UC Santa Cruz

Title
Enviro-Envision Visualizing Climate Change through Art

Permalink
https://escholarship.org/uc/item/1nn1f5kn

Author
Deck, Kathleen

Publication Date
2019

UNIVERSITY OF CALIFORNIA
SANTA CRUZ

Enviro-Envision
Visualizing Climate Change through Art

A thesis paper submitted in partial satisfaction
of the requirements for the degree of

Master of Fine Arts
in
Digital Arts and New Media

by
Kathleen Deck
June 2019

The thesis of Kathleen Deck is approved:

_____
Professor Sharon Daniel, chair

_____
Professor Warren Sack

_____
Professor Edward Shanken

_____

Lori Kletzer
Vice Provost and Dean of Graduate Studies

TABLE OF CONTENTS

LIST OF APPENDICES

ABSTRACT

Enviro-Envision
Visualizing Climate Change through Art
Kathleen Deck

From the beginning of the environmental movements of the 1960s, humans have sought to convey messages of the tragedy of human destruction of the earth. Since then, the world has shifted greatly, and the extent and effects of climate change have become more apparent, yet most humans still cannot fully comprehend the "hyperobject" of climate change. Art with its emotional qualities has been seen to illicit change and comprehension of complicated issues like climate change.

In this thesis it is argued that eco-art and new media art practices, together, can effectively communicate the effects of climate change. The ecologically themed new media art project *Enviro-Envision*, which is an interactive installation showing the effects of human impact and climate change on the past, present, and future of a Santa Cruz coastal redwood ecosystem, illustrates how innovative and vital such interdisciplinary projects can be in communicating climate change. The digital, interactive, and figurative data visualization approaches are compared in context with other contemporary projects and their strategies for the creation of a work with a climate change theme.

Key words: eco-art, environmental art, coastal redwood, climate change, visualization, immersion, affect, figurative data visualization, interactive, digital art, technology, new media.

DEDICATION

To our planet, and to our future.

ACKNOWLEDGEMENTS

INTRODUCTION

Early in 2019, carbon dioxide (CO2) levels reached 414 parts per million

(PPM) in the earth's atmosphere [figure 1].[1] CO2, emitted mostly by human driven

fossil fuel, is a gas that contributes to the greenhouse gas effect, which traps in heat

and drives climate change through a positive feedback loop that is effectively causing

widespread despeciation. In 1880, CO2 was only 280 PPM, since then atmospheric

CO2 content has risen by forty-six percent and this is the highest that CO2 has been

in more than three million years.[2] This is significant because around three million

years ago, the sea level was higher, covering much more of the planet's surface and

the temperatures were much warmer than what humans have ever been exposed to.

By looking into the past, we can reconstruct past climates and understand how higher

levels of CO2 affected life. So even though predicting the future is almost impossible,

the past can help us estimate and inform some of the changes that we will expect to

see with a warming planet. Something more complicated to understand is the amount

of uptake of CO2 by the oceans and biosphere. Thus far, much of the CO2 emitted

has been absorbed by these carbon sinks. Old growth forests, particularly ones that

contain huge trees, such as the coastal redwood trees, can be major sources of carbon

sequestration, which will become increasingly more important to maintain and protect

as we go forward in the future. Although CO2 is only one of the greenhouse gases,

---

1. US Department of Commerce, "ESRL Global Monitoring Division - Global Greenhouse Gas Reference Network."
2. "How the World Passed a Carbon Threshold and Why It Matters."

and only one part of the problem, it explicitly demonstrates how directly our actions affect our planet.

The dramatic increase in CO2 is frightening and significant, yet humans continue life as usual seemingly unable to fully comprehend the extent of the impact of our behavior on life on Earth, much less make a concerted effort to mitigate those impacts. Timothy Morton refers to incomprehensible phenomena, such as climate change, as "hyperobjects," which, as he describes,
"are phenomena that are so distributed in space and in time that we are unable to comprehend or understand their size, scope, scale, and impact."[3] It seems that even though we are presented with data, facts, evidence, and more, we still cannot, in any easy means, make the connection between our actions and our futures. Julien Knebusch also mentions this incomprehensible quality stating that:

> climate seems impossible to conceive as a totality except in subjective terms . . . The perception of climate is the perception of an arrangement, a configuration of the real. Climate is thus a multidimensional phenomena in which are combined the contributions of nature, culture, history and geography, but also the imaginary and the symbolic [4]

This multidimensional quality makes the climate in climate change difficult to define and climate seems impossible to conceive as a totality except in subjective terms . . .

---

3. Morton, *Hyperobjects*.
4Knebusch, "The Perception of Climate Change."

The perception of climate is the perception of an arrangement, a configuration of the real. Climate is thus a multidimensional phenomena in which are combined the contributions of nature, culture, history and geography, but also the imaginary and the symbolic [5]

This multidimensional quality makes the climate in climate change difficult to define and conceptualize. Climate naturally fluctuates and varies between regions and cultures. Inherently, climate cannot be condensed to a singular meaning that can be easily interpreted, thus contributing to the complexity of climate change.

It was not until the 1960s when humans began to realize their impact on the environment on a larger scale. Since then there has been an increase in the number of people focused on understanding, communicating and solving environmental issues, but it is still the case that most people have yet to be able to comprehend, much less recognize the issue. There is an urgent need for effective communication strategies as we work together to tackle climate change and art, with its affective qualities, can be used to solve and understand environmental issues in creative ways.

Affect and Art

Art, since its origins, has used affect as a means to convey our relationship with the environment. The emotional component that art adds to environmental issues is what makes tackling hyperobjects such as climate change possible. In the *Affectivist Manifesto*, Brian Holmes (2008) states that "the expressive techniques of

---

5. Knebusch, "The Perception of Climate Change."

art are able to multiply those immediate changes along a thousand pathways of the mind and the senses . . . Artistic activism is affectivism, it opens up expanding territories."[6] The affective qualities found in art, allow it to activate our senses and elicit an emotional response. Furthermore, art has the ability to extend understanding and emotional connection. Through the affect found in art, we can comprehend the possibility of change and be stimulated to imagine different realities. As art critic Lucy Lippard says, such art "cares about, challenges, involves, and consults the audience for whom it is made, respecting community and environment … and is engaged with its audience in articulating a differently understood past, an alternate present, or a set of possible futures."[7] Art has the power to, not only connect with the audience from whom it is made, but also evoke emotion. When individuals can visualize their futures, emotions can be provoked, and massive action can be demanded. The author Joanna Nurmis states that, "an artwork often points itself outward to the person viewing it, activating their emotional sensitivity, reflecting their personal responsibility, and challenging them to a change of mind."[8] Art can persuade individuals to make changes, making it easier for large-scale changes like those associated with the climate crisis to happen. The need for change has never been greater and as we search for solutions to the crisis associated with climate

5. "THE AFFECTIVIST MANIFESTO," *Continental Drift* (blog), November 16, 2008, https://brianholmes.wordpress.com/2008/11/16/the-affectivist-manifesto/.
7. "Before California."
7. Joanna Nurmis, "Visual Climate Change Art 2005–2015: Discourse and Practice," *Wiley Interdisciplinary Reviews: Climate Change* 7, no. 4 (2016): 501–16, https://doi.org/10.1002/wcc.400.

change, art can be one of the ways that we can emotionally connect with individuals and inspire change.

Affect is inherent to art but is not intrinsic to contemporary science. Climate change communication needs an interdisciplinary approach to succeed in, not only communicating the scientific facts, but evoking an emotional response that can inspire change. There is a need for an increase of what Donna Haraway refers to as, "Art science activisms . . . working with beauty and fury in enlisting the possibility of ongoingness."[9] Interdisciplinary art science projects have the potential to bring several areas of knowledge together, translating complicated information into emotional instigations. This is something that science alone cannot offer.

The ecological concern of the 1960s, inspired many artists who were interested in working with interdisciplinary approaches in evoking emotional comprehension of ecological issues. For the last sixty years, artists have continued this trajectory of ecologically concerned art, using a variety of strategies and mediums, in creating art that communicates the most important issue of our time: climate change. More recently, with prolific digital technology, increasing numbers of ecologically concerned artists are using digital technology to create their work. In this thesis it is argued that eco-art and new media art practices, together, can effectively communicate the effects of climate change. The ecologically themed new media art project *Enviro-Envision*, which is an interactive installation on the effects of human impact and climate change on the past, present, and future of a Santa Cruz

---

9. Haraway, "Anthropocene, Capitalocene, Plantationocene, Chthulucene."

redwood ecosystem, illustrates how innovative and vital such interdisciplinary projects can be in communicating climate change. The digital, interactive, and figurative data visualization that the project employs, are innovative and successful approaches to understanding climate change. These approaches will be compared in context with other contemporary projects and their strategies for the creation of a work with a climate change theme. Author Gabriella Giannachi offers a three-strategy framework, in her article, Repr*esenting, Performing and Mitigating Climate Change in Contemporary Art Practice,* through which to understand the strategies used by artists in making climate change work. These strategies include: representations, performance environments and interventions.[10] Many of the projects mentioned fall into one or more of the three categories drawing attention to the multidisciplinary, multi-medium, and multi-strategy approaches used by the artists to communicate the multifaceted issue of climate change.

Artists such as Gunnar Liestøl, Laura Cunningham, Anne Zahalka, SuperFlux, Natalie Jeremijenko, and Michael Mandiberg, discussed in comparison to *Enviro-Envision,* use their art practices in furthering the definition of an eco-centric artistic practice. The projects that will be discussed in relation to *Enviro-Envision* are: *A State of Change: Forgotten Landscapes of California*, a book featuring a collection of works by Laura Cunningham, *Situation Simulation,* a climate change visualization platform by Gunnar Liestøl, *Wild Life in the Age of the Anthropocene* and *Wild Life,*

---

10. Giannachi, "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice."

Australia, a collection of photo media works by Anne Zahalka, the *Future Energy Lab* by SuperFlux, *The Environmental Health Clinic*, by Natalie Jeremijenko, and *Real Costs* by Michael Mandiberg. All of these projects seek to educate and inform the general public about climate change and use three main strategies in order to do so.

LITERATURE REVIEW AND HISTORICAL CONTEXT

Eco-art

The eco-art movement was born out of the transformative time of the 1960s and 1970s. During this era, as Americans were demanding equality and freedom for all, a concern for the environment was also acknowledged on a larger scale. This was the first time in history that environmentalists began to broadly consider the pervasive ill effects of human activity on the environment. While this was happening, the science behind climate change was just beginning to be realized by scientists and the public. In 1962, Rachel Carson's *Silent Spring* was released. This non-fiction environmental science book represented the first of its kind to address widespread environmental issues, which in turn sparked the global environmental movement that began in the 1960s.

The poignant environmental concerns brought to light by Carson's book, inspired many of the pioneers of eco-art. Amanda Boetzkes writes that "for many environmentalists on the West Coast, *Silent Spring* was the impetus to bring

agriculture back into the hands of the public and, correspondingly, to understand the complexity of natural processes"[11] The realization of human-made destruction began to merge with artistic expression. Environmental movements such as Eco Aesthetics were addressed in the 1960s by artists such as Joseph Beuys, Ant Farm, Hans Haacke, Alan Kaprow and the Harrisons. Inspired by Carson's book, these artists, and others, were the pioneers that were shifting the view towards creating art while addressing modern problems pertaining to the environment.

The pioneering eco-artists became concerned with making art that was ecocentric, as Linda Weintraub, in her book *To Life!* explains: "[the term that] refers to the principle that humans are not more important than other entities on earth [ecocentrism] is the opposite of anthropocentrism, which interprets reality in terms of human values and experiences"[12] Up until this point in history, art, at least in the western sense, had generally been anthropocentric. Eco-artists challenged this anthropocentric approach with their work and the transformative movements in the 1960s encouraged this artistic ecocentric endeavor to take place. Contemporarily, eco-art is often used interchangeably with the terms "ecologically concerned art," "environmental art" and "ecocentric art."

Increase in Digital Technology

11. As cited in Shanken, *Art and Electronic Media*.Auther et al., *West of Center*.
12. Weintraub, *To Life! Eco Art in Pursuit of a Sustainable Planet*.

Since the 1960s, society has also seen great shifts in how we interact with and understand our impacts on the Earth. With the advancement of computer technologies, and specifically the advent of the World Wide Web in the mid-1990s, there has been a major shift in how we interact with systems and individuals. Throughout history, artists have always commented on and used technology in the making of their work. In recent years, digital technology has developed exponentially and, among other things, it has resulted in a widespread access to these tools. This access to digital technology extends to contemporary artists who are continually motivated to use digital technology in their practices in order to further explore the medium. New media can be defined as anything that can be created, viewed, modified, and/or distributed through computers and/or the Internet. For purposes of this paper, the term "new media" is used interchangeably with digital media and electronic media.

STRATEGIES

Representation

The first strategy that artists use in climate change-themed works, outlined by Giannachi, is representation, in which "emphasizing visualization and communication" is vital.[13] *Enviro-Envision* primarily falls into this first category, using images of the past, present, and future to promote comprehension and an

---

13. Giannachi, "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice."

emotional response. Giannachi mentions that these kinds of works "aim to raise awareness by drawing attention to the dystopian future that climate change is generating"[14] Other works that employ this strategy are *Situated Simulation* by Liestøl, *A State of Change: Forgotten Landscapes of California* by Cunningham, and *Wild Life in the Age of the Anthropocene* and *Wild Life, Australia* by Zahalka.

Representing climate change is no easy task. But as author Anna Gibbs reminds us:

> The power of the image lies in part in its speed of reach. A small number of experimental studies that measured data. . . have found that humans react physiologically to images faster than we can cognitively process and make sense of them. Primarily affective rather than representational in their modus operandi, media both aim directly at the human nervous system and are entirely dependent on it for their existence[15]

Images are inherently affective and by using imagery in representing climate change, emotions can be provoked, and a motivation for change found. The representations used, in *Enviro-Envision* and the other projects show how important the role of visuals is in producing an emotional impact in audiences.

14. Giannachi.
[15] Anna Gibbs, "Affect Theory and Audience," in *The Handbook of Media Audiences* (John Wiley & Sons, Ltd, 2011), 251–66, https://doi.org/10.1002/9781444340525.ch12.

In attempting to visualize the "hyperobject" of climate change, *Enviro-Envision* depicts three different time periods. The six-hundred year timespan, from 1500 to 2100, depicted with digital tools, condenses an abundance of information and can help us further understand the concept of climate change. In looking at our past, not only can we see how life will be affected by an increase in CO2 in the future, we can also better understand the present. The other projects that also look into the past to understand the present are *SitSim* and *A State of Change.* Author J.B. MacKinnon, reminds us that in understanding "nature" we need to look into the past to understand our present. He states that we:

> cannot hope to make sense of this thing we call nature by looking at what surrounds us, or even by seeking the wilderness. Instead, as science has begun to recognize, we need to reach back and revisit the past- tens, hundreds, even thousands of years ago. What we find there is the living planet at its most extraordinary, often so far beyond what we know today that it challenges our expectations of what life on earth can be….But the history of nature…calls on us to remember losses, not only in the wild, but within ourselves. The past asks us how, what, and why we allow ourselves to forget.[16]

Enviro-Envision looks into the past, reconstructing what the environment reality was five-hundred years ago and reminds us of what has been destroyed, changed, removed, or forgotten since that time [figure 6]. We often accept nature as it is, not

---

16. *The Once and Future World: Nature as It Was, as It Is, as It Could Be.*

being able to conceive how it was before or how it will be in the future. We might even think that we, or others, are nostalgic when remembering the nature that we grew up with, discounting the severity of the changes happening around us. As more and more changes occur with climate change, the worry is that with each generation, information will be lost, and future generations will accept nature as it is, not realizing, even as we do today, the ecological diversity that has been degraded over time. Giannachi writes that "Engaging audiences to think about the environment as a nature-culture hybrid encourages them to reflect about their own dwelling…about the interconnecting paths between *who* we are, *where* we are and *what* will become of us"[17] By connecting the past, present and future into a single interface, audiences can further understand the context in which they exist. With the climate changing, more rapidly than humans have ever seen, there is a necessity for projects, like *Enviro-Envision*, which can, through artistic visuals and informative narration, situate audiences in a period of time and promote reflection and appreciation of an environment.

A major part in creating the visuals for *Enviro-Envision*, was researching how our particular environments have changed, why they have changed, and how they will change in the future. To understand how the local Santa Cruz environment has changed, *Enviro-Envision* involved extensive research in order to understand the history of the area and how it used to look before the area was colonized. The

17. Giannachi.

University of California Santa Cruz digital archive library and the national archives were used to find and look at maps and photos of the area from the late 1800s. Reconstructing the past and imagining the future required understanding how temperature and precipitation affect the flora and fauna life.

The future visuals depicted involved researching different climate change scenarios. Representative Concentration Pathways (RCP), developed by the United Nations' Intergovernmental Panel on Climate Change (IPCC), are scenarios that project greenhouse gas concentrations in the future.[18] The IPCC is the United Nations body for assessing the science related to climate change. [19] For the project, the worst-case and best-case RCP trajectories were instrumental. The worst-case scenario that has been projected is RCP 8.5, which predicts that by 2100 there will be a rise in CO2 levels to 936 PPM, which will increase the global average annual temperature about 5-8° C by 2100 [figure 8].[20] The other scenario incorporated in the piece is RCP 2.6, which is the most optimistic scenario proposed by the IPCC, reflecting an approximate increase in the global average annual temperature by 0.3-1.7°C by 2100 [figure 9].[21] RCP 2.6 is slightly more optimistic than that proposed by the UN Paris Agreement's goal of "keeping a global temperature rise this century well below 2

18. "IPCC - Intergovernmental Panel on Climate Change."

[19] "IPCC - Intergovernmental Panel on Climate Change," accessed November 5, 2018, http://www.ipcc.ch/.

[20] "Climate Model: Temperature Change (RCP 8.5) - 2006 - 2100 Dataset | Science On a Sphere," accessed June 12, 2019, https://sos.noaa.gov/datasets/climate-model-temperature-change-rcp-85-2006-2100/.

[21] "Climate Model: Temperature Change (RCP 2.6) - 2006 - 2100 Dataset | Science On a Sphere," accessed June 12, 2019, https://sos.noaa.gov/datasets/climate-model-temperature-change-rcp-26-2006-2100/.

degrees Celsius above pre-industrial levels and to pursue efforts to limit the

temperature increase even further to 1.5 degrees Celsius"[22]

The visuals of the *Enviro-Envision* project were also informed by species

distribution and density models, that show how density and distribution of species

will shift as the climate warms.[23] Also accessed for this project were the materials

written for the City of Santa Cruz, Central California, and the State of California in

the preparation of the changing climate, such as the latest California's Climate

Change Assessment, US Geological Survey's latest Scientific Investigations Report,

Santa Cruz City's Climate Adaptation Plan, and several other studies specific to Santa

Cruz. These documents and collections of data helped to determine how to visualize

the environmental changes. Additionally, communications with scientists and other

groups who are researching and visualizing future climate change effects in the Santa

Cruz area, assisted the understanding of varying perspectives on how climate change

will affect the Santa Cruz Redwood ecosystem.

In order to visualize the correct scenario and to get the most accurate results in

making the images for *Enviro-Envision*, a spreadsheet was used to record the data;

record what that translated to visually; and document how that would be represented

in the images. For example, in quantifying a decrease in numbers of species from the

present to the future, that aspect required approximate numbers of a particular species

---

[22] "What Is the Paris Agreement? | UNFCCC," accessed June 7, 2019,
https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement.

[23] Matthew Collins et al., "Long-Term Climate Change: Projections, Commitments and Irreversibility," n.d., 108.

in a region and subtract more or less in the image depending on the scenario and predicted outcome for the species. The images sought to visualize what the four graphs overlaid on them displayed more explicitly, which included: a decline in biodiversity; a rise in temperature; a rise in CO2 PPM; and the intervals and intensity of fire in the area [figure 10]. This figurative data visualization was an innovative aspect of *Enviro-Envision*. This visualization required meticulous research and translation, in order to achieve the most accurate results. The goal of the imagery was to not only be accurate, but also artistically interesting. One goal of the piece was to have the audience to believe and ponder the depiction, hopefully eliciting an affective response.

Another project that employs a similar figurative data visualization approach in representing climate change is *A State of Change: Forgotten Landscapes of California.* Cunningham's methods of working are very similar to the approach in *Enviro-Envision.* Artist-naturalist, Laura Cunningham, uses her planetology and biology knowledge in studying and visualizing the historic and living wildlife in California. Cunningham's book, *A State of Change: Forgotten Landscapes of California*, features her oil paintings, sketches, and extensive research which she completed in reconstructing California's past landscapes. Cunningham has "...spent more than two decades poring over historical accounts, paleontology findings, and archaeological data" in order to visualize the forgotten. [24] Her meticulous work shows that by looking into the past, we can begin to understand what the future will be like.

_____

24. "Laura Cunningham Fine Art."

Cunningham says that, "Observing and understanding the changing landscape we live on, so that we can adapt with it, may be our best survival behavior."[25] Visuals have a visceral impact on audiences and this particular method of visualizing data in representing climate change and human impact makes it easier to see qualitative impacts. As we move forward into the future, it is important to continue to use such unique and creative methods in visualizing climate change data.

Another project which is similar to *Enviro-Envision* is *SitSim.* This project, created by Gunnar Liestøl, is a mobile augmented reality platform that visualizes future climate change effects. So far, the *SitSim* team has created two prototypes, one from the west coast of Norway and the other from the iconic Opera House in Oslo. These prototypes, particularly the Oslo platform, show a dystopian view of the future based on the most dramatic climate change models and scenarios of sea level rise. With this mobile app, the user can hold up their phone to see the sea rise and urban abandonment present in year 2222 around the iconic Opera House waterfront location in Oslo. *SitSim* also has created other augmented reality (AR) applications, all of which experiment with locative storytelling and new genres.[26] This project is a great example of how new media can be used to show the future effects of climate change while being present in the particular location. *SitSim*'s main goal is to educate users about the effects of climate change. Liestøl tested the project with young adult users and found that they "had a strong experience of the changed 'reality' of the place,

25. Cunningham, *A State of Change*.
26. Liestol, Morrison, and Stenarson, "Visualization of Climate Change in Situ."

seeing simultaneously the *now* of the physical perspective and the possible future *then* of the same place." [27] By situating audiences in a particular location, they can gain a greater knowledge of the dramatic changes expected to occur with a change in climate. Representational climate change art projects can be used to help expand how we interpret and educate around the effects of climate change.

The main thing that differentiates *Enviro-Envision* from *SitSim*, is that *SitSim* is using AR technology in producing a real-time, mobile, and location-based visualization. *Enviro-Envision* started as an AR project, but morphed over time, into an interactive installation. With the increasing realism found in computer generated imagery, there is no doubt that location based apps, like *SitSim*, will increasingly be used to inform the public, not only about the future effects of climate change, but also about mitigation strategies and solutions and how the implementation of those strategies will affect communities.

For example, Tiffany Wise-West, the Sustainability & Climate Action Manager at the city of Santa Cruz, is using virtual reality (VR) technology to educate the Santa Cruz community about sea level rise solutions. Her team uses this technology in communicating ideas such as what an engineered sea wall will do and cost for the city of Santa Cruz and how it will look and affect water flows, comparing the inevitable two-foot sea rise predicted for the year 2100 and how that will affect the city with no mitigation strategies in place.[28] Projects such as this are helping to

---

27. Stenarson and Liestøl, "Visualization of Climate Change in Situ (2015)."
7/11/2019 4:38:00 AM28"Climate Adaptation Planning | City of Santa Cruz."

educate communities and are providing perspective on the large-scale issues which many locales will be facing within the next few years due to climate change impacts.

Imagery, especially futuristic imagery, can play a huge role in inspiring and imagining future realities. Another project that uses representation, similarly to *Enviro-Envision,* is *Wild Life in the Age of the Anthropocene* and *Wild Life, Australia,* which is a collection of photo media works by Anne Zahalka. Zahalka is a photo media artist who works with themes of climate change, Anthropocene, nature, and humans.[29] In her most recent collection titled *Wild Life in the Age of the Anthropocene* and *Wild Life, Australia,* she uses photos and digital collage in depicting a future world where nothing has been left untouched by humanity. Zahalka uses background imagery from constructed museum scenes and "has made interventions introducing planes slashing across a painted sky, rubbish piling up beside an animal encounter, and cityscapes infiltrating the horizon in order to mark out unsettling ethical issues and the dramatic changes that have taken in these habitats today."[30] These scenes seem oddly familiar, reminding us that this future is not far away or outside of the realm of the possible any longer. As stated on her website, "By digitally inserting traces of reality into this idealised, optimistic imagery, Zahalka subverts these fixed narratives and reflects on the changing relationship that exists between people and the natural world."[31] She, as seen in other ecologically themed

---

[29] "Wild Life in the Age of the Anthropocene, 2018," ANNE ZAHALKA, accessed May 3, 2019, http://zahalkaworld.com.au/wild-life-in-the-age-of-the-anthropocene-2018/.
30"Wild Life in the Age of the Anthropocene, 2018."
31"Wild Life, Australia, 2019."

practices, works in an interdisciplinary manner and collaboratively in composing these visual narratives. Even though the visuals and subject matter are very similar between *Enviro-Envision* and Zahalka's work, *Enviro-Envision* uses more than just imagery alone to portray information about what the audience is seeing. However, Zahalka's photo media works are a great example of how ecologically themed new media work can use representation in effectively communicating climate change.

These works show how the hyperobject of climate change can be represented visually. As illustrated by *Enviro-Envision, A State of Change, SitSim,* and *Wild Life in the Age of the Anthropocene* and *Wild Life, Australia*, representation plays an important role in evoking empathy from audiences and can be used to effectively communicate climate change. The projects use imagery of environments in promoting comprehension and an emotional response, this strategy is one of the three used by Giannachi to categorize climate change themed artworks. *Enviro-Envision* primarily falls into this first category, but also uses the second strategy outlined by Giannachi.

Performance Environments

Representing climate change, is not the only strategy that artists use to communicate climate change through their work. There are also performance environments. This second strategy is defined by Giannachi as, "art facilitating the experience of climate change...[using] immersive environments, so that climate

change can be experienced directly as well as analyzed."[32] *Enviro-Envision* sought to include a layer of immersion, with the large scale installation format and audio content. Another project which employs this strategy is *The Future Energy Lab* by SuperFlux. Use of this strategy by both *Enviro-Envision* and *The Future Energy Lab,* furthered the experience and, therefore, the understanding of climate change.

One of the goals of *Enviro-Envision* was to immerse viewers in the landscape. The landscape was projected onto a nine-foot by sixteen-foot tall screen in a dark exhibition space. Portrait orientation was used, rather than landscape orientation, to not only draw attention to the scale of the trees, but to situate the environment in the same context as a human portrait. This orientation removed the audience from the typical landscape orientation associated with landscapes, computer screens and TV screens, and helped them have a unique awareness of the Santa Cruz redwood ecosystem. The scale of the projected imagery evoked a similar emotional reaction to that of experiencing redwood trees in person, helping to immerse the audience in the experience.

Enviro-Envision included, along with large scale visuals, audio content and ambient sounds, offering a multi-sensory experience for the audience. The project has three main images, including the past, present and future. Additionally, the project contains thirty-two ellipses, which by hovering with the cursor, a mix of narration and ambient sounds are revealed. This information forms a narrative about the ecosystem

32Giannachi, "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice."

and how it has and will continue to be impacted. The project's narration was written by UC Santa Cruz reserve manager, Alex Jones, and myself. Jones narrated the piece, adding a unique perspective to the narration with his natural science background. There were ambient sounds that corresponded to different ellipses in the piece that included sounds of chopping of wood, marbled Murrelet chirping, burning forest and more. There were also ambient nature sounds composed by Andy DiLallo, specific to each of the three-time frames that played in the background. This included sounds from the past with no human-attributed sounds and more sounds from nature, the present with more human sounds and less nature, and the future with barely any nature sounds and mostly man-made sounds such as airplanes, cars, etc. The pairing of the visuals with the audio, provides the audience with a multi-sensory experience, immersing and attracting them to interact with the work.

The interactive element of *Enviro-Envision* allows each audience member to have a unique experience with the piece. This project invites the audience to control what time period they view, and what narrative they follow and at what pace. As they made their own way through the timeline and the scenes played out, the audience had the chance to maneuver their way to any aspect of their choosing. The personalized way to experience the piece invited the audience to take their time and not only be exposed to the varying visual portrayals, but also the layered audio sensations, as well as the tactile ability to choose with the hand. This invited the viewer to experience what they wanted as many times as they wished. The digital media used in *Enviro-Envision* allows for unique audience interactions to take place that would not

otherwise be possible. Authors Joshua Green and Henry Jenkins mention how audiences of interactive media can use the "content at their disposal to forge connections with each other, to mediate social relations, and to make meaning of the world around them."[33] The digital interactivity found in new media projects, such as *Enviro-Envision,* can expand access to and understanding of issues, making it possible for audiences to choose how they experience a work. The audiences' inquisitiveness guides them, as seen in *Enviro-Envision*, to the levels of knowledge and at their own pace. The multi-level sensory experience offered brought the subject-matter to the audience in a very visceral way, which hopefully allowed minds to open up and let knowledge, information and passion to flourish.

Furthermore, permitting each person to control how they experience the piece, makes the project and the project narrative individual to each audience member and this is one way that ecologically concerned new media art has the potential to allow us to, as Knebusch states, "experience and reveal our inner participation with climate, the rupture of its balance and its meaning for our inner world"[34] The subjective nature of interactive works allows for unique interactions which can bring personal implication to the subject matter and an awareness of the impacts on the self. When we can relate to climate and have a reflection on how climate affects us, we become closer to understanding the hyperobject of climate change.

---

[33] Joshua Green and Henry Jenkins, "Spreadable Media: How Audiences Create Value and Meaning in a Networked Economy," in *The Handbook of Media Audiences* (John Wiley & Sons, Ltd, 2011), 109–27, https://doi.org/10.1002/9781444340525.ch5.
34. Knebusch, "The Perception of Climate Change."

Another project that uses immersion as a strategy for educating audiences about climate change is *The Future Energy Lab* by SuperFlux. SuperFlux is a UK studio that designs mitigation strategies and creates futuristic spaces that embody climate change realities. Originally commissioned in 2017 by United Arab Emirates Ministry of Energy and the Prime Minister's Office, *The Future Energy Lab*, evaluates and produces, for a particular region, what the future climate and solutions may look like. This presentation consists of several components aimed at designing and showing future strategies and problems that might arise in a specific location. The part of this presentation that is particularly immersive and impactful is the future air quality samples. By using data and predictions, conical flasks are filled with three different air quality types, each containing a different climate fate. This piece creates a sensory experience for the audience, letting them actually smell what the air quality might be, in this case, in the United Arab Emirates, by 2050 if they continue releasing emissions at the current rate. SuperFlux, wants to "give people a very emotional, concrete experiential perspective of that future so you could actually touch a part of that future."[35] This project, similar to *Enviro-Envision*, seeks to evoke an emotional connection with the future, in order to promote change. Authors Kathryn Yusoff and Jennifer Gabrys mention how "Creative practices may open up new scales of sensation, new forms of representation, both aesthetic and political, and expanded publics for engaging with this critical issue."[36] The scale of sensation offered by the

35. "Superflux - Translating Future Uncertainty into Present Day Choices."

[36] Kathryn Yusoff and Jennifer Gabrys, "Climate Change and the Imagination," *Wiley Interdisciplinary Reviews: Climate Change* 2, no. 4 (2011): 516–34,

projects shows how immersion can be used to increase engagement and understanding of climate change. The SuperFlux project takes immersion into another level than *Enviro-Envision,* providing a full sensory experience for the audience. Immersion, in this case, helps to captivate and engage audiences in not only the issue at hand, but also possible solutions.

Both *Enviro-Envision* and *The Future Energy Lab* use the second strategy, introduced by Giannachi, of immersion in furthering the experience and, therefore, the understanding of climate change for their audiences. In attempting to immerse the audience, *Enviro-Envision*, provides a multi-sensory interactive experience using digital media technology. SuperFlux designs mitigation strategies and creates futuristic spaces that embody climate change realities as seen in *The Future Energy Lab*. The immersive formats seen in both projects help to transform data into a sensory based experience, making future predictions and the data associated with climate change tangible.

Interventions

The third, and last strategy, discussed by Giannachi comprises interventions that "encourage behavioral change."[37] For example, artist Natalie Jeremijenko's

---

https://doi.org/10.1002/wcc.117.
37Giannachi, "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice."

Environmental Health Clinic and artist Michael Mandiberg's *Real Costs* (2007) projects successfully promote behavioral change.

Jeremijenko is a great example of someone working at the intersection of electronic media and ecocentrism. She is not only an artist, but also a designer and an engineer with a unique background "in biochemistry, engineering, neuroscience and History and Philosophy of Science."[38] She directs *The Environmental Health Clinic*, which comprises interventions in prescribing concrete and actionable solutions to individuals with environmental health issues.[39] For instance, a patient with asthma might be prescribed to plant a garden in their neighborhood that can help clean the urban air. In the artist's words:

> [n]ew technologies such as the ones we're using at the Environmental Health Clinic present new opportunities to address and reimagine our institutional frameworks. But seizing these opportunities requires each individual's participation and intelligent sense-making . . . [o]nly through this sort of hands-on coordination can we begin to understand the complexity of our urban ecosystems and determine solutions.[40]

Jeremijenko is providing not just a space for the community to reveal local environmental issues, but also the technology and tools for fixing these issues. The citizen science approach found in this work demonstrates how vital intervention-

---

38 "Natalie Jeremijenko - Faculty Bio."
39 Giannachi, "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice."
40 "Environmental Health Clinic - Home."

based works can be in local communities. Giannachi mentions that intervention-based works "operate by producing change in a particular community as a part of the work" and in this project, Jeremijenko's local New York community gain access to prescribed creative, yet concrete, solutions to local environmental issues.[41] This project shows how change can start on a small scale but over time have a large impact on a community and the world.

Another work that uses the strategy of intervention is Michael Mandiberg's *Real Costs* (2007) which is a browser plug in that shows you how much CO_2 is emitted and the number of tree-years in which to offset these emissions, while looking at travel sites.[42] This piece channels the power of digital technology in providing the audience with instant feedback. This feedback that is provided to the audience reveals the power that real-time systems have in simultaneously collecting and processing large amounts of data in educating audiences and effecting future change. The author, Edward Shanken, writes about this saying that:

> By providing the user with instantaneous feedback about the environmental consequences of their travel choices, *Real Costs* harnesses the potential of real-time systems to, in Burnham's words, 'gather and process data … in time to effect future events within those environments'. Indeed, similar programs have been adopted by municipal public transportation systems, such as the HKL in Helsinki. In this example, an artist's innovative

41Giannachi.
42Shanken, *Art and Electronic Media*.

work not only creates awareness in an art context but also anticipates and

provides a model for similar applications in a larger social context.[43]

 Mandiberg's piece, successfully boils down the complexity of climate change based

on decisions made today. This work illustrates how works that "encourage behavioral

change" can not only influence their immediate audiences, but also promote a larger

societal change. [44] This reflects back to the AR projects created by Liestøl and Wise-

West that show how visuals can be used to promote public understanding of not only

climate change, but the solutions and mitigation strategies associated with the issue.

Shanken, writes about the:

> increasing number of contemporary artists, including Tiffany Holmes, Natalie
>
> Jeremijenko, Andrea Polli and Amy Youngs, [who] are using electronic media
>
> to create artworks that explore questions of air, water, noise pollution and to
>
> employ art as a strategic tool for creating awareness and promoting
>
> conservation.[45]

Electronic media has impacted ecologically concerned art practices, by offering a new

medium in which to reach audiences. The digital technology has potential in climate

change themed works to condense large amounts of information and provide access to

more people than ever before. This is evident in *Enviro-Envision*, and in some of the

---

[43] Edward A. Shanken, "Investigatory Art: Real-Time Systems and Network
Culture," *NECSUS. European Journal of Media Studies* 1, no. 2 (2012): 77–89,
https://doi.org/10.5117/NECSUS2012.2.SHAN.
44Giannachi, "Representing, Performing and Mitigating Climate Change in
Contemporary Art Practice."
45Shanken, *Art and Electronic Media 36*.

other projects mentioned. The immediacy and reach of the electronic media, as seen in Mandiberg's work, is important in understanding how our current actions affect future realities. New media has the potential to be used increasingly by artists seeking to "encourage behavioral change" and find solutions to climate change.[46]

The third, and final strategy, discussed by Giannachi comprises interventions and shows how art has potential to promote change. In the article *'Raising the Temperature:' The Arts on a Warming Planet* the authors mention how "the arts represent a potential public space that can open up the framing of a particular problem, rather than closing down the possibilities for action, limiting solutions, and presenting problems framed exclusively by experts." Art can be used as a means to connect with a large audience and to offer tangible solutions for individuals to combat environmental issues. This promotion of behavioral change is seen in Jeremijenko's *Environmental Health Clinic* and Michael Mandiberg's *Real Costs* (2007) projects. Although *Enviro-Envision* does not currently employ this third strategy, there is potential for it to address this in future iterations.

Future Iterations

Enviro-Envision, as seen at the *Receivership* show, can be shown in a gallery setting, and ideally at an immersive and true to life scale. The piece can also, due to its digital format, be formatted in a variety of ways, allowing for it to fit and be

---

46Giannachi, "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice."

adapted to fit many different spaces in the future. In order for this piece to occupy

another space and exist, beyond the *Receivership* exhibition, a website will be made

for the project. The digital access associated with a website will allow those who

cannot experience the project in person, an opportunity to explore, not only what was

present at the exhibition but also the additional research and material that is

conducted and collected in the making of the project. The project will be continued in

the future, creating new iterations that might incorporate new technology, such as

AR, an intervention-based approach, and include different ecosystems in order to

educate and engage about critical issues surrounding our local environments and

climate change.

CONCLUSION

From the burgeoning movements prompted by Rachel Carson's book, *Silent

Spring,* came real concern for the environment and activism seeking to bring about

political and social change. Pioneering ecologically-minded artists of the 1960s and

1970s sought to bring awareness and solutions to pressing environmental issues of the

time. The eco-artists were some of the first to become concerned with making art that

was ecocentric, involving entire natural systems, rather than just the human ego.

Since then, the world has shifted greatly, and the extent and effects of climate

change have become more apparent, yet humans still cannot fully comprehend the

"hyperobject" of climate change. The emotions evoked by art have the power to

promote change and comprehension of complicated issues like climate change. A variety of artists, including those mentioned, are working to elicit passion and to convey a message of the necessity of change. The ecologically themed new media art project *Enviro-Envision* demonstrates the necessity for such interdisciplinary projects in communicating climate change. The digital technology, interactivity, and figurative data visualization used in the project, are innovative approaches to comprehending climate change. These approaches, compared in context with other contemporary projects' strategies for making climate change themed work, show the variety and importance that art can have in communicating climate change. Artists such as Gunnar Liestøl, Laura Cunningham, Anne Zahalka, SuperFlux, Natalie Jeremijenko, and Michael Mandiberg, discussed in comparison to *Enviro-Envision*, demonstrate how art can provide understanding of and solutions to environmental issues.

Climate change is not a simple problem to solve, and consequently will not have a simple solution. As we continue to work together to find solutions, it will be important to have compassion, and art, due to its affective nature, can continue to improve understanding and inspire change in individuals. There is an alarming immediacy for change, and we can work together to demand change, and this can happen starting now.

BIBLIOGRAPHY

"20180827-StatewideSummary.Pdf." Accessed November 18, 2018.
http://www.climateassessment.ca.gov/state/docs/20180827-StatewideSummary.pdf.

"AFTER ICE: WELCOME TO THE NEW NORMAL." Guariglia. Accessed November 5,
2018. https://guariglia.com/app1.

Alternative, Not An. *Amphibious Architecture*, 2010. https://vimeo.com/8508425.

"Amphibious Architecture." Accessed December 11, 2017.
http://www.expandedenvironment.org/amphibiousarchitecture/.

Amy Balkin. "Invisible 5." Accessed May 3, 2019. http://tomorrowmorning.net/invisible5.

"Anthropocene Curriculum." Accessed May 3, 2019. https://www.anthropocene-
curriculum.org/pages/root/participants/anna-tsing/.

Arellano, Gustavo. "Will the California Grizzly Make a Comeback?" latimes.com.
Accessed December 2, 2018. https://www.latimes.com/opinion/op-ed/la-oe-arellano-
grizzlies-20180718-story.html.

"Art (and Science) Talk with Natalie Jeremijenko | NEA." Accessed December 11, 2017.
https://www.arts.gov/art-works/2014/art-and-science-talk-natalie-jeremijenko.

"Art and Technology." In *Theories and Documents of Contemporary Art*, n.d.

"Art Makes Environmental Change Real." Scientific American. Accessed December 13,
2018. https://www.scientificamerican.com/article/art-makes-environmental-change-
real/.

AURA. *Donna Haraway, "Anthropocene, Capitalocene, Chthulucene: Staying with the
Trouble", 5/9/14*, 2014. https://vimeo.com/97663518.

Auther, Elissa, Adam Lerner, Museum of Contemporary Art/Denver, and Scottsdale
Museum of Contemporary Art, eds. *West of Center: Art and the Counterculture
Experiment InAmerica, 1965-1977*. Minneapolis : [Denver, Colo.]: University of
Minnesota Press ; Published in cooperation with the Museum of Contemporary Art
Denver, 2012.

"Before California: Laura Cunningham." *David Brower Center* (blog). Accessed May 17,
2019. https://browercenter.org/exhibit/before-california-laura-cunningham/.

Bérigny, Caitilin de, Phillip Gough, Majdi Faleh, and Erika Woolsey. "Tangible User
   Interface Design for Climate Change Education in Interactive Installation Art."
   Leonardo 47, no. 5 (November 2014): 451–56.
   https://doi.org/10.1162/LEON_a_00710.

"Big Trees, Felton, Santa Cruz Co. / Tabor Photo., San Francisco." Image. Library of
   Congress, Washington, D.C. 20540 USA. Accessed December 2, 2018.
   https://www.loc.gov/resource/ppmsca.51093/.

Bolter, Jay David. "Digital Media and Art: Always Already Complicit?" Edited by Lisa
   Gitelman, Marie-Laure Ryan, and Johanna Drucker. *Criticism* 49, no. 1 (2007): 107–
   18.

"Cal-Adapt." Accessed November 5, 2018. http://cal-adapt.org/.

"California Climate Change Assessment." Accessed November 5, 2018.
   http://www.climateassessment.ca.gov/.

"California Coastal Records Project." Accessed November 5, 2018.
   https://www.californiacoastline.org/cgi-
   bin/timecompare.cgi?image=7932009&latdeg=36.921703&longdeg=121.858247&fla
   gs=0&year=1979&hidden=0&oneimage=1928/1928500005-1979/7932009-.

"California Views. No. 8. Redwood Trees, Santa Cruz Mtns." Image. Library of Congress,
   Washington, D.C. 20540 USA. Accessed December 2, 2018.
   https://www.loc.gov/resource/pga.12086/.

Carruth, Allison. "Urban Ecologies and Social Practice Art." *Resilience: A Journal of the
   Environmental Humanities* 1, no. 1 (2014). https://muse.jhu.edu/article/565577.

Carson, Rachel. *Silent Spring*. Fortieth anniversary edition, First Mariner books edition.
   Boston: Houghton Mifflin, 2002.

"Causes of Climate Change | Climate Change Science | US EPA." Accessed May 3, 2019.
   https://archive.epa.gov/epa/climate-change-science/causes-climate-change.html.

Cembalest, Robin. "A Climate Change in the Art World?" *ARTnews* (blog), November 13,
   2012. http://www.artnews.com/2012/11/13/a-climate-change-in-the-art-world/.

Change, NASA Global Climate. "Carbon Dioxide Concentration | NASA Global Climate
   Change." Climate Change: Vital Signs of the Planet. Accessed May 3, 2019.
   https://climate.nasa.gov/vital-signs/carbon-dioxide.

Chodos, Rafael. "REFLECTIONS ON THE IMPACT OF 'THE DIGITAL REVOLUTION' ON ART AND RELIGION." *CrossCurrents* 62, no. 2 (2012): 260–69.

"Climate Adaptation Planning | City of Santa Cruz." Accessed November 5, 2018. http://www.cityofsantacruz.com/government/city-departments/city-manager/climate-action-program/climate-adaptation-planning-copy.

"Climate Change: Atmospheric Carbon Dioxide | NOAA Climate.Gov." Accessed May 3, 2019. https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

"Climate Change Impacts on Human Health over Europe through Its Effect on Air Quality." Accessed May 3, 2019. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5773909/.

"Climate Model: Temperature Change (RCP 8.5) - 2006 - 2100 Dataset | Science On a Sphere." Accessed June 12, 2019. https://sos.noaa.gov/datasets/climate-model-temperature-change-rcp-85-2006-2100/.

"Climate R&D: Home." Accessed November 5, 2018. https://www2.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp.

Coles, Laura Lee, and Philippe Pasquier. "Digital Eco-Art: Transformative Possibilities." *Digital Creativity* 26, no. 1 (2015): 3–15. https://doi.org/10.1080/14626268.2015.998683.

Collins, Matthew, Reto Knutti, Julie Arblaster, Jean-Louis Dufresne, Thierry Fichefet, Xuejie Gao, William J Gutowski Jr, et al. "Long-Term Climate Change: Projections, Commitments and Irreversibility," n.d., 108.

"CSSR_Ch4_Climate_Models_Scenarios_Projections.Pdf." Accessed June 12, 2019. https://science2017.globalchange.gov/downloads/CSSR_Ch4_Climate_Models_Scenarios_Projections.pdf.

Cubitt, Sean. *Eco Media*. Contemporary Cinema, 1. Amsterdam: Rodopi, 2005.

Cunningham, Laura. *A State of Change: Forgotten Landscapes of California*. Berkeley, Calif: Heyday, 2010.

Davis, Heather M., and Etienne Turpin, eds. *Art in the Anthropocene: Encounters among Aesthetics, Politics, Environments and Epistemologies*. First ed. Critical Climate Change. London: Open Humanities Press, 2015.

Demos, T. J. *Against the Anthropocene: Visual Culture and Environment Today*. Berlin: Sternberg Press, 2017.

Dion, Mark, Lisa G. Corrin, Miwon Kwon, and Norman Bryson. *Mark Dion*. Contemporary Artists. London: Phaidon Press, 1997.

Dion, Mark, Gregory Wittkopp, and Cranbrook Academy of Art Museum. *Weird Science: A Conflation of Art and Science*. Cranbrook Art Museum, 1999.

"Discovery of the Ice Age." Accessed November 5, 2017. http://earthguide.ucsd.edu/virtualmuseum/climatechange2/02_1.shtml.

"Drawdown." Accessed May 3, 2019. https://www.drawdown.org/.

"Drought in Sierra Streams." *UCNRS* (blog), March 28, 2019. https://ucnrs.org/drought-in-sierra-streams/.

"Earth 2100 | ABC - Dailymotion Video." Dailymotion. Accessed May 3, 2019. https://www.dailymotion.com/video/x1gvn9j.

"Earth Day: Disease Spread among Species Is Predictable | NSF - National Science Foundation." Accessed December 1, 2018. https://www.nsf.gov/news/news_summ.jsp?cntn_id=134447&org=NSF.

"Ecosystem Ecology | Learn Science at Scitable." Accessed May 3, 2019. https://www.nature.com/scitable/knowledge/ecosystem-ecology-13228212.

Ede, Siân. *Art and Science*. London ; New York: I. B. Tauris, 2005.

Environment, State of the. "2016 SoE Land Likelihood of Vegetation Change under Climate Scenarios - Projected (2050 MIROC 5 RCP 8.5)." Accessed January 13, 2019. https://data.gov.au/dataset/2016-soe-lan-climate-scenarios-projected-2050-miroc.

"Environmental Health Clinic." Accessed December 7, 2017. http://www.nyu.edu/projects/xdesign/clinic/.

"Environmental Health Clinic - Home." Accessed December 7, 2017. https://www.facebook.com/xclinic/.

Etheridge, D. M., L. P. Steele, R. L. Langenfelds, R. J. Francey, J.-M. Barnola, and V. I. Morgan. "Natural and Anthropogenic Changes in Atmospheric CO2 over the Last 1000 Years from Air in Antarctic Ice and Firn." *Journal of Geophysical Research: Atmospheres* 101, no. D2 (1996): 4115–28. https://doi.org/10.1029/95JD03410.

"Feral Robotic Toy Dogs Designed to 'Sniff Out' Environmental Toxins Set Loose on April 5." YaleNews, April 4, 2003. https://news.yale.edu/2003/04/04/feral-robotic-toy-dogs-designed-sniff-out-environmental-toxins-set-loose-april-5.

Fernández, Miguel, Healy H. Hamilton, and Lara M. Kueppers. "Back to the Future: Using Historical Climate Variation to Project Near-term Shifts in Habitat Suitable for Coast Redwood." *Global Change Biology* 21, no. 11 (November 1, 2015): 4141–52. https://doi.org/10.1111/gcb.13027.

"Foreword : Memory as Model / Lucy R. Lippard -- Introduction : The Counterculture Experiment : Consciousness and Encount," n.d.

Fuller, Matthew. "Art for Animals." *Part of a Special Issue: The Animal Gaze* 9, no. 1 (April 2010): 17–33. https://doi.org/10.1386/jvap.9.1.17_1.

Fuller, R. Buckminster. "THE WORLD GAME." *Ekistics* 28, no. 167 (1969): 286–92.

Gadanho, Pedro. *Eco-Visionaries: Art, Architecture, and New Media after the Anthropocene*. Berlin: Hatje Cantz Verlag, 2018.

Galafassi, Diego, Sacha Kagan, Manjana Milkoreit, María Heras, Chantal Bilodeau, Sadhbh Juarez Bourke, Andrew Merrie, Leonie Guerrero, Guðrún Pétursdóttir, and Joan David Tàbara. "'Raising the Temperature': The Arts on a Warming Planet." *Current Opinion in Environmental Sustainability*, Sustainability governance and transformation 2018, 31 (April 1, 2018): 71–79. https://doi.org/10.1016/j.cosust.2017.12.010.

Giannachi, Gabriella. "Representing, Performing and Mitigating Climate Change in Contemporary Art Practice." *Leonardo* Early Access, no. Early Access (n.d.): 124–131. https://doi.org/10.1162/LEON_a_00278.

Gibbs, Anna. "Affect Theory and Audience." In *The Handbook of Media Audiences*, 251–66. John Wiley & Sons, Ltd, 2011. https://doi.org/10.1002/9781444340525.ch12.

"Global Carbon Project (GCP)." Accessed May 21, 2019. https://www.globalcarbonproject.org/.

Goble, Dale D. "WHAT 'ARE' SLUGS GOOD FOR? ECOSYSTEM SERVICES AND THE CONSERVATION OF BIODIVERSITY." *Journal of Land Use & Environmental Law* 22, no. 2 (2007): 411–40.

"Gods Handiwork." Image. Library of Congress, Washington, D.C. 20540 USA. Accessed December 2, 2018. https://www.loc.gov/item/2007660660/.

Green, Joshua, and Henry Jenkins. "Spreadable Media: How Audiences Create Value and Meaning in a Networked Economy." In *The Handbook of Media Audiences*, 109–27. John Wiley & Sons, Ltd, 2011. https://doi.org/10.1002/9781444340525.ch5.

"Greenhouse Gas Scenarios." Accessed May 3, 2019. https://www.climatechangeinaustralia.gov.au/en/climate-campus/modelling-and-projections/projecting-future-climate/greenhouse-gas-scenarios/.

Greenlee, Jason M., and Jean H. Langenheim. "Historic Fire Regimes and Their Relation to Vegetation Patterns in the Monterey Bay Area of California." *The American Midland Naturalist* 124, no. 2 (1990): 239–53. https://doi.org/10.2307/2426173.

Guattari, Félix. *The Three Ecologies*. Athlone Contemporary European Thinkers. London: Athlone Press, 2000.

Hansen, James, Makiko Sato, and Reto Ruedy. "Perception of Climate Change." *Proceedings of the National Academy of Sciences* 109, no. 37 (September 11, 2012): E2415–23. https://doi.org/10.1073/pnas.1205276109.

Haraway, Donna. "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin." *Environmental Humanities* 6, no. 1 (2015): 159–65. https://doi.org/10.1215/22011919-3615934.

Haraway, Donna Jeanne. *Staying with the Trouble: Making Kin in the Chthulucene*. Experimental Futures : Technological Lives, Scientific Arts, Anthropological Voices. Durham: Duke University Press, 2016.

———. *The Companion Species Manifesto: Dogs, People, and Significant Otherness*. Chicago, Ill: Prickly Paradigm, 2003.

Heartney, Eleanor. "Art for the Anthropocene Era." *Art in America* 102, no. 2 (February 2014): 76–81.

Hindiyeh, Jordan. "Promoting Environmental Sustainability Through Art," 2017. http://www.escholarship.org/uc/item/53f3s8gg.

Holmes, Tiffany. "Eco-Visualization: Promoting Environmental Stewardship in the Museum." *The Journal of Museum Education* 32, no. 3 (2007): 275–85.

"How the World Passed a Carbon Threshold and Why It Matters." Yale E360. Accessed May 3, 2019. https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters.

Hughes, Craig, Stevie Peace, Kevin Van Meter, and Team Colors Collective, eds. *Uses of a Whirlwind: Movement, Movements, and Contemporary Radical Currents in the United States*. Edinburgh ; Oakland: AK, 2010.

"Hurricane Irma Turns Virgin Islands Brown." Accessed May 24, 2019. https://climate.nasa.gov/images-of-change?id=628.

ICA Boston. *Mark Dion: The Classical Mind*. Accessed February 12, 2018. https://www.youtube.com/watch?v=JBYfv0Fb7IA.

"Interactives – Climate Change: Vital Signs of the Planet." Accessed November 5, 2018. https://climate.nasa.gov/interactives/climate-time-machine.

"IPCC - Intergovernmental Panel on Climate Change." Accessed November 5, 2018. http://www.ipcc.ch/.

Irland, Basia. "Eco-Art." In *Keywords for Environmental Studies*, 60–61. NYU Press, 2016. http://www.jstor.org/stable/j.ctt15zc5kw.23.

Iversen, Chelsea. "How Climate Change Is Affecting Our Redwood Forests." The Bold Italic, December 6, 2016. https://thebolditalic.com/will-climate-change-kill-the-redwoods-1a2c33d2dad7.

Jarvis, Brooke. "The Insect Apocalypse Is Here." *The New York Times*, November 27, 2018, sec. Magazine. https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html.

jeremijenko, natalie. *Feral Robotic Dog Pack*, 2010. https://vimeo.com/10075678.

Jeremijenko, Natalie. "Natalie Jeremijenko | Speaker | TED." Accessed December 7, 2017. https://www.ted.com/speakers/natalie_jeremijenko.

———. "The Bureau of Inverse Technology: Reversing Standards of Evidence." *Thresholds*, no. 29 (2005): 71–73.

J.R. McNeill, and Peter Eneglke. *The Great Acceleration: An Environmental History of the Anthropocene since 1945*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 2014.

Keeley, Jon E. "Native American Impacts on Fire Regimes of the California Coastal Ranges." *Journal of Biogeography* 29, no. 3 (2002): 303–320. https://doi.org/10.1046/j.1365-2699.2002.00676.x.

KELLEY, LINDSAY. "Cooking and Eating across Species:: Natalie Jeremijenko’s Cross(x)Species Adventure Club." In *The Taste of Art*, 279–92. Cooking, Food, and Counterculture in Contemporary Practices. University of Arkansas Press, 2017. https://doi.org/10.2307/j.ctt1n7qkd6.22.

Knebusch, Julien. "The Perception of Climate Change." *Leonardo*, April 2007.

Lakoff, George, and Mark Johnson. *Metaphors We Live By*. Accessed April 24, 2018. http://www.press.uchicago.edu/ucp/books/book/chicago/M/bo3637992.html.

Lam, Steven, Gabi Ngcobo, Jack Persekian, Nato Thompson, Anne Sophie Witzke, and Liberate Tate. "Art, Ecology and Institutions." *Third Text* 27, no. 1 (January 2013): 141–50. https://doi.org/10.1080/09528822.2013.753196.

Larson, Brendon. *Metaphors for Environmental Sustainability : Redefining Our Relationship with Nature*. New Haven [Conn.]: Yale University Press, 2011.

Lasnier, Guy, and Tim Stephens. "Experts Discuss Science and Policy at First UCSC Climate Science Conference." UC Santa Cruz News. Accessed November 18, 2018. https://news.ucsc.edu/2014/03/climate-conference.html.

"Laura Cunningham Fine Art." Accessed May 17, 2019. https://lcunningham-art.com/.

Lehmann, Susan. "Economic Development of the City of Santa Cruz, 1850-1950," n.d., 33.

"Let It Be." *UCNRS* (blog), September 16, 2014. https://ucnrs.org/let/.

"Licungo River Flooding, Mozambique." Accessed December 5, 2018. https://climate.nasa.gov/images-of-change?id=538.

Liestol, Gunnar, Andrew Morrison, and Tomas Stenarson. "Visualization of Climate Change in Situ." In *2014 International Conference on Virtual Systems & Multimedia (VSMM)*, 251–56. Hong Kong, Hong Kong: IEEE, 2014. https://doi.org/10.1109/VSMM.2014.7136657.

Lightfoot, Kent G., Rob Q. Cuthrell, Chuck J. Striplen, and Mark G. Hylkema. "Rethinking the Study of Landscape Management Practices among Hunter-Gatherers in North America.(Report)." *American Antiquity* 78, no. 2 (2013): 285–301. https://doi.org/10.7183/0002-7316.78.2.285.

Liotta, P. H. *Gaia's Revenge : Climate Change and Humanity's Loss*. Politics and the Environment. Westport, Conn.: Praeger Publishers, 2007.

"Lovely Weather: Art & Climate Change Projects 2010." *Leonardo* 44, no. 2 (April 2011): 188–89.

MacKinnon, J.B. *The Once and Future World : Nature as It Was, as It Is, as It Could Be*. Boston ; Houghton Mifflin Harcourt, 2013.

Malpas, Jeff. "Amphibious Architecture." *Landscape Architecture Australia*, no. 151 (August 2016): 44–49.

Manifesto for Living in the Anthropocene. Brooklyn, NY: Punctum, 2015.

Mann, Michael E., Raymond S. Bradley, and Malcolm K. Hughes. "Global-Scale Temperature Patterns and Climate Forcing over the Past Six Centuries." *Nature* 392, no. 6678 (April 1998): 779–87. https://doi.org/10.1038/33859.

"Mark Dion." School of the Art Institute of Chicago. Accessed February 12, 2018. http://www.saic.edu/visiting-artists-program/events/mark-dion.

Martin, Claire. "Natalie Jeremijenko: Welcome to the Anthropocene." *Landscape Architecture Australia*, no. 146 (May 2015): 40–42.

Milman, Oliver. "Sinking Santa Cruz: Climate Change Threatens Famed California Beach Town." *The Guardian*, October 11, 2018, sec. US news. https://www.theguardian.com/us-news/2018/oct/11/santa-cruz-sinking-climate-change-beaches-surfing.

"Mitigation of Shock." Mikhaela. Accessed June 11, 2019. https://mikhaeladietch.com/mitigation-of-shock.

Morton, Timothy. *Hyperobjects: Philosophy and Ecology after the End of the World*. Posthumanities 27. Minneapolis: University of Minnesota Press, 2013.

Moser, Susanne C. "Communicating Adaptation to Climate Change: The Art and Science of Public Engagement When Climate Change Comes Home." *Wiley Interdisciplinary Reviews: Climate Change* 5, no. 3 (2014): 337–358. https://doi.org/10.1002/wcc.276.

NASA. "NASA Maps California Drought Effects on Sierra Trees." Climate Change: Vital Signs of the Planet. Accessed December 5, 2018. https://climate.nasa.gov/news/2457/nasa-maps-california-drought-effects-on-sierra-trees.

"Natalie Jeremijenko - Faculty Bio." Accessed December 1, 2017. https://steinhardt.nyu.edu/faculty/Natalie_Jeremijenko.

"Natalie Jeremijenko Talks about the Environmental Health Clinic on Vimeo." Accessed December 7, 2017. https://vimeo.com/165529680.

"National Climate Assessment." National Climate Assessment. Accessed May 3, 2019. https://nca2014.globalchange.gov/node/9473.

"Nat.Jeremijenko.Project.Hub." Accessed November 26, 2017. http://www.nyu.edu/projects/xdesign/.

Neumark, Norie, ed. "Technology and Machines Speak (for) Themselves." In *Voicetracks*, 91–122. Attuning to Voice in Media and the Arts. MIT Press, 2017. http://www.jstor.org/stable/j.ctt1pwt5m3.8.

"Northern California Coastal Forests | Ecoregions | WWF." Accessed May 3, 2019. https://www.worldwildlife.org/ecoregions/na0519.

Nurmis, Joanna. "Visual Climate Change Art 2005–2015: Discourse and Practice." *Wiley Interdisciplinary Reviews: Climate Change* 7, no. 4 (2016): 501–16. https://doi.org/10.1002/wcc.400.

Pali, Brunilda. "Art for Social Change: Exploring Restorative Justice through the New Media Documentary Inside the Distance." *Restorative Justice* 2, no. 1 (2014): 85–94. https://doi.org/10.5235/20504721.2.1.85.

Parmesan, Camille, Nils Ryrholm, Constantí Stefanescu, Jane K. Hill, Chris D. Thomas, Henri Descimon, Brian Huntley, et al. "Poleward Shifts in Geographical Ranges of Butterfly Species Associated with Regional Warming." *Nature* 399, no. 6736 (June 1999): 579–83. https://doi.org/10.1038/21181.

Pembroke, Ella Saltmarshe and Beatrice. "How Art and Culture Can Help Us Rethink Time." Accessed June 11, 2019. http://www.bbc.com/future/story/20190521-how-art-and-culture-can-help-us-rethink-time.

"Petrochemical America, Richard Misrach & Kate Orff - ATLAS OF PLACES." Accessed May 3, 2019. https://atlasofplaces.com/Petrochemical-America-Richard-Misrach-Kate-Orff.

Piekarski, Wayne, and Bruce H. Thomas. "Using ARToolKit for 3D Hand Position Tracking in Mobile Outdoor Environments." In *Augmented Reality Toolkit, The First IEEE International Workshop*, 2–pp. IEEE, 2002.

"Pittermann Lab :: Research." Accessed December 2, 2018. http://pittermann.eeb.ucsc.edu/index.php/research/.

"Post Global Warming Survival Kit | Transmediale." Accessed May 20, 2019.
https://transmediale.de/content/post-global-warming-survival-kit.

"PROFILE: The Engineering of Art." *ASEE Prism* 9, no. 8 (2000): 10–10.

"Projects | Alexis Rockman." Accessed May 3, 2019. http://alexisrockman.net/projects/.

"Projects | The Canary Project." Accessed May 3, 2019. http://canary-project.org/projects/.

"Psw_gtr258.Pdf." Accessed May 3, 2019.
https://www.fs.fed.us/psw/publications/documents/psw_gtr258/psw_gtr258.pdf.

"Published on the Occasion of an Exhibition Held at the Museum of Contemporary Art
Denver, Nov. 10, 2011-Feb. 19, 2012 An," n.d.

Quéré, Corinne Le, Robbie M. Andrew, Pierre Friedlingstein, Stephen Sitch, Judith Hauck,
Julia Pongratz, Penelope A. Pickers, et al. "Global Carbon Budget 2018." *Earth
System Science Data* 10, no. 4 (December 5, 2018): 2141–94.
https://doi.org/10.5194/essd-10-2141-2018.

Randerson, Janine. "Between Reason and Sensation: Antipodean Artists and Climate
Change." *Leonardo* 40, no. 5 (September 2007): 442–48.

"RCP 8.5: The Climate-Change Disaster Scenario - The Atlantic." Accessed May 3, 2019.
https://www.theatlantic.com/science/archive/2019/01/rcp-85-the-climate-change-
disaster-scenario/579700/.

Riahi, Keywan, Shilpa Rao, Volker Krey, Cheolhung Cho, Vadim Chirkov, Guenther
Fischer, Georg Kindermann, Nebojsa Nakicenovic, and Peter Rafaj. "RCP 8.5—A
Scenario of Comparatively High Greenhouse Gas Emissions." *Climatic Change* 109,
no. 1–2 (November 2011): 33–57. https://doi.org/10.1007/s10584-011-0149-y.

"RISING EMISSIONS DRIVE GREENHOUSE GAS INDEX INCREASE - Welcome to
NOAA Research." Accessed May 21, 2019.
https://www.research.noaa.gov/article/ArtMID/587/ArticleID/2455/RISING-
EMISSIONS-DRIVE-GREENHOUSE-GAS-INDEX-INCREASER.

"Road to '65: Creating a Design for the New Campus." UC Santa Cruz celebrates 50
years. Accessed December 1, 2018. http://50years.ucsc.edu/new-campus/.

Rosenthal, Sue. "Book Review: A State of Change: Forgotten Landscapes of California -."
Bay Nature. Accessed December 5, 2018. https://baynature.org/article/book-review-a-
state-of-change-forgotten-landscapes-of-california/.

Saker, Hassen. *Natalie Jeremijenko Talks about the Environmental Health Clinic*, 2016. https://vimeo.com/165529680.

Sala, Osvaldo E., F. Stuart Chapin, Juan J. Armesto, Eric Berlow, Janine Bloomfield, Rodolfo Dirzo, Elisabeth Huber-Sanwald, et al. "Global Biodiversity Scenarios for the Year 2100." *Science* 287, no. 5459 (2000): 1770–74.

Schmalstieg, Dieter, and Daniel Wagner. "Experiences with Handheld Augmented Reality." In *Mixed and Augmented Reality, 2007. ISMAR 2007. 6th IEEE and ACM International Symposium On*, 3–18. IEEE, 2007.

Scholz, Trebor. "New-Media Art Education and Its Discontents." *Art Journal* 64, no. 1 (2005): 95–108. https://doi.org/10.2307/20068369.

"Science Highlights: Ecological Effects of Climate Change | NCEAS." Accessed November 5, 2018. https://www.nceas.ucsb.edu/science/climate.

"Scitable | Learn Science at Nature." Accessed May 3, 2019. https://www.nature.com/scitable.

"Screen Ecologies: Art, Media, and the Environment in the Asia-Pacific Region on JSTOR." Accessed November 5, 2017. http://www.jstor.org.oca.ucsc.edu/stable/j.ctt1c2crsq.

"Search Results for Santa Cruz." Library of Congress, Washington, D.C. 20540 USA. Accessed December 2, 2018. https://www.loc.gov/search/?q=santa+cruz&sp=6.

Shaftel, Holly. "What's in a Name? Weather, Global Warming and Climate Change." Climate Change: Vital Signs of the Planet. Accessed December 5, 2018. https://climate.nasa.gov/resources/global-warming.

Shanken, Edward A., ed. *Art and Electronic Media*. Themes and Movements. London ; New York: Phaidon Press, 2009.

———. "Art in the Information Age: Technology and Conceptual Art." *Leonardo* 35, no. 4 (2002): 433–38.

———. "Artists in Industry and the Academy: Collaborative Research, Interdisciplinary Scholarship and the Creation and Interpretation of Hybrid Forms." *Leonardo* 38, no. 5 (2005): 415–18.

———. "Introduction: The Reception and Rejection of Art and Technology: Exclusions and Revulsions." *Leonardo* 41, no. 2 (2008): 160–61.

———. "Investigatory Art: Real-Time Systems and Network Culture." *NECSUS. European Journal of Media Studies* 1, no. 2 (2012): 77–89. https://doi.org/10.5117/NECSUS2012.2.SHAN.

"Showdocument.Pdf." Accessed November 18, 2018. http://www.cityofsantacruz.com/home/showdocument?id=63040.

"SICB - 2017 Meeting - Abstract Details." Accessed February 13, 2018. http://www.sicb.org/meetings/2017/schedule/abstractdetails.php?id=1551.

"Silicon Monuments: Home." Accessed November 5, 2018. http://artsites.ucsc.edu/faculty/eanderson/SiliconMonuments/.

Sinatra, Gale M., CarolAnne M. Kardash, Gita Taasoobshirazi, and Doug Lombardi. "Promoting Attitude Change and Expressed Willingness to Take Action toward Climate Change in College Students." *Instructional Science* 40, no. 1 (January 1, 2012): 1–17. https://doi.org/10.1007/s11251-011-9166-5.

"SNAPSHOTS_feralrobots.Pdf." Accessed December 13, 2017. http://proboscis.org.uk/publications/SNAPSHOTS_feralrobots.pdf.

"Superflux - Translating Future Uncertainty into Present Day Choices." Superflux. Accessed November 5, 2018. http://superflux.in/.

"Susannah Sayler and Edward Morris of the Canary Project, January 24." EXTRACTION, January 18, 2017. https://extraction.sites.ucsc.edu/sayler-and-morris-canaryproject/.

Taplin, Roslyn. "Contemporary Climate Change Art as the Abstract Machine: Ethico-Aesthetics and Futures Orientation." *Leonardo* 47, no. 5 (November 2014): 509–10. https://doi.org/10.1162/LEON_a_00827.

"THE AFFECTIVIST MANIFESTO." *Continental Drift* (blog), November 16, 2008. https://brianholmes.wordpress.com/2008/11/16/the-affectivist-manifesto/.

"The Decline of San Francisco Fog." *The Weatherlution* (blog), September 21, 2015. http://weatherlution.com/decline-of-san-francisco-fog/.

The Editors of ARTnews. "How to Fix the Art World, Part 4." *ARTnews* (blog), November 30, 2016. http://www.artnews.com/2016/11/30/how-to-fix-the-art-world-part-4/.

"The Harrisons' Future Garden at the UCSC Arboretum | Institute of the Arts and Sciences." Accessed November 5, 2018. http://ias.ucsc.edu/content/2018/harrisons-future-garden-ucsc-arboretum.

"The Last Grizzly." Sequoia Parks Conservancy. Accessed December 2, 2018.
    http://www.sequoiaparksconservancy.org/4/post/2015/11/the-last-grizzly.html.

"The Q&A: Natalie Jeremijenko, Thingker." *The Economist*, September 20, 2010.
    https://www.economist.com/blogs/prospero/2010/09/environmental_design.

"The Role of Arts in Addressing Climate Change Solutions Is Understated - Stockholm
    Resilience Centre." Text, February 19, 2018.
    https://www.stockholmresilience.org/research/research-news/2018-02-19-the-art-of-
    transformation.html.

"The Stanford Ocean Acidification Experience." *VHIL* (blog). Accessed November 5,
    2018. https://vhil.stanford.edu/soae/.

"The Summen Project." The Summen Project. Accessed December 2, 2018.
    http://www.fogsci.com/.

"The Watermarks Project (2009) - Chris Bodle." Rhizome. Accessed May 20, 2019.
    http://rhizome.org/editorial/2009/feb/12/the-watermarks-project-2009-chris-bodle/.

"Tiffany Holmes - World Offset (2008)." Accessed June 4, 2019.
    https://tholme.myportfolio.com/world-offset-2008.

"Timeline." Accessed May 3, 2019. http://math.ucr.edu/home/baez/timeline.html.

Travis, John. "Genes on Display." *Science News* 158, no. 25 (2000): 392–94.
    https://doi.org/10.2307/4018573.

US Department of Commerce, NOAA. "ESRL Global Monitoring Division - Global
    Greenhouse Gas Reference Network." Accessed May 3, 2019.
    https://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html.

———. "NOAA/ESRL Global Monitoring Division - THE NOAA ANNUAL
    GREENHOUSE GAS INDEX (AGGI)." Accessed May 21, 2019.
    https://www.esrl.noaa.gov/gmd/aggi/aggi.html.

US EPA, OSWER. "Overview of the Brownfields Program." Overviews and Factsheets.
    US EPA, January 8, 2014. https://www.epa.gov/brownfields/overview-brownfields-
    program.

USGCRP. "Climate Science Special Report." Accessed November 5, 2017.
    https://science2017.globalchange.gov/chapter/14/.

"USGS Scientific Investigations Report 2012–5132: Simulation of Climate Change in San Francisco Bay Basins, California: Case Studies in the Russian River Valley and Santa Cruz Mountains." Accessed November 5, 2018. https://pubs.usgs.gov/sir/2012/5132/.

Vesna, Victoria, ed. *Database Aesthetics: Art in the Age of Information Overflow*. University of Minnesota Press, 2007. https://doi.org/10.5749/j.cttts7q7.

Wallen, Ruth. "Ecological Art: A Call for Visionary Intervention in a Time of Crisis." *Leonardo* 45, no. 3 (May 5, 2012): 234–42.

Weintraub, Linda. *To Life! Eco Art in Pursuit of a Sustainable Planet*. Berkeley: University of California Press, 2012.

———. *What's next: Eco Materialism and Contemporary Art*. Bristol, UK ; Intellect, 2019.

"What Does 400 Ppm Look Like?" Carbon Visuals. Accessed May 3, 2019. http://www.carbonvisuals.com/blog/400-ppm.

"What Is the Paris Agreement? | UNFCCC." Accessed June 7, 2019. https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement.

"Who Was Henry Cowell?" Accessed December 2, 2018. https://limeworks.ucsc.edu/news/2015/newsletter-f2015-henry-cowell.html.

"Why So Many Climate Models? | California Climate Commons." Accessed January 13, 2019. http://climate.calcommons.org/article/why-so-many-climate-models.

"Wild Life, Australia, 2019." ANNE ZAHALKA. Accessed May 9, 2019. http://zahalkaworld.com.au/wild-life-2019/.

"Wild Life in the Age of the Anthropocene, 2018." ANNE ZAHALKA. Accessed May 3, 2019. http://zahalkaworld.com.au/wild-life-in-the-age-of-the-anthropocene-2018/.

Williams, A. Park, Rachel E. Schwartz, Sam Iacobellis, Richard Seager, Benjamin I. Cook, Christopher J. Still, Gregory Husak, and Joel Michaelsen. "Urbanization Causes Increased Cloud Base Height and Decreased Fog in Coastal Southern California." *Geophysical Research Letters* 42, no. 5 (March 16, 2015): 1527–36. https://doi.org/10.1002/2015GL063266.

"With Climate Change No Longer in the Future, Adaptation Speeds Up - The New York Times." Accessed May 3, 2019. https://www.nytimes.com/2018/09/21/climate/climate-change-adaptation.html.

Wolkovich, E. M., B. I. Cook, J. M. Allen, T. M. Crimmins, J. L. Betancourt, S. E.
    Travers, S. Pau, et al. "Warming Experiments Underpredict Plant Phenological
    Responses to Climate Change."
    Nature 485, no. 7399 (May 2012): 494–97. https://doi.org/10.1038/nature11014.

"Xdesign Environmental Health Clinic." xdesign Environmental Health Clinic, n.d.
    http://www.nyu.edu/projects/xdesign/.

*You Are Here : Exposing the Vital Link between What We Do and What That Does to Our
    Planet*. First edition. New York, NY: HarperOne, 2008.

Yusoff, Kathryn, and Jennifer Gabrys. "Climate Change and the Imagination." *Wiley
    Interdisciplinary Reviews: Climate Change* 2, no. 4 (2011): 516–34.
    https://doi.org/10.1002/wcc.117.

Zhang, Yang, Kai Wang, and Chinmay Jena. "Impact of Projected Emission and Climate
    Changes on Air Quality in the U.S.: From National to State Level." *Procedia
    Computer Science*, 14th International Conference on Mobile Systems and Pervasive
    Computing (MobiSPC 2017) / 12th International Conference on Future Networks and
    Communications (FNC 2017) / Affiliated Workshops, 110 (January 1, 2017): 167–73.
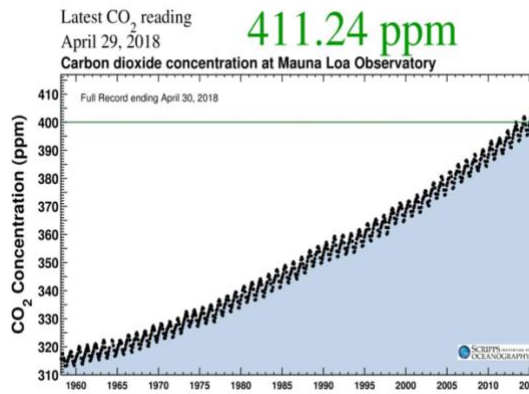   https://doi.org/10.1016/j.procs.2017.06.074.

APPENDIX A: IMAGES

Fig 1. CO2 PPM April 2018

Source: US Department of Commerce, NOAA.

Fig 2. *Enviro-Envision* at the *Receivership* exhibition, the past

Fig 3. *Enviro-Envision* at the *Receivership* exhibition, the past featuring logging
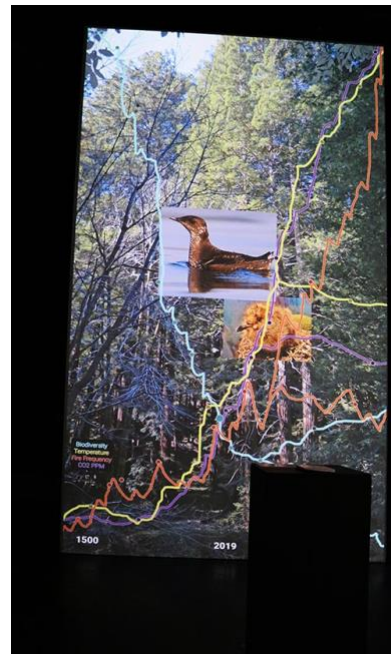

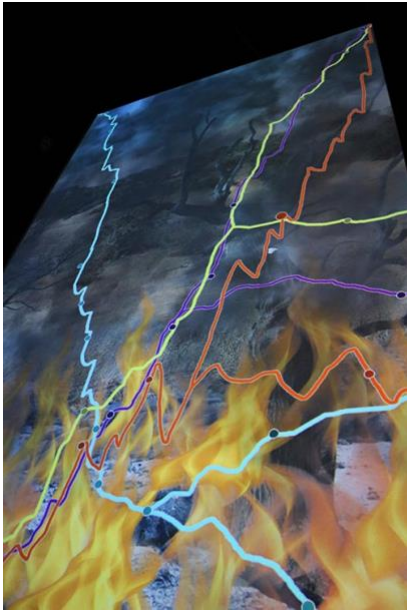Fig 4. *Enviro-Envision* at the *Receivership* exhibition, the present featuring Marbled Murrelet

Fig 5. *Enviro-Envision* at the *Receivership* exhibition, the future RCP 8.5 featuring fire
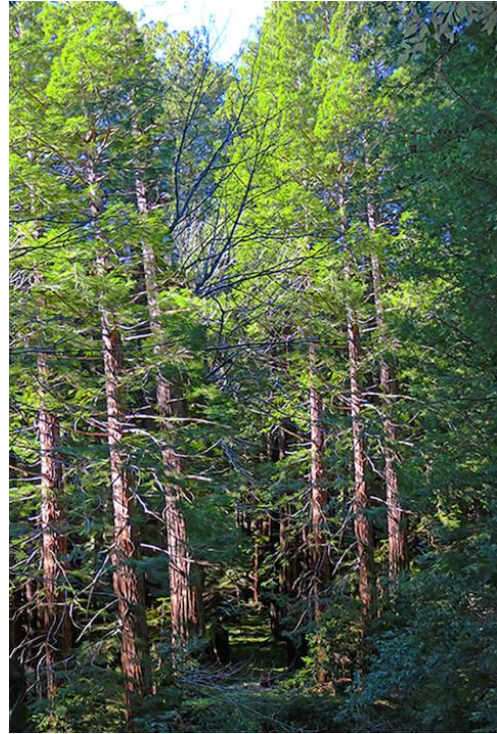

Fig 7. *Enviro-Envision* The present

Fig 6. *Enviro-Envision* The past

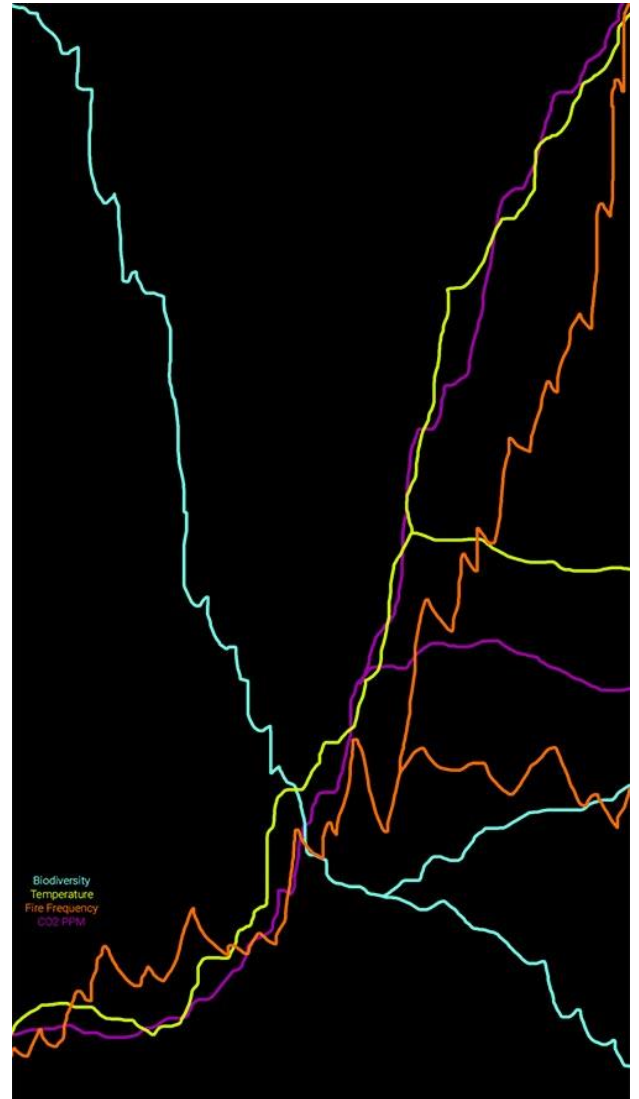

Fig 8. *Enviro-Envision* The future, 8.5 RCP

Fig 9. *Enviro-Envision* The future, 2.6 RCP

Fig 10. *Enviro-Envision* The four graphs