Put a Frame on It: Contextualizing Climate Change for Museum Visitors

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Abstract

Public opinion polls continue to show that Americans are divided—particularly along political and ideological lines—on whether climate change is real and warrants immediate action. Those in the natural and social sciences have recognized that effective communication is key to closing the gap that exists between scientific and public understanding on this issue. A body of social science research on climate change communication has emerged within the last decade. This field has identified strategies for climate change communicators and educators, emphasizing the importance of framing climate change issues in ways that help it resonate with a wider range of public concerns and values in order to develop a shared belief regarding the necessity of action. Museum exhibits and programs on climate change that were developed within the last five years are likely to have benefitted from this body of work.

This qualitative research seeks to examine and analyze the various ways museums in the United States are communicating about climate change related issues to the public. Three case studies of museum exhibits on climate change issues were examined. The scope and purpose of climate change communication in museums, the specific messages that museums are choosing to communicate, and how those messages are being framed for public audiences were explored through these case studies. The findings suggest that museums are considering their audience when framing messages about climate change and have used work from the climate change communication field to inform message development. In particular, museums are making climate change issues more relevant by emphasizing social, economic, and human health concerns, and are considering strategies to counteract fear-fatigue and empower visitors to take action.

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CHAPTER 1: Introduction

Scientists first discovered the link between carbon dioxide levels in the Earth's atmosphere and global climate in the early 1800's—contributing to our understanding of the greenhouse effect, which keeps our planet warm and habitable. Since then, further scientific work has shown that human activities have increased the concentration of carbon dioxide in the atmosphere through the burning of fossil fuels. These higher concentrations of greenhouse gases have contributed to the unprecedented rate of global warming that has occurred since the industrial revolution. We now refer to this phenomenon as anthropogenic climate change.

Anthropogenic climate change became more widely known to the public in the early 1990's as concerns within the scientific community grew regarding the impact this global warming trend might have on the global climate system. Much of the early communication was done by climate scientists who believed in the power of the evidence to convince the public of the reality of the threat and the need to act. On the other side of the issue, were certain politicians—many who were supported by special interests in the oil industry—who tried to cast doubt on the scientists and the evidence (Oreskes & Conway, 2010). Refereeing this debate for public consumption, was the media, who played up the controversy, further confusing public understanding and politicizing the issue (Nisbet, 2009; McCright & Dunlap, 2011).

In the 21st century, we are finally beginning to come to terms with the very real threat that climate change presents not only to the environment, but to our social, political, and economic systems as well. Most climate scientists agree that climate change is happening and is the result of human activities. Many of the effects of climate change are already impacting people and ecosystems and the consequences of inaction are likely to be quite severe with very serious ethical and societal implications. In order to respond effectively, a public consensus on the

seriousness of climate change must be reached (Hoffman, 2012). However, a gap between the scientific community and public understanding continues to persist. Public opinion polls continue to show that Americans are divided—particularly along political and ideological lines—on whether climate change is real and warrants immediate action (Hoffman, 2012).

Those in the natural and social sciences have recognized that effective communication is key to closing the gap that exists between science and public understanding on this issue. A body of social science research on climate change communication has emerged over the last decade. Much of this research has focused on identifying the factors that influence people's beliefs about climate change, and the barriers to public understanding and action that exist. Using these findings, the field has identified strategies for climate change communicators and educators, emphasizing the importance of framing climate change issues in ways that help it resonate with the public's concerns and values.

Museums have much to contribute in terms of communicating climate change issues to the public and furthering civic engagement with this issue. Because this issue has become so heavily politicized, museums can leverage their position of public trust in order to educate, inform, and engender public discourse and deliberation (Kadlec, 2009). Museums, particularly science centers, zoos, and aquariums, recognize the role they can play in climate change communication and how it is central to furthering their educational missions. Several coalitions, funded by federal grant-making organizations, have formed to investigate how to interpret climate change for the public in science centers, zoos, and aquariums.

Museum exhibits and programs on climate change that were developed within the last five years are likely to have benefitted from work on climate change communication that has taken place both inside and outside the museum field. The goal of this research is to examine and

analyze the various ways museums in the United States are communicating about climate change related issues to the public. By applying the lessons learned from research in the climate change communication field, three case studies of museum exhibits on climate change issues were examined. Through these case studies the specific messages that museums are choosing to communicate, how those messages are being framed for public audiences, and the scope and purpose of the communication was explored.

Although this research does not address the effectiveness of climate change communication in museums, it provides a framework for assessing how museums are communicating currently—laying the groundwork for future research that might explore the impact of climate change communication in museums. In addition, exploring the intersection between intended impacts, messages, and audience can help inform the choices museums make when developing an exhibit or interpreting climate change and other related issues to the public. This work can serve to further illustrate how framing influences the messages imparted to visitors and why thoughtful message framing is an important aspect of climate change communication.

CHAPTER 2: Review of the Literature

Although the science of climate change is not new, scholarly work on how best to communicate it is still relatively recent. Over the last decade or so, climate change communication has emerged as a field all its own because of "a pressing need perceived by those directly involved in communicating the issue and by those who wish to support these communication efforts through theoretically and empirically founded insights" (Moser, 2010, p. 33). The first two sections of the review of literature synthesizes some of the main findings from this body of work, including the characteristics of climate change that make it challenging for people to understand, the factors that influence individuals' perceptions of risk and motivations to act, and the need to tailor communication to specific audiences by framing messages in ways that help them resonate with people's concerns and values.

The remaining sections, expand the literature to include the role of museums in communicating climate change, theory for developing better public engagement with issues, and specific findings from audience research and evaluation conducted in museums, zoos, and aquariums. Section three looks at a framework for understanding how public opinion on issues of societal import, such as climate change, evolve over time, and how this might inform the ways we choose to communicate the issue. Section four examines the role of museums in society, and how science museums in particular might play a role in increasing public engagement with social issues like climate change. Section five looks at the intersection between museum work and climate change communication—outlining findings from research that has been conducted within this intersection to date.

I. Climate Change Communication and Public Perceptions of Risk

Climate change communication has been challenged by perceived threats to certain values and self-interests. Adaptation, and especially, mitigation solutions to climate change are seen as intensely political because they require a fundamental restructuring of our largely fossil fuel-based economy. "In the United States, climate change remains a highly contested political issue as proposed solutions and policy mechanisms are viewed by some as conflicting with closely held values, priorities, and interests such as national sovereignty, economic growth, job security, and the 'American way of life'" (Moser & Dilling, 2007, p. 7). Borick and Rabe (2010) found that the strongest factor predicting an individual's belief in global warming was party affiliation. Although they found that the majority of the Americans they surveyed (7 out of 10) believed that climate change was real and that the Earth was warming, Republicans were twice as likely as Democrats or Independents to attribute the change in climate to natural, rather than human causes. A recent Gallup poll showed that this political divide still exists—75% of Democrats versus 40% of Republicans say they personally worry about global warming (Saad, 2013). The work of McCright and Dunlap (2011) further outlines the political nature of the problem. They found that liberals and Democrats were more likely to hold beliefs about global warming that are consistent with the scientific consensus and to express concern about the problem of climate change, than were conservatives and Republicans:

> The moderating effect of political orientation challenges the common assumption of climate change communicators (e.g., scientists and policymakers) that more information or education will help convince Americans of the need to deal with climate change. Particularly for those on the Right, this seems unlikely to prove effective. Our results, along with those of prior studies, show that education and self-reported understanding of global warming have little effect on the views of climate change held by Republicans and conservatives. Reducing climate skepticism among this large segment of the American populace will require far more than simply providing additional information (p. 179).

This ideological divide can be explained by a psychological phenomenon referred to by some as moral tribalism. One's group identification exerts a powerful influence on where one stand's on an issue and this in turn influences how information about that issue is interpreted because strong feelings of self-esteem and belonging are derived from exhibiting and adhering to the values of that group. Evidence that conflicts with the position, or that is derived from a morally opposed out-group member, is met with skepticism, while consistent evidence that comes from a trusted in-group member is accepted uncritically (Markowitz & Shariff, 2012). Applying this idea of moral tribalism to political parties helps to explain why Republicans and conservatives are less likely to believe in climate change. Many of the messages about climate change have been framed in ways that favor liberal rather than conservative values. "As a result, by climate change messages remaining focused on the moral priorities of liberals at the expense of those resonant with conservatives, many in the latter group have been left not just uninvolved in action on climate change, but morally hostile to it" (Markowitz & Shariff, 2012, p. 244). The related phenomenon of motivated reasoning, whereby partisan audiences interpret and process information in a biased manner based on their predisposed beliefs, can also help to explain the partisan divide. When exposed to information on climate change, due to the political contentiousness of the issue, ideological and political predispositions are activated, increasing polarization (Hart & Nisbet, 2012).

In addition to the politicization of climate change that has occurred over time, Susanne Moser (2010) argues that there are a number of other challenging traits that make climate change a tough issue for the layperson to understand and perceive as an urgent problem. Numerous studies have shown that the mental models (i.e. mental constructs about cause and effect based on prior knowledge and experience) that people hold about climate change influence their causal

thinking about how and when to address the problem (Reynolds, Bostrom, Read, & Morgan, 2010; Bostrom et al., 2012). If someone holds an inaccurate mental model of the causes of climate change, then they are more likely to respond in inappropriate or ineffective ways.

Climate change is a problem rife with complex scientific evidence that can be difficult for non-experts to integrate into their pre-existing mental models. For example, carbon dioxide and other greenhouse gases are invisible and due to time lags in the accumulation of these gases in the atmosphere and the subsequent effects on the climate system, it is difficult for people to understand the urgent need to reduce greenhouse gas emissions when they have yet to personally experience these effects. This temporal delay also makes it seem like climate change will be a problem that impacts future generations more than the current one (although recently the impacts of climate change on current populations has become more apparent) (Moser, 2010). In addition to this temporal delay, there is a perception, especially in economically-advantaged societies, that the impacts of climate change are geographically remote—affecting ecosystems and people in other parts of the world. Fewer than half of Americans believe they will personally be harmed by climate change (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2012). Markowitz and Shariff (2012) say "the consequence of this spatial and temporal distance is that victims of climate change are likely to be seen, at best, as relatively less similar to oneself than are nearby contemporaries, and at worst, as out-group members" (p. 244). When this is the case, people feel less morally obligated to act on their behalf (Markowitz & Shariff, 2012). Similarly, this distancing impacts people's perceptions of risk. Leiserowitz (2007) found that Americans perceive climate change as a moderate risk, but think the impacts will most likely affect people and places that are geographically distant. He advocates for highlighting potential local and

national impacts, current impacts, and in particular impacts on human health as a way to help people better understand the urgency of the problem.

Building this sense of urgency about climate change, comes with one particular caveat, however. Although there is no denying the importance of emotional responses in psychological perceptions of risk, climate change communicators should be mindful of fear and guilt appeals. Fear appeals are only effective in changing attitudes and motivating constructive responses when people feel personally vulnerable, have useful information about ways to respond effectively to solve the problem, have a positive self-efficacy to carry out that response, and view the cost of responding as acceptable (Moser, 2007). In other words, fear appeals must be tempered with appeals to positive emotions such as hope, pride, and empowerment. Similarly, once people understand the causes of climate change, feelings of guilt can be triggered. Even though no one person is wholly responsible, all of us are accountable for causing climate change as an unintended side effect of behavior and lifestyle choices. When feelings of guilt are triggered, people tend to "engage in biased cognitive processes to minimize perceptions of their own complicity" (Markowitz & Shariff, 2012, p. 244). This leads to defensive responses from people as they shift the blame elsewhere and focus on the costs of mitigation efforts as reasons to not engage in changing their own behavior (Markowitz & Shariff, 2012).

II. Climate Change Communication and Framing

The literature discussed so far suggests that simply providing more information is not in and of itself, the answer to improving public engagement on the issue of climate change—indicating that how the information is communicated is at least equally important. There are many factors that influence people's perception of the issue and create challenges for climate change communicators. In 2008, the Yale Project on Climate Change and the George Mason

University Center for Climate Change Communication conducted an audience segmentation analysis of the American public, and identified six "unique audiences within the American public that each responds to climate change in their own distinct way" (Maibach, Roser-Renouf, & Leiserowitz, 2009). These six segments, also referred to as the "Six Americas," categorize the American public along a spectrum based on their belief in global warming, the degree to which they are concerned about climate change, and their motivation to act to alleviate it. The six audience segments from the most concerned and motivated to the least concerned and motivated are: the Alarmed, the Concerned, the Cautious, the Disengaged, the Doubtful, and the Dismissive. The more concerned end of the spectrum tends to be comprised of liberal-leaning Democrats, while the less concerned end of the spectrum tends to be comprised of evangelical and socially conservative-leaning Republicans. These two groups vary greatly in the values and concerns they wish to uphold. This study helps those wishing to communicate about climate change identify target audiences for their communication efforts. Bostrom, Bohm, and O'Connor (forthcoming) argue, however, that six segments may be too many:

> Examination of the statistical basis for the "Six Americas" segmentation suggests that statistical fit increased with the number of segments; the analysis reported does not rule out either that as few as three segments might have sufficed to capture most of the variance in attitudes and beliefs (e.g., enthusiasts who say yes to everything and are generally pro-environment, disengaged who pay little to no attention to the topic of climate change, and discounters who discount the future, discount science, and discount climate change) rather than the six segments defined by Leiserowitz et al. (p. 3).

However, it does seem clear that there are distinct segments within the American public, and a "one message fits all" approach to climate change communication is likely to be ineffective because certain messages will resonate with the values of one segment, while eliciting strong resistance from another segment—especially when considering the two segments at opposite ends of the spectrum. The question that follows then is how to effectively tailor communication

to these audience segments in order to encourage those on the fence (i.e. the doubtful, disengaged, and cautious, or simply the disengaged if one considers there are only three segments) to become more concerned and motivated to act? Additionally, for those who are concerned and want to act, how does one effectively target this audience to ensure that they respond productively and support the most effective mitigation and adaptation policies?

Andrew Hoffman (2012) hypothesizes that climate change communicators must look for areas of common ground between the outcomes they wish to achieve (i.e. greater public engagement) and the underlying worldview of their audience.

> People interpret information by fitting it to pre-existing narratives or issue categories that mesh with their worldview. Therefore information must be presented in a form that fits those templates, using carefully researched metaphors, allusions, and examples that trigger a new way of thinking about the personal relevance of climate change (Hoffman, 2012, p.35).

In other words, messages need to resonate with people's concerns and values and be made more accessible to ensure the accurate restructuring of mental models. This idea is often referred to as "framing." Framing provides context to an issue, but the goal is not to deceive or manipulate. Rather, when the appropriate frame is used, it can make credible climate science more accessible to the public (Center for Research on Environmental Decisions, 2009). Frames can be used to pare down information and give greater weight to certain considerations or elements—emphasizing why an issue might be a problem, who or what might be responsible, and what can be done about it (Nisbet, 2009). "A frame links two concepts, so that after exposure to this linkage, the intended audience now accepts the concepts' connection. However, in many cases, a specific frame only is effective if it is relevant—or applicable—to the audience's preexisting interpretations" (Nisbet, 2009, p.17). Therefore it is key for climate change communicators to

find frames that resonate with the values and worldviews of those who are less inclined to believe in climate change and perceive it as a threat.

This can prove to be a difficult task, and recent climate change framing research has focused on demonstrating empirically the effects of proposed frames that might have wider public appeal. For example, highlighting public health or national security issues related to climate change have both been proposed as possible consensus-building frames (Nisbet, 2009). A recent study looked at the emotional reactions elicited by these two frames as well as the more traditional environmental problem frame. The researchers found that the public health frame was the most likely to elicit feelings of hope across audience segments, while the national security frame was the most likely to elicit feelings of anger across audience segments (Myers, Nisbet, Maibach, & Leiserowitz, 2012). In particular, the public health frame elicited more hope than either the national security or environmental frame among the cautious, disengaged, and doubtful segments. Similarly, Maibach, Nisbet, Baldwin, Akerlof, and Diao (2010) found that on the whole, people responded positively to an essay on health and climate change. It should be noted that although the findings from these studies lend support to the potential of the public health frame to unite a divided public, they are by no means conclusive. Although positive and hopeful reactions were elicited across segments, the alarmed and concerned segments responded more positively than the other segments did in general.

It is also interesting to note that the Maibach et al. (2010) study found that responses were more positive to information about the health benefits of mitigation policies than information about the associated health risks of climate change. The findings of Bain, Hornsey, Bongiorno, and Jeffries (2012) also indicate the importance of frames that emphasize mitigation and adaptation benefits over frames that emphasize them as a means to prevent losses. That study

found that emphasizing the societal benefit of action on climate change led to greater pro-environmental intentions among climate change deniers than a frame that emphasized avoiding the risks of climate change.

Political polarization adds another confounding dimension to framing efforts. Hart and Nisbet (2012) found that exposure to climate change messages increased polarization between Democrats and Republicans due to motivated reasoning:

> Among Democrats, exposure to messages that contained either low or high social distance cues increased support for climate mitigation. At the same time, support for climate mitigation among Republican participants exposed to messages with low social distance cues were unmoved in their support for climate mitigation compared with control while exposure to messages with high social distance cues resulted in decreased support among Republicans for climate mitigation policy (p. 716).

The authors argue that these findings suggest that framing climate change in terms of local impacts is a means to prevent further political polarization. Performing a meta-analysis of the literature on targeting and tailoring messages, Bostrom et al. (forthcoming) conclude that:

> There seems to be a general assumption that Tip O'Neill's aphorism, 'all politics is local', is accurate and meaningful for climate change. The implications of the quote seem to be that we need to show people that climate change poses a threat to their communities so that they will act to mitigate, including pressuring their elected officials to enact strong mitigation policies. While the emerging evidence on this suggests that localizing climate change is an effective strategy, there is also lots of evidence of movements that have created policy changes where major policy activists faced no threats in their communities (p. 5).

The literature on framing climate change has yet to provide clear and conclusive results as to which frames can improve public engagement, however, there do appear to be frames with greater potential than others (i.e. public health, localizing the issue, emphasizing benefits of solutions like improving our society or economy). Additionally there appears to be a consensus in the literature that framing in general is considered an important tool for climate change

communicators and that framing has demonstrable effects on audiences (Bostrom et al., forthcoming).

III. Climate Change and Public Judgment

A recurring theme in the literature is that awareness and knowledge of the science of climate change is not enough to motivate all segments of the American public to respond constructively to the problem climate change presents. When the "Six Americas" study was released in 2009, the alarmed and concerned segments comprised approximately 51% of the American public (Maibach, Roser-Renouf, & Leiserowitz, 2009). These are the two segments most concerned and motivated to act. They are also the two segments most supportive of national policies to reduce greenhouse gases. The other four segments comprised the remaining 49% (Maibach et al., 2009). Since the first study conducted in 2008, the study has been repeated twice yearly for the last three years to track the distribution of the American public among the six segments. In January 2010, the proportion of the public in the alarmed and concerned segments had dropped 11 percentage points, and the proportion in the dismissive segment had more than doubled from 7 to 16 percent (Leiserowitz, 2013). Since then, the numbers in the most concerned segments have rebounded close to 2008 levels (Alarmed, 16%, Concerned, 29%), while the less concerned segments have contracted (Leiserowitz, 2013). Other public opinion polls have also showed a general trend towards greater public acceptance of climate change in general ("More say there is solid evidence of global warming," 2012).

These studies show that public opinion on this issue is not static, but has been changing and evolving slowly over time. However, the "Six Americas" study and other opinion polls continue to show that a gap between the scientific community and public understanding continues to persist. When people are faced with issues of societal import, particularly those

whose implications can only be understood through the language of science, a noticeable gap often develops between expert and public understanding. Daniel Yankelovich (1991) argues that in order to overcome this gap, "public judgment" towards an issue needs to be strengthened. He defines "public judgment" as "the state of highly developed public opinion that exists once people have engaged an issue, considered it from all sides, understood the choices it leads to, and accepted the full consequences of the choices they make" (p. 6). Public opinion evolves into public judgment through a three-stage process:

- Stage 1: Consciousness Raising. In this stage people become aware of the problem, largely through media sources, and a sense of urgency develops as this awareness builds. As a result concern and readiness for action grows.
- Stage 2: Working Through. Once people have reached this stage, they have come to the conclusion that the issue is one that is worth addressing, and they begin seeking information about what this will mean in terms of both the impacts and consequences of action versus inaction. They also begin seeking out alternatives for dealing with the issue, weighing the pros and cons of various choices.
- Stage 3: Thoughtful Judgment. It is in this final stage where "public judgment" is realized. People have intellectually and emotionally resolved to change their behavior and act accordingly to solve the problem. When the majority of the public has reached this stage, this is where the greatest civic impact can be achieved, as sound "public judgment" influences policy decisions of governments and elites.

Sound "public judgment" on climate change has yet to be reached. Yankelovich's "Stages of Public Judgment" provide a useful framework for looking at how effective climate change communication can encourage greater public engagement. Climate change communicators

should be tailoring communication efforts at all three stages of public judgment, in order to help the public move towards a social consensus on the issue (Kadlec, 2009).

IV. Museums, Society, and Public Engagement in Science (Climate Change)

Over the last fifty years, museums have shifted their focus from an inward approach centered on collections care and exhibitions, to an outward approach centered on museum visitors and providing them with educational and social services. Lois Silverman (2010) says this about the evolution of the museum field in general:

> Museums have long been considered institutions that benefit society, most familiarly through the activities of collecting, preserving, and educating about valuable artifacts and art. Today, the world's museums are embracing starkly bolder roles as agents of well-being and as vehicles for social change (p. 2).

This outward shift in focus has altered the relationship between museums and their communities, and as a result, museums have begun to measure and evaluate success in terms of the impacts they have on their audience and community. "Museums then, have been required to develop new goals that respond to local and global social concerns, to articulate and justify their value in social terms, to demonstrate and measure their impact and to develop new working practices to reflect these trends" (Sandell, 2007, p. 5).

Looking at science museums in particular, Larry Bell (2009) argues that museums have a vital role to play in communicating science issues by taking a social science approach. "A social science approach suggests that science museums should build more social science perspectives, societal implications, ethics, and public policy issues into exhibits and programs. Museums should strive to increase public knowledge about societal implications of new and current technologies" (Bell, 2009, p. 25). In order to do this, Bell advocates for cooperation between science museums and experts in the social science field.

Alison Kadlec (2009) also argues for the civic potential of science museums, and the urgent need for them to realize this potential:

> In an age when an increasing number of pressing public problems are marbled with scientific and technical complexity, the need to bridge the confounding gaps that exist between science and public life is more urgent than ever. Because they hold public trust as nonpartisan cultural centers, museums can impact civic issues on wide-scales without becoming politicized, and thus promote improved public problem-solving around vexing problems such as climate change, our energy future, and twenty-first century workforce development (Kadlec, 2009, p. 37).

Kadlec cites Daniel Yankelovich's "Stages of Public Judgment" as a way to explore how museums might realize their civic potential by acting as nonpartisan intermediaries, aiding the public's movement through the three stages and towards sound "public judgment." The role she sees museums playing at each stage are outlined below:

- Stage 1: Consciousness Raising. As awareness is raised, urgency to confront the problem grows. Sometimes this can lead to people feeling overwhelmed or fearful about their ability to realistically solve the problem—resulting in disengagement with the issue. Given that the awareness raising that occurs during this stage is largely driven by the media, museums can help by channeling this growing sense of awareness into greater public engagement by leveraging their ability to inspire awe, wonder and hope. They can also provide information that acts to dispel the myths and misconceptions that tend to be prevalent at this stage.
- Stage 2: Working Through. In this stage, museums can help the public grapple with their choices and options by framing the issue for deliberation. To generate constructive public discussion and debate, museums can provide information about the range of approaches to dealing with a problem and the trade-offs associated with each.

- Stage 3: Thoughtful Judgment. At this stage people have intellectually and emotionally resolved to change their behavior and act accordingly to solve the problem. Therefore, people at this stage are in need of information, ideas, and community resources that will help them translate these resolutions into practice. Museums can accomplish this by providing their visitors with the necessary information and resources to facilitate behavior change. They can also facilitate and inspire active involvement in the community and the decision-making process.

V. Museums and Contemporary Climate Change Communication

Given the evolution of thinking about the purpose of museums, and the role of science museums in particular, museums have good reason to be involved in communicating and interpreting climate change for the public. Museums, particularly science centers, zoos, and aquariums, recognize the role they can play in climate change communication and how it is central to furthering their educational missions (Grajal, 2012). Several coalitions, funded by federal grant-making organizations, have formed to investigate how to interpret climate change for the public in science centers, zoos, and aquariums. Therefore, this last section of the review of literature will highlight some of the work that has occurred as a result of these partnerships between museums, non-profits, and other formal and informal science education institutions to address climate change communication challenges.

Communicating Climate Change (C3) is a project funded by the National Science Foundation (NSF). This project is led by the Association of Science and Technology Centers (ASTC) and twelve science centers collaborating with local research centers to develop programs, exhibits, and citizen science projects related to climate change that will "expand the role of science centers in educating the general public and inspiring changes in attitudes and

concerns about climate change" (McCracken, 2009). Front-end evaluation conducted for this project found that there are some climate change related topics that are of common interest to visitors despite the differences in their beliefs regarding climate change. These topics included the impacts of climate change on human health, the current evidence for climate change globally and locally, and the impact of climate change on the visitor's region.

The C3 project also partnered with the Yale Project on Climate Change to conduct the "Six Americas" study among visitors to science centers and compare the knowledge levels of frequent and occasional visitors to science centers with non-visitors on the topic of climate change. In general, a larger portion of frequent visitors to science centers are alarmed or concerned than occasional or non-visitors. The occasional and non-visitor samples more closely resemble the national averages across the six segments. This study also found that those who frequently visited science centers had a higher level of knowledge about climate change than occasional or non-visitors, but that in-depth understanding of the issue was lacking across all three groups—leading to misunderstandings about the causes and solutions to climate change. This relates back to work from the climate change communication field on mental models (Bostrom & Lashof, 2007; Reynolds et al., 2010; Bostrom et al., 2012). One other important finding was that frequent and occasional museum visitors rank informal science institutions, like science centers and museums, among the most trusted sources of information on climate change (Leiserowitz & Smith, 2011).

ASTC also conducted audience research, in conjunction with Reach Advisors, to understand which science policy issues are of the greatest interest to the public. The majority of survey participants (79%) chose "the environment and climate change." As compared with the other topics examined in the survey, visitors responded emotionally to the topic of the

environment and climate change (Wilkening & Chung, 2009). "The clear thread running through [visitor] comments is that our future is imperiled; that, even more important, our children will see dramatic changes due to climate change; and that education now is imperative to ensure a future for our children" (Wilkening & Chung, 2009, p. 12). The researchers also found that in general people wanted to know the basics of the scientific topics, then move on to understanding how they relate to their daily lives (i.e. the social context of the issues).

Another NSF funded project, the Climate Literacy Zoo Education Network (CLiZEN) is also tackling climate change communication, but in zoo and aquarium settings. The goal of CLiZEN is "to develop a new approach to climate change education, an approach that encourages people to make personal connections to climate change by activating their sense of caring and concern for charismatic animals whose very existence is threatened due to human behavior" (Grajal, 2012, p. vii). An e-book titled *Climate Change Education: A Primer for Zoos and Aquariums* was published in 2012. This text is meant to be a guide for climate change interpreters working in zoo settings. It incorporates findings from the climate change communication field and audience research conducted in the partner zoo organizations.

The National Network for Ocean and Climate Change Interpretation (NNOCCI) is another NSF funded project that is focused on improving interpretation of climate change issues related to the oceans. One of the project partners, the FrameWorks Institute, has been conducting research on public perceptions of climate change and oceans over the past decade. Drawing on this research, as well as the work of "opinion scholars," the FrameWorks Institute claims "the issue will have to be reframed to induce more systems thinking, to connect humans to the environments and chain of life that affect us, and to emphasizing causes and solutions, not merely impacts" (Bales, 2009, p.4).

CHAPTER 3: Methods

I. Research Goal and Questions

The goal of this research is to examine and analyze the various ways museums in the United States are communicating about climate change related issues to the public. In order to accomplish this goal, the research was focused around answering the following questions:

1. What messages are museums communicating?
2. How are museums framing these messages for public audiences?
3. What is the scope and purpose (intended impact) of the communication?

II. Sampling

Three case studies of museum exhibits dealing with climate change and/or the related issues of environmental impact and sustainability were chosen. The following criteria were used in selecting the three case study sites:

1. Have an exhibit related to climate change on display that was installed within the last five years.
2. Have a mission related to conservation of the natural world or public understanding of science (i.e. a science or natural history museum).
3. Have an annual budget of at least $15 million. This requirement was to ensure that the chosen institutions have greater institutional capacity, receive large numbers of visitors each year, and are nationally recognized.
4. The museums selected needed to be geographically diverse and not confined to one region of the United States.

5. The three exhibits chosen needed to deal with climate change in varying degrees in order to tease apart how this might affect the framing of messages.

Three science centers were selected that met these criteria:

A. Marian Koshland Science Museum (The Koshland) in Washington, D.C.
B. Science Museum of Minnesota (SMM) in St. Paul, Minnesota
C. Oregon Museum of Science and Industry (OMSI) in Portland, Oregon

The exhibit at the Koshland talks exclusively about climate change, the exhibit at SMM talks about climate change as it relates to other impacts humans have on the planet, and the exhibit at OMSI deals with sustainability—an issue tangential to climate change.

III. Methods

A mixed methods approach was used to collect data sources for this study. The data was coded and analyzed for trends related to the research questions. The sources are listed below and also summarized in Table 3.1:

Site Observations. Each of the three case study sites was visited in person to make site observations and take photographs of all the labels and interactive elements in the exhibit. These photographs and the observations became the primary sources that were coded to answer the research questions.

Semi-structure Interviews. Semi-structured interviews with at least one museum staff member at each institution were conducted. Possible participants were identified based on their involvement in the development of exhibit content. These individuals included principal investigators identified on the grant award abstract for the exhibit and/or exhibit content development staff identified on the museum's website. Staff members were contacted via email and were asked to provide contact information for any other staff

members that may have been involved in the exhibit development or evaluation. Those individuals that responded and agreed to participate were those interviewed. Interviews included: two at the Koshland, two at SMM, and one at OMSI. Each participant was asked questions related to the challenges involved and the intended impact of each exhibit. Interviews were either conducted on site during my visit to the museum, or via phone or Skype. Further detail about the questions and instruments can be found in the next section. The interviews were mainly used as sources for contextual information about the exhibits.[1]

Document Analysis. In some cases, the interviewed staff members provided evaluation reports and internal exhibit development documents. These documents were helpful in providing context during analysis.

Website Content. Each of the three exhibits had an associated website. This online content was an additional source of information about the exhibits. This content was not coded during analysis.

[1] IRB exemption was applied for and granted on March 19, 2013.

Table 3.1. Data Sources

	Koshland	*SMM*	*OMSI*	*Coded for Analysis?*
Site Observations	Photographs of all labels and digital interactives, observation notes	Photographs of all labels and interactives, observation notes	Photographs of all labels and interactives, observation notes	Yes
Interviews	1. Director 2. Former Deputy Director	1. Project Leader, Science and Social Change 2. Program Director, Global Change Initiatives	1. Senior Exhibit Developer	No
Documents	Statement of Task	Front-end evaluation report ("Six Americas" SMM Audience Segmentation Analysis)	Front-end evaluation report, exhibit descriptions	No
Exhibit Website	https://www.koshland-science-museum.org/explore-the-science/earth-lab#.UaZm1Y4n9Ko	http://www.sciencebuzz.org/earth	http://choices.omsi.edu/	No

IV. Instruments: Semi-structured Interviews

The interviews focused on the following topics:

- The intended goals and messages of the exhibit.
- The programming created to accompany the exhibit. How does the programming relate, supplement, or support the exhibit's messages?
- The role evaluation and audience research played in the development of the exhibit.
- Successes and challenges experienced around creating the exhibit and programming.

- Resources both inside and outside the museum field that were used to help with the construction of messages for the exhibit.
- Challenges of creating effective climate change messages for the public in general.
- Concerns regarding messaging that are unique to the institution or audience.

Semi-structured interviews were used as they allow one the freedom to pursue questions and topics as they arise during the interview—providing richer and deeper data for analysis. The questions asked during the interviews can be found in Appendix A.

V. Instruments: Coding Book for Site Observations

A detailed coding book (Appendix B) was created for coding all data sources collected during site observations. These data sources included photographs of all exhibit labels and interactive elements, as well as observation notes made during the site visit about the interactives. Each label and interactive constituted a separate code-able unit. There were four categories of coding employed. The first two categories emerged from the data, while the second two categories were a priori and based on the theory and literature that was reviewed:

Category 1. Exhibit Concepts – these codes emerged from the exhibits themselves as well as the information provided by museum staff during the interviews. These codes identify the major themes and messages in each exhibit, and help to answer the first research question: What messages are museums communicating?

Category 2. Connection to Climate Change – these codes were developed to understand how closely the exhibit content is related to the science of climate change.

Category 3. Message Frames – these codes were designed to help with answering the second research question: How are museums framing their messages for public audiences? A report, titled "The Psychology of Climate Change Communication" (2009)

published by the Center for Research on Environmental Decisions at Columbia University, provides a research-based "toolbox" of frames that climate change communicators can use to employ to help messages resonate with the diversity of values and worldviews present in the American public. This report, in conjunction with the findings from the other sources consulted for the literature review, was instrumental in determining the codes for this category. These codes were classified into five categories: context frames, solution frames, scope frames, action frames, and immediacy frames. The literature used to develop each of the codes is included below:

1. **Context Frames**: These frames work to provide context for the issue in terms of making it resonate with people's concerns and values. There are four codes for this category—environmental stewardship, economic development, social well-being, and public health (Leiserowitz, 2007; Center for Research on Environmental Decisions, 2009; Nisbet, 2009; Maibach et al., 2010; Myers et al., 2012).
2. **Action frames**: These frame the consequences of action or inaction on the issue (i.e. what we stand to lose or gain by responding to the issue). There are two codes for this category—promotion focus and prevention focus. Research has shown that some people are more prevention focused and will be more motivated to act if by doing so they minimize losses, while others are promotion focused and are more likely to act if they will maximize benefits (Center for Research on Environmental Decisions, 2009; Bain et al., 2012).
3. **Scope Frames**: These frames provide context in terms of geographic and social distance. Many people still perceive climate change as something that will affect

people and ecosystems in other parts of the world (Leiserowitz, 2007; Moser, 2010; Hart & Nisbet, 2012; Bostrom et al., forthcoming). There are three codes for this category—global, national, and local.

4. **Immediacy Frames**: These frames are about the timeline associated with the issue. One of the barriers to understanding and action on climate change is that people often feel removed both spatially and temporally—lowering their perception of risk and urgency to act (Leiserowitz, 2007; Moser, 2010). There are two codes for this category—current issue and future issue.
5. **Solution frames**: These frames imply that the problem is solvable and where the responsibility for solutions lies. There are two codes for this category—ingenuity/innovation and shared responsibility (Moser, 2007; Bain et al., 2012).

Category 4. Stages of Public Judgment – these codes were developed using David Yankelovich's "Stages of Public Judgment" as outlined by Alison Kadlec (2009). Kadlec argues that museums can engage the public at each stage and move people towards better understanding and engagement with issues that affect them, such as climate change. These three stages were used as a framework for identifying and analyzing the scope and purpose of the exhibit messages in relation to the intended impact goals and audience. These three stages make an ideal framework because they not only provide a context for understanding where an audience may be in terms of their engagement with an issue, but also the ways in which communication can impact audiences at each stage to move them forward to the next. In other words, these three stages can give insight into both who may be affected by the communication (scope) and to what end (purpose).

The detailed coding book for coding categories 3 and 4 (a priori codes) can be found in Appendix B. The coding book provides the codes developed for each category, a definition for each, and an example from each exhibit to illustrate the definition. Coding categories 1 and 2 (emergent codes) will be discussed in further detail in the next chapter.

VI. Data Analysis

All coding and analysis of the collected sources was completed using the qualitative analysis software, NVivo. Each photograph of an exhibit label or interactive element was considered a single code-able unit. Each of these units was coded for any of the coding categories that were applicable, using the definitions from the coding book. This means that each code-able unit could be assigned multiple codes—one from each category or multiple codes from the same category (See Figure 3.1 and Table 3.2 for an example).

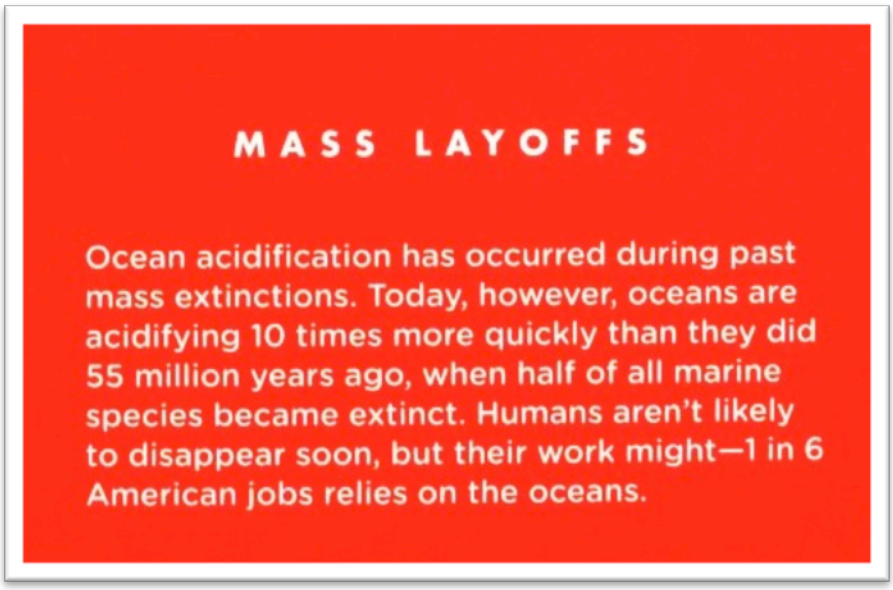

Figure 3.1. Coding Example
This label from the Future Earth exhibit at SMM was coded for Category 1, 2, 3 and 4. The table below shows what codes were assigned for each category.

Table 3.2. Coding Example

Coding Category	***Coded for…***	***Why?***
Category 1. Exhibit Concepts	Human impacts	"oceans are acidifying 10 times more quickly than they did 55 million years ago"
Category 2. Connection to Climate Change	Explicit	"Ocean acidification" is a related problem of climate change.
Category 3. Message Frames	Context frames: 1. Environmental stewardship 2. Economic development	 1. "mass extinctions" "half of all marine species became extinct" 2. "their work might—1 in 6 American jobs relies on the oceans"
	Action frames: Prevention focus	"half of all marine species became extinct" "Humans aren't likely to disappear soon, but their work might" Both statements imply that we will lose something if we don't act.
	Immediacy frames: Current	"Today" and "disappear soon"
	Scope frames: National	"American jobs"
	Solution frames: None	Nothing about solutions in label
Category 4. Stages of Public Judgment	Stage 1	Provides information that helps raise awareness of why ocean acidification is a problem we should be concerned with.

Category 3 (Message Frames) and category 4 (Stages of Public Judgment) were developed prior to the coding process, and these codes did not evolve or change during data analysis. However, Categories 1 (Exhibit Concepts) and 2 (Connection to Climate Change) emerged upon reviewing the data. Category 1 began to emerge as information from the interviews and documents were reviewed, and as the photographs and observation notes taken during the site observations were reviewed. The educational goal and key messages of the

exhibit, as articulated by the interviewees, were considered during the development of codes for this category. Because these goals and messages were unique to each exhibit, different codes for each exhibit were developed. At the end of the coding process, similarities between the codes that developed from each exhibit were identified. This idea will be explored further in the next chapter.

Category 2 emerged from the varying degree to which each exhibit referenced climate change. This emergent coding category was developed during the coding process for Category 1 as a means of identifying which messages and themes dealt with climate change directly, and which did not.

The data sources from each exhibit were coded separately. In other words, all the data from the Koshland exhibit was coded first, then the SMM, and finally the OMSI exhibit. Each exhibit was coded for category 1 first, and then category 2 as it emerged from the coding process for category 1. Categories 3 and 4 were coded next simultaneously. Once data from all three exhibits had been coded, each coding node within the categories was reviewed using NVivo. This second round of coding was done as a quality control measure to ensure that nothing had been assigned the wrong code and to double check agreement with how the data was coded from the first round. During this process, some data was recoded, as understanding of the coding categories had deepened during the process in terms of what to look for—particularly for categories 1 and 2. The first round of coding was much more detailed and during this second round of coding, some coding nodes were combined and collapsed, as some nodes were similar or provided unnecessary and extraneous detail.

CHAPTER 4: Results and Discussion

I. Overview of Case Study Sites and Exhibits

This section provides a brief summary and background of the case study museums and chosen exhibits. This information provides context for the discussion of the results that follow. Photographs of the exhibits can be found in Appendix C.

***Earth Lab: Degrees of Change* at the Marian Koshland Science Museum.** The Marian Koshland Science Museum (The Koshland) in Washington D.C. is the public outreach branch of the National Academy of Sciences, a private non-profit that plays an advisory role to the federal government. Scientists from the National Academies produce reports on current science that help to further understanding of science and technology and the roles they play in public life. The museum opened in 2004 and all of the Koshland's exhibits are based on the information contained in reports from the National Academies. In addition, a Scientific Steering Committee, consisting of scientific experts in a wide range of fields, is assembled to advise during all stages of exhibit development and design. The Koshland's target audience is unique amongst science museums, mainly consisting of teens and adults, rather than family groups with young children.

The museum's current exhibit on climate change, *Earth Lab: Degrees of Change*, opened in 2011 and is the second climate change exhibit the museum has developed. Patrice Legro, the museum's Director, noted that the museum chose to do a new exhibit on climate change, after noticing from front-end surveys of museum visitors and the general public, that a shift had occurred in the type of information people were seeking about climate change. In the interview, she stated:

> Everything we had was all around the evidence. And of course that was back in 2004. People coming into the museum where asking: is it real? So that exhibit really addressed the evidence, and what we found by 2008 is that they were asking different questions.

> Instead of is it real, they were saying: okay we got it, now tell us what to do about it (personal communication, April 11, 2013).

The previous exhibit had mainly focused on the causes and evidence for climate change, but in 2008 they began to notice that their audience wanted to know more about the potential actions for mitigation and adaptation. Therefore, the current exhibit was designed to reflect this shift in audience perception.

When development of an exhibit at the Koshland begins, a document known as a Statement of Task is developed to outline the key messages and educational goal of the exhibit. According to this document, the educational goal of the *Earth Lab* exhibit is that visitors "will find answers to their questions about recent climate change, will explore the vulnerabilities and impacts of climate change, and will gain a greater understanding of how to mitigate future climate change and adapt to its effects."

The *Earth Lab* exhibit centers around a digital interactive "game" that deals with decision-making and climate change mitigation. In the "game" visitors take on the role of a policy maker in order to decide how we as a nation should respond to climate change. Visitors are first asked to prioritize and rank a set of four values: cost savings, air quality, land preservation, and oil independence. In the next step of the game, visitors are given a set of mitigation strategies to choose from, and are tasked with the goal of lowering greenhouse gas emissions from current levels to 203 parts per million by 2050. Through the game's interface, visitors can begin employing mitigation strategies, while keeping in mind the values they had prioritized at the beginning. When conflicts arise between the visitor's values and the mitigation options they choose, the game interface alerts them, and prompts them to adjust one of the two in order to resolve the conflicts and reach the final goal—thereby demonstrating the trade-offs inherent in the decision-making process. The final step in the "game" extrapolates the visitor's

mitigation strategy to a global level—comparing their strategy to "business as usual," and showing what the subsequent rise in global temperature will be.

There are a total of five digital interactives in the exhibit, including the mitigation simulator described above. The other four interactives deal with the following: the processes that contribute to climate change, the role human activities, particularly energy production, play in greenhouse gas emissions, the current and predicted impacts of climate change, and the importance of models in understanding climate change and predicting the outcomes of our actions. Other elements in the exhibit include labels, pictures, videos, and a few artifacts.

The Koshland has not conducted a summative evaluation of the exhibit yet to measure whether the educational goal is being met. However, remedial evaluation was conducted on the mitigation simulator interactive. This evaluation found that people were getting the main takeaway that there are many factors, issues, and values to consider when making decisions regarding climate change mitigation. Evaluation regarding dwell times in the museum has shown that people who do engage with the exhibit, engage for long periods of time. People tend to spend most of their time in the exhibit with the first wall and decision table. Less time with the last wall about mitigation and adaptation. (P. Legro, personal communication, April 11, 2013; E. Shugart, personal communication, April 16, 2013)

***Future Earth* at the Science Museum of Minnesota.** The Science Museum of Minnesota (SMM) in St. Paul, Minnesota says their mission is to "turn on the science: realizing the potential of policy makers, educators, and individuals to achieve full civic and economic participation in the world" ("Science Museum of Minnesota - About Us," 2013). The *Future Earth* exhibit was funded by a grant awarded from NSF in 2008 for SMM's Future Earth Initiative, and opened at the museum on Earth Day in 2012. The exhibit deals with the

Anthropocene epoch—an informal term coined for the latest geologic epoch in Earth's history due to the significant impact of human activities on the planet. *Future Earth* talks about the various ways humans have altered the planet's terrestrial ecosystems, ocean, and atmosphere—climate change being one of them. The *Future Earth* exhibit is intended for SMM's current audience, which includes mostly family groups with young children and a growing number of adult groups as well.

SMM conducted front-end evaluation of their audience prior to developing the Future Earth exhibit. This evaluation involved conducting their own version of the Six Americas study, using an abbreviated survey from that study, to determine how their audience was distributed among the six segments. They found that their audience was statistically indistinguishable from the national sample:

> The main differences between SMM visitors and the general public are between proportions of people with disengaged and dismissive attitudes. Fewer SMM visitors are disengaged, but more are dismissive than in the general public. However, the overall sample of SMM visitors is statistically indistinguishable from the larger population. To track change over time, Leiserowitz, Roser-Renouf, and Maibach (2010) collected another round of global warming attitudes at the same time as this study was underway; SMM data were statistically indistinguishable from either set. (Phipps, 2010).

Patrick Hamilton, the Principal Investigator on the *Future Earth* project mentioned that they focused the exhibit on reaching the segments in the middle: "We weren't going to change the minds of the deniers, but there is this middle group--cautious, disengaged, and doubtful, that according to the research we thought could be influenced particularly in the context of a museum visit" (personal communication, April 26, 2013). He went on to say that even though the alarmed and concerned are worried about the issue, that doesn't mean they are necessarily well informed, so they felt that these segments would still get value from the exhibit. This implies that the exhibit is designed for a very broad audience (i.e. the general public at large).

The educational goal of the exhibit was for visitors to understand and articulate in their own words the three main messages of the exhibit, which are:

1. Humans now dominate the planet and are changing planetary systems in significant ways.
2. Today's populace has remarkable human assets that will help us deal with the challenges these changes will create.
3. We need to take advantage of these assets and innovate now in order to ensure that we, and our planet, continue to thrive well into the future.

Mr. Hamilton noted that the second message was one that was missing somewhat from the exhibit, and was going to be added in the near future. This is not the only change in store. Very recently, subsequent to visiting the museum for this research, the physical layout of the exhibit was changed in order to improve the flow of visitors through the exhibit and to help them better understand the connections between the different exhibit elements. Mr. Hamilton also conveyed that some additional changes to the exhibit graphics are planned. A summative evaluation of visitor's reactions to and understanding of the exhibit's key messages will not be conducted until all these changes have taken place.

The exhibit includes labels, graphics, hands-on interactives, and videos. Just off the exhibit's main area, is the Planet Earth Decision Theater, where the museum's Science on a Sphere (SOS) is being used as part of an interactive, presenter-led program that reinforces the exhibit's three main messages. Audience members are surveyed about their knowledge and opinions by answering multiple choice questions posed by the presenter during the program. The audience members submit their answers via a device known as an iClicker, and an anonymous bar graph of how people answered is generated. The questions posed are designed to lead the audience through the key messages and to gauge people's opinions related to those messages.

When this program is not taking place in the theater, a film about agriculture and food production, titled "Two Billion More Coming to Dinner," runs on a loop on the SOS. A third theater piece, utilizing objects and the SOS was still in development at the time this paper was written.

Clever Together: Our Everyday Choices **at the Oregon Museum of Science and Industry.** The Oregon Museum of Science and Industry (OMSI) in Portland, Oregon, is "dedicated to improving the public's understanding of science and technology. OMSI makes science exciting and relevant through exhibits, programs, and experiences that are presented in an entertaining and participatory fashion" ("About OMSI," 2013). *Clever Together: Our Everyday Choices* is a bilingual (English/Spanish) exhibit on sustainability and is supported by a grant from the National Science Foundation (NSF) awarded in 2009 (DRL-0917595). The exhibit opened as a permanent addition to the museum's Earth Hall in 2012.

Clever Together is not really about climate change, but about the tangential issue of sustainability. This exhibit was chosen as one of the case studies for two reasons:

1. In order to look at a sustainability exhibit to see how messages about climate change were incorporated, and whether there were any differences in how those messages might be framed and contextualized.
2. The grant award abstract that was reviewed prior to visiting the exhibit implied that a connection between climate change and sustainability would be explicitly made in the exhibit. The abstract stated that "the project responds to calls for broad environmental education of the public in response to environmental crises (such as climate change), and specific research suggesting that even museums that do provide information about such

issues rarely help their visitors learn to make the comparisons necessary to make more sustainable choices" ("Award Abstract #0917595," 2009).

The *Clever Together* exhibit defines sustainable decision-making in terms of the well-being of "three pillars": our environment, society, and economy. Of the three case study exhibits, this exhibit has the most specific target audience: both English and Spanish speaking family groups from the Portland metro region, with a special emphasis on reaching 10 to 17 year olds. This is the only exhibit that focused the exhibit content on the community in which the museum resides. Kari Jensen, Senior Exhibit Developer, said: "We wanted to make the exhibit about our community, but by our community and for our community too" (personal communication, April 15, 2013).

Front-end evaluation was conducted to determine both the English and Spanish-speaking audience's perceptions and understanding of sustainability and their decision-making process with regards to sustainable choices, including difficulties and barriers to making those choices. Ms. Jensen provided a summary report of this front-end evaluation during her interview. This front-end evaluation found that the public, especially the English-speaking public, mainly perceived sustainability in terms of environmental practices such as reducing waste and conserving natural resources. Both audiences were able to identify activities that they already engage in that have positive impacts on the sustainability of their community, but also indicated that some of these activities were things that they did not engage in as frequently as they would like. The reasons given for less frequent engagement included constraints of time, lack of money or high cost, and lack of knowledge or access to information that would help them make better choices. Another finding that has bearing to this research is that the public expressed a strong belief that individual actions could have strong positive impacts on the sustainability of their

community. These findings together suggest, that the target audience of OMSI values sustainability and may be looking for information that will help them overcome barriers that prevent them from engaging in sustainable behaviors as frequently as they would like. During the interview, Ms. Jensen stated: "We were going for people who had already started thinking about what they could do, that's where Portlanders are in general. People here value environmental behaviors and sustainability and they are willing to do a little bit more" (personal communication, April 15, 2013).

The main idea of the exhibit is that "We can cultivate a more sustainable community by building skills and making decisions that maximize positive impacts" (K. Jensen, personal communication, April 15, 2013). The intended educational goals of the exhibit are for visitors to:

1. gain a more holistic understanding of sustainability as a balance of environmental, social, and economic considerations (the "three pillars")
2. engage with choices they make in their everyday lives in the Portland metro region, that can have the greatest impact on the sustainability of their community.
3. practice real skills that they can incorporate into their everyday lives at home.

The exhibit examines choices about transportation, food, consumption of materials, and energy use. It does so through labels, hands-on interactive elements, colorful graphics, and stories from real Portlanders who are making sustainable choices. The exhibit itself was also developed with sustainability in mind. A green exhibit checklist, developed by OMSI, was consulted during the design, fabrication, and installation process. Labels in the exhibit highlight some of the decisions the exhibit designers had to consider when making the exhibit. These decisions include what materials to use in exhibit fabrication as well as thinking about equity and making the exhibit as inclusive of as many Portlanders as possible. A summative evaluation of the exhibit has yet to be

conducted, but formative and remedial evaluation of exhibit interactives were conducted during the design process and shortly after install.

II. Exhibit Concepts

Four exhibit concept codes (category 1) emerged from the *Earth Lab* exhibit at the Koshland: 1) the evidence and causes for climate change, 2) the current and future impacts of climate change, and 3) the possible solutions for mitigation and adaptation. Table 4.1 below lists some of the exhibit elements that were coded for each of the concepts. Pictures of the exhibit elements can be found in Appendix C.

Table 4.1. *Earth Lab* Exhibit Concepts

Code	***Exhibit Elements***
Evidence and causes	Changes wall, Causes wall, Trends wall, CO2 explorer, models interactive
Impacts	Effects wall, Impacts explorer, Mitigation Simulator
Solutions	Adaptations wall, Mitigation Simulator, Mitigation wall, models interactive

Of the three case studies, this exhibit was "the climate change" exhibit. The exhibit dealt directly with climate change from start to finish and did not bring in any other environmental issues or problems. Therefore, 100% of this exhibit was coded as "explicit" for category 2 (Connection to Climate Change). The causes and evidence for climate change focused on human activities that produce carbon emissions and how natural variations are not enough to explain the observed temperature rise. The impacts of climate change included sea level rise, ocean acidification, extreme weather events, and the effects these will have on ecosystems and human societies. The adaptation and mitigation strategies for reducing greenhouse gases covered in the exhibit are from a policy-making level in terms of what governments, industries, and businesses can do.

The exhibit concept codes that emerged in the *Future Earth* exhibit at SMM were: 1) human activities that impact planetary systems, and 2) innovative solutions that can and are being developed and used to meet the challenges our human impact has created. Table 4.2 below lists some of the exhibit elements that were coded for each of the concepts. Pictures of the exhibit elements can be found in Appendix C.

Table 4.2. *Future Earth* Exhibit Concepts

Code	***Exhibit Elements***
Human impacts	Agriculture Issues panel, Agriculture interactive, Atmosphere interactive, Atmosphere wall, Ocean acidity interactive, Ocean Issues panel
Innovative solutions	Agriculture Solutions panel, Exergy interactive, Flow score interactive kiosk, Ocean Solutions panel, Atmosphere wall, "Follow a sunbeam" flipbook

As mentioned in the previous section, this exhibit is not focused only on climate change. In fact the overall topic of this exhibit is "the anthropocene," although this term is never used directly. This is an informal term coined for the latest geologic epoch in Earth's history due to the significant impact of human activities on the planet. *Future Earth* talks about the various ways humans have altered the planet's terrestrial ecosystems, ocean, and atmosphere. Climate change is covered in the atmosphere portion of the exhibit. Some of the other topics include land-use and agriculture, population growth and urban development, and the climate change related issue of ocean acidification. The exhibit covers the impacts of our actions and the possible solutions for dealing with the problems this creates for each of these. About half of the exhibit elements were coded as "explicit" for category 2 (Connection to Climate Change). The elements coded for this came from the areas of the exhibit that covered the atmosphere and ocean.

Three exhibit concept codes emerged from the *Clever Together* exhibit at OMSI: 1) defining sustainable decision-making, 2) behavior choices and their impacts, and 3) sustainable actions visitors can take to make a positive impact. Table 4.3 below lists some of the exhibit elements that were coded for each of the concepts. Pictures of the exhibit elements can be found in Appendix C.

Table 4.3. *Clever Together* Exhibit Concepts

Code	***Example***
Defining sustainability	Introductory area panels, "We make clever choices!" interactive & panel
Behavior choices and impacts	"We are energy savers!" panel, "We prevent food waste!" panel, "We use human power!" panel, "We know our options" panel, "We are super sorters!" panel, "We take public transit!" panel, Making of the Exhibit panels
Sustainable actions	"We are energy savers!" interactive, "We prevent food waste!" interactive, "We use human power!" interactive, "We know our options" interactive, "We are super sorters!" interactive, "We take public transit!" interactive, Making of the Exhibit panels

There was only one direct reference that connected the concept of sustainability and climate change in the exhibit (see Figure 4.1). This was coded as "explicit" for category 2 (Connection to Climate Change).

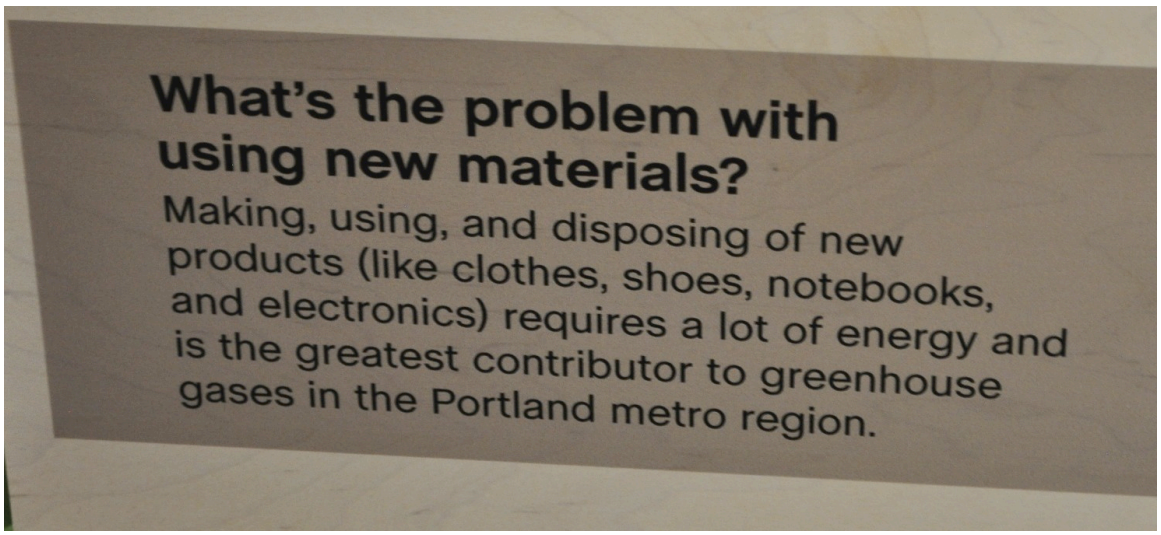

Figure 4.1. The one reference to climate change in the *Clever Together* exhibit.

III. What Messages Are Being Communicated?

The three case study exhibits represent a range of climate change related messages—ranging from a very specific environmental context, as seen in the Koshland exhibit, to a more general environmental context as seen in the OMSI exhibit. Although the three exhibits covered different concepts related to climate change, it is interesting to note where the messages were conceptually similar. All three exhibits had messages about impacts and solutions:

1. Impacts: What effects will climate change, human activities, and more sustainable choices have on ecosystems and people? In the Koshland exhibit, this was the concept area coded as "impacts." In the SMM exhibit, this was the concept area coded as "human impacts;" and in the OMSI exhibit, this was the concept area coded as "behavior choices and their impacts."
2. Solutions: What can we do to improve the current and future situation? In the Koshland exhibit, this was the concept area coded as "solutions;" in the SMM exhibit, this was the concept area coded as "innovative solutions;" and in the OMSI exhibit, this was the concept area coded as "sustainable actions."

Across all the exhibits, the concepts that align with these two messaging areas were coded in fairly equal proportion. Staff members, interviewed at all three museums, mentioned that they wanted to avoid making visitors feel depressed, scared, or guilty. They wanted to represent the science accurately, but also wanted to leave visitors feeling hopeful. One way they attempted to accomplish this was by balancing their messaging to not only include the impacts of the problem, but also the solutions or actions that could be taken to address it. By spending equal time on impacts and solutions, you can keep people hopeful that the challenges the impacts present can be overcome.

It is clear that the messages in each exhibit were crafted with the intended audience in mind. Each museum conducted front-end evaluation that helped to inform decisions about what to include in the exhibit for their target audience. For example, the Koshland used their front-end evaluation to determine what kind of scientific information about climate change their visitors were seeking. This led them to include more information about mitigation and adaptation strategies. Thinking about the OMSI exhibit, the findings from the front-end evaluation may help to explain why there was only one explicit connection between climate change and sustainable choices. They found that their target audience valued sustainability, and it is often assumed that those who value sustainability already have a basic understanding of why it is important.

IV. Message Frames

All three case study exhibits were coded for five different frame categories: Context frames, action frames, scope frames, immediacy frames, and solution frames. Definitions for each code within the category can be found in the coding book in Appendix B. Coding was completed using NVivo, as described in Chapter 3. Every time a label or exhibit element was coded for one of the message frame codes NVivo recorded this as a single reference for that code. In order to identify trends and patterns in the data, NVivo code matrix queries were used to see how frequently each code showed up in the data sources from the three case study exhibits.

Context Frames. All three exhibits used each of the four context frames. The table below provides some representative examples from exhibit labels to illustrate how the different exhibits employed each frame.

Table 4.4. Context Frame Examples

Code	*Koshland*	*SMM*	*OMSI*
environmental stewardship	"Changes in climate have contributed significantly to **outbreaks of the mountain pine beetle** in North America."	"But reducing the carbon dioxide we put in the air and conserving coral reefs, **we can sustain the oceans** we depend on."	"We will also **protect the environment** by using less water, fertilizer, and energy to produce food in the first place."
economic development	"Compact biogas plants offer a clean, **affordable**, sustainable, and reliable renewable fuel source for thousands of rural residents in developing countries."	"Exergy is about taking advantage of the energy that might otherwise escape, unused, from our homes and workplaces. See why **engineers, power companies and businesses** are all about exergy."	"Because I ride the bus I don't pay a car loan, for parking, or pay parking tickets. **It's way cheaper**!"
social well-being	"Projected increases in sea levels and coastal flooding will interact with **underlying vulnerabilities in many coastal communities**."	"More than half the planet's **human population lives in cities**, so we need to understand how urban ecosystems work, and how they affect the world around them."	"Equity is a **social aspect to sustainability** that implies that all people should have access to resources and opportunities necessary for meeting basic needs and advancing health and well-being, regardless of race, ethnicity, income, age, gender, language, sexual orientation, ability, health status, and other markers of identity."
public health	"Heat wave early warning systems and cooling centers can help **reduce illness and deaths associated with heat waves**."	"When disaster wipes out a city's sanitation system, just **one sick person can cause an outbreak of deadly disease**."	"We built Clever Together using plant- and water-based materials wherever possible, making the exhibit **safer for exhibit builders and museum-goers**."

The public health frame was utilized the least across all three exhibits. Social well-being was utilized the most in both the Koshland and SMM exhibits. The OMSI exhibit utilized the environmental stewardship frame slightly more than the other three frames.

Other Frames. Looking at the other four types of frames, there are some notable trends and differences between the three exhibits. First, in terms of action frames, the Koshland exhibit tended to favor the prevention focus frame, while the OMSI exhibit was the opposite—tending to favor the promotion focus frame. The SMM exhibit, like the Koshland exhibit, also tended to favor the prevention focus frame, but to a lesser degree—the exhibit only had a few more references coded for the prevention focus than for the promotion focus frame.

The scope frames are another area where the OMSI exhibit differed most notably from the other two. The Koshland and SMM exhibit are framed predominantly from a global and national perspective, rather than a local one. The OMSI exhibit, on the other hand had no references that framed the content as global. There were a few references to national (United States) statistics that indicated the problem discussed was national and not only a concern for the local community. For example, this statistic was provided on the panel accompanying the "We use human power!" interactive from the exhibit: "Forty percent of all car trips in the U.S. are made within two miles of home." Overwhelmingly, the OMSI exhibit framed the content as a local issue.

In terms of immediacy frames, this is one area where the exhibits tended to frame the most similarly. Across all three exhibits, the current frame was used more than the future frame. The Koshland and SMM exhibits tended to use the future frame more than the OMSI exhibit did, but none of the three exhibits used the future frame more than the current frame. Additionally the exhibit elements that were coded for the future frame, were coded as such because they referred

to future impacts or problems, however these were still anchored in time to the present by mentioning the need to act now. Table 4.5 below provides some examples of this through exhibit labels.

Table 4.5. Future Frame Examples

Koshland	***SMM***	***OMSI***
"Even if greenhouse gas emissions were to stop tomorrow, we would still be impacted by climate change cause by greenhouse gases already in the atmosphere. We can prepare for inevitable change by adapting proactively—taking steps now to adapt to future climate change impacts."	"One thing we know for sure: expect uncertainty. The climate of the future will be less stable than it is today. How should we prepare?"	"Sustainability means living responsibly so that we can thrive today and into the future."

Finally, the OMSI exhibit definitely favored the shared responsibility solution frame over the innovation/ingenuity solution frame. This was primarily accomplished through the use of the word "we" throughout the text of the exhibit, as well as references to what people could do in their communities and at home. Additionally, many of the exhibit interactives, such as the food waste interactive, also reinforced the idea of "working together" to accomplish a task—requiring visitors to interact with each other in a modified pinball game to keep the pinball or "food item" from being thrown away, wasting the resources that went into producing it. The Koshland exhibit tended to frame solutions as a matter of human innovation/ingenuity rather than as a shared responsibility. The fact that the shared responsibility frame did not show up as much in this exhibit as it did in the others makes sense when you look a little closer at the messages conveyed about mitigation and adaptation strategies. Most of the mitigation and adaptation strategies discussed in the *Earth Lab* exhibit were those that will need to be managed by businesses or

industries, governments, or scientific research and innovation. There was only one reference to lifestyle choices that individuals can change to contribute to the solution (Figure 4.2).

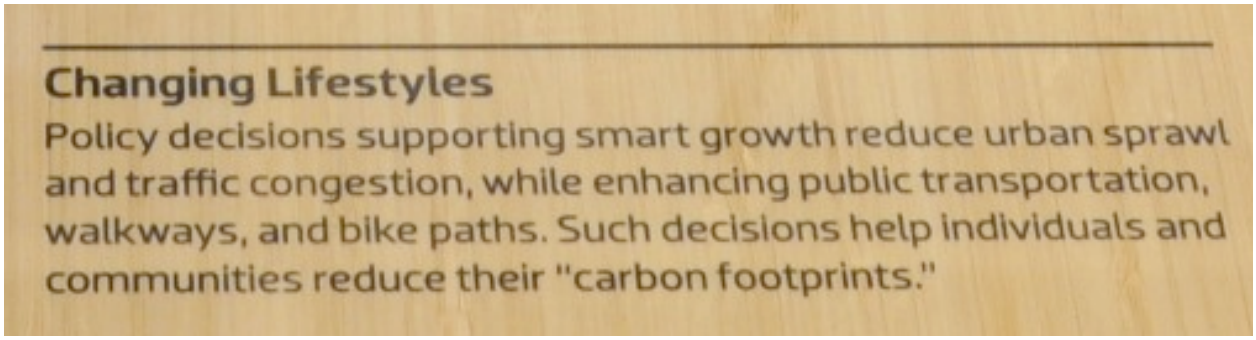

Figure 4.2. Changing Lifestyles Label

The model below (Figure 4.3) attempts to summarize and illustrate the observed differences between the exhibits by placing them along a continuum. The Koshland and SMM exhibit were more similar in terms of how they framed their messages. These two exhibits tended to be more prevention focused than the OMSI exhibit, and emphasized global and national concerns over local ones. They also used the future frame more often; however, it is important to note that none of the case study exhibits was primarily future focused. The Koshland exhibit is placed on the "future" end of the continuum only because it used the future frame the most of the three. The one area where the SMM exhibit and OMSI exhibit are more similar to each other than they are to the Koshland exhibit is in the use of solution frames. The OMSI exhibit predominantly employed the shared responsibility frame. The SMM exhibit also used the shared responsibility frame more, but only slightly more than it used the innovation/ingenuity frame. For this reason, the SMM exhibit is placed closer to the right side of the continuum.

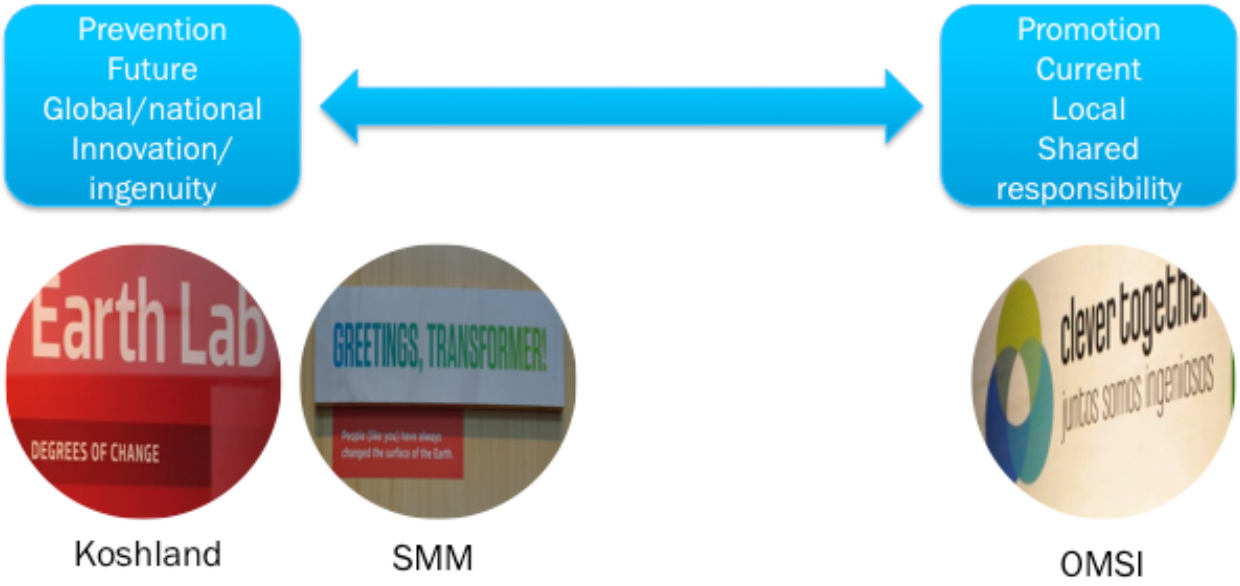

Figure 4.3. Message Frames Model

Combining Frames. Looking at how the exhibits combine frames was also of interest. For this, data from all three exhibits was combined and the framing codes were cross-tabbed using coding matrix queries in NVivo. There were two noticeable and interesting trends that seemed to be consistent across all three exhibits.

First, economic development was the only context frame to be used most often with a promotion focus. When economic development and the promotion focus frames are combined, the message tends to focus on saving money and energy for businesses and individuals. Table 4.6 below gives some examples where the economic development and promotion focus frames were used together. Second, both solution frames tend to occur with a promotion focus. Table 4.6 below also gives some examples of this combination of frames.

Table 4.6. Combining Frames

	Koshland	***SMM***	***OMSI***
Economic development + promotion focus	"Increasing the heating and cooling efficiency of buildings provides significant energy savings and reduces greenhouse gas emissions."	"Exergy is about taking advantage of the energy that might otherwise escape, unused from our homes and workplaces. See why engineers, power companies and businesses are all about exergy."	"Taking actions to reduce the amount of food we waste will save us money on buying groceries we won't eat. We will also protect the environment by using less water, fertilizer, and energy to produce food in the first place."
Solution frames + promotion focus	"Small-scale innovations play an important role in reducing greenhouse gases. For example, compact biogas plants offer a clean, affordable, sustainable, and reliable renewable fuel source for thousands of rural residents in developing countries." (innovation/ingenuity frame)	"How can we feed ourselves and care for the land? Around the world, scientists are working together to make the best use of the Earth's resources."	"Portlanders are known for being creative problem solvers. Let's get Clever Together with our friends, families, and neighbors and find small changes that make a big difference!"(shared responsibility frame)

V. How Are Museums Framing Messages?

Finding the economic development, social well-being, and public health frames in each of the case study exhibits, suggests that messages are being given social contexts that could help them resonate with a wider audience. Research has pointed in particular to the potential of the public health frame to unify because it connects the issue to health problems that are already familiar and perceived as important—making it more personally relevant (Nisbet, 2009). It is interesting that this frame was utilized the least in all three exhibits, despite its potential to resonate with new, less engaged audiences.

The three exhibits varied the most in terms of how they employed action, immediacy, scope, and solution frames. In particular, the OMSI exhibit differed the most from the other two. A possible explanation is the overall topic of the exhibit as well as the community focus of the exhibit. For example, because the OMSI exhibit focuses on the local community, it makes sense that it used the local frame more than a national or global frame. Additionally, the local focus of the OMSI exhibit has the potential to resonate better with visitors, especially those in their target audience, because it makes the issue more personally relevant (Leiserowitz, 2007). The fact that all three exhibits framed there messages as current rather than future issues is an area that seems to align well with the current body of research on climate change communication, which notes the importance of making the issue less temporally distant (Leiserowitz, 2007; Moser, 2010). In terms of action frames, the Koshland's predominant prevention focus and the OMSI's predominant promotion focus could mean that these two exhibits will resonate best with those who share a compatible worldview. Because the SMM exhibit uses both the prevention and promotion focus in fairly equal proportion, it has the potential to resonate with a wider audience (Center for Research on Environmental Decisions, 2009).

Finally, it appears that frames are being combined in interesting and potentially effective ways in the three case study exhibits. The pairing of economic development and the promotion focus frames results in messages that make it seem like actions and solutions provide the added benefit of saving money—something that many people tend to value. This has the potential to improve engagement by making the issue more personally relevant. Both solution frames also tend to occur with a promotion focus. This could be a potential strategy for avoiding doom and gloom by emphasizing the additional benefits that potential solutions could provide—a decidedly hopeful idea, and one that less engaged audiences seem to find appealing (Bain et al., 2012).

VI. What is the Scope and Purpose of the Communication?

In order to determine the scope and purpose of the communication that takes place in the three case study exhibits, Daniel Yankelovich's three "Stages of Public Judgment" were used as a framework for analyzing the exhibits' messages in relation to the intended audience. These three stages make an ideal framework because they not only provide a context for understanding audience engagement with an issue, but also the ways in which communication can impact audiences at each stage to move them forward to the next. In other words, these three stages can give insight into both who may be affected by the communication (scope) and to what end (purpose).

Definitions for each code within the Stages of Public Judgment category can be found in the coding book in Appendix B. Coding was completed using NVivo, as described in Chapter 3. Every time a label or exhibit element was coded for one of the three stages NVivo recorded this as a single reference for that stage. In order to identify trends and patterns in the data, NVivo code matrix queries were used to see how frequently each code showed up in the data sources from the three case study exhibits. The model below (Figure 4.4) visually represents these findings and compares them to the intended audience for the exhibits.

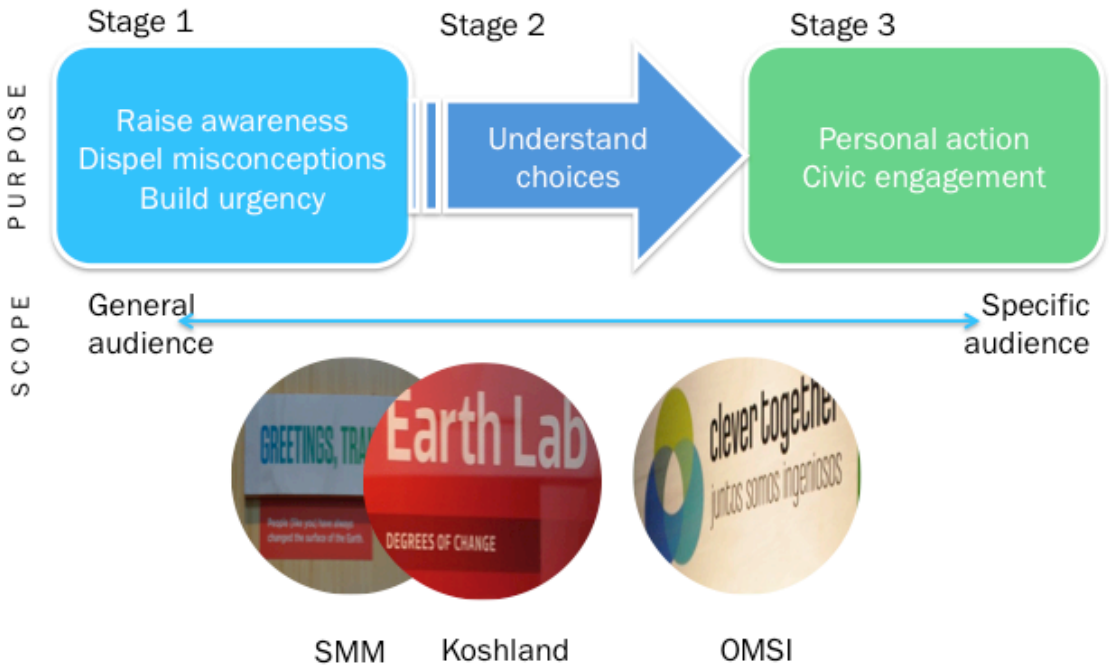

Figure 4.4. Scope and Purpose Model

The three exhibits fall along a continuum created by the three stages. The Koshland and SMM exhibits both mainly addressed audiences at stage one and stage two, indicating that the purpose of the communication was mainly to raise awareness, dispel misconceptions, and help people understand the types of choices we will have to make as a society. These two exhibits also had the broadest target audiences. The OMSI exhibit mainly addressed audiences at stage two and three, indicating that the purpose of the communication was to help visitors understand sustainable decision-making better and motivate personal action towards greater sustainability. This exhibit had a more specific target audience-—focusing on Portlanders rather than the general public at large.

If one considers the intended audiences for each exhibit and the findings from their front-end evaluations, it appears that all three exhibits are doing a nice job of aligning their purpose and scope. The Koshland found that most visitors coming to the museum had indicated a belief

in climate change, and were looking for information about what they could do about it. The elements that address stage two seem most aimed at this new majority of visitors who want to better understand the choices and trade-offs of policy decisions regarding climate change. The SMM's "Six Americas" segmentation analysis of their audience revealed that their visitors were very similar to the general public at large. Because they wanted to reach a rather broad range of audience segments with their exhibit, their use of elements that address all three stages makes sense.

Finally, it is where the OMSI exhibit addresses stage three that the differences between this exhibit and the other two become the most apparent. The exhibit's focus on concrete, everyday, community-centered behaviors has the potential to provide visitors with the information and tools they need to overcome barriers that prevent them from making more sustainable decisions. This is the kind of information visitors at stage three will need in order to incorporate the sustainable choices they have come to believe are important into their daily lives. This element of inspiring personal action and behavior change in the OMSI exhibit is very different from the other two case study exhibits. Given the findings from OMSI's front-end evaluation and the more specific target audience for this exhibit, addressing stage three seems very reasonable. The evaluation results suggest that the target audience has a basic awareness of sustainability issues (stage one), has worked through the alternatives, choices, and trade-offs associated with the issue (stage two), and is looking for information that will help them align behavior and lifestyle (stage three).

CHAPTER 5: Conclusions

By applying the lessons learned from research in the climate change communication field, three case studies of museum exhibits on climate change issues were examined. Through these case studies, the specific messages that museums are choosing to communicate, how those messages are being framed for public audiences, and the scope and purpose of the communication was explored.

The findings from these case studies suggest that museums are framing messages to provide a social context to the issue. This has the potential to make climate change more personally relevant to visitors and to unite a currently divided public by highlighting shared values related to human health, wellbeing, and the economy. The findings also suggest that museums are thinking about their audience when designing messages about climate change. This was evidenced by the front-end evaluation work conducted by each of the case study sites. Finally, the findings suggest that museums are considering possible strategies to counteract messages of fear and guilt that have often been associated with environmental and climate change issues. All three case study participants expressed that they want to avoid making people feel only "doom and gloom." They want to have visitors leave feeling hopeful and empowered to make a difference. Balancing information about impacts with information about possible solutions or personal actions visitors can take is one way the case study sites attempted to do this through their exhibits.

Additionally, this research is mainly exploratory and was designed to elucidate how and if museums have been incorporating communication best practices into their exhibits about climate change related issues. This research, then did not try to address the effectiveness of climate change communication in museums, rather it sought to provide a framework for

assessing how museums are communicating currently which might help to inform future choices museums make when developing an exhibit or interpreting climate change and other related issues to the public. The findings from this research cannot be used to comment on the effectiveness of the frames or strategies observed in the case study exhibits. One can only compare these observations to what the literature in climate change communication and framing so far have said, and the potential certain frames or strategies might have to impact museum visitors. Providing social context, integrating local and current concerns, and focusing on both impacts and solutions (particularly personal actions visitors can take) seem like good starting places for museums wanting to create an exhibit about climate change. Future research, then, should look at how these things are actually impacting visitors' perceptions and understandings about climate change.

It is difficult to say whether these findings are generalizable across the field. In other words, one cannot be certain that the strategies and frames that were observed in these exhibits, would also be found in other exhibits on similar topics in comparable institutions. However, it does seem that the museum field in general is becoming more aware of the role they can play in communicating climate change to the public. The coalitions and networks discussed in the literature review are one example of this. In terms of the case studies, staff members from all three institutions had an awareness of research from the climate change communication field, and named particular reports or studies that had helped to inform exhibit development. In particular, the "Six Americas" study was mentioned by all three institutions. There is a wealth of research out there to inform such work, and museums should take advantage of this in order to improve exhibits or programs

This study is not without limitations, some of which have already been alluded to (e.g. its exploratory nature and questionable generalizability). Another limitation is the focus on exhibits. There are many museums that have programs about climate change, even though they may not have a current exhibit on the topic. Therefore, looking at the messages and frames employed in programming is an area of interest for future research. Comparing exhibits and programs is another possibility.

It is clear from this research that museums want to make discernable impacts on their visitors through their exhibits on climate change. It is clearly something that these three case study institutions feel is important, and that the field in general feels is important. The field should continue to explore framing strategies that will empower visitors to act and improve public engagement. The field should also continue to learn more about their audience both in terms of where their current understanding with the issue lies, as well as the concerns and values they share and the barriers that might be preventing greater action. Museums can and do have a vital role to play in communicating climate change to the public—leveraging their position of public trust to further understanding and public judgment.

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Appendix A: Interview Guide

Theme 1: Climate Change Messaging

1. In your professional experience, what challenges do museums in the United States face when creating an exhibit or program related to climate change?
    a. Why do these challenges exist?
    b. How does your museum handle these challenges?
2. What are the pros and cons of communicating about climate change through an exhibit?
    a. Through a program?

Theme 2: Climate Change Messages Specific to the Exhibit

3. What were the intended impact goals of the exhibit?
    a. Who is the intended audience?
4. What key messages do you hope visitors walk away with?
    a. How does the exhibit communicate or frame these messages within a broader context?
    b. Why did you choose to frame them in this way?
5. What are some of the programs that were created to go along with the exhibit?
    a. How does the programming relate to or reinforce the messages in the exhibit?
    b. Does any of the programming have different goals or messages from the exhibit? Is any of it intended for a different or more specific audience than the exhibit?
6. How have visitors responded to the exhibit and program messages?
    a. Have you conducted any formal evaluation related to this?
    b. What have you learned from this?

Theme 3: Designing the Exhibit and Its Messages

7. Was there anything unique to your museum and your audience that you had to consider when creating the exhibit and its messages?
8. What data or resources, if any, did you use to aid you in framing the messages for the exhibit?
    a. Did audience research or evaluation play a part?
    b. Did any climate change communication or public opinion research play apart?
    c. Did partnerships with other museums or community organizations play a part?

Conclusion:

9. Why did your museum choose to do this exhibit at this time?
10. What do you see as the role of your museum in communicating about climate change related issues to the public?
    a. What responsibilities does your museum have to uphold?
    b. What position does your museum want or need to take? (i.e. neutral? advocacy? etc.)

Appendix B: Coding Book

Category 3. Message Frames

Context Frames	*Definition*	*Examples*
environmental stewardship	environmental concerns/impacts. Mentions ecosystems, species, biodiversity, habitats…	"Changes in climate have contributed significantly to **outbreaks of the mountain pine beetle** in North America." (Koshland)
		"But reducing the carbon dioxide we put in the air and conserving coral reefs, **we can sustain the oceans** we depend on." (SMM)
		"We will also **protect the environment** by using less water, fertilizer, and energy to produce food in the first place." (OMSI)
economic development	concerns/impacts regarding the economy. Mentions jobs, industries, or monetary costs or benefits for individuals, families, or communities.	"Compact biogas plants offer a clean, **affordable**, sustainable, and reliable renewable fuel source for thousands of rural residents in developing countries." (Koshland)
		"Exergy is about taking advantage of the energy that might otherwise escape, unused, from our homes and workplaces. See why **engineers, power companies and businesses** are all about exergy." (SMM)
		"Because I ride the bus I don't pay a car loan, for parking, or pay parking tickets. **It's way cheaper**!" (OMSI)
social well-being	social, political, or community/family concerns/impacts	"Projected increases in sea levels and coastal flooding will interact with **underlying vulnerabilities in many coastal communities**." (Koshland)
		"More than half the planet's **human population lives in cities**, so we need to understand how urban ecosystems work, and how they affect the world around them." (SMM)

Context Frames	*Definition*	*Examples*
social well-being		"Equity is a **social aspect to sustainability** that implies that all people should have access to resources and opportunities necessary for meeting basic needs and advancing health and well-being, regardless of race, ethnicity, income, age, gender, language, sexual orientation, ability, health status, and other markers of identity." (OMSI)
public health	health concerns/impacts	"Heat wave early warning systems and cooling centers can help **reduce illness and deaths associated with heat waves**." (Koshland)
		"When disaster wipes out a city's sanitation system, just **one sick person can cause an outbreak of deadly disease**." (SMM)
		"We built Clever Together using plant- and water-based materials wherever possible, making the exhibit **safer for exhibit builders and museum-goers**." (OMSI)

Action Frames	*Definition*	*Example*
prevention focus	Content was coded for this if it framed action/inaction in terms of minimizing current/future losses. Uses words similar to the following: Ought, maintenance, minimize losses, responsibility, necessity, protect, vigilant, avoiding mistakes, prevent, duty, obligation, defend, safety, security, must, should, cautious, careful, stop (Center for Research on Environmental Decisions, 2009)	"We can **prepare** for inevitable change by adapting proactively—**taking steps now to adapt** to future climate change impacts." (Koshand)
		"Our mission? Find dynamic new ways to **sustain** the land that sustains us." (SMM)
		"By using energy efficient products and being mindful about our behaviors, we can **reduce** environmental and health problems associated with energy generation…" (OMSI)

Action Frames	*Definition*	*Example*
promotion focus	Content was coded for this if it framed action/inaction in terms of maximizing current/future benefits. Uses words similar to the following :Ideal, attain, maximize gains, hope, wish, advance, eager, avoid missed opportunities, promote, aspire/aspiration, support, nurture, add, open (Center for Research on Environmental Decisions, 2009)	"Policy decisions **supporting** smart growth reduce urban sprawl and traffic congestion, **while enhancing** public transportation, walkways, and bike paths." (Koshland)
		"There's not much unused farmland out there, but **we can get more** food out of the land we're already using." (SMM)
		"Making more sustainable choices can **save money, improve our community and support a healthy environment**." (OMSI)

Scope Frames	*Definition*	*Example*
local	Content was coded for this if it stressed local/community concerns.	"Such decisions help **individuals and communities** reduce their 'carbon footprints'" (Koshland)
		"The choices **you make at home** can become part of the solution." (SMM)
		"**Portlanders** are known for being creative problem solvers. Let's get Clever Together with **our friends, families, and neighbors** and find small changes that make a big difference!" (OMSI)
National/regional	Content was coded for this if it stressed U.S. concerns across the country or in particular regions/states.	"In the western **United States**, the frequency of large wildfires has increased, due in part to earlier spring snowmelt and higher temperatures." (Koshland)
		"Human effects on the atmosphere are changing our global climate, but what does that mean for **Minnesota**?" (SMM)
		"About 40% of the food produced in the **U.S.** is thrown away." (OMSI)

Scope Frames	***Definition***	***Example***
global	Content was coded for this if it stressed global/international concerns.	"People in **many parts of the world** are already adapting to current or projected impacts of climate change." (Koshland)
		"Over the course of human history, people have reshaped 40 percent of **Earth's land surface** into cities, cropland and pastures." (SMM)
		No examples from OMSI. Nothing could be coded as "global."

Immediacy Frames	***Definition***	***Example***
current issue	Content was coded for this if it stressed present concerns. Looked for word cues and tense cues to assign this code.	"Relocation efforts for some of these communities **are already underway**." (Koshland)
		"Rising carbon dioxide (CO2) levels **acidify** our oceans, **affecting** the entire marine food chain." (SMM)
		"Could you walk, bike, or skateboard one place **this week** instead of going by car?" (OMSI)
future issue	Content was coded for this if it stressed future concerns. Looked for word cues and tense cues to assign this code.	"As the global average temperature continues to rise, impacts of climate change are **expected** to increase. What impacts can we **expect** to see and where? How **might** society and ecosystems adapt to the these changes?" (Koshland)
		"Earth's 7 billion human beings already use 90 percent of the land suitable for growing food. What **will happen** in 2050, when our population reaches 9 billion?" (SMM) "Sustainability means living responsibly so that we can thrive today and **into the future**." (OMSI)

Solution Frames	*Definition*	*Example*
shared responsibility	Content was coded for this if it stressed governments, industries, societies, communities, or individuals working together to become part of the solution. Emphasized visitor's inclusion in this through the use of "we" rather than "humans" or "people" in general.	"As **our world** develops and the population increases, so does **our production** of greenhouse gas emissions that cause climate change. How can **we reduce** greenhouse gas emissions to reduce the severity of climate change?" (Koshland)
		"Can **you think of ways** that humans can both thrive and meet the challenges ahead?" (SMM)
		"**How can we** save money and reduce energy-related pollution?" (OMSI)
Innovation/ingenuity	Content was coded for this if it stressed the importance of human creativity and problem-solving in finding solutions or the means for making better choices.	"**Increasing the heating and cooling efficiency** of buildings provides significant energy savings and reduces greenhouse gas emissions." (Koshland)
		"But **human ingenuity harnessed the power of fossil fuels, and it could also find ways** to keep their byproduct, CO2, from harming the oceans." (SMM)
		"The Clever Together team found **creative ways** to reduce our consumption of new resources by…" (OMSI)

Category 4. Stages of Public Judgment

	Definition	*Example*
Stage 1 Consciousness Raising	Content was coded for this stage if it raised awareness of the problem, attempted to dispel misconceptions, or created a sense of urgency.	"While many uncertainties remain regarding the exact nature and severity of future impacts, the need for action seems clear." (Koshland) **Urgency**
		"Some activities that help us thrive, such as making electricity, increase insulating gasses and warm the climate." (SMM) **Raise awareness**
		"Living sustainably is more than recycling and choosing green products." (OMSI) **Dispel misconseptions**

	Definition	***Example***
Stage 2 Working Through	Content was coded for this stage if it presented alternatives for dealing with the issue, or provided information about trade-offs to inform choices.	Mitigation Simulator interactive: helps visitors understand that there are a variety of ways we can lower carbon emissions and that there will be trade-offs to consider when making policy decisions. (Koshland) **Alternatives & tradeoffs**
		"His process could reduce CO2 further if powered by electricity run partly from renewable sources. Or it could run on electricity generated by its own byproduct, hydrogen gas." (SMM) **Alternatives**
		"When facing a choice like what to buy or how to get somewhere, keep the following three considerations in mind and choose the option with the most benefits." (OMSI) **Trade-offs**
Stage 3 Thoughtful Judgment	Content was coded for this stage if it helped connect the dots between solutions and lifestyle choices, inspired civic efficacy, or provided information to help people change their behavior.	No examples from the Koshland. Nothing could be coded as "stage 3."
		"There are many things you can do to slow your resource flow, from simple first steps to larger commitments. *Which ones are right for you?*" (SMM) **Solutions and lifestyle**
		"Forty percent of all car trips in the U.S. are made within two miles of home. By using human power for just one of these trips a week, we can collectively make a big difference." (OMSI) **Solutions and lifestyle** "We Know Our Options" interactive: it provided information about resources in the community and examples of individuals and business in Portland that are making a difference in terms of sustainability. (OMSI) **Information to aid behavior change; Inspire civic efficacy**

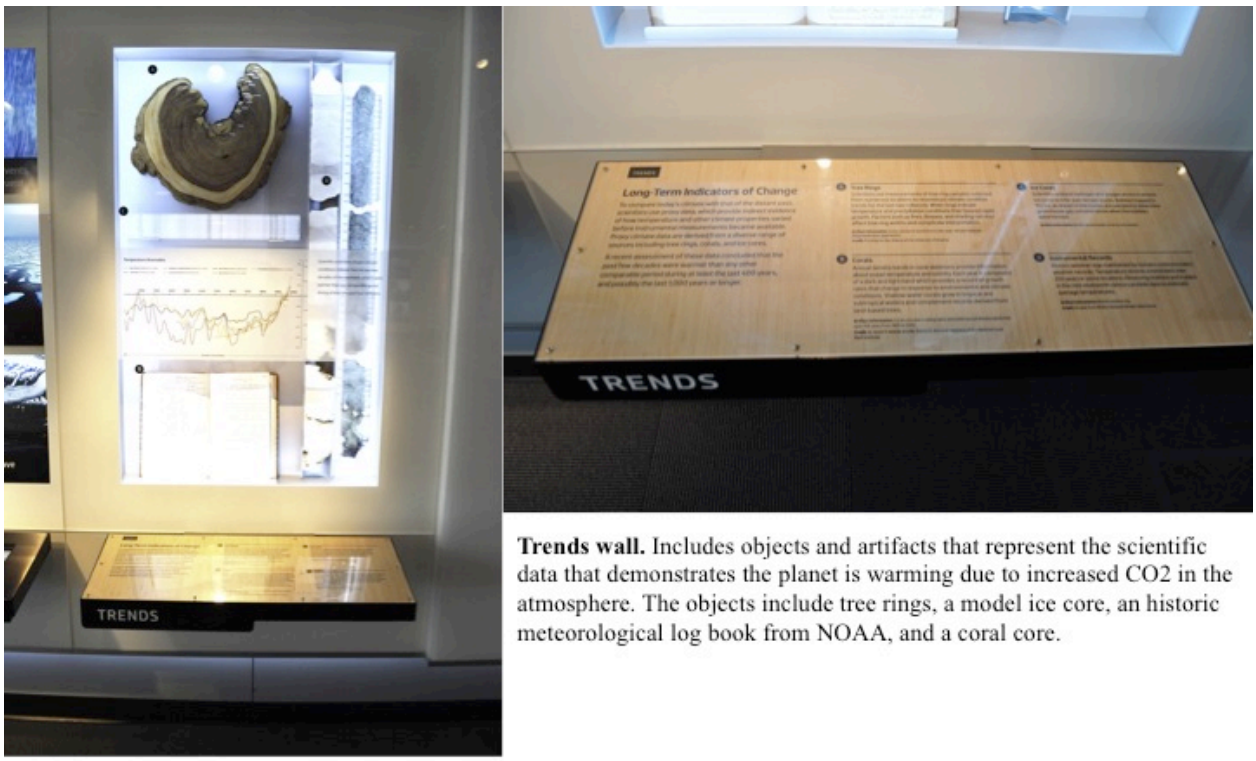
Appendix C: Exhibit Photographs

Earth Lab: Degrees of Change (Marian Koshland Science Museum)

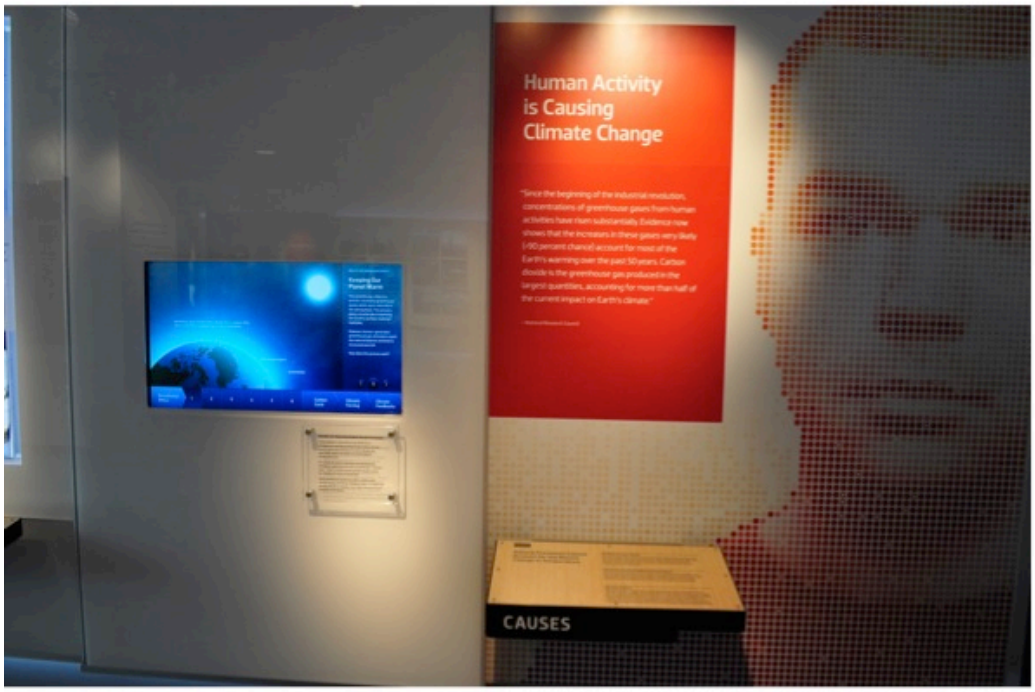
Introductory Panel

Left hand side of exhibit. Includes Changes, Trends, and Causes sections

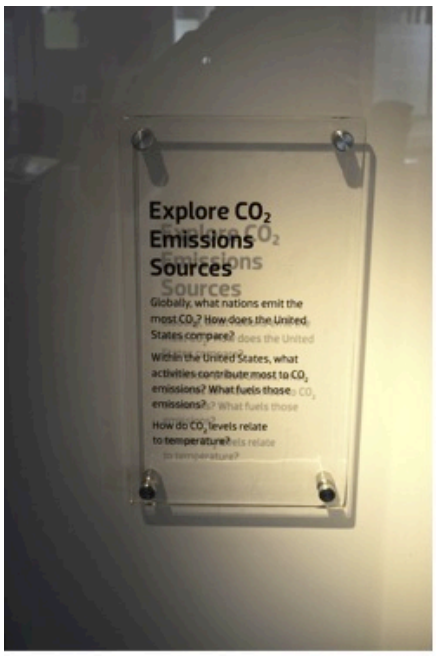
Changes wall. This section talks about recent, observed changes that can be attributed to climate change. Pushing the button next to each label displays a corresponding video or animation that illustrates these changes.

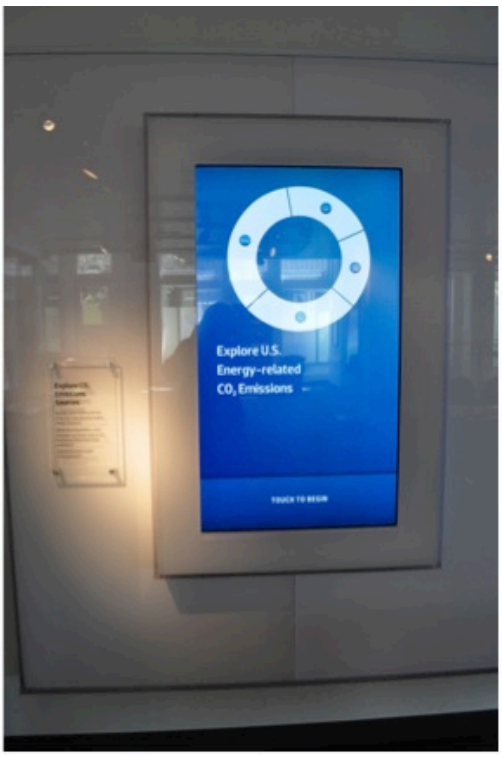


Trends wall. Includes objects and artifacts that represent the scientific data that demonstrates the planet is warming due to increased CO2 in the atmosphere. The objects include tree rings, a model ice core, an historic meteorological log book from NOAA, and a coral core.



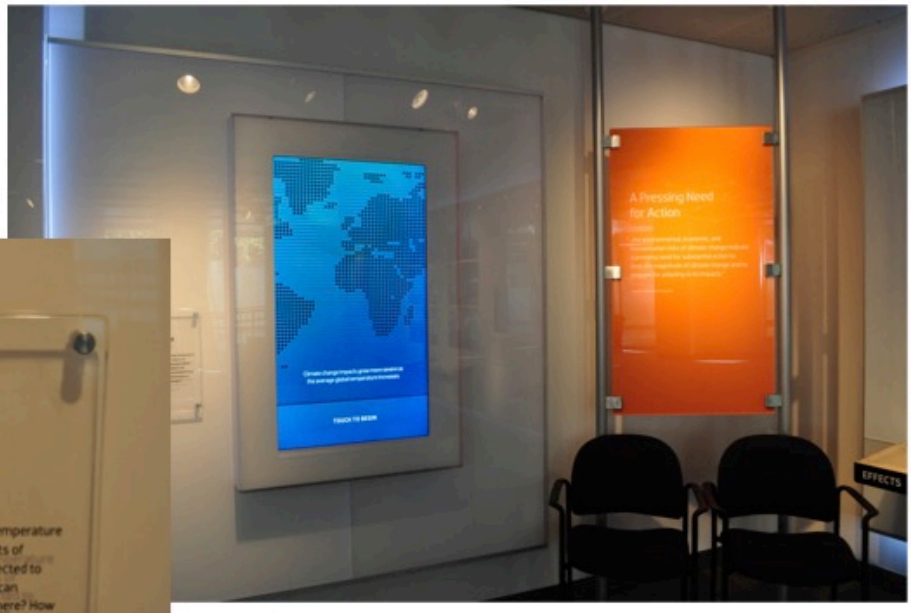
Causes wall. This section explains why the evidence points to human activities as the primary cause of climate change. The interactive on the left includes modules about the greenhouse effect, carbon cycle, climate forcing, and climate feedback loops.





CO2 Explorer. This interactive "unpacks" CO2 emissions data by country and economic sector.

Mitigation Simulator. This interactive game is located in the center of the exhibit. Here visitors take on the role of policy makers, trying to align values and mitigation strategies in order to lower carbon emissions.



Impacts Explorer. This interactive allows visitors to explore current and projected impacts of climate change on ecosystems, food, oceans, coasts, society, and weather.

Effects wall. Pushing buttons next to each label, plays a short video documentary about current effects from around the globe on both people and ecosystems. The interactive on the right includes modules about climate models and how they are used to understand past climate and predict future climate scenarios.

Mitigation & Adaptation walls. These sections talk about several possible mitigation and adaptation strategies that are already underway.

Right hand side of exhibit. Showing the Effects, Mitigation, and Adaptation sections.

Future Earth (Science Museum of Minnesota)

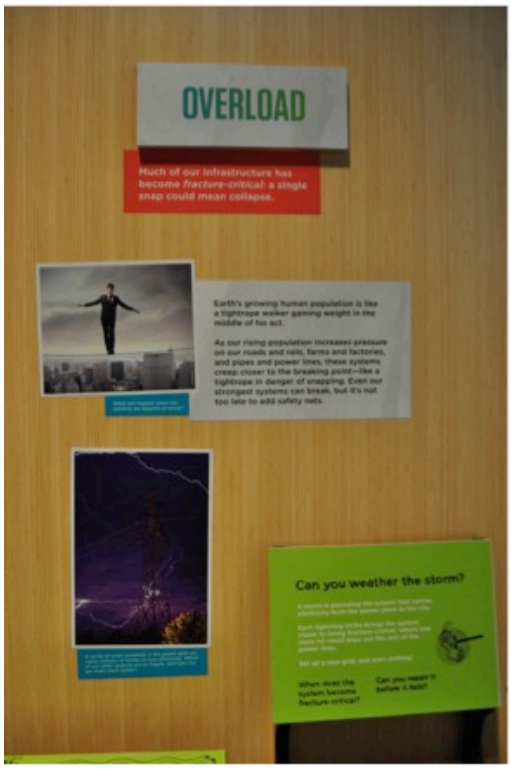
Terrestrial Impacts Section: Part I

Agriculture Issues & Solutions panels. These two panels discuss how humans have altered available land to grow crops and raise livestock. We have already used most of the suitable land to do this. How will we be able to feed our growing population in the future?

Agriculture interactive. Visitors can pull out these drawers to see maps that show the area of land used for growing crops over the last 200 years and how this compares to the global population.

Land use interactive. Visitors can turn each satellite picture over to learn more about the ways humans have altered the terrestrial landscape of the planet.

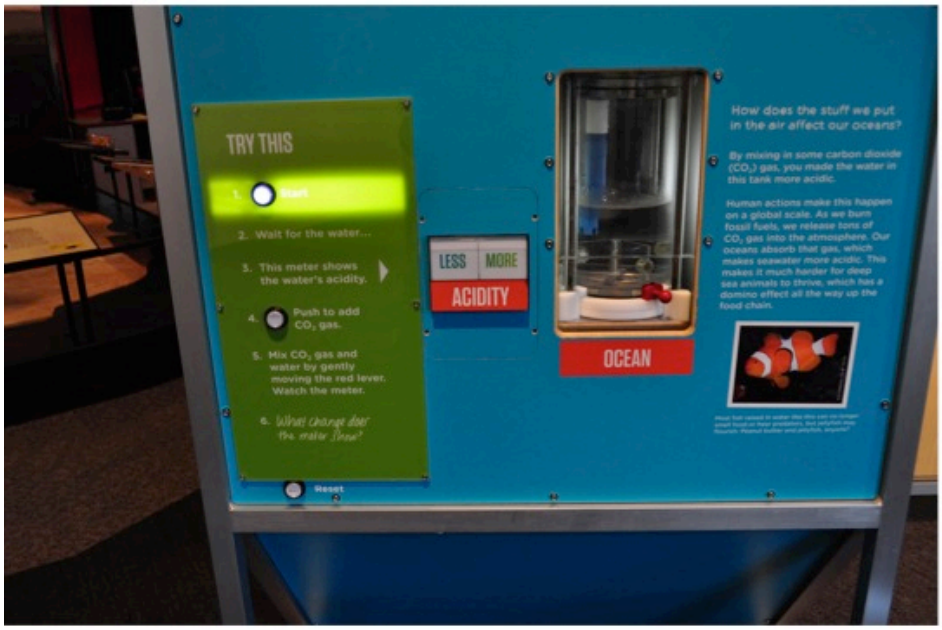
Terrestrial Impacts Section: Part II



Infrastructure Issues & Solutions panels. These two panels discuss urban development and our degrading human infrastructure. This explores how we can make the structures we build more resilient to handle the stress caused by everyday use, as well as the stress caused by extreme weather and other natural disasters.

Fracture-critical interactive. This interactive is a variation on a "break the ice" game. It illustrates how human systems can become fracture-critical when they are not designed with resiliency in mind.

Ocean Impacts Section: Part I



Ocean acidification interactive. This interactive has visitors "mix" CO2 into seawater to show how this lowers the pH—demonstrating the process of ocean acidification.

Ocean Issues & Solutions panel. These two panels discuss how the burning of fossil fuels is increasing ocean acidity.

Terrestrial Impacts Section: Part II

Ocean acidity model. This globe runs a data visualization loop showing how ocean acidity has changed over time.

Environmental Models panels. These two panels discuss modeling and how it is used to understand the past and predict possible future outcomes. These panels refer directly to the ocean acidity model pictured above.

Atmosphere Impacts Section

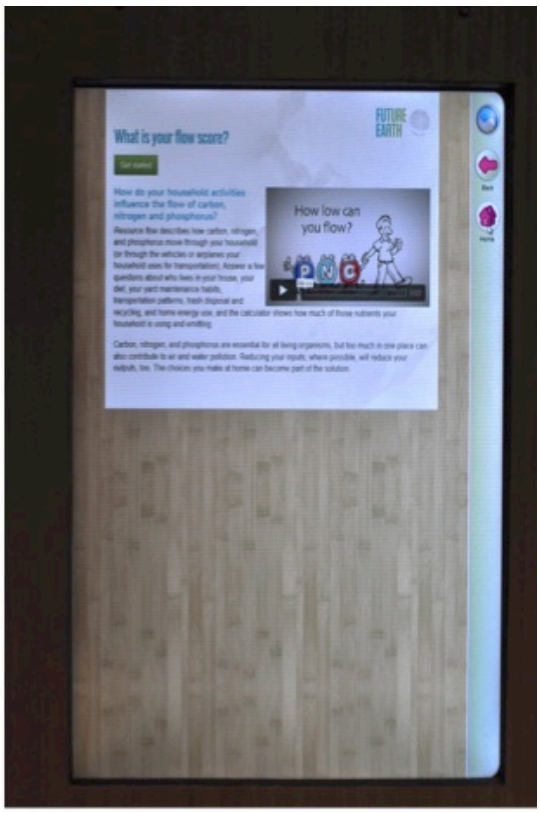
Atmosphere wall. This wall shows a scale drawing of the Earth compared to the atmosphere. Labels discuss the role of our atmosphere in supporting life how human activities are affecting global climate.

Atmosphere interactive. Helps visitors understand how the greenhouse effect heats up the planet. Instead of using the term greenhouse gases, the exhibit refers to carbon dioxide and methane as "insulating" gases because they trap heat like a blanket. The accompanying "Follow a Sun Bean" flipbook discusses the greenhouse effect further.

Videos. This section of the exhibit plays four short videos on the following topics: cities, exergy, resiliency, and modeling.

Planet Earth Decision Theater. The museum's Science on a Sphere (SOS) is used as part of an interactive, presenter-led program that reinforces the exhibit's three main messages. When this program is not taking place in the theater, a film about agriculture and food production, titled "Two Billion More Coming to Dinner," runs on a loop on the SOS.

Exergy interactive. This pinball-like interactive demonstrates how energy efficiency can be improved.



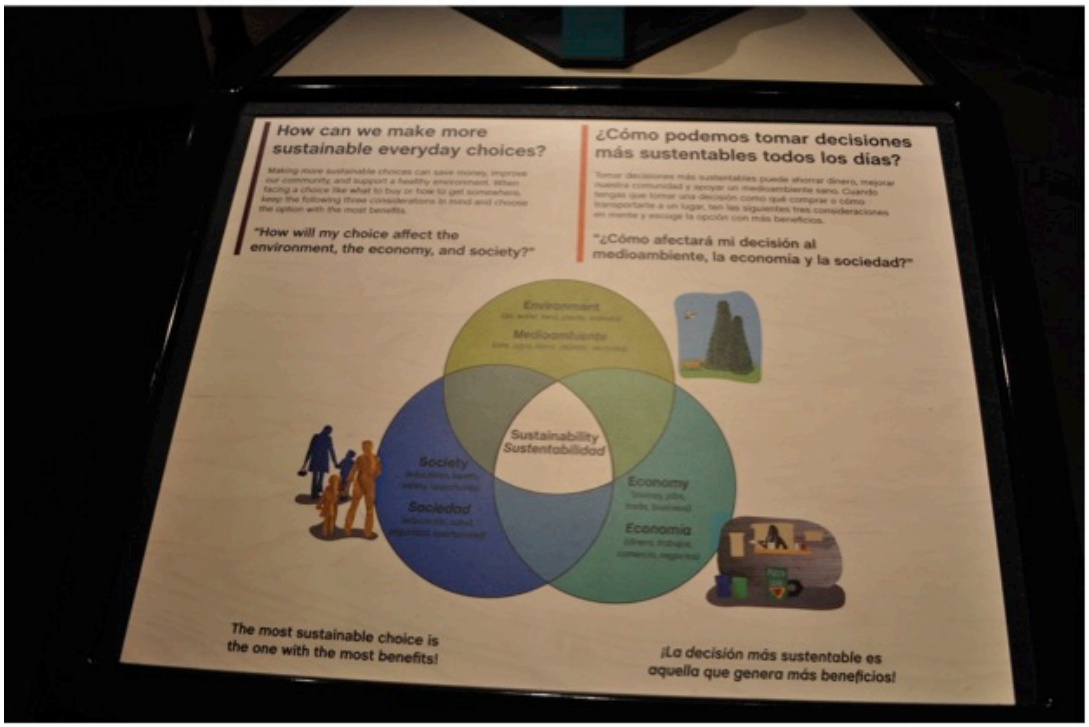
Flow score interactive kiosk. At this kiosk visitors can find out what their household carbon, nitrogen, and phosphorous emissions are, and learn about ways to reduce their impact.

Clever Together: Our Everyday Choices (Oregon Museum of Science and Industry)

View of exhibit floor. Shows the introductory area on the back wall with large video screen that shows a series of short animations and video clips of diverse Portlanders engaging in sustainable behaviors.

Introductory area panels. These panels ask visitors to think about what sustainability means.

"We make clever choices!" interactive. Visitors work together to build a three-sided catenary arch that represents the three pillars of sustainability.



"We make clever choices!" panel. This panel accompanies the above interactive exhibit and explains how visitors can make more sustainable choices by considering the three pillars.

"We use human power!" interactive. Visitors can hop on the bike or treadmill to take a virtual trip around Portland. As visitors "walk" or "ride" they see the scenes in front of them flip and facts about the benefits of biking and walking. This exhibit was not on the floor during the time of the site observation visit. It is seen here in the shop, waiting to be repaired.

How can we get around with fewer car trips?

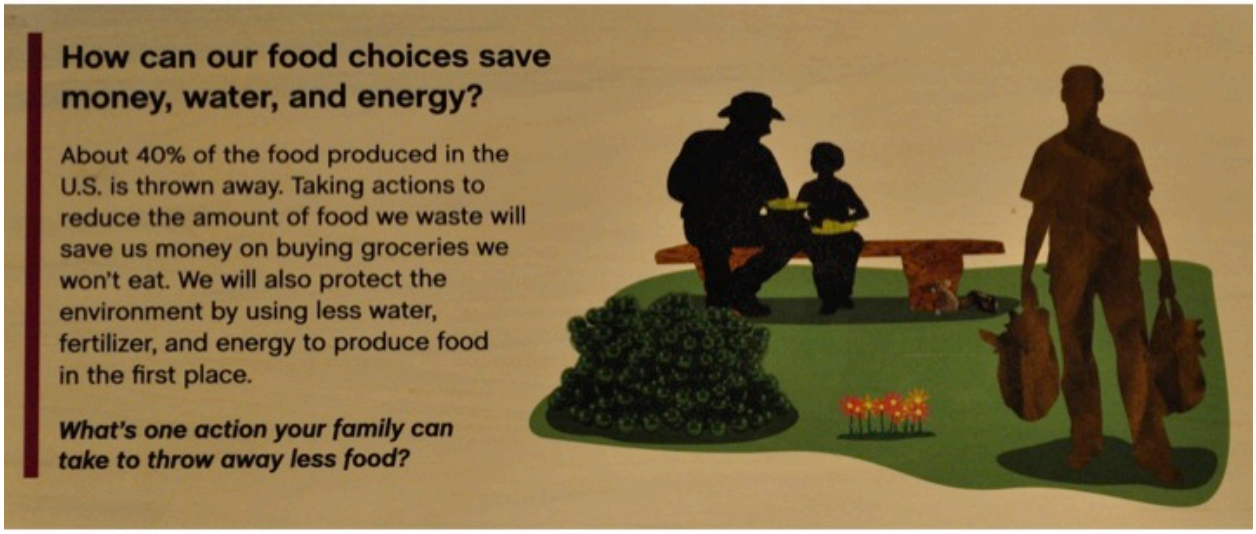
Getting around by human power (like walking, biking, unicycling, or even jumping rope) causes virtually no air or water pollution. These options are less expensive than driving and are a great way to get exercise.

Forty percent of all car trips in the U.S. are made within two miles of home. By using human power for just one of these trips a week, we can collectively make a big difference!

Could you walk, bike, or skateboard one place this week instead of going by car?

"We use human power!" label text.

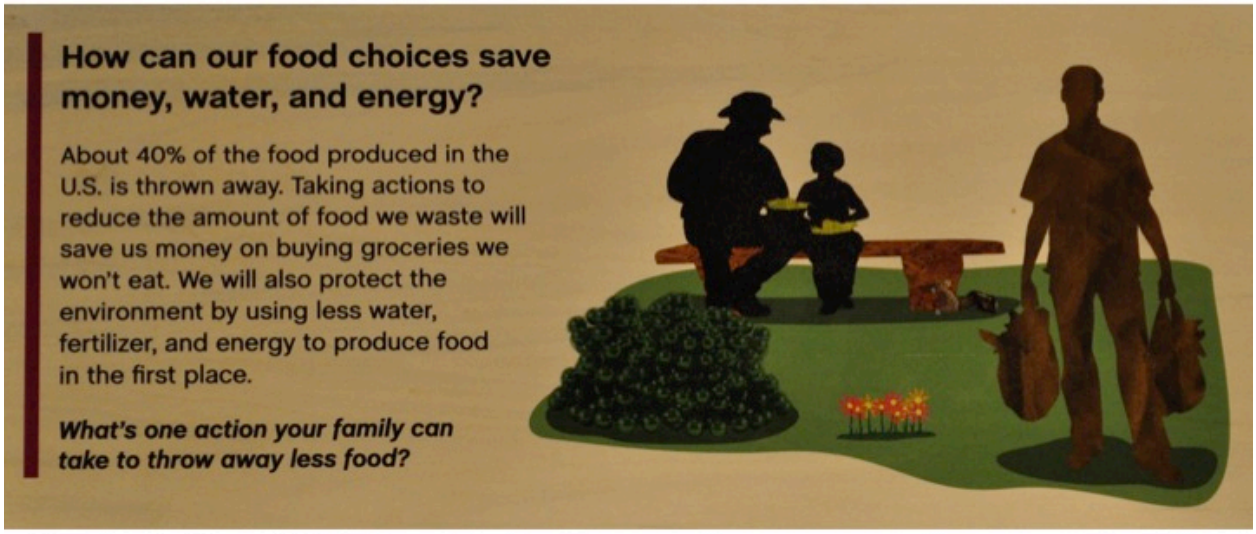
"We prevent food waste!" interactive. Visitors must work together to play this pinball-like game—moving the "food" (represented by the ball) into "waste-reduction" targets to prevent it from ending up in the "landfill" at the bottom of the table. Each "waste-reduction" target gives an example of a way to prevent food waste and the water, energy, and resources that go into producing and transporting it.



"We prevent food waste!" label text.

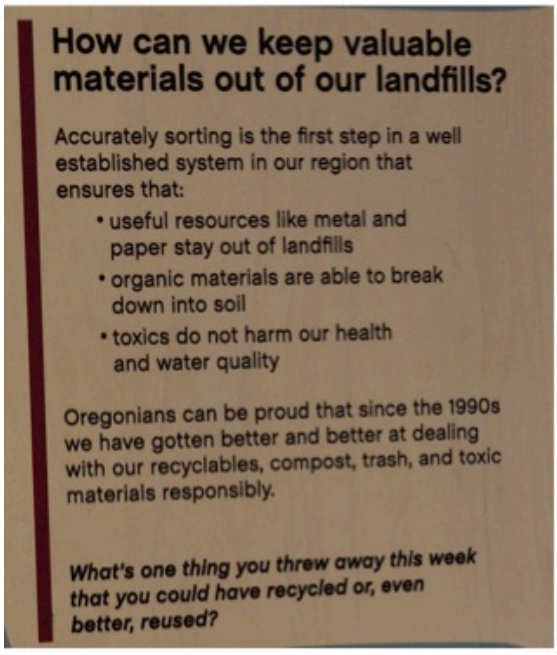
"We take public transit" interactive. Visitors can sit in this recreation of a Portland bus and listen to stories from real Portland bus commuters about the environmental, social, and economic benefits of riding the bus.

"We prevent food waste!" interactive. Visitors must work together to play this pinball-like game—moving the "food" (represented by the ball) into "waste-reduction" targets to prevent it from ending up in the "landfill" at the bottom of the table. Each "waste-reduction" target gives an example of a way to prevent food waste and the water, energy, and resources that go into producing and transporting it.



"We prevent food waste!" label text.

"We are super sorters!" interactive. Visitors "practice sorting waste items into recycling, compost, waste, and toxic waste bins. Display cases on either side of the interactive provide information about how to properly dispose of commonly missorted items.



How can we keep valuable materials out of our landfills?

Accurately sorting is the first step in a well established system in our region that ensures that:

- useful resources like metal and paper stay out of landfills
- organic materials are able to break down into soil
- toxics do not harm our health and water quality

Oregonians can be proud that since the 1990s we have gotten better and better at dealing with our recyclables, compost, trash, and toxic materials responsibly.

What's one thing you threw away this week that you could have recycled or, even better, reused?

"We are super sorters!" label text.

"We know our options!" interactive. Visitors can turn the six rotating blocks (three on each side) to learn about sustainable resource in the Portland metro region. The six resources are: community gardens, farmers markets, lending libraries, public transit, arts and cultural centers, and reuse centers. Each side of one of the resource blocks has different information about the resource: 1) and explanation of the resource, 2) a statistic about the environmental, economic, or social impact of that resource, 3) a story about a real Portlander, and 4) a map showing where that resource is located or a set of tips for utilizing the resource.

"We are energy savers!" interactive. Here visitors can manipulate objects in a pretend house to learn about ways they can save energy at home.

How can we save money and reduce energy-related pollution?

About a quarter of all energy used in the U.S. is consumed by homes. This energy is used for heating and cooling, lighting, and powering electronic appliances. By using energy efficient products and being mindful about our behaviors, we can reduce environmental and health problems associated with energy generation—and save money while we're at it!

Try this!

Can you find seven ways to prevent energy waste?

"We are energy savers!" label text.

Making of the Exhibit panels. This three-sided kiosk has panels explaining how the exhibit developers incorporated sustainable decision-making into the development of the exhibit. The three panels talks about key decisions that were made and the environmental, social, and economic impacts of those decisions.