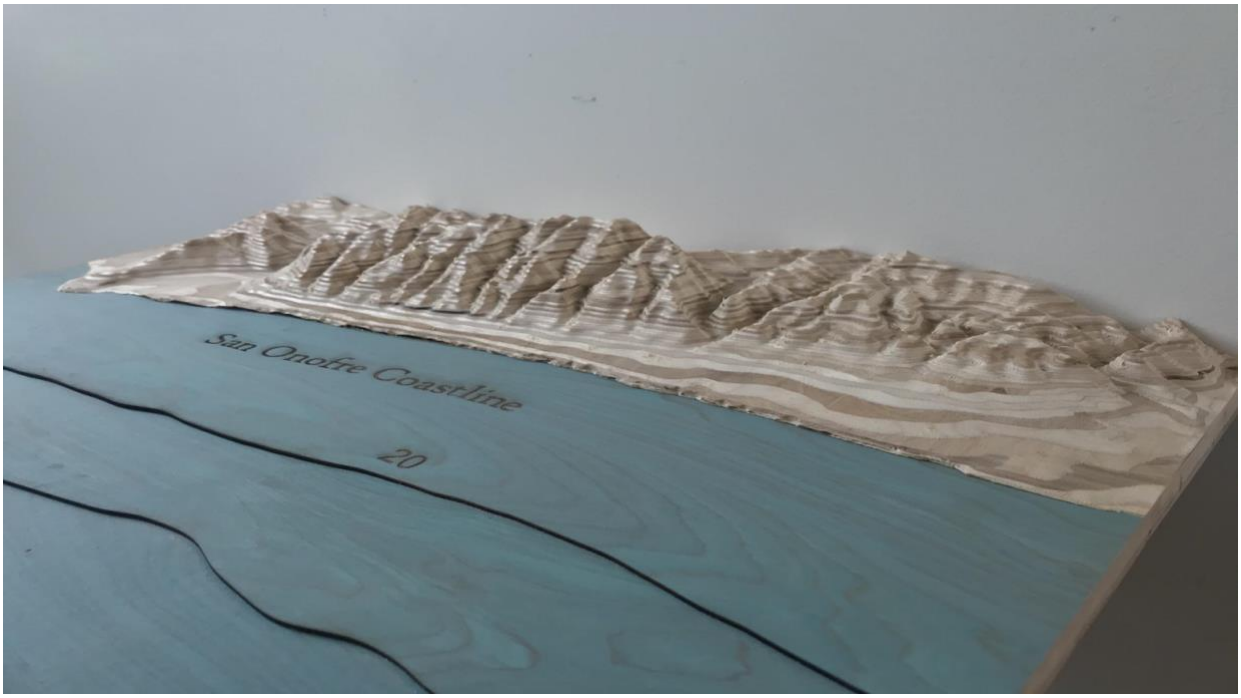
2019

Facilitating Experience through Fabrication and Blue Biophilic Design

Teague Scanlon

Facilitating Experience through Fabrication and Blue Biophilic Design

Teague Scanlon



In partial fulfillment of a Bachelor of Arts degree in Environmental Analysis

Pomona College, Fall 2019
Claremont, CA

Readers:
Professor Char Miller
Professor Walker Wells

ABSTRACT

The way humans currently interact with the atmosphere and oceans around us is unsustainable, with pollution entering our waters faster than we are collecting it, and the sea level rising faster than we are building coastal barriers to protect our current infrastructure. This thesis explores the common methodology for communicating climate change and its future effects, and highlights an opportunity for using infrastructure to facilitate interaction with the urban-aquatic interface. By promoting experiential contact with the natural spaces that are most at risk to climate change's impacts, a sense of stewardship for those spaces will spur behavioral change and activism. On a local level, this thesis explores the history of public access to San Onofre State Beach, and the possibility for the restriction of that access in 2021. Using a 3D topographic and bathymetric model of San Onofre State Beach, I attempt to highlight the beauty of the undeveloped California coastline, and the benefits of keeping this 6.5-mile coastline within the State Parks system.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Char Miller for his unwavering support throughout the entirety of my college career, and for consistently instilling curiosity in whatever topic is being discussed. I'd like to thank the EA department as a whole, for trusting their students to explore our curiosities in creative, sometimes unconventional ways, and for providing the necessary funding to do that. I'd like to thank Walker Wells, for first exposing me to the concept of "biophilic design" and for mentally reframing a discombobulated, loosely stung web of ideas into a fluid argument. I'd like to thank my mother, Preston Payne, for fielding numerous stressed phone calls, and for having an eye for grammar mistakes like no other. Thank you to Tristan Marsh for his unending positivity and assistance with all things related to Rhino and the CNC router, and to Michael O'Malley for kindly letting me use the machinery and facilities needed to produce the model. I would love to thank Kyle Lenhart-Wees for Illustrator and Laser Cutter help, and for distracting me when I needed it most during class. And finally, thank you to my wonderful friends for exploring California's beautiful coastlines with me, and showing me the areas worth fighting for.

CHAPTER 1: INTRODUCTION

Through new neuroscientific technologies, sociological research, and countless positive experiences, "the cognitive and social capital" (a term Timothy Beatley dubbed in his book, *Blue Biophilic Cities*) that healthy waterways provide for communities is becoming clearer (Beatley). Yet it is also becoming clear that the way humans currently interact with our atmosphere and the ocean, both recreationally and industrially, is unsustainable, with the sea level rising faster than we imagined, and plastic pollution inundating our beaches, diets, and farmlands. The ocean surface hides from us the incredibly biodiversity and activity occurring just below, which makes it easier to practice an out-of-sight, out-of-mind mentality towards marine environments: taking in the seafood, and giving back our trash, effluent, and wastewater. Flaws in this framework are becoming obvious though, as cities are spending hundreds of millions of dollars on coastal barriers to defend against sea level rise, and are predicted to spend billions more in the coming decades. The Center for Climate Integrity predicts that US coastal communities will need to spend over $400 billion by 2040 (Study: U.S. Costal Communities Face More Than $400 Billion in Seawall Costs by 2040). Fortunately, with these infrastructural improvements, cities have the opportunity to develop infrastructure and initiatives that facilitate easy and accessible contact between land-dwelling residents and the ocean, spurring a sense of stewardship for the oceans' health, while maximizing the long-term social, cognitive, and financial capital of those communities. Infrastructure and the intelligent design of space as a whole has an incredible ability to affect the experiences that occur within and around those spaces and as we come to terms with the future effects of sea-level rise on our coasts, we must design long-term infrastructural solutions to remain resilient. We have the opportunity to design in a blue biophilic manner. In this blue, biophilic philosophy, designers maintain an awareness of the co-evolution

that humans have experienced alongside nature and water for hundreds of thousands of years, and our innate need to connect with nature, and more specifically water, to be happy and healthy.

CHAPTER 2: SEA LEVEL RISE

In 2013, the Intergovernmental Panel on Climate Change, the UN's panel of scientists tasked with reviewing and reporting on the state of knowledge of climate change, predicted that we would see a .91-3.2-foot increase in mean sea level, depending on how drastically we can reduce emissions (Church et al.) The most recent IPCC report, released on September 25, 2019, was written by over 100 international experts and based on more than 7,000 studies (IPCC). One scenario trumps the previous high-emissions scenario modeling a 3.6-foot total sea level rise by 2100, and could reach 17 feet or more by 2300 (Mooney, Plumer). In low-emission scenarios, 100-year flood events are expected to occur annually by 2050 in Los Angeles, Miami, Honolulu, San Diego, and various other major US coastal cities (Mooney). Unfortunately, climate change is not "coming." Climate change is here, and is hitting harder than we previously envisioned.

In Miami Beach a phenomenon dubbed "Sunny day flooding" has become relatively normalized, with flooding from high tides alone affecting streets all around the city, which has an average elevation of only 4.4 feet above sea level (Miami Beach & Sea Level Rise). King Tides (an informal term for exceptionally high tides, due to the sun and moon lining up to create a larger gravitational pull annually in September and October), caused tide levels to be up to 13 inches higher than average tide heights during October 2019 (Miller). These tides made numerous coastal streets, parks, and sidewalks around South Florida unusable.

Figure 1. King tide flooding in Downtown Miami in October, 2016. CC Image from Commons Wikimedia user B137

An NOAA report released in summer 2019 found that the Southeast US is experiencing 190 percent more of these sunny day flooding events than experienced in 2000, and this number is expected to keep increasing (U.S. National Oceanographic and Atmospheric Administration). In Miami Beach, steps are currently being taken to compensate for these changes, largely through a $400-million bond which includes elevating roadways and driveways and installing 60 generator-powered storm water pumps, which remove pollution, suspended particles, and oils from runoff before returning the water into Biscayne Bay (Staletovich). Miami Beach is considered relatively progressive in the scale of this project, partly out of necessity (Miami Beach is constantly rated the most at-risk city for sea level rise) but also because it is easier for a wealthier Miami Beach to raise $400 million dollars than most other coastal communities. Unfortunately, as time passes it is going to be increasingly difficult and increasingly expensive to

make large-scale infrastructural changes, which will bring a plethora of environmental justice issues. According to a recent study, 110 million people currently live below the average high tide line and are only dry because they are protected by expensive coastal barriers. Research by Climate Central, a non-profit news organization that researches and reports climate science, found that that number will increase to 150 million people by 2050 (Lu, Flavelle). Countries can rush to raise funds for resilience infrastructure, but that is no easy task. San Francisco voters approved a $425 million bond in November 2018, which is set to strengthen the Embarcadero Seawall and extend it a meager 3 miles. It is estimated to cost $5 billion for the full necessary improvements (Mayor London Breed Announces First Bond Sale to Strengthen the Embarcadero Seawall). Vietnam on the other hand, is estimated to have a bulk of the southern part of the country underwater at high tide. One quarter of the population, more than 20 million people, currently live on land that will be inundated by 2050.

Infrastructure is possible, but financially infeasible in situations this grand. Large-scale population movement is inevitable, which will exacerbate conflict, separate communities, and increase political instability in already unstable regions like Iraq (which is estimated to have its second largest city, Basra, be underwater in 2050) (Lu, Flavelle). By 2045, 20,472 of today's homes in California are at risk of becoming chronically inundated by flooding. These homes house an estimated 50,661 people, ranging in age from kindergarteners to the elderly, and include vacation homes to house-rich families, whose mortgage and expenses are higher than their income (Alexander). Sea level rise is an environmental crisis, but environmental crises incubate social crises, and our current action (or lack thereof) will drastically affect the social issues of future generations, intensifying current trends of increasing environmental refugees, food insecurity, and unsafe drinking water.

CHAPTER 3: POLLUTION

Pictures flood social media showing beaches with more trash than sand and sea creatures caught in plastic packaging, instigating reflexive emotional responses. It is no secret that human pollution is proving to be a problem for marine environments, but only recently are researchers studying the effects of micro plastics on these environments.

Figure 2. A quintessential plastic pollution image commonly used in an attempt to spur behavioral change. Littered Beach, Bali, Indonesia. CC Image from GRID-Arendal resources library by: Lawrence Hislop. www.grida.no/resources/1117

There are currently an estimated 100,000,000 metric tons of plastic in the oceans, all of which are slowly being broken down into micro and nano particles, which become harder to clean up and easier for marine life to consume. Eight million metric tons of plastic enter the ocean every year, while an estimated 5.25 trillion plastic particles exist in our surface waters

today (Gourmelon, Eriksen et al). A study published in *Frontiers in Marine Science* found that 73% of mesopelagic fish caught in the Northwest Atlantic had micro plastics in their stomachs (Alina et al). Historically micro plastics have not been a huge concern to human health, mainly due to the understanding that we do not generally eat the guts and digestive tracts of seafood (with the exception of most shellfish), where most of the plastic particles reside. Additionally, plastic polymers are generally understood to be non-toxic, and too large to translocate across biological membranes. But plastics almost always contain chemical additives, including "plasticizers, flame retardants, pigments, antimicrobial agents…[etc.]" (Smith et al.). These additives generally leach from the polymers relatively quickly and have the ability to translocate across biological membranes in fish. This process allows the additives to enter the parts of marine animals that we do consume, and after consumption, allows those particles to leave humans' digestive tracts and make their way into the human liver, gall bladder, gastrointestinal tract, and lungs (Smith et al.) This exposure has been linked to "cardiopulmonary responses, alterations of endogenous metabolites, genotoxicity, inflammatory responses, oxidative stress, effects on nutrient absorption, gut microflora, and reproduction" (Smith et al). Similar to people's slow acceptance of daunting sea level statistics, one can expect that most people won't consciously conceptualize the translocation of chemical particles across biological membranes when voting on legislation or deciding how to dispose of a plastic bag. Companies like Vissla, in partnership with the Surfrider Foundation, attempted to elicit a more mainstream, pointed response by prototyping a "Rising Seas Wetsuit." Features include an LED display featuring air quality, water quality, solar radiation, and bacteria levels, as well as grip pads to counteract oil spills, and a water/radiation tight headpiece. Vissla claims that this concept was made to "portray the urgency and effects of climate change in a way that would reach the surfing community but

be a powerful-enough blow to the gut to reach outside of the surf world as well" (The Rising Seas Wetsuit). While none of these wetsuits are actually in production, the video-led campaign spurred widespread publicity and served as a call-to-action to surfers and non-surfers alike. The concept was reported on by dozens of news sources and disseminated various resources for activism, including signing letters for Congress and donating to the Surfrider Foundation.

CHAPTER 4: CLIMATE CHANGE COMMUNICATION

In the field of environmental science, research highlighting the effects of anthropogenic climate change are clear and irrefutable. Scientific findings and projections abound, explicating exactly how many particles of CO2 will be in our atmosphere in one, two or three decades, or how many trillions of plastic particles are in our oceans. When governmental and environmental agencies present these statistics, they often do not have the intended effect of creating behavioral change. It is difficult for humans to really know what 14 inches of sea level rise looks like compared to 24 inches, or the difference between sea levels predicted in 2030 versus those in 2040. The predictions can be memorized, to be flaunted in a future conversation amid dramatic pauses and somber gazes, but the ability for humans to think in abstract projections and statistically perfect scenarios is limited, and often leads to guilt and anxiety rather than stewardship and activism. In the growing field of behavioral psychology, researchers are finding that the anticipation of future emotional states influence most decisions far more than reason (Williamson et al.). Rather than sharing dooming facts to invoke fear and guilt, "highlighting one's feelings of pride or joy as a result of sustainable behavior…can produce stronger pro-environmental behavioral intentions" (Williamson et al.). When the issue of climate change is marketed as a strictly environmental problem, dissociated from our daily lives, our actions reflect

that abstraction by spurring activism and behavioral change only when we have the time and energy to do so. According to a 2009 study, 69% of American's believed that our personal actions could not make any difference for climate change (Leiserowitz et al.) Susanne Moser, a leading researcher in the science of climate change communication, cites nine key reasons why this may be the case; "invisibility of causes, distant impacts, lack of immediacy and direct experience of the impacts, lack of gratification for taking mitigative actions, disbelief in human's global influence, complexity and uncertainty, inadequate signals indicating the need for change, perceptual limits and self-interest" (Moser). She suggests reframing the messages that we use to convey the crisis--"The distant problem must be brought home; the invisible causes and impacts must be made visible; the inconceivable solutions must be illustrated" (Moser). In regard to the lasting effect of such messaging:

> emotional impact is desirable to the extent it leads to the intended behavioral outcome. Messages that increase worry, concern, or even fear, for example, must be accompanied by information that allows audiences to translate their feelings into remedial action, lest communicators risk that audiences only manage their internal emotional experience (i.e., fears), rather than the external danger evoked by the message. (Moser)

An early attempt at instigating an emotional response from people using hard-hitting imagery was the establishing of polar bears as the face of climate change, looking confused on a rapidly shrinking iceberg.

Figure 3. A polar bear precariously checks the thickness of the ice sheet. CC Image by Commons Wikimedia user Mario Hoppman.

This imagery, however, has proven relatively ineffective at instigating change for those who are not personally interested in polar bears. The impact seems distant from the comforts of our own homes, and the call to action is confusing (often combined with the subliminal suggestion to buy Coca Cola of all things) rather than highlighting proactive changes that can be performed (Hulme). With the relatively newfound awareness of the effectiveness of different avenues of communication, a recent project based in Delta, British Columbia attempted to restructure this messaging, turning the impersonal, distant, and guilt-inducing into a personal, vivid, and action-inspiring message. These researchers designed an interactive, 3D game that took place in the participants' flood-prone hometown, complete with local landmarks and soundscapes. The players made decisions related to the future, and then immediately travelled

through time to see the consequences of their mitigation measures (Olaf et al). With the advice of Stephen R.J. Sheppard, in his book, *Visualizing Climate Change*, the researchers attempted to keep the game "local, visual, and connected," due to Shephard's premise that responses to climate change would last longer and people would be more engaged if the effects on their own localities were highlighted (Sheppard). Researchers gave questionnaires to participants before and after the game. They found a significant increase in the responsibility that participants placed on their local governments to support adaptation solutions, supporting the claim that visceral, local experience can modify behavior and vindication effectively (Olaf et al.)

In a similar, slightly more reproducible vain, Virtual Planet Technologies in California developed a virtual reality program using drone footage, local land elevation data, topographical maps, and 3-D modeling to show what local coastlines will look like as sea levels rise, in an attempt to make the scientifically-understood effects of climate change concretely understood by the general public ("Virtual Planet Technologies LLC). Humans are creatures of emotion, and for the collective, systematic, human-driven change required to shift humankind towards inhabiting our planet sustainably, we need to show people what there is to lose in our own backyards, and why creating a sustainable planet is worth the fight. Jonathan Franzen, in his controversial 2019 opinion piece for the *New Yorker*, outlines some painfully necessary advice; "If you care about the planet, and about the people and animals who live on it, there are two ways to think about this. You can keep on hoping that catastrophe is preventable, and feel ever more frustrated or enraged by the world's inaction. Or you can accept that disaster is coming, and begin to rethink what it means to have hope" (Franzen). For better or for worse, both of these methodologies benefit from an acute awareness of what the future will hold, scientifically and conceptually. Only when a widespread, realistic understanding of how the places that we feel

most connected to are changing (what will flood, what will die, and what will become inundated by saltwater) can necessary action occur in the often bureaucratic and slow fight for environmental justice.

CHAPTER 5: THE OPPORTUNITY FOR INTERVENTION

The goal is to facilitate vivid, immersive experiences that cultivate a caring stewardship and affinity towards healthy, natural environments. This can be done annually, akin to a pilgrimage to Yosemite, to take in the wonder and pledge to treat the earth better than one does, because landscapes like this are at stake. Or perhaps monthly, in the form of local programming connecting locals to their natural environments, like the "Pier into the Night" initiative in Gig Harbor, Washington. Scuba divers live-stream underwater cameras onto large screens on the pier on the first Saturday night of every month, showing off octopuses, squid, fish, and kelp (Pier into the Night). Visitors to the pier can "[Peer] into the Night" to directly witness the underwater ecosystem in all its vitality, potentially feeling a greater compulsion to protect those creatures, whether in legislation or a grocery store aisle. Realistically though, I think these opportunities for interactions with our local environments need to be omnipresent. Rather than an active decision to connect with nature in order to feel more stewardship and appreciation of it (similar to someone actively planning dinner with an acquaintance in order to connect with them rapidly), these moments need to be spread throughout people's lives, and this has been shown to work in numerous studies globally. During interviews with environmentalists in Norway and Kentucky, the most common source of commitment to environmental protection in both locations was "experience of natural areas," far outnumbering "sense of social justice," "education," or "principles and religion" (Chawla).

We can preach and teach about the value of natural spaces, but showing their value is far more effective. The spaces we occupy have the ability to facilitate these kinds of interactions, and can benefit both the occupants and the environments that the occupants will feel affinity towards. One-third of the world's population, almost 2.4 billion people, live within 60 miles of an oceanic coast, making the aquatic-urban interface (the zone where city and ocean meet) dense in population, industry, and biodiversity (Living Ocean). This density grants planners, architects, and recreationalists alike with the unique ability to facilitate that oceanic interaction more efficiently than facilitating interactions with mountain or forest landscapes. While attempting to infrastructurally funnel people up mountain roads or into rainforest reserves is unfeasible for obvious reasons (and would rapidly deteriorate the lands we are trying to preserve), infrastructure on the aquatic-urban interface would immediately be met by a population eager to utilize and take part. Unfortunately for city governments, trillions of dollars globally will need to be invested into coastal environments in the coming decades to account for sea level rise, but this grants communities the opportunity to combine this necessary investment with awe-inducing side effects. The city of Seattle took advantage of this opportunity during a $410 million seawall project. Newborn salmon used to have to navigate through a dark maze of wooden piers, surrounded by deep water species that are not typical of a newborn salmon's diet. As part of the new seawall project, an underwater corridor is being built, illuminated with glass tiles in the pedestrian sidewalk above. A rocky surface on either side of the corridor provide nooks and crannies for microalgae and small invertebrates, while humans can kayak on the surface (Christensen). These types of projects highlight the positive holistic approach that communities can take as they undergo the necessary transformations that come with sea level rise. Planners may be able to play a role in mental health too.

CHAPTER 6: MENTAL HEALTH BENEFITS OF OUR COASTS

Humans are inherently self-serving beings, and to keep people passionate about using certain spaces, there needs to be benefits for the spaces' users, rather than just benefits for the spaces themselves. Luckily, with recent advancements in neuroscientific technology, scientists can study, categorize, and quantify the mind-altering effects of different spatial characteristics using EEGs and fMRIs. The mental benefits of natural space, or spaces that share elements with natural spaces are well-documented in current research.

A 2001 study funded by the EPA found that the average American spends 93% of their time inside buildings or cars (Klepeis et al.) Given the relatively rapid shift in lifestyle from outdoor to indoor living, as contrasted with the historical practices of humanity, a large number of research projects is being performed on the effects of nature on human wellness, suggesting the importance of rekindling the urge that humans feel to affiliate with other forms of life. The field of biophilic design attempts to cater to that urge through the creation of space, proving to promote mental, emotional, and physical health. The term "biophilia" was first dubbed in its modern form by Edward O. Wilson in 1984, in a book of the same name. While biophilia technically means "a friendly feeling toward life," Wilson claims that the human mind generally focuses on "life and lifelike processes," so biophilia should be understood as "an inborn affiliation with the rest of life" (Wilson). Since the term's inception, it has been appropriated by psychologists, environmental scientists, and designers alike, conveniently categorizing a relatively abstract concept by establishing measurable indicators in the form of "patterns of biophilic design" (Browning et al). In 2008, Stephen Kellert wrote a book named *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life* in which he outlines six biophilic design elements and 72 biophilic design attributes (Marro). Kellert's fragmentation of a

holistic design philosophy into individual, identifiable features helps architects and planners see space through the exemplification of natural elements, without dictating exactly what that needs to look like. While Kellert's categorization of these design attributes and elements is recent, the desire to integrate nature into design is far from a new concept. Gardens as we know them today have been around for centuries, and decoration symbolizing nature has been practiced on pottery and walls for even longer than gardens. Only now with large-scale measurable effects of biophilic design on brain chemistry and physical health, researchers can more easily isolate the specific characteristics of nature and their specific effects, physiologically, cognitively, and psychologically, on the spaces' users. One of the seemingly omnipresent characteristics of nature is the presence of water, and plenty of research has attempted to analyze exactly how it affects humans.

Water in general has an incredibly powerful impact on improving concentration and memory restoration, largely due to the unique sounds that water makes as it crashes (Alvarsson et al.). Additionally, the auditory presence of water lowers heart rate and blood pressure, which immediately reduces stress and benefits physical health long term (Alvarsson et al). The presence of water is especially beneficial amidst wide open green space. Jo Barton and Jules Pretty, from the University of Essex, researched the effects of "green exercise" on mental health, which is the performance of physical activity in natural spaces. Barton found that this particular activity improved self-esteem and positively affected the mood of the participants, with the highest mood boost among the mentally-ill, and the greatest self-esteem boost for young people. Proximity to water added even more benefit to the participants (Barton et al). Naturally, consistent micro moments of mood and self-esteem boosts have the ability to lead to larger scale wellness. Other researchers from the University of Essex collected survey data from almost 26,000 respondents

throughout England, where one in six adults suffer from mental health disorders such as depression and anxiety, with two to three times higher prevalence rates in the lowest 20% income bracket than the highest. The study found that living in large towns and cities near the ocean is linked with improved mental health, and the correlation was strongest for those in the lowest earning households, suggesting an ability to reduce health inequalities by facilitating oceanic interaction (University of Exeter). Thankfully, this research is being noticed. Flotation Therapy has been used (to great results) for patients with ADD, autism, PTSD, anxiety, and depression, while surf camps for children with autism have been proliferating all around the world (Kjellgren et al., Surfers Healing). City planners and governments are also making infrastructural efforts, demonstrating their recognition that increased access to the ocean can benefit individuals and ecosystems alike. In 2009, only half of England's coast was accessible to the public, but after legislation and activism to make the aquatic-urban interface more publicly accessible, a 2,800-mile coastal path will open to the public in 2020 (Kirkpatrick). Snorkeling trails in Australia have been established in recent decades, building off of similar frameworks apparent in hiking trails, which help to make the experience more accessible than most current ocean activities (Trails: Snorkel). Planners around the world are beginning to recognize the incredible opportunity that our coasts offer, and the city-wide benefits that come from making them more accessible.

CHAPTER 7: MY LOCAL, VISUAL, CONNECTER CONTRIBUTION

I recognize the irony in writing an academic paper highlighting that our framework around environmental issue communication needs to move away from a strictly educational, scholarship-based format, towards a more experiential, local, connected one. If we want to bring

awareness of issues regarding the aquatic-urban interface, they need to be applicable to the people with whom we are trying to connect, which prompted my interest in highlighting a current debate regarding San Onofre State Beach.

An hour south of Claremont lies a 6.5-mile span of essentially undeveloped coastline, looking remarkably similar to what it looked like 80 years ago, while nearby San Clemente and Dana Point have developed extensively. Since the 1930's people have surfed the world-class waves alongside that coastline, including Old Man's, Church, Lower Trestles, Uppers, and Middles. During World War 2, the private land was sold to the U.S. Marine Corps, but development remained light, as it was mainly used for practicing amphibious landings. After many discrepancies between surfers, marines, and the secret service (after President Nixon built his "Western White House" there in 1969), Nixon signed a one dollar 50-year lease for land to the California State Parks Department, in 1971. Today, this 6.5 mile stretch of coastline attracts over 2 million visitors a year, for surfing, hiking, mountain biking, and camping (Connelly). However, in 2021, the lease expires, and the U.S. Military has made no statements about its plans for the coastline, leaving the State Parks Department and California recreationalists unsure of its future.

In an attempt to highlight the natural beauty of this uniquely undeveloped coastline, I built a 3D topographical model out of wood, from San Onofre Mountain to the edge of the coastal shelf, about 100 miles offshore, using plywood, a CNC router, and laser cut bathymetry lines. The model has the unique ability to mirror the land it represents so closely, because of the striking lack of development that exists on that stretch of coastline, aside from a couple of roads and small shelters. The little 3-foot by 4-foot wooden model pales in comparison to the beauty of the San Onofre Coastline, and what that coastline enables for the creatures that exist on it, but

maybe that little model can inspire a little more appreciation for one of the few undeveloped tracts of land that California still has to offer. If so, I did my job.

CHAPTER 8: THE MODEL

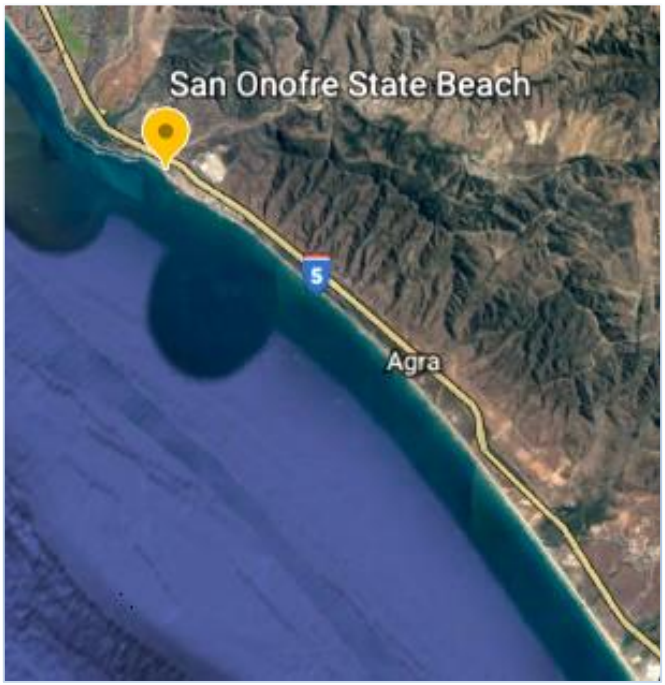


Figure 4. Map showing the location of San Onofre State Beach. *Google Earth*, earth.google.com/web/.

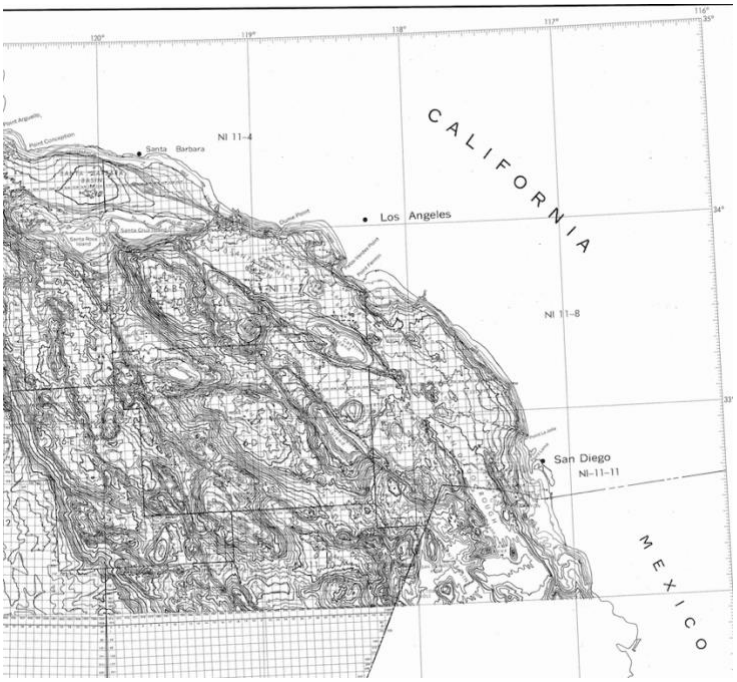


Figure 5. A section of a Southern California Bathymetry Map. BR-15, *NOAA Public Domain*, https://www.ngdc.noaa.gov/mgg/bathymetry/maps/area4.html

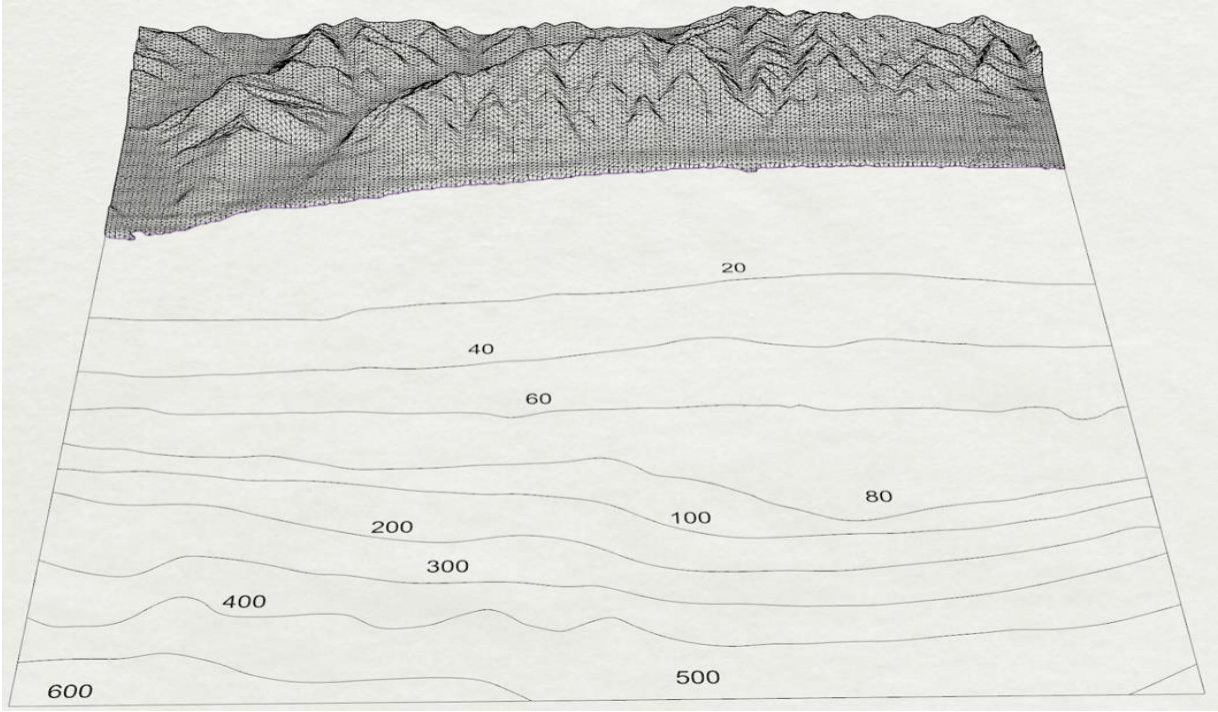


Figure 6. A rendered model of the San Onofre coastline, designed on Rhino.

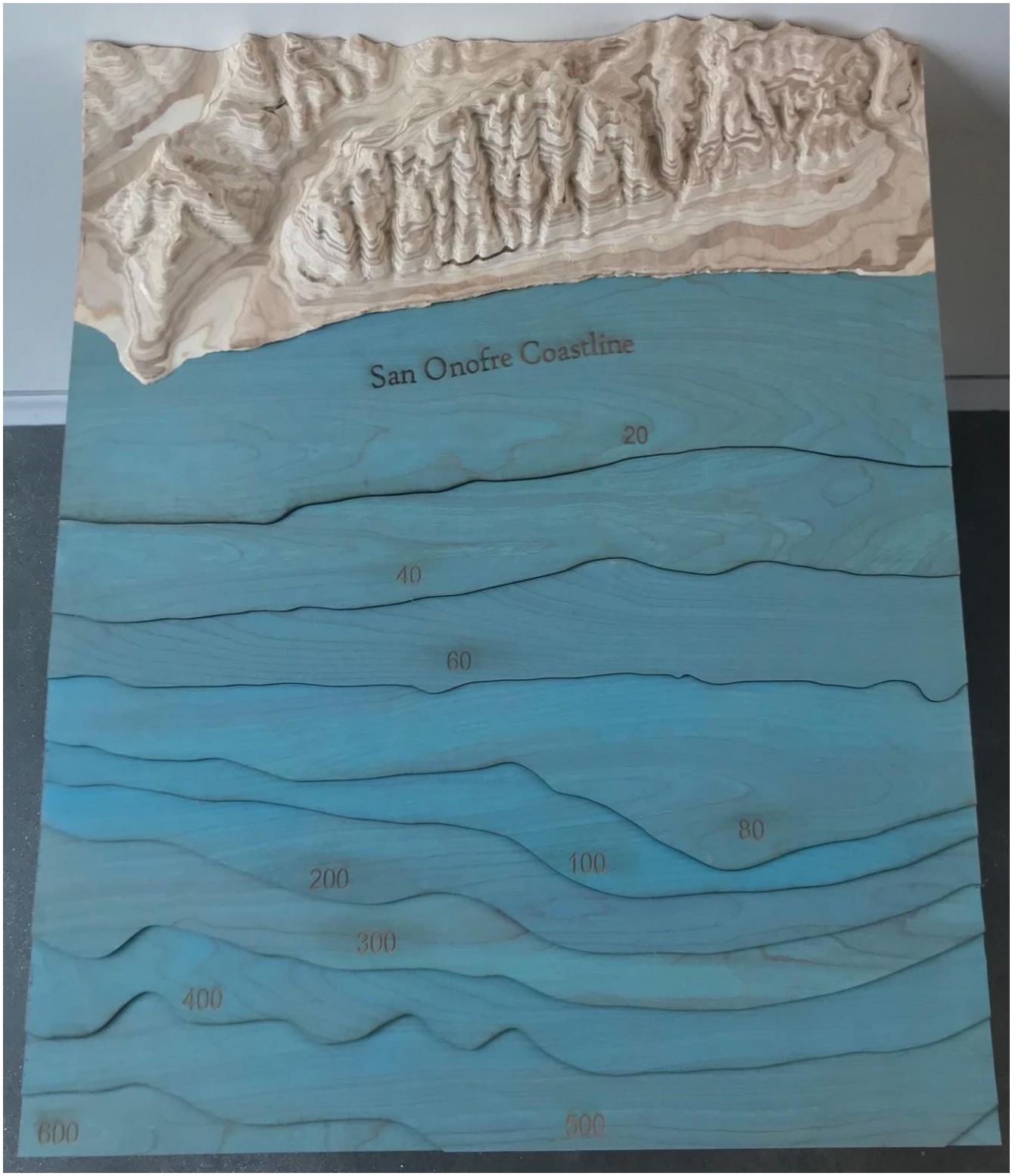


Figure 7. The San Onofre Coastline from above, with the mountainous topography reduced using a CNC router, and the bathymetry lines stained, laser cut and laminated.

Figure 8. A bird's eye view of the San Onofre Coastline Model.

WORKS CITED

A. Kjellgren, H. Edebol, T. Nordén and T. Norlander, "Quality of Life with Flotation Therapy for a Person Diagnosed with Attention Deficit Disorder, Atypical Autism, PTSD, Anxiety and Depression," Open Journal of Medical Psychology, Vol. 2 No. 3, 2013, pp. 134-138. doi: 10.4236/ojmp.2013.23020.

Alexander, Kurtis. "Many Coastal Properties May Be Flooded out by 2045, Climate Report Warns." SFChronicle.com, San Francisco Chronicle, 18 June 2018, www.sfchronicle.com/science/article/Many-coastal-properties-may-be-flooded-out-by-13002375.php.

Alina M. Wieczorek, Liam Morrison, Peter L. Croot, A Louise Allcock, Eoin Macloughlin, Olivier Savard, Hannah Brownlow and Thomas K. Doyle. Frequency of Microplastics in Mesopelagic Fishes from the Northwest Atlantic. Frontiers in Marine Science, 2018 DOI: 10.3389/fmars.2018.00039

Alvarsson, Jesper & Wiens, Stefan & Nilsson, Mats. (2010). Stress Recovery during Exposure to Nature Sound and Environmental Noise. International journal of environmental research and public health. 7. 1036-46. 10.3390/ijerph7031036.

Barton, Jo, and Jules Pretty. "What Is the Best Dose of Nature and Green Exercise for Improving Mental Health? A Multi-Study Analysis." ACS Publications, Environmental Science and Technology, 25 Mar. 2010, pubs.acs.org/doi/abs/10.1021/es903183r.

Beatley, Timothy. Blue Biophilic Cities: Nature and Resilience Along The Urban Coast. Springer International Publishing, 2018.

Browning, William, et al. "14 Patterns of Biophilic Design." Terrapin Home - Terrapin Bright Green, 12 Sept. 2014, www.terrapinbrightgreen.com/reports/14-patterns/.

Chawla, Louise. (2006). Learning to love the natural world enough to protect it. Barn. 2. 57-78.

Chris Mooney, Brady Dennis. "New U.N. Climate Report: Massive Change Already Here for World's Oceans and Frozen Regions." The Washington Post, WP Company, 25 Sept. 2019, www.washingtonpost.com/climate-environment/2019/09/25/new-un-climate-report-massive-change-already-here-worlds-oceans-frozen-regions/.

Christensen, Ken. "Seattle's New Seawall: Holding Back the Tide, Protecting Salmon." Crosscut, Crosscut, 22 Feb. 2018, crosscut.com/2017/05/seattle-seawall-salmon-protection.

Church, J.A., P.U. Clark, A. Cazenave, J.M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifield, G.A. Milne, R.S. Nerem, P.D. Nunn, A.J. Payne, W.T. Pfeffer, D. Stammer and A.S. Unnikrishnan, 2013: Sea Level Change. In: Climate Change 2013: The Physical Science Basis.

Connelly, Laylan. “With 2 Years Left on San Onofre Beach Lease, State – and Surfers – Hope Military Won't Put End to Access.” Orange County Register, Orange County Register, 31 Aug. 2019, www.ocregister.com/2019/08/30/with-2-years-left-on-san-onofre-beach-lease-state-and-surfers-hope-military-wont-put-end-to-access/.

Eriksen M, Lebreton LCM, Carson HS, Thiel M, Moore CJ, Borerro JC, et al. Plastic Pollution in the World’s Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. PLoS One. 2014;9(12):e111913.

Franzen, Jonathan. “What If We Stopped Pretending the Climate Apocalypse Can Be Stopped?” The New Yorker, The New Yorker, 8 Sept. 2019, www.newyorker.com/culture/cultural-comment/what-if-we-stopped-pretending.

Gourmelon G. Global plastic production rises, recycling lags. Vital Signs. 2015. Google Scholar

Hulme, M. (2009). Why We Disagree about Climate Change: Understanding Controversy, Inaction and Opportunity. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511841200

IPCC, 2019: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

Kirkpatrick, Noel. “England's Coast Path Will Cover 2,800 Miles of Seashore.” MNN, Mother Nature Network, 18 Oct. 2018, www.mnn.com/earth-matters/wilderness-resources/blogs/englands-coast-path-will-cover-2800-miles-seashore.

Klepeis, Neil E, et al. “The National Human Activity Pattern Survey (NHAPS): a Resource for Assessing Exposure to Environmental Pollutants.” Nature News, Nature Publishing Group, 26 July 2001, www.nature.com/articles/7500165.

Leiserowitz A., Maibach E., & Roser-Renouf, C. (2009). Climate change in the American mind: Americans’ climate change beliefs, attitudes, policy preferences, and actions. New Haven, CT; Fairfax, VA: Yale Project on Climate Change, School of Forestry and Environmental Studies, Yale University; and the Center for Climate Change Communication, Department of Communication, George Mason University.

“Living Ocean.” NASA, NASA, 13 Nov. 2019, science.nasa.gov/earth-science/oceanography/living-ocean.

Lu, Denise, and Christopher Flavelle. “Rising Seas Will Erase More Cities by 2050, New Research Shows.” The New York Times, The New York Times, 29 Oct. 2019, www.nytimes.com/interactive/2019/10/29/climate/coastal-cities-underwater.html?&action=click&module=MoreInSection&pgtype=Article®ion=Footer&contentCollection=Climate%2Band%2BEnvironment.

Marro, Marcy. “Building for Biophilic Design.” Metal Architecture, 1 June 2018, www.metalarchitecture.com/articles/building-for-biophilic-design.

“Mayor London Breed Announces First Bond Sale to Strengthen the Embarcadero Seawall.” Mayor London Breed Announces First Bond Sale to Strengthen the Embarcadero Seawall | Office of the Mayor, Office of the Mayor, 2 Apr. 2019, sfmayor.org/article/mayor-london-breed-announces-first-bond-sale-strengthen-embarcadero-seawall.

“Miami Beach & Sea Level Rise.” Miami Beach – Rising Above, www.mbrisingabove.com/climate-science/sea-level-rise/.

Miller, Kimberly. “King Tides: South Florida's Had 4 Straight Days of Record High Tides.” The Palm Beach Post, The Palm Beach Post, 15 Oct. 2019, www.palmbeachpost.com/news/20191015/king-tides-south-floridarsquos-had-4-straight-days-of-record-high-tides.

Moser, Susanne C. “Communicating Climate Change: History, Challenges, Process and Future Directions.” Wiley Online Library, John Wiley & Sons, Ltd, 22 Dec. 2009, onlinelibrary.wiley.com/doi/abs/10.1002/wcc.11.

Olaf Schroth, Jeannette Angel, Stephen Sheppard & Aleksandra Dulic (2014) Visual Climate Change Communication: From Iconography to Locally Framed 3D Visualization, Environmental Communication, 8:4, 413-432, DOI: 10.1080/17524032.2014.906478

“Pier Into the Night.” Harbor WildWatch - Environmental Education, 2019, www.harborwildwatch.org/programs/public-programs/pier-into-the-night/.

Plumer, Brad. “Major Climate Report Warns of Severe Damage to the World's Oceans.” The New York Times, The New York Times, 25 Sept. 2019, www.nytimes.com/2019/09/25/climate/climate-change-oceans-united-nations.html.

Sheppard, S. (2012). Visualizing Climate Change. London: Routledge, https://doi.org/10.4324/9781849776882

Smith, M., Love, D.C., Rochman, C.M. et al. Curr Envir Health Rpt (2018) 5: 375. https://doi.org/10.1007/s40572-018-0206-z

Staletovich, Jenny. “Miami Forever Bond Project to Mitigate Effects of Sea Level Rise.” Miami, 30 May 2019, www.miamigov.com/Notices/News-Media/Miami-Forever-Bond-Project-to-Mitigate-Effects-of-Sea-Level-Rise.

“Study: U.S. Costal Communities Face More Than $400 Billion in Seawall Costs by 2040.” IGSD, 20 June 2019, www.igsd.org/study-u-s-costal-communities-face-more-than-400-billion-in-seawall-costs-by-2040/.

"Surfers Healing." Surfers Healing, www.surfershealing.org/.

Trails: Snorkel." Trails WA, trailswa.com.au/trails/trail-types/snorkel/.

"The Rising Seas Wetsuit." The Rising Seas Wetsuit, Vissla, risingseas.vissla.com/.

University of Exeter. "Coastal living linked with better mental health: Living close to the sea could support better mental health." ScienceDaily. ScienceDaily, 30 September 2019. <www.sciencedaily.com/releases/2019/09/190930214514.htm>.

U.S. National Oceanographic and Atmospheric Administration. 2018 state of U.S. high tide flooding with a 2019 outlook. Technical Report NOS CO-OPS 090. June 2019.

"Virtual Planet Technologies LLC." Virtual Planet Technologies LLC, virtualplanet.tech/.

Williamson, K., Satre-Meloy, A., Velasco, K., & Green, K., 2018. Climate Change Needs Behavior Change: Making the Case For Behavioral Solutions to Reduce Global Warming. Arlington, VA: Rare.

Wilson, Edward O. "Biophilia." Google Books, 1984, books.google.com/books/about/BIOPHILIA.html?id=CrDqGKwMFAkC.