was an additional limitation in my reporting on the various museum exhibitions highlighted in the Background portion of this paper. I was not able to visit the majority of these displays. Thus, my reports concerning them have been taken primarily from written accounts, thus I have no way of

adding my input to them. However, in some instances I was able to interview staff involved in the creation of several of the exhibitions. These interviews were also done by e-mail and telephone, the latter affording me more opportunity to flesh out written accounts and information gathered through e-mail exchanges.

Visitor Surveys

To gain an understanding of the public's perception of climate change, whether interviewees had seen information on the subject in science museums, and to compare my findings with other surveys and polls, I conducted visitor surveys at four science-based museums located in the San Francisco Bay Area and Monterey, California. I interviewed a total of 70 adult visitors to gain a basic understanding of their comprehension of climate change and what they believe the role of science museums should be in presenting the subject. I would have liked to carry out further surveys, but was constrained by lack of time. More survey responses would have given a broader base from which to extrapolate findings to the general science museum audience, particularly within California. However, the results I obtained were suggestive of the knowledge and beliefs about climate change held by the adult science museum audience throughout the country. The results are also colored by the fact that, generally speaking, the coastal regions of California are ideologically left leaning.

The survey instrument consisted of one page and solicited visitors' familiarity with the subject of global warming. It inquired as to whether they felt science museums should address the subject, how interested they would be in seeing such material, and their preferences as to the form of museum presentation, e.g., exhibits, lectures, etc. My interviews were conducted in February and March, 2005 at four science museums: California Academy of Sciences (San Francisco), Chabot Space & Science Center (Oakland), Lindsay Wildlife Museum (Walnut Creek), and Monterey Bay Aquarium (Monterey). Not surprisingly perhaps, the responses I received varied in content due to the museum setting and the reasons people were there. For instance, the Monterey Bay Aquarium appeals highly to tourists who may not be particularly disposed to answering questions on a serious topic. Perhaps for that reason, I had more interview refusals and hurried responses at that institution than at the other three locations.

There is also the possibility that respondents answered my questions the way they believed they "should," perhaps saying what they thought I wanted to hear. Or they may have tried to appear more informed than they actually were. In fact, several male interviewees did appear to be doing just that, i.e., responding in a "swaggering" manner, while actually being rather uninformed about the topic. On the other hand, some people were timid with their replies, stating they weren't sure if they had the "correct" answers even though I had assured them that being right or wrong was not important.

PRODUCT DESCRIPTION

My research for this paper disclosed that science museums vary in their ability to access information on climate change exhibition materials, and may not know the best ways to utilize such information due to their relative lack of internal resources. For the culmination of this master's project, I therefore proposed a panel session for the 2006 annual meeting of the Western Museums Association in Boise, Idaho, which will help science museums understand the why's and how's of creating exhibitions on climate change. The session is primarily targeted to curators and exhibit developers, although it may also be of interest to educators/programmers, since museum educators often participate in exhibit development, and museum programs are frequently related to exhibition

topics. The three panel members will represent the New England Aquarium (NEA), the California Academy of Sciences (CAS), and the New England Science Center Collaborative (NESCC), all of whom have designed exhibitions on global warming and believe that the public should be informed about the climate change dilemma. Session participants will learn the various ways that climate change has been exhibited in these institutions, which vary in floor space and staff size.

Panelist information will demonstrate what can be done to educate the public on climate change, and will inform and inspire participants to do the same. Speakers will also discuss their ideas about the use of advocacy to motivate conservation-minded behaviors in museum visitors. These speakers and their institutions vary in their stance on this topic, from full endorsement espoused by NEA and NESCC, to the varying stance of CAS. The NESCC representative will also discuss the pros and cons of museum partnerships, and will introduce two similar collaboratives in Connecticut and North Carolina, which are loosely patterned after NESCC. NESCC is supporting these other alliances by sharing ideas, materials and training based on its six years of experience with the collaborative process. Throughout this session, speakers will provide visual representations of climate change exhibits from their institutions, and discuss programs related to them, such as kits, outreach activities, radio shows, and websites.

I will act as moderator, introducing the session by sharing some of my findings from this paper. That will include a variety of perspectives from the museum field on dealing with controversial environmental topics, why it is important for science museums to offer climate change information and remedies to their visitors, and the importance of using educational theories and conducting visitor surveys to create successful exhibitions. Combining selected findings from this paper with the practical experience of the panelists will give session participants models that make sense for their institutions. The session will end with a question and answer period, and participants will be provided with additional resources to take with them, including material from each panelist, a book/article reference list and helpful climate change and museum websites. All museums are unique, as are their locales, so not all will benefit from one formula for the creation of a global warming exhibit. Thus, this panel session provides museums with an opportunity to customize a climate change display based on their funding, space, staff capacity and regional community needs.

GLOSSARY

The following terms appear frequently in this project. To help clarify their use, definitions are provided below.

1. Advocacy: In its common usage, this term is usually defined as political or social activism, such as attempting to influence legislation or campaigning for a particular cause. However, for this study it is used to mean the endorsement of a particular action or concept.
2. Carbon Dioxide (CO₂): A colorless, odorless gas composed of one atom of carbon and two of oxygen. One of several important greenhouse gases.
3. Climate Change: The scientific term for global warming (see below), which is more descriptive of the phenomenon. While a general warming of the planet is the current trend, not all locations on the planet will necessarily become warmer as climate change progresses. Depending on a host of factors, some could actually become colder.
4. Collaboration: An interactive relationship with a long-term focus between two or more organizations created by a combining of assets, mission and commitment. Collaborations bring the resources of previously separate entities into a new structure with commitment to a common purpose.
5. Fossil Fuels: Fuels (i.e., coal, natural gas and petroleum) that were formed from carbon-based materials millions of years ago. These substances are remains of organic matter that escaped the normal decay processes, and their carbon molecules became trapped, fossilized and compressed.
6. Global Warming: The popular term for global climatological changes taking place due to human-induced, excessive release of so-called greenhouse gases into the atmosphere.
7. Greenhouse Effect: A warming effect that occurs in Earth's atmosphere as carbon dioxide and other gases absorb heat energy from Earth and emit it back to the planet.
8. Greenhouse Gas: An atmospheric gas that absorbs infrared energy from the Earth's surface and emits it back toward Earth. Includes carbon dioxide, methane, water vapor, and since the Industrial Revolution, certain smog-producing particulates from the combustion of fossil fuels.
9. Methane (CH₄): A colorless, odorless, flammable gas composed of one atom of carbon and four of hydrogen. One of several important greenhouse gases, and much stronger in its greenhouse effect than carbon dioxide. Major avenues of production include marshes, swamps, rice paddies and the digestive process of ruminants (hoofed mammals that chew the cud, such as cattle).
10. Partnership: An interactive relationship between two or more organizations that may or may not be a long-range endeavor.⁷

⁷ David Chesebrough, "Museum Partnerships: Insights From the Literature and Research," *Museum News* 77, no. 6, (November/December 1998): 50-53, as found in Victoria Deardorff, "Seeking Sustainability: Collaborations Between Science Museums and Community-Based Organizations, master's project, John F. Kennedy University, 25 August, 2003, 26.

II. BACKGROUND

INTRODUCTION

Science museums have always displayed the natural world in some form. Early attempts were meant to entertain the public with displays of exotic or unusual species, but conveyed little of the complexity or life histories of the items exhibited. In recent decades this depiction of nature has shifted to include complex ecological concepts and current environmental problems. This type of programming has become standard fare in the majority of science centers. However, these institutions are being increasingly called upon by museum organizations and prominent professionals in the field to adopt a more activist stance, and offer steps which visitors can take to offset environmental degradation. This appeal for advocacy is not new—it has surfaced sporadically since the 1970s, when knowledge of environmental deterioration began to emerge. Science museums were seen as an avenue to educate their visitors, who could take steps to ameliorate the growing dilemma. But the call for museum advocacy has seen limited acceptance over the years. However, the growing problem of climate change is placing a demand on science centers to inform the public about it and, additionally, provide them with information to remedy the causes.

For some museums, this shift from being a place of presentation of facts, to one of actively working to bring about a change in visitor behavior, is a struggle. Museum professionals must often deal with expectations and conventions which call for their objectivity or neutrality—the latter being a much beloved value of science and, by extension, science museums. On the other hand, they must increasingly contend with demands for community betterment and relevance in a changing world. Scientists agree that global warming is one of the five greatest crises facing the planet today. The topic has generated hundred of articles and symposia, especially in the last five years. Additionally, it has spawned political, social and economic disputes, as well as misrepresentations by the media and government—all of which confuse the issue for this country's citizens, who often lack the scientific understanding to clear away the rhetoric. This paper explores what science museums can do, and are doing, to inform the general public about climate change and inspire them to action. The following subsections cover the history and current status of climate change and the general populace's understanding of it, trace the growth of environmental education in science museums, and provide a picture of the various ways that some science centers are representing climate change.

THE DYNAMICS OF CLIMATE CHANGE

A Warming Earth

Weather, temperature, climate, the elements, local conditions—these all refer to regional climatic variances. But the term *climate change*, popularly known as global warming, refers to a fluctuation in the average temperature over the entire earth within a specific time frame, such as a shift from a cold glacial to a warmer interglacial period. Current evidence of a warming earth has spawned debate over how much is caused by humans and how much is occurring naturally. While our planet has seen many climate fluctuations over its approximate 4.5-billion-year history, there is presently enough data for scientists to state, with a high degree of certainty, that the average global rise in temperature seen in the last 150 years is human induced. An understanding of their research and findings is essential to a discussion of the topic. What follows is a brief summary of the vast resources that exist on this subject, which is consistent with the consensus view held by the scientific establishment.

Scientific Definition of Climate Change

The atmosphere is made up of a thin layer of gases, with nitrogen and oxygen constituting more than 99 percent. The other one percent consists of several gases, a few of which are pivotal in global temperature control--carbon dioxide, water vapor and methane. When sunlight strikes the planet's surface it is changed to heat, much of which is reflected back toward space as infrared radiation. While atmospheric gases are largely transparent to incoming light, this is not true for infrared. Some of this reflective heat is absorbed by molecules of carbon dioxide (CO₂--which constitutes less than 0.1 percent of the air), as well as water vapor (clouds) and methane (CH₄), reflecting it downward. These various absorptive molecules are known as greenhouse gases, and the subsequent warming of the planet is called the greenhouse effect. While these gases exist in very small amounts, they have a powerful impact--without them the global median temperature would be about 0° F.⁸

Prehistoric Climate Change

Since the waning of the last glacial period about 10,000 years ago, human societies have evolved with incoming sunlight and outgoing infrared closely balanced. However, cool/warm cycles have been the norm for several million years. At the height of the last major glaciation, 20,000 years ago, mile-high ice sheets covered much of the northern hemisphere, locking up enough ocean water to drop sea levels by over 100 meters relative to the present. Interestingly, global average temperatures were only 5 to 7°C cooler than they are currently.⁹ From this fact alone, it can be seen that even small average temperature shifts can lead to dramatic climate changes. There is another factor to note about this process: natural, sustained rates of global temperature change through warming/cooling trends proceed at about 1°C per millennium.¹⁰ If the present rate of human-induced release of carbon dioxide and methane--ten times the natural pace--continues unabated, temperatures are expected to increase by 1-5°C within the present century.¹¹

Historic Climate Change: A Human-Induced Dilemma

The planet's past 10,000-year climatic stability has made possible increasingly sophisticated agricultural systems, permanent human settlements, and most recently, technologies which have afforded an unprecedented standard of living for much of the developed world.¹² Humanity's current high-tech lifestyle has, of course, a price we are all familiar with--a growing human population competing for resources from degraded and polluted ecosystems. Where did this problem begin? The answer is Europe. With advances in medicine, industry, sanitation and the end of the great plagues, between 1750 and 1850 Europe's human population doubled. When Europeans colonized North America, their rapid expansion across the continent was fueled by wood.¹³ Clear cutting and burning added about half a billion tons of carbon to the atmosphere each year. The slash and burn activity, which occurred in this country's early years, was played out all across the planet,

8 Laurence Pringle, *Global Warming: The Threat of Earth's Changing Climate* (New York: SeaStar Books, 2001), 10-11.

9 Stephen H. Schneider, *Laboratory Earth: The Planetary Gamble We Can't Afford to Lose* (New York: BasicBooks, 1997), 45.

10 Ibid., 48-50.

11 Tim Appenzeller and Dennis R. Dimick, "Signs From Earth," *National Geographic*, September 2004, 9.

12 Richard E. Leakey, *The Making of Mankind* (New York: The Rainbird Publishing Group Limited, 1981), 200-202. Research by Leakey and other anthropologists suggests that global climate change may have been one of the drivers of the Agricultural Revolution. As ice sheets shrank worldwide about 10,000 years ago, a warmer, moister environment ensued. People living in the Mediterranean, China and Mesoamerica slowly changed from a primarily hunting/gathering lifestyle to agriculture. See also Richard B. Alley, "Abrupt Climate Change," *Scientific American* 201, no. 5 (November 2004), 64-65.

13 Jonathan Weiner, *The Next One Hundred Years* (New York: Bantam Books, 1990), 53-54. According to the botanist John T. Curtis, before this intrusion, the northern portion of the American continent was "an essentially continuous forest cover." But during the period of colonization, in New York, Michigan, Wisconsin and Minnesota alone 90 percent of the forest cover was felled. Weiner, 53-54.

and continues to this day, especially in the tropics. But by the mid-1800s another force, the Industrial Revolution, was contributing even more carbon to the air due to the burning of coal, oil and natural gas, the so-called fossil fuels.¹⁴

The nineteenth century was not only a time of expansion, it was a time of invention. The first practical internal combustion engine and machine-driven refrigerator, the harnessing of electricity, to name just a few, were made possible by the burning of carbon-containing fuels. However, there was an immediate after effect. Along with the destruction of forests, these fuels released many more tons of carbon dioxide per year into the atmosphere. This dynamic was well known by scientists of the day, as the existence of this gas, and others, was grasped as early as the 1600s. The dynamics of the greenhouse effect and the role of carbon dioxide as a powerful greenhouse gas were both understood by the mid 1800s.¹⁵ From that time into the middle of the next century various scientists—such as Swedish chemist Svante Arrhenius in the late 1800s, and British engineer George Callendar in the early 1900s—-noted the amount of carbon going up in smoke, and voiced their concerns as to its ramifications. But business was booming. They were ignored by government and industry alike.¹⁶

The Current Situation

In 1995, a team of researchers at Lawrence Livermore National Laboratory in Berkeley, California concluded that the current pattern of atmospheric heating matched projections by computer models of “greenhouse gas,” plus sulfate warming, and was different than what would be produced naturally. In that same year NOAA’s National Climatic Data Center verified an increase of extreme weather events in the United States. They concluded, by a probability of 90 percent, that growing weather extremes were due to a rise in greenhouse gases, and that this intensification was not consistent with natural cycles. Instead, these patterns looked like computer-generated projections for emissions from fossil fuel burning.

In 2001, the United Nations’ Intergovernmental Panel on Climate Change issued a report that the climate was changing more rapidly than had been anticipated just six years earlier. This report, produced by scientists from 100 countries, predicted that extreme weather events would intensify worldwide due to the burning of coal and oil. It further disclosed, “Earth’s average temperature could rise by as much as 10.4 degrees [Fahrenheit] over the next 100 years—the most rapid change in 10 millennia.” The report concluded that “economic losses from natural catastrophes increased from about \$4 billion a year in the 1950s to \$40 billion in 1999.” In 2003, the UN disclosed that monetary losses from climate events for that year had risen to \$60 billion.¹⁷

The above statistics are powerful by themselves, but they correspond to equally impressive events occurring in the last five to ten years from the North to the South Pole, from the equator to the highest mountains. In fact, computer models have predicted that global warming-related anomalies would first be seen in these locations. Much of the land and ice cover at both latitudes are being impacted significantly by atmospheric warming.¹⁸ Rising temperatures have caused the melting of glaciers worldwide as well. For instance, Glacier National Park in Montana had 150 glaciers in the

¹⁴ Schneider, 10.

¹⁵ Weiner, 27.

¹⁶ Ibid., 29-30.

¹⁷ Ibid., 5-6.

¹⁸ Appenzeller, 14. While the average global temperature rose 1°F in the 20th century, in Alaska it rose about 5°F in the last 30 years. The annual sea ice breakup off the Alaskan coast is happening nine days earlier than it did 150 years ago, and freezeup ten days later. Since 1978 the area of perennial ice has decreased by 9 percent per decade. Average winter temperatures in the Antarctic have increased almost 9°F over five decades. Early 2002 saw the collapse of a 1,250 square mile section of the Larsen Ice Shelf. Appenzeller, 20.

nineteenth century; currently there are 35. They are thawing so fast that scientists estimate they will be gone in 30 years.¹⁹

Warming and rising waters in the North and South Poles are being matched in the Pacific Ocean. Estimates by various scientists have calculated a rise in ocean levels of one-half to one meter by the end of this century, putting coastal cities at risk from rising waters.²⁰ Elevated ocean temperatures are causing population shifts in marine organisms, with impacts to commercial fish stocks.²¹ Other research predicts cause for concern for the physical and economic safety of this country's citizens. It is expected that global warming will produce more wildfires in the western U.S. Blazes are expected to double along with the doubling of atmospheric carbon dioxide predicted for later in this century, with an earlier start to the fire season.²² Asthma afflicts over 300 million people globally, and is expected to grow to 400 million in 20 years. The American Public Health Association attributes this, in part, to smog and global warming, which are linked to fossil fuel burning industries and car exhaust.²³ Harvard University researcher Christine Rogers noted, "This is a real wake-up call for people who think global warming is only going to be a problem way off in the future or that it has no impact on their lives in a meaningful way."²⁴

Rising temperatures also seriously affect wildlife and plant populations. Flora and fauna in all locales are showing alterations in range, abundance, timing of specific events (such as migration), and behaviors.²⁵ Different species respond at different rates to such disturbances, altering biological community structures.²⁶ A minor temperature elevation can have major repercussions for some species. One well-known example is the precipitous decline of amphibians taking place in highlands around the world, believed to be partly attributable to global warming.²⁷

19 Ross Gelbspan, *Boiling Point*, (New York: Basic Books, 2004), 21-22.

20 Meg Green, "Home of the Brave," *Best's Review*, November 2004, 21. In the U.S., coastal counties account for 17 percent of the land area, but more than half of the nation's population lives there. In the next 15 years, coastal numbers are expected to increase by 27 million people, putting more people at risk from rising waters. Green, 21.

21 Robert R. Twilley, et al., *Confronting Climate Change in the Gulf Coast Region* (Washington, D.C.: Union of Concerned Scientists and Ecological Society of America, 2001), 29. Water temperatures off the southern California coast have increased from 2^E to 3^E F in the last four decades. In that time, warming in the top 600 feet of water led to the collapse of commercial anchovy fishing in the area. Twilley, 29. See also C.D. Harvell, et al., "Emerging Marine Diseases—Climate Links and Anthropogenic Factors," *Science* 285, (3 September 1999): 1505-1510.

22 Paul Tolme, "Will Global Warming Cause More Wildfires?" *National Wildlife Federation* 42, no. 5 (August/September 2004): 14-16.

23 Carl Lowe, "Catch Your Breath," *Energy Times*, October 2004, 24.

24 Rene Ebersole, "Out of Breath," *National Wildlife Federation* 43, no. 3 (April/May 2005): 14.

25 Stephen H. Schneider and Terry L. Root, eds., *Wildlife Responses to Climate Change: North American Case Studies* (Washington, D.C.: Island Press, 2002), 22.

26 Ibid, 95. Ecologists are concerned that predicted climate changes could exacerbate species extinction rates, especially since plants and animals attempting to migrate to more hospitable areas will be hampered by habitat fragmentation, pollution and the introduction of non-native species competing for similar resources. Ibid, 95.

27 J. Alan Pounds and Robert Puschendorf, "Ecology: Clouded Futures," *Nature* 427:107-109, 08 January 2004 [journal on-line] available from <http://www.nature.com/cgi-taf/DynaPage.taf?file=nature/journal/v427/n6970/full/42710.html>; Internet; accessed 13 December 2004.

The Politics of Global Warming

“...there is no convincing evidence that global weather is becoming more extreme.”

– Media release by Global Climate Coalition, an oil industry lobbying group, March 1995.²⁸

“With all of the hysteria, all of the fear, all of the phony science, could it be that man-made global warming is the greatest hoax ever perpetrated on the American people? It sure sounds like it.”

– Senator James Inhofe (R-OK), July 28, 2003²⁹

While these statements are eight years apart, they indicate the ongoing efforts by such organizations and individuals to allay the public’s fears as to the pressing nature of climate change. Despite the overwhelming scientific evidence of the seriousness of the global warming phenomenon, comprehensive, accurate public education about it has been limited. This is due, in part, to the political and economic dimensions of the problem. Research discussed in subsequent sections of this paper discloses that citizens in the United States are concerned about global warming and want to understand more about it. But this is a contentious subject since the major part of the world’s energy comes from fossil fuels--oil, coal and natural gas. Certain officials in the U.S. federal government, the fossil fuel industry, and some economists, assert that any cutback in the use of these fuels will have serious economic ramifications. Other politicians, economists, and those in the “green” energy professions, assert that the upsurge in business from the sale of alternative energies would more than offset a downsizing in fossil fuel-based industries. But, again, the federal government’s current position on this issue is one of denial or avoidance. Reflecting a stance of public deception on the problem, in a November 2002 memo to the Republican Party from a political consultant, a section titled *Winning the Global Warming Debate*, asserted, “Should the public come to believe that the scientific issues are settled, their views about global warming will change accordingly. Therefore you need to continue to make the lack of scientific certainty a primary issue.”³⁰ Administration spokespersons continue to contend that the uncertainties in climate projections are too great to warrant mandatory action to cut fossil fuel emissions. In 2003, the White House altered the Environmental Protection Agency draft, *Report on the Environment*, which upheld other studies asserting that human activities contribute significantly to climate change. So many changes were made to the document that the entire section was ultimately deleted from the version released for public comment. According to EPA researchers, that portion was cut to avoid compromising their credibility by misrepresenting the scientific consensus on the issue.³¹ Very recently, Chief of Staff to the Bush Administration’s environmental policy council, Philip A. Cooney, resigned after it was revealed that he had edited government scientific reports to cast doubt on the link between greenhouse gas emissions and rising temperatures.³²

A lack of fuller reporting on global warming by the mainstream media (i.e., newspapers, television and popular magazines) has also served to obfuscate the issue for the general populace. Unfortunately, these are the sources on which most people rely for information about the world.³³

28 Ross Gelbspan, *The Heat Is On: The Climate Crisis, The Cover-Up, The Prescription*, (New York: Perseus Books, 1997), 38.

29 Gelbspan, *Boiling Point*, 37.

30 Gelbspan, *Boiling Point*, 41.

31 Scientific Integrity in Policy Making, *Distorting and Suppressing Climate Change Research* (accessed 18 June 2005), available from <http://webexhibits.org/bush/5.html>.

32 Andrew C. Revkin, “Ex-Bush Aide Who Edited Climate Reports to Join ExxonMobil,” *New York Times*, 15 June 2005 (accessed 16 June 2005), available from <http://www.nytimes.com/2005/06/15/science/14cnd-climate.html?hp&ex=1118808000&en>.

33 Laura N. Rickard, “More Than Hot Air: The Role of Informal Science Education in Communicating Global Climate Change,” Honors Thesis, Brown University, May 2004, 28. A 2002 poll found that 44

According to Ross Gelbspan, Pulitzer Prize winner and news journalist/editor of over 30 years, the superficial coverage of global warming stems partly from the fact that aggressive career paths at news outlets lie in following politics, not science. For instance, in 1997 when Congress voted not to ratify the Kyoto Protocol, and later in 2001 when this country withdrew from the Kyoto process, the media focused not on climate change itself, but on the resulting diplomatic tensions between the U.S. and other countries.³⁴

While the mainstream media has not addressed global warming in much depth, information on the subject has, at times, been disseminated by certain parties to confuse and mislead. The vast majority of these false assertions are funded by the fossil fuel industries. For example, in late 1995, Robert Balling, a geographer whose work was partially funded by oil and coal interests, authored an editorial piece in *The Wall Street Journal* titled “Keep Cool About Global Warming.” This article cast doubt on reports from the United Nation’s Intergovernmental Panel on Climate Change. Balling stated that Panel summaries were “slanting the underlying message of the . . . document. . . News accounts [using those summaries] misrepresent reality when they use selective information. . . and make claims about increased confidence in the scientific community. . . of potentially catastrophic climate changes.”³⁵

Public Understanding of Climate Change

Since climate change is often misrepresented in the popular media and its causes denied by certain political factions, it should come as little surprise that a significant portion of the general population assigns a relatively low priority to the issue. A 2001 Gallup Environmental Poll revealed that while 61 percent of Americans believed climate change is occurring and its effects would be experienced in their lifetimes, 30 percent of them believed the press to be overestimating the problem, with 36 percent unclear on the issue. Of a list of thirteen environmental concerns presented to the same individuals, global warming ranked 12th, behind drinking water safety and tropical deforestation.³⁶ A more recent survey conducted in 2004, The PIPA/Knowledge Networks Poll, found that three in four Americans believe that global warming is a real problem, but the majority interviewed were divided on whether the issue is truly pressing or can be dealt with gradually through low-cost steps. When respondents were asked how much they had heard about climate change, 14 percent stated “a great deal,” 48 percent had heard “some” about it, and 38 percent said they had heard “not very much” or “nothing at all.” Ongoing surveys have shown that in the last few years public concern about global warming has dropped. The view that climate change is serious and calls for steps to be taken now went from 41 percent in 1998 to 31 percent in 2004.³⁷

Inadequate information about global warming from the news media and the U.S. government has precluded Americans from accurately assessing what should be done about it. Science museums are an ideal, trusted public venue for communicating its importance to a very large audience. The next section illustrates how these institutions have been helping the public grasp such difficult environmental issues for decades.

percent of adults identify television as their primary source of information on the latest developments in science and technology, followed by newspapers and magazines (16 percent). Rickard, 28.

³⁴ Gelbspan, *Boiling Point*, 68-69.

³⁵ Gelbspan, *The Heat Is On*, 34.

³⁶ Rickard, 15.

³⁷ Program on International Policy Attitudes, *Americans on Climate Change* (accessed 15 June 2005), available from <http://www.pipa.org/cgi-bin/search.swish.pl?query=Americans+On+Climate+Change+results=0>.

SCIENCE MUSEUMS, ENVIRONMENTAL EDUCATION AND ADVOCACY

In the United States, nineteenth century world fairs and expositions were the ancestors of the science/technology museums which developed later. The evolution of these centers paralleled major technological developments and scientific knowledge about the world. Their representation of the environment followed this pattern as well. Over time, science museums developed a more complex depiction of nature, as ongoing research and a better informed populace called on museums to give a deeper examination of the natural world.

By the end of the 1970s, with greater media, political and activist attention focused on ecological problems, serious concern about the environment was firmly ensconced in American society.³⁸ In response to the public interest in environmental degradation, science museums expanded their exhibits to address these issues--again keeping pace with scientific insights and societal issues of the time. By the late 1980s, museologists began to inquire as to the role museums could play as activists for environmental issue. A publication coinciding with a 1990 ICOM/UNESCO symposium noted that museums were being asked to assume a less neutral stance on such topics and inspire visitors to become involved in corrective actions.³⁹

Due to the growing sense of responsibility that museum educators felt they had to educate their audiences on conservation issues, during the early 1990s they also began to re-evaluate their mission statements. The Smithsonian's National Museum of Natural History in Washington, D.C. went through this process, with staff questioning whether they needed an end purpose beyond simply presenting information. After evaluating their societal role, they chose to redefine their mission to include a more proactive stance. The new mission read, "The National Museum of Natural History is dedicated to understanding, interpreting, and conserving the integrity and diversity of the natural world so that informed choices can be made about the interdependent future."⁴⁰ Over the last ten years or so, museum professionals have continued to foreground this inquiry as to the role advocacy can play in these institutions.⁴¹ They believe that simply offering the facts on pressing issues is no longer adequate, or in some instances even ethical, given their urgency. The next section presents examples of science museums which have used advocacy in exhibiting very different, but equally controversial, subjects.

Controversy and Advocacy - Three Museum Perspectives

The following accounts illustrate how and why these three science museums, varying in size and content, took an activist stance when they covered the controversial issues of a major oil spill, the AIDS epidemic, and human responsibility for environmental degradation.

1. Darkened Waters: Profile of an Oil Spill

On March 24, 1989, the supertanker *Exxon Valdez* ran aground on Bligh Reef in Alaska's Prince William Sound, spilling 11 million gallons of crude oil into the sea. The oil spread from the Sound into the Gulf of Alaska, eventually contaminating more than 600 miles of coastline. For two years following the spill, area fisheries were disrupted, as well as the economic and social structures of some 17 coastal communities. It was the largest such spill in the United States, and eventually killed hundreds of thousands of birds, mammals, and fish, negatively impacting tourism to the region as

38 Ibid., 42-45.

39 Ibid., 67.

40 Ibid., 68.

41 Hein, 3-7.

well. The Pratt Museum, a natural history museum located in the town of Homer on the Kenai Peninsula, quickly reacted to the disaster. Museum staff and board members felt they had a responsibility to the public to document this event.⁴² An exhibition was put together in eight weeks, with input drawn from local residents, clean-up workers, government officials, the fishing and tourism industries, and environmental organizations. In the early days of the spill, representatives of the oil industry and governmental agencies were not allowed to speak of the incident due to the likelihood of a lawsuit. However, the museum's curator persuaded them to provide input, since the curator felt they should have a chance to tell their sides of the story. Presenting balanced and diverse perspectives of the incident continued throughout the various phases of the exhibition process.⁴³

The exhibit dealt with an emotionally charged topic, and its ethical, legal, social, political, environmental and economic issues. Oil and gas development on the Kenai Peninsula and offshore had taken place for about 30 years before the incident, and the petroleum industry had become powerful. During the controversy over whether to build a pipeline to Valdez and ship oil, the industry had promised that there would never be a spill; but if it did happen, the local populace was assured it would be cleaned up in matter of days. Within three days of the *Exxon Valdez* accident, it was clear that cleanup efforts were failing, and area residents were "shocked and outraged." An initial meeting between the public and oil industry representatives bordered on violent. Oil interests tried to discourage documentation of the spill and subsequent events, and didn't understand why the museum wanted to do an exhibit.⁴⁴ While the museum made every effort to represent all sides of the incident no matter how controversial, from its beginnings *Darkened Waters* was never neutral in tone. The Pratt took the position that oil spills are negative, and that all possible actions should be taken to prevent them from happening. The display made a "strong stand" to encourage wise use and conservation of energy resources. Because the exhibit subject was so wrenching, it became clear to exhibit developers that visitors needed examples of constructive ways to react to it, and to the spill itself. Displays included profiles of people who had engaged in constructive efforts, such as encouraging socially and environmentally sound business practices. A brochure was displayed, giving ways that people could help conserve energy or recycle petroleum products. To further incorporate as many viewpoints as possible, the words of involved individuals were presented on text panels through a series of "points of view," including profiles with photographic portraits. An audio component included statements from the area's Native people. To help local visitors and nonresidents cope with what they saw and learned, the usual visitor comment cards were supplemented with a special book so people could express their feelings.⁴⁵ The museum utilized the help of several local environmental organizations, especially in researching and accessing certain information and data. Each such organization was profiled in the exhibit, creating an atmosphere of trust for their part in the process.⁴⁶

Due to repeated encouragement from visitors, this exhibition eventually toured the United States for 11 years (1991-2002). A condensed version is still on display at the Pratt Museums, which also published a 60-page book about the history, science and technology of the oil industry. The traveling version has found a permanent home in Cordova, Alaska, a community hard hit by the spill. This is the only exhibit in the United States to chronicle an oil spill, and museums staff and visitors alike still feel that the incident should not be forgotten.

42 Pratt Museum, *Darkened Waters: Profile of an Oil Spill*, (accessed 14 June 2005), available from <http://www.prattmuseum.org/index.php?id=16>.

43 Mike O'Meara, *Let the People Speak*, Report on the Exxon Valdez Oil Spill, nd, 2.

44 Mike O'Meara, "Re: Questions for Thesis," E-mail interview with author, 15 June 2005.

45 O'Meara, *Let the People Speak*, 2-4.

46 McGraw, 127.

2. What About AIDS?

The issue of climate change has parallels in another global problem—the AIDS epidemic. Both are basically natural phenomenon, but enhanced (spread) by human activities; they have generated political and societal controversy, as well as misinformation; and when each began to find its way into the mainstream media, there was denial and rejection by the general populace. Additionally, before each became more fully researched, the public did not have enough information available to make enlightened decisions on ways to avoid exposure to the risks. Museums have found that creating exhibits and programs about AIDS has been problematic due to reactive issues imbedded within the subject—drug addiction, sexuality, gay rights, illness and death. But there are museums which have taken on the challenge. The exhibit developers of one exhibit, *What About AIDS?*, circulated by ASTC beginning in 1993, felt that by educating the public they could help prevent the spread of the disease. Not only did they offer the facts on AIDS (its science, methods of transmission, etc.) they included steps that visitors could take to protect themselves from exposure.⁴⁷

What About AIDS? was developed by the Franklin Institute, with six other member museums of the National AIDS Exhibit Consortium.⁴⁸ Although those working on the project were committed to it, they worried that visitors, potential funders, and their own colleagues would react negatively to the idea. As one exhibit developer at the Franklin Institute expressed it, “How would the public view our museum for creating an exhibit about a virus that is passed on by dirty needles and sex?” To alleviate the trepidation of those working at the Institute that the subject of AIDS was too controversial to exhibit successfully, American Red Cross representatives were called in to give classes to everyone in the museum—from guards to public relations staff—on the science of AIDS, public health policies, misconceptions surrounding it, and how to talk to people about the disease. Committees were formed so that all those involved could work together on difficult aspects of the project. When this exhibit was first discussed in the late 1980s, AIDS was beginning to kill many young people. This age group was an important segment of the exhibit’s target audience. The Franklin Institute’s Board of Trustees Education Committee was predominantly Catholic, and members were concerned that teen abstinence would be emphasized in the exhibition. An exhibit developer brought in a brochure titled *101 Ways to Make Love Without Doing It*, a list of fun and romantic activities couples could do, rather than engage in sex. This was well received by the committee, and set up a productive work relationship between the Board and museum staff.⁴⁹

The Public Relations Department insisted on a three-month preview period of the show so that visitors could evaluate the presentation, thus better informing project participants on the public’s reception of the upcoming exhibit. Visitors were asked to fill out evaluation sheets, and local school officials and AIDS organizations, as well as a representative from the local archdiocese, were invited to critique the pending show. Necessary changes were then made before the real exhibit opened. But museum staff realized that the strong feelings generated by the subject made it necessary to create a place where visitors could safely express their views. The most successful of the “talk-backs” explored were index cards for people to write their thoughts and then drop them into a wooden box. The cards were subsequently put into a book for visitors to read. Additionally,

47 Roberta Cooks, “Is There a Way to Make Controversial Exhibits That Work?” In *Transforming Practice*, ed. Joanne S. Hirsch and Lois H. Silverman (Washington, D.C.: Museum Education Roundtable, 2000), 104-105.

48 Marjorie Schwarzer, *AIDS Talk*, Personal Notes and Conversation, 1 July, 2005, 2.

49 Cooks, 106.

an exhibition wall was covered with visitor comments, so people would see that the museum welcomed many different points of view.⁵⁰

The exhibit eventually went on tour and was hosted by more than 40 museums. One of these was the Exploratorium, a science, art and human perception museum in San Francisco. As an original member of the AIDS Exhibit Consortium, Exploratorium staff were strongly motivated to host the exhibition. Doing so involved reassessing the museum's commitment to its community. However, staff realized that the show provided an opportunity to pay tribute to AIDS-related achievements in the Bay Area, and to highlight the museum's commitment to AIDS education. Planning staff for the exhibit encompassed several departments and job functions. A broad community advisory panel was formed, consisting of AIDS service agencies, funding groups, science media, AIDS activists, and others. This panel met frequently and focused on networking, information sharing, staffing/training, and audience development.⁵¹

The AIDS exhibit was located in the center of the museum's exhibition floor, and the design team endeavored to create different spaces within that area, ranging from quiet and contemplative, to more central areas for activities, demonstrations, and interactions. Several existing exhibits dealing with immunology and epidemiology were updated and added to the AIDS material, and several new installations were developed. A Gallery of Honor, AIDS resources material, and the Names Project Quilt panels were included to highlight the Bay Area. An important part of this exhibit also was the opportunity for visitors to express their thoughts and feelings. Several avenues were provided for ways they could respond, including a "remembrance" video, and a prayer flag activity.⁵²

Host institution reports on the success of *What About AIDS?* showed that they all felt it entailed a lot of work, but was worthwhile. It fortified departmental communications at all levels, honing skills in designing later exhibitions. Relationships and partnerships with community organizations, public health groups and local officials begun during the *AIDS* exhibition were renewed and strengthened. The show also provided a way for visitors to deal with related issues in their own lives, and hosting museums reported that public response was overwhelmingly positive. Visitors lauded its role in promoting AIDS awareness and doing so with sensitivity.⁵³

3. The Human Factor

The Royal Saskatchewan Museum is a mid-sized, natural and human-history museum located in Regina, Saskatchewan, Canada. In 2001, it opened a new gallery consisting of a reproduction of unaltered provincial landscapes; text and panels showing the province's connection to distant locations; and a section titled *The Human Factor*—which examines human relationships with the natural environment and within society. The story line is about connections and dependencies that keep the Earth and its systems in balance. This exhibition covers topics such as loss of biodiversity, climate change, human population growth, and the present human-induced extinction event. Blending ecology, economics and psychology, it identifies the industrialized world view as the cause of these problems—i.e., that capitalist-based societies use natural resources unsustainably. To balance these disturbing assertions, the importance of restorative economics, individual choices, and the human connection to nature are also stressed, giving visitors an emotional respite from the unsettling claims of the display.⁵⁴ The issues of climate change and ecological constraints on

50 Ibid., 107.

51 Exploratorium, Unpublished Handout, 1996, 1-2.

52 Ibid., 2-3.

53 Association of Science - Technology Centers, Newsletter, Vol. 23, Vol. 1, January/February 1995, 12, 24-25.

54 G. C. Sutter and D. Worts. In press, "Negotiating a Sustainable Path: Museums and Societal Therapy." R. R. Janes and G. C. Contay, eds., *Looking Reality in the Eye: Museums and Social*

economic growth potentially set the stage for political responses. To avoid negative feedback from the regional government, museum staff informed officials about possible points of contention, were careful not to question governmental policies, and emphasized the extensive research that underpinned the story.

In developing this exhibition, museum staff wanted to ensure that visitors would come away with a clear understanding of the environmental and sociological problems, but also with a desire to help solve them. The exhibit challenges industrialized values--questioning the objectivity of reductionist science and reliance on it to the exclusion of other "ways of knowing." It also addresses the divisive effects of a social focus on independence, aggression, and competition.⁵⁵ Educational staff have realized that visitors could have both positive and negative responses to the material. They could be inspired to reflect on their own values (what staff have hoped would happen), or they could become emotionally defensive, hampering development of new insights. In addressing these concerns, efforts were made to anticipate how visitors might respond to the exhibition by conducting formative visitor surveys, aiming for a tone of optimism throughout the exhibit, and by including features designed to heighten and then relieve levels of anxiety. The latter is done by quickly following distressing information by material intended to provide a sense of comfort. For example, the intrinsic value of nature and human goodness are emphasized; biophilia, sustainability and success stories are covered in detail. Emphasizing the importance of daily choices gives visitors steps they can take to make a difference.

By focusing on the issues in an integrated fashion, topics often remote from the general populace's awareness are personalized. While the exhibit is direct and unapologetic, solutions are not given in a "preachy" manner. But neither does the museum passively dispense information. Rather, it takes a middle road, encouraging visitors--as individuals and community members--to identify their true needs, as opposed to what society might endorse, and reflect on the ramifications of their actions. To determine visitor responses to this show, evaluation efforts ranged from front-end studies to gauge knowledge levels; and a focus group, responding to many of the group's suggestions, including trying to reflect a range of viewpoints—e.g., scientific, religious and aboriginal—about the value of the Earth. Also, heart-rate monitors were installed in certain sections of the exhibit to ascertain emotional reactions. Feedback was solicited from grade-school students who were involved in some aspects of exhibit development. Summative evaluations revealed that visitors felt the overall experience was positive, and that some insights inspired them to make lifestyle changes along the lines suggested in the exhibition.⁵⁶

Although these three exhibitions focused on different subjects for different reasons, several themes emerged as to why they were created, as well as the ways that controversy and advocacy were handled. First, staff at each center believed they had a responsibility to their communities and their publics to create these exhibits. This sense of duty was a major cohesive factor in helping participants work through difficulties in designing the exhibits and coordinating efforts between themselves and outside agencies. Second, these museums were proactive in involving outside voices in the displays. For the Pratt Museum, this meant input from those impacted by the oil spill and well as those responsible for it. The Franklin Institute and Exploratorium also included various community voices to bring a fuller picture of the AIDS epidemic phenomenon to their audiences. The Royal Saskatchewan solicited extraneous viewpoints, and staff members were careful to couch exhibit information in a way acceptable to the museum's funding governmental officials.

Responsibility (Calgary, AB: University of Calgary Press), 6-7.

⁵⁵ *Ibid.*, 7.

⁵⁶ *Ibid.*, 8.

These exhibits all contained emotionally charged material. To gauge visitor understanding and reactions to the subject matter, each institution conducted front-end, formative and/or summative evaluations. Doing this helped the museums tailor information and presentation methods to enhance viewer comprehension and acceptance of the intended messages. Additionally, they offered visitors ways to express their feelings about the issues—e.g., comment cards, “talk-back walls,” and verbal feedback. Finally, none of the exhibitions were neutral in tone or intent. They all presented the facts fully and honestly without being “preachy;” were forthright in noting the causes of the dilemmas; and made certain that visitors were shown how they could help with the problems that were addressed.

MAXIMIZING VISITOR UNDERSTANDING OF THE MESSAGE: EDUCATIONAL THEORY AND VISITOR RESEARCH

Educational Theories

As illustrated by the three exhibitions discussed above, science museums have been successful in communicating not only contentious but complex scientific material to their visitors because they are well-trusted, informal learning environments which are able to present scientific and technological subjects in ways that are understandable to visitors. Helping museums shape and enhance their presentations for a growing and varied audience is a large body of educational theory and museum visitor research. Addressing the theories first, the following concepts speak directly to conservation-related exhibitions.

Exhibit developers at science centers hope that visitors will understand the “take-home” messages in environmental displays. This might not happen, however, as visitors may or may not be familiar with the subject matter, or may be tired of hearing “gloom and doom” stories. Conservation issues can, after all, be distressing, often telling a tale of negative human impacts on a failing natural world. There is a recognized psychologically counterproductive impact from repeatedly hearing distressing information, i.e., people can become immune to responding in a proactive way—in effect, they shut down emotionally, especially when they believe there is nothing they can do about the situation. My literature review of museum education theory supports this finding. For example, learning theorist, John Dewey, noted that some experiences can actually be mis-educative, meaning they have the effect of blocking further learning. Dewey states:

Any experience is mis-educative that has the effect of arresting or distorting the growth of further experience. An experience may. . . engender callousness; it may produce lack of sensitivity and of responsiveness. . . . Each experience may be lively, vivid, and ‘interesting,’ and yet their disconnectedness may artificially generate dispersive, disintegrated, centrifugal habits. The consequence of formation of such habits is inability to control future experiences. They are then taken, either by way of enjoyment or of discontent and revolt, just as they come.⁵⁷

This is important for museum educators to understand, as it highlights the need to structure educational formats in such a way as to avoid possible visitor immunity to the message due to past exposure, or overexposure.

Prior experiences of museum visitors need to be kept in mind for another reason as well. According to certain learning theories, most notably the constructivist model, for optimal information uptake

57 John Dewey, “Experience and Education, New York: Macmillan, 1938, 13-14. Quoted in George E. Hein, *Learning in the Museum*, 2 (New York: Routledge, 1998). See also Peggy Ruth Cole, “Constructivism – Rediscovering the Discovered,” *Curator* 38, no. 4 (1995): 225-227.

the learner must be able to associate an educational situation with what is already known or has been experienced. According to this model, it is almost impossible to learn something without being able to make a past association to it. This is found to be true even for very young children.⁵⁸ Psychological and neuroscience research supports this conclusion as well—learning is rooted in the realities of the physical world, the individual’s personal context. As John Falk and Lynn Dierking have pointed out in their book, *Learning from Museums*, the failure of educators to acknowledge this connection profoundly affects educational practices. They note that children and adults alike are all too often taught concepts within decontextualized physical environments. This impedes their ability to learn the material, and then transfer that information to a new situation.⁵⁹

Visitor understanding and acceptance of conservation messages is also influenced by affective factors, the emotions that a museum and its exhibits can engender. Attention span and subsequent recall of material are enhanced when a subject is found to be stimulating and interesting. Research into this aspect of learning has revealed several components of affect, including curiosity, duty (i.e., to help oneself or others learn) motivations, interests, feelings and attitudes.⁶⁰ In the early 1990s, research was conducted at several science museums to determine how these elements regulate visitor resonance with, and enjoyment and understanding of, museum exhibitions. These inquiries demonstrated the importance of personal connections (with the subject matter) and whole-body, kinesthetic and immersion experiences. Of particular importance when considering environmental displays, this research demonstrated that material which takes into account affective learning often stimulates a renewed appreciation of societal duty, such as adopting conservation measures.⁶¹ Another salient aspect of affective learning is its role in causing the visitor to take a second look at an object or label. Museum education which takes affect into account builds into the presentation a personal reason for visitors to invest further attention in a subject,⁶² helping to answer the long-standing visitor question, “Why should I care about this material?” In *Lessons Without Limit*, John Falk and Lynn Dierking speak of the biological dimensions of affect, noting the evolutionary history of the “feedback loops that exist [within the brain] between emotional states and learning processes.” They hold that the stronger the emotional “value” of an experience, the more likely the sensory information will become a part of memory.⁶³

Blending Theory with Visitor Research

Science centers increase their chances of designing effective exhibitions by paying attention to research on how people learn within that setting. They can also test exhibit ideas and models with real visitors by conducting their own visitor research, as no theories exist which can predict exactly how an audience will respond to specific displays. Visitor evaluations, at all stages of exhibit development, offer constructive steps for maximizing educational effectiveness, emotional impact, and minimizing mechanical and communication shortcomings. Not only are visitor needs ascertained, but through the process they feel they are helping create the display. Other benefits to museums from conducting evaluations include keeping exhibit development staff focused on how

58 Hein, 156-157.

59 John H. Falk and Lynn D. Dierking, *Learning from Museums: Visitor*

Experiences and the Making of Meaning (Walnut Creek, CA: Altamira Press, 2000), 58-59. See also Kodi R. Jeffery, “Constructivism in Museums: How Museums Create Meaningful Learning Environments,” in *Transforming Practice*, ed. Joanne S. Hirsch and Lois H. Silverman (Washington, D.C.: Museum Education Roundtable, 2000), 212-221.

60 Peter Anderson and Bonnie Cook Roe, *Roles of Affect in the Museum Visit and Ways of Assessing Them*, vol. one (Chicago: Museum of Science and Industry, 1993): 9. See also Barbara L. Martin and Leslie J. Briggs, *The Affective and Cognitive Domains: Integration for Instruction and Research* (Englewood Cliffs, NJ: Educational Technology Publications, Inc., 1986).

61 Anderson, 17-31.

62 Lisa Roberts, “The Elusive Qualities of ‘Affect,’” in *What Research Says About Learning in Science Museums* (Washington, D.C.: Association of Science - Technology Centers, May 1990), 21.

63 John Falk and Lynn Dierking, *Lessons Without Limit* (Walnut Creek, CA: Altamira Press, 2002), 38-39.

their work affects their audience, and helping to avoid arguments when team members disagree on an exhibit component.⁶⁴ The following examples demonstrate how learning theories and visitor research contribute to visitor satisfaction and comprehension of the exhibit message.

For the average American science museum visitor, there might seem to be no *direct* connection between his/her life and certain environmental subjects being presented, e.g., razing of forests in the Amazon, the bushmeat trade in Africa, dwindling fruit bat populations in Guam. The challenge then is how to build a bridge between the visitor and the distant and/or abstract topic being considered. A number of museological writings on visitor message uptake reveal that these hindrances to learning can be, and have been, handled successfully by museum staff using a variety of compensatory techniques. One example is the Wildlife Conservation Society/Bronx Zoo in New York. Educators there wanted to put together a new exhibition featuring gorillas, which would display these, and other animals, in an outdoor, naturalistic, 6.5 acre setting. This exhibit covered animals and bioregions in Africa--unlikely to be seen by the majority of those attending the exhibit. It was well known by creators of the exhibition that zoo visitors tend to focus on the animals displayed and not the information about them. Because of this, exhibit designers were concerned that people would be caught up with animal viewing and miss the messages about their precarious position in the wild. As the authors of this article note, this concern was handled by first paying attention to public expectations and interests; and second, communicating messages visually through exhibitry and media, as well as experientially with activities that supported visitor feelings of connectedness with the messages being conveyed.⁶⁵

The project team began the first phase of their investigations by conducting formative evaluations, including quantitative studies, and one qualitative study consisting of four focus groups. These processes were done to elicit information from visitors about their understanding of the topic, as well as their expectations and needs, to inform exhibition design or interpretation. The evaluation process concluded with a lengthy summative evaluation done over three seasons, consisting mainly of exit interviews. Through these ongoing efforts and staff's response, a strong level of general visitor satisfaction with the overall experience was achieved, as evidenced by the many positive comments found in the final evaluations. Of greater significance was the high level of success in passing on visitor understanding of ecological and conservation problems in the African regions covered. This was especially found with repeat visitors, which the exhibit was successful in drawing. It was acknowledged that people were obviously impressed by up-close views of gorillas and other charismatic animals. But the creative combination of simulated (i.e., immersive) African landscapes, descriptive signage, mixed media and experiential opportunities, contributed to understanding the conservation messages the zoo wanted visitors to take home with them.

Visitor research and mixed presentation modes geared to fostering discovery of, and most importantly, appreciation and stewardship of the natural environment, have been found by other museums to be helpful, even pivotal, in influencing visitor understanding of conservation issues.

In February 1992, the Franklin Institute Science Museum of Philadelphia, Pennsylvania, in collaboration with the Association of Science-Technology Centers, opened the exhibition *Greenhouse Earth*. This 5,000 square-foot production was developed after four years of extensive content research and testing with visitors. It aimed at responding to public concerns about the causes and impacts of global warming, explored climate change research methods, and offered insight into its economic and social context as well as energy-efficient technologies to counter warming trends.

64 Samuel Taylor, "Try It! Improving Exhibits Through Formative Evaluation," (Washington, D.C.: Association of Science - Technology Centers, 1991), 13, 84-85.

65 Jeff Hayward and Marilyn Rothenberg, "Measuring Success in the 'Congo Gorilla Forest's Conservation Exhibition," *Curator* 47, no. 3 (July 2004): 261-282.

During the show's creation, exhibit developers consulted with nearly 30 scientific advisors to gain the most up-to-date information possible on climate change. One such advisor, Dr. Willett Kempton of Princeton University's Center for Energy and Environmental Studies. The museum's own visitor surveys on laymen's understanding of climate change were compared to Dr. Kempton's in-depth interviews on the subject. Results of the two studies dovetailed—people were concerned about the issue, but were confused about its causes. Most interviewees attributed it to ozone depletion. They also wanted to know what they could do about climate change. Based on these visitor studies and advisor input, the exhibition was organized into nine, 14-foot modules, which included numerous photographs and charts, interactive devices, audiovisual and computer components, as well as a theater piece written for the exhibition. The stage presentation, as well as several “talk-back” activities, invited visitors to express their feelings and opinions about global warming. The final section of the exhibition showed them some factors that might alter the course of climate change, worldwide individual and community efforts in that direction, and the important role that visitors themselves could play in that endeavor.⁶⁶

In the early 1990s, the Franklin Institute put together another exhibition on climate change, *Global Gamble*, using basic scientific information and a different format than the above program. Utilizing a (familiar) TV game show format, visitors were given choices on how to slow the climatological process. Evaluations conducted before and after exposure to various concepts in the exhibit revealed an overall gain in visitor ability to explain global warming, rising from 27 to 58 percent. Those who could name at least one greenhouse gas grew from 35 to 78 percent.⁶⁷ Supporting the role of the evaluation process, Alan Friedman, Director of the New York Hall of Science, pointed out that it is “not the cheapest way to develop exhibits. But it is the cheapest way to develop effective exhibits.”⁶⁸

At California's Monterey Bay Aquarium (MBA), audience research and evaluation are important ways for science museums to engage their visitors on environmental topics.⁶⁹ Over time, the aquarium has come to rely on the evaluation process in teaching people about the marine environment. Through these studies it has been found that after viewing the various exhibits visitors do feel a strong sense of responsibility to protect the oceans. But often they do not comprehend how their individual actions have an impact on ocean health. MBA has responded to this by incorporating into its displays more suggestions for specific conservation behaviors, such as using the Sea Food Watch Card and ways to avoid polluting the oceans. When this process began in the 1980s, staff was concerned how visitors would react. Would they be offended, or feel they were being preached to? Using the evaluation process it was found that, rather than being displeased, the “majority” of people were actually interested in learning more about ocean conservation.⁷⁰

Speaking directly to the concept of affect, the MBA has found that, “Seeing marine animals in person allows visitors to connect with nature in a way that. . .is not possible outside an institution. . .the live animal experience. . .can act as a vehicle for getting visitors to learn about, care about, and want to conserve animals and their habitats.”⁷¹ To build on this connection and reach visitors with information about marine conservation, the Aquarium has taken other steps as well. Probably one of the most important was refining its mission statement into a single, concise idea: “The mission of

66 Wendy Pollock, Association of Science-Technology Centers, Personal Communication, 9, January 2006

67 Mintz, 10.

68 Ibid., 11.

69 Steven Yalowitz, “Evaluating Visitor Conservation Research at the Monterey Bay Aquarium,” *Curator* 47, no. 3 (July 2004): 283-284.

70 Ibid., 284-291.

71 Ibid., 283.

the Monterey Bay Aquarium is to inspire conservation of the oceans.” This alteration has led the institution to increase its exhibition conservation content and conduct more evaluations focused on visitor understanding of the issues, their attitudes and behavior. The change also brought about closer coordination between exhibit development and evaluation.

The Aquarium is an excellent example of how far activism in exhibition content and presentation style can carry a subject that is potentially distressing to visitors. Various exhibits display fishing practices detrimental to marine populations, and, in some instances, inhumane. For instance, a display on trawl fishing shows that the ocean bottom is dredged from large fishing boats, but only certain fish brought up are kept. Many other unwanted dead and dying organisms are thrown overboard. Another display discusses shark fin soup. This soup is made from the dorsal fins of sharks. What will not be mentioned on any restaurant menu is the manner in which the fins are obtained. The Aquarium deals with this directly and graphically, with video footage of live sharks being reeled onto boats, having their dorsal fins cut off, and then thrown back into the water to bleed to death. In tandem with these disturbing images is signage encouraging visitors not to eat seafood taken in these ways. Nearby are other, visually pleasing displays meant to alleviate distress by highlighting fish caught using more acceptable methods. This technique of confronting visitors with stressful information and then diffusing it with useful suggestions for ameliorating the problem, has served the Aquarium well, as attested to by its high visitorship . It also points out that advocacy, when done well, need not be an alienating process. Rather, it can bring people “into the fold” by asking them to engage in more ethical and environmentally sustainable behaviors.

Looking again at the subject of climate change, an exhibition created in 1992 by New York City’s American Museum of Natural History (AMNH) serves as an excellent example of a large, successful show growing out of a controversial, little understood topic. It additionally highlights the many techniques that can be used to promote visitor comprehension of an abstract subject. *Global Warming: Understanding the Forecast* spent eight months at the AMNH and then toured for four years, reaching over two million people.⁷² Through visitor evaluations it was found to be highly successful in building audience concern about the subject.

Because global warming encompasses multiple disciplines, it was decided that this effort should be a collaborative one, and the help of an environmental advocacy organization, Environmental Defense Fund (currently named Environmental Defense), was enlisted. AMNH provided the expertise on exhibits and educational programming; the Fund contributed knowledge about the science and policies of the topic. Additionally, scientists worldwide, such as paleobotanists, paleontologists, mineralogists, zoologists, archeologists, geologists, as well as specialists in climate change and related disciplines, supplied specific information as needed. NASA provided computer-generated images for use in the show’s multimedia interactives.⁷³ Front-end evaluations began two years before the show opened; exhibition developers wanted to learn about visitor conceptions of global warming, and thus better plan for the exhibition’s content. The majority of interviewees had heard of global warming, but had limited understanding of the subject. Testing of text and exhibit prototypes continued over the next two years.⁷⁴

Several presentation techniques were used throughout the exhibition so that visitors with different learning styles would have access to the material. These included text panels, interactive computers, videos, hands-on displays, photographs, photo murals, art reproductions, globes, posters and

72 Eva Zelig and Stephanie L. Pfirman, "Handling a Hot Topic—Global Warming: Understanding the Forecast," *Curator* 36, no. 4 (April 1993): 256.

73 *Ibid.*, 257.

74 *Ibid.*, 258.

models.⁷⁵ An exhibit-based book was available for purchase, mirroring the exhibition in content. This book included a list from the exhibition of 20 remedial actions readers could take in their daily lives to help stem the advance of global warming.⁷⁶ Additionally, exhibit planners worked with AMNH's Education Department to construct an outreach package meant to extend the display beyond the museum walls. This material was tailored to the elementary school level and above, and to general adult audiences. In conjunction with the show were a range of interpretive offerings: exhibition explainers, a symposium, a lecture series, science fiction and documentary film festivals, science demonstrations, and a workshop with field trip.⁷⁷ A summative evaluation revealed that the interactive exhibits, which comprised two-thirds of the total displays, were the most popular segment, and succeeded in conveying the information most effectively.⁷⁸

AMNH's global warming exhibit was meant, in part, to correct misconceptions about climate change coming from media reports. Another important aspect was to present material which supported visitor conservation behavior by showing how ".individual actions can add up, giving visitors a sense of hope rather than helplessness." For instance, two exhibit components featured practical energy-conservation steps people could take to reduce greenhouse gases. This was done to counteract a prevalent attitude found in the front-end interviews—visitors felt there wasn't much they could do about the problem.⁷⁹

Summative evaluations and comments from the exhibition guest book disclosed that the "vast majority" of visitors expressed deep concern about environmental issues, and were eager for more information. Many stated that they hadn't realized before that they were part of the global warming problem. Also of significance, a large number of those who viewed this show urged the museum to take a more activist stand, with statements such as, "You need to be more shocking—this is no joke guys;" and "It is time for the museum to step forward and become an outspoken advocate for social and political policies which will ensure more responsible use of our planet. You have a bully pulpit. Use it."⁸⁰

Several related concepts come out of the above material, crossing boundaries of museum and education theories and practices. First, research findings on the importance of past experience and how people respond to new information are borne out by the museum phenomena described. At all four centers, visitors had very little context for understanding habitats in Africa or in the oceans, or for the abstract notion of climate change, as they were outside peoples' everyday experience. All of these organizations used similar techniques to understand their audiences' prior comprehension of the subject matter and need for guidance, and how best to structure exhibition content based on that knowledge. Also important was a mixed presentation style, including the use of signage, various media, partnering with necessary experts, photographs, murals, art, supporting literature, outreach, and lectures. Of additional significance was the close contact to exotic animals visitors were given at the Bronx Zoo and MBA, presented in naturalistic settings. This brought the animals out of the realm of imagination and into the visitors' immediate experience. Thus, both these institutions addressed both the constructivist and affective theories of learning, which strongly enhanced visitors' grasp of the material. It was noted specifically that Aquarium guests could connect with the animals there in a way not possible outside of that context. In other words, the animals seen in the

75 Ibid., 261.

76 Andrew Revkin, *Global Warming: Understanding the Forecast*, (New York: American Museum of Natural History and Environmental Defense Fund, 1992), 169-171.

77 Zelig, 268.

78 Ibid., 265.

79 Ibid., 266-267.

80 Ibid., 269-270.

Aquarium, indeed, the watery medium itself, are ordinarily outside the experience of most people. But being in close proximity creates an interest and emotional resonance, therefore a reason for visitors to take protective steps. The bold conservation messages within these museums offered ways people could help with the problems they were learning about. Their acceptance that they could make positive contributions to conservation efforts was particularly impressive, since many of them had come to the exhibitions feeling helpless in affecting change. This latter attitude points to the disconnect people can have between an environmental dilemma and seeing themselves as a causative (or helpful) factor.

Science museum efforts to bring the natural world closer to the experience of visitors also pertains to the subject of climate change, which is basically about varying weather patterns, invisible atmospheric gases, and complex scientific concepts. The problem can seem as remote as the science of it. This is especially true in this country, since most of the United States exists at a latitude not currently experiencing global warming impacts to the extent found in Alaska. In displaying climate change material, both the Franklin Institute and AMNH were able to raise visitor comprehension of the covered issues by determining their prior knowledge, and gearing exhibition content accordingly. Through its evaluation process, AMNH discovered that, in general, its visitors did not understand how they were contributing to global warming.

Despite some initial reservations that their audiences would reject their taking an activist stance, neither AMNH or MBA found that their visitors were put off by the call for action. When museum guests realized what was at stake, and how the subject touched their lives, they were very positive in their response. But for this to happen the institutions went to considerable lengths to make sure their messages could bridge the gap between prior beliefs and accurate perception of the issues presented. This receptivity should come as welcome news to museums wanting to take a stronger stance on climate change and advocacy, but, like some of my interviewee institutions, have been leery of alienating the public.

As noted in earlier sections of this paper, advocacy does not have a lengthy history in science museums; only in the last ten to fifteen years has it been increasingly supported within the museum field. The three exhibitions discussed above, *Darkened Waters*, *What About AIDS?* and *The Human Factor*, as well as exhibits at the Bronx Zoo, American Museum of Natural History and Monterey Bay Aquarium, all took an activist role by encouraging visitors to help ameliorate the problems their presentations dealt with. The following section gives a more detailed report on views of activism held by museum oversight organizations and other museum practitioners, and the legalities of advocacy for the nonprofit sector.

ADVOCACY IN SCIENCE MUSEUMS: THE CHALLENGES IN TAKING AN EXPLICIT IDEOLOGICAL STANCE

Advocacy and museum representation are two arenas which, at first glance, might seem to stand in contradiction. Museums are created to educate the public, not to advance a politically-oriented agenda. This can be seen as especially true for science-based museums, as science strives to be fundamentally neutral in stance. However, there are different ways to view advocacy, which is defined in this study as favoring or recommending a particular approach or practice. The term is often used in reference to political leveraging or lobbying, as in attempting to influence legislation. It may also concern social activism, such as campaigning for minority or abortion rights. In the realm of scientific disclosure, advocacy is to be interpreted in a different manner. First of all, science strives to minimize unscientific, biased behavior in its fact finding, using the objective tool of the scientific method to test and retest its hypotheses. Once a solid body of verifiable data

supports a particular theory (meaning a concept firmly grounded in observation and experiment), previously competing ideas are usually rejected. An example is Charles Darwin's theory of evolution. While ongoing research continues to flesh out and refine the basic premise, its assertions are accorded validity by the majority of scientists. Other hypotheses have been given little, or no, credence, as they don't furnish enough evidence to discredit Darwin's original hypothesis. So, while science does not advocate for the personal biases of scientists (at least it's not supposed to), it definitely does advocate for--meaning stand behind--the currently perceived truth of any scientific matter.

The scientific process has revolutionized humanity's understanding of the physical world. However, critiques of this system have noted that such inquiry is, and cannot be, a completely objective endeavor. As has been pointed out by philosopher Thomas Kuhn, the "facts" of science change over time, shifting from one theory to another as world views evolve. Scientific beliefs are also heavily influenced by ideas about the world held by a given culture, the personal background of the person doing the research, and what phenomena are chosen for study--to name just a few of the myriad influences on the investigative process.⁸¹ This viewpoint is offered here to bring balance to the concept of science having the final word on a topic at any given time.

As noted previously in this paper, early science museums were allied to industrial and technological progress. They continue to endorse and display the findings, methodologies and accomplishments of science and technology. But as informal education destinations, they need to present material in a format which museum goers will find both instructive and enjoyable. This obligation has been in tension with the more progressive agenda of environmentalism to some degree since the 1960s and 1970s. Due to accelerating environmental degradation, science museums are having to take a closer look at their core ideas on promoting aggressive conservation and the avenues open to them for doing so.

Legal Restrictions on Museum Activities

While ideological neutrality is an impossibility for a museum and its representations due to inherent, if unconscious, human biases, museums are, nevertheless, subject to certain legal restrictions as to the activities they can engage in while retaining their tax-exempt, 501(c)(3) status. These limitations relate to specific politically oriented activities, and for museum purposes, the basic tenets are relatively simple. Non-profits cannot encourage the public to contact members of a legislative body to support or oppose legislation. Likewise, they themselves may not expend a substantial part of their activities (or money) in trying to influence legislation (lobbying). However, they may be involved in issues of public policy by holding educational meetings, preparing and distributing educational materials, or otherwise considering such issues in an educational manner. Additionally, non-profits are strongly forbidden from participating, in any way, in a political campaign on behalf of a candidate, and their leaders are prohibited from speaking personally on political matters as if they represent the views of their own organization.⁸² It can be seen that the above rules are not so restrictive as to prevent museums from disseminating educational information to the public on subjects which might be politically contentious, or even encouraging remedial action, as long as it is not partisan or legislative in nature.

81 Hein, 67; Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962) 2-3.

82 Internal Revenue Service, *Political and Lobbying Activities*, prepared by the Department of the Treasury (adapted from IRS Publication 1828, *Tax Guide for Churches and Religious Organizations - February 2004*) (accessed 12 December 2004), available from <http://www.irs.gov/charities/charitable/article/p,,id=120703,00.html>.

The Role of Science Museums as Conservation Activists

Science museums often champion the pleasure of learning about the natural world. They also espouse ideological positions, such as energy efficiency, sustainable technology and habitat protection. These are easy topics to advocate for, as a rather broad spectrum of society embraces such steps. Where contentious subjects are concerned, all too often the problem is presented without offering remedies if it is felt that such topics might offend, or otherwise alienate, visitors, board members or funders.⁸³ Some museums are reluctant to display controversial issues for fear their status as unbiased sources of scientific knowledge will be compromised in the public's eye, or that they will lose funding from government or corporate sponsors. However, given the dynamics of enhanced visitor expectations, as well as growing ecological problems, museum educators increasingly feel that this way of doing business is inadequate to meet these challenges. Some commentators have been quite outspoken on this topic. In a 1998 article in *Museum News*, the authors go so far as to state that despite "dazzling technological capability in information management," natural history museums "remain in the 1800s." They feel that answers to their evolution lie, in part, on their relevancy and activism.⁸⁴ Willard L. Boyd, former president of Chicago's Field Museum, agrees, "If museums are to be on the frontier of public appreciation and learning about their subject matter, they will be involved in controversies arising from new discoveries, new creations, and new interpretations. . . ."⁸⁵ Taking a proactive stance turns out to have the full backing of the American Association of Museums (AAM), the American Zoo and Aquarium Association (AZA), as well as the Association of Science - Technology Centers (ASTC).

Excellence and Equity, released by the AAM in 1992, called upon museums nationwide to place education (defined broadly as, "exploration, study, observation, critical thinking, contemplation, and dialogue"⁸⁶), as central to their public service. This report speak directly to these institutions' attempts to meet the challenges of a rapidly changing world: "Museums perform their most fruitful public service. . . by fostering the ability to live productively in a pluralistic society and to contribute to the resolution of the challenges we face as global citizens."⁸⁷ Certain efforts were seen as being at the heart of a museum's educational function. These included serving as a place for "presenting and testing alternative ideas and addressing controversy," and to "communicate change in global systems and. . . addressing questions that affect the global village."⁸⁸

The AZA likewise promotes a more activist role for members. Its Conservation Education Committee developed a set of recommendations, which state, in part: "We have the responsibility to care for the Earth, to leave healthy ecosystems for our families and future generations," and "Responsible zoos and aquariums share knowledge, ideas and projects that empower people to take conservation action."⁸⁹ ASTC has addressed the necessity for greater social responsibility in its centers by hosting CEO forums on that topic.⁹⁰ It has also explicitly promoted advocacy, acknowledging that due to the pressing nature of many environmental problems, science museums need to endorse certain positions. ASTC further asserts that science is part of a larger picture of global change, and educational strategies must engage visitors in the issues, provide a scientific

83 Mintz, 5.

84 Leonard Kriskalka and Philip S. Humphrey, "Fiddling While the Planet Burns: The Challenge for U.S. Natural History Museums," *Museum News* 77, no. 2 (March/April 1998): 29.

85 Willard L. Boyd, "Museums as Centers of Controversy," *Daedalus* 128 (Summer 1999): 186.

86 *Ibid.*, 8.

87 Report of the AAM Task Force on Museum Education, *Excellence and Equity*. By Bonnie Pitman, chair, American Association of Museums, 1992, 6.

88 *Ibid.*, 12.

89 American Zoo and Aquarium Association, *Conservation Messages*, (accessed 26 April 2005), available from <http://www.aza.org/ConEd/ConMessages/>.

90 Emily H. Koster, "Science Centers as Innovators," *Daedalus* 128 (Summer 1999): 288.

framework for understanding them, and then empower visitors to make a difference.⁹¹ In other words, to advocate for conservation action should not be considered some sort of advancement of a private agenda, but simply timely, and responsible, museum practice.

Some institutions are currently confronting these challenges head on. In Los Angeles, the Natural History Museum, dating from 1913, is, like many older institutions, attempting to revitalize itself, most recently with a \$300 million expansion plan. But, according to Jane Pisano, its President and Director, the purpose is not just a physical retrofit, but rather, “to present our collections in ways that inspire people to take responsibility. . . in a way that will make them better citizens.” John W. McCarter, President and Chief Executive of the Field Museum in Chicago, states, “We have studied the environment since our founding in 1893, but the nature of the work has changed. . . . We have become advocates.” Likewise, curators are involved in creating exhibitions which go beyond a mere listing of facts. A recent show at the American Museum of Natural History in New York, “Frogs,” presents material about specific human activities that have decimated frog populations and destroyed their habitats. At Philadelphia’s Academy of Natural Sciences, a permanent installation demonstrates how people’s actions negatively affect water quality and what they can do to remedy the situation.⁹²

The Monterey Bay Aquarium in California, one of the largest aquariums in the world, has dealt creatively with advocacy. From its opening in 1984 to the present, its focus evolved from educating visitors about the wonders of Monterey Bay, then introducing conservation topics into its programs and exhibitions, and finally to encouraging visitors to take action on problems relevant to the marine environment.⁹³ Continuing this enterprising trend, in late 2004 it opened a new division, the Center for the Future of the Oceans. Following recommendations from the U.S. Commission on Ocean Policy and the Pew Oceans Commission, the Center will support ocean policy reform at the state and federal levels by building support for such revisions.⁹⁴ As previously noted, the Aquarium changed its mission statement to focus its conservation efforts more clearly. In the last decade other science museums have revised their mission statements as well, reflecting their conviction that they need to be involved more directly in environmental education and research.⁹⁵

* * * * *

Climate change is one of the five major environmental issues facing the planet today. As has been shown throughout this Background section, science centers have a history of explaining complicated scientific and technological subjects, more currently with the aid of educational theory and visitor research techniques. They are thus in an excellent position to help the general populace understand the global warming dilemma. The next section will describe what science museums reviewed for this project are doing to bring this understanding about.

91 Mintz, 4-5.

92 Suzanne Muchnic, “Breaking Out of the Diorama,” *Los Angeles Times*, 31 October 2004, Part II, sec. E38.

93 Jenny Sayre Ramberg, et al., “Mission, Message, and Visitors: How Exhibit Philosophy Has Evolved at the Monterey Bay Aquarium,” *Curator* 45, no. 4 (April, 2003): 302-320.

94 Business Journal of Silicon Valley/San Jose, *Monterey Bay Aquarium Creates Center for the Future of the Oceans*, January 14, 2004, (accessed 13 March 2005), available from <http://www.bizjournals.com/sanjose/stories/2004/01/14/daily9.html?GP=OTC-MJ1752087487>.

95 Muchnic, E38. Examples include the Santa Barbara Museum of Natural History, Academy of Natural Sciences in Philadelphia, the Carnegie Museum of Natural History in Pittsburgh, and the Natural History Museum of Los Angeles County. Muchnic, E38.

III. FINDINGS AND CONCLUSIONS

For this project I conducted surveys, literature reviews and interviews. In February and March of 2005, I completed a visitor survey at four California science museums, ranging from the small, locally-focused Lindsay Wildlife Museum, the mid-sized Chabot Space & Science Center with an audience primarily from the greater Bay Area, to the large institutions of the California Academy of Sciences and the Monterey Bay Aquarium, which routinely receive national and international visitors. The surveys were done to investigate visitor knowledge of climate change and interest in seeing museum presentations on the subject. I chose these four science centers due to their differences in size and audiences, which I felt would give me a broad base of responses to my questions. Through a literature review I investigated current thinking on the science museum's role in presenting controversial environmental issues, the importance of innovation in the museum field, and the concept of sustainability and its implications for the environment, society and general museum practice. I interviewed 22 representatives of science museums and environmental conservation organizations to gain a sense of their ideas on advocacy, and their work, past and present, alone or in partnerships with each other, on communicating environmental issues, especially climate change, to the public. I wanted to gain an understanding of their efforts to change visitors' consciousness and behavior vis-à-vis the natural environment. My findings are presented in three subsections organized by research method—surveys, literature reviews and interviews—following by over-arching conclusions based on what was learned.

VISITOR SURVEYS

In order to obtain a first-hand account of the public's understanding of climate change, whether they believe science museums should be covering the subject, and to compare my findings with other visitor research and public environmental opinion polls, I conducted four visitor surveys (the survey form can be found at Appendix A, and the table of survey results at Appendix B). These were done at the following California museums: Lindsay Wildlife Museum in Walnut Creek on February 19, 2005; Chabot Space & Science Center in Oakland on February 21, 2005, California Academy of Sciences in San Francisco on February 26, 2005, and at the Monterey Bay Aquarium in Monterey on March 5, 2005. I interviewed 70 museum visitors, and to be age consistent only adults were questioned. Survey participants were chosen randomly. While standing in one particular space in each museum, I selected every third person or group crossing a nearby point.

Visitor Surveys - Findings

Almost 100 percent of the interviewees were California residents, and all of them had heard the terms "climate change" or "global warming." When asked to define those terms, a little less than one-half (40 percent) stated that climate change is human-induced and entails the release into the atmosphere of carbon dioxide and other greenhouse gases. A little over one-third (36 percent) made general statements of weather changes, but did not mention that humans are a causative factor. Somewhat less than one-quarter of respondents believed that ozone depletion is the cause of global warming, and the remaining persons weren't sure what the terms meant. Almost three-quarters of interviewees had not seen climate change information at any museum.

In answering the two rated questions (a scale of 1 through 10, with 1 lowest and 10 highest) on how important it is for science museums to offer information on climate change, and whether respondents would be interested in seeing such material, almost all gave a score of 5 and above (93 percent and 94 percent respectively), while close to three-quarters gave scores of 8 and above (69

percent and 67 percent respectively). As to why these ratings were given, about two-thirds (62 percent) stated that people need to know about the subject; almost one-quarter (20 percent) believed that museums are in a position to help the public understand what they can do to remedy the problem. A similar number felt that since it is a scientific topic, science museums should educate the public about it and explain how it is relevant to their lives (note: this issue was only addressed at the last three museums surveyed, as it grew out of answers received at the first one.)

Of those interviewees who gave an interest score of 5 and above in seeing climate change material at a museum, just about three-quarters wanted to see exhibits only, a little less than half were interested in programs only, and less than one-quarter were interested in only going to lectures. Almost one-third were enthusiastic about both exhibits and programs. Other permutations of presentation venues received less than 10 percent of votes.

Visitor Surveys - Conclusions

With almost all interview respondents being from California, answers to this study are most representative of the views of the people of this state. It would be difficult to say with certainty whether the results also represent opinions from the rest of the country. However, efforts were made to conduct the survey randomly, so it can be said with some confidence that similar answers would be given by the general U.S. population.

Survey results gave me a broad sense of the knowledge and beliefs that the public has about global warming. Even though all interviewees had heard of climate change, less than half had more than a modest understanding of it (this finding correlates with data coming from front-end visitor research done at the American Museum of Natural History for its climate change exhibition,⁹⁶ as well as public surveys discussed in the Background section of this paper). Slightly less than half understood that present climatological changes are human-induced. The remainder only knew that the subject has something to do with changes in the weather, or believed that ozone depletion is the cause; some didn't know anything about it. This general lack of knowledge about global warming dovetails with statements made by several museum interviewees discussed below, and visitor surveys completed for the global warming exhibitions highlighted in this paper. Despite these various levels of understanding, a high percentage of survey respondents felt it was important to very important for science museums to present information on the topic. The small percentage (less than one-quarter) of respondents who felt that museums can help visitors understand what they can do about climate change can be interpreted in two ways: these respondents did not generally perceive museums as advocates; or they did not know what the remedies are for climate change, so could not conceive of what museums might tell them in that regard. Finally, a high percentage reported they would go to a museum to learn more about global warming, with the strongest interest being in exhibits and programs.

The combination of little knowledge of global warming or exposure to climate change information in a museum, and a high percentage wanting museums to cover the topic, strongly points to a gap in science museum programming, and suggests that the museum-going public is open to receiving such information. Museum patrons seemed to realize that global warming presents a threat, even if they weren't quite sure how. Since science museums routinely address environmental topics, these interviewees believe that such institutions are a logical venue for its presentation.

96 Ellen Giusti, *Global Warming: Understanding the Forecast, An Assessment* (New York: American Museum of Natural History, 1993), 1. See also Mintz, 10-11.

LITERATURE REVIEW FINDINGS

A number of authors in the museum field recognize that inventive presentation methods can help these institutions tackle challenging issues. This topic was discussed in a 2003 American Association of Museum's conference panel in Portland, Oregon. It was acknowledged that innovation is often shied away from by staff and their stakeholders.⁹⁷ Session participants felt that probably the biggest problem in dealing with the topic is the fear of risk taking. They also recognized that inherent in taking risks is the possibility of failure. But to create, it is necessary to step outside of one's comfort zone, and this was viewed as absolutely essential if museums are to be regarded as relevant in a rapidly evolving world. Chris Cawte, a session participant and Managing Director of MET Studio Design Ltd., London, England, summed up the session participants' conclusions:

We believe that the time has come for America's museums to come out of the classroom, get back out on the road, avoid the turn to Disneyland. . . . It's time to stop preaching to the converted and to challenge your visitors—not in the high-handed didactic manner of the past, but by engaging with real life, real meaning and real cultural imperatives.⁹⁸

Another subject pertinent to science museums and the subject of climate change is sustainability. This word refers not only to the environmental sustainability of certain human practices, but to whether human societies are sustainable as a whole within the context of current customs, and if museums themselves are sustainable when they ignore these issues. Dr. Glenn Sutter and Douglas Worts, both Canadian museum professionals, have addressed these topics at length. In a recent museum journal article, "What is Sustainability?", Sutter, of the Royal Saskatchewan Museum, reminds the reader that the current collective impact of humanity is greater than the productive capacity of the Earth. He also observes that most of the population is concentrated in cities, separated physically and psychologically from nature, thus causing a disconnect from the environmental systems on which people depend.⁹⁹ Sutter cautions that the word, sustainability, is sometimes used by organizations that are interested in maintaining the status quo. Corporate and political policies refer to "sustainable economic growth," even though unbridled economic expansion is causing significant social and ecological stresses. But sustainability can be thought of in the context of how we relate to our physical and social worlds, and reducing our economic activities to protect current and future generations.¹⁰⁰ He believes that education systems, including museums, must help visitors recognize biophysical limits, and our finite abilities to understand and work within them. Thus, attention must be redirected to understanding and managing ourselves. He also believes that educators need to be frank about this, but should avoid feelings of hopelessness. Rather, people should be enlightened and empowered by the information they are given.¹⁰¹

In a joint paper on sustainability, and the place of museums in providing "societal therapy" toward the goal, Sutter and Worts allude to a problem not often found in literature on environmental issues. They assert that people are all too often reluctant to acknowledge the impacts of their choices, or the cultural values that support them.¹⁰² Sutter and Worts question whether it is advisable for museums to let this myopic view go unassessed. They acknowledge that the museum community is increasingly concerned about sustainability. But for some this means sustaining *museums* as they

97 John Chiodo, "Out of the United States of Mind," *Exhibitionist* 23, no. 2 (Fall 2004): 28.

98 *Ibid.*, 32

99 Glenn C. Sutter, "What is Sustainability?" *WestMuse* (Summer, 2004): 5.

100 *Ibid.*, 5

101 *Ibid.*, 5-7.

102 Sutter and Worts, 1.

currently are; others in the field would prefer to reshape museums so they contribute to *society's* sustainability. The latter professionals strongly believe that museums must act as agents for social change, fostering an elevated sense of consciousness, relatedness, and humility in their publics.¹⁰³ This will support, directly and indirectly, changes within and across cultures, and ultimately the human impact on the natural world.

Douglas Worts, of the Art Gallery of Ontario, recently wrote on the contribution of museums to a more holistic society and healthier ecosystems, observing that the majority consider themselves to be existing for public education, but that all too often this goal is not met.¹⁰⁴ His article examines how a society's values inform its ideas about, and treatment of, nature. In the Western mind, an extroverted, rational pragmatism dominates, which is channeled into the ability to acquire material wealth and power. A core belief of this viewpoint is that humanity can dominate and control the natural world. On the other hand, for some Eastern societies, a more introverted, spiritual approach has directed their behavior, based on the view that people must live in harmony with nature. While acknowledging that both systems have their strengths and weaknesses, he cautions that humanity's future may depend on integrating these approaches, collectively and individually.¹⁰⁵

Worts believes that museum educational strategies are important avenues for informing the public about the possible outcomes of staying the current course. However, these strategies must help people to feel as empowered and responsible participants in achieving a sustainable future. Worts advises that regardless of how good our environmental science becomes, how impressive our recycling programs are, or how effectively the regulatory systems work, they are not enough if there is no change in the public's consciousness or consumption patterns.¹⁰⁶

Literature Review - Conclusions

Many of the positive characteristics discussed by Chiodo and Cawte were demonstrated in the exhibitions discussed in the Background section. Practical steps were also taken to foster consciousness in their visitors about sustainability and humanity's place within the natural world, concepts promoted by Sutter and Worts. Doug Worts spoke about this topic in my interview with him, observing that when museum directors, curators, board members, or others, "see their responsibility as primarily to the well-being of the community, as opposed to an academic discipline, then many things are possible."¹⁰⁷ But such a process of change is not a given, or instantaneous. As several interviewees for this paper have noted, major changes in human behavior take time. In this country, with its decidedly exploitive ideas about the natural world, an emotional connection to nature and regard for its needs are all too often eclipsed by a desire for possessions and position which can play out in disruption of natural systems. Both Sutter and Worts believe that museums must directly confront the idea that nature exists only to serve humanity. The sustainability of both human societies and the environment is at stake. While humans are dependent on a healthy environment, ultimately one impacts the other, so they are intertwined and interdependent.

103 Ibid., 2.

104 Douglas Worts. "On the Brink of Irrelevance? Art Museums in Contemporary Society," Les Tickle, et al., eds., *Researching Visual Arts Education in Museums and Galleries, An International Reader* (Dordrecht: Kluwer Academic Publishers), 2003, 1.

105 Ibid., 5.

106 Ibid., 6.

107 Douglas Worts, "Re: Report." E-mail interview with author, 24 February 2005.

INTERVIEW FINDINGS

To obtain an in-depth understanding of the various ways science centers have represented climate change to visitors and their views on museum advocacy, I interviewed ten science museum staff members. Also interviewed were seven representatives from environmental advocacy organizations to ascertain their views on partnership building with science museums. I additionally sought information from participating staff in four collaborations made up predominantly of science museums, but including environmental groups, universities and governmental entities working in whole or in part on climate change. My purpose in researching the collaboratives was to determine the advantages that partnering has conveyed to the participants.

Interviews – Science Museum Personnel

(See Appendix C for a list of interviewees)

In my interviews with the following science museum professionals, I tailored my questions to each institution. Generally speaking, however, queries covered the following three topics: 1) whether these museums have presented climate change material, in what form, and some factors that have helped and hindered that effort; 2) if they felt it is appropriate for their museums to take an advocacy stance in these presentations; and 3) if partnerships were established with sister institutions or environmental groups.

1. John Aikin, Curator of Planning and Design at the **SAN FRANCISCO ZOO**, was chosen as an interviewee because he is the curator for new exhibits. Even though the Zoo currently has a few graphics which touch on climate change, Aikin informed me that the institution would like to dedicate a full exhibition to the subject in the future. He recognizes the importance of taking that step, since the Zoo is a conservation entity, and climate change has consequences for wildlife and humans. However, the Education Department has briefed their docents on it, and offers some instruction in their formal and informal education programs. He noted that because zoos are both recreation and conservation facilities, to successfully inform the public about this subject they must find ways to engage them as well as educate. However, Aikin stated that the Zoo does communicate that global warming is most likely accelerated, if not caused by, the burning of fossil fuels, echoing Dewey's "constructivist" philosophy that knowledge gained cannot be separated from life's circumstances.¹⁰⁸ Furthermore, Aiken believes that whether advocacy is appropriate for similar institutions depends on their mission statement. He indicated that his Zoo's mission does take an activist stance, as it "inspires caring for nature and advances conservation action." His thoughts as to why similar museums may not deal with climate change ranged from lack of funding to a poor fit between the particular audience and the message. Though the Zoo partners with environmental organizations (such as The Wildlife Conservation Society, Earth Watch and Conservation International) for many of its exhibits and programs, like organizations must share a similar mission for partnering to take place.

2. Eric Havel is the Environmental Instructor at **CHABOT SPACE & SCIENCE CENTER (CSSC) IN OAKLAND, CALIFORNIA**. His department showcases a hands-on floor demonstration on climate change several times per month. While CSSC has not had a self-standing

¹⁰⁸ Hein, 18-19.

exhibit on climate change, Havel feels that the Center should be putting more emphasis on the topic, as it is one of the five leading environmental issues of our time, with global and long-lasting implications. Factors that prevent CSSC from having more robust offerings on climate change are Havel's own lack of time, and that topic not being a central theme at his institution. For other science centers, he opined that contributing reasons could be insufficient knowledge about the subject on the part of museum educators and exhibit developers, a lack of hands-on activities, and global warming's political nature. CSSC is a participant in the newly-formed NASA group, Earth Explorers Institute (EEI), which has been formed, in part, to maintain a network of science museums and other institutions for interaction and information sharing about Earth system sciences, including climate change. Havel believes CSSC is in a good position to use NASA's latest Earth science data and research on global warming.

Havel feels that neutrality is important in successful exhibitions, because the most meaningful experiences for visitors come through their personal discovery. Though he and the museum's docents have tried to remain neutral in climate change presentations, they have sometimes taken an activist stand due to not having enough experimental displays to allow visitors to determine on their own what they can do about the problem. Chabot has partnered in the past two years with UC Berkeley's Lawrence Hall of Science in outreach events, notably Berkeley's Earth Day, offering climate change and other science-based activities. In 2005, Chabot shared its Earth Day booth space not only with Lawrence Hall of Science, but with representatives and information from Union of Concerned Scientists, California Academy of Sciences, and World Environment Day. Havel also attended a climate change-focused round table at the 2004 ASTC Conference.

3. Carolyn Kaichi, Planetarium Manager and a spokesperson at the **BISHOP MUSEUM IN HAWAII**, informed me that her institution has only exhibited climate change information in a media presentation on threats to coral reefs from ocean warming. This display is produced by National Wildlife Federation. Kaichi feels the museum should develop exhibition material on climate change as it is an important subject, and their responsibility is to educate the general public on Hawaii's natural and human history. However, her museum is "cautiously neutral" in all exhibitry. The Bishop Museum is a member of NASA's EEI, having joined the collaborative to gain more information on climate change and related topics, make connections with the other involved organizations, and utilize NASA's extensive satellite and Earth-based resources to augment its public offerings.

4. Mary Miller, Science Producer and Science and Museum Liaison at the **EXPLORATORIUM IN SAN FRANCISCO**, informed me that her center has never had exhibits or major programs devoted exclusively to climate change, although their large website has a section on the topic. Because global warming is occurring world wide, she would like to see the museum do more on the subject, as she also believes it is a responsibility of science museums--as trusted, neutral spaces--to offer accurate and timely facts.

While the Exploratorium strives for neutrality in its presentations, letting people draw their own conclusions about the information presented, Miller feels that the center does advocate for scientific accuracy. Their web-based, Climate Change Research Explorer (www.exploratorium.edu/climate) global warming information, for example, reports that 90 percent of climate scientists say that global warming is taking place. Miller believes that her institution has never partnered with other museums on environmental exhibits, nor with environmental groups, although they might later. The

Exploratorium is also a member of EEI, and Miller will specifically be looking for more material on climate change from NASA and others in that group.

5. John Pickle is the Program Manager for Global System Science at the **MUSEUM OF SCIENCE IN BOSTON**. He was interviewed because the museum is part of EEI, and is also a member of the New England Science Center Collaborative (a regional partnership of science centers specifically formed to share information between them on global warming). Pickle has only been with that institution for three years, but he didn't think it has ever mounted an exhibit on global warming, although it plans to do so in the future to showcase what can be done to help with the problem, a stance he supports. He believes this can best be done by taking a positive approach, such as showing people how they can save money in the process of being environmentally conscious. But he acknowledged that museum changes take time.

The museum is also the lead institution within the NASA grant, "Measuring Vegetation Health: Using Light to Look at Our World," which investigates vegetation responses to natural and human-induced environmental processes. It has a new exhibit on "nowcasting the weather" (called WeatherWise). While not directly focused on climate change, that display is opening the door to related factors, such as urban heat islands. The museum also offers two programs which are peripherally related to global warming-- Current Science and Technology, a 10-20 minute, live presentation on key and current science/technology issues in the news; and Technology Forum, which seeks to engage visitors in discussing issues around technology, society, culture and economics, and the successes, drawbacks and implications of technology in their own lives.

6. **THE MARIAN KOSHLAND SCIENCE MUSEUM**, an arm of the U.S. National Academy of Sciences (NAS), opened in Spring 2004 **IN WASHINGTON, D.C.** This center is the first science museum in the country to have a permanent, major exhibition on climate change. The National Research Council, the working arm of the NAS, had published 75 extensively researched reports on global warming, so proponents of the new museum felt it could provide a rich display on the subject. I interviewed Erika Shugart, the Deputy Director there, in her role as scientist and exhibit developer. Shugart informed me that NAS advises the federal government, so the Koshland does not take any kind of advocacy role. Exhibitions report out scientific facts, and leave it to visitors to draw conclusions or take action.

7. Juan Carlos Solis, of the **CALIFORNIA ACADEMY OF SCIENCES (CAS)** was interviewed in his capacity as Public Programs Coordinator for the institution. I chose CAS as it provides a climate change floor demonstration once a month, and also offers information on the topic through several other venues. Additionally, it is in the process of building a new facility in San Francisco which will utilize extensive green technology in its design to lessen its environmental impact.

CAS has introduced climate change information as part of a prior exhibition on glaciation, through its website, as an interactive floor demonstration in its Naturalist Center, acting as host for a lecture on global warming by journalist and author Ross Gelbspan, and as co-sponsor for a climate change symposium in early 2005 at the Oakland Museum. An exhibition on California is being planned which will include climate change impacts on the state. Solis informed me that whether, how much and in what form advocacy is a part of these exhibitions/programs varies with the setting. However, the science of it makes it clear that humans are the causative factor. He does believe that it is the

responsibility of science museums to take an advocacy role on topics that are a threat to humans, such as with climate change. Solis believes that other similar museums may not offer information on the topic due to conflicts with funding sources and the politics of the issue. As to CAS's partnering activities, most of their shows are produced in-house, although they worked with the Audubon Society on a bird exhibit, and have received programming input from the International Crane Foundation and Coral Reef Alliance.

8. My project has primarily focused on organizations in the United States. However, I interviewed two Canadian-based museum professionals, Dr. Glenn Sutter and Douglas Worts, due to their in-depth writings on the issues of ecological and cultural sustainability, and their efforts in developing visitor concern for the natural world. Glenn Sutter, Curator of Ornithology & Human Ecology at the **ROYAL SASKATCHEWAN MUSEUM**, espoused the view that both active advocacy and neutrality should be avoided. He believes that strong activism can draw attention to an issue, but can also have a polarizing effect that hinders cooperation. He cited an example of this situation in a study he conducted called the Frenchman River Biodiversity Project. Several conservation organizations were interested in the region also, but local members of the project steering committee did not want to ask them for support as they viewed the organizations as activists. On the other hand, he feels that "passive advocacy" should be instituted when the topic involves sustainability, since all people and institutions have a vested interest in it. Passive advocacy explores all aspects of an issue, including strategies for change, but lets visitors decide for themselves which path to pursue. His museum does, however, take a stand with *The Human Factor* exhibit, which holds up human activities as responsible for altered structures and functions of ecosystems worldwide. He believes some obstacles museums can run into when working on contentious issues are lack of support from management, and politics and funding being closely coupled to the message presented.

9. Douglas Worts is currently employed as museum educator and audience researcher at the **ART GALLERY OF ONTARIO**. Worts feels that the primary responsibility of museums is to provide a forum for reflection and discussion, as opposed to identifying the "right perspective." However, where serious situations, like climate change, are concerned, he believes these institutions should play a leadership role in clearing away the "self-interested rhetoric" often clouding the decision-making processes in society. Additionally, he said that neutrality, while valuable as a facilitator of dialogue, is not very helpful in the face of global systems collapse due to society ignoring the warning signs. In other words, presenting the facts of such matters clearly and honestly for the public should be an ethical consideration for science museums.

In Worts' experience, art museums are far removed from issues offering an opportunity to play an advocacy role. But for science museums, he believes the most important factor influencing advocacy is their leaders, i.e., if influential members in the organization see their responsibility as primarily to the institution's community, as opposed to some academic discipline, many things can be accomplished. He stressed that museums should "get out of the business" of simply presenting information. It is important, but not in short supply. He feels the bigger challenge is fostering consciousness, relatedness and responsible action.

10. Dr. William Spitzer, Vice President of Programs and Exhibits at the **NEW ENGLAND AQUARIUM** (NEA) responded generously to my questions. NEA promotes stewardship by

engaging with environmental issues at multiple levels and ensuring that all programming is grounded in rigorous science. Spitzer believes this is essential to maintaining NEA's credibility as well as building a long-term relationship with its audiences. His Aquarium has offered climate change material in several ways: in an exhibit on jellies; as part of a short film it made for aquariums and zoos titled *In Hot Water*; and a training course for teachers on the subject. Scientific evidence is used throughout to explain what global warming is, what its effects are, and what people can do about it.

Citing statistics similar to those given by Eric Havel, Spitzer said there is a broad scientific consensus that climate change is one of the top five threats to biodiversity. The Aquarium is committed to focusing on those top five in its research and education. He strongly feels that any institution dedicated to protecting the environment or human health and security should be talking about climate change. Echoing several other interviewees, he stated that advocacy derives directly from an institution's mission. For the NEA this is, in part: "to increase understanding of aquatic life and environments, to enable people to act to conserve the world of water," which inherently advocates for aquatic conservation. If a museum's mission lacks a broad social purpose or a notion of stewardship—e.g., only referring to the promotion of science and technology—it has no basis on which to serve as an effective advocate. Additionally, a museum's mission can be a barrier to taking on any subject that is perceived as controversial, potentially unpopular, or not seen as a "sexy" topic. Finally, Dr. Spitzer informed me that the aquarium works with various organizations as exhibit/program content advisors and collaborators. NEA is also a participating member of NASA'S EEI, and Spitzer is on the steering committee for that organization.

Interviews – Environmental Advocacy Organizations

(See Appendix C for a list of interviewees)

These environmental advocacy groups were included among the key informants for this study due to their national/international environmental focus. All of them have climate change information on their websites and staff working on the topic either in whole or as part of their job activities.

1. ***WORLD WILDLIFE FUND (WWF)*** is one of the largest conservation groups in the world, working internationally on a broad range of programs, including climate change. It has extensive information about the subject on its large website. Michael Case was interviewed in his capacity as Research Scientist in WWF's Climate Change Program. He told me that WWF is open to working collaboratively with museums, as many in his organization believe they need to support both the science and the educational aspects of environmental issues. But he wasn't sure if WWF had actually partnered in the past with museums. If not, he felt it was probably a question of staff capacity, as there is only one other climate change scientist, besides him, working in the D.C. office. Several weeks after our initial interview, Case contacted me to say that his supervisor had been talking with a number of science museum personnel regarding WWF providing them with information on climate change. Two centers he mentioned by name were the Koshland Science Museum and the Exploratorium. Case emphasized in his communication that his organization is "eager" to work with museums on climate change exhibitions.

2. ***THE NATURE CONSERVANCY (TNC)*** is another international conservation group, focused primarily on buying and preserving undeveloped land. It is concerned with global warming, especially its effects on biodiversity. Bill Stanley, Acting Director of TNC Global Climate Change Initiative, didn't know if TNC has partnered in the past with any science museums on environmental issues, but believes that this type of partnering, in general, is a growing trend. TNC

does have scientists on staff willing to lecture on climate problems, or otherwise work with museums, and they have been invited in the past to speak at several. He added that TNC is starting a project that could very well be used in such a setting. This entails cataloguing current and future climate change impact areas in writing and photographs, and putting the information together so as to be useful to science museums.

I also spoke with Jennifer Denney, Senior Communications Manager, who stated that TNC has worked with many museums over the years, primarily on the art and landscapes of their many conservation sites around the world. Small scale exhibits are run at their preserves in support of local education. She confirmed that TNC is interested in partnering with museums to educate the public about the impacts of climate change on species and natural systems.

3. **NATIONAL WILDLIFE FEDERATION (NWF)** is the largest environmental advocacy organization in the United States, pursuing a great many projects in this country and abroad. It has two climate change offices—one in Washington, D.C. and the other in Seattle, Washington. My contact, Patty Glick, Climate Change Specialist in Seattle, noted that NWF has partnered extensively with zoos and aquariums over the years, including Busch Gardens in Tampa Bay, Sea World Orlando, and Ohio's Toledo Zoo. Such partnerships have supported those institutes' efforts to provide science-based, environmental information to their visitors, and have given NWF added venues for its research material and programs, such as Backyard Wildlife Habitat. Glick was instrumental in the recent adoption of an NWF global warming-related DVD by 17 science centers, marine sanctuaries, state and national parks, and wildlife refuges. She worked with Jack Hanna at the Columbus Zoo to narrate the DVD.¹⁰⁹

The tendency of some science museums to remain "neutral" on environmental policy issues might impact their desire to work with environmental advocacy groups. Glick believes, however, that if the information offered by such groups is based on sound science and does not involve legislative matters, the more progressive museums will be open to taking the step. Glick supports NWF's position on partnering with science centers, acknowledging that doing so provides a greater opportunity for her organization to reach the public. She also expressed her personal enthusiasm for being more involved with these museums. She affirmed that NWF can provide scientific experts to speak on climate change, and that they have strong ties with outside scientists whom they can "sponsor" for such events.

4. **ENVIRONMENTAL DEFENSE**, another national group, also concerns itself with global warming matters. It has collaborated with science museums in the past, most notably with the American Museum of Natural History on their climate change exhibition of the early 1990s, *Global Warming: Understanding the Forecast*. Joseph Plagenz, Associate Director of Environmental Defense, informed me that the presidents of the two institutions worked jointly on the idea of a collaboration on global warming. The exhibit was the first major one of its kind to tour the U.S., from 1992 to 1998. Environmental Defense is very open to partnering with science-based museums. Plagenz believes it is vital for the public to understand the science of global warming, and science museums are an excellent setting for them to gain a deeper understanding of the topic. He added that his institution has worked on climate change issues with the New England Science Center Collaborative and the North Carolina Grassroots Science Museums Collaborative.

109 Patty Glick, "Re: Interview Questions-NWF." E-mail interview with author, 31 January 2005.

Peter Goldmark, Director of Climate and Air Programs at the same organization, additionally informed me that their office does have scientists willing to lecture at museums on global warming and related topics. Even though Goldmark had not been involved in this type of endeavor since his employment there, he believes that the in-depth experiences museums can offer are powerful influences on society, which is especially true in these days of “infotainment, horror movies, Fox News, and other self-indulgences.”

5. **NATURAL RESOURCES DEFENSE COUNCIL (NRDC)** is heavily involved on the global warming front, with an extensive website on the topic. According to Dr. Dan Lashof, Science Director of its climate center, NRDC is willing to work with science-based museums on climate change programming, as this type of partnering is an important way to “validate” the subject for the general public. His organization does have scientists, including himself, who are willing to lecture at science museums on global warming. Similar to The Nature Conservancy’s efforts, NRDC has utilized art to convey the global warming message. Several years ago, it created an exhibit of 30 photographs of Gary Braasch, which capture the effects of climate change throughout the world. The photos were exhibited in the building where NRDC has its offices, as well as at the Field Museum in Chicago and the Science Museum of Minnesota.

6. **UNION OF CONCERNED SCIENTISTS**, as its name implies, is an organization made up of scientists who report on, and advocate for, a variety of scientific issues, including the environment. It has extensive reports available on global warming impacts for different regions of the United States, as well as an extensive website on climate and energy-related topics. In our discussion, Jason Mathers, Outreach Coordinator - Global Environment Program, told me that UCS is generally open to working collaboratively with science museums, however, hindrances to greater UCS involvement with museums are its small staff and shifting goals over time, which might not include partnering with museums. Nevertheless, he does feel that such facilities are a good venue for reaching a broad audience—more so perhaps than environmental groups because museums are seen by the public as being less partial.

Interviews – Science Museum Collaboratives

(See Appendix C for a list of interviewees)

Four collaboratives were surveyed for this paper. These groups represent a potentially new direction in the museum field for institutions wanting information or involvement on climate change projects, or otherwise with an interest in the collaborative process.

1. The NASA Goddard Space Flight Center, located in Greenbelt, Maryland, was established in the late 1950s to develop new aeronautic and astronautic technologies and to conduct Earth and space science research. Over time, NASA became a world leader in climate modeling. A key objective of the agency’s research is analysis of environmental and climate data sets, coming from surface-based, aircraft and spacecraft platforms. In 2004, the GSFC collaborated with the Jet Propulsion Laboratory and other NASA centers, as well as participants from more than two dozen informal education institutions, to establish the **EARTH EXPLORERS INSTITUTE (EEI)**. The EEI is a learning network and cooperative community of best practice aimed at promoting public literacy about Earth system science. One of the group’s main goals is to develop programs to bring NASA satellite data and other Earth science research to the public in ways that are engaging and interactive. Thus, members of the EEI are not the endpoint; rather, they partner in an ongoing endeavor to reach

the target audience that has been characterized as the “science attentive public.” Specifically, members of this segment of the public are defined as relatively heavy seekers and consumers of scientific information, and they consider themselves knowledgeable in a given science subject and are willing to participate in public policy-relevant dialogue about that subject. Through his many years of research in public science communication strategies, Professor Jon D. Miller of Northwestern University, estimates that roughly 40 million adult Americans fit into this category. According to Miller’s research, a large percentage of the science attentive public visits museums and is more likely to make return visits to such institutions than other segments of the American public.¹¹⁰

In November 2004, GSFC and the Maryland Science Center hosted the first, week-long EEI workshop for professionals from informal science education organizations around the country. During this workshop, the approximate 50 participants decided to consolidate and focus on four main areas: 1) Create and maintain a learning network so that they can continue to interact, share information, evolve and develop a set of best practices in informal Earth science education; 2) Hold a workshop, or series of them, in which NASA scientists and technical personnel can teach EEI participants how to access NASA data archives, visualize the data and convert them into public communication products; 3) Develop a pilot program for a series of open discussions about Earth science issues of interest to local constituents, to ultimately help citizens become more conversant in Earth science topics; and 4) Create a pilot program for amateur scientists to establish tools and techniques for ground-based observations and measurements to be cross-compared with NASA’s satellite data. This last program can easily be used in interactive demonstrations in science centers, but will also lend itself to at-home learners to facilitate family participation.

I spoke to David Herring, Program Manager for Education and Outreach within the Earth Sciences Division at GSFC, and one of NASA’s coordinators for the EEI, who told me that another aim of the newly formed partnership is the development of new Earth system science informal education programs. They will be hosted by science centers, and feature the use of information coming from NASA’s 18 orbiting satellites. Climate change-related satellite data to be used by museum members includes: surface temperature, forest fires, plant growth, carbon drawdown, radiant energy fluxes, atmospheric transport of natural and human-introduced atmospheric chemicals, and others, based on availability and appeal. Associated topics of interest noted by the science centers themselves are polar cap changes, glaciers, and air quality. Although the EEI is just getting started, the symposium focused the efforts of the group to work in partnership, and members expressed their enthusiasm as to what they can achieve together.

2. THE NEW ENGLAND SCIENCE CENTER COLLABORATIVE (NESCC) consists of 30 New England science museums, environmental organizations, and scientific research institutions, which came together in 1999 to specifically address climate-related environmental changes occurring within their geographical location. My contact for this Collaborative, Mary Lou Krambeer, is a consultant hired as a liaison and oversight person for all the museums. She helps them gather information and develop project ideas. Krambeer opined that these museums have a responsibility to offer exhibits and programs on climate change, and be “big players” in the dialogue, as they are trusted, educational institutions. This partnership gives its members a way to take action.

110 National Aeronautics and Space Administration, “Overview of NASA’s Earth Explorers Institute,” nd, 3-4; also, David Herring, NASA, Personal Communication, 16 January 2006.

When NESCC began, she informed the centers that they could not be political; that they must “educate not advocate.” But she said they could suggest actions and solutions to the problem, which is not technically defined as advocacy. Not all of the museums in the group had, as yet, used climate change materials. Several reasons for this include: staff being pulled in too many directions, a shortage of staff, lack of money, and insufficient staff training on the issues. NESCC has lent support by offering free or low-fee meetings and training with scientists, and by using museum members’ expertise in education or exhibit/program development. By working together the group has produced: a traveling, computer-based presentation on climate change; a backpack kit consisting of a portable collection of materials and activities for hands-on learning; a speaker’s bureau; museum outreach activities, and a weekly climate-related radio program.

NESCC is preparing a proposal to the National Science Foundation to produce interactive, inquiry-driven exhibitions, simulation games and on-line educational programs that interpret climate change effects on the communities and ecosystems that are the focus of the participating museums. The exhibit itself will use iconic images of the region to illustrate current global warming impacts, and will present stories that are harbingers of larger climate changes to come. It is designed to immerse visitors in real-life scenarios, letting them experience being part of the feedback loops between their daily decisions, resulting emissions and their own impacts on New England. Six science centers in Connecticut have agreed to host this exhibition.

3. The ***NORTH CAROLINA GRASSROOTS SCIENCE MUSEUMS COLLABORATIVE*** is made up of 25 science centers in that state. It was initiated by eight of them in 1990 to support one another in exhibition and program building, with the goal of improving the public’s understanding of science and technology. Currently, the partnership shares material and ideas with NESCC on climate change. I interviewed Dr. Fran Nolan, Executive Director at the North Carolina Museum of Natural Sciences and spokesperson for the Collaborative. He did not know of any climate change exhibitions being shown within the group, although approximately ten centers have used the NESCC climate change backpack kit. The centers revamped the Presenter’s Guide for the kit to reflect the people and landscapes of the southeastern United States. These museums are very interested in hosting exhibitions on global warming, but Nolan believes the limiting factor has been the lack of material.

Though Nolan couldn’t speak for all of the centers, he guessed that their basic stance in presenting global warming has been neutral—just giving the facts and letting visitors form their own conclusions, as these museums do not want to be viewed by their audiences as partisan on controversial issues. Personally, however, he believes in taking a stronger position—that science museums should be offering a broad base of information on the subject, as the issue is critical to the future of environmental and human health. In his own words, “We cheat people of their future by political backpedaling.”¹¹¹

4. The recently formed (October 2004) ***CONNECTICUT SCIENCE CENTER COLLABORATIVE (CTSCC)*** is a state partnership of 22 science centers, scientists, NGO’s, and state agencies. However, there are a total of 35 science centers in Connecticut directly or indirectly involved with the group. This Collaborative is modeled after NESCC, and was created to inform Connecticut’s populace about the impacts of climate change in the state, and what can be done to

111 Fran Nolan, “Re: Interview NCARCollab.” E-mail interview with author, 19 April 2005.

reduce rising levels of greenhouse gases. As Prof. Steven Hamburg, a co-founder of the Collaborative noted, “While climate change is one of the most comprehensively studied scientific topics of our time, the levels of public knowledge and understanding continue to be low.”¹¹² All of the 22 science centers interviewed before the project began expressed their willingness to educate their visitors on climate change and what can be done about it. They all felt they would be more effective, however, if they had additional technical and financial support. Another aim of the group is for member scientists and science educators to work together, share expertise and resources, and generate project ideas.

Richard Polonsky, the other co-founder of CTSCC, informed me of additional concerns felt by science museums in that state. These centers have been losing attendance, and feel they need to be more relevant to their audiences. While museum staff want to tackle contemporary and contentious issues, they have been worried about compromising their institutions’ objectivity and possibly alienating visitors. Partnering with like facilities and scientists is helping them address such concerns. The museums are also working with regional and national environmental advocacy organizations to better understand, and present, climate change information. Those organizations include Connecticut Audubon, Clean Air–Cool Planet, as well as Environmental Defense, Natural Resources Defense Council, and Union of Concerned Scientists. The Collaborative additionally obtains ideas and materials from NESCC.

CTSCC is involved with the Connecticut Climate Action Plan. The state has asked the Collaborative to submit a three-year proposal for development of exhibits and educational programs focusing on renewable energy. CTSCC is also working with the Goddard Institute for Space Studies to develop a proposal to NASA that would use the Collaborative as a vehicle to disseminate NASA’s research from its Global Climate Change Program. Through the Collaborative’s participating science centers, more than 3.5 million museum visitors a year could be reached with this information. These projects will give CTSCC the opportunity to demonstrate to federal and state agencies that science center collaboratives are a low cost and effective way to educate many people about complex issues such as climate change. Polonsky further informed me that most federal research grants given to climate scientists come with a provision that part of the money be spent on education and public outreach. These scientists admit that they generally do not have the outlets to accomplish the task. Rather than apportioning these funds among numerous parties, CTSCC proposes they be “bundled,” and given to organizations such as CTSCC or NESCC that are in the business of connecting scientists to the public through the creative programming that science centers provide.

Polonsky provided me with a list of the Collaborative’s programs for 2005-06, which are tailored to fit the different audiences of member museums, and relate the effects of climate change to their public’s “sense of place.” The program provides opportunities for museum educators to discuss climate change studies with scientists, including visits to laboratories or field sites. The scientists learn how informal educators present complicated subjects to the public. The program also includes Backpack training (NESCC’s teaching tool, which is endorsed by NASA). A roster of 25 to 30 high profile speakers is being developed for scientific presentations to museum members, and at board meetings and special events, with each speaker asked to contribute an article to science center publications or the local press. These articles will be organized and disseminated by the Collaborative. CTSCC will sponsor an annual student competition to propose solutions to climate change to raise awareness on the subject, demonstrate what young people can do, and create calls to action. The competition will be run by the science centers through their community school outreach

112 Steven Hamburg, “Seasons of Change - Signs of Climate Change in New England,” Grant Application, nd, 1.

programs. CTSCC's ambitious plan also includes science and nature centers throughout the state telling the story of global warming affects on local communities and ecosystems. A similar program has been launched by the state (the Clean Energy Trail), which CTSCC intends to link to its Climate Trail. Finally, CTSCC plans to develop a web site so the public can learn more about climate change and the Collaborative.

Interview Conclusions

General Overview

My interviewees from science museums and environmental advocacy organizations have expressed a number of overlapping concepts. Broadly speaking, there is a consensus that science museums have a major role to play in presenting climate change information to the public. Many respondents from both groups felt that these museums have a responsibility to the public to do so, given its challenging nature--citing global threats to the environment, human cultures and health. Most of the advocacy group spokespersons believe that the general public has confidence in the veracity and impartiality of information found in science museums. Mary Miller, of the Exploratorium, asserted that science centers must be offering timely and accurate information, as the public needs trusted spaces in which to learn. Peter Goldmark from Environmental Defense expressed a similar opinion--that science museums are very needed, as they can counter the superficial information coming from the popular media.

Science Museums

Several of my interviewees expressed concern that by exhibiting controversial or worrisome subjects they might alienate their visitors. However, visitor surveys conducted at the museums highlighted in this paper had found quite the opposite. For example, the Monterey Bay Aquarium has discovered through ongoing visitor research that the public does not mind being exposed to such information, as long as they are simultaneously offered ways they can help with the problem. Audience acceptance of the Aquarium's activist role is attested to by its high visitorship--approximately 2 million visitors in 2004.

Regarding the use of advocacy to influence visitor behavior, museum professionals expressed varying thoughts about its appropriateness. While some museums strive to remain neutral at all times, allowing visitors to draw their own conclusions, others are not so cautious. The California Academy of Sciences' use of advocacy depends on the particular setting. Generally speaking, its exhibits present facts about the objects displayed without discussing, or suggesting remedies for, environmental problems. However, it did co-host a scientific symposium on global warming in early 2005, and included a global warming presentation in its lecture series. I attended these events, and in both instances, the speakers left no doubt as to the human causes of the problem, and stated we must all take actions to stem its advance. The Academy also hosts a monthly, hands-on floor demonstration which explains the link between carbon dioxide and atmospheric temperature. While the demonstration itself does not speak to global warming per se, visual aids openly address the phenomenon, its anthropogenic factors, and what can be done about it. Docents welcome and encourage discussions with visitors on current climate change issues. Juan Carlos-Solis at the Academy echoed his museum's position in his belief that museums must take an advocacy role on issues which are a threat to humans. That idea was also strongly voiced by Dr. Spitzer at the New England Aquarium, who feels that museums asserting a commitment to protection of the environment and humans should be offering information on climate change.

Providing a system of anxiety alleviation similar to that of the Monterey Bay Aquarium, *The Human Factor* exhibit incrementally presents details about the ecological crisis alongside positive

aspects of humanity. Especially sobering or potentially stressful displays are followed by tranquil, thought-provoking, or even amusing, spaces. Finally, a Solutions area focuses on positive environmental steps being taken by society, which visitors can also adopt.¹¹³

Several respondents stated that a museum's mission statement is pivotal to what it will and will not do and to its relationship with the public. It was noted in this paper's Background section that the Monterey Bay Aquarium changed its mission statement to better fit its desire to be a voice for marine conservation, particularly of the Monterey Bay, which the building overlooks. William Spitzer at the New England Aquarium and John Aikin of the San Francisco Zoo, made similar observations as to the importance of a museum's mission. Both facilities are led in their advocacy stance and choice of exhibitry by their mission statements.

Douglas Worts believes that museums need strong internal leaders who see their responsibility as being to the community when faced with contentious issues. He took the idea of obligation a step further--that museums must foster a change of consciousness in visitors, to a greater relatedness between people and their environment, and promotion of responsible actions.

The majority of the science museums covered in this paper have partnered with sister facilities or environmental groups to some extent. Those who have not done so are open to it. A high proportion of the centers also had global warming material in their exhibits, programs, kits, on websites, and even in radio programs. Museums whose efforts were limited expressed enthusiasm for working toward the goal of treating the subject more thoroughly. However, a number of obstacles were mentioned as standing in the way of such efforts. Eric Havel at Chabot Space & Science Center noted his own shortage of time to do more. Other interviewees noted additional actual or potential barriers, e.g., a lack of cohesiveness with existing exhibitions, limited access to exhibit materials, the controversy surrounding global warming, funding shortages, and political conflicts. To handle these drawbacks, a number of museums have sought partnerships by coming under the umbrella of one of the collaboratives discussed. This type of partnering is seen by them as a path to gathering information and support from similar organizations which have already done the work, and/or a way to bridge unfamiliar territory together. Collaborative participants feel a responsibility to inform citizens living in their specific regions about the global warming problem and what they can do to help. These alliances are helping their publics understand climate change by showing them how it impacts their own lives in their own regions, thus promoting experiential and affective learning in their visitors, two crucial educational components propounded by psychologists and visitor research professionals and discussed earlier in this paper. Science museums which have joined these partnerships total nearly 100, primarily from the northeastern U.S. and North Carolina. Through NASA's EEI, centers throughout the country are represented as well. As climate change gains in national importance, other science centers will, no doubt, begin looking for ways to inform their constituencies on the topic. They can gather information, as well as gain confidence, from those facilities which, through working solo or with others, have covered similar ground.

113 Glenn C. Sutter, "Ecocentrism, Anxiety, and Biophilia in Environmental Education: A Museum Case-Study." In W. L. Filho, ed., *Communicating Sustainability* (New York: Peter Lang Scientific Publisher), 344.

Environmental Groups

In my interviews with representatives of environmental advocacy organizations, I focused my questions on two subjects: Whether they have worked with science-based museums on environmental issues, including climate change, and do they have scientists in their institutions willing to partner with such museums to bring climate change material to the public.

All of the organizations contacted had worked with science museums in some way over the years, and were enthusiastic about continuing the process. Several of them expressed the opinion that science centers can extend the reach of advocacy organizations, as museums are excellent, impartial and trusted sources of information. Where climate change is involved, these attributes are crucial since this topic is being inadequately covered by U.S. news agencies from which the general public gets most of its information on world events.

Several interviewees stated they had encountered science centers which were leery of working with environmental advocacy groups because, by association, they didn't want to be perceived by the public as taking sides. Glenn Sutter mentioned a corresponding occurrence on a biodiversity project in Canada involving his and other museums. Local museum members did not want the involvement of interested environmental organizations because they viewed them as activists, and did not want to risk being perceived in the same light by their audiences. Patty Glick of National Wildlife Federation addressed this issue, stating that when working with environmental groups, science centers do not have to include related legislative/political matters in a presentation. To do so is not only unnecessary to convey a given conservation message, it is also unlawful for them to do so. Museums that would like to use the expertise of environmental advocacy groups, but are afraid their reputations will be compromised in the public's eye, need only realize that this is not an all-or-nothing situation. Such environmental groups are quite happy to lend assistance at whatever level is needed, avoiding political aspects of a topic as necessary.

The science museums covered in this paper have used various strategies to advocate more forcefully for change in their representations of global warming. These range from the structuring, or restructuring, of their mission statements, to focusing on their commitment to the public and/or the natural world, and to collaborating with other science centers and/or environmental organizations. The majority of the environmental organizations had worked on a variety of projects with museums, including climate change, and all interviewees informed me they were quite willing to continue. However, several mentioned being hindered at times by "staff capacity," though this did not seem to stand in their way of being open to dialogue with museums about such possibilities. Michael Case of World Wildlife Fund informed me that they are exploring joint efforts with the Koshland Science Museum and Exploratorium, even though WWF's Washington, D.C. office only has two climate change scientists, and they are also working internationally. It seemed clear from these interviews that a commitment to solving environmental dilemmas stimulates these individuals to work on whatever fronts will promote solutions. Some will be better able to respond to requests than others; however, more requests might well foster internal growth to support greater outreach capability. All of the environmental groups were able to provide scientists to speak about global warming in science museums. However, results from the visitor surveys I conducted indicated that a very low percentage of museum visitors are interested in hearing such lectures, preferring to learn about the subject through exhibitions or programs. This would suggest they do not want to "lectured at," which coincides with research findings at the Monterey Bay Aquarium indicating that visitors preferred that the museum not "preach" to them about environmental problems.

Of the organizations reviewed, National Wildlife Federation appeared to have the broadest experience in working with science centers, especially zoos and aquariums. It should be noted that NWF has regional offices throughout the U.S., so it may well be in a better position than most such

institutions to work with museums around the country. While the environmental groups covered in this report do not necessarily have the same staffing capabilities, if those with fewer scientists receive more requests for their input, associations at many levels may become possible. It is also important to keep in mind that science museums do not have to have all the answers on climate change to provide an educative and meaningful experience. As has been pointed out by one museum professional,

“It seems eminently preferable to open minds by offering partial insights than it is ... to fail entirely to address a subject.”¹¹⁴

114 Koster, 289.

IV. RECOMMENDATIONS

I believe that science museums need to take an active role in presenting climate change information to the public, as the general populace does not have a strong grasp of the problem due to inadequate reporting on the subject by the popular media and misleading statements from the federal government. Additionally, they should be showing their visitors the types of actions required of them to help stem the buildup of atmospheric greenhouse gases—the primary cause of global warming—so that global warming does not cause extensive damage to the environment and human societies. With few reliable resources on climate change in the mainstream media,¹¹⁵ the average American has little understanding of the phenomenon and the threat it carries, posing a barrier to timely solutions.¹¹⁶ Science museums have traditionally mirrored current scientific issues and their impacts on society. They should now move beyond mirroring (which tends to be a passive mode of representation), to taking a more proactive stance by filling this information gap, given their available space, staff and funding.

One way that science museums can inform and enhance socially responsible exhibitions on climate change is by forming alliances with environmental advocacy organizations and other science centers. These associations offer many benefits to the involved parties (and to their end users), but the partnering effort also places obligations on both sides. While each organization and joint venture is unique, several guidelines generally apply. The missions of each must be compatible relative to ecological stewardship, and especially a commitment to advocacy by the science museum. Staff capacity should be adequate for the time and effort required in contacting and working with another institution, and compatible goals should be agreed upon from the outset, which will support the partnering efforts throughout the term of the project. Funding commitments also need to be taken into consideration by each side. Closely matched financial resources will help ensure that participants are able to do their part in bringing a venture to fruition. Paying attention to these parameters will contribute significantly to a successful alliance.

Both science museums and environmental organizations have a number of reasons to seriously consider partnership building. Working alone, the average science center may not have the monetary, informational or staffing resources necessary to address global warming or its remedies adequately. Likewise, environmental groups may be hampered by lack of staff, time or money. Additionally, they only have access to a finite number of members, contacted primarily through written means—newsletters, magazines/journals, and web sites. By working together, environmental institutions can: 1) extend their educational reach through utilization of the museum space and audience; 2) share ideas and methods on ways to educate citizens on climate change; 3) provide training on the science of global warming to museum educators; and 4) contribute methods of “selling” the public on the need for them to engage in conservation behaviors. Science centers can: 1) offer their strengths in visual representation of scientific concepts; 2) contribute regional and local focus when interpreting the effects of global warming; 3) tap into different funding sources than might otherwise not be available to an environmental group; and 4) give an environmental group access to external parties and potential stakeholders the museum routinely works with, such as formal educators (e.g., middle and high school teachers), to extend educational opportunities and audiences. Models of partnering discussed throughout this paper include temporary affiliations, such as that of the American Museum of Natural History and Environmental Defense on a large climate change exhibition. Longer-term efforts are illustrated by the New England Science Center Collaborative’s alliance of museums from that region, as well as the three other collaboratives

¹¹⁵ Gelbspan, *Boiling Point*, 67-69.

¹¹⁶ Rickard, 15-18.

reviewed. To give museums and environmental organizations, working alone or in partnerships, the tools to more fully educate the public about global warming and inspire them to help with the problem, I offer two sets of recommendations—one to science centers and the other to environmental advocacy groups.

FOR SCIENCE MUSEUMS:

1. Employ visitor studies to understand the best ways to present climate change, and instill a spirit of environmental stewardship in visitors.

Some science museums have trepidations about displaying controversial environmental subjects, or encouraging activism in visitors. For example, the Bishop Museum in Hawaii, and several of the museums in the North Carolina collaborative are anxious that doing so may offend or otherwise alienate a segment of their publics who feel that museums should be neutral. Other science centers, such as the San Francisco Zoo, are concerned about balancing entertainment with more serious material. People inevitably come to science museums with a broad range of perceptions about the natural world due to their backgrounds and interests. But evaluations and research done to ascertain visitor receptivity to contentious environmental topics (including climate change), revealed that they are not put off when exposed to them. Rather, visitors welcome the opportunity to know more about such issues, as long as they are shown how they can mitigate the problem.¹¹⁷

Each science museum serves a unique community, with its own history, needs and expectations, and thus has a responsibility to educate community members on subjects likely to impact them. To optimize their presentation of climate change in ways best suited to those constituencies, museums should conduct in-depth visitor studies. Front-end evaluations will shed light on visitor awareness of climate change and what methods might best transmit the intended concepts, i.e., exhibitions, floor demonstrations, programs, etc. Formative evaluations will determine whether the intended messages are being communicated effectively, and what types of changes need to be made if they are not. Finally, summative evaluations will let the museum know if it has been successful in imparting its messages, and give direction for future efforts on potentially controversial topics.

2. Structure exhibition material on climate change to highlight how it impacts visitors personally, and instill a sense that they can help with the problem.

Climate change has been studied extensively by research scientists, and they have produced a large body of writings on the subject. However, the general public finds it difficult to understand complex and abstract scientific material. This type of information should, therefore, be used judiciously, depending on the targeted audience. Global warming is not only a climatological issue. Its ramifications cut across a number of socially and environmentally relevant subjects, such as threats to biodiversity and extinction rates, impacts on the agricultural sector, economic stability/growth, and effects on human health--all of which have been covered in the Background section. Museums should present the subject from a variety of angles (including the museum's specific geographic region) to demonstrate the ways climate change does, or may, affect the populace directly. They should also explain the intimate connection that has existed for humankind's history between people's lifestyle choices and the climate. When the exhibit's information can show that

¹¹⁷ Yalowitz, 283-297; and Zelig and Pfirman, 257-271.

climatological changes are relevant to people's lives in crucial ways, it will be personally meaningful and motivating to them, and not simply exist as an abstract concept.¹¹⁸

Because climate change is a potential threat, it can be upsetting to visitors.¹¹⁹ As noted earlier, research has found that when people are repeatedly confronted by distressing information on situations they believe they cannot change, over time they become immune to those stories. To avoid the possibility that museum visitors may feel disheartened or helpless when confronted by the facts of climate change, they must be given ways to make a difference. Museums should point out that present climatological changes are not only being caused by human activities, but they can also be mitigated and eventually reversed by human activities. Then museums must offer concrete steps that visitors can take to do that. Some of the most successful efforts covered in this paper include exhibitions at the American Museum of Natural History and the Royal Saskatchewan Museum, the *What About AIDS?* exhibit, and the accomplishments of the New England Science Center Collaborative and Monterey Bay Aquarium. All of these endeavors have presented the dilemmas honestly, have utilized visitor surveys to understand the needs and perceptions of their audiences, and have employed a variety of display techniques to educate their visitors based on those needs and understanding.

3. Form alliances with other science museums and/or environmental advocacy groups to educate visitors on global warming and inspire them to become agents for change.

Some museums have their own research scientists who contribute meaningfully to the institution's endeavors. For museums that do not have that luxury, but want to provide global warming information, there is promise in the form of collaborations with sister institutions and environmental advocacy organizations which are actively dealing with the subject. All the environmental groups interviewed for this project expressed a desire to work with science centers on climate change issues. They are able to provide speakers, and/or give input to flesh out a museum's existing or contemplated education modalities. The latter can be a simple matter of making research findings available, or participating more fully as content advisors in a full-blown exhibition. In working with environmental groups, the enabling role of the museum's mission statement comes to the forefront. A mission which includes environmental advocacy will support a common vision for the work to be done by both parties. Museums which have their own scientists on staff can take advantage of additional outside expertise by partnering with environmental groups. In fact, several of the museums researched for this paper receive input from such organizations to augment the material from their own in-house science personnel. Those institutions include the California Academy of Sciences, San Francisco Zoo and New England Aquarium.

Science museums wanting to educate their staff on climate change, needing ideas on the best ways to display it, or seeking input on how to start their own museum alliance, can contact collaborative members named in this paper. Those groups are creating and sharing information on several fronts, e.g., exhibit development, creation of kits, and free or low cost training sessions for educational staff on the science of climate change. (Contact information for the museums, environmental advocacy groups, and collaboratives which were reviewed for this project can be found at Appendix C.)

¹¹⁸ Leakey, 200-215.

¹¹⁹ Sutter and Worts, "Negotiating a Sustainable Path," 6-8; and Zelig and Pfirman, 266-267.

4. Adhere to the science of climate change in exhibits, while using a variety of presentation methods to create an educating, inspiring and personal experience for visitors.

Exploring social issues in science museum exhibitions serves many valuable functions. It provides needed information, fosters critical thinking skills and introspection on complex topics, and underscores the real-world relevance of science and technology. Climate change is an excellent example of such a topic. However, it is also contentious, and some information about it found in the popular media can be misconstrued or misleading, as shown in this paper's Background section. Science museums should therefore avoid using data of mainstream media sources, especially ones which are politically oriented. These may well add an additional layer of controversy onto the basic subject, possibly subjecting the museum to accusations of bias, or of dispensing inaccurate and/or unsubstantiated material.

Staying with the substantiated evidence of climate change does not have to equal a narrow or uninteresting exhibit. Museums should start with the scientific context, and the current and predicted influences on human and environmental systems, to include alternatives to predicted outcomes depending on steps taken to curb its effects. While adequate text illuminates the issues, visitors rarely spend a great deal of time with the written portion of a display. So other explanatory modes need to be employed. Depending on museum resources, interactive floor demonstrations, videos, art, photographs, cartoons, computer screens, live theater, story tellers and docents can all serve to enrich and enliven an exhibit. When skillfully done, the last three educational methods can significantly facilitate visitor learning, as they provide a human interactive context for acquiring information. As delineated in the Background, learning within museums is greatly facilitated by experiences that connect with people's lives both before and after their visit. Presentations that personalize the material will encourage visitor "ownership" of it and facilitate their retention of the message over time.¹²⁰ This paper has focused on the educational value of museum exhibitry. However, In *Learning from Museums*, Falk and Dierking noted that, "People learn by accumulating understanding over time. . . . the knowledge and experience gained from museums is incomplete; it requires enabling contexts to become whole."¹²¹ Thus, the addition of relevant field trips to locations experiencing direct effects of global warming would continue the visitor learning experience outside the museum walls. Further expanding upon the museum experience, visitors can be provided with lists of relevant television shows, web sites, books and magazines that can be accessed after leaving the museum.

While not every exhibition component will be meaningful to every visitor, using a variety of teaching modes will ensure that different learning styles and interests will be engaged, maximizing the likelihood they will connect with the issues in a significant way. Science centers which have successfully used these blended approaches include the American Museums of Natural History, the Franklin Institute, Exploratorium and the Pratt Museum.

¹²⁰ Falk and Dierking, *Learning from Museums*, 139, 187-189.

¹²¹ *Ibid.*, 139-140.

FOR ENVIRONMENTAL ADVOCACY ORGANIZATIONS:

1. Use the venue of science museums to gain a broader base for educating the public on climate change.

Science museums are trusted by the public. The information they disseminate is believed to be impartial and accurate, presented in ways that visitors find enjoyable as well as enlightening. Environmental advocacy organizations partnering with science museums will be taking advantage of the important role these museums play as trusted public institutions. Additionally, they will have access to a greater number of educational modalities than is normally available to them, and reach a broader audience than is otherwise possible. Environmental groups can extend their reach even further by associating with, or officially joining, any of the museum collaboratives discussed in this paper. Taking that one step, they will have access to a multitude of science museums, as well as other organizations which are part of the collectives. Those other organizations include educational institutions of all levels, state parks, “green teams,” lay scientific societies, public media, and federal, state and local governmental entities. These collaboratives currently have few environmental groups affiliated with them.

Some science center staff have expressed doubts about working with environmental advocacy groups, concerned that these organizations are primarily interested in advancing political/legislative agendas. This reticence was expressed by several interviewees for this project, as well as others in the environmental advocacy field.¹²² While museums may want to take advantage of the rich stock of scientific information these advocacy groups possess, and tap their constituencies for visitors or members, they must also be careful, as they are forbidden by law to engage in any formal political or legislative activities. To allay this concern, environmental organizations should be clear in their outreach attempts as to the information they are offering and their reasons for doing so. The majority of reviewed science centers stated they had either worked with environmental advocacy groups or were open to the possibility. This represents a rich opportunity which environmental advocacy groups should investigate.

2. Offer climate change information to science museums in diverse ways to suit their needs.

Climate change is not just a scientific topic—it manifests in many forms and science centers may very well be open to exploring the various aspects of the phenomenon. This is especially true for climatological changes expected to impact, or already impacting, particular localities, such as Alaska, the Gulf and New England states. For instance, topics might include heat-induced vector range expansion; expected shifts in rainfall and snow patterns and the ramifications for agriculture and water supplies. Also of interest are the potential health consequences of rising temperatures in the U.S., especially for the young, elderly and infirm. Drawing attention to the heat-related deaths of approximately 35,000 Europeans in 2003 would alert museum visitors to the dangers inherent in atmospheric warming of even a very few degrees.¹²³ More general information might contain a treatment of worldwide glacial melts, or the earlier spring and later fall weather being reported internationally, with attendant shifts in bird migration patterns. This would be of special interest to the large number of birders in this country. The issues can be shown in artistic formats, such as The Nature Conservancy’s planned climate change photography exhibit noted in the Findings section. If

¹²² McGraw, 118.

¹²³ Gelbspan, *Boiling Point*, 8.

any of the more obvious ramifications of climate change (e.g., melting glaciers, spatial shifts in wild plant communities) are occurring close to a contacted museum, field trips to experience them first hand would further enhance the public's understanding of the problem. Museum members can also be offered the opportunity to participate in climate change field research projects, similar to the programs available through National Wildlife Federation's work/travel programs, and World Wildlife Fund's Climate Change College.¹²⁴ Such field activities would help to demystify global warming for participants and give them ways to make positive contributions towards its amelioration. Additionally, programs conducted "on site" provide trip members a real-life context for understanding the problem. Finally, these exhibits and programs would illuminate the fact that climate change is not something happening only in remote lands or in the distant future.

¹²⁴ National Wildlife Federations (accessed 17 July 2005), available from <http://www.nwf.org/expeditions>; and World Wildlife Fund (accessed 17 July 2005), available from <http://climatechangecollege.org>.

CONCLUDING THOUGHTS

America was not founded, and did not grow, with an awareness that humans thrive best in a natural environment that is intact and healthy. While technological advances have brought about a high standard of living for this country, resulting poor environmental stewardship has caused widespread pollution and ecological deterioration. To stem the advance of climate change, our society is at a crossroads where definitive steps need to be taken to cut the production of greenhouse gases and move into a more balanced relationship with the earth. Science museums have, for decades, covered many environmental problems, but on the topic of climate change relatively little has been done on a national scale. This is especially surprising when the phenomenon's disruptive potential to human societies in the near term is taken into account. Climatological shifts are also a major threat to biodiversity, and to the species already in danger of extinction, which most science centers address at some level. Museums must move past neutral, passive and safe approaches, display greater social responsibility in their exhibitry, and take a stronger advocacy stance to provide the American public with the information, understanding and inspiration it needs to help slow the advance of climate change. By doing so, science centers will not only be upholding the mandates of the AAM, ASTC and AZA, but will also be making significant contributions to the worldwide efforts to stem the rising tide of global warming, for the benefit of both the natural world and humanity, now and for the future.

* * * * *

*“Before I flew I was already aware of how small and vulnerable
our planet is; but only when I saw it from space, in all its
ineffable beauty and fragility, did I realize that humankind’s
most urgent task is to cherish and preserve it for future
generations.”*

Astronaut, Sigmund Jähn
German Democratic Republic

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VI. APPENDICES

APPENDIX A

VISITOR SURVEY CONDUCTED AT FOUR CALIFORNIA SCIENCE MUSEUMS

VISITOR SURVEY FORM

DATE _____ MUSEUM _____

TIME BEGAN _____

Hello, my name is Shelly Ryan, and I am here to conduct a visitor survey for my master's thesis on the subject of climate change, aka global warming. I don't work here; these questions are for my use in the paper. Would you mind answering a few questions about climate change to help me with my research? It will take 5 minutes or less. There are no right or wrong answers; I just want to get your thoughts.

1. Do you live in California, or are you visiting from another state or country?

CA Resident _____ Visiting _____ From _____

2. Have you ever heard the terms "climate change" or "global warming"?

Yes _____ No _____

3. How would you describe what it means?

4. Have you ever seen information at a museum on climate change?

Yes _____ No _____

5. On a scale of 1 to 10, with 1 low and 10 high, how important do you think it is for science museums to have information on climate change?

1 2 3 4 5 6 7 8 9 10

5a. Why did you give this rating?

6. On a scale of 1 to 10, with 1 low and 10 high, how interested would you be in seeing information on climate change at a museum?

1 2 3 4 5 6 7 8 9 10

7. (If interest is 5 or above) Would you be most interested in:

Exhibits_____ Programs (e.g., classes, floor demos)_____

Lectures_____

APPENDIX B

SURVEY RESULTS - 70 INTERVIEWEES

1. Do you live in California, or are you visiting from another state or country?

California	91%
Other State	7%
Other Country	2%

2. Have you ever heard the terms “climate change” or “global warming”?

100% of respondents had heard both these terms.

3. How would you describe what it means?

Human-induced pollution and releases of carbon dioxide and other greenhouse gases are causing climate changes worldwide	40%
General statements of weather changes, but not stating that humans are a causative factor	36%
Ozone depletion causes warming of Earth	21%
Don't know; not sure	3%

4. Have you ever seen information at a museum on climate change?

Yes = 30% No = 70%

5. On a scale of 1 to 10, with 1 low and 10 high, how important do you think it is for science museums to have information on climate change?

Scores of 5 and above	Scores of 8 and above
93%	69%

5a. Why did you give this rating?

(Note: This question was only asked at the last three of the four museums, as it grew out of answers given at the first one, for a total of 55 interviews.) Respondents gave the following three

types of answers:

People need to know about climate change	62%
Museums are able to show people what they can do about climate change	20%
It is part of science, so science museums should teach it	18%

6. On a scale of 1 to 10, with 1 low and 10 high, how interested would you be in seeing information on climate change at a museum?

Scores of 5 and Above	Scores of 8 and Above
94%	67%

7. (If interest is 5 or above) Would you be most interested in:

(Note: The answers for this question total over 100%, as most respondents indicated more than one choice.)

Exhibits _____ Programs (e.g., classes, floor demos) _____

Lectures _____

Exhibits Only	76%
Programs Only	46%
Lectures Only	19%
Exhibits Plus Programs	31%
Programs Plus Lectures	Less than 5%
Exhibits Plus Lectures	Less than 5%
All Three Choices	10%

APPENDIX C

INTERVIEWEES

Science Museums

- | | |
|--|--|
| 1. Art Gallery of Ontario
Contact: <u>Douglas Worts</u>
Educator and Audience Research
317 Dundas St., W.
Toronto, ON, Canada
416-979-6660 (x227) | 4. California Academy of Sciences
Contact: <u>Juan-Carlos Solis</u>
Public Programs Coordinator
875 Howard St.
San Francisco, CA 94103
415-321-8108 |
| 2. Bishop Museum
Contact: <u>Carolyn Kaichi</u>
Planetarium Manager
1525 Bernice St.
Honolulu, HI 96817
808-847-8203 | 5. Chabot Space & Science Center
Contact: <u>Eric Havel</u>
Environmental Instructor
10000 Skyline Blvd.
Oakland, CA 94619
510-336-7326 |
| 3. Boston Science Museum
Contact: <u>John Pickle</u>
Program Manager for Global Systems
Science
Science Park
Boston, MA 02114
617-589-0436 | 6. Exploratorium
Contact: <u>Mary K. Miller</u>
Science Producer, Science & Museum
Liaison
3601 Lyon St.
San Francisco, CA 94123
415-561-0347 |

7. Koshland Science Museum

Contact: Erika Shugart

Deputy Director

The National Academies

500 Fifth St., NW

Washington, D. C. 20001

202-334-3864

10. San Francisco Zoo

Contact: John Aikin

Curator of Planning and Design

1 Zoo Rd.

San Francisco, CA 94132

415-753-7035

8. New England Aquarium

Contact: William S. Spitzer,

Ph.D.

Vice President, Programs and Exhibits

Central Wharf

Boston, MA 02110

617-973-6567

9. Royal Saskatchewan Museum

Contact: Glenn C. Sutter, Ph.D.

Curator of Ornithology & Human Ecology

Regina, SK, Canada

306-787-2859

Environmental Advocacy Groups

1. Environmental Defense

Contacts: Joel Plagenz

Associate Director

Peter Goldmark

Director of Climate and Air Program

257 Park Avenue South, 17th Fl.

New York, NY 10010

212-505-2100

2. Natural Resources Defense Council

Contact: Dan Lashof, Ph.D.

Science Director for Climate Center

1200 New York Ave., NW, #400

Washington, D.C. 20005

202-289-6868

3. National Wildlife Federation

Contact: Patty Glick

Climate Change Specialist

6 Nickerson St., Suite 200

Seattle, WA 98109

206-285-8707

4. The Nature Conservancy

Contacts: Bill Stanley

Acting Director, Global Climate Change Initiative

Contact: Jenny Denney, Senior

Communications Manager

4245 Fairfax Dr.

Arlington, VA 22203

703-841-5300

5. Union of Concerned Scientists

Contact: Jason Mathers

Outreach Coordinator, Global Environment Program

Two Brattle Square

Cambridge, MA 02238

617-547-5552

6. World Wildlife Fund

Contact: Michael Case

Research Scientist

1250 24th St., NW

Washington, D.C. 20037

202-822-3473

Science Museum Collaboratives

1. Connecticut Science Center Collaborative

Contact: Richard Polonsky

Innovation Works

107 Glessner Rd.

Bethlehem, NH 03574

603-444-1110

2. National Aeronautics and Space
Administration (Earth Explorer Institute)

Contact: David Herring

Program Mgr. For Education and Outreach

NASA's Goddard Space Flight Center

Greenbelt, MD 20771

301-614-6219

3. New England Science Center Collaborative

Contact: Mary Lou Krambeer

Coordinator

46 Oak Ridge Rd.

Bethlehem, NH 03574

603-444-0949

4. North Carolina Grassroots Science
Museums Collaborative

Contact: Fran Nolan, Ph.D.

Executive Director

North Carolina Museum of Natural Sciences

11 W. Jones St.

Raleigh, NC 27601

919-733-7450