SEAFLOOR MACHINA:

AGING TECHNOLOGIES IN THE DEPTHS OF THE PACIFIC OCEAN

by

HAYLEY GENEVIEVE BRAZIER

A DISSERTATION

Presented to the Department of History
and the Division of Graduate Studies of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 2023

DISSERTATION APPROVAL PAGE

Student: Hayley Genevieve Brazier

Title: Seafloor Machina: Aging Technologies in the Depths of the Pacific Ocean

This dissertation has been accepted and approved in partial fulfillment of the requirements for the Doctor of Philosophy degree in the Department of History by:

Marsha Weisiger	Chairperson
Mark Carey	Chairperson
Ryan Jones	Core Member
David Sutherland	Institutional Representative

and

Krista Chronister	Vice Provost for Graduate Studies

Original approval signatures are on file with the University of Oregon Division of Graduate Studies.

Degree awarded June 2023

DISSERTATION ABSTRACT

Hayley Genevieve Brazier

Doctor of Philosophy

Department of History

June 2023

Title: Seafloor Machina: Aging Technologies in the Depths of the Pacific Ocean

Everyone is talking about, reporting on, and studying the ocean, focusing on issues from sea level rise and pollution to coral reefs and algae blooms. Yet the piece we are missing in our study of the sea is understanding how we are industrializing the ocean floor, how the marine environment is responding to that industrialization, and how our present-day society cannot function without the manipulation, engineering, and management of machines on the seabed. By combining historical, primary source research with present-day marine science, this study offers one of the first environmental histories of the ocean floor.

The dissertation analyzes the development of three seafloor industries in the northeast Pacific Ocean from the 1890s into the present day, including oil and gas drilling in the shoreline, telecommunications cables on the continental shelf, and cabled observatories in the abyss. These industries have become indispensable to onshore society: offshore drilling accounts for approximately 30 percent of the globe's supply of oil; undersea cables facilitate 98 percent of all Internet and international phone traffic; and cabled observatories are scientific instruments at the forefront of collecting marine data that can help to prepare society for earthquakes, tsunamis, and the effects of climate

change. Fixed seabed infrastructure has become one of the most important ways that humans are interacting with the ocean, just as fisheries have been to previous generations.

I argue that the industrialization of the northeast Pacific's seabed has resulted in a persistent interaction between marine life and machines. Within months of entering the seawater, marine life colonizes seafloor technologies and transforms them into habitat, a transition I refer to as the machine's *biotic afterlife*. The biotic afterlife marks not only the decades or centuries the machine will spend in the sea but also its integration into the seafloor's ecology. Once these machines have spent years, decades, and now centuries in the ocean, what to do with them—to remove, or not to remove?—is the underlying question that drives this dissertation. Ultimately, as this research shows, the removal of machines from the seabed is often a political decision, rather than an ecological one.

CURRICULUM VITAE

NAME OF AUTHOR: Hayley Genevieve Brazier

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene
Colorado State University, Fort Collins
University of Kansas, Lawrence

DEGREES AWARDED:

Doctor of Philosophy, History, June 2023, University of Oregon
Master of Arts, History, May 2013, Colorado State University
Bachelor of Arts, History, May 2010, Colorado State University

AREAS OF SPECIAL INTEREST:

Environmental History
History of Science and Technology
U.S. West History
Pacific History

PROFESSIONAL EXPERIENCE:

Donald M. Kerr Curator of Natural History, High Desert Museum, 2021-Present

Andrew W. Mellon Dissertation Fellow, Center for Environmental Futures, University of Oregon, 2020-2021

Graduate Employee, Center for Environmental Futures, University of Oregon, 2019-2020

Graduate Employee, Digital Humanities Initiative, University of Oregon, 2017-2019

Graduate Teaching Fellow, Department of History, University of Oregon, 2015-2017

Historical Researcher, Public Lands History Center, 2012-2015

Graduate Teaching Assistant, Department of History, Colorado State University, 2011-2013

GRANTS, AWARDS, AND HONORS:

Joan Cahalin Robinson Prize, Society for the History of Technology, 2021

Doctoral Dissertation Research and Improvement Grant, National Science Foundation, 2020

Graduate Fellowship in the History of Science, American Meteorological Society, 2020 (declined)

Travel to Collections Award, Lemelson Center, Smithsonian Institution, 2020

Graduate Research Fellowship, Wayne Morse Center, 2019

John L. and Naomi Luvaas Graduate Fellowship, College of Arts and Sciences, University of Oregon, 2019

Graduate Research Support Fellowship, Oregon Humanities Center, University of Oregon, 2019

Richard D. Brown Summer Research Award, Department of History, University of Oregon, 2018, 2019

Environmental Studies Department Interdisciplinary Research Seed Grant, University of Oregon (Grantees: Hayley Brazier; Holly Moulton; Dr. Mark Carey; Dr. David Sutherland), 2018

Digital Humanities Summer Institute Tuition Scholarship, University of Victoria, 2017

ENHANCE School in the Public Environmental Humanities, Travel Grant, KTH Royal Institute of Technology, 2017

Gary E. Smith Summer Professional Development Award, University of Oregon, 2016

Harry Rosenberg Scholarship for Academic Excellence in Western American History, Colorado State University, 2012

History Honors Thesis Excellence Award, University of Kansas, 2010

History Departmental Honors, University of Kansas, 2010

Phi Betta Kappa, University of Kansas, 2010

Melissa Evans Study Abroad Scholarship, University of Kansas, 2010

Honors Program Developmental Grant, University of Kansas, 2008

Office of Study Abroad Scholarship, University of Kansas, 2008

PUBLICATIONS:

Brazier, Hayley and Mark Carey. "Environmental History, the History of Science, and the History of the Polar Regions." In *The Cambridge History of the Polar Regions*, edited by Adrian Howkins and Peder Roberts, 724-748. New York and Cambridge: Cambridge University Press, 2023.

Brazier**,** Hayley. "Disease, Disaster, and the Internet: Reconceptualizing Environmental Hazards in the Time of Coronavirus." *Journal of Environmental Media* 1 (August 2020): 10.1-10.8.

Huber, Katherine and Hayley Brazier. "Teaching the Ocean: Literature and History in the Study of the Sea." *Interdisciplinary Studies in Literature and the Environment* (October 2020).

Brazier, Hayley. "Practicing in Place: The Environmental History Retreat." *Environmental History,* Field Note. April 2016. https://environmentalhistory.net/field-notes/2016-brazier/.

ACKNOWLEDGMENTS

This project would not be possible without the support of multiple organizations that saw potential in my odd goal of writing a history about the seafloor. Thank you to the National Science Foundation, the Center for Environmental Futures and the Andrew W. Mellon Foundation, the Wayne Morse Center, the Oregon Humanities Center, the Smithsonian's Lemelson Center, and the University of Oregon's Department of History.

Thank you to my co-advisors, Mark Carey and Marsha Weisiger, who made me a better writer and thinker. I'm proud of the scholarly partnerships we built together and grateful for your friendships. Thank you to my committee members Ryan Jones and David Sutherland, whose expertise deepened my appreciation of the sea. Many other scholars have guided me including Alessandro Antonello, Maren Bzdek, Mark Fiege, Adrian Howkins, Janet Ore, Jared Orsi, Sarah Payne, and Casey Shoop.

Working towards my Ph.D. felt like an eight-year climb up a mountain, both rewarding and challenging. I'm thankful for those who joined me on the journey: Emily Cole, Dara Craig, Nichelle Frank, Lacey Guest, Rebecca Hastings, Misaki Kato, Tara Keegan, Olivia Molden, Holly Moulton, Zachary Provant, Rebekah Sinclair, Kenneth Surles, Miles Wilkinson, Haley Williamson Tabakci, and Olivia Wing.

To my family: all accomplishments I share with you and because of you. Thank you Lorraine, Morgan, Rogers, my aunts and uncles, Josh, and Theo for your unending support. To the dogs who came into my life during graduate school—Nelson, Addie, Talon, and Ruby—thank you for taking me on walks and sitting with me late at night, in the mornings, and every hour between. And finally, I'm thankful for Thomas, who held my hand to the end.

TABLE OF CONTENTS

Chapter Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

"A lot goes missing in the deep." Helen Scales.[1]

If the sky had not been clear and the tide not out, I would have never noticed the old cable tangled in the shoreline. Bamfield was having a sunny day—a rarity for this little ocean town, which sits on the west coast of Vancouver Island and receives the brunt force of the Pacific's waves, wind, and rain. The line looked to be the core of an undersea telegraph cable, made of the purest copper on earth and surrounded by now-eroding gutta percha or rubber. Beginning in 1902, Bamfield served as the landing site for the first transpacific telegraph cable. In grand fashion, dozens of staff processed the incoming and outgoing telegraph messages that whizzed across the British empire.[2] By the time I stood on Bamfield's shoreline, those cable operators were long deceased and the telegraph building demolished, and a university marine science center now occupying the site.[3] I turned to an employee of the marine science center and pondered aloud, "should we pull the cable out, or leave it here?" Yet I knew the answer before I asked the question. Marine life encrusted the cable so thickly that it was stuck to the seabed. Besides, removing the debris would mean certain death for the little organisms growing on its

---

[1] Helen Scales, *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat that Imperils It* (New York: Atlantic Monthly Press, 2021), 163.

[2] The telegraph station closed in 1959. See R. Bruce Scott, "Bamfied Cable Station: The Weakest Link," *Daily Colonist* (June 2, 1968), D-D01.24, Bamfield Historical Society, Bamfield, Canada.

[3] R. Bruce Scott, *Gentlemen on Imperial Service: A Story of the Trans-Pacific Telecommunications Cable* (Victoria, British Columbia: Sino Nis Press, 1994), 108.

surface. The Pacific held the cable tightly within its grasp, just as it does with so many other aging technologies resting on the seafloor.

Figure 1.1. Marine organisms grow on an abandoned cable core near Bamfield, British Columbia. Photograph by the author.

Everyone is talking about, reporting on, and studying the ocean, focusing on issues from sea level rise and plastics pollution to coral reefs, algae blooms, and climate change. Yet the piece we are missing in our study of the sea is an understanding of how we are transforming the ocean floor, how the marine environment is responding to that transformation, and how our present-day society cannot function without the historical manipulation, engineering, and management of infrastructure on the seabed. Using environmental history, science and technology studies, and marine science insights, this dissertation offers one of the few environmental histories of the northeast Pacific seafloor.[4] I argue that the industrialization of the northeast Pacific's seabed has resulted in a persistent interaction between marine life and human machines.[5] In turn, marine life transformed these machines from shiny, streamlined technologies into organism-covered habitats. After the machines have spent years, decades, and now centuries in the ocean, what to do with them—to remove, or not to remove?—is the underlying question that drives this dissertation. Seafloor technologies have provoked extreme reactions from the public, who typically hate them, love them, or completely ignore them, sometimes regardless of their effect on the marine environment. Thus, removing machines from the seabed often becomes a political decision, rather than an ecological one.

Our story begins in the 1890s, when oil and gas seekers first drilled for fossil fuels in Southern California's shoreline, leaving behind hundreds of derelict piers, wood piles, and leaking wells. The dissertation then moves into the twentieth century as companies and governments installed undersea telegraph, telephone, and then fiber optic cables across the northeast Pacific's continental shelves. Finally, we conclude near the present day, in the abyss, where scientists are installing vast networks of cabled instruments. These three types of seafloor industries have become indispensable to today's society: offshore drilling accounts for approximately 30 percent of the globe's supply of oil; undersea cables facilitate 98 percent of all Internet and international phone traffic; and cabled observatories are scientific instruments at the forefront of collecting marine data

[4] For a discussion of the northeastern Pacific Ocean as a unique marine region, see David Igler, "The Northeastern Pacific Basin: An Environmental Approach to Seascapes and Littoral Places," in *A Companion to American Environmental History*, ed. Douglas Cazaux Sackman (Hoboken, NJ: John Wiley and Sons, 2010): 579-594. On the history of "technology" as a word and field, see Eric Schatzberg, *Technology: Critical History of a Concept* (University of Chicago Press, 2018).

[5] I use Merriam-Webster's definition of "machine": a mechanically, electrically, or electronically operated device for performing a task. See "Machine," Merriam-Webster.com, accessed April 1, 2023, https://www.merriam-webster.com/dictionary/machine.

that can help to prepare society for earthquakes, tsunamis, and the effects of climate change.[6] This dissertation shows that the development of fixed seabed infrastructure has become one of the most important ways that humans are interacting with the marine environment, just as fisheries have been in previous generations.

Marine environmental historians have called on scholars to "dive beneath the waves."[7] To write stories that only consider the surface of the water risks ignoring a great portion of marine history. As historian W. Jeffrey Bolster writes, "Relegated to the role of narrative device, packaged as a sublime scene or means of conveyance, and shorn of its genuine mysteries and capacity for change, the ocean appears in most histories as a two-dimensional air-sea interface."[8] This study avoids the two-dimensional trap and investigates the ocean at three depths along the seafloor: the shore, the shelf, and the abyss.

---

[6] U.S. Energy Information Administration, "Offshore Production Nearly 30% of Global Crude Oil Output in 2015," *Today In Energy*, October 25, 2016, https://www.eia.gov/todayinenergy/detail.php?id=28492. Christopher R. Barnes, "Quantum Leap in Platforms of Opportunity: Smart Telecommunications Cables," in *Challenges and Innovations in Ocean in Situ Sensors: Measuring Inner Ocean Processes and Health in the Digital Age*, eds. Eric Delory and Jay Pearlman (Amsterdam: Elsevier, 2019), 209. On high voltage power cables, see Bastien Taormina, Juan Bald, Andrew Want, Gérard Thouzeau, Morgane Lejart, Nicolas Desroy, and Antoine Carlier, "A Review of Potential Impacts of Submarine Power Cables on the Marine Environment: Knowledge Gaps, Recommendations and Future Directions," *Renewable and Sustainable Energy Reviews* 96 (2018): 380-391; "Submarine Cables and BBNJ," International Cable Protection Committee (ICPC Ltd. August 1, 2016): 1,5, https://www.un.org/depts/los/biodiversity/prepcom_files/ICC_Submarine_Cables_&_BBNJ_August_2016.pdf.

[7] Ryan Tucker Jones, "Running into Whales: The History of the North Pacific from Below the Waves," *American Historical Review* 118 (April 2013): 350; see also Helen M. Rozwadowski, "Ocean's Depths," *Environmental History* 15 (July 2010): 520-525; W. Jeffrey Bolster, "Opportunities in Marine Environmental History," *Environmental History* 11 (July 2006): 567-597.

[8] W. Jeffrey Bolster, "Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500–1800," *American Historical Review* 113 (February 2008): 23.

Figure 1.2. The dissertation is organized into three parts: the shoreline, the continental shelf, and the abyss. Image by the author.

From an ecological perspective, the seafloor is one of the most important regions of the ocean. Unique from the water column or water's surface, the seabed hosts a great majority of the ocean's organisms. Of the nearly two hundred and thirty thousand identified species that exist in the ocean, 98 percent are benthic, meaning they reside on or near the seafloor. The remaining 2 percent are pelagic species—such as dolphins, sharks, and whales—which live in the water column.[9] So when North American companies began to install instruments on the ocean bottom in the late-nineteenth century, it kicked off an interaction between their machines and the world's busiest and biggest habitat. Many terms describe this zone of the ocean: seabed, seafloor, ocean bottom, bed of the ocean—these phrases are interchangeable in the following pages. I define the seafloor as any location where the ocean's saltwater flows or sprays over the ground, even if temporarily. Thus the seafloor begins at the uppermost point on the beach where water reaches during high tide. Wherever saltwater touches, the seafloor exists.

Around the global ocean, approximately four thousand marine species are known to colonize submerged technologies. Colonizers are marine organisms that attach hard and fast to a variety of surfaces—tacky, smooth, craggily, slick—and rarely move from that spot for the duration of their life. For these resilient species, all objects are fair game: rocks, cables, logs, the bottom of ships, offshore drilling platforms, barrels, scientific instruments—everything. They begin their work just seconds after a squeaky clean surface enters the seawater and then begin to colonize it in four unique stages. Molecules are the first to arrive. They cover the object's surface in what scientists call a biofilm or slime layer. Next, diatoms and bacteria latch on and add to the slime layer, followed by macroalgae and protozoa. Then the larvae of bigger organisms such as barnacles, tunicates, and mussels drift by the object's surface, examine the slime layer and then settle down, latch on, and stay there for the long haul.[10] Finally, in the months and years

---

[9] Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography*, 12th edition (Boston: Pearson, 2017), 375, 384.

[10] Diego Meseguer Yebra, Søren Kiil, Kim Dam-Johansen, "Antifouling Technology—Past, Present and Future Steps Towards Efficient and Environmentally Friendly Antifouling Coatings," *Progress in Organic Coatings* 50 (2004): 79; Gregory D. Bixler and Bharat Bhushan, "Biofouling: Lessons from Nature," *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 370, no. 1967 (May 2012):

to follow, larger species begin to hang around the now-colonized surface, including fish, sea stars, crabs, and other mobile creatures. This process does not happen totally by accident. Macrofoulers may select objects based on the qualities of the slime layer, an opportunistic move that provides them nutrients, shelter and depending on the object an unexpected dose of toxicity. Once settled, the colonizers hold on tight despite their exposure to a variety of temperatures, salinity levels, contaminants, or seawater heights. These sessile (or fixed) species are tough cookies in an ocean already filled with resilient organisms.[11] Colonization is just one type of interaction between marine life and seafloor technologies, but it's one of the more significant.

Scientist Helen Scales refers to marine colonizers as "animal hitchhikers," which are notorious among marine industries for causing damage.[12] Biofouling, or the unwanted colonization of surfaces by marine life, is a big problem for anyone who owns a machine in the ocean. Globally, marine technology owners spend an estimated 5.7 billion dollars a year to combat biofouling. Marine colonizers can clog outlet pipes, obstruct aquaculture nets, blur sensors and camera lenses, and dramatically weigh down ships. In some instances, colonizers hitch a ride on a ship and, in the process of traveling halfway around the world, find themselves in new waters as an invasive species.[13] The long battle

---

2391; Katie Smyth, Nikki Christie, Daryl Burdon, Jonathan P. Atkins, Richard Barnes, Michael Elliott, "Renewables-To-Reefs? Decommissioning Options for the Offshore Wind Power Industry," *Marine Pollution Bulletin* 90 (2015): 251.

[11] Yebra, "Antifouling Technology," 79-80.

[12] Scales, *Brilliant Abyss*, 26.

[13] "Alternative Methods for Environmentally Friendly Fouling Control," Eurofish International Organisation, last modified December 20, 2019 *https://eurofish.dk/alternative-methods-for-environmentally-friendly-fouling-control/*; W. J. Tudor, *Structures in the Deep Ocean: Engineering Manual for Underwater Construction* (Port Hueneme, California: U.S. Naval Civil Engineering Laboratory, 1964), 2-44.

between biofoulers and marine technology owners is an ongoing one that far predates this dissertation's chronological scope. What this dissertation does consider, however, are those biofouling organisms that have interacted with seafloor machines in the northeast Pacific Ocean since the late 1800s.

Within months of entering the seawater, marine life colonizes seafloor technologies and transforms them into habitat, a transition I refer to as the machine's *biotic afterlife*. The biotic afterlife marks not only the decades or centuries the machine will spend in the sea but also its integration into the seafloor's ecology.[14] Covered in algae, barnacles, sea stars, limpets, worms, spiders, and crabs, these organisms come to depend on the machine as hard substrate that provides protection, breeding grounds, and food. In some cases, a seafloor machine becomes so overrun with marine life that it's impossible to discern the original object. The biotic afterlife of seafloor technologies is a concept I draw, in part, from the book *Alien Ocean: Anthropological Voyages in Microbial Seas*, in which Stefan Helmreich dives into the ocean's perplexing duality. Throughout the book, he describes a "double discourse on the sea, as alternatively amiable stranger and enemy other"—an environment that is understood by humans as one part alien, one part familiar.[15] Over time, human technologies installed on the seafloor also take on this duality: part machine, part ocean; part recognizable, part unrecognizable;

---

[14] The ecological definition of habitat is a place that "meets all the environmental conditions an organism needs to survive. For an animal, that means everything it needs to find and gather food, select a mate, and successfully reproduce." See "Habitat," National Geographic, accessed January 10, 2023, https://education.nationalgeographic.org/resource/habitat/.

[15] Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Berkeley: University of California Press, 2009), 9. See also Donna J. Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century," in *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991), 149-181.

a little less human, a little more alien. After the machine has spent decades and sometimes centuries in the ocean, it's this subsequent lifespan that we rarely learn about.[16] This dissertation is concerned with the environmental story that unfolds *after* their installation.

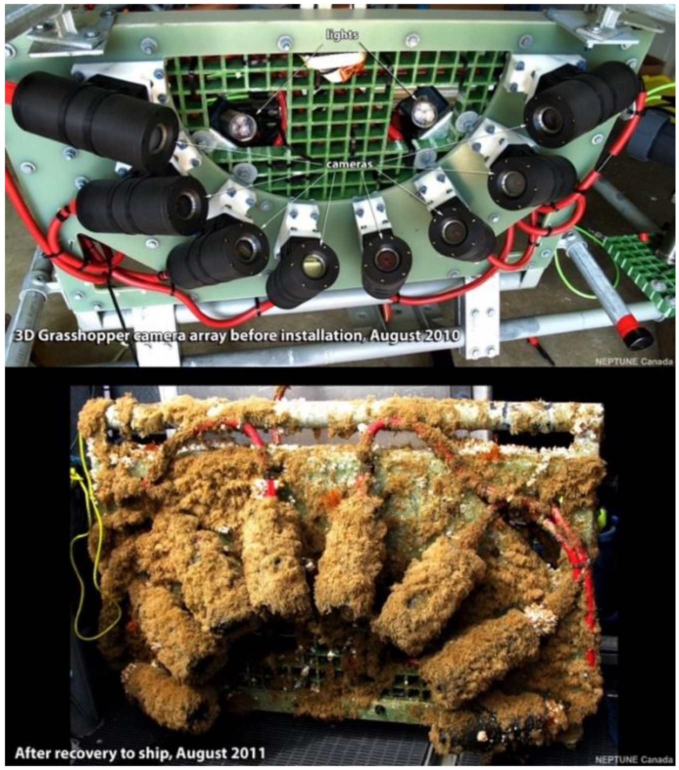


Figure 1.3. Two pictures of a single 3D camera array—one taken before entering the ocean, and second picture captured after. Marine life colonizes almost any surface that arrives on the seafloor. Image courtesy of Ocean Networks Canada.

[16] In his book *Rubble,* Gastón R. Gordillo analyzes Argentinian sites of destruction. He rejects the words "debris" and "ruins" for these sites—which are objects stuck in history—in exchange for the word "rubble." Rubble, he argues, is "produced, destroyed, remade." In other words, they take on an afterlife, to use my phrasing. See Gastón R. Gordillo, *Rubble: The Afterlife of Destruction* (Durham: Duke University Press, 2014).

The Blue Humanities

Increasingly attentive to the close relationship between humans and the sea, humanistic scholarship on the ocean has flourished in the last few decades. Sometimes called the blue humanities, these scholars specialize in environmental history, science and technology studies (STS), historic preservation, and literature, among other fields. Broadly defined, the blue humanities is the study of humans and the ocean, including ocean-oriented art, culture, travel, resource extraction, and industrialization.[17] This dissertation contributes to the blue humanities by combining historical, primary source research with present-day marine science to tell an environmental story about machines on the seabed. In this story, the history of machines and the agency of the ocean combine and emerge.

In the historical study of oceanography, the development of marine technologies is often associated with the evolution of marine science in the eighteenth and nineteenth centuries. Historians of science Michael Reidy and Helen Rozwadowski write, "Use of the sea rested on reliable knowledge of the ocean."[18] But as this dissertation shows, the

---

[17] For an overview of the blue humanities, see Steve Mentz, *An Introduction to the Blue Humanities* (New York: Routledge, 2024), forthcoming; John R. Gillis, "The Blue Humanities," *Humanities* 34 (May/June 2013), https://www.neh.gov/humanities/2013/mayjune/feature/the-blue-humanities.

[18] Michael Reidy and Helen M. Rozwadowski, "The Spaces In Between: Science, Ocean, Empire," *Isis* 105 (2014): 338-351; see also Michael Reidy, *Tides of History: Ocean Science and Her Majesty's Navy* (University of Chicago Press, 2008); Eric L. Mills, *The Fluid Envelope of Our Planet: How the Study of Ocean Currents Became a Science* (University of Toronto Press, 2009); Helen Rozwadowski, *Vast Expanses: A History of the Oceans* (London: Reaktion Books, 2018); Helen Rozwadowski, "Ocean's Depths." *Environmental History* 15, no. 3 (July 2010): 520-525; Helen M. Rozwadowski and David K. van Keuren, eds. *Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment* (Canton, Mass: Science History Publications, 2004); Helen M. Rozwadowski's *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea* (Cambridge, MA: Harvard University Press, 2005); Bernard Finn and Daqing Yang, eds., *Communications Under the Seas: The Evolving Cable Network and Its Implications* (Cambridge, MA: MIT Press, 2009); Simone M. Müller, "From Cabling the Atlantic to Wiring the World: A Review Essay on the 150th Anniversary of the Atlantic

early industrialization of the northeast Pacific seafloor was not generally the result of advanced scientific knowledge, which was still minimal in the late nineteenth and early twentieth centuries. In fact, as recently as the mid-nineteenth century, the seafloor beyond shallow waters was still a foreign environment for scientists and mariners, who had never laid eyes on it. They were only beginning the daunting process of studying and mapping the seabed. In the regions outside of harbors, busy coastal areas, or along shipping routes, the ocean's depths remained a great mystery, save for a small but growing record of samples and measurements. Debates surged about whether life, in any form, could even survive on the deep seafloor.[19] Therefore, the swift industrialization of the seafloor was the result of societal necessity—a need to quickly communicate between foreign shores and a need for more natural resources to power the growing number of machines on land. In the northeast Pacific Ocean, a lack of understanding of the seabed's depths, terrain, and marine life did not stop entrepreneurs from attempting to industrialize the ocean bottom, it merely posed challenges.[20] Even today, about 15 percent of the global ocean

---

Telegraph Cable of 1866," *Technology and Culture* 57, no. 3 (July 2016): 507-526, David Igler, *The Great Ocean: Pacific Worlds from Captain Cook to the Gold Rush* (New York: Oxford University Press, 2013); Jacob Darwin Hamblin, "Seeing the Oceans in the Shadow of Bergen Values," *Isis* 105 (June 2014): 352-363; Reidy, *Tides of History*, 2008; Philip E. Steinberg, *The Social Construction of the Ocean* (Cambridge University Press, 2001); Simone M. Müller, *Wiring the World: The Social and Cultural Creation of Global Telegraph Networks* (New York: Columbia University Press, 2016); Gary Kroll, *America's Ocean Wilderness: A Cultural History of Twentieth-Century Exploration* (Lawrence: University Press of Kansas, 2008).

[19] C. Wyville Thomson, *The Depths of the Sea*, 2nd edition (London: MacMillan, 1874), 24; Tony Koslow, *The Silent Deep: The Discovery, Ecology and Conservation of the Deep Sea* (University of Chicago Press, 2007), 14-15; Robert Kunzig, *Mapping the Deep: The Extraordinary Story of Ocean Science* (New York: W. W. Norton, 2000), 89.

[20] For published primary sources histories on the development of instruments for the Pacific, see *The All Red Line: The Annal and Aims of the Pacific Cable Project*, ed. George Johnson (Ottawa: James Hope and Sons, 1903); Ernest Ingersoll, *The Book of the Ocean* (New York: Century, 1898); Thomson, *Depths of the Sea*; Kenneth Orris Emery, *The Sea off Southern California; A Modern Habitat of Petroleum* (New York: Wiley, 1960); John Murray, *Report on the Scientific Results of the Voyages of the HMS Challenger, 1873-1876* (Edinburgh: Neill and Company, 1891).

seafloor has been mapped to a one-hundred meter resolution, meaning many of the ocean's mysteries still prevail despite the continued expansion of marine technologies.[21]

In addition to the strong association made between marine technology and oceanography, historians of science and STS scholars have also analyzed marine technology as tools of territorialism, colonialism, and global hegemony. Many scholars have argued that submarine cables functioned as extensions of imperialism, creating a link between colonial outposts around the world. Other authors have argued for the importance of cable infrastructure as critical to global finance, transportation, and communication.[22] Of the broad array of marine technologies that now sit on the seabed, telegraph cables in the Atlantic Ocean have been of particular scholarly and popular attention.[23] Fewer studies have focused on undersea cables across the Pacific, and even fewer in the northeast Pacific.[24] This dissertation makes a significant contribution to existing scholarship by moving the blue humanities away from framing marine

---

[21] Jon Copley, "Just How Little Do We Know about the Ocean Floor?" *The Conversation UK*, October 9, 2014, https://theconversation.com/just-how-little-do-we-know-about-the-ocean-floor-32751.

[22] Daqing Yang, *Technology of Empire: Telecommunications and Japanese Expansion in Asia, 1883-1945* (Cambridge, MA: Harvard University Press, 2010); Müller, "From Cabling the Atlantic to Wiring the World"; Nicole Starosielski, *The Undersea Network* (Durham, NC: Duke University Press, 2015); Jean-Guy Rens, *The Invisible Empire: A History of the Telecommunications Industry in Canada, 1846-1956,* trans. Käthe Roth (Montreal: McGill-Queen's University Press).

[23] See Müller, *Wiring the World;* Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981); Daniel R. Headrick and Pascal Griset, "Submarine Telegraph Cables: Business and Politics, 1838-1939," *Business Historical Review* 75, no. 3 (Autumn 2001): 543-578; Finn et al., *Communications Under the Seas.*

[24] Exceptions include Yang, *Technology of Empire*; Starosielski, *The Undersea Network*; Robert W. D. Boyce, "Imperial Dreams and National Realities: Britain, Canada and the Struggle for a Pacific Telegraph Cable, 1897-1902," *English Historical Review* 115, no. 460 (Feb., 2000): 39-70; Rebecca Robbins Raines, *Getting the Message Through: A Branch History of the U.S. Army Signal Corps* (Washington, D.C.: Center of Military History, U.S. Army, 1996); David Eric Jessup, "Connecting Alaska: The Washington-Alaska Military Cable and Telegraph System," *Journal of the Gilded Age and Progressive Era* 6, no. 4 (October 2007): 384-408.

technologies solely as tools of territorialism and instead illuminates the historical interactions between undersea technologies and the Pacific marine environment.

Professionals who work within the industries of offshore drilling, undersea telecommunications, and marine science have produced extensive bodies of grey literature, books, and peer-reviewed articles for their respective fields. This literature often overlooks other seafloor users or environmental factors—in short, it lacks the STS, historical, and larger socioeconomic and political dimensions that this dissertation offers. Industry's narrow focus is changing, however, as more scholars advocate for marine spatial planning (MSP) to share the seafloor's seemingly unlimited space and resources.[25] Recent undersea cable publications, for example, acknowledge the problems cables can pose for fishermen, who snag their nets and boat anchors on undersea lines.[26] Despite these strides, marine science scholarship and industry-specific literature are inclined to analyze one seabed industry at a time, meaning there is a dearth of comprehensive and comparative studies between seafloor industries. While it is important that this dissertation links societies and environments to show how technology and society are mutually constitutive, this project also suggests that technologies and infrastructures

[25] See Rebecca Retzlaff and Charlene LeBleu, "Marine Spatial Planning: Exploring the Role of Planning Practice and Research," *Journal of Planning Literature* 33, no. 4 (2018): 466-491; Luke Fairbanks, Noëlle Boucquey, Lisa M. Campbell, and Sarah Wise, "Remaking Oceans Governance: Critical Perspectives on Marine Spatial Planning," *Environment and Society: Advances in Research* 10 (2019): 122-140; A.D. Guerry, M.H. Ruckelshaus, J.R. Bernhardt, G. Guannel, C.K. Kim, M. Marsik, J.E. Toft, D.A. Sutherland, "Modeling Benefits from Nature: Using Ecosystem Services to Inform Coastal and Marine Spatial Planning," *International Journal of Biodiversity Science, Ecosystems Services and Management* 8 (2012): 107-121.

[26] L. Carter, D. Burnett, S. Drew, G. Marle, L Hagadorn, D. Bartlett-McNeil, and N. Irvine, *Submarine Cables and the Oceans – Connecting the World*, UNEP-WCMC, Biodiversity Series No. 31. ICPC/UNEP/UNEP-WCMC (2009), 45, 48; Tracy Lynn Holman, *Multiple Uses of the Seabed Off the Oregon Coast: An Analysis of Recent Interactions between the Fishing Industry and the Submarine Cable Industry* (Master's Thesis, University of Washington, 2000).

affect each other, developing over time in relation to other built artifacts, in this case, on the ocean floor. The intertwined dialectical relationship that plays out among multiple human and non-human actors is precisely why scholars have recently devoted so much attention to technonatures, social-ecological systems, coupled natural and human systems, hybrid landscapes, Actor Network Theory, and New Materialism, among other trends.[27]

In the study of technology and society, there is also an important role played by non-human nature—geological conditions, ocean currents, climate change, and natural hazards—in the historical evolution of machines, power, economic development, and societies more broadly. In this way, a history of seafloor technologies and infrastructures must link the history of marine science and technology with marine environmental history, as some scholars have recently encouraged.[28] The coastline, in particular, has attracted the most attention—an ecological and cultural space where communities have

---

[27] For scholarship that discusses these environmental themes and approaches, see Haraway, "Cyborg Manifesto"; Maria Kaika, *City of Flow: Modernity, Nature, and the City* (New York: Routledge, 2005); Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002); Mark Carey, *In the Shadow of Melting Glaciers: Climate Change and Andean Society* (New York: Oxford University Press, 2010); Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987); Philip Steinberg and Kimberley Peters, "Wet Ontologies, Fluid Spaces: Giving Depth to Volume through Oceanic Thinking," *Environment and Planning D: Society and Space* 33 (2015): 247-264; Andrew C. Isenberg, ed., *The Oxford Handbook of Environmental History* (New York: Oxford University Press, 2014); Rafico Ruiz, "Iceberg Economies," *TOPIA: Canadian Journal of Cultural Studies* 32 (2018): 179-199; Marsha Weisiger, *Dreaming of Sheep in Navajo Country* (Seattle: University of Washington Press, 2009); Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford University Press, 1964); Damian White and Chris Wilbert, "Introduction: Technonatural Time-Spaces," *Science as Culture* 15, no. 2 (June 2006): 95-104.

[28] Helen Rozwadowski, "Oceans: Fusing the History of Science and Technology with Environmental History," in *Companion to American Environmental History*, ed. Douglas Cazaux Sackman (Oxford: Wiley-Blackwell, 2010): 442-461; Rozwadowski, "Ocean's Depths"; Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard, eds., *New Natures: Joining Environmental History with Science and Technology Studies* (University of Pittsburgh Press, 2013); Joseph E. Taylor III, "Knowing the Black Box: Methodological Challenges in Marine Environmental History," *Environmental History* 18 (January 2013): 60-75.

flourished and often re-engineered the shoreline to meet the fluctuations of the seaside economy. Spanning the great depth of human history, many civilizations have thrived on the resources that the coastal ocean provides. From the Indian Ocean and Mediterranean Sea to the Bering Strait, coastal communities have drawn materials from the sea for food, clothing, shelter, religion, and leisure. The histories of coastal communities have more recently become a central topic for environmental historians, who have produced a surge of scholarship that features the coastline. This field is sometimes called the New Coastal History, or the study of how human populations have not only thrived near coastlines, but also altered them.[29]

Historians who study the ocean's deeper depths have most often chronicled the development of fisheries and pelagic hunting, particularly in the nineteenth and twentieth centuries as misguided regulatory policies failed to protect many marine species from extinction and ecological collapse. It is these environmentally harmful, commercial industries that have received the most scholarly attention from marine environmental historians, including the work of W. Jeffrey Bolster, Ryan Tucker Jones, Joseph Taylor

[29] David Worthington, "Introducing the New Coastal History: Cultural and Environmental Perspectives from Scotland and Beyond," in *The New Coastal History: Cultural and Environmental Perspectives from Scotland and Beyond,* ed. David Worthington (Cham, Switzerland: Palgrave Macmillan, 2017), 3-4; John R. Gillis, *The Human Shore*: *Seacoasts in History* (Chicago: University of Chicago Press, 2012) 1, 9-10, 99. See also Alain Corbin, *The Lure of the Sea: The Discovery of the Seaside in the Western World 1750-1840,* trans. by Jocelyn Phelps *(*London: Penguin Books, 1995); Christopher L. Pastore, *Between Land and Sea: The Atlantic Coast and the Transformation of New England* (Cambridge, MA.: Harvard University Press, 2014); Matthew Morse Booker, *Down by the Bay: San Francisco's History between the Tides* (Berkeley: University of California Press, 2013); Andrew Lipman, *The Saltwater Frontier: Indians and the Contest for the American Coast* (New Haven, CT: Yale University Press, 2015); Connie Y. Chiang, *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast* (Seattle: University of Washington Press, 2008); David Biggs, *Quagmire: Nation-Building and Nature in the Mekong Delta (*Seattle: University of Washington Press, 2010); Isaac Land, "Tidal Waves: The New Coastal History," *Journal of Social History* 40 (Spring 2007): 740-741.

III, Connie Chiang, Arthur McEvoy, and Lissa Wadewitz.[30] This dissertation builds on the study of the deep blue sea to evaluate how marine technologies have altered its environments, but it will add a new dimension to marine STS and environmental history by moving away from the study of fisheries and pelagic hunting. This study examines the historical development of technologies that are permanent or semi-permanent installments on the seafloor. There is a clear rationale for studying so-called "permanent" seafloor infrastructure: they have been understudied in comparison to other mobile gear and machines that occupy the ocean just temporarily to facilitate warfare, travel, fisheries, or pelagic hunting. In the twenty-first century, fixed seafloor technologies have become indispensable to onshore society and a key means through which we interact with the sea.

Not all blue humanities scholars have chosen to dive below the waves, however. In 2007, historian Isaac Land wrote, "'Oceanic' history was always a metaphor; how many historians ever wrote about salt water?"[31] Despite Land's proclamation, plenty of us do. This dissertation writes about saltwater and I'm joined by a number of other marine environmental historians doing the same.[32] For starters, saltwater plays an

---

[30] Arthur McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980* (Cambridge University Press, 1986); Lissa K. Wadewitz, *The Nature of Borders: Salmon, Boundaries, and Bandits on the Salish Sea* (Seattle: University of Washington Press, 2012); Ryan Tucker Jones, *The Empire of Extinction: Russians and the North Pacific's Strange Beasts of the Sea, 1741-1867* (New York: Oxford University Press, 2014); W. Jeffrey Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail* (Cambridge, MA: Belknap Press, 2012); Taylor, *Making Salmon*; Chiang, *Shaping the Shoreline*; Igler, *Great Ocean*; Ryan Tucker Jones, *Red Leviathan: The Secret History of Soviet Whaling* (University of Chicago Press, 2022); Carmel Finley, *All the Fish in the Sea: Maximum Sustainable Yield and the Failure of Fisheries Management* (University of Chicago Press, 2011).

[31] Land, "Tidal Waves," 740; also quoted in Jones, "Running into Whales," 351.

[32] Jason W. Smith, *To Master the Boundless Sea: The U.S. Navy, the Marine Environment, and the Cartography of Empire* (Chapel Hill: University of North Carolina Press, 2018).

important role in the environmental history of the seabed. It corrodes metal, transports the juvenile organisms that colonize instrument surfaces, removes wastes and delivers food for sessile marine life, and dilutes the crude oil that splashes from drilling machinery.[33] When considering saltwater itself, it's clear that the sea is more than a metaphor. The Pacific's animals, seaweeds, winds, sediments, and waves are important characters in this story. Here, the ocean's agency emerges.[34]

Scholars of the Pacific have developed a robust field to analyze the region's colonial histories. Historian Ann Elias writes that many white colonists around the world felt excited to "capture the 'unseen' and the 'unknown,'" regions of the ocean, "as the colonials were apt to call regions of the planet that were new to them but not to others, such as Indigenous maritime peoples and marine animals and plants."[35] Developers of seafloor machines often participated in that colonialism. For example, in the nineteenth century British engineer Charles Bright referred to the Pacific Ocean as "the greatest gap of all."[36] Another cable expert, Herbert Laws Webb, reminisced that submarine cable developers had "for many years cast longing glances at the Pacific Ocean—the one great

---

[33] Bixler et al., "Biofouling: Lessons from Nature," 2391.

[34] This dissertation relates to the growing discipline of animal studies and draws ideas from both that field and Indigenous scholars, who write and think about other species with an oftentimes different perspective than western ecological sciences. See Mieke Roscher, André Krebber, and Brett Mizelle, eds., *Handbook of Historical Animal Studies* (München, Wien: De Gruyter Oldenbourg, 2021); Carl Safina, *Beyond Words: What Animals Think and Feel* (New York: Henry Holt, 2015); Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teaching of Plants* (Minneapolis: Milkweed Editions, 2013).

[35] Ann Elias, *Coral Empire: Underwater Oceans, Colonial Tropics, Visual Modernity* (Durham: Duke University Press, 2019), 122.

[36] Charles Bright, *Submarine Telegraphs: Their History, Construction, and Working* (London: C. Lockwood and Son, 1898), 146, 151.

gap in the submarine-cable system of the world."[37] The key word in both of their sentiments is "gap," representing their perspective of a region unused, undeveloped, and open for colonization. For them, the Pacific and its seafloor were a foreign land, valuable but woefully underutilized. Echoing Bright and Webb's sentiments, many North Americans and Europeans saw the Pacific Ocean as a grand frontier, while industrializing its seafloor represented the greatest of intellectual, expeditionary, and technological challenges.[38] These colonial perspectives stood in stark contrast to the hundreds of Indigenous nations and communities whose homelands frame the Pacific Ocean basin. For those communities, the Pacific has never represented a "gap" nor a "single ocean world," as historian David Igler points out, but instead a place of interchange, travel, resources, and homeland.[39] It was, therefore, the colonizer who gazed at the Pacific's dark waters and challenging depths and saw an untouched void primed for industrial development. To view of the Pacific as foreign, unaltered, and conquerable separated seafloor industrialists from those nations and communities that have long flourished along the Pacific Rim.

---

[37] Herbert Laws Webb, "Proposed Cables under the Pacific," *Engineering Magazine* 6 (October, 1893-March, 1894): 845.

[38] Kroll, *America's Ocean Wilderness,* 2, 7; Steinberg, *The Social Construction of the Ocean*, 5-6.

[39] Igler, *Great Ocean,* 4. See also Epeli Hau'ofa, "Our Sea of Islands," *Contemporary Pacific* 6, no. 1 (Spring 1994): 148-161; Jennifer McKinnon, Julie Mushynsky, and Genevieve Cabrera, "A Fluid Sea in the Mariana Islands: Community Archeology and Mapping the Seascape of Saipan," *Journal of Maritime Archaeology* 9, no. 1 (June 2014): 59-79; Matt K. Matsuda, "The Pacific," *American Historical Review* 111, no. 3 (June 2006): 758-80; Joshua L. Reid, *The Sea Is My Country: The Maritime World of the Makahs* (New Haven, CT: Yale University Press, 2015); Frances Steel, ed., *New Zealand and the Sea: Historical Perspectives*, (Wellington, New Zealand: Bridget Williams Books, 2018); Jones, *Empire of Extinction;* Lisa Han, "The Blue Frontier: Temporalities of Salvage and Extraction at the Seabed," *Configurations* 27 (2019): 463.

Considering the Future

In the twenty-first century, the scale and breadth of new machines arriving on the ocean floor will increase every year. Over seven hundred and forty five thousand miles (1.2 million km) of fiber optic Internet cables are in operation around the world—enough cable to wrap around the Earth's equator more than twenty-seven times.[40] That number doesn't include an estimated ninety-four percent of old cables abandoned on the ocean floor, a number that likely amounts to hundreds of thousands of telegraph and telephone lines.[41] Consider, as well, the twelve-thousand offshore oil and gas rigs that speckle the global ocean, two thousand of which will be decommissioned before 2040. What will happen to those aging rigs?[42] In addition to these for-profit industries, scientists operate 193 observatories on the seafloor around the global ocean, a number that's always growing.[43] Most countries own a significant amount of space on the seafloor: the United States, for instance, controls 4.2 million square miles (10,877,950 sq. km) of seafloor, a number that exceeds its 3.8 million square miles (9,841,955 sq. km) of terrestrial land.[44]

---

[40] This dissertation uses the U.S. customary units system for measurements, which is standard for a humanities publication written within the United States. However, I provide metric conversions in instances of exact measurements, including meters (m), kilometers (km), and liters (L).

[41] Jeffrey Marlow, "Undersea Internet Cables Can Detect Earthquakes—And May Soon Warn of Tsunamis," *New Yorker* (July 26, 2022), https://www.newyorker.com/science/elements/undersea-internet-cables-can-detect-earthquakes-and-may-soon-warn-of-tsunamis; Senay Boztas, "Buried at Sea: The Companies Cashing In On Abandoned Cables," *Guardian,* December 14, 2016, https://www.theguardian.com/sustainable-business/2016/dec/14/ocean-pollution-cable-waste-technology-reuse-recycling-circular-economy-crs-holland.

[42] Sean van Elden, Jessica J. Meeuwig, Richard J. Hobbs, and Jan M. Hemmi, "Offshore Oil and Gas Platforms as Novel Ecosystems: A Global Perspective," *Frontiers in Marine Science* 6 (September 4, 2019): 1-2.

[43] "Submarine Cables and BBNJ," 6-7.

[44] Trujillo, *Essentials of Oceanography,* 370.

These areas will become busier with machines, many of which provide new sources of energy. Offshore wind farms, for instance, provided just 0.3 percent of global energy production in 2019, but the industry's distribution has been growing by 30 percent every year. By 2040, offshore wind may be a trillion dollar industry.[45]

All of these big machines—offshore drilling platforms, wind farms, wave farms, cabled observatories, underwater data centers, and other types of seafloor infrastructure—will age and die in the ocean. Undoubtedly, their obsolescence will arrive in about twenty to thirty years after installation, the typical lifespan of a seafloor machine since the nineteenth century.[46] The question of what will happen to these technologies at the end of their life, however, remains unanswered. Despite more than one-hundred and twenty years of industrial development on the Pacific seabed, there is no single policy or solution for dealing with aging machines in the ocean.

Considering the intimate interactions between marine species and machines, a relationship that can often benefit organisms, I ultimately conclude that marine industries and the governments that regulate them should think long and hard before installing *new* machines in the ocean. Marine life undoubtedly colonizes technologies that arrive on the seafloor. Whether or not that attraction leads to increased production of native species—or a higher numbers of individuals in the region—is more difficult to answer, and varies

---

[45] "Offshore Wind Outlook 2019," International Energy Agency, November 2019, https://iea.blob.core.windows.net/assets/495ab264-4ddf-4b68-b9c0-514295ff40a7/Offshore_Wind_Outlook_2019.pdf, 3, 15 13.

[46] Smyth et al., "Renewables-To-Reefs?" 247. If oil and gas companies claim bankruptcy, which is common within the State of California, taxpayers must pay millions, if not a few billion, to decommission and remove drilling materials. See Phil Willon, "Failures of California's First Plan to Stop Offshore Oil Drilling Cast Shadow over New Efforts," *Los Angeles Times*, November 29, 2021, https://www.latimes.com/california/story/2021-11-29/failures-of-california-rigs-to-reefs-program-offshore-oil; Christopher Barnes, interview with the author, February 21, 2023.

based on the technology and its location in the ocean. At every stage of a machine's existence on the seafloor—installation, removal, or abandonment—there's an ecological ripple and a corresponding reaction that's more difficult to measure. To complicate matters further, there is evidence that invasive species, such as the lionfish in the Gulf of Mexico, are aided in their expansion by the habitat artificial reefs provide.[47] For those reasons, industries should not introduce new seafloor technologies for the purpose of creating new sources of habitat.

Figure 1.4. An octopus latches onto a deep-sea instrument in the northeast Pacific Ocean. Photo courtesy of Ocean Networks Canada/CSSF-ROPOS.

[47] See Olivia Langhamer, "Artificial Reef Effect in Relation to Offshore Renewable Energy Conversation: State of the Art," *Scientific World Journal* (2012): 1; L. Antrim, L. Balthis, C. Cooksey, *Submarine Cables in Olympic Coast National Marine Sanctuary: History, Impact, and Management Lessons,* Marine Sanctuaries Conservation Series ONMS-18-01, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries (Silver Spring, MD, 2018), 43; Anja Schulze, Deana L. Erdner, Candace J. Grimes, Daniel M. Holstein, Maria Pia Miglietta, "Artificial Reefs in the Northern Gulf of Mexico: Community Ecology Amid the 'Ocean Sprawl,'" *Frontiers in Marine Science* 7 (2020): 1; van Elden, "Offshore Oil and Gas," 1-3, 4.

CHAPTER II

SQUIRT, FLOAT, BUMP, AND ANCHOR

Reproductive juices swirl in Southern California’s coastal waters. Anemones, sea stars, limpets, and mussels squirt billions of eggs and sperm into the sea, anticipating their progeny will collide with their intended partners to create a fertilized egg. Other organisms, like barnacles, squeeze out their eggs already fertilized. In either case, the fertilized eggs grow into larvae, which continue to float in the seawater until, one day—*thud!*—the little ones bump into hard substrate. Rocks, corals, kelp, debris, and even the shells other animals make for good substrate. Really, any hard surface is a safer option than drifting through the water column untethered, where most will die. Surface means safety. It’s a numbers game, and the statistics are not in their favor: a single oyster may pop out fifty million eggs in one reproductive round, hoping that just one will grow into an adult.[1] It’s no surprise, then, that once a juvenile collides with suitable substrate, these home-loving species hunker down for good.

Each species has a unique method of attaching. The periwinkle snail secretes a sticky mucus that bonds them to the substrate—they eat this mucus, freeing themselves, if they need to move. Limpets, on the other hand, grow their shell to meet the exact shape of the surrounding surface. Mussels reach out with a group of byssal threads that function

[1] “Seashores: Reproduction,” Exhibit Panel Text, Royal BC Museum, Victoria, Canada, visited February 23, 2023; Genny Anderson, “The Splash Zone,” “The High Tide Zone,” and “The Mid Tide Zone,” accessed January 30, 2023, marinebio.net; Mara Grunbaum, “What Whale Barnacles Know,” *Hakai Magazine*, November 9, 2021, https://hakaimagazine.com/features/what-whale-barnacles-know/.

like dozens of skinny, sticky arms.[2] Nary is a swath of hard substrate uncolonized: mussels clump together in mounds; buckshot barnacles grow on the shells of mussels; aggregating anemones cluster and arrange themselves by genetic likeness. Once established, a majority of these sessile organisms—meaning species that anchor to one surface—will stay in that spot until they perish. A single gooseneck barnacle may live for two decades, for instance, never moving from its home and community.[3] When it comes to sessile species and hard substrate, it's a till-death-do-us-part kind of relationship and one not to be taken lightly.

Sessile creatures have undergone this squirt, float, bump, and anchor sequence since time immemorial, a tradition as familiar to California's shoreline as the waves, tides, and saltwater. Wherever the sun is plentiful, marine life blossoms and makes quick work of bare surfaces. But one day in 1897, something altogether new entered their coastal habitat—new to the global ocean, for that matter. Oil and gas drilling piers, first made of wood and later metal, began to stretch from the beach into the coastal ocean. With the structures submerged in water during high tide, hundreds of thousands of these free-floating juveniles collided with the piers' tall legs, drill bits, and pipes, establishing a bond that would last the duration of the organism's life. Even above the water, the colonization continued as seabirds landed on the piers to rest and roost. Unknown to the oil and gas drillers, or at least an unintended outcome, their machines offered new

---

[2] Mary Bates, "How Do Barnacles Mate?" *Wired*, July 17, 2014, https://www.wired.com/2014/07/how-do-barnacles-mate/; "California Mussel," Marine Species Portal, California Department of Fish and Wildlife, accessed January 30, 2013, https://marinespecies.wildlife.ca.gov/california-mussel/false/; Anderson, "The Splash Zone," "The High Tide Zone," and "The Mid Tide Zone."

[3] Genny Anderson, "The Splash Zone," "The High Tide Zone," and "The Mid Tide Zone."

habitat. The drilling piers weren't just a flash in the pan, either. The industry would boom for half a century, its remnants and trash enduring in the shoreline much longer.

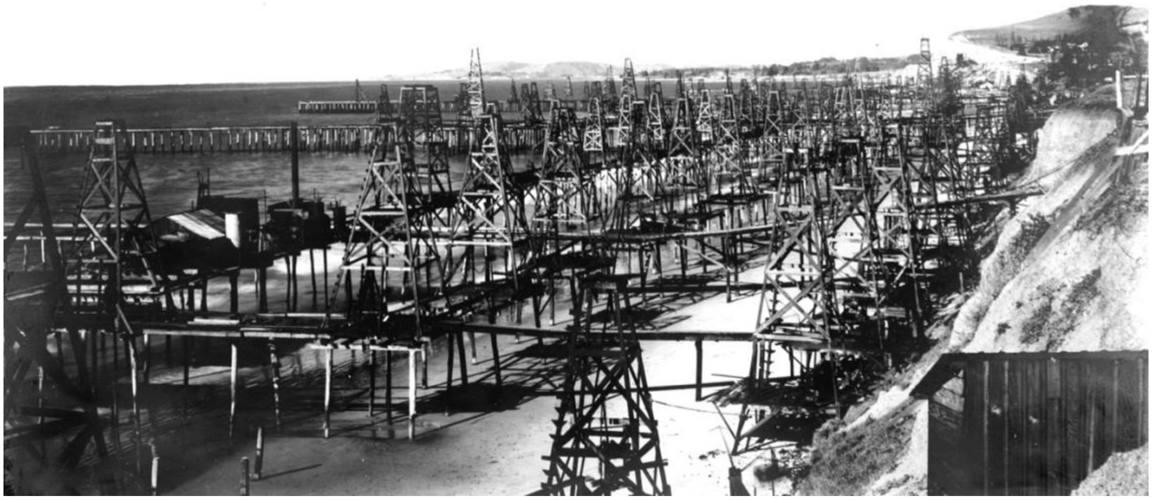


Figure 2.1 Within a few years of striking oil, drilling piers, derricks, and other debris cluttered Summerland, California's beach. Photograph by G.H. Eldridge, 1902, United States Geological Survey, Denver Library Photographic Collection, Denver, Colorado.

Between the 1890s and 1940s, hundreds of piers and thousands of derricks cluttered beaches up and down Southern California's shoreline. Oil seekers sniffed, poked, and prodded into the state's shallow sea bottom. Companies built wharves into the waves, inserted metal where there was sand, and extracted oil from below the kelp. The drilling piers and beach-side derricks arrived near communities wholly unprepared for the industrial boom: Goleta, Carpinteria, Huntington, El Capitan, Long Beach, Seal Beach, Isla Vista, Coal Oil Point, Venice Beach, Dos Pueblos, Montalvo, Newport, and Alamitos all hosted coastal drilling derricks.[4] In the 1920s alone, drillers punctured the shallow

[4] See Robert Sollen, *An Ocean of Oil: A Century of Political Struggle over Petroleum off the California Coast* (Juneau, Alaska: The Denali Press, 1998); "To Drill for Oil in Ocean at Redondo," *Los Angeles Herald,* June 12, 1908; "Will Prospect for Oil in Ocean off Redondo," *Los Angeles Herald,* October 18, 1908; "Local Firm Wins $20,000 Award to Build Pier," *San Pedro News Pilot,* December 6, 1928; Charles S. Jones, *From the Rio Grande to the Arctic: The Story of the Richfield Oil Corporation* (Norman: University of Oklahoma Press, 1972), 46; "Offshore Area is Modern Habitat of Petroleum, Writes RH Author," *Palos Verdes Peninsula News,* January 21, 1960.

seafloor in at least eight-hundred and fifty locations, helping to make California the largest oil-producing state in the nation by the end of the decade.[5] The rate that operators pumped crude from the Pacific was one-hundred and fifty thousand times faster than the speed it originally took for the ocean's dead marine organisms to decompose, fold into the seabed, and transform into fossil fuels.[6] As rigs crowded the shoreline, the industry shocked California's nearby residents, who gazed upon their drilling machinery with anger. Fearful of losing every inch of their shore to an extractive industry, a community-driven *Save the Beaches!* campaign began in the 1920s and demanded that the industry shut down and go away.

On the other side of the coastline, and within the shallow waters, marine life displayed an opposite reaction to the Californians. Always in search of hard substrate, organisms adopted the drilling piers as habitat. Sessile species, in particular, colonized almost any available nook and cranny, no matter if the material was metal, wood, or rope.[7] Swallowed by the sediments and covered in anemones, algae, and tunicates, drilling structures began to serve at the will of bivalves, rather than corporations. Spending a majority of their existence in the ocean rather than out of it, drilling piers and their dilapidated remnants transformed into marine objects, ultimately leading to a double

[5] "Final Environmental Impact Report for the Becker Legacy Wells Abandonment and Remediation Project," California State Lands Commission, July 2017, https://www.slc.ca.gov/wp-content/uploads/2017/07/FEIR.pdf, I-5.

[6] "Offshore Area Is Modern Habitat of Petroleum, Writes RH Author," *Palos Verdes Peninsula News*, January 21, 1960.

[7] Marine life avoids copper, which is toxic to them.

life, or biotic afterlife, on the ocean floor. After years of colonization and transformation, they became part machine and part ocean—a type of hybrid object.[8]

Despite the permanent mark this early offshore industry made on California's coastline, relatively few scholars have addressed the environmental history of "tideland oil drilling," the phrase Californians invented for the industry during the early twentieth century.[9] Instead, historians have been drawn to California's post-World War II era when companies began to install offshore platforms further away from the shoreline.[10] Platform

[8] Environmental history texts that introduce this environmental hybridity include Richard White's, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995); William Cronon's, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton, 1992); Richard White, "From Wilderness to Hybrid Landscapes: The Cultural Turn in Environmental History," *Historian* 66 (Fall 2004): 557–64; Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999); Marsha Weisiger, *Dreaming of Sheep in Navajo Country* (Seattle: University of Washington Press, 2009); Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford University Press, 1964); Mark Carey, *In the Shadow of Melting Glaciers: Climate Change and Andean Society* (New York: Oxford University Press, 2010); Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980* (Cambridge University Press, 1990); David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: W. W. Norton, 2006); Nancy Langston, *Where Land and Water Meet: A Western Landscape Transformed* (Seattle: University of Washington Press, 2006); Mark Cioc, *The Rhine: An Eco-Biography, 1815-2000* (Seattle: University of Washington Press, 2002); Patricia Nelson Limerick, *A Ditch in Time: The City, the West and Water* (Wheat Ridge, Colorado: Fulcrum Publishing, 2012); Donald J. Pisani, *To Reclaim a Divided West: Water, Law, and Public Policy, 1848-1902* (Albuquerque: University of New Mexico Press, 1992); Jessica B. Teisch, *Engineering Nature: Water, Development, and the Global Spread of American Environmental Expertise* (Chapel Hill: North Carolina Press, 2011); Helen M. Rozwadowski and David K. van Keuren, eds. *Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment* (Canton, MA: Science History Publications, 2004).

[9] Scholarship that does discuss tideland oil drilling in the early twentieth century includes Sollen, *An Ocean of Oil;* Teresa Sabol Spezio, *Slick Policy: Environmental and Science Policy in the Aftermath of the Santa Barbara Oil Spill* (University of Pittsburgh Press, 2018); Jack Davis, *The Gulf: The Making of An American Sea* (New York: Liveright, 2017); Paul Sabin, *Crude Politics: The California Oil Market, 1900-1940* (Berkeley: University of California Press, 2005); David F. Myrick, "Summerland: The First Decade," *Noticias* 34, no. 4 (Winter 1988), 97. One contemporary defined "tideland" as the "land owned by the state below the line of the ordinary high water mark." See "The Whipstock Bill," *San Pedro News Pilot*, July 18, 1936.

[10] See Tyler Priest, *Offshore Imperative: Shell Oil's Search for Petroleum in Postwar America* (College Station: Texas A&M University Press, 2007); Sollen, *An Ocean of Oil*; William R. Freudenberg and Robert Gramling, *Oil in Troubled Waters: Perceptions, Politics, and the Battle over Offshore Drilling* (New York: State University of New York Press, 1994); Dolly Jørgensen, "Environmentalists on Both Sides: Enactments in the California Rigs-To-Reefs Debate," in *New Natures: Joining Environmental History with Science and Technology Studies*, eds. Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard (University of Pittsburgh Press, 2013). For oil drilling in the Gulf of Mexico, see Davis, *The Gulf*; Stephen

Hazel was the first to arrive in 1958, followed by a few dozen platforms in the decades after.[11] The historical attraction is clear: with offshore drilling platforms and tankers having leaked millions of gallons of crude into the ocean since the 1960s, environmental historians have most particularly analyzed the industry's pollutive effects. Historian Teresa Sabol Spezio's recent book *Slick Policy: Environmental and Science Policy in the Aftermath of the Santa Barbara Oil Spill* tracks that very story of environmental decline, a tale that hinges on Santa Barbara's devastating 1969 oil spill. The colossal event brought oil pollution to the forefront of Americans' minds, galvanizing the environmental movement and harkening new coastal regulations.[12] Today, and despite the environmental risks, offshore drilling provides approximately 30 percent of the globe's supply of oil, making it one of the most significant industries in global history in both production and pollution.

As this chapter will detail, offshore drilling began in the late 1890s, seventy years before the Santa Barbara oil spill, in the 1890s, when wildcatters first built large piers into the shoreline. While their drilling infrastructure was massive, their knowledge of the

---

Haycox, "'Fetched Up': Unlearned Lessons from the *Exxon Valdez*,'" *The Journal of American History* (June 2012): 219.

[11] James Houseworth and William Stringfellow, "A Case Study of California Offshore Petroleum Production, Well Stimulation, and Associated Environmental Impacts," in *An Independent Scientific Assessment of Well Stimulation in California,* Volume III: *Case Studies of Hydraulic Fracturing and Acid Stimulations in Select Regions: Offshore, Monterey Formation, Los Angeles Basin,* eds. Jane C.S. Long, Laura C. Feinstein, and Jens Birkholzer et al. (Sacramento: California Council on Science and Technology, 2015), 34.

[12] Spezio, *Slick Policy;* Jon Hamilton, "How California's Worst Oil Spill Turned Beaches Black and the Nation Green," *NPR*, January 18, 2019, https://www.npr.org/2019/01/28/688219307/how-californias-worst-oil-spill-turned-beaches-black-and-the-nation-green; Dolly Jørgensen, "An Oasis in a Watery Desert? Discourses of an Industrial Ecosystem in the Gulf of Mexico Rigs-to-Reefs Program," *History and Technology* 25, no. 4 (December 2009): 343-364; Mark Kaiser, "Louisiana Artificial Reef Program," *Marine Policy* 30 (2006): 605–23; Paul Sammarco, Amy Atchison, and Gregory Boland, "Expansion of Coral Communities within the Northern Gulf of Mexico via Offshore Oil and Gas Platforms," *Marine Ecology Progress Series* 280 (2004): 129–43; Dan Rothbach, "Rigs-to-Reefs: Refocusing the Debate in California," *Duke Environmental Law and Policy Forum* 17 (2007): 283–95.

coastal ecosystem and its elements was minimal. That seemed to matter little as companies poured their money and resources into this nascent seafloor industry. California's public, however, did not throw their support behind the industry. Although their emerging car culture, factories, and other technologies consumed growing quantities of oil and gas, Californians detested the presence of oil and gas piers in their shoreline. They imagined the beach to be a place of leisure, recreation, culture, and tourism—but not labor and industry. As the two parties dueled it out in newspapers, political campaigns, and court rooms, marine organisms living in the subtidal and intertidal zones adapted to the intrusion.

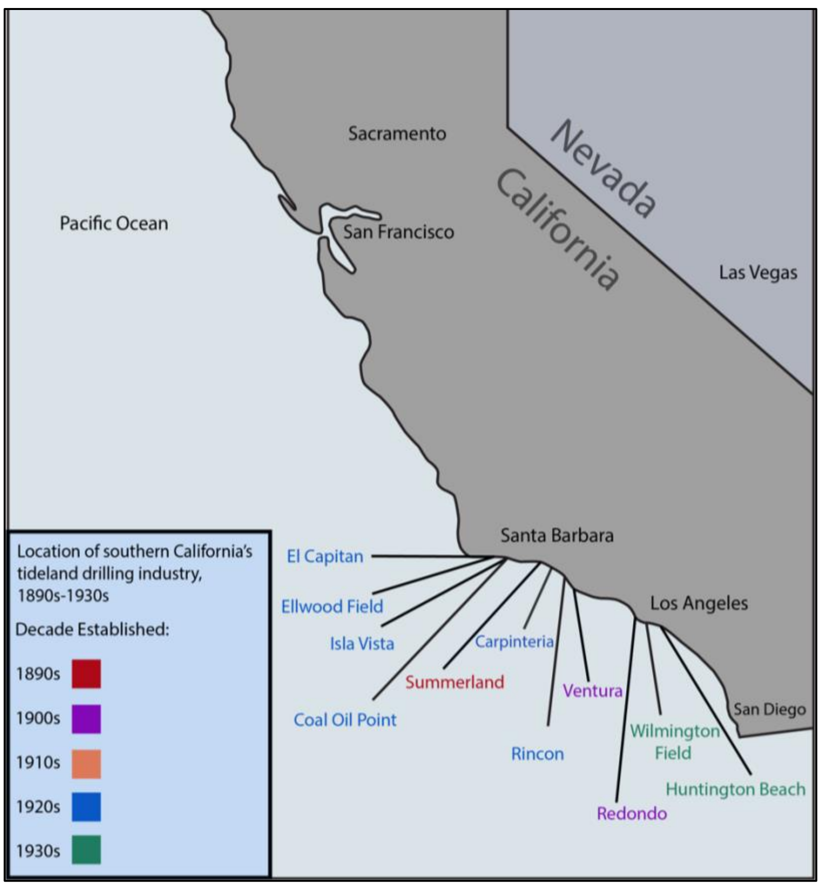


Figure 2.2. Location of Southern California's tideland drilling industry, 1890s-1930s. Image by the author.

The Search for Oil

California's tideland drilling history begins in Summerland, a small community that peers down onto the Pacific Ocean from a steep marine terrace. Marine terraces look something like a massive rocky staircase that are molded from the earth by the crash of waves against the coastline. Summerland sits on the first step of the staircase, the one nearest the seashore.[13] Henry Williams founded the town of Summerland in the 1880s as a haven for Spiritualists. Spiritualists identified as Christians that believed in using seances to communicate with the dead. Williams originally advertised the Summerland's plots to his fellow practitioners, promising that this town, located just a few miles south of Santa Barbara, boasted "climate, soil and scenery…far superior to that of any health resort in the country."[14] Seeking religious companionship, individuals and families moved to Summerland from across the country, having little economic interest in the Pacific Ocean except for the vistas it provided.[15] Spiritualism was not Williams's sole passion, however. He sought to make a living from the Summerland's mineral resources, both marine and terrestrial. Those who knew him reported that Williams was "imbued

---

[13] See Marjorie Schulz, Corey Lawrence, Dan Muhs, Carol Prentice, Sam Flanagan, "Landscapes from the Waves—Marine Terraces of California," United States Geological Survey, Fact Sheet 2018-3002, March 2018; Larry D. Gurrola, Edward A. Keller, James H. Chen, Lewis A. Owen, and Joel Q. Spencer, "Tectonic Geomorphology of Marine Terraces: Santa Barbara Fold Belt, California," *GSA Bulletin* 126, no. 1-2 (January February 2014), 231.

[14] Henry L. Williams, "Our Plans for Summerland," *Reconstructor*, June 12, 1890, File "Spiritualist Association," Carpinteria Valley Museum of History, Carpinteria, California.

[15] "A Surprised Community," *San Francisco Call*, March 10, 1895.

with the idea that oil existed in paying quantities beneath the ocean bed."[16] He suspected that his town's shoreline could make him a rich man, rather than a struggling one.

In 1895, Williams gathered a group of helpers and headed down to the beach. With simple tools in hand, the men began to dig down into the sand, disturbing the species that sought refuge within the ground. Resident sand fleas and round-bodied woodlice scurried away along their usual escape routes, which they normally took during the daily incoming tide. The shovels also passed by dozens of unsuspecting ghost shrimp and spiny sand crabs, creatures typically safe in their subterranean dungeons. Clearly, these humans were no normal beachgoers. For Williams and his men, a few days of digging proved well worth it. A few dozen feet into the sand, they found oil below the wet sediments and burrowing animals.[17] Bingo.

When Williams discovered oil on Summerland's beach, the production of fossil fuels was already a forty-year-old industry in the United States. It started back in 1859, when the Pennsylvania Rock Oil Company developed the first drilling rig in Titusville, Pennsylvania. The industry began with a sputter, not a gush. Although oil could be used in kerosene lamps, much of America's machinery still ran on resources like coal, waterpower, or animal labor. So in the immediate years following the unearthing of oil at Titusville, there was not a great demand or market for gasoline or fuel oil—the discovery

---

[16] "Southern Santa Barbara County and Its Resources: Souvenir Edition," *Summerland Advanced Courier*, February 1900, File: "Summerland," Carpinteria Valley Museum of History, Carpinteria, California; "A Surprised Community," *San Francisco Call* 77, no. 90, March 10, 1895; H. L. William's Land Grants, 1890, File, "Spiritualist Association," Carpinteria Valley Museum of History, Carpinteria, California.

[17] While one newspaper reported sixty feet, it's unclear how deeply Williams dug with simple hand tools or if he indeed had motorized tools for assistance. See "A Surprised Community," *San Francisco Call*, March, 10 1895; Edward F. Ricketts and Jack Calvin, *Between Pacific Tides*, 4th edition, revised by Joel W. Hedgpeth (Stanford: Stanford University Press, 1968), 72, 214.

preceded the need.[18] It required time for inventors to design machines that could transform oil into energy. Design they did. In a few swift decades, the process of searching, drilling, refining, and selling oil transformed from a small outfit in rural Pennsylvania to a massive, wealth-ridden industry.[19] By the end of the nineteenth century, the oil industry was identifying new markets for its fuel oil, including railroad locomotives, steam ships, factories, and power plants, which reframed crude from a curious liquid into a downright necessity.[20] The question across America was no longer *if* oil would be useful, but instead, where the hell to find more of it.

In the second half of the nineteenth century, Californians quickly joined the oil game by finding and establishing fields on land.[21] In 1897, the state produced approximately 2.5 million barrels of petroleum annually. By 1901, that number jumped to over fourteen million barrels, making California one of the leading producers in the country and the world. The state's oil fields and refineries spread out across multiple counties, including Ventura, Humboldt, Fresno, Los Angeles, Orange, Santa Barbara, Santa Clara, and Kern. According to estimates at the time, these counties supported close

---

[18] National Industrial Conference Board, *Oil Conservation and Fuel Oil Supply* (New York: National Industrial Conference Board, 1930), 28; Morgan Downey, *Oil 101* (n.p.: Wooden Table Press, 2009), 1-2.

[19] *Report of the Commission of Corporations on the Transportation of Petroleum,* Department of Commerce and Labor (Washington, DC: Government Printing Office, 1906), xx, xxiii; Downey, *Oil 101*, 4.

[20] *Proceedings of the Eleventh and Twelfth Annual Meetings of the Pacific Coast Gas Association* (San Francisco, CA: Althof and Bahls, July 21, 22, 23, 1903, and July 19, 20, 21, 1904), 95-96, 307; National Industrial Conference, *Oil Conservation and Fuel Oil Supply*, 28; Ralph Arnold, *Geology and Oil Resources of the Summerland District, Santa Barbara County, California*, United States Geological Survey, Department of the Interior (Washington: Government Printing Office, 1907), 12-13.

[21] Nancy Quam-Wickham, "'Cities Sacrificed on the Altar of Oil,' Popular Opposition to Oil Development in 1920s Los Angeles," *Environmental History* 3, no. 2 (1998): 191.

to three-thousand productive wells and forty oil refineries.[22] For the state's growing residential communities, drilling derricks were becoming a familiar eyesore within towns and across the countryside. By the time Williams founded the little town of Summerland, the state was already knee-deep in the fossil fuel industry—its economy, environment, and labor deeply connected with oil and gas.[23] What was totally foreign, however, was an oil industry that crept onto the beach.

Among the state's scientists and wildcatters, there was a growing suspicion that where oil was known to exist on land, it might also exist in the neighboring stretch of ocean floor. But by the late nineteenth century, not a single person or company had yet developed the technological know-how to draw oil and gas from the sea. A novel idea for white colonists, oil's presence in the seafloor was no big surprise for the Chumash people, who since time immemorial have claimed this region as their homeland. When Spanish settlers expanded into Southern California in the eighteenth century, the Chumash were living in large communities along the Santa Barbara channel, adjacent to the waters that provided them an array of resources. The Chumash used the asphalt seeps that appeared along the coastline to make pottery, arrows, plank canoes, baskets, and other items.[24] These traditions were displaced when the Spanish forced Chumash

---

[22] "Oil Field-California," Box no. 10, Collection No. 71, Series 1: Historical Photographs, American Petroleum Institute Photograph and Film Collection, National Museum of American History Archives, Smithsonian Institution, Washington, D.C.; *Proceedings of the Eleventh and Twelfth Annual Meetings,* 94, 305.

[23] See Sabin, *Crude Politics*; Sollen, *An Ocean of Oil.*

[24] A. Munns and L. Haslouer, "Phase 1 Archaeological Resources Report," Santa Barbara Museum of Natural History Master Plan, Santa Barbara, California, 2013; George Homans Eldridge, *The Asphalt and Bituminous Rock Deposits of the United States* (Washington: Government Printing Office, 1901), 209, 452; Sollen, *An Ocean of Oil*, 4-5.

communities into the confines of Franciscan missions. Subsequent occupations by Mexican and then American colonizers, including their foreign diseases, further reduced the Chumash's access to their homelands, ultimately forcing them onto a small reservation in 1901.[25] By the time Henry Williams purchased the lands adjacent to the Santa Barbara Channel in the late 1800s, multiple waves of settler colonialism had forcibly removed the Chumash from the Summerland area.

In the late 1800s, white Californians began to appreciate the marketable quantities of oil and gas that bubbled from cracks along the shoreline. The California State Mining Bureau dedicated their investigations to Santa Barbara County, where they noticed oil and gas spontaneously leaked from the sand.[26] In 1897, the Bureau reported, "It is also evident that…oil-yielding formations extend south in the ocean."[27] Without hesitation, but also without a sense of plan or consequence, state mineralogists and geologists openly

---

[25] "Our History," Santa Ynez Band of Chumash Indians, accessed February 1, 2023, https://www.santaynezchumash.org/chumash-history. For scholarship on the history of settler colonialism and the genocide of Indigenous people in California and the U.S. West, see Roxanne Dunbar-Ortiz, *An Indigenous Peoples' History of the United States* (Boston: Beacon Press, 2014); Weisiger, *Dreaming of Sheep in Navajo Country*; William J. Bauer Jr., *California through Native Eyes: Reclaiming History* (Seattle: University of Washington Press, 2016); Tara Aine Keegan, "Running the Redwood Empire: Indigeneity, Modernity, and a 480-Mile Footrace" (PhD diss., University of Oregon, 2021); John Ryan Fischer, *Cattle Colonialism: An Environmental History of the Conquest of California and Hawai'i* (Chapel Hill: University of North Carolina Press, 2015); Karl Jacoby, *Shadows at Dawn: A Borderlands Massacre and the Violence of History* (New York: The Penguin Press, 2008); Mark David Spence, *Dispossessing the Wilderness: Indian Removal and the Making of the National Parks* (New York: Oxford University Press, 1999); Pekka Hämäläinen, *The Comanche Empire* (New Haven, CT: Yale University Press, 2008); Ari Kelman, *A Misplaced Massacre: Struggling over the Memory of Sand Creek* (Cambridge: Harvard University Press, 2013); Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teaching of Plants* (Minneapolis: Milkweed Editions, 2013).

[26] R. F. Yerkes, H. C. Wagner, and K. A. Yenne, "Petroleum Development in the Santa Barbara Channel Region," in *Geology, Petroleum Development, and Seismicity of the Santa Barbara Channel Region, California*, Geological Survey Professional Paper 679 (Washington: United States Printing Office, 1969), 13-14; Ira Leifer, Ken Wilson, Robin Lewis, Randy Imai, and John Tarpley, "Oil Emissions from Nearshore and Onshore Summerland: Final Report," OSPR Technical Publication No. 07-001, State of California Department of Fish and Game Office of Spill Prevention and Response (April 2007), 1.

[27] W. L. Watts, *Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara Counties*, California State Mining Bureau Bulletin No. 11 (December, 1896), 54-55.

shared their vision of a seafloor filled with fossil fuels. Catching the oil bug, journalists joined in the excitement and painted a picture of a coastline practically bursting with crude. "Oil is evident everywhere," enthused the *Santa Barbara Morning Press*, "flowing on the surface in the creeks, seeping into sump holes, oozing out of the cliffs on the beach, and even found in little beads in the rocks as they are broken apart."[28] For any observer visiting the beach, it would be difficult to miss the black tar that seeped from the earth's pores. The same was true for natural gas, which escaped from the ground. One woman who grew up in Summerland in the 1890s remembered that kids would shove pipes into the dirt, light them with a match, and play ball by gas light into the night.[29]

Eyeing the ocean and seeing dollar signs, oil and gas seekers were buoyed by decades of technological innovation. By the 1890s, humans were doing things they couldn't have dreamed of just a few decades before: locomotives travelled between coasts and over mountain ranges; telegraph messages zoomed across the Atlantic Ocean in seconds; entire cities lit up with electric lights; and disembodied human voices traveled through telephone lines from city to city. Plus, drilling technology already existed for land—how hard could it be to drill into the seafloor? Despite the knowledge that oil and gas might exist in marketable quantities below the seabed, and despite the fact that a robust onshore industry already existed, what had not been done before—by oil entrepreneurs, state geologists, or any other person in North America—was to develop a system to retrieve it. That's where Henry Williams steps back in.

---

[28] "Where Oil Flows on Creek's Surface," [Santa Barbara] *Morning Press*, June 18, 1907.

[29] "A Surprised Community," *San Francisco Call*, March 10, 1895; May Lambert, *Growing Up with Summerland, 1874-1975* (Carpinteria Valley Historical Society, n.d.), 38.

Figure 2.3. John B. Treadwell's pier extends into the sea at Summerland, California. Treadwell abandoned the pier in the early 1900s, but his well casings persisted in the shoreline into the twenty-first century. Photo by Ralph Arnold, ca. 1906, United States Geological Survey, Denver Library Photographic Collection, Denver, Colorado.

The First Drilling Piers

When Williams began to pump oil from Summerland's beach, it was the little spark that ignited a colossal global industry, but he couldn't know that at the time. What was apparent to him in 1895, however, was that Summerland's shore had enough oil and gas to justify digging more wells. Williams's first well led to a second, and in just a matter of weeks, he was making swiss cheese out of Summerland's beach.[30] Others

[30] The first attempts to drill on the land that would later become Summerland likely started in the 1870s. Williams was aware that oil and gas existed below Summerland and reserved the right to use, profit from, or sell the town's mineral resources, see H. L. Williams to Lucy A. Wright et al., Deed, 1890, File: Spiritualist Association, Carpinteria Valley Museum of History, Carpinteria, California; H. L. Williams to Edward J. Balch et al., Deed, 1890, File: Spiritualist Association, Carpinteria Valley Museum of History, Carpinteria, California. Williams sunk two wells in the town in 1887 or 1888; see Arnold, *Geology and Oil Resources of the Summerland District*, 13, 16; "A Surprised Community: How Oil Was Found in Summerland," *San Francisco Call*, March 10, 1895.

joined. Using a drill powered by a small engine, one wildcatter established fifty wells, which ranged from one-hundred to two-hundred feet below (30-60m).[31] The region's newspapers, as always, were there to report on Summerland's industrial reach into the belly of the beach. "Most everybody in the civilized world has heard of Summerland," wrote the *San Francisco Call* at the outset of Summerland's oil boom.[32] Word spread that the little town was delivering oil, creating an "oil-boring fever" that "began to fire the veins of Summerland people, and even to agitate the citizens of Santa Barbara," reported the *San Francisco Call*. Even the town's children were "vigorously removing the top soil with fireshovels and rigging toy derricks."[33] Within months, other small-time oil seekers arrived and drilled holes next to Williams's, pockmarking the beach with drill pits, barrels, and pipes.[34] In 1897, two years after Williams's initial strike, entrepreneurs with more capital and expertise showed up in Summerland. They assumed correctly that the biggest pockets of oil and gas stretched deeper into the subtidal zone, but nobody had ever tried to reach those pockets. With simple tools and little capital, the wildcatters needed some method to mount the derricks out over the water, keeping it high and dry

---

[31] "Summerland Oil Strike," *San Francisco Call*, December 20, 1895.

[32] "A Surprised Community," *San Francisco Call*, March 10, 1895.

[33] Ibid.

[34] By 1895, Williams already had a few wells drilled on the beach, see Arnold, *Geology and Oil Resources of the Summerland District*, 16-17; "A Surprised Community," *San Francisco Call*, March 10, 1895; Alan Grosbard, "Treadwell Wharf in the Summerland, California, Oil Field: The First Sea Wells in Petroleum Exploration," in *Discoverers of the 20th Century: Perfecting the Search*, eds. Charles A. Sternbach, Marlan W. Downey, Gerald M. Friedman (Tulsa: American Association of Petroleum Geologists, 2005), 45; Watts, *Oil and Gas Yielding Formations*, 55; "Treadwell's Wharf," *Los Angeles Herald*, August 12, 1898; Myrick, "Summerland: The First Decade," 97.

while a drill and pipe extended down into the seabed. Their solution was the good old-fashioned pier, also called a wharf.[35]

John B. Treadwell, an engineer with ties to the Southern Pacific Railroad Company, was one of those wildcatters who followed the smell of oil to Summerland. Arriving in 1897, his team was the first to construct a long wharf from Summerland's beach into the sea. The wharf stretched a fifth of a mile into the water, no small feat in 1897 or today. Along the top of the wharf, Treadwell's team cut large square holes over which the derricks sat, leaving an opening for the drill to travel down to the seabed.[36] Each drill poked a new hole into the ground, or what they called a well. Treadwell's wharf had nineteen wells, at least.[37] Each well was comprised of a long metal pipe, called a casing, that connected the drilling rig apparatus above the water to the layers of crude below the seafloor. The casings stopped seawater and sand from invading the oil as it traveled to the surface. Treadwell's wharf-and-drill structure required little capital and little knowledge to build, lending itself to quick construction and replication. As one historian writing in a different context has observed, "On the beach, it took little capital to make capital."[38] The same held true for tideland drilling in Summerland. Treadwell

---

[35] In the 1890s and early 1900s, wildcatters and newspapers more commonly used the term "wharf" for the drilling structures. Nowadays, the term "pier" is more common. I employ both.

[36] Most wells reached approximately six-hundred feet (183 m) into the seabed, though some were shallower at five-hundred (152 m). See "Light Oil Has Been Found in the Summerland Field," *Los Angeles Herald*, September 8, 1901; "Summerland Oil Fields," *Los Angeles Herald,* July 21 1900; "Santa Barbara," *Los Angeles Herald*, August 30, 1900; "Treadwell's Wharf," *Los Angeles Herald,* August 12, 1898.

[37] "Debris Litters the Tide Lands," *San Francisco Call* 84, no. 74, August 13, 1898; Ira Leifer and Ken Wilson, "The Tidal Influence on Oil and Gas Emissions from an Abandoned Oil Well: Nearshore Summerland, California," *Marine Pollution Bulletin* 54 (2007): 1497.

[38] Bathsheba Demuth, *Floating Coast: An Environmental History of the Bering Strait* (New York: W. W. Norton, 2019), 208.

and company focused all of their efforts on getting the piers, drill bits, and casings into the seafloor as quickly as possible. They dedicated an opposite amount of energy to considering how they would ever remove those materials.

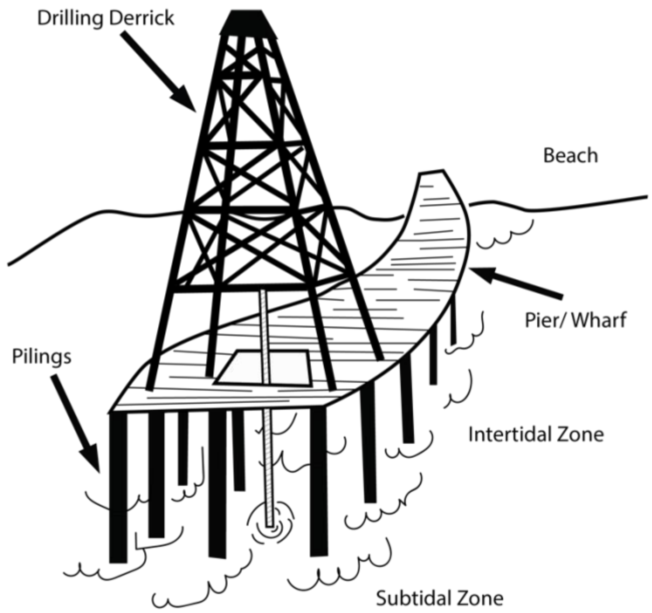


Figure 2.4. The basic configuration of a tideland drilling pier. Image by the author.

Treadwell's wharf wasn't alone for long. A host of new oil companies joined the Summerland hustle: the Seaside Oil Company, Sea Cliff Oil Company, the Sunset Oil Company, and the Marine Oil Company, to name a few.[39] By 1899, just a couple of years after Treadwell first constructed his long wharf and four years after Williams first found oil within the beach, Summerland had four new piers standing side-by-side, grasping for space in the intertidal zone. Just a year later, the number of piers grew to eleven and

[39] "Producers Combine in Summerland Field," *Santa Barbara Weekly Press*, January 9, 1908; "Santa Barbara," *Los Angeles Herald*, August 30, 1900.

counting, while the number of derricks measured in the hundreds. As the *Santa Barbara Weekly Press* succinctly described Summerland's oil boom, "Everybody worked overtime poking holes in the ground."[40] Considering the entire Summerland oil field spanned approximately two-hundred and thirty acres, Summerland's drilling companies crammed onto the beach.[41] But their jostle for space on the beach didn't matter, it was the reach into the ocean that counted most. The company with the longest wharf had the best chance of tapping the subterranean pool that dwelled in the seafloor furthest away from the beach.[42]

Covered in a new type of industrialization, the seashore was no longer a natural passageway between the land and sea, but instead an industrial site, valuable for the oil and gas it held within its depths. As historian Jack Davis has noted about this era's drilling piers, "It was both an eager and a timid reach"—eager because no other industry had ever stepped into the ocean to procure resources from its subterranean depths, yet timid because it relied on a simple wharf structure that the seafarers had long ago developed to moor ships.[43] Davis contends, "You can split hairs and say that putting a derrick over water close enough to swim or wade to land—two to ten times closer than your drill hole was deep…wasn't really offshore drilling. Except, these rigs on creeks and bays were the precursors to the far-flung rigs on the large sea. And they had some of the

[40] "Two Claimants for One Lot," *Santa Barbara Weekly Press*, January 9, 1908.

[41] "The Oil Wells of the Sea," *San Diego Union and Daily Bee*, March, 18 1908; "Wealth Streams from County's Oil Fields," [Santa Barbara] *Morning Press*, March 24, 1921.

[42] "Oil and Mining in this County," *Santa Barbara Weekly Press*, January 2, 1902.

[43] Davis, *The Gulf*, 276.

same taste, look, and feel."[44] A closer relative to docks than the mammoth platforms that dot the Santa Barbara Channel today, tideland oil drilling infrastructure still functioned as an important technological and cultural predecessor to the big offshore rigs.

Summerland's seafloor industry made for big news, but it produced less in the way of fossil fuels. The nearshore oil and gas field began to sputter out during the 1910s and 1920s, giving the wildcatters a choice to give up or expand the industry elsewhere.[45] They chose to expand. World War I was over, the nation's economy was growing, and Californians were committed to consuming more fossil fuels than ever before. One report for the California State Assembly found that in the years following World War I, California produced 30 to 35 percent of the country's crude oil and 20 to 25 percent of the world's. Spurred on by the high price for a barrel of crude, oil and gas companies began looking everywhere—including the ocean floor—for more fossil fuels.[46]

By the 1920s, Summerland's cottage industry had outgrown that section of seashore and boomed into a region-wide phenomenon. Towns up and down Southern California's coastline turned to their own shoreline for new sources of oil and gas. At Goleta, Carpentaria, Huntington, Long Beach, Isla Vista, Coal Oil Point, Venice Beach, Montalvo, Newport, Alamitos, Dos Pueblos, Montalvo, Newport, and Seal Beach,

[44] Davis, *The Gulf*, 278.

[45] There was active drilling at Summerland from the mid-1890s until 1940, with its peak around 1900-1910. In total, Summerland Field produced approximately three million barrels of oil, not a large amount by industry standards. See SLC, "Final Environmental Impact Report for the Becker Legacy Wells," ES-1.

[46] Richard Nehring, *Oil and Gas Supplies for California: Past and Future* (Santa Monica: Rand, 1975), 2.

companies prodded their coastal waters.[47] Newspapers relayed the search with excitement. The *San Francisco Call* reported that the seashore from Miramar to Rincon is "rich in oil." The article continued, "There is a mad rush to secure a strip of oil lands on the beach at almost every point between Miramar and Rincon. Everyone within a radius of six miles of Summerland who can afford to put down a well has either done so or is preparing to do so."[48] Thanks in part to the growing tideland drilling industry, the state produced over seventy-seven million barrels in 1910, which nearly quadrupled to over three-hundred million barrels by 1960.[49] The tideland drilling industry exploded onto the scene at the same historical moment that California's larger oil and gas industry became indispensable to the global economy. The state's population—and the industry's main consumers—was growing, too. By 1900, over 1.4 million people lived in California, many of them dwelling near the coastline.[50]

Ellwood Beach near the town of Goleta scored big for oil and gas seekers.[51] First developed in 1928, and just up the shoreline from Summerland, Ellwood was where oil and gas companies professionalized their approach to tideland drilling. Here, companies

---

[47] Sollen, *An Ocean of Oil*, 12-13, 15-18; "To Drill for Oil in Ocean at Redondo," *Los Angeles Herald*, June 12, 1908; "Will Prospect for Oil in Ocean Off Redondo," *Los Angeles Herald*, October 18, 1908; "Seeking Oil in the Ocean Bed in Monterey Region," *Santa Cruz News*, April 9, 1923; "Rincon Oil Strike," *San Francisco Call*, February 5, 1899; Huntington Beach had beach-side derricks and at least one pier; see "Oil Well at Huntington Beach," Security Pacific National Bank Photo Collection, TESSA Digital Collections of the Los Angeles Public Library.

[48] "Rincon Oil Strike," *San Francisco Call*, February 5, 1899.

[49] D. E. Ritzius, Susan F. Hodgson, William F. Guerard, Jr., E. R. Wilkinson, and Don Lande, *California Oil, Gas, and Geothermal Resources: An Introduction*, 5th edition (Sacramento: California Department of Conservation Division of Oil, Gas, and Geothermal Resources, 1993), 10, 12.

[50] Richard Orsi, *Sunset Limited: The Southern Pacific Railroad and the Development of the American West, 1850-1930* (University of California Press, 2005), 49.

[51] Contemporaries often spelled it "Elwood."

used sturdier materials to withstand the ocean's waves and sand.[52] By 1930, just two years after the first discovery of oil in Ellwood tidelands, oil production hit its highest level of annual production at nearly fifteen million barrels of oil, or about 6 percent of California's total output for the year. In a race against other companies, the Pacific Western Oil Company brought in twelve-to thirteen-thousand barrels a day. The Barnsdall Oil Company one-upped them by pulling in thirteen thousand barrels a day with a single well.[53] At its peak, Ellwood had thirteen drilling piers, each supporting multiple derricks and dozens of wellholes.[54] With that level of productivity, the tideland drilling industry cemented itself not only physically in the coastline, but also financially for the state's economy.

Oil and gas production not only delivered profits, but it also arrived with extra paraphernalia. A crowd of materials supported each field: pipelines, engine houses, storage tanks, onshore processing facilities, roads, trucks, and regular mooring docks for transporting shipments by boat.[55] In 1928, one company paid for the construction of a fifteen-hundred foot pier at the Ellwood Field, which, when working in conjunction with the Rio Grande Oil Company's seafloor pipeline, would facilitate tankers to transport oil to and from Southern California.[56] In 1929, the General Petroleum Corporation of

---

[52] Schaufele, "Erosion and Corrosion," 329.

[53] Sabin, *Crude Politics*, 61; 130; Wendy L. Bartlett, "Elwood Oil Field, Santa Barbara County, California," *AAPG Pacific Section* (1998), 220-221; Charles S. Jones, *From the Rio Grande to the Arctic: The Story of the Richfield Oil Corporation* (Norman: University of Oklahoma Press, 1972), 46, 50.

[54] "Platform Holly/Piers 421/Venoco Bankruptcy," California State Lands Commission, February 16, 2023, accessed February 19, 2023, https://www.slc.ca.gov/oil-and-gas/southellwood.

[55] "Summerland Oil Strike," *San Francisco Call*, December 20, 1895.

[56] "Local Firm Wins $20,000 Award to Build Pier," *San Pedro News Pilot*, December 6, 1928.

California laid a pipeline along the bed of the seafloor, too. Extending a half-mile from shore, the pipeline transported oil from ships to onshore storage tanks. The *Beaverton Review* reported that this submarine pipeline was "believed to be the only one of its kind on the North American continent"—apparently unaware of Ellwood's pipeline installed a year earlier.[57] The oil and gas materials, it seems, were accumulating on the seafloor faster than contemporaries could track. And everywhere there were holes: some for bringing oil and gas up, others for dropping waste and debris down into the seabed. The immediate effect was the seashore's increasingly industrialized appearance—a forest of metal that included wooden piers and the stench of crude. Oil derricks were so dense that people compared them to weeds, erected closely enough that "the legs of derricks interlocked."[58] Tideland drilling materials transformed a once-picturesque shoreline into a scene straight out of an Upton Sinclair novel. Tideland drillers and their spectators focused so much on the expansion of the industry that they never mentioned, nor even seemed to notice, the marine ecosystem the piers punctured. Marine life, however, responded to the new arrivals.

[57] "Service Conquers Ocean Hazard," *Beaverton Review*, August 30, 1929.

[58] "Oil Field- California" and "Oil Field – California – General –Moving Homes (1926)," Box No. 10, Collection No. 71, Series 1: Historical Photographs, American Petroleum Institute Photograph and Film Collection, National Museum of American History, Smithsonian Institution, Washington, D.C.; Quam-Wickham, "'Cities Sacrificed of the Altar of Oil,'" 192-193.

Life in the Intertidal Zone

The intertidal zone is an ecological borderland that belongs neither to the sea nor the land.[59] Twice a day, the tide swallows the shore and then spits it back out. Most organisms living here are adapted to survive in both air and saltwater. Scientists now refer to this space between low tide and high tide as the intertidal zone, a unique world in and of itself, where fauna abound. Of all the regions of the ocean, few are busier than the intertidal zone. A great majority of the ocean's organisms are drawn to the shore, flourishing because of the abundance of sunlight and nutrients.[60] On the opposite side of the beach, a similar magnetism occurs. Humans are drawn to the ocean's edge, reliant on its rich selection of resources, seafaring, and recreation. In the present day, approximately fifty percent of the globe's population resides within one-hundred miles (161 km) of the shoreline, a figure expected to grow to seventy-five percent by 2025. The rise in coastal populations marks a continuation in human history, rather than a change. Human societies have always flourished at the coastline, just like marine life.[61]

[59] Rachel Carson, *The Edge of the Sea* (Boston: Houghton Mifflin, 1955).

[60] John R. Gillis, *The Human Shore: Seacoasts in History* (University of Chicago Press, 2012), "Introduction"; Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography*, 12th edition (Boston, MA: Pearson, 2017), 305.

[61] John R. Gillis, "The Blue Humanities," *Humanities* 34 (May/June 2013), https://www.neh.gov/humanities/2013/mayjune/feature/the-blue-humanities; Helen Scales, *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat that Imperils It* (New York: Atlantic Monthly Press, 2021), xii. For other histories on the borderland between ocean and land, see Hayley Brazier and Mark Carey, "Boundaries of Place and Time at the Edge of the Polar Oceans," in *The Cambridge History of the Polar Regions*, eds. Adrian Howkins and Peder Roberts (Cambridge, UK: Cambridge University Press, 2023), 724-748.

Within the intertidal zone, marine species concentrate in thickest layers. We might classify them into three broad groups: those that hunker down, those that slink, and those that tunnel.[62] These groups compete for space and food, arranging themselves into a rainbow of horizontal lines in the act of doing so. Each line boasts a village of organisms that prefer to stick near their kind: at the top is the splash zone, full of sand flies, snails, and crabs—creatures that withstand dryness and need only minimal deliveries of seawater. Next, in the upper tidal zone, species have adapted to being fully submerged for one half of each day, including barnacles, sea stars, mussels, and limpets. Most of these organisms have a method for sealing in moisture when the tide departs. Third down is the lower tidal zone, where life truly begins to flourish with the double dose of seawater and sunshine. Here, lichens, sea stars, sea anemones, urchins, sponges, and algae blossom. Within each of these littoral zones, species have adapted to the tide's waves, winds, and predators.[63]

The last stop is the sublittoral or subtidal zone, an area always covered by seawater. Here, life is active, teaming, and colorful. The sunflower star shines with every shade of the sunset as it creeps along rocks. The California eel, with its shocking blue eyes, lurks low and suspicious. Brightest of all are the lime-green kelp plants that grow packed together as thriving forests. Kelp forests, like the great majority of the ocean's living things, flourish where the sun is brightest. Unlike plants whose roots branch into

---

[62] W. J. Tudor, *Structures in the Deep Ocean: Engineering Manual for Underwater Construction* (Port Hueneme, California: U.S. Naval Civil Engineering Laboratory, 1964), 2-42.

[63] Jeff Wheelwright, *Degrees of Disaster: Prince William Sound: How Nature Reels and Rebounds* (New Haven, CT: Yale University Press, 1994), 40; David Igler, "The Northeastern Pacific Basin: An Environmental Approach to Seascapes and Littoral Places," in *A Companion to American Environmental History*, ed. Douglas Cazaux Sackman (Hoboken, NJ: John Wiley and Sons, 2010): 586.

the ground, kelp is a type of algae that anchors hard to the seafloor's rocks. Kelp uses its gas-filled bladder to float from the ocean's bottom to the top. In good conditions, a single kelp can grow dozens of inches in a day—a remarkable pace for a seaweed.[64] Often visible just below the surface of the water, kelp forests are a "physical link between the surface and undersea worlds," as one scientist has described them.[65] The forests can grow in such thick stands that they calm the sea's surface, providing protection for maritime travelers in addition to marine life.[66]

In the underwater world of the Santa Barbara Channel, kelp forests provide habitat where habitat is scarce. Nearly eight hundred species come to California's kelp forests to dine, procreate, hide, and rest.[67] Both seasonal and permanent residents roam through kelp, most looking for protection from the dangers of the open water. All creatures, large and small, are welcome here: from seals and crustaceans to juvenile fish, which are just beginning their life cycle. Thanks to the warm seawater that flows in from the south and the cooler waters that arrive from the north, the kelp forests provide a smörgåsbord of chow for its year-round inhabitants and seasonal visitors. The forests are busy with animals darting left, right, and every which way. In their wake, marine life leaves a messy concoction of feces, body parts, sperm and eggs, broadcasted through the

---

[64] National Marine Sanctuaries, "Kelp Forests," National Oceanic and Atmospheric Association, accessed October 12, 2020, https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html.

[65] Nicole Near, "Appendix B: The Cultural Importance of Kelp for Pacific Northwest Tribes," *Puget Sound Kelp Conservation and Recovery Plan*, January 2020, p. B-1.

[66] Ricketts, *Between Pacific Tides*, 3-4.

[67] Todd Woody, "California's Critical Kelp Forests are Disappearing in a Warming World, Can They be Saved?" *National Geographic*, April 30, 2020, https://www.nationalgeographic.com/science/article/california-critical-kelp-forests-disappearing-warming-world-can-they-be-saved.

water column in an eternal flurry. Marine species may use every inch of the forests as habitat. Crabs clutch the kelp's center stipe and swing to the cadence of the water. Sea hares, a type of fat slug, slowly wonder through the stipes. "This protective feature is a characteristic of life among the kelp forests," wrote the American naturalist Ernest Ingersoll, "many animals simulating [the kelp] so perfectly in color that the best-trained eyes often fail to observe them."[68] Even gray whales travel to the kelp forests to find refuge for their calves. At the base of the kelp lurk abalone, the brilliantly designed sea snail famous in California's waters for its pearly shell. It spends its time living on the rocks that surround the base of the kelp, making kelp and abalone companion species. Where the abalone are big and numerous, the kelp are also big and numerous.[69]

But the kelp cannot protect every little thing. Death lurks here, too, for predators know of the riches that await them hidden between the green appendages, the "usual concomitants of life in a crowded environment," wrote marine biologist Ed Ricketts.[70] The daily burden of life in the subtidal zone—aggressive competitors, voracious sea stars, and heavy interlopers—does not necessarily prompt individuals to move onto deeper regions of the seafloor. Despite the difficulties and dangers of the tidal and subtidal zone, marine life thrives here and survives where other species could not.[71]

---

[68] Ernest Ingersoll, *The Book of the Ocean* (New York: Century, 1898), 257.

[69] In the twenty-first century, a majority of the abalone and kelp forests are dead and gone, victims of a warming ocean, an expansion of their predator the purple sea urchin, and toxic chemicals entering the ocean. See Woody, "California's Critical Kelp Forests."

[70] Ricketts et al., *Between Pacific Tides*, 356; National Marine Sanctuaries, "Kelp Forests," National Oceanic and Atmospheric Association, accessed October 12, 2020, https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html; SLC, "Final Environmental Impact Report for the Becker Legacy Wells," 11-29; Channel Islands National Park, "Kelp Forests," National Park Service, accessed October, 24 2020, https://www.nps.gov/chis/learn/nature/kelp-forests.

[71] New evidence shows that sessile species may tolerate extreme temperatures thanks to heat shock proteins. See Michael Allen, "How Will Creatures that Can Barely Move Handle Climate Change?" *Hakai*

Figure 2.5. In the Santa Barbara Channel, a Garibaldi fish swims near kelp, sea urchins, and a sea star, which are anchored to the rocks. Between the 1890s and 1940s, drilling piers entered an environment where organisms colonize hard substrate. Photo courtesy of Antonio Busiello.

At any place where the vivid green kelp swayed just under the surface, tideland drillers could be sure their wharf pilings and drill bits would encounter a rockier sea bottom, the primary base from which kelp grows. The piling drivers and subsequent drill bits would need to crunch through numerous layers of rock—shale, mudstone, or phosphorite—before encountering a pocket of fossil fuels.[72] In the 1890s and early 1900s,

Magazine, February 15, 2023, https://hakaimagazine.com/news/how-will-creatures-that-can-barely-move-handle-climate-change/.

[72] Kenneth Orris Emery, *The Sea off Southern California; A Modern Habitat of Petroleum* (New York: Wiley, 1960), 16. Channel Islands National Park, "Kelp Forests."

at a time when wood was a relatively plentiful and inexpensive, oil and gas drillers used wooden pilings to hold up their piers. Operators derived wood from a range of trees, such as Oregon pine or eucalyptus. Interesting, the golden-colored lumber meant to spend its long life in the woods of the Pacific Northwest sank down into an entirely different type of forest. At increasingly fast rates, the country's conventional building materials made their way into the ocean bottom—a meeting of the familiar and the foreign.[73]

Drilling piers stood out like a sore thumb: static objects in an ecosystem always busy and changing. But the stark differences between the two—one hard and unmovable, the other always growing and dying—did not necessarily equate to incompatibility. Instead, the piers entered an environment where marine life already knew how to adapt to daily disturbances including harsh storms, naturally-occurring oil seeps, competition for space, fishing gear, and predators. Rachel Carson described this subtidal zone as "a place of compromise and conflict and eternal change."[74] The longer piers not only entered the kelp forests, but they also began to perform a function similar to the kelp. Boasting a large area of uncolonized hard surfaces, the structures attracted marine life. The alternative to not finding a spot—free floating in the water column, being tossed in the

---

[73] Summerland had a lumber yard that supplied lumber to the industry. "Southern Santa Barbara County and its Resources: Souvenir Edition," *Summerland Advanced Courier* (February 1900), Carpinteria Valley Museum of History, Carpinteria, California; "Tug Starts North with Piling in Tow," *San Pedro News Pilot*, September 19, 1930; H. J. Schaufele, "Erosion and Corrosion on Marine Structures, Elwood, California," *Proceedings of Conference on Coastal Engineering* 1 (n.d.): 329; "At Summerland," *Los Angeles Herald*, October 18, 1900. On perceptions of the ocean as an alien form, see Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Berkeley: University of California Press, 2009), xi, 9. Using wood, the drillers risked the unwanted arrival of shipworms, a marine pest that bores deep into any wood that dares enter their ocean. As the termite of the sea, a plague of shipworms can make pudding of a solid wooden pier in a matter of months. Rachel Carson pointed out that "This absolute dependence of a sea creature on something derived from the continents seems strange and incongruous." See Rachel Carson, *The Edge of the Sea* (Boston: Houghton Mifflin, 1955), 185, 186; Ricketts, *Between Pacific Tides*, 359; Emery, *The Sea off Southern California*, 16.

[74] Carson, *Edge of the Sea*, vii.

waves or strewn on the beach—means a much higher risk of death. In this environment, a wood piling provides a rare blessing. The pilings on piers, docks, and other mooring structured have hosted such a dense body of organisms that when marine biologist Ed Rickett's wrote his now-famous study, *Between Pacific Tides*, he classified their pilings as a unique type of habitat alongside estuaries, bays, protected outer coasts, and open coasts.[75] Said differently, pilings and marine life made a good match.

Colonization looks chaotic to humans, but there is order to its madness. Species organize themselves into distinct sections up and down the pilings, which replicate the horizontal groupings of the intertidal zone. The water's depths and nearness to predators typically determines where an organism establishes its homestead: some species seek fulltime moisture, while others prefer being wet just part of each day. Those wanting a dryer and safer experience, such as the littleneck clam, anchor to the higher surface areas.[76] The clam competes for space with another type of mollusk, the mussel. Both creatures rely on their hard shells to hide from the predators that step and walk all over their exteriors. When the tide recedes and leaves their little bodies exposed to the dry air, the shells perform a second duty of sealing in moisture. Lingering just below them are barnacles, which cohabitate alongside California mussels. Of the softer variety is the hydroid, which is plant-like in its appearance and hangs around the upper parts of the pilings. Hydroids are a type of double colonizer, growing directly on the backs of the barnacles and mussels, which in turn grow on the pilings. And everyone benefits from an

[75] Ricketts et al., *Between Pacific Tides*, 5.

[76] Stanley D. Rice, Jeffrey W. Short, Mark G. Carls, Adam Moles, Robert B. Spies, "The *Exxon Valdez* Oil Spill," in *Long-Term Ecological Change in the Northern Gulf of Alaska*, ed. Robert B. Spies (Amsterdam: Elsevier, 2007), 465-466.

empty barnacle shell: porcelain crabs, sea spiders, and the moss-like *Alcyonidium mytili* find protection within each empty casing.[77] When it comes to pilings, creatures colonize any available surface. Plastered three-and-four deep, however, marine species living on the drilling piers care little if the wood came from Oregon or Washington, if the metal was galvanized or untreated, or if sufficient oil flows from the seafloor through the metal casings.[78] Substrate is substrate.

On the portion of the piling that is wettest and closest to the seafloor, more species crowd in. Rock crabs and shrimp crawl up and down, carefully avoiding the swaying tentacles of the brown, warty sea anemone. There is playfulness, too: the pink pom-pom hydroid found at the top also grows down at the bottom, where it dances like a flower in the swirling water.[79] The stalked tunicate, hefty and strong, chooses a space on the lowest part of a piling. Onlookers often describe the tunicate as a mixture of chunky, meaty, warty, fleshy, and round. On pilings, they grow in such thick clusters that they completely obscure the substrate below. Using their mucus to feed, they trap small bits of food floating in the water. Here again, the wharf's colonizers get colonized: sea anemones, hydroids, and fellow tunicates attach to the initial tunicate, using it as their base as they proceed to grow outwards into the water, all the better to catch a meal from the constant swirl of marine detritus.[80] Kelp, lichen, and turf algae spread at the rocky bottom. Young kelp crabs scurry around the seafloor, preferring to eat kelp when it's

---

[77] Ricketts, *Between Pacific Tides*, 348-350.

[78] Dolly Jørgensen, "An Oasis In a Watery Desert? Discourses on an Industrial Ecosystem in the Gulf of Mexico Rigs-to-Reefs Program," *History and Technology* 25, no. 4 (December 2009): 343.

[79] Carson, *Edge of the Sea*, 106.

[80] Ricketts, *Between Pacific Tides*, 183, 350-356, 370.

available and switching to hydroids or shellfish if they must. Algae grows in every crack and crevice, turning brown wood green. Fish, eels, sea lions, sea otters, jelly fish, and mammals, drawn into the bustling food web, drift between the wooden legs.[81] At every single location where wood, metal, pier, or pipe meet seafloor, marine organisms of every shape and color are sure to follow.

Up and down the pilings, neighbors eat neighbors. The despotic sea star rules the wharf and intertidal zone. Its favorite meal is the clusters of immobile mussels, which have little option but to live at high tide to avoid the sea star's range. If they colonize a portion of a pier that's too low in the water, the mussel's only recourse is to remain tightly closed as the sea star passes. But if a sea star should happen to choose a mussel, however, the star will work for hours to open its tightly closed shell. Once exposed, the sea star drops its stomach into the mussel's shell and eats the little animal inside. Other more mobile species, like the limpet and abalone, notoriously flee from the approaching sea star. Even the sea star's closest relatives—other sea stars—may fall prey to this hungry echinoderm. The one organism the sea star does not bother to touch is the anemone, all gooey and algae-green.[82]

Predators come from above, too, to feed around the colonized surfaces. Gulls, cormorants, and pelicans swirl around the top of each pier, delivering feathers of greens, reds, browns, and yellows against the drab colors of the oil barrels and drills.[83] The birds

---

[81] "Our New Docks," Exhibit Panel Text, Charleston Marine Science Center, Charleston, Oregon, visited June 11, 2022; "Coastal Hazards and Legacy Oil and Gas Wells Removal and Remediation Program: Progress Report," California State Lands Commission, 9; Ricketts, *Between Pacific Tides*, 357.

[82] Genny Anderson, "The Mid Tide Zone"; "Annual Report," Scripps Institution of Oceanography (La Jolla: University of California, San Diego, 1967), 15.

[83] Channel Islands National Park, "Seabirds and Shorebirds," United States National Park Service, accessed October 10, 2020, https://www.nps.gov/chis/learn/nature/seabirds.html.

treat the decks as a resting and nesting site, dropping their characteristics dollops of white nitrogenous poop across every available surface.

Within months of entering the ocean, then, piers began to serve a dual purpose: oil and gas production on the one hand, and habitat on the other. Enveloped in poop and algae, eggs and sperm, seafloor technologies took on a biotic afterlife as part machine, part ecosystem. After months and then years spent in the ocean, worn down by sand and waves and plastered thick with organisms, Southern California's drilling piers took on a hybrid identity—both alien from humans and familiar to them.[84]

Oil and gas drillers never intended for their piers to mesh with the complex ecology of the intertidal world, but it was not an unexpected outcome. Marine life routinely clings to any part of a boat, dock, buoy, or pier that touches seawater. At times, however, oil and gas drillers did take umbrage at the "organic growth" on their wharves, as one oil and gas engineer described it in the 1940s. Fearing that marine life would cause erosion and corrosion and undermine the structural integrity of the pilings, companies sometimes sent divers into the water, tools in hand, to manually scrape marine life off the wood and metal. Any life at the mercy of the scraping tools died instantly. Not all companies scraped their wharves, though. This practice was more common at bountiful tideland oilfields that were proving to last longer than a few years, including oil field at Ellwood Field north of Santa Barbara. There, companies took extra measures to extend the life of the wharves.[85] In due time, however, organisms would begin to re-colonize the open surfaces of the pilings, again transforming the structure into an artificial reef.

---

[84] Helmreich, *Alien Ocean,* 9.

[85] Schaufele, "Erosion and Corrosion," 329.

Considering the fact that oil and gas companies typically abandoned their wharves in the ocean once the oil stopped flowing, then marine life would eventually have the final say in the matter.

As Summerland's tideland drilling experiment expanded to the north and south, enveloping beach after beach, there was one response less expected, and less welcome for oil and gas drillers. Unlike marine life, the Californians on the coastline rejected the drilling piers. Promoting a distinct vision of how the coastline should appear—free of clutter, recreation-ready, and pristine—California's communities fought the oil and gas industry's arrival to their beaches.

Protect the Beaches!

Californians initially regarded the industry's drilling wharves as a tourist spectacle. Between the 1890s and 1910s, visitors traveled from far and wide to gawk at Summerland's peculiar drilling wharves that stretched from the beach into the sea. The *San Francisco Call* called it "one of the most novel sights along the Pacific coast," a sentiment many other national and state publications shared.[86] The *Los Angeles Herald* noted the many tourists who made their way to Summerland to "wonder at its unique wharves and the wells sunk through the Summerland bay."[87] Others, however, expressed

[86] "Oil Wells in the Sea Form Novel Sight," *San Francisco Call*, November 24, 1907.

[87] "Big Contract Missed," *Los Angeles Herald*, March 29, 1903.

a more critical view. Observing from a distance, one onlooker used the words "gaunt" and "skeleton" to describe the piers.[88] Communities along the Santa Barbara Channel expressed worries that the "unsightly oil derricks" at Summerland might spread to Santa Barbara where it would defile the "beautiful resident sites" and decrease their resale value.[89] These early critics, often lamenting the loss of a pristine beach, signaled the bigger controversy to come.

Oil operators went where they could find oil, which included rural areas, busy towns, and popular swimming beaches. In Carpinteria, a town located five miles (eight km) down the coast from Summerland, the citizens fought the arrival of one oil and gas company. The Continental Oil Company built one derrick along Carpinteria's shoreline but decided in the 1930s to remove it, likely due to the town's stark opposition. The derrick's biggest offence to the townsfolk was the bigger industry it represented, which threatened nearby real estate values. One newspaper reported that some "prospective purchasers of homesites would not buy because of the possibility of oil development here."[90] Having successfully forced Continental Oil Company from its shoreline, Carpinteria's citizens celebrated the "struggle that was made to save our waterfront from spoliation." At the heart of battles against tideland oil drilling was not a singular dislike of industrial development in general, but instead a dislike of industrial development along their beach.

---

[88] "The Oil Wells of the Sea," *San Diego Union and Daily Bee*, March 18, 1908; "Oil Wells in the Sea Form Novel Sight," *San Francisco Call*, November 24, 1907.

[89] "Railway Scheme to Seize Land," *San Francisco Call*, February 14, 1899.

[90] "Puzzling Oil Situation Seems Near Solution," *Carpinteria Herald*, July 18, 1930, File: Oil, Early Development, Carpinteria Valley Museum of History, Carpinteria, California.

Whether they knew it or not, Californians idealized an unfettered shoreline thanks, in part, to a recent cultural renaissance that celebrated a return to the sea. "Before the nineteenth century," writes historian John Gillis, "attitudes toward the oceans were more utilitarian than aesthetic."[91] That all began to change in the 1800s, when Americans and Europeans rediscovered the beauty of the shore, shedding their previous opinion that the ocean was an unpossessable environment that lacked civilization. Upper and middle-class Europeans and North Americans pursued a return to the seaside, a renaissance in coastal art and leisure. It's this return to the shoreline where many blue humanities scholars have concentrated their research. Historians such as Alain Corbin, John R. Gillis, and John Mack have shown that in the eighteenth and nineteenth centuries, Europeans and Americans did an about-face: they quickly developed a newfound affection for the sea, a place that had been previously designated as a dangerous, working-class environment.[92] Their celebration of the seaside uprooted a centuries-old Judeo-Christian belief that the wild ocean was no place for Christians. After all, the Christian god is a gardener, not a sailor.

By the time the tideland drilling industry was booming along Southern California's coastline, however, Americans had established the seaside as a place of retreat from urban areas, an environment at which to pursue natural history, exercise, and relaxation. By this point, the shoreline was as much a Godly place as the garden. "Today at this very moment," the *Palos Verdes Peninsula News* warned, "the power of oil is

---

[91] Gillis, "The Blue Humanities."

[92] John R. Gillis, *The Human Shore*: *Seacoasts in History* (University of Chicago Press, 2012) 1, 9-10, 99. See also Alain Corbin, *The Lure of the Sea: The Discovery of the Seaside in the Western World 1750-1840*, trans. by Jocelyn Phelps (London: Penguin Books, 1995); John Mack, *The Sea: A Cultural History* (London: Reaktion Books, 2011).

threatening to desecrate God's gift to men—the beautiful ocean landscape of the Pacific."[93] Carpentaria's citizens fought the oil and gas industry at its shore because it was the one environment that promised to heal them in a way that their terrestrial surroundings could not. Tideland oil derricks were ruining what the American populace had just recently learned to love.[94]

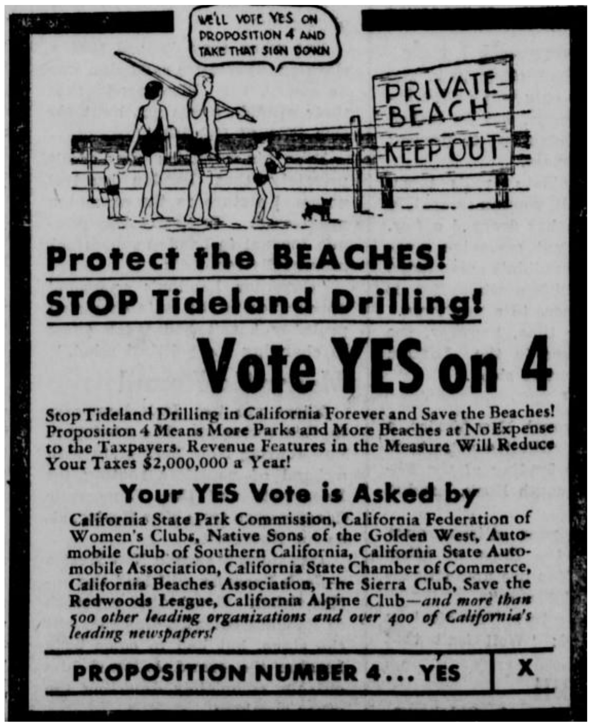


Figure 2.6. In the 1920s and 1930s, Californians rallied against the expansion of tideland oil drilling. *Madera Tribune*, November 1, 1936, California Digital Newspaper Collection, Center for Bibliographic Studies and Research, University of California, Riverside.

---

[93] "Oil Drilling Danger Looms for Palos Verdes Tideland," *Palos Verdes Peninsula News*, September 9, 1954.

[94] For other coastal histories, see Isaac Land, "Tidal Waves: The New Coastal History," *Journal of Social History* (Spring 2007): 731-743; Robert Ritchie, *The Lure of the Beach: A Global History* (Oakland: University of California Press, 2021); Christopher L. Pastore. *Between Land and Sea: The Atlantic Coast and the Transformation of New England* (Cambridge, MA: Harvard University Press, 2014); David Worthington ed., *The New Coastal History: Cultural and Environmental Perspectives from Scotland and Beyond* (Cham, Switzerland: Palgrave Macmillan, 2017).

Beautiful as the ocean landscape was to Californians, it did come with some natural annoyances. First was its stench. “The smell of low tide,” wrote Rachel Carson, “compounded of the faint, pervasive smell of worms and snails and jellyfish and crabs—the Sulphur smell of sponge, the iodine smell of rockweed, and the salt smell of the rime that glitters on the sun-dried rocks”—odors that bothered some coastal visitors.[95] Other beachgoers had accepted, even come to love, the familiar smells of iodine and sulfur that characterized the seaside. There was also the problem of ordinary marine debris, usually comprised of a mixture of rotting seaweeds and broken shells and crab parts. One newspaper complained about the flies that naturally congregated around piles of kelp. “With all the hue and cry to save the beach why allow rotten kelp, breeding millions of flies, to cover our most important beach and impress our summer guests unfavorably by the sight and smell?” the newspaper demanded.[96] If rotting kelp was bad enough, it was unlikely that this same public would accept the stench of crude as it dripped from wharves and floated on the surface of the water. Like rotten eggs roasting under a hot sun, crude could overpower even the fishiest smelling beach. One oil well at Venice Beach besmeared the shore to such a degree that a member of neighboring Huntington Beach’s Chamber of Commerce protested the “perversion of beach areas” and feared for the fate of his own city.[97] Even the Playground Commission of Los Angeles lamented Venice’s beach was forever “ruined.”[98]

---

[95] Carson, *Edge of the Sea*, 41.

[96] Untitled, *Coronado Eagle and Journal*, July 17, 1929.

[97] “Tideland Grant to the City of Huntington Beach,” California Proposition 11 (1932). http://repository.uchastings.edu/ca_ballot_props/291.

[98] “Bathing Beaches Hit by Borers for Oil,” *Santa Cruz News*, October 8, 1930.

By the late 1920s, anti-drilling groups were forming almost as quickly as the derricks were going up.[99] *Protect the Beaches!* and *Save the Beaches!* were the rallying calls for a newly awoken citizenry who argued that the bed of seashore was a common good and should be part of the public domain.[100] Up and down the Southern California coastline, community groups threw their weight behind beach protection measures. "'More than 100 civic bodies, commercial organizations and women's clubs have joined in the fight,'" explained Ole Hanson, president of the Save the Beaches League.[101] From the Sierra Club and Automobile Club of Southern California to the National City Matrons to the Los Angeles Realty Board, a spectrum of civil groups banded together to protect California's beaches from further drilling infrastructure.[102] Together, they blamed the oil industry and its workers for making an unethical decision to soil the region's beaches in exchange for profits. In their campaign, they asked communities to support politicians and measures that would ban tideland drilling.[103]

Tideland drilling smelled bad and looked even worse, but its biggest offense for campaigners was that is restricted their access to the beach. Newspapers presented the problem as a fight against two ways of using one stretch of beach: recreation or oil drilling. The two couldn't be expected to share the same space. If the oil industry won

---

[99] "'Save the Beaches,'" *San Pedro News Pilot*, October 19, 1928; For a history of diseased environments in California, see Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2007).

[100] "Oil Drillers and Tidelands," *Organized Labor*, February 11, 1928; "'Save Our Beaches' Motto at Meeting," *Mill Valley Record*, March 12, 1937.

[101] "Save Beaches League Would Defeat No. 11," *Coronado Eagle and Journal*, October 23, 1932; "Vote Yes on Proposition 4," *Calexico Chronicle*, October 30, 1936.

[102] "Protect the Beaches," *Blade Tribune*, January 31, 1924

[103] "Protecting the Beaches," *San Pedro News Pilot*, January 28, 1930.

out, then the beach would never be the same again. "Venice oil men will be ready to admit later on that the despoliation of that once popular bathing strand was not justified by the returns," one Long Beach newspaper opined in 1930. "Crowds that line every available bit of [Venice Beach] during the summer days," it went on, "eloquently prove the need for conserving the natural playgrounds for the people's use."[104] Recreation and tourism were key arguments wielded against the industry. The shore had become a place of both culture and recreation. "With their children in sailor suits, middle-class parents began to colonize the shore for fun as well as health," writes historian John R. Gillis.[105] Tideland drilling infrastructure played no part in the public's idealization of the shore as a place of recreation, beauty, and leisure.

Though an eyesore, and despite the public campaign to shut them down, an industrialized beach was often profitable for both the drilling companies and the adjacent community. As crude flowed from the ocean into cars, railroads, and factories on land, so too did revenue. Royalties from oil drilling paid for multiple buildings within Huntington Beach, including a newly constructed city hall and civic center.[106] Thanks to the new source of income, Huntington's mayor pronounced, "There is a place for everything, including pleasure, residence, business, industry and oil. The Huntington Beach ocean front is the best place for two of these things—pleasure and oil."[107] Huntington Beach's visitors were sandwiched in by the Pacific Ocean to the west and Standard Oil's towering

---

[104] "Bathing Beaches Hit by Borers for Oil," *Santa Cruz News* 46, no. 137, October 8, 1930.

[105] Gillis, "The Blue Humanities."

[106] "We Surrender to Huntington Beach," [Huntington Beach] *The Sun*, August 9, 1935.

[107] "That Tideland Drilling," *La Habra Star*, October 28, 1932.

derricks to the east. Stretching out along the sand, a beachgoer could touch the cool seawater with their toes on one side and feel the heat rebound from the oil derricks on the other. Huntington Beach was California's coastal problem in a nutshell: a paradise for both the oil man and the leisure-seeker. For those oil and gas supporters like Huntington's mayor, the beach could host both leisure and mining, sand crabs and pipelines, kelp and metal casings, brine and sulfur.[108]

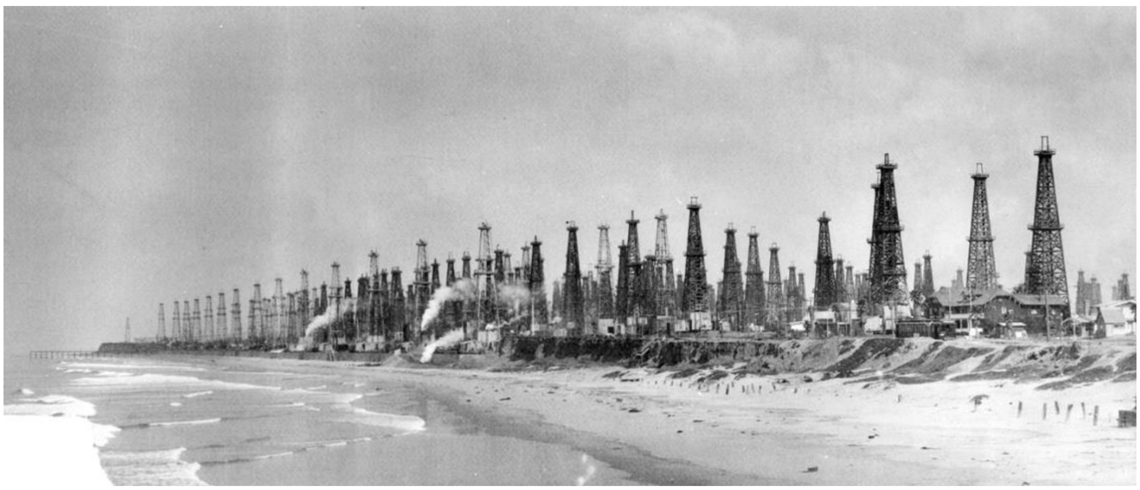


Figure 2.7. At Huntington Beach, oil and gas companies erected derricks near the beach to tap the subterranean pools of fossil fuels located under California's shoreline, 1926. Photo courtesy Orange County Archives.

An oiled seashore stinking of rotten eggs seemed a fair exchange for the money, energy, and jobs that accompanied the industry. At Rincon, the Ventura Oil Workers' Union No. 120 joined the local chamber of commerce to argue in favor of drilling on the seashore. For them, the beach was not valuable for its picturesque views, but for its jobs. In 1928, for example, the union estimated that around one-thousand people were currently digging wells at the Rincon field alone. Men who may have never labored or recreated at sea were now working with black tar sticking to their boots, balancing on tall

[108] For a history of machines entering idyllic environments, see Marx, *Machine in the Garden*, 226.

wooden beams to avoid the incoming tide, and feeling the sea breeze on their skin. The union argued that the floor of the seashore, like land, was a viable place for labor, industry, and profit. It would be wrong, they argued, for the state to deny workers the right to make a living there in favor of recreators.[109]

Coastlines are contested spaces. Historian William Cronon noted, "coastlines are especially revealing places to think about the arbitrary boundaries of labor and leisure that people impose on the natural world."[110] Connie Chiang similarly demonstrates that point in *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast*, in which she tracks the growth of tourism in Monterey. There, tourists helped to shape the view that Monterey's fisheries were bad, dirty, and pollutive, just as beach-goers in Southern California perceived coastal drilling as bad, dirty, and pollutive. The two types of industries—recreation and labor—often existed at the same locations at the ocean's edge, fighting for space and the right to define how the coast should be used. As Chiang points out, "Because these enterprises sought to transform the same stretch of sand and sea, they often struggled for dominance."[111] Neither side, however, seemed especially worried about the lobsters, garibaldis, sea otters, urchins, whales, or kelp who made their home underneath the water—although environmental health did become a bigger point of

[109] "Oil Drillers and Tidelands," *Organized Labor*, February 11, 1928.

[110] William Cronon, "Foreword: On the Shore Between Work and Play," in Connie Y. Chiang, *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast* (Seattle: University of Washington Press, 2008), xi.

[111] Chiang, *Shaping the Shoreline*, 6.

contention in the decades to follow. Instead, a century ago, the health of marine life mattered less. Theirs was a fight over aesthetics, recreation, and money.[112]

Families who labored at the piers benefitted from the source of work and income. One Summerland resident, May Lambert, grew up in the town and witnessed the growth of the oilfield. Lambert knew that other Californians purposefully drove country roads to avoid passing through Summerland. Despite the town's grimy beachfront and pungent smell, "the money was pouring in," she reckoned.[113] Tideland oil and gas laborers may have shared less romanticism for a picturesque seaside than the naturalists, explorers, and residents who so ardently fought against its industrialization. Early in Summerland's oil boom, one newspaper reported that "The Summerland aristocrat wears a tarry jumper and is besmeared with oil from head to foot."[114] The industry smelled and looked unsightly, but for any oil seeker or working-class family whose income depended on the derricks, the seashore was not singularly a thing of beauty—although it could be that, too—but was primarily a place of production. For someone like May Lambert or the "Summerland aristocrat," industry, labor, and beauty coexisted along one stretch of beach.

Tideland drilling could be as dangerous for those who lived and worked near the industry. Oil pooled at the base of the derricks, draining into the seawater and smearing tarry black globs and mousse across the beach. Far more hazardous was the delicate task of pumping, storing, and moving oil through a series of pipes and tanks. As a flammable

---

[112] For further reading on public perceptions about the ocean in the earth twentieth century, see Ann Elias, *Coral Empire: Underwater Oceans, Colonial Tropics, Visual Modernity* (Durham: Duke University Press, 2019), 4. See also Booker, *Down by the Bay*.

[113] Lambert, *Growing Up with Summerland.* 31.

[114] "A Surprised Community," *San Francisco Call*, March 10, 1895.

substance, oil presented a constant risk of catching fire or exploding. In 1899, for example, one of S. W. Knapp's oil derricks in Summerland struck a gas deposit, causing an explosion that threw debris and chunks of land hundreds of feet into the air.[115] In 1921, a truck carrying oil caught fire, causing the Seaside Oil Company's surrounding storage tanks, powerhouse, pier, and additional buildings to burn. Because of Seaside Oil Company's close proximity to the residential portions of Summerland, the burn "threatened the whole town."[116] Three years later, the Seaside Oil Company again experienced a life-threatening explosion and fire. Seemingly from nowhere, two booms "rocked" the company's laboratory and shook the town. The subsequent fire burned the laboratory building to the ground.[117] Tideland drilling made the seashore hazardous in a way that differed from the traditional threats people faced when they ventured into the ocean.

Considering its dangers, smells, and greasy debris, tideland oil and gas drilling was a political tripwire. A well-known state senator, William Knowland, once mused, "Whenever we get into subjects like tideland oil drilling, horse racing or liquor, I want to look at the bills two or three times before acting."[118] Mustering more humor about the topic than many of his peers, Knowland hit on something important: drilling into the seafloor was a sore point that roused public and political emotions to a fever pitch. But unlike those other vices of drinking and gambling, Californians were not seeking to

---

115 "Another Gusher," *Morning Press*, February 3, 1899; Quam-Wickham, "'Cities Sacrificed of the Altar of Oil,'" 192-193.

116 "20,000 Loss in Summerland," *Morning Press*, January 8, 1921.

117 "Big Oil Blaze At Summerland," *Madera Tribune*, January 23, 1924.

118 George Helmer, "Politically Speaking," *Calexico Chronicle*, April 1, 1937.

totally restrict access to the seafloor. It was the opposite problem: everyone wanted a piece. The seabed's industrialization pushed the seafloor onto the center stage of both Californian and national politics. There, politicians battled over which groups had the right to access—and alter—the seashore and its subterranean resources.[119]

What started as a novel, curious industry in the late 1890s had, by the early 1930s, developed into an all-out legal and political brawl for the coastal seafloor. Paul Sabin's *Crude Politics: The California Oil Market, 1900-1940s* details the political struggle between coastal oil and gas companies and the Californian public. As Sabin notes, one key question at the heart of the fight to save the beach was "Where did coastal 'tidelands' begin, and who owned them?" More specifically, who had the right to lease the tidelands to oil and gas drillers—the State of California or the federal government? Californians hoped for state control, not only because profits would benefit the local region, but also because they might wield more regulations over where and when drilling infrastructure wrecked their beaches. Ultimately, multiple court cases and federal acts in the 1940s and 1950s determined that the state owned three nautical miles (5.5 km) of the seafloor, beginning at the high tide mark and extending into the sea. The federal government got the rest.[120]

Revenue mattered to the state, as well to private oil and gas companies. Although the state often had a contentious relationship with seashore oil drilling within its three nautical miles (5.5 km)—sometimes blocking drilling permits—it could not help but

---

[119] See Nancy Langston, *Forest Dreams, Forest Nightmares: The Paradox of Old Growth in the Inland West* (Seattle: University of Washington Press, 1995) and Samuel Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920* (Harvard University Press, 1959).

[120] Sabin, *Crude Politics*, 54-55.

notice the opportunity to make money from the nascent seafloor industry.[121] By the end of the 1920s, California was one of the largest oil-producing states in the nation. Oil fields on land produced the majority of that oil, but tideland piers contributed, too.[122] In 1930, one newspaper reported that California pocketed $50,000 in one month by collecting royalties from fifty-three wells pumping oil from the state-controlled tidelands, much of that seafloor oil coming from Ellwood.[123] The profit justified the industry's continued presence in the shoreline.

While many Californians disliked the drilling piers, they still relied on the oil the industry provided, revealing a disconnect between production and consumption. By 1930, Californians belonged to a country that consumed roughly 60 percent of the world's supply of fuel oil and almost all the natural gas, according to the National Industrial Conference Board.[124] Writing of California in the mid-twentieth century, but no less true of the 1920s and 1930s, literary scholar Stephanie LeMenager describes this core contradiction: "Oil, on the one hand, and beaches, on the other, struck at the heart of middle-class aspiration."[125] The middle-class wanted both oil resources and beach resources, but they did not necessarily want them to occupy the same physical space.

---

[121] "Court Denies Permits for Beach Oil Drilling," *Eagle Rock Advertiser* 3, no. 14, August 8, 1930; "State Turns Down Many Prospectors," *Calexico Chronicle*, December 23, 1929.

[122] SLC, "Final Environmental Impact Report for the Becker Legacy Wells," I-5.

[123] "Tide Royalties Reach $50,000 in Single Month," *Calexico Chronicle*, September 24, 1930.

[124] National Industrial Conference Board, *Oil Conservation and Fuel Oil Supply*, 1.

[125] Stephanie Stephanie, *Living Oil: Petroleum Culture in the American Century* (New York: Oxford University Press, 2014), 25.

Conclusion

Between the 1890s and 1940s, the tideland drilling industry mottled Southern California's coastlines. Though simple in design, the wharf-and-drill structures worked well enough for California's drilling companies for nearly fifty years, even as other industries made great technological strides with their automobiles, airplanes, submarines, and radio. Ultimately, though, tideland drilling reached obsolescence by the 1940s. The public campaigns to block further growth of the unsightly infrastructure from their beaches, combined with the industry's discovery of bigger oil fields further from the shore, led to its decline.

When tideland drilling piers entered California's coastline, there were two decisive but totally opposite reactions from the species who lived in the ocean and those who live on land. The marine species flocked to the piers, creating habitat where habitat is scarce. Theirs was a story of immediate attraction. On the other side of the beach, however, certain Californians abhorred drilling piers, labeling them pollutive and aesthetically ruinous. Despite Californians' efforts to stop the growth of tideland drilling and return the shoreline to a more picturesque state, supporters of *Protect the Beaches!* campaigns never achieved full success. As the next chapter will show, when the supplies ran out, oil and gas companies left behind well casings, wooden pilings, and other industrial trash that littered the beach.

During their long afterlife on the seafloor, the industry's aging machines became junk to everyone except marine life. During the late twentieth and twenty-first centuries, some Californians sought to remove the very same materials that marine life transformed into habitat. Here, then, we have a key ethical dilemma, and one that appears and reappears throughout this dissertation. What is trash for humans becomes home for the sea star, anemone, rock fish, sponge, crab, and sea cucumber. Removing those seafloor technologies always results in their death. That's the problem to which Chapter III turns next.

CHAPTER III

THE AFTERLIFE OF DRILLING DEBRIS

In the tidal zone of the Santa Barbara Channel, a small hole has been causing a big problem. Not much wider than a Coca-Cola can, the abandoned oil well provides the last visible reminder that G. F. Becker once claimed this portion of Summerland's beach as his territory. But Becker is long-dead and so is California's tideland oil and gas boom. His well has lived on, though, vomiting sludge and gas onto the beach for a hundred years. California's State Lands Commission (SLC) lovingly calls the nuisance, "Becker's Well," an environmental problem that has stalked the otherwise picturesque beach into the twenty-first century.[1] But Becker's wellhole isn't alone in the sand. It's just one of hundreds of "legacy" wells peeking out into the Southern California's coastal waters, with an estimated four hundred in the Summerland area alone.[2] Up the shoreline near Goleta, the tidal zone bears even larger artifacts from the town's 1930s drilling boom. Two building-sized piers stand resolute in the upper tidal zone, each concrete structure

---

[1] "Environmental Impact Report for the Becker Legacy Wells Abandonment and Remediation Project," California State Lands Commission, July 2017, https://www.slc.ca.gov/wp-content/uploads/2017/07/FEIR.pdf, II-42, ES-1 through ES-4.

[2] Robert Sollen, *An Ocean of Oil: A Century of Political Struggle over Petroleum off the California Coast* (Juneau, AK: Denali Press, 1998), 203; SLC, "Final Environmental Impact Report for the Becker Legacy Wells," I-5, ES-1; Although the state calls them "legacy," California's seashore oil wells still persist in modern day; for a discussion of the "alleged pastness" of debris in ruined landscapes; see Gastón R. Gordillo, *Rubble: The Afterlife of Destruction* (Durham: Duke University Press, 2014), 2; J. E. Caselle, M. S. Love, C. Fusaro, and D. Schroeder, "Trash or Habitat? Fish Assemblages on Offshore Oilfield Seafloor Debris in the Santa Barbara Channel, California," *ICES Journal of Marine Science* 59 (2002): S258-S259.

protecting a ninety-year-old wellhead underneath it. In 2019, when the state attempted to plug one of the wells, the cantankerous well heaved eighty-four gallons (318 l) of oil onto the beach—a surprise to everyone.[3] Despite a century of storms, thrashing waves, course sands, and multiple amelioration attempts, these drilling materials persist.

During the excitement of the tideland drilling boom that began in the 1890s and puttered out by the 1940s, oil and gas developers never planned for the moment when the industry would end. But when it did, men like Becker ditched their materials in the growing junkyard of abandoned oil dreams. Dozens of other companies and wildcatters did just the same. Before they left, some attempted to plug their wells with material they found lying around: rocks, telephone poles, pieces of wood or metal, debris from trash heaps—items that SCUBA divers, a century later, would find stuffed into the seabed.[4] Left to crumble over the decades, much of the drilling equipment eventually washed away into the Pacific. Certain materials, however, remained steadfast in the seafloor—pipes protruding from the seabed, mounds of trash, pilings, concrete slabs, pieces of wood, and wellholes.[5] Some, like Becker's Well, were more persistent than others.

Now the unlucky owners of a long-gone industry, the SLC spends millions of dollars mobilizing engineers, biologists, construction workers, and hefty construction

[3] "Ellwood/South Ellwood Decommissioning Project," City of Goleta, California State Lands Commission, June 27, 2019, https://www.slc.ca.gov/wp-content/uploads/2019/06/Town-Hall-Presentation-FINAL-June-2019.pdf.

[4] Sollen, *An Ocean of Oil*, 18.

[5] A majority of these debris sites have been discovered and described by the SLC, regional scientists, and local fishermen. See Caselle et al., "Trash or Habitat?" S259; SLC, "Final Environmental Impact Report for the Becker Legacy Wells," II-3; Ira Leifer, Ken Wilson, Robin Lewis, Randy Imai, John Tarpley, "Oil Emissions from Nearshore and Onshore Summerland: Final Report," OSPR Technical Publication, no. 07-001, State of California Department of Fish and Game – Office of Spill Prevention and Response, April 11, 2007.

equipment to plug the wells, identify trash sites under the water, and remove derelict piers. And yet removal is too strong of a term. The SLC cannot eliminate the old well casings so much as cap and reinforce them. Playing a curious game of whack-a-mole, plugging one wellhole risks more oil seeping from a neighboring legacy well.[6] What took weeks to dig and mere hours to abandon will exist in the ocean indefinitely. Nonetheless, many Californians deem these clean-up operations a success. When the SLC capped Becker's wellhole, one employee of a marine pollution watchdog exclaimed, "It's fabulous, we've been waiting for it for 100 years."[7] The state agrees. The SLC's Lieutenant Governor expressed that each amelioration effort "moves us one step closer to a future free of fossil fuels and restores access to a beautiful coastline."[8]

Still, there are others who fear that removing these drilling artifacts may do more environmental harm than good. In response to the state dismantling two drilling piers, one person lamented to an online Santa Barbara community forum, "Guess not many people care where the swallows will be nesting now."[9] The commentor has a point. As Chapter II established, drilling piers have provided habitat for intertidal marine life since the late nineteenth century. Now, in the twenty-first century, marine life continues to colonize the industry's leftover debris. Mussels, snails, barnacles, sea stars, tunicates, and hydroids anchor to their hard surfaces, which in turn attract mobile species that swim

---

[6] SLC, "Final Environmental Impact Report for the Becker Legacy Wells," III-25 through II-26.

[7] Keith Hamm, "Summerland's Becker Well Capped," *Santa Barbara Independent*, March 1, 2018, https://www.independent.com/2018/03/01/summerlands-becker-well-capped/.

[8] Eleni Kounalakis quoted in California State Lands Commission Press Release, February 16, 2023, https://www.slc.ca.gov/content-types/last-two-shorezone-oil-piers-in-the-state-are-removed/.

[9] "Update on Ellwood Decommissioning Project," Edhat.com, accessed February 2, 2023, https://www.edhat.com/news/update-on-ellwood-decommissioning-project, Commenter A-1670366831.

around the debris piles. Even the tiny tops of broken well holes, like Becker's, support communities of algae and tubeworms.[10] These organisms care little if the drilling debris obstructs a picturesque beach. To them, it's home. As oceanographer Milton Love told me, choosing to colonize a pier isn't a bad idea for a sessile organism; substrate can mean survival.[11] But when the SLC removes, caps, plugs, or bulldozes derelict drilling debris, marine life has just two options: move or die. For sessile species that cannot relocate, including tunicates, mussels, algae, barnacles, and anemones, removal means death.[12]

Despite the presence of marine life, the SLC is responsible for cleaning up what is generally believed to be a pollutive mess. *Believed* being the operative word, here. It's easy to assume that visible industrial debris is pollutive—bad for humans, and bad for the environment. But this chapter questions that assumption. True, tideland drilling likely contributed a small amount of pollution in the 1920s, 1930s, and 1940s. Today, its debris produces even less. Despite these realities, the state is spending millions of dollars to dismantle the very materials that marine life has integrated into their ecosystems. What, then, is motivating the state's push to plug the wells and dismantle the old piers? It's a

---

[10] Ira Leifer, Ken Wilson, Robin Lewis, Randy Imai, and John Tarpley, "Oil Emissions from Nearshore and Onshore Summerland: Final Report," OSPR Technical Publication No. 07-001, State of California Department of Fish and Game - Office of Spill Prevention and Response (April 2007), 13; Ira Leifer and Ken Wilson, "The Tidal Influence on Oil and Gas Emissions from an Abandoned Oil Well: Nearshore Summerland, California," *Marine Pollution Bulletin* 54 (2007): 1499.

[11] Milton Love, phone call with the author, January 19, 2023.

[12] Histories that discuss human impacts to marine life include Ryan Tucker Jones, *The Empire of Extinction: Russians and the North Pacific's Strange Beasts of the Sea, 1741-1867* (New York: Oxford University Press, 2014); Ryan Tucker Jones, *Red Leviathan: The Secret History of Soviet Whaling* (University of Chicago Press, 2022); Tucker Malarkey, *Stronghold: One Man's Quest to Save the World's Wild Salmon* (New York: Spiegel and Grau, 2019); W. Jeffrey Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail* (Cambridge, MA: Belknap Press, 2012); David Igler, *The Great Ocean: Pacific Worlds from Captain Cook to the Gold* Rush (New York: Oxford University Press, 2013); Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980* (Cambridge University Press, 1990); Joshua L. Reid, *The Sea Is My Country: The Maritime World of the Makahs* (New Haven, CT: Yale University Press, 2015).

curious environmental riddle that requires us to dive back in time. At the center of this story is the public's perception of what constitutes an ideal coastline. From the 1890s to the 1940s, Southern California's oil and gas drilling infrastructure accosted the senses and caused Californians to reexamine how they valued the coastal seafloor.

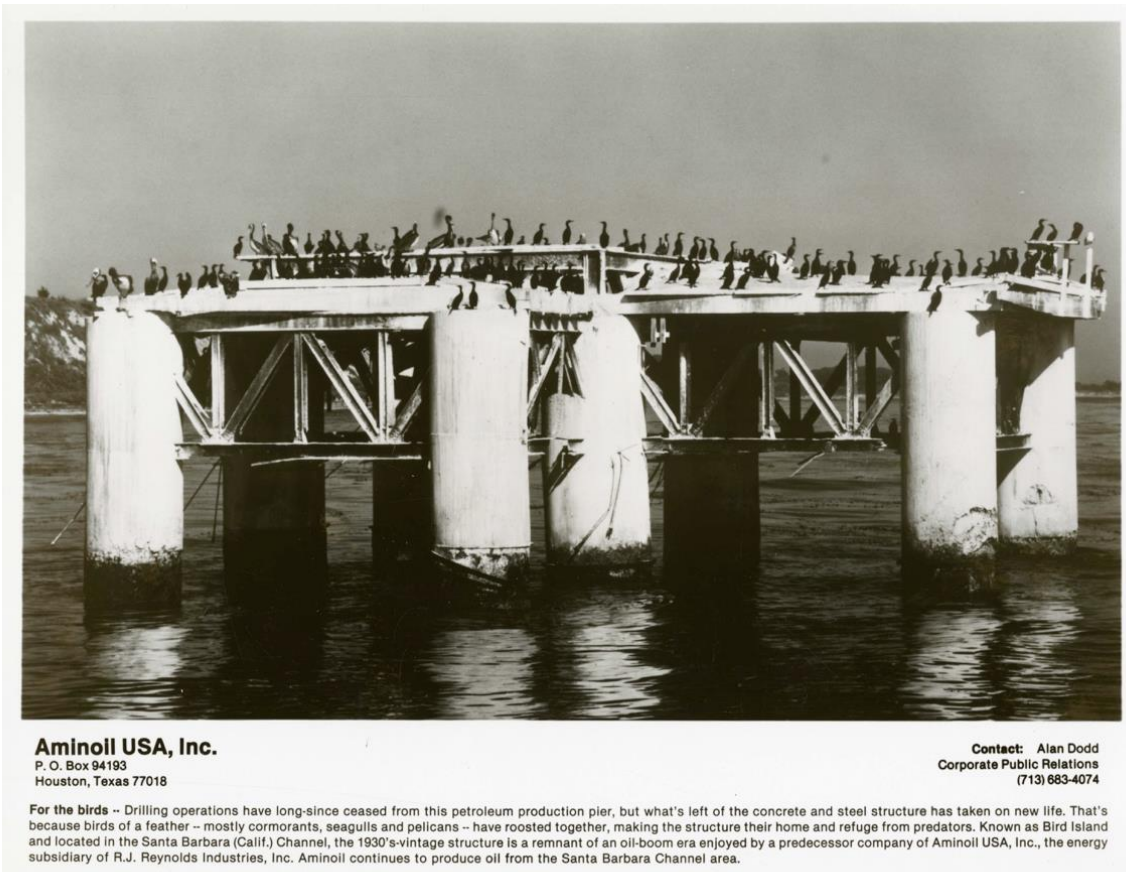


Figure 3.1. Seabirds, photographed in 1982, sit on an abandoned drilling pier originally erected in the 1930s. Known by locals as "Bird Island," pelicans and cormorants continued to use the pier as habitat. American Petroleum Institute Photograph and Film Collection, Box 37, Series 2: Modern Photographs, Collection No. 711, Archives Center, National Museum of American History, Smithsonian Institution, Washington, D.C.

Notwithstanding objections from environmental groups, who see value in the artificial reefs, Southern California's historical relationship with the offshore oil industry indicates that all old drilling debris, even that colonized by marine life, will be removed.

A century of community resistance against the tideland drilling industry, which started with the 1920s *Protect the Beaches!* campaign, has established a regional predilection towards eradicating all coastal drilling materials. And in 1969, when oil spewed from Platform Holly into the Santa Barbara Channel, it not only cemented Californians' aversion toward the offshore drilling industry, it also marked a continuation of the public's campaign to remove coastal drilling that began fifty years before. For those Californians exhausted by decades of oil spills and coastal development, tideland drilling trash is just another source of ick and sick in the Pacific. As such, tideland drilling debris gets tossed into the same group as radioactive waste, raw sewage, plastics, fertilizers from agricultural fields, and antibiotics—foreign objects that were never meant to be in the Pacific in the first place.[13] Put simply, Californians have always hated the oil and gas industry on their ocean doorstep; they don't want the industry's trash remaining there, either.[14]

---

[13] For histories on pollution in the oceans, see Jacob Darwin Hamblin, *Poison in the Well: Radioactive Waste in the Oceans at the Dawn of the Nuclear Age* (New Brunswick: Rutgers University Press, 2009); Helen Scales, *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat that Imperils It* (New York: Atlantic Monthly Press, 2021); Jeff Wheelwright, *Degrees of Disaster: Prince William Sound: How Nature Reels and Rebounds* (New Haven, CT: Yale University Press, 1994); Christopher Dunagan, "Fish Affected by a Legacy of Pollution," *Kitsap Sun*, April 5, 2014, https://archive.kitsapsun.com/news/environment/fish-affected-by-a-legacy-of-pollution-ep-355399370-355632001.html/; Joseph E. Taylor III, *Making Salmon: An Environmental History of the Northwest* (Seattle: University of Washington Press, 2001); Lissa K. Wadewitz, *The Nature of Borders: Salmon, Boundaries, and Bandits on the Salish* Sea (Seattle: University of Washington Press, 2012); Helen M. Rozwadowski, and David K. van Keuren, eds. *Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment* (Canton, Mass: Science History Publications, 2004); Connie Y. Chiang, *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast* (Seattle: University of Washington Press, 2009); Joshua L. Reid *The Sea Is My Country: The Maritime World of the Makahs* (New Haven, CT: Yale University Press, 2015); Rachel Carson, *The Edge of the Sea* (Boston: Houghton Mifflin, 1955, sixth printing).

[14] For a history of the 1969 Santa Barbara Oil Spill, see Teresa Sabol Spezio, *Slick Policy: Environmental and Science Policy in the Aftermath of the Santa Barbara Oil Spill* (University of Pittsburgh Press, 2018).

This chapter reexamines and reevaluates how we think about waste in the coastline. First, it considers the amount of oil and chemical toxins that have likely seeped from the tideland drilling materials, both historically and in the present day, and its effects within the marine ecosystem. Next, I consider how exactly the ocean dismantled tideland drilling debris and what we should do with the trash that remains. The research demonstrates that while the removal of century-old tideland drilling materials may do more harm than benefit to colonizing species, for some Californians, that's missing the point. Beloved because of its beauty and accessibility, many people want to see their shoreline returned to an unindustrialized state, or at least something visually close to it. When it comes to removing drilling materials in the ocean, it's often a question of historical perception and public opinion, not ecology.[15]

The Persistence of Trash

Creatures of the intertidal zone have long understood that it's nearly impossible to survive while standing upright in the shoreline. The rough waves, fluctuating sands, predators, and dehydrating air can kill you. To survive, sand fleas, crabs, worms, snails and other beach-dwelling species dig down into the sand, scurry for protection on a nearby rock, or move deeper into the ocean to follow the receding tide. During the first

[15] Other scholars agree that controversy surrounding offshore platforms comes down to questions of environment and belief systems. Dolly Jørgensen, in particular, makes this argument. See "Environmentalists On Both Sides: Enactments in the California Rigs-To-Reefs Debate," in *New Natures: Joining Environmental History with Science and Technology Studies*, eds. Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard (University of Pittsburgh Press, 2013), 51-52; Milton Love, phone call with the author, January 19, 2023.

half of the early twentieth century, oil drillers did not heed what the sea star, barnacle, sand flea, or crab already knew: to survive in the changing intertidal zone, one should stay flush to the bottom.[16] Even better, dig down into sediments or find a protective crevice.

Drilling piers stood unfortunately vertical and tall in an environment where everyone else survives by staying horizontal and low. The Pacific's sand, wind, and waves wielded significant power against the oil industry's tideland infrastructure, which sat like match sticks in the world's strongest wave pool. In 1907, a large wave crashed into a drilling wharf and derrick at Ventura. In one pulse, the wave "lifted the deck bodily" and took with it everything else associated with the oil-pumping operation. "With the wharf went the big donkey engine, the big derrick, several thousand feet of lumber, the big pipelines, loading cars…and a large amount of oil, crude and refined," reported the *Morning Press*.[17] The ocean's waves then tossed about the rubble, displacing it across the beach and carrying the rest away into the Pacific. What before was a site of industry had, in seconds, become a trash heap. Drilling infrastructure could transform into rubbish in a matter of seconds, and just one wave or one storm was enough to spur the transition.

It wasn't just the waves that waged an all-out attack on tideland drilling machinery. Sand's abrasive effects were powerful enough to round steel corners. In turn, engineers quickly learned that all pilings should be rounded, instead of squared, before they installed them in the ocean. Water and oxygen licked away at the shiny metals, too,

---

[16] Kenneth Orris Emery, *The Sea off Southern California; A Modern Habitat of Petroleum* (New York: Wiley, 1960), 77.

[17] "High Wave Took Wharf," [Santa Barbara] *Morning Press*, December 11, 1907.

turning once-slick surfaces into rust and rot. Where shale blanketed the seafloor, the sharp rocks cut away at the wooden pilings, further undermining their stability. Even fungi invaded wooden planks, causing them to rot.[18] One engineer working at the Ellwood field in the 1940s wrote of the "unusual forces of nature acting on marine structures in exposed waters."[19] Despite the companies' best efforts, the intertidal zone's small creatures often survived where iron, wood, and steel could not.

Instead of converting their infrastructure to lay flat against the seafloor, however, engineers doubled down and reinforced the vertical wharf design. They poured extra concrete around the base of pilings, coated wooden pilings with steel, installed new support beams, galvanized all nails, bolts, and nuts, and built wharves even taller to evade the high waves. Where kelp clung to the structure's base, a problem referred to as "kelp loading," engineers added extra bracing to support the extra weight. Companies sometimes hired divers to swim below the waterline to inspect the pilings and scrape off marine life.[20] In either case of wood or metal, drilling infrastructure did not easily withstand the continual punch of the waves, wind, and saltwater—a problem that engineers called "wave shock."[21] When it came to the first three decades of the nascent offshore industry, then, the ocean clearly maintained the upper hand.

---

[18] Schaufele, "Erosion and Corrosion," 329, 333.

[19] Ibid., 326.

[20] Schaufele, "Erosion and Corrosion," 326, 328-329, 332; "Tug Starts North with Piling in Tow," *San Pedro News Pilot*, September 19, 1930.

[21] National Marine Sanctuaries, "Kelp Forests," National Oceanic and Atmospheric Association, https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html, accessed 12 October, 2020; Ricketts, *Between Pacific Tides*, 179.

Drilling companies had one major advantage, however. They needed only to keep their piers upright as long as the field's supply of oil lasted, but no longer than that. In places like Ventura or Summerland, competitive companies pumped so quickly and indiscriminately that the wharves needed to stay erect for just a few years, or a couple of decades at most.[22] Once the Pacific Ocean claimed an object as its own, the humans who originally installed the drilling machines had to work hard to win it back. Usually, if the materials were out of sight, they didn't bother—all but forgetting about its existence and abandoning it on the seabed in perpetuity. California's tideland oil and gas drilling companies did just this, deserting their materials when the oil and gas stopped flowing out. Designed for quick installation rather than quick removal, seafloor machines languished in the ocean after they stopped being useful to their owners.

Despite the ocean's power, there were certain materials from the tideland drilling fields with astonishing staying power in the shoreline. The old wells casings, in particular, have shown remarkable resilience. Held open by metal pipes, the state calls these holes "legacy wells"—improperly abandoned well holes that were not effectively plugged or capped. Wells have survived long beyond the men who first installed them, their children, and now their children's children. Each of these wells once had a pier and derrick towering above them, but now they usually sit alone in the seabed. The metal casings rise just a few inches from the seafloor, but not always. In the early 2000s, a group of researchers found two metal well casings, all "corroded and cracked," extending no less than nine feet (2.7 m) from the seafloor up into the water column. Despite their

[22] On California's competitive oil and gas industry, see Michael R. Adamson, *Oil and Urbanization on the Pacific Coast: Ralph Bramel Lloyd and the Shaping of the Urban West* (Morgantown: West Virginia University Press, 2018), 3.

age, the wells are still doing their job: transporting oil and gas from subterranean strata to the ocean's surface. They provide an easy pathway for fossil fuels otherwise trapped under rocks, sediments, and intense pressure. For being such simple technologies, the hundreds of legacy wells that pockmark the shoreline sure are persistent.[23]

The well casings aren't alone down there. There's also remnants of the tall wooden piers, oil barrels, debris piles, and derelict derricks. Divers have even found a four-cubic foot concrete block sitting on the seabed, more debris from the tideland drilling boom.[24] A century of waves, erosion, storms, and colonizing marine life have altered these artifacts, but not fully removed them. Even in this shallow area of the ocean, like all depths of the sea, what goes down onto the seafloor rarely comes back up. The public's obliviousness about the materials turns to demands for removal when the materials reappear in public view—an oily squirt from a forgotten wellhole or a foot cut on a protruding pipe. Sometimes, there's a seasonal routine to this industrial peep show. During the annual winter months, a thrashing Pacific Ocean pulls sand away from the beach, revealing even more wellheads.[25] The wells occasionally secrete a small mixture of oil and gas, sometimes depositing a trail of brown residue into the tidal water. More often, you can smell them before you see them. Because of their visual and olfactory offensiveness, it's easy for regional communities to assume the debris requires immediate attention. "These wells pose a potential risk to our public and to the environment," argued the city planner for the nearby town of Goleta, who—citing environmental

[23] Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," 5.

[24] Ibid., 16, 24.

[25] The same holds true for Gulf of Mexico, see Jack Davis, *The Gulf: The Making of an American Sea* (New York: Liveright, 2017).

concerns—requested that the state spend more time and funds plugging the old wells at their beach. With the remains more visible, public perception rushes forward with more force than the oil dripping from the wells.

A public nuisance, someone must be held responsible for the detritus. That's the stage at which the SLC finds itself now, for the original owners are long gone. The commission spends a significant amount of time, and taxpayer's dollars, undoing the oil boom that mechanized the seashore during the first half of the twentieth century. Nowadays, the SLC has a hell of a time getting those remnants *out* of the ocean. Consider the army of engineers, administrators, construction workers, and environmental organization watchdogs whose jobs it is to "ameliorate" (as the SLC calls it) the materials still stuck in the coastal seafloor.[26]

Twenty-first century amelioration efforts aren't the commission's first rodeo with the tideland drilling debris, either. The state has been been trying to plug these bad boys for decades. After "multiple and sometimes-unsuccessful abandonment efforts"—which occurred in 1960s, 1970s, and 1990s—the SLC decided on another round of surveys of the legacy wells, beginning in 2001 and extending to 2005. A group of contracted scientists examined the debris from every angle, "shore-side, beach, sea-surface, underwater, and aerial surveys and historical research," before arriving at a sound conclusion. "Our findings suggest," reported the scientists in 2005, "that any future abandonment efforts are likely to result in a similar lack of success."[27] Scientists and

---

[26] SLC, "Final Environmental Impact Report for the Becker Legacy Wells," ES-1; 2-18; Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," 16, 24.

[27] Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," ii, iii, 1, 5; Emery, *The Sea off Southern California,* 77.

engineers have not invented any other way to remove the casings that hadn't already been tried three times before; the wells will stay put. Instead, the SLC can only plug and cap the legacy wells: they cannot extract the casings. Becker's pesky wellhole in Summerland's shoreline is perfect case in point: a large concrete slab now covers a can-sized hole. Too bad for the marine life, for in the early 2000s researchers found algae and swarms of ornate tubeworms growing adjacent to an abandoned well, labeled S-3, in the Summerland field.[28]

That's just the legacy wells. Dozens of debris mounds still sit under the water, offering habitat for marine organisms, too. From Point Conception down to southern Los Angeles, debris such as dismantled piers, tires, and concrete mounds clutter the seabed—the types of nuisances that can snag a trawl net or collide with a surfer. Scientists have discovered at least thirty-three species of fish living on or near these old rubble piles. Rockfish are the most frequent. Brown rockfish, yellowtail rockfish, copper rockfish, and vermilion rockfish come in variations of browns, golds, and reds, but all share in common their black, buggy eyes.[29] Frequent, too, are the surfperches, their dark eyes surrounded by a gold and silver ring. The barred sand bass joins the fish at the debris piles, as well, its eyes an eerie blood orange. On the seabed, these fish see habitat where humans see trash. Like a natural reef structure, the debris offers helpful topographic features: holes, crannies, and coverings, all perfect for hiding, hunting, and procreating.[30]

---

[28] Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," 13; Leifer, et al., "The Tidal Influence on Oil and Gas Emissions," 1499.

[29] Caselle, et al., "Trash or Habitat?" S258-S260.

[30] Ibid., S264.

Despite the fact that bits of toxic chemicals may remain, SLC's current disinterest in removing the debris offers a good outcome for marine life.

The demands for removing old tideland drilling debris become even more complex when considering the tribal nations that are geographically or culturally connected to Southern California's coastline, their rightful homelands. For them, the long afterlife of drilling materials often represents histories of pollution and colonialism. Tribal reactions to removing old drilling debris, however, is not necessarily a straightforward "remove" response. When the SLC first proposed the multi-week effort to plug Becker's wellhole, for instance, the Native American Heritage Commission withheld its opinion on the project until the SLC further consulted with the regional tribal governments, including the Chumash. Without communication, the Commission noted, abandonment projects might cause "inadvertent discoveries of Native American human remains" and other cultural resources. In other words, removing a pipe or pier would do more harm than good if, in the course of abandonment, the SLC uncovered culturally sensitive remains or materials.[31] One point is persists: removing old tideland drilling debris is rarely a straightforward option.

In the twenty-first century, California's tribal nations are fighting for more authority to govern, manage, and reclaim areas of the coastal ocean to stop future development of oil and gas. One such initiative is the Chumash Heritage National Sanctuary, which would set aside an area of the ocean north of the Santa Barbara Channel

[31] SLC, "Final Environmental Impact Report for the Becker Legacy Wells," II-5, II-6, II-10.

and protect it from further oil and gas exploration and development.[32] As Mati Waiya, Chumash ceremonial elder and Wishtoyo Foundation executive director, told the Center for Biological Diversity, “new wells and horizontal drilling will harm sacred Chumash Native American cultural resources on the ocean floor.” He continued, “Just as concerning, in the inevitable event of an oil spill, the natural environment the Chumash people depend on will be severely harmed and onshore village and burial sites will be destroyed.”[33] If supporters are successful in creating the Sanctuary, Indigenous tribes would have the authority to decide which drilling debris to formally abandon or leave in the seabed—a choice that has been the domain of the SLC and private corporations in past decades.

Let’s Talk About Oil, Baby

How much oil and gas did tideland drilling operations secrete in the shoreline? Surely, the drilling sites looked dirty, but it’s difficult to discern pollution from perception. In the early twentieth century, when the industry was at its peak, neither the State of California nor the oil and gas companies closely regulated pollutive emissions.[34]

---

[32] Leon E. Panetta, “Op-Ed: Create a Tribal-Led Marine Sanctuary and Stop Oil Spills on the California Coast,” *Los Angeles Times,* October 22, 2021, https://www.latimes.com/opinion/story/2021-10-22/oil-spills-marine-sanctuary-northern-chumash.

[33] “Goleta Rally to Oppose Offshore Oil Drilling in California Sanctuary,” Center for Biological Diversity, Media Advisory, October 18, 2016, https://www.biologicaldiversity.org/news/press_releases/2016/offshore-drilling-10-18-2016.html.

[34] The State Division of Oil did impose some regulations. Nancy Quam-Wickham, “‘Cities Sacrificed of the Altar of Oil,’ Popular Opposition to Oil Development in 1920s Los Angeles,” *Environmental History* 3,

Plus, the Pacific's waves seemed to wash away much of the oil that dripped from tideland drilling operations, leaving the historical record far from attentive to the topic. But research performed later in the twentieth and twenty-first centuries can help us recreate and reassess what conditions may have been like between the late 1890s and early 1940s. Subsequent oil and gas studies at spill sites in the twentieth century, applied to California's coastline a century ago, can tell us something about the effects of tideland oil drilling.

Before we dive into the science, it's worth reflecting on historical accounts from those who visited the piers. People who found themselves near the wharves and derricks in the early twentieth century reported an intense corporeal experience: the smell of gas rested heavy in the air, the constant din of the rigs and men at work overwhelmed the sound of the crashing waves, and oily debris painted the beach. As drillers pierced deep into the seafloor, the gas pressure sent "streams of oil spurt[ing] out upon the water," enough to turn the water from its natural blue color to one of oil-black.[35] Oil pooled at the base of the drilling piers, tarry black globs of dried oil were strewn across beach, and a sheen of oil was visible on top of the water. "Much oil is necessarily wasted under the peculiar conditions which prevail," reported one newspaper in 1900, "and this dripping upon the water has the effect of making a considerable patch of old ocean as calm and smooth as a land-locked bay."[36] Even a single gallon of oil could visibly alter the water's surface.

---

no. 2 (1998): 191 and Paul Sabin, *Crude Politics: The California Oil Market, 1900-1940* (Berkeley: University of California Press, 2005), 54-59.

[35] "Oil Under the Sea," *Hanford Journal*, September 26, 1900.

[36] Ibid.

If the oil pollution wasn't coming from the drilling piers themselves, then it spewed from pipes that carried wastewater from oil plants and deposited it directly into the ocean.[37] In 1938, the Shoreline Planning Commission warned of the "ruinous pollution of California's ocean-shore playground." They went on, "oil scum in the water is carried for miles in all directions…resulting in impairment of property values in adjoining areas."[38] Tideland drilling wells appeared to make the ocean boil with crude.[39] When oil spilled from the drilling piers and seafloor wells, it likely slicked the surface of the water for many days or weeks before settling into the top centimeters of the sand along highest reach of the tidal zone, where it would have stayed for months.[40] For any onlooker, tideland drilling operations smelled like pollution and looked like pollution.

We can glean something about the pollution from tideland drilling piers by studying the history of onshore derricks, which at the same historical moment in the early twentieth century were taking over residential streets and the countryside. On a day-to-day basis, those terrestrial derricks leaked enough oil for the liquid to run down the streets of the coastal cities and enter the water. At the Los Angeles harbor, for instance, onshore derricks splattered oil onto the land, which in turn flowed down into the sea. Aghast onlookers noted that oil then carpeted the seawater, reportedly multiple inches in

---

[37] "'Save the Beaches,'" *San Pedro News Pilot*, October 19, 1928.

[38] Quoted in "Oil Drilling On Our Beaches Must Be Stopped," *Palos Verdes Peninsula News* 10, no. 41, October 14, 1938.

[39] Leifer et al., "The Tidal Influence on Oil and Gas Emissions," 1505.

[40] Ronald M. Atlas, Donald M. Stoeckel, Seth A. Faith, Angela Minard-Smith, Jonathan R. Thorn, and Mark J. Benotti, "Oil Biodegradation and Oil-Degrading Microbial Populations in Marsh Sediments Impacted by Oil from the Deepwater Horizon Well Blowout," *Environmental Science and Technology* 49 (2015): 8356.

thickness.[41] At any location where derricks went up and oil came out, a mess of dark crude blanketed the surrounding environment. Gushers sent oil, rocks, and other debris into the air for hours while dried oil caked onto roofs and lawns.[42] The same outcomes likely pervaded the shoreline around the drilling piers, but instead of oil caking streets and lawns, it plastered rocks and sand. Seawater took the remainder and swirled it into the shore's ecosystem.

In comparison to the newspapers and other visitors who saw tideland drilling as highly destructive and pollutive, some contemporaries quietly pointed to larger sources of pollution. Floyd I. Beckwith, director of the California Beaches Associated, stuck his neck out by noting that sewage flowing from the cities polluted the beaches well before tideland drilling piers.[43] He wasn't wrong. In 1939, the Army Corps reported that the amount of pollution in Southern California's waters was a "serious problem," but tideland drilling wasn't the primary cause. Cargo ships, oil tankers, and other maritime vessels were also big offenders, their crews routinely tossing trash and oil over the side or allowing the oil to leak from their tanks. Once in the water, the pollution traveled to the beaches or swirled around the water's surface.[44] Third in line were industrial yards, and finally oil refineries and oil fields.[45] But those statistics mattered little to an angry public

---

[41] Quam-Wickham, "'Cities Sacrificed of the Altar of Oil,'" 192-193.

[42] Ibid., 92.

[43] "Beach Study Fund Sought," *San Pedro News Pilot*, July 28, 1936. From the 1960s onwards, Southern California dumped approximately 1.1 billion pounds of sewage sludge into the Pacific Ocean. See Trujillo et al., *Essentials of Oceanography,* 356.

[44] "Oil and Refuse Pollution: Navigable Waters of the United States in Southern California," U. S. Army, Corps of Engineers (Los Angeles: U. S. Engineer Office, 1939), 1, 3; "Sue Tanker Capt. For Dumping Oil Within Port Limit," *San Pedro News Pilot* 12, no. 306, September 24, 1925.

[45] "Oil and Refuse Pollution," Corps of Engineers, 1, 3.

that wanted a beach visibly unimpeded by metal and wood. Their fight to *Save the Beaches!* reflected their idealization of an unindustrialized beach.

Despite perceptions of its toxicity, a little oil in the ocean isn't a bad thing or even a foreign thing. Oil naturally seeps from Southern California's coastal seafloor, a daily occurrence as routine a thousand years ago just as it is today. The state coastline is particularly ripe with oil and gas seeps, or as one historical account described it, the shore "oozed greasy slime."[46] A recent report found that California's coastal seafloor naturally seeps around five million gallons (18.9 million L) of oil every year. Those five million gallons are just a fraction of the global seafloor average, which seeps around forty million gallons (15.1 million L) every year.[47] Long before drilling wharves arrived in the 1890s, Southern California's marine species had evolved to withstand a certain amount of crude in their environment.

When oil arrives, its journey through the ecosystem is complex and not easily observable. Some oil evaporates, some biodegrades with the help of microbes, and some settles in for the long haul in the bodies of organisms and seafloor sediments.[48] Certain species tend to survive, while others tend to perish. And still others have a relatively neutral response. Those most at risk of death-by-oil are the babies. Eggs and larvae often die as a result of the complex chemical reaction that occurs when saltwater mixes with the chemicals found in crude oil—nitrogen, sulfur, oxygen, metals, hydrocarbons.[49]

---

[46] "Dumping Oil Out of the Ocean," *San Francisco Call*, November 20, 1989.

[47] Leifer, et. al., "Oil Emissions from Nearshore and Onshore Summerland," 1, 23.

[48] Atlas, et al., "Oil Biodegradation," 8359.

[49] Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography*, 12th edition (Boston, MA: Pearson, 2017), 351.

Those better off are adult and mobile species. An animal's ability to move out of the way of danger is called an avoidance mechanism. Sea lions have the mechanism, whales have it, crabs have it, but for those lifeforms that attach to a hard surface—mussels, clams, limpets, algae, moss—quick escape is not possible. Immobile species that cling to rocks, kelp, and pilings are more likely to perish from toxic doses of crude. And yet even without escape, some sessile species can still survive an oil slick.

Take the periwinkle sea snail as a good example. Tiny and delicate though it appears, the periwinkle bears the rough intertidal environment well. The periwinkle will not only survive without seawater for weeks at a time; but it can also endure a good slicking when oil naturally seeps from the seabed. But timing is everything. If crude drips at the highest heat of mid-day, the oiled rocks will bake to a higher temperature than unoiled rocks. With this added heat, the periwinkles are less likely to be successful at attaching to the rock and more likely to perish.[50] Depending on conditions, sea anemones can fare alright, too. Scientists have noticed that when oil collects around the squishy, gooey edges of one Californian anemone, *Anthopleura elegantissima,* they rarely die from such a frosting.[51] Barnacles take a more active approach and attempt to fend off the oil. When oil drips or oozes around them, the barnacles extend out their wiry arms, called cirri, past the edge of their limestone shells in an attempt to clear the surrounding water. If the oiling is light, the barnacles may survive. But if the oil arrives in thick waves, the barnacle's goo-crusted cirri are unable to locate the flecks of food in the water, and death

---

[50] Dale Straughan and Diane Hadley, "Experiments with Littorina Species to Determine the Relevancy of Oil Spill Data from Southern California to the Gulf of Alaska," *Marine Environment Research* 1, no. 2 (October 1978): 137, 160-161.

[51] M. Foster, M,. Neushul, R. Zingmark, "The Santa Barbara Oil Spill Part 2: Initial Effects on Intertidal and Kelp Bed Organisms," *Environmental Pollution* 2 (1971): 126.

will come.[52] But again, the timing matters greatly. If crude slathers the nearby shore at the start of the low-tide, then many hours will pass before the returning high-tide can wash away the oil, leaving intertidal species exposed to the material that much longer. Heat, plus a lengthy exposure to oil, are a deadly pairing for sessile creatures.[53] What's an adaptive advantage for some species—anchoring down to hard surfaces—becomes a disadvantage when toxins arrive, be it an oil spill or another foreign chemical.

Compare the sessile creatures like the periwinkle snail to that of the extra-mobile Pacific sanddab, which is flat like a pancake and colored like one, too. The sanddab is a flatfish that hides in the soft sediments of the seafloor. It uses its toad-like eyes to gaze at the creatures moving above, some of which become the sanddab's victims—crab, shrimp, even an unlucky cephalopod—and some of which, like sharks and halibut, are its eternal foes. Nowadays, scientists commonly find sanddabs congregating on the seafloor around drilling platforms, so it's likely that, historically, the juveniles also slunk around the base of drilling piers that cluttered the shallow waters of Rincon, Ellwood and other fields in the early 1900s. With a lifespan similar to that of a dog's, the sanddabs that survive into adulthood gradually move into the deeper expanse of seafloor and away from the intertidal zone.[54] Mobile species like sanddabs have the ability to flee from small spills,

---

[52] Foster et al., "The Santa Barbara Oil Spill," 127-128.

[53] Straughan et al., "Experiments with Littorina," 140, 162.

[54] "Pacific Sanddab," Sea Grant California, accessed November 1, 2020, https://caseagrant.ucsd.edu/seafood-profiles/pacific-sanddab; James Houseworth and William Stringfellow, "A Case Study of California Offshore Petroleum Production, Well Stimulation, and Associated Environmental Impacts," in *An Independent Scientific Assessment of Well Stimulation in California Volume III: Case Studies of Hydraulic Fracturing and Acid Stimulations in Select Regions: Offshore, Monterey Formation, Los Angeles Basin*, eds. Jane C.S. Long, Laura C. Feinstein, and Jens Birkholzer et al. (Sacramento, California: California Council on Science and Technology, 2015), 89.

meaning the environmental effects of a few gallons of crude here and there are not necessarily deadly. Marine has adapted to the peaks and lows of oil seeps.

Kelp forests cannot sidestep an influx of crude, but the forests' reaction to large oil spills proves an interesting study.[55] Multiple spills in the twentieth century provided researchers an opportunity to study kelp's response spills; they discovered that heavy doses of fuel oil did not drastically affect the algae's populations. The kelp withstood the toxins far better than other species including birds, mussels, and sea otters.[56] The same trend held true after 1969 Santa Barbara Oil Spill, when over eighty-thousand barrels of oil poured from the offshore platform, Holly. Oil from that spill did appear to kill some red algae that grew high on the shoreline, but it did not severely affect the brown algae deeper in the water, including kelp.[57] Instead of perishing, scientists have demonstrated that when confronted with oil, kelp forests usually collect the goo among their tall ribbons and rubbery bladders, just as they collect all manner of fish, mammals, and invertebrates.

At Summerland, as in other locations, scientists have observed kelp clutching the crude, helping to prevent oil spills originating on land from heading out to sea and, vice versa, slowing the spread of oil that has spilled at sea from sliming the beach. Kelp canopies also slow the sink of oil traveling from the water's surface into the seafloor

---

[55] Stephen Haycox, "'Fetched Up': Unlearned Lessons from the *Exxon Valdez*,'" *The Journal of American History* (June 2012): 219.

[56] P. Peckol, S. C. Levings, S. D. Garrity, "Kelp Response Following the *World Prodigy* Oil Spill," *Marine Pollution Bulletin* 21, no. 10 (1990): 473, 475.

[57] Foster et al., "Santa Barbara Oil Spill," 125-126, 130.

sediments.[58] To the degree that the earliest tideland drilling equipment leaked, spilled, and spurted oil from the drilling derricks, then the kelp swaying under the water's surface likely reacted with some neutrality. Kelp does not benefit from the oil spills, nor does it easily bow to its presence. In addition to kelp, other marine elements will come to the aid of marine life in the aftermath of an oil spill. Seawater is one of those features. As the water swirls, it keeps the less-dense oil afloat at the water's surface, not allowing much of the material to fall onto the rich benthic life that exists on the seafloor.[59] In comparison to kelp, seagrass is a photosynthetic plant that grows in shallow waters. For as much habitat as seagrass provides for species of the Pacific Northwest, including salmon, rockfish, and crabs, it's equally sensitive to human forces. Seagrass is sensitive to ship anchors, shading from piers, chemicals, and oil.[60] When oil touches the seagrass, the tarry goo clumps the grass's wispy blades, which can result in browning, dryness, and death.[61]

Similar to seagrass, invertebrates function as the proverbial canary in the coal mine.[62] The most enduring victims of oil spills are mollusks—invertebrates that often have a hard, outer shell. Mussels, a type of mollusk, have fleshy bodies that act as squeegees for chemicals, soaking up the toxic components of the seawater that swirl

---

[58] Leifer et al., "Oil Emissions from Nearshore and Onshore Summerland," 25; Foster et al., "Santa Barbara Oil Spill," 125-126, 130.

[59] Foster et al., "Santa Barbara Oil Spill," 122; Wheelwright, *Degrees of Disaster*, 95.

[60] "Eelgrass Grows Here," Informational Panel, East Government Dock, Bamfield, Canada.

[61] Thomas A. Dean and Stephen C. Jewett, "Habitat-Specific Recovery of Shallow Subtidal Communities Following the Exxon Valdez Oil Spill," *Ecological Applications* 11, no. 5 (October 2001): 1456; Foster et al., "The Santa Barbara Oil Spill," 121; Wheelwright, *Degrees of Disaster*, 80.

[62] Dean et al., "Habitat-Specific Recovery," 1467; Kelp also soak up carbon, see Todd Woody, "California's Critical Kelp Forests are Disappearing in a Warming World, Can They be Saved?" *National Geographic*. April 30, 2020, https://www.nationalgeographic.com/science/article/california-critical-kelp-forests-disappearing-warming-world-can-they-be-saved.

surround them. In the last few decades, scientists discovered that mussels are a proxy, or test strip, for all sorts chemicals that pollute seawater. If you want to glean a snapshot of the alphabet soup of chemicals that flow from land down into the Pacific Ocean—PCBs, PBDEs, PAHs, DEHPs, DDT—grab a mussel.[63] Mussels keep time on increasingly toxic water.

Within the seafloor's sediments, tiny microorganisms unseen to the human eye will also respond to an influx of oil, although their reaction to oil is different than most other lifeforms. Recent oil spills have revealed the process of hydrocarbon biodegradation, during which microorganisms break down the oil and return the site to the microbial diversity that proliferated before the spill.[64] Certain microorganisms, called mycobacteria, energetically *blossom* with a good dose of oil. After an oil spill, they flock to the oiled cite where they feed and grow. When confronted with oil, then, microbial diversity at first declines, but in the months following, the microbes make quick work of the oil and begin to bounce back. [65] In other words, microbes get to cleaning. Today, much of the oil that leaks into the sediments of Summerland's field, for example, is highly "degraded," meaning microbes are diligently nibbling away at the crude.[66] It's these types of nuanced marine responses to oil leaks that don't necessarily make the

---

[63] Stanley D. Rice, Jeffrey W. Short, Mark G. Carls, Adam Moles, Robert B. Spies, "The *Exxon Valdez* Oil Spill," in *Long-Term Ecological Change in the Northern Gulf of Alaska*, ed. Robert B. Spies (Amsterdam: Elsevier, 2007), p. 422. Barnacle shells also reflect changing conditions in the surrounding seawater; see Mara Grunbaum, "What Whale Barnacles Know," *Hakai Magazine*, November 9, 2021.

[64] Nuttapol Noirungsee, Steffen Hackbusch, Juan Viamonte, Paul Bubenheim, "Influence of Oil, Dispersant, and Pressure on Microbial Communities from the Gulf of Mexico," *Scientific Reports* 10, no. 1 (April 2020): 1.

[65] Atlas, et al., "Oil Biodegradation," 8356-8357, 8364.

[66] Leifer et al., "Oil Emissions from Nearshore and Onshore Summerland," 28.

headlines. Though microscopic, the oil's effects on these little creatures is equally worth comparing to that of the seabird or the sea star, the macrofauna that usually garner the most public attention.

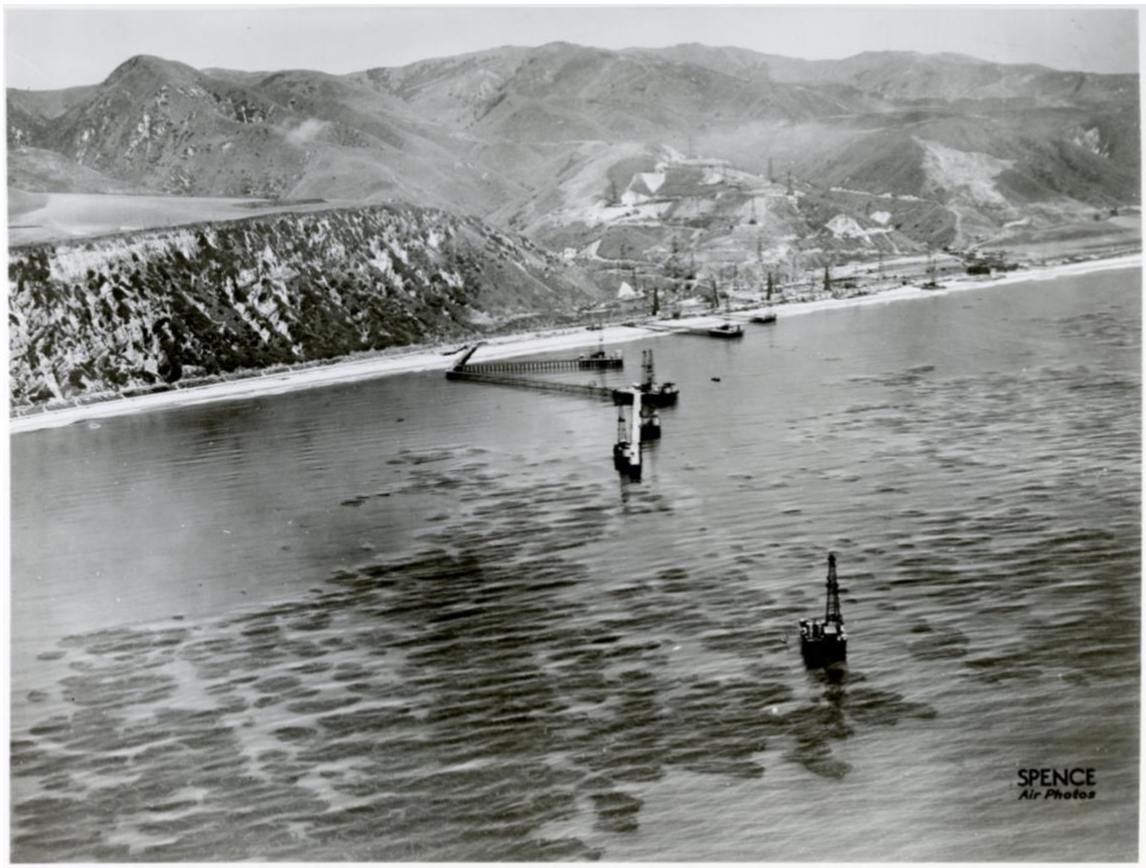


Figure 3.2. Tideland drilling piers extend into the Pacific Ocean at the Rincon Field in Ventura County, California, 1938. Kelp beds are visible in the foreground, which are known to capture and sequester oil. American Petroleum Institute Photograph and Film Collection, Series 1: Historical Photographs, Collection no. 711, Archives Center, National Museum of American History, Smithsonian Institution, Washington, D.C.

Although diminutive when compared to the catastrophic oil spills that marred the Pacific Ocean in the second half of the twentieth century, it's safe to assume that tideland drilling wharves and their seafloor wells leached many dozens of gallons gas and oil into the ocean over the decades. Let's consider those numbers from a historical perspective. Summerland alone boasted over four-hundred beach and intertidal wells during its early twentieth-century heyday. If each one of those wells leaked a little each day, such as a handful of gallons, that could equate to 264 gallons (999 L) of oil and over 3,963 gallons (15,002 L) of gas entering the marine tidal zone daily. More than likely, however, due to daily and seasonal fluctuations, the emissions would have been far less. “Oil sheens in the Summerland area,” reported scientists studying Summerland’s legacy wells in the twenty-first century, “exhibited enormous variability on time scales from months…to seconds.” Factors such as the tide, swell, and chemical makeup of the water affects when oil seeps and how much.[67] The likelihood is that some of the wells would have leaked even less, while some could have leaked more.[68] In a trickle rather than a gush, old tideland drilling wells have continued to glaze the seabed for more than a century. There is no evidence to assume, however, that tideland drilling industry ever produced a massive oil spill akin to the 1969 blowout in the Santa Barbara Channel or the 1989 *Exxon Valdez* spill in the Gulf of Alaska. We can conclude, however, that this early offshore industry still contributed some crude into the Pacific, and through the 1920s, 1930s, and 1940s, it polluted with squirts and drips rather than floods and flows.

Those squirts and drips continue into twenty-first century in the form of legacy wells. For instance, John B. Treadwell, who built Summerland’s first offshore drilling wharf in 1897, improperly plugged his wells. One of his holes, which the SLC has labeled “Treadwell T-10,” has continued to leak less than a gallon of oil and ten gallons of gas on certain days for over a hundred years—sometimes more, sometimes less. That

[67] Leifer, et al., “Oil Emissions from Nearshore and Onshore Summerland,” 25.

[68] For context, the 2010 Deepwater Horizon Oil Spill released more than 130 million gallons into the Gulf of Mexico in a matter of months. See National Oceanic and Atmosphere Administration, “Oil Spills,” accessed January 1, 2022, noaa.gov/education/resource-collections/ocean-coasts/oil-spills.

amount of oil is not enough to slime wildlife, but it is enough crude to darken the waters above the well with "black oily bubbles." By comparison, before the SLC capped it, Becker's wellhole, located near Treadwell's, occasionally seeped three gallons (11 L) in one day.[69] In total, legacy wells at Summerland have continued to cause visible oil slicks about ten days every year. Some environmental groups argued that emissions were only increasing in the twenty-first century, by how much and in reference to what data, they did not say.[70]

When it comes to oil pollution at the tideland drilling sites, public perceptions often play a stronger role than calculation—a factor both today and a century ago. After a four-year study of the Treadwell T-10 legacy well, completed in 2005, a group of scientists argued that the emissions are "small and short-lived, particularly compared to other natural oil sources in the Santa Barbara Channel."[71] Instead of determining that the old wellheads are pollutive, they concluded that, "One of the important study conclusions was that observer perception can significantly affect perceived emissions of oil, and lead to emission estimates highly divergent from quantitative emission measurements."[72] In other words, spectators think they see more oil than is actually present, in turn leading to the belief that tideland drilling debris is extremely pollutive. To most people, oil flows look worse than they really are, both in the early twentieth century and today. One group

---

[69] SLC, "Final Environmental Impact Report for the Becker Legacy Wells," II-22; Leifer et al., "Oil Emissions from Nearshore and Onshore Summerland," ii.

[70] SLC, "Final Environmental Impact Report for the Becker Legacy Wells," II-53.

[71] Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," ii; Leifer, et al., "The Tidal Influence on Oil and Gas Emissions," 1499.

[72] Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," iii.

of scientists studying legacy well emissions at Summerland also noted in 2007, "We propose that perception plays a significant role in oil emissions estimates…There are many reasons that can lead observers to over-estimate oil emissions." Observations of oil spillage, which are often "gross overestimates," have nevertheless governed how the public has viewed the tideland drilling industry both in the early twentieth century and today.[73] When it comes to the long afterlife of drilling debris, what's pollutive or not pollutive is often a matter of perception and opinion.

The Pacific's sand, waves, and living organisms often adapt to the intrusion of crude in their environment. So it's an understatement to say that the ocean's response to oil spills is intricate—a fact that scientists have discovered in the wake of large disasters during the twentieth century. In 1989, for instance, millions of gallons of oil flooded Alaska's Prince William Sound. The catastrophic spill proved to be a scientific opportunity to study the effects of toxins in a marine ecosystem. Scientists discerned that "After the first few weeks, the oil was transported, transformed, and retained in ways that were often unexpected."[74] Upon noting the growth of biota that flooded into the ripped-open Exxon Valdez tanker, scientists concluded that the crude was actually invigorating certain forms of life, while killing others. "Which scenario was right? Oil as killer or oil as stimulus?" questions Jeff Wheelwright, who studied the mixed-bag of the spill's aftereffects in his book *Degrees of Disaster: Prince William Sound: How Nature Reels*

[73] Leifer, et al., "Oil Emissions from Nearshore and Onshore Summerland," 37.

[74] Rice et al. "The *Exxon Valdez* Oil Spill," 428.

and Rebounds. Wheelwright answers his own question: "Probably both."[75] Even years after the *Exxon Valdez* spill, there was no clear way to describe the disaster's long-term effects.[76] "The poor researchers," he writes, "They had a devil of an assignment untangling the threads of the oil spill from the living fabric of Prince William Sound."[77] Wheelwright concludes, "Petroleum was of the earth, and the earth was responding to it dynamically."[78] But this type of dynamic reaction, which is measured and studied over years, is difficult to explain to a public demanding the removal of old drilling debris.

In the twenty-first century, over 50 percent of the oil that pollutes the ocean is derived from human industries and activities, most of it flowing into the sea from boats, streets, cars, and marine vessels. Natural seafloor seeps account for the other half of crude in the ocean.[79] Of the portion that human's contribute, oil and gas production sites account for 6 percent. The oil that cakes our streets, parking lots, and factories drips and dribbles and joins the ongoing flow of water and sediment that continually moves from the land into the sea. In other words, chemicals surrounding us, on land, prove the most problematic in the twenty-first century.[80] Any oil that was once pumped from the seabed

---

[75] Wheelwright, *Degrees of Disaster*, 14.

[76] Haycox, "'Fetched Up,'" 219.

[77] Wheelwright, *Degrees of Disaster*, 30.

[78] "Our New Docks," Exhibit Panel Text, Charleston Marine Science Center, Charleston, Oregon, June 11, 2022; Wheelwright, *Degrees of Disaster*, 11.

[79] Trujillo et al., *Essentials of Oceanography*, 354; Leifer, et al., "The Tidal Influence on Oil and Gas Emissions," 1495.

[80] On histories of environment and human health, see Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2007); Brett Walker, *Toxic Archipelago: A History of Industrial Disease in Japan* (Seattle: University of Washington Press, 2010); Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1962); Greg Mittman, *Breathing Space: How Allergies Shape Our Lives and Landscapes* (New Haven, CT: Yale University Press, 2007); Kate Brown, *Plutopia: Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium*

ultimately returns to the ocean, but—now mixed with other chemicals picked up on land—in a more threatening form. It's an unwelcome homecoming.

Creosote

Crude oil was not the only material swirling around the drilling wharves, threatening the very organisms that used the structures for habitat. During the first half of the twentieth century, oil companies covered their wooden pilings in a thick black substance called creosote, a type of tar made from coal.[81] Other dock owners were applying the same thing to their marine technologies: from San Francisco Bay to Seattle's waterfronts, they slathered their pilings with creosote to discourage biofouling.[82] When applied onto the wooden pilings, creosote slowed the seawater's decay of the wood and effectively kept fungi and wood-boring pests, such as shipworms, from infiltrating the wood. For over a century, creosote was a cheap, accessible, and easy option for any company or individual constructing wooden infrastructure into the sea, be it a drilling wharf, dock, or pier.

As present-day scientists have discovered, however, creosote's toxic components do not stay put on the surface of the wood, nor do they discern between killing unwanted animals, such as shipworms, and other types of marine life. Polycyclic aromatic

---

Disasters (New York: University of Oxford Press, 2013); Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES*. (New Haven, CT: Yale University Press, 2011).

[81] H. J. Schaufele, "Erosion and Corrosion on Marine Structures, Elwood, California," *Proceedings of Conference on Coastal Engineering* 1 (n.d., ca. 1950), 327, 328, 331, 333.

[82] Dunagan, "Fish Affected."; "Our New Docks."

hydrocarbons (PAHs) bleed from the creosote and enter the seawater. PAH is also a component of crude oil, meaning marine life at the wharves could have been exposed to quantities coming from the wood, leaky seafloor wells and pipes, and natural oil seeps.[83] But PAHs in creosote arrive in a more toxic dose. Fish embryos, such as herring eggs, do not grow or hatch normally when exposed to even small amounts of PAHs.[84] PAHs can also affect marine species' immune systems and reproductive capabilities, and cause DNA damage, physical abnormalities, liver and skin lesions, fin erosion, and cancer.[85] It doesn't take much PAH seeping from creosote-treated pilings to pollute the marine environment up and down the food chain, either.[86] It leaches into everything: the shells of mollusks; the innards of crabs and sea stars; the muddy sediments; the delicate lining of fish eggs; and finally the bellies of bigger species. The organisms that lived on or around the drilling piers—sea stars, clams, mussels, tunicates, sea spiders, worms, and all sorts of fish—were being exposed to toxic chemicals from the very structures that provided them habitat. And yet despite that fact, contemporary studies have shown that PAH exposure is not necessarily worse for marine life near offshore platforms than those exposed to natural seafloor oil seeps.[87] Even once the Environmental Protection Agency began to regulate the use of creosote for marine structures, companies turned to treating

[83] Houseworth et al., "A Case Study of California Offshore Petroleum Production," 89.

[84] Christine Werme, Jennifer Hunt, Erin Beller, Kristin Cayce, Marcus Klatt, Aroon Melwani, Eric Polson, and Robin Grossinger, "Removal of Creosote-Treated Pilings and Structures from San Francisco Bay," California State Coastal Conservancy (December 10, 2010): 28.

[85] Ibid., 28-29.

[86] Dunagan, "Fish Affected."

[87] See Houseworth et al., "A Case Study of California Offshore Petroleum Production," 90.

their marine structures with copper or arsenic, which also proved harmful to marine life.[88] When it comes to toxicity in the ocean, it's rarely a straight-forward story.

In the early to mid-1900s, the companies that slathered creosote on their wharves were likely unaware of creosote's poisonous characteristics—its toxicity has been twenty-first century concern.[89] Even if oil drillers were aware of creosote's toxicity, there is no evidence to indicate that they would have stopped applying it to their wharves. Because drilling companies used creosote on their piers at Ellwood and likely at every other drilling pier in Southern California, it would have affected the creatures that lived on the wharves and swam in the nearby during the 1920s, 1930s, and 1940s, or until the wharves fell apart and washed away.[90] The wooden pilings at Ellwood, Ventura, Summerland, and other locations are now largely gone, meaning the creosote from those piers no longer leach toxins into the local shoreline.

Although most of Southern California's drilling piers have washed away, creosote from old pilings continues to leach into bays up and down the northeast Pacific Ocean, including in Puget Sound and San Francisco Bay. And yet, because the role of seafloor technologies in the marine environment slides between advantages and disadvantages, the removal of creosote-covered wood would mean reducing habitat for other species that rest on the old docks, including birds and sea lions. In turn, that wildlife attracts onlookers and tourists, meaning the docks have become not only habitat—albeit toxic habitat—but also a cultural resource for coastal populations who come to see the animals.

---

[88] "Our New Docks."

[89] Werme, "Removal of Creosote-Treated Pilings," vi, 23; 29

[90] Schaufele, "Erosion and Corrosion," 327, 328, 331, 333.

Thus, removing the piers in these locations is a controversial decision.[91] Likewise, creosote seeps into the environment slowly over time, sometimes made worse by disturbances. Well-meaning environmental groups could cause creosote contamination to peak during the dock's removal—the ultimate Catch 22.[92]

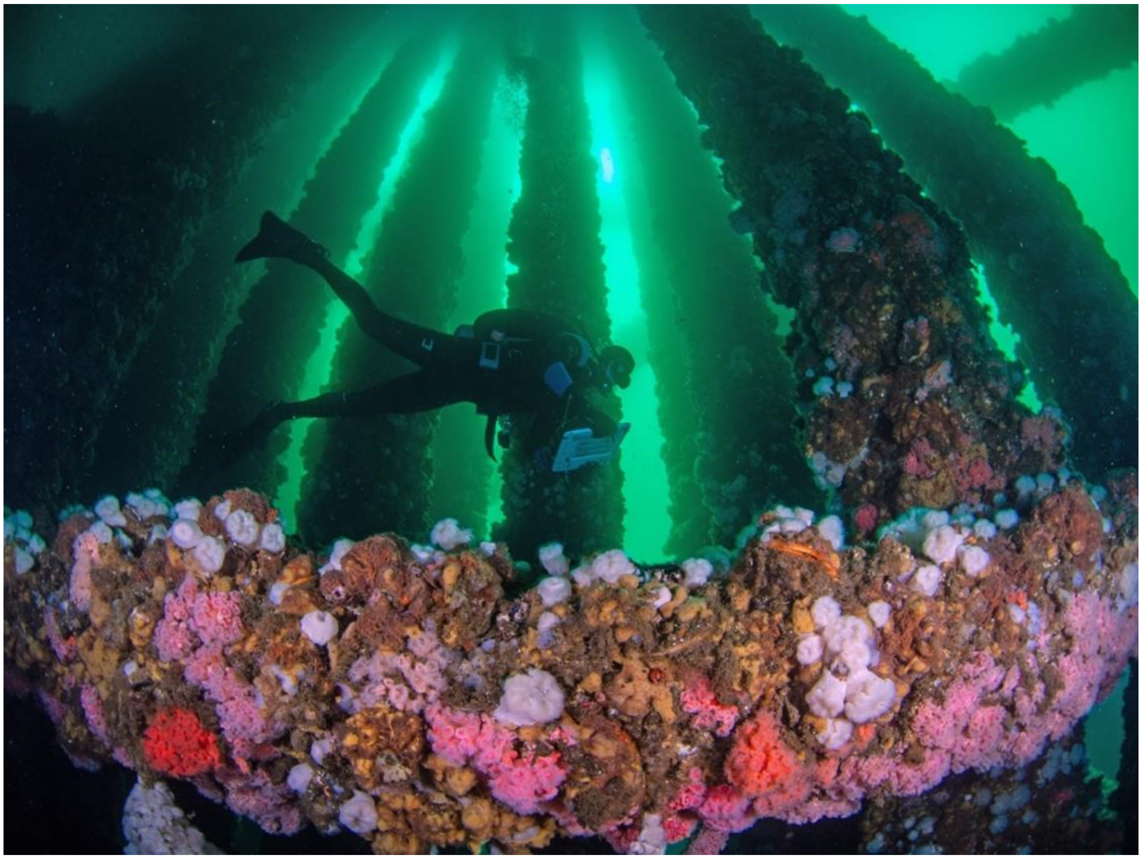


Figure 3.3. Marine organisms colonize the connectors of an offshore drilling platform in the Santa Barbara Channel. Photograph by Desmond Ho, image courtesy of Milton Love.

---

[91] Werme, "Removal of Creosote-Treated Pilings," 33.

[92] Ibid., 24

Rigs-To-Reefs

When it comes to aging machines in California's coastline, the State Lands Commission (SLC) has two big problems on its hands: the drilling debris that litters the intertidal zone—remnants of the first half of the twentieth century—and the much larger drilling platforms erected during the second half of the twentieth century, which sit deeper in state waters on the continental shelf. Although they are different technologies from different eras—with tideland piers booming before World War II, and offshore platforms arriving in the decades after—they share more characteristics than not. Both technologies procured oil and gas from the seabed, both leave infrastructure and debris in the ocean, and both have been largely unpopular among Californians. The question of whether to remove derelict and aging platforms is a divisive problem that pervades both nearshore and offshore industries.

Twenty-seven oil and gas platforms sit in federal and state waters off California's coastline, a relatively small number when compared to the roughly twelve-thousand platforms that dot the global ocean.[93] All of them are dead or dying, having reached the end of their technological usefulness. Once the platforms have pumped all that they can pump, their owners have two options. Option one is to sever the structure at the seafloor, cap the wells, and remove the structure completely. The second option is to leave the

[93] van Elden et al., "Offshore Oil and Gas Platforms," 1-9. A 2011 estimate stated there are 7,500 existing offshore rigs worldwide. See Peter I. Macreadie, Ashley M. Fowler, David J. Booth, "Rigs-to-Reefs: Will the Deep Sea Benefit from Artificial Habitat?" *Frontiers in Ecology and the Environment* 9, no. 8 (2011): 455.

base of the structure in the ocean, called the rig, to function forevermore as an artificial reef. The second option, to leave the rig in the water, is known as "rigs-to-reefs." In the first scenario, oil and gas companies would be removing the industrial debris and returning the ocean to something of its original state, although the wells, capped at the base of the seafloor, could forever leak oil and gas into the water column. In the second scenario, the marine life that has already established life on and around the rig—sea stars, urchins, tunicates, fish, sharks, and potentially invasive species—could continue to use the rig as habitat.[94]

In the mid-1980s, President Ronald Reagan and Congress passed a law, then a plan, for transforming obsolete offshore oil and gas platforms into artificial reefs.[95] Companies framing the Gulf of Mexico were the first to make artificial reefs out of rigs, which became a common practice acceptable to most states, communities, and companies involved.[96] Californians, however, didn't begin debating rigs-to-reefs options until the 1990s when Chevron retired four big platforms. Ultimately, Chevron removed all four of its platforms, not keeping a single one for artificial reefs, but their removal sparked a larger debate about what to do with California's other aging platforms in state waters.[97]

---

[94] Santa Barbara Maritime Museum, "What Should We Do with Decommissioned Platforms?" Exhibit Panel Text, Visited October 22, 2018; Jørgensen, "Environmentalists On Both Sides," 62; Anja Schulze, Deana L. Erdner, Candace J. Grimes, Daniel M. Holstein, Maria Pia Miglietta, "Artificial Reefs in the Northern Gulf of Mexico: Community Ecology Amid the 'Ocean Sprawl,'" *Frontiers in Marine Science* 7 (2020): 1.

[95] Villere C. Reggio Jr., *Rigs-To-Reefs: The Use of Obsolete Petroleum Structures as Artificial Reefs* (New Orleans: U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, 1987), 2-3.

[96] Sean van Elden, Jessica J, Meeuwig, Richard J. Hobbs, and Jan M. Hemmi, "Offshore Oil and Gas Platforms as Novel Ecosystems: A Global Perspective," *Frontiers in Marine Science* 6 (September 2019): 2; Reggio Jr., *Rigs-To-Reefs*, 6.

[97] Jørgensen, "Environmentalists On Both Sides," 56-57.

Not one company has applied to decommission their rig under California's 2010 updated rigs-to-reefs program. The permitting, the companies claim, has proven far too difficult and therefore unworthy of their effort.[98] Unlike the Gulf of Mexico, where oil and gas companies in Texas and Louisiana have received broader support from the state and public to convert hundreds of old rigs into artificial reefs, the conversion process off the coast of California's has drawn much stronger controversy.[99] In California, one camp has vehemently argued that the rigs should stay in the ocean to provide a source of habitat; on the other side of the debate are those who argue that the rigs are continual source of marine pollution and thus should be removed.

Opponents of artificial reefs argue that oil platforms are not only aesthetically ruinous to an otherwise beautiful shoreline, but they're also a form of toxic trash.[100] Carla Frisk, a board member for anti-oil organization formed after the 1969 spill, *Get Oil Out!* told a local newspaper "[Oil and gas companies] agreed to take everything away, and they should take everything away."[101] This industrial trash, opponents say, like other sources of pollution in the ocean, were forced upon the marine environment without the broad approval of the public nor the ocean's marine organisms. Consider Platform Gina, for instance, a drilling structure on California's outer continental shelf first installed in 1982.[102] All sorts of chemicals and materials drain from Gina into the surrounding

---

[98] Phil Willon, "Failures of California's First Plan to Stop Offshore Oil Drilling Cast Shadow Over New Efforts," *Los Angeles Times*, November 29, 2021.

[99] Jørgensen, "Environmentalists On Both Sides," 56.

[100] Ibid., 56, 52.

[101] Yamamura, "Say So Long to Santa Barbara's Offshore Platforms."

[102] Houseworth et al., "A Case Study of California Offshore Petroleum Production," 30.

seawater: oil, grease and traces ethyl benzene, ammonia, phenol, polycyclic aromatic hydrocarbons (PAHs), arsenic, cyanide, cadmium, and metals. Mounds of toxic drilling muds and other trash litter the seafloor around the old rig, to boot.[103] In 1991, one of Gina's pipes spilled fifty barrels of oil into the sea, adding to the effluents swirling about the platform's tall metal legs.[104] It is not alone with her leakage. Other platforms sitting in federal waters dispense effluent, a perfectly legal practice outside state waters.[105] In a state where millions of people live near or visit the coastline, and where thousands of people remember the devastating 1969 Santa Barbara spill, these continual spills matter significantly.

And yet despite all of the toxic effluents swirling about, marine life is drawn to Gina's intricate metal rigging—a place for mating, hiding, sleeping, and anchoring. The other twenty-six platforms near California's coastline offer just the same. "Imagine the best tide pool you've ever seen, flipped from horizontal to vertical," writes John McKinney for *Pacific Standard*. The rigs support such a great variety and abundance of invertebrates and fish that it functions as a "de factor marine reserve."[106] Not only is marine life drawn to life at the rigs, but studies have shown that certain species even reproduce at higher rates in the jungle of metal connectors.[107] After sitting on the seafloor for decades, entire lineages of mobile and sessile species call these rigs home. The

---

[103] Willon, "Failures of California's First Plan."

[104] Ibid., 76.

[105] Houseworth et al., "A Case Study of California Offshore Petroleum Production," 68-70, 74, 90, 91.

[106] John McKinney, "After the Oil Runs Out: Rigs to Reefs," *Pacific Standard,* July 14, 2017.

[107] Houseworth et al., "A Case Study of California Offshore Petroleum Production," 84, 90.

communities of fish found near rigs are somewhere between twenty to fifty times larger than those nearby in the open water.[108] In one study, fish removed and relocated from one platform to a nearby natural reef quickly returned to their original habitat. Scientists call the organisms' return "site fidelity," and some individuals show it more than others. Studied over two years, the widow rockfish showed strong site fidelity to platforms in the Santa Barbara Channel, meaning they returned and returned again. Some groundfish are known to travel between the platforms, like traveling from island to island. Rockfish, in particular, seem to prefer the offshore platforms over naturally occurring reefs—the same species that also frequent the tideland drilling debris located nearer to the beach. At the offshore rigs, baby rockfish swim near the top while the juvenile and adult rockfish frequent the base.[109]

But the rockfish aren't the only species known to frequent rigs. The cowcod looks something like an overstuffed stuffed animal—enlarged lips, protruding eyes, and an orange, bulbous body. In the Santa Barbara Channel, it frequents the platform's rigs alongside lingcods and bocaccio fish. Here, the three over-fished species seek refuge among the metal grids, which provide intricate nooks and crannies from which to hunt and hide. Research has concluded that for certain groundfish, offshore platforms "may be of higher quality to some individuals than natural reefs."[110] And no organism displays

---

[108] McKinney, "After the Oil Runs Out."

[109] Caselle, et al., "Trash or Habitat?" S263; Christopher G. Lowe, Kim M. Anthony, Erica T. Jarvis, Lyall F. Bellquist, and Milton S. Love, "Site Fidelity and Movement Patterns of Groundfish Associated with Offshore Petroleum Platforms in the Santa Barbara Channel," *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 1, no. 71-89 (2009): 72, 85.

[110] While some fish species are found near platforms, they do not necessarily have a higher degree of site fidelity. See Lowe et al., "Fidelity and Movement Patterns," 71, 72, 85.

more loyalty than the sessile ones—sponges, barnacles, mussels, tunicates—for once they have anchored themselves to a surface, they aren't going anywhere.

Proponents of rigs-to-reefs see the utility of converting the platforms into permanent habitat, not because they support offshore oil and gas drilling, but because they support marine life. After all, for the millions of anchored and mobile organisms living on the structure, the rig is *already* their permanent habitat. It's their home now. Those who favor artificial reefs recognize the heart of the dilemma: they cannot remove the very structures that millions of individual organisms have already colonized. When it comes to balancing the pros and cons, then, the toxicity of the rigs is a drawback that does not necessarily outweigh their service as habitat. As one set of scientists wrote about offshore platforms, "any adverse impacts of intentional fluid discharge are less than the advantages afforded by the platform environment."[111] The same holds true for tideland drilling debris closer to the shoreline—yes, some crude and creosote may linger around the materials, but the amount is not catastrophic, nor even immediately important when compared to other environmental pollutants flowing into the Pacific's ecosystems. Having spent an entire career studying the life that thrives on offshore rigs, one oceanographer reported, "These platforms are habitat for millions of animals. My opinion is that it's immoral to kill huge numbers of animals in any kind of habitat."[112] For many people, the rigs symbolize life, not pollution.

---

[111] Houseworth et al., "A Case Study of California Offshore Petroleum Production," 86.

[112] Jean Yamamura, "Say So Long to Santa Barbara's Offshore Platforms," *Santa Barbara Independent*, January 1, 2019.

Ultimately, the decision to decommission and leave an offshore rig as artificial reef, or remove it completely, often comes down to personal preferences. As historian Dolly Jørgensen points out in her research on the rigs-to-reefs debate, "Both sides could claim (and rightfully so) that they were doing what was best for the environment; yet deciding what was best was a value judgement." As the history of seafloor drilling infrastructure shows, it's not purely a question ecology—that's over-simplifying the point. "As a whole," Jörgensen continues, "the [rigs-to-reefs] debate centered on different versions of nature, rather than on scientific knowledge."[113] The same debate surrounds the tideland drilling materials close to shore, except that controversy first erupted sixty years earlier and lingers into today. Science and technology studies scholars call this difference of environmental opinions "enactment"—both sides seek a healthier sea, but they vary in their personal definitions of what is natural, and what is not.[114]

No matter the outcome of platforms caught in the rigs-to-reefs debate, no option will undo the past. And unfortunately, there doesn't appear to be a strong industry opinion on the eventual outcome of aging offshore platforms that sit in the ocean right now. "There is little consensus on best practices for decommissioning," concludes one group of scholars.[115] One hundred and twenty years since the first drills pierced the seafloor, the industry is still unsure what to do with their aging machines. The physical remnants of the offshore oil industry, particularly the wellholes, will never completely go away. It's an ocean altered, a seafloor pierced, bled of millions of gallons of fossil fuels

---

[113] Jørgensen, "Environmentalists On Both Sides," 52.

[114] Ibid., 53.

[115] Macreadie et al., "Rigs-to-Reefs," 455.

then plugged and capped like a Band-Aid to a wound. The state can never fully remove these old wells, no matter how much taxpayer monies they throw at the problem. One truth is clear when it comes to the last century of California's coastal oil drilling: the seafloor, once industrialized, does not easily return to its original state. It's an environment transformed, permanently.

Conclusion

While oil and gas drillers made swiss cheese out of the tideland's subterranean layers, marine species responded in no single way. In some instances, the intrusion of crude oil, wooden pilings, metal casings, and industrial chemicals harmed habitat and exposed immobile invertebrates, such as barnacles or clams, to doses of toxic chemicals. On the other hand, the majority of tidal species like sea stars, sponges, algae, periwinkles, mussels, crabs, and numerous fish—always in search of a hard surface from which to feed, hide, or hunt—benefitted from the added habitat of drilling piers. And still others had a neutral response to the industrial intrusion. Kelp, for example, neither flourished nor succumbed to the influx of pipes, wood pilings, and globs of crude. In the end, tideland drilling machinery and its century of persistent debris did not cause an ecological catastrophe, but it has caused an expensive and ongoing clean-up operation.

In the grand picture of the ocean's health in the twenty-first century, abandoned legacy wells in the intertidal zone are a relatively small problem. And yet, the SLC will continue to spend millions of dollars to plug legacy wells like Becker's—small holes that contribute some pollution, but not a substantial amount.[116] By comparison, For all the past and present focus on the machines that tap the seafloor along California's coastline—wharves, directional drilling rigs on beaches, drilling islands, offshore platforms, abandoned wells—these machines are a visible reminder of oil pollution in the ocean, but they are not the primary source of it. "The amount of road oil and improperly disposed oil regularly discharged each year into U.S. waters as non-point source pollution is as much as one-and-a-half times the amount of the *Deepwater Horizon* oil spill!" write two oceanographers, seemingly exacerbated by peoples' misperceptions about the source of marine pollution.[117] Despite that fact, the SLC is buoyed by funding and public support to remove the remnants of tideland drilling infrastructure. To the Californians who own property near the shoreline or access it for health and recreation, it's trash worth trashing. And yet rockfish, anemones, limpets, and mussels may not agree if we were able to ask them, and they were able to answer.

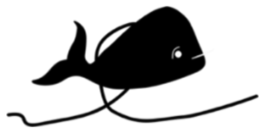
---

[116] California is expected to pay significantly more—over $21.5 billion—to plug improperly abandoned oil and gas wells and sites on land. See Mark Olalde, "California Will Need $21.5 Billion to Clean up Its Oil Sites. Who's Going to Pay for It?" *High Country News*, May 23, 2023, https://www.hcn.org/articles/energy-industry-california-will-need-215-billion-to-clean-up-its-oil-sites-whos-going-to-pay-for-it.

[117] Trujillo et al., *Essentials of Oceanography*, 362.

CHAPTER IV

LIFE ON THE CABLE



"Hove to!" yelled one of *Burnside*'s sailors as the crew struggled to steady the ship against the Gulf of Alaska's cold wind. In 1909, the men found themselves rushing around the decks of a ship repurposed for installing submarine telegraph cables. But instead of installing a new cable, they were on a mission to fix a line already sitting on the seafloor of the continental shelf. The trouble started a few weeks before when telegraph operators in Seattle and Valdez noticed that messages clogged between the two cities, halting the only method of fast communication between Alaska and the Lower Forty-Eight. At rest in the dark depths of the northeast Pacific Ocean, the operators could only speculate what might be slowing the cable's messages. The U.S. Army Corps dispatched the *Burnside* to determine the problem.[1]

Sea lions, curious as always, popped their heads just above the water's surface. Fishing vessels were a normal sight here, but the *Burnside* appeared to be doing something altogether different. The crew pushed a large metal hook, called a grapnel, over the side of the ship. On its journey to the seafloor, the grapnel passed life of every size: whales, pollock, shrimp, halibut, urchins, microbes. The sailors waited blindly on deck for the line to cease unreeling, indicating the grapnel had reached the seafloor many

[1] "Whale Strangled Self," *Athena Press*, November 5, 1909.

hundreds of feet below. The *Burnside* steamed back and forth, to and fro, scraping the grapnel along the seafloor until the slightest bit of tension on the line indicated a successful snag of the telegraph cable.[2]

The *Burnside*'s crew had performed this task before: hook the cable, pull up the cable, cut out the damaged section, and splice in a new segment. But on this round, efforts to pull the cable to the ocean's surface required a perplexing degree of heave-ho. "The crew had never had such a time hauling a cable on board as they did that day on the Alaska coast," reported the *Athena Press*. Once the cable finally emerged at the surface, the sailors quickly understood what the hang-up was all about—this very same problem had happened a few years before.[3] For tangled within the cable was the body of a large whale, the line binding the flesh of the whale's decomposing head. In such a state of deterioration, the sailors could only speculate on its type: sperm, blue, bowhead, beaked, right, fin, sei, humpback, minke, or gray?[4] Likely, it was a sperm whale, who feed, mouths open, along the seabed.[5] Whatever the species, the *Athena Press* put the responsibility directly on the whale: "the fish proved himself his own hangman," it reported.[6]

---

[2] Undersea cables, submarine cables, seafloor cables are terms I use interchangeably in this chapter to reference undersea telegraph cables.

[3] "Fish Story," *Morning Astorian*, January 25, 1905; "Whale Strangled Self," *Athena Press*; Bruce K. Heezen, "Whales Entangled in Deep Sea Cables," *Deep Sea Research* 4 (1957): 106-107.

[4] "Whale Strangled Self," *Athena Press*; Heezen, "Whales Entangled," 108.

[5] A sperm whale entangled in a deep-sea cables proved that the cetacean could dive to depths of 3,720 feet. See Heezen, "Whales Entangled," 105.

[6] "Whale Strangled Self," *Athena Press*.

Submarine telecommunications cables have rested in the depths of the northeast Pacific Ocean for over one-hundred and thirty years. A technology that has connected colonial and financial outposts around the world, scholars have predominantly studied telegraph cables through the lens of imperialism.[7] "Telegraphy = globalization, the history of wiring the world commencing with the Atlantic cable of 1866 seems to suggest," writes historian Simone Müller.[8] Scholars have this interpretation spot on: submarine cables were both a product and facilitator of globalization; the two went hand-in-hand. Glance at almost any primary source from the nineteenth and early twentieth centuries, and you'll find cable promoters from the United States, continental Europe, and the British Empire linking undersea telegraph cables with a global colonialist project. In 1898, for example, cable engineer Charles Bright encouraged "English-speaking and English-governed countries" to lay transoceanic cables for the "national, inter-colonial, and Anglo-American" cause.[9] Bright's message was common.[10] And yet submarine cables weren't *only* figurative technologies representing imperial expansion. They were

---

[7] On submarine cables and global colonialism, see Daqing Yang, *Technology of Empire: Telecommunications and Japanese Expansionism in Asia, 1883–1945* (Cambridge, MA: Harvard University Press, 2010); Simone M. Müller, *Wiring the World: The Social and Cultural Creation of Global Telegraph Networks* (New York: Columbia University Press, 2016); Nicole Starosielski, *The Undersea Network* (Durham, NC: Duke University Press, 2015); Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981); Jean-Guy Rens, *The Invisible Empire: A History of the Telecommunications Industry in Canada, 1846-1956*, trans. Käthe Roth (Montreal: McGill-Queen's University Press); Robert W. D. Boyce, "Imperial Dreams and National Realities: Britain, Canada and the Struggle for a Pacific Telegraph Cable, 1897-1902," *English Historical Review* 115, no. 460 (Feb., 2000): 39-70.

[8] Simone M. Müller, "From Cabling the Atlantic to Wiring the World: A Review Essay on the 150th Anniversary of the Atlantic Telegraph Cable of 1866," *Technology and Culture* 57, no. 3 (July 2016): 508.

[9] Charles Bright, *Submarine Telegraphs; Their History, Construction, and Working* (London: C. Lockwood and Son, 1898), 151.

[10] See also, for example, Agnes Giberne, *The Romance of the Mighty Deep* (Philadelphia: J. B. Lippincott Company, 1905), Chapter 16.

physical objects, too, which embarked on a biotic afterlife once they landed on the seafloor.

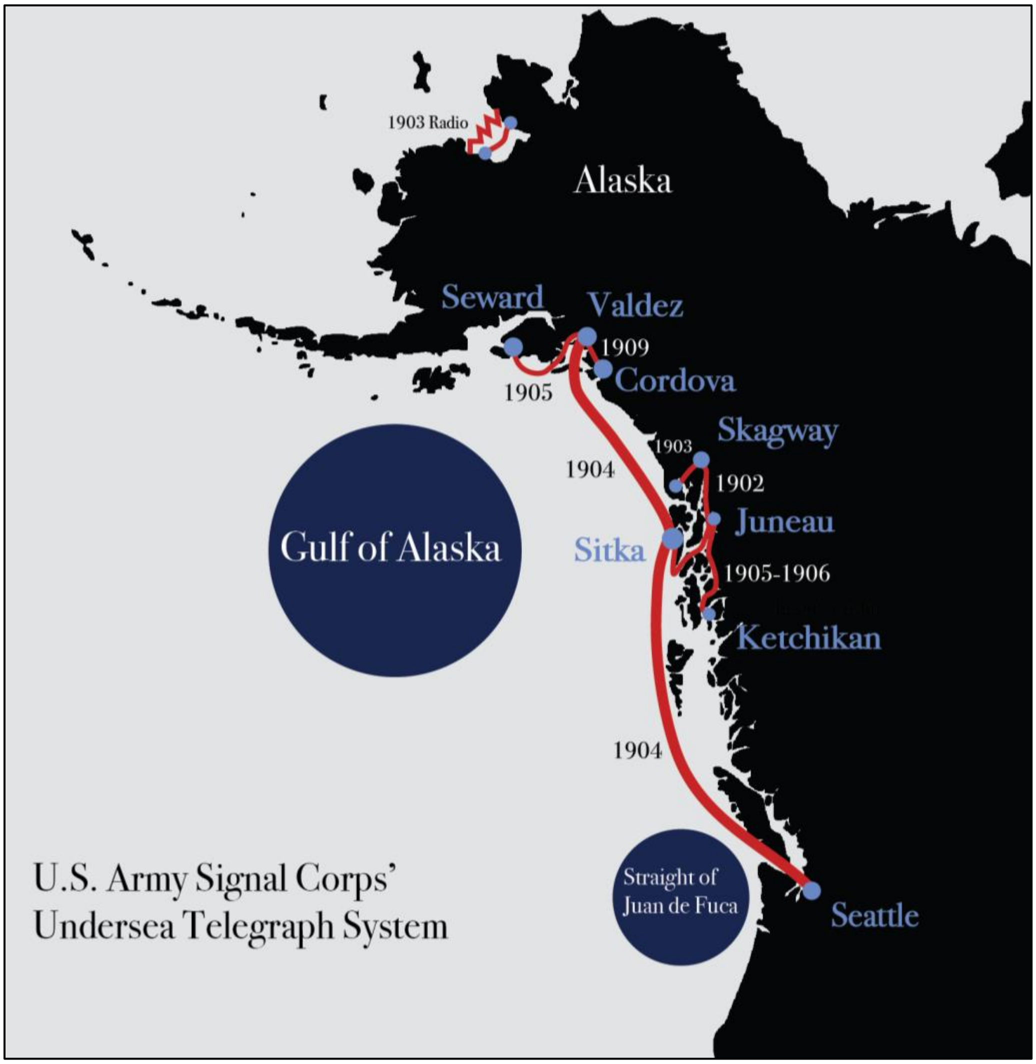


Figure 4.1. U.S. Army Signal Corps' early twentieth-century undersea telegraph system in the Gulf of Alaska. The red lines show the route of the Alaska submarine cable system. Image by the author.

Shifting away from telegraphy = globalization, the following two chapters ask and answer something altogether different: once installed on the seabed, how has marine life interacted with submarine cables? What happens when old or broken cables are abandoned in the ocean, and is that a cause for public concern? The answer to the first question should come as no surprise: marine life has colonized the cables, procreated around the cables, found shelter near the cables, and died by the cables. For ocean-dwelling organisms, a cable's hard surface has presented an opportunity to anchor down where surfaces are sometimes scarce. Similar to the drilling piers in Southern California, it's the sessile species such as anemones, tunicates, mussels, sea stars, urchins, and algae that are the first to arrive and the last to leave.[11] For them, the cable is home. These species approach the cable mildly and integrate the machine into their watery world. Their aim is not to break, but to seize. Thrust together, cables and marine life amalgamate, spurring the cable into a biotic afterlife on the seabed. As months and years pass, the cable transforms into an object that is part machine, part ecosystem. In this second story, far away from human eyes, marine life and undersea cables interacted and intermingle—sometimes with deadly consequences, like the decomposing whale, but usually not. Humans historically only caught a glimpse of this interaction if the technology resurfaced.

The Alaska submarine cable system, the one in which the whale met its death in 1909, is an ideal system to explore the historical interplay between of cables, marine life, and the seabed. First completed in 1904 and expanded in the decades thereafter, the Army Signal Corps constructed an expansive land and terrestrial cable system to connect remote areas of Alaska to the Lower Forty-Eight. Named the Washington-Alaska

[11] Bastien Taormina, Juan Bald, Andrew Want, Gérard Thouzeau, Morgane Lejart, Nicolas Desroy, Antoine Carlier, "A Review of Potential Impacts of Submarine Power Cables on the Marine Environment: Knowledge Gaps, Recommendations and Future Directions," *Renewable and Sustainable Energy Review* 96 (2018), 385; Christoph Kraus and Lionel Carter, "Seabed Recovery Following Protective Burial of Undersea Cables – Observations from the Continental Margin," *Ocean Engineering* 157 (2018): 251, 259; Blue mussel *Mytilus edulis* colonizes cables in North Pacific. See A. Marty, C. Berhault, G. Damblans, J.-V. Facq, B. Gaurier, G. Germain, T. Soulard, F. Schoefs, "Experimental Study of Hard Marine Growth Effect on Hydrodynamical Behavior of a Submarine Cable," *Applied Ocean Research* 114 (2021): 4.

Military Cable and Telegraph System (WAMCATS), which changed to the Alaska Communications System (ACS) in 1936, I refer to it here by the more popular phrasing that newspapers employed: the Alaska cable.[12] Although singular, the "cable" system included one backbone cable with many branching, shorter cables. The main stem cable was nearly one-thousand miles (1,609 km) long and followed the seafloor of the continental shelf from Sitka down to Seattle. The branching cables connected the main stem to various towns around the Gulf of Alaska. The entire Alaska system included 2,524 miles (4,062 km) of submarine cable—enough line to stretch the entire width of the U.S. from Los Angeles to New York City.[13]

Despite its scale, few historians have studied the Alaska cable system—but they should.[14] The Northeast Pacific, a tectonically active region, creates a burst of new records every time a cable break occurred and the Signal Corps deployed its cable ship to fix a fault. Plus, the U.S. Army Signal Corps owned and operated the system until 1962 when the U.S. Air Force operated it for a brief time. In 1970, Radio Corporation of America purchased the ACS, marking the system's passage into private hands.[15] The

---

[12] In addition to telegraph cables, the system included a few miles of wireless radio connection and dozens of telegraph offices. See Robert D. Jones, "The Washington-Alaska Military Cable and Telegraph System," *Alaska-Yukon Magazine* (1907)—Box 11-9, State Library Historical Collections, Alaska State Library, Juneau, Alaska; "The Alaska Cable Service," *Daily Alaskan*, October 16, 1907; Rebecca Robbins Raines, *Getting the Message Through: A Branch History of the U.S. Army Signal Corps* (Washington, D.C.: Center of Military History, U.S. Army, 1996), 236; "CO ACS SEATTLE WASH," MS 11 11-9-3 ACS History, Sample Forms, Station Diagrams, and Miscellaneous Records, 11-9, U.S., Alaska Communication System News Clippings/Publications, 1900-1958, Alaska State Library – Historical Collections, Juneau, Alaska.

[13] "The Alaska Cable Service," *Daily Alaskan*. One scholar reported 2,128 miles (3,425 km) of undersea cable. See David Eric Jessup, "Connecting Alaska: The Washington-Alaska Military Cable and Telegraph System," *Journal of the Gilded Age and Progressive Era* 6, no. 4 (Oct. 2007): 407.

[14] Exceptions include Raines, *Getting the Message Through* and Jessup, "Connecting Alaska."

[15] "Submarine Phone-Cable System Ordered for Southeast Alaska," *Seattle Times*, June 12, 1969, MS 11-5 ACS News Items and Clippings Jan.-June 1969, State Library Historical Collections, ASL; Jessup, "Connecting Alaska," 407.

Signal Corps' WAMCATS and ACS papers are now publicly accessible in the state library at Juneau, Alaska. There, on public view, the records provide us a window into the cable's existence in the ocean and the extremes the Army Signal Corps undertook to keep it safe down there.

The Alaska system is largely forgotten now, but it was downright popular in the first half of the nineteenth century. As the Army Signal Corps installed, expanded, and repaired the system during from the early 1900s until the 1960s, readers in the Pacific Northwest consumed newspaper accounts and scientific reports about the cable's existence on the shelf. And because any private resident or company could send a telegraph on the system, the cable proved to be a lifeline for both the military and private citizens alike. The system was "part and parcel of the Alaska scene" and now central to the lore of Alaskan history.[16]

This history shows that submarine telegraph cables were a far more popular technology than the tideland drilling piers the delivered oil and gas from California's seafloor. Why? As the chapter explores, when it comes to technologies on the seabed, the public held two different expectations for the shoreline in comparison to the continental shelf. In California, drilling machinery invaded a picturesque beach, often contributing new oil slicks, bad smells, and unsightly debris. Submarine cables, on the other hand, occupied a deeper region of the seabed, an environment where few claimed access or ownership. Inert with a low profile, submarine cables were out of sight, out of mind. Because of their subtlety, the public was free to imagine submarine cables in an environment that was equal parts foreign and enigmatic. Submarine cables inspired

---

[16] "ACS Oversees 48th Anniversary in Alaska Service," *Nome Nugget*, May 26, 1949; "New Cable is Needed," *Cordova Daily Times*, February 23, 1922.

Americans to dream about the cable's host environment, the Pacific seafloor, without having to worry about the technology restricting their access to the beach. The submarine telegraph cable, they understood, was going where no man had ever gone before. Even a dead whale, hanged after a fearsome fight with a cable, only added to the machine's allure.

Wiring the Shelf

In the early twentieth century, telegraph cables occupied an environment their owners knew very little about. Cable-layers understood that rocks and other debris naturally fell from the coastline down onto the seabed, resulting in a floor that could be variously muddy, sandy, or rocky.[17] They knew that marine life blossomed in the shelf's waters because lifegiving sunlight reached towards the bottom. And they recognized that the shelf served as a halfway zone between the shoreline and the abyss, a "kind of borderland under the sea, connecting dry land with the greater ocean-depths," as one naturalist described it.[18] Beyond those basics, however, the shelf's geology still remained something of a mystery. How the shelf formed in the first place prompted serious debate—did so much debris fall from the land that the seafloor was "built up" and grew taller and taller? Or did the ocean's rough currents chip away at the edges of the

[17] U.S. Geological Survey, "Thirteenth Annual Report of the United States Geological Survey, 1891-92" (Washington, DC: Government Printing Office, 1893), 121.

[18] Giberne, *Romance of the Mighty Deep*, 21.

continents to form a ledge?[19] Lingering mysteries about the seabed's formation and movements perplexed scientists into the twentieth century.

Thanks to later discoveries in the field of plate tectonics, we now know that the shelf is an extension of the same granitic rock that makes up the continents, unlike the igneous basalt that comprises the deepest seafloor of the abyssal plains. The ocean has so much seawater that it spills past its edges and onto the continent—like water sloshing over the edge of a sink onto a counter. The magnitude of that water is so great that there appears to be a seamless transition between the seawater above the continental shelves and that of the abyssal ocean below.[20] It's interesting to realize that when fish, sharks, and whales swim along the continental shelves, they are technically traveling over land.

The shelf hosts the ocean's most boisterous marine party. Everyone is here: plants and algae, big fishes, little fishes, corals, swimming predators, flying predators. Vital to the shelf's popularity is the availability of sunlight, which penetrates below the surface of the water into the deeper column. At 660 feet below (201 m), sunlight becomes faint to the human eye. Feeble sunbeams can reach 3,300 feet down (1,005 m), after which the ocean is totally dark, abysmally so. But the sun's rays still reach the seafloor along most world's continental shelves, which are on average four-hundred feet deep (122 m).[21] This sunlight supports a lavish buffet of food resources, which entices a variety of species

---

[19] Fridtjof Nansen, *The Norwegian North Polar Expedition 1893-1896* (Christiania, Denmark: A. W. Brøgger, 1904), 100, 103, 132; Ernest Ingersoll, *The Book of the Ocean* (New York: Century Co., 1898), 11.

[20] Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography*, 12th edition (Boston: Pearson, 2017), 24, 88.

[21] Helen Scales, *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat That Imperils It* (New York: Atlantic Monthly Press, 2021), 3; Trujillo et al., *Essentials of Oceanography*, 88.

otherwise unrelated to each other. Oceanographer John Murray called the continental shelf "the great feeding-ground of the ocean."[22] Comparably verdant environments on land include the wet rainforests and lush riparian environments framing riverways. In all of these ecosystems, species pack in, feasting on nutrients.

The first telegraph cables were intended for use on land, not the ocean, however. Invented in the late 1830s by Samuel B. Morse, the telegraph machine increased the speed of communication between two terrestrial locations by sending a set of electrical pulses through a protected copper wire.[23] Other contemporary inventors produced similar machines, but Morse's technology was compact and included its own signaling code.[24] Morse Code, they called it. Electrical pulses appeared as dots and dashes (. __ __ …. .__ __ …. .__ __ …. __ __ . .. __ .. .__ __ … .. ..__ __ __ . …. __) with each arrangement representing individual letters.[25] When written down in sequence and translated, these electrical pulses transformed into words and sentences. Morse's telegraph was beyond useful—it was revolutionary.[26] In an era when messages normally took weeks or months to reach their destinations via train, horse, or boat, a telegraph message required just minutes. In an emerging era of global communication, a cable's

---

[22] John Murray and G. V. Lee, *The Depth and Marine Deposits of the Pacific* (Cambridge, MA: Harvard College, June, 1909), 160-161.

[23] U.S. War Department, *Annual Report of the Chief Signal Officer 1902* (Washington, DC: Government Printing Office, 1902), 17.

[24] Rens, *Invisible Empire,* 9.

[25] Morse's first telegraph message transmitted between Baltimore and Washington, D.C. stated "What Hath God Wrought?" See "First telegraphic message—24 May 1844," Library of Congress, accessed March 22, 2022, https://www.loc.gov/resource/mmorse.

[26] For a study of scientific revolutions, see Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd edition (University of Chicago Press, 1970), although the telegraph is not mentioned in Kuhn's book.

ability to move information quickly made it an indispensable machine. By the mid-nineteenth century, the U.S. alone boasted approximately one hundred thousand miles (160,934 km) of terrestrial telegraph lines.[27] Communicating via a long wire was a technological leap that was here to stay.

A handful of entrepreneurs wondered if the telegraph could connect not only cities, but also continents. With little adaptation to the terrestrial cable design, they began by dropping a telegraph line down into the ponds, rivers, and shallow bays near their homes.[28] "If I braid four copper wires instead of just two," one would wonder, "could I more clearly hear a signal as far as the lighthouse?" If the signal was weak, the inventor pulled the cable back to the surface to tweak its copper-to-rubber ratio.[29] Even Samuel Morse dabbled with underwater telegraph lines. As historian Bernard Finn has noted, "They moved blindly ahead, believing that landline techniques and equipment would suffice."[30] Failure was the name of the game—supplies, funding, and ships were hard to come by, ship anchors snapped cables, or signals never arrived at their intended destination.[31]

---

[27] Robert Luther Thompson, *Wiring the Continent: The History of the Telegraph Industry in the United States, 1832-1966* (Princeton, NJ: Princeton University Press, 1947), 9, 11, 440. For a history of wired technologies, see Gloria Calhoun, "Why Wire Mattered: Building U.S. Networked Infrastructures, 1845-1910," *Technology and Culture* 62, no. 1 (2021): 156-84.

[28] Newspapers reported on a submarine cable being laid between Port Townsend and Seattle and another between Victoria and Canada as early as 1872. See "Pacific Submarine Telegraph Cables," *New York Times*, November 13, 1872; Bright, *Submarine Telegraphs*, 2.

[29] Gloria Calhoun writes that 1845-1910 were "formative years for much wired-network infrastructures." Calhoun, "Why Wire Mattered," 159-160.

[30] Bernard Finn, "Submarine Telegraphy: A Study in Technical Stagnation," in *Communications Under the Seas: The Evolving Cable Network and Its Implications*, eds. Bernard Finn and Daqing Yang (Cambridge, MA: MIT Press, 2009), 14-15. See also, Neal Stephenson, "Mother Earth Mother Board," *Wired*, December 1, 1996, https://www.wired.com/1996/12/ffglass/.

[31] Bright, *Submarine Telegraphs*, 2, 13.

Figure 4.2. A sea anemone grows on a segment of the ATOC cable off the coast of Half Moon Bay, California. © 2003 Monterey Bay Aquarium Research Institute.

Despite the setbacks, by the 1850s, inventors and investors alike were ready to lay submarine cables across an entire ocean basin. The first and most famous transoceanic cable involved Cyrus W. Field, whose initial efforts to lay a cable across the Atlantic Ocean between Ireland and Newfoundland failed in 1857, 1858, and 1865, but finally proved successful in 1866.[32] That success not only allowed Britain and the United States to communicate in a matter of minutes, instead of weeks, but also validated the submarine telegraph industry in the world's eyes. With Field's success, all hands were on deck to wire the oceans—or the Atlantic, at least. By the turn of the twentieth century, thirteen transoceanic cables crisscrossed the Atlantic; the Pacific, by comparison, had not a single one.[33] When a private firm laid yet another transatlantic cable in 1869, the

[32] *The All Red Line: The Annal and Aims of the Pacific Cable Project*, ed. George Johnson (Ottawa: James Hope and Sons, 1903), 46-47; Müller, "From Cabling the Atlantic to Wiring the World," 508.

[33] Müller, "From Cabling the Atlantic to Wiring the World," 508; For other submarine telegraph histories, see Bernard Finn and Daqing Yang, "Introduction," in *Communications Under the Seas*, 6; Arthur C. Clarke, *Voices across the Sea* (New York: Harper and Row, 1974), ii, 13-14. In 1850, an unsuspecting fisherman cut the first submarine telegraph cable across the English Channel. In 1859, the British laid a

Sacramento Daily Union commented from the other side of the country, "the time may not be far distant when we shall have the Atlantic, and the Pacific also, gridironed with telegraph cables."[34] But as the nineteenth century turned into the twentieth there was still no transpacific line connecting North America to Russia or Asia, although there were some smaller submarine cables connecting coastal regions around the edge of the Pacific.[35]

There was good reason for cable-layers to pause at the shores of the Pacific Ocean. Its depth, breadth, and size placed this basin in a different league than the Atlantic. Due to the Pacific's dimensions, private companies would need support from their respective governments. In other words, they couldn't afford to go it alone. In the late 1800s and early 1900s, private firms owned and operated most submarine cables, although they often relied on government support in the form of financial subsidies, scientific data, legal protections, or landing rights. In 1898, one estimate put ninety percent of total submarine telegraph cable ownership squarely under the domain of a few large companies, while various governments around the world owned the remaining

cable through the Arabian and Red Seas to connect India with England, but this too failed, see Daniel R. Headrick and Pascal Griset, "Submarine Telegraph Cables: Business and Politics, 1838-1939," *The Business History Review* 75, no. 3 (Autumn 2001): 546, 554; *The All Red Line,* 47.

[34] "The New Cable," *Sacramento Daily Union* 37, no. 5715, July 22, 1869.

[35] For example, the U.S. military planned to install a submarine cable across the mouth of the Columbia River to connect Fort Canby and Fort Stevens in 1883. Untitled, *Daily Astorian*, September 8, 1883. The U.S. Congress also approved funding for a submarine telegraph to run between Fort Stevens to the lighthouse sitting atop Tillamook Rock, Oregon. See "Congressional Work Affecting this North Pacific Coast," *Daily Morning Astorian*, March 5, 1889. By the 1880s, coastal submarine cables connected Mexico to Peru, Chile, and the United States. See James D. Reid, *The Telegraph in America* (New York: John Polhemus Publiser, 1886), 522-525, File 1-D01.4, Container P, Bamfield Historical Society, Bamfield, Canada.

submarine cables.[36] Private companies and investors "lingered coyly on the shores of the Pacific," waiting on their governmental "life-belts" to help them lay the first transpacific cables.[37] Finally, a half-century after the Atlantic received its first transoceanic cable, British and American companies—with varying degrees of governmental support—undertook two separate transpacific cable projects that connected the west coast of North America to Asia. The British finished their line in 1902, the Americans in 1903.[38] Despite the clear lag behind the transatlantic cables, the industry was particularly proud of these new transoceanic lines. In 1903, the British Telegraph Construction and Maintenance Company noted that their awe-inspiring line between Bamfield, Canada, to Fanning Island "is not only the longest span of cable in existence, but also one of the last links in the chain of submarine cables now encircling the globe."[39] At last, the Pacific was wired.

With two new, privately-owned cables connecting North American with Asia, the U.S. government turned its attention to the Alaskan territory, whose population was growing, and fast. This wasn't just any population, however. The Alaskan newcomers were known to be rowdy. "With the discovery of gold in the Klondike in 1896 and Nome

---

[36] Bright, *Submarine Telegraphs*, 154-155; Edward J. Malecki and Hu Wei, "A Wired World: The Evolving Geography of Submarine Cables and the Shift to Asia," *Annals of the Association of American Geographers* 99, no. 2 (April 2009): 360-361.

[37] Herbert Laws Webb, "Proposed Cables under the Pacific," *The Engineering Magazine Co*. 6 (October 1893-March 1894), 848.

[38] The Commercial Pacific Cable Company laid and owned the transpacific American cable line. See *Western Union Telegraph Company vs. Commercial Pacific Cable Company, Supreme Court of the State of California*, S. F. No. 864, March 22, 1916, pp. 4-5, Box No. B-48, Collection No. 205, Series 11: Law Department Records, 1868-1979, Western Union Telegraph Company Records, National Museum of American History, Smithsonian Institution, Washington, D.C.

[39] *The Telegraph Construction and Maintenance Company Limited* (London: Maclure, 1903), p. 4, Box 835, Western Union Telegraph Company Records, National Museum of American History, Smithsonian Institution, Washington, D.C.

in 1898," reflected the *Nome Nugget*, "thousands of prospectors stampeded to Alaska bringing with them the gamblers, robbers and other lawless elements who prey on new frontiers." These supposed miscreants with their "strife and killings that went on in the roaring camps" threatened the successful development of the new territory.[40] The unregulated lawlessness combined with a booming settler population proved to be a dangerous combination in a location so removed from federal oversight. The U.S. government seemed to place most of its concern on the territory's new arrivals, rather than its oldest residents. Indigenous nations were established in the Gulf of Alaska, including the Tlingit, Haida, Eyak, Dena'ina, Yup'ik, Tsimshian, Chugach, and Alutiiq.[41]

The U.S. sent in the Army. Despite their presence, there was no way to connect the Army's military outposts to decision-makers in Washington, D.C. Before 1904, the Americans relied on an overland telegraph route through Canada to communicate between the Alaskan territory and the Lower Forty-Eight. But the Army needed a private line of communication that couldn't be intercepted by a foreign nation, something that could bypass Canada completely. The seafloor would provide the solution. Despite the fact that the northeast Pacific's continental shelf is a deep, dark, foreboding environment,

---

[40] "ACS to Celebrate 58th Anniversary," *Nome Nugget*; "Press Packet: 97th Anniversary, Army Signal Corps," pp. 1, 31, Box MS 11 Alaska Communication Systems, File MS 11-11, Folder 1 AK Communications Systems, State Library Historical Collections, Alaska State Libraries, Juneau.

[41] For histories of Alaska and American colonialism, see Juliana Hu Pegues, *Space-Time Colonialism: Alaska's Indigenous and Asian Entanglements* (Chapel Hill: University of North Caroline Press, 2021); Maria Sháa Tláa Williams, ed., *The Alaska Native Reader: History, Culture, Politics* (Durham, NC: Duke University Press, 2009); Stephen W. Haycox, *Alaska: An American Colony*, 2nd edition (Seattle: University of Washington Press, 2020); Bathsheba Demuth, *Floating Coast: An Environmental History of the Bering Strait* (New York: W. W. Norton, 2019); Ryan Tucker Jones, "A 'Havok Made among Them': Animals, Empire, and Extinction in the Russian North Pacific, 1741-1810," *Environmental History* 16, no. 4 (October 2011): 585-609; Ryan Tucker Jones, *The Empire of Extinction: Russians and the North Pacific's Strange Beasts of the Sea, 1741-1867* (New York: Oxford University Press, 2014).

it at least wasn't foreign territory.[42] Seeking a system fully under the control of the American military, the Army Signal Corps decided to get further into the cable business.[43] Brigadier General A. W. Greeley, Chief Signal Officer, reported that the cable system was "absolutely essential if the United States intends to encourage commercial and other enterprises in Alaska." The territory, he concluded, had "the greatest financial value to the American Republic."[44] An undersea telegraph cable would ensure Alaska's security and commercial growth.

In May 1900, Congress allocated funds to build an expansive Alaskan telegraph system that would span both land and sea, with the main undersea connection linking Alaska to Washington state.[45] The U.S. Army Signal Corps started installation on the undersea portion in 1900, connecting short hops between Skagway and Juneau in 1902, and Skagway and Haines in 1903, plus an attempt to lay a cable in the icy Norton Sound, which ultimately failed.[46] In 1904, they planned to install the longest section of the undersea system and its central backbone, the nearly one-thousand miles (1,609 km) of

---

[42] "Press Packet: 97th Anniversary, Army Signal Corps," 21.

[43] By 1902, the Army Signal Corps laid thirty-two submarine telegraph lines stretching thirteen hundred miles (2,092km) around the Philippines. The Alaska cable system was the Corps's second undersea cable project, and the first in the Gulf of Alaska. See *Annual Report of the Chief Signal Officer 1902*, 17. The Signal Corps originally called the Alaska Cable system "WAMCATS" in 1900, changed to ACS in 1936, and then changed to United States Army Alaska Communication System (USACS) in 1957. See "New Name for ACS," *Nome Nugget*, February 25, 1957.

[44] "Skagway-Juneau Cable," *The Hillsboro Argus*, March 21, 1901.

[45] *Annual Report of the Chief Signal Officer 1902*, 3; "Press Packet: 97th Anniversary, Army Signal Corps," 8.

[46] Pack ice twice severed the undersea cable in Norton Sound in 1900 and 1901. In 1903, the U.S. Army Signal Corps ditched the cable idea altogether and instead built a cutting-edge "wireless telegraphy" system, or radio, to communicate across the sound. See Jessup, "Connecting Alaska," 392-395.

submarine telegraph cable that would connect Sitka to Seattle—no simple task.[47] And it wasn't just the distance that proved a challenge. The seafloor's depth posed a problem, too. Gulf of Alaska's mountainous coastline indicated to the cable-layers that they were dealing with a correspondingly deep shelf. "Generally speaking," one naturalist wrote in 1881, "the height of the land and the depth of the water" were closely parallel each other.[48] In the Gulf of Alaska, such a theory proved true: extending from the coastline, the seafloor plunges hundreds of feet below, and at spots, thousands of feet further. The Gulf of Alaska's shelf is deeper than the global average, which is 443 feet (135m).[49] The Army Signal Corps had some data on the Gulf of Alaska's physical makeup, but not much. On board the cable ship, the crew would have had in their possession sounding maps with hundreds of seafloor depth measurements printed on it. The U.S. Navy collected these depth measurements, called bathymetry, during prior surveying expeditions. The maps provided only a rough sketch of the seabed's features.[50] Beyond that, their knowledge of the shelf was hazy. Despite their limited knowledge of the Gulf of Alaska, its geology, bathymetry, and marine life, there wasn't time for further exploration. Alaska's growing territorial population desperately needed a cable.

---

[47] "Cable to Alaska," *Corvallis Gazette*, September 2, 1904 stated the cable's distance between Sitka and Seattle at 800 miles (1,282km); "Soon To Start Actual Work," *Daily Alaskan*, August 4, 1901.

[48] J. Francon Williams, *The Geography of the Oceans* (London: George Philip and Son, 1881), 58.

[49] Thomas Weingartner, "The Physical Environment of the Gulf of Alaska," in *Long-Term Ecological Change in the Northern Gulf of Alaska*, ed. Robert B. Spies (Amsterdam: Elsevier, 2007), 14; Trujillo et al., *Essentials of Oceanography*, 88.

[50] Three significant U.S. sounding expeditions in the late nineteenth century included the *Tuscarora, Albatross* and *Thetis.* See "The Report of the Pacific Cable Committee," *The Electrical Review* (1899): 15-16; U.S. Commission of Fish and Fisheries, *Telegraph Cable Between the United States and the Hawaiian Islands* (Washington: Government Printing Office, 1892), 7-8; "The Ocean Depths," *New York Times*, March 29, 1874; George E. Belknap, *Deep-Sea Soundings in the North Pacific Ocean* (Washington: Government Printing Offices, 1874), 5, 13; "The Ocean Depths," *New York Times*, March 29, 1874.

The Army Signal Corps knew little about the shelf environment, but at least they knew something about their cable ship. The Cable Ship (CS) *Burnside* was the Corps' pride and joy. Before the U.S. Army captured it in 1899, the *Burnside* led many different lives: *Yeoman*, the London-built ship that traveled to-and-from Australia; *Rita*, the Spanish embarcacion; *USS Burnside*, the American cargo vessel; and finally, the *CS Burnside*, a retrofitted cable ship in the service of the U.S. Army Signal Corps.[51] Whatever its name and whoever its owner, the *Burnside*'s most important attribute was its ability to travel by steam. As a steamer, the captain could better plot a straight course and steady speed, critical for dispensing telegraph cables over the ship's bow. By the early 1900s, the *Burnside* joined about forty cable ships that traveled the global ocean installing new lines, transporting cables, or fixing faults.[52] Despite fifty years of cables transmitting messages through the ocean, undersea telecommunications was still a novel industry.

Compared to the other cable ships, the *Burnside* would be working in one of the colder regions of the ocean. Steaming across the Gulf of Alaska's chilly waters, the ship passed an underwater scene that not a single human had ever set eyes on. When the *Burnside*'s crew began to lay the main stem of the Alaska cable in 1904, the Gulf was fresh from the excitement of the annual spring plankton bloom.[53] A mixture of factors

---

[51] "Press Packet: 97th Anniversary, Army Signal Corps," 21; Bill Glover, "CS Burnside," Atlantic-Cable.com, updated June 9, 2015.

[52] Bright, *Submarine Telegraphs,* 161-163.

[53] Theodore Cooney, "The Transfer of Matter and Energy Through the Food Web," in *Long-Term Ecological Change,* 62; Robert B. Spies and Thomas Weingartner, "Long-Term Change," in *Long-Term Ecological Change*, 259.

produce the spring plankton bloom, including strong winds, the movement of nutrients and warming waters, and a few strong dollops of iron-rich whale poop. Blended together, this nutritious soup gives birth to millions of phytoplankton and zooplankton. The plankton are so miniscule that despite their overwhelming presence in the water, they are almost imperceptible to the human eye.[54] En masse, however, the bloom sets off a trophic cascade that recruits animals up and down the food chain. All sorts of species arrive to forage on the plankton. Once there, they join a frantic season of birth and mortality, hunting and feeding, growth and loss.[55]

To be young and small in the Gulf of Alaska means almost certain death. In this sea, "Something is always gaining at something else's expense," writes science journalist Jeff Wheelwright.[56] Acting on instinct, newly born species huddle together in a vain attempt to avoid the notice of predators. Pacific herring are one of those species. These fish will gather into tight groups at the water's surface to ward off enemies. Safety in numbers, the thinking goes. The masses of juveniles shift from side to side when a seal or whale approaches. Despite their numbers, the statistics usually favor the predators. Most younglings die.[57] The Pacific herring are not alone in their fervent effort to age. Millions of other fish born during the spring bloom survive only as long as it takes for the larger animals to identify their presence. Pollock, sand lance, salmon, and cod are easily

[54] Scales, *Brilliant Abyss,* 121.

[55] Theodore Cooney "The Marine Production Cycle," in *Long-Term Ecological Change*, 49, 55.

[56] Jeff Wheelwright, *Degrees of Disaster: Prince William Sound: How Nature Reels and Rebounds* (New Haven, CT: Yale University Press, 1994), 17.

[57] Cooney, "The Transfer of Matter," 67.

swallowed into the bellies of bigger fish, mammals, and birds.[58] A feeding frenzy waged from below and above the ocean's surface means the predatory attacks are incessant. Everywhere death lurks, its presence is as ubiquitous as the seawater.

During the spring bloom, krill also grow and perish en masse. Most abundant of these crustaceans are *Thysanoessa intermis* and *Thysanoessa longipes*, two types of krill with delicate translucent bodies and beady, black eyes. Many thousands of these creatures float about dead and dying in the waters of the Gulf of Alaska, having achieved their life's task of reaching adulthood and procreating. The demise of the krill means a feast for all others, however. Birds skim the beaches and surface waters for this delightful treat, easily separating the krill's wafery legs from their pink torsos. Small krill can satiate the big animals, too. Whales swim the waters, mouths open, and gorge on the pink crustaceans by the thousands.[59] It's a happy season of easy meals for the hunters.

Just as birds congregated around the drilling wharves in Southern California, murres, puffins, and kittiwakes loitered near the *Burnside*—creatures of the sky craving resources from the sea. In the Gulf of Alaska, murres are everywhere, easily visible on the blue waters thanks to the striking contrast between their sleek black head and white chests. "Plop!" goes the water's surface as the murre dives down into the sea. Swimming with the agility of a fish, the bird reemerges seconds later with another unlucky pollock. Flourishing at the intersection between land, sea, and sky, the murres can walk along the coastal rocks, swim deep within the sea, and fly high in the air. Such a trio of skills deserves an extra moment of appreciation. The murre is not the only bird that swims for

[58] Cooney, "The Transfer of Matter," 64.

[59] Ibid., 64, 66.

its food. The puffins make their home in the Gulf of Alaska, too. They have round animated eyes that give them a perpetual appearance of sadness. As with the murres, the puffin body is black and white except for the bright explosion of blood-orange that decorates its beak, feet, and eyes.[60] Impish though they may seem, the puffins kill just as well as the murres, diving into the water to catch a buffet of herring, crab, shrimp, and squid.[61] The seabirds move freely between land to sea, from surface to depths, and from life to death.

The spring bloom delivers new life, too. Rockweed, a type of algae, clings to the rocks and relies on little bags of air to rise to the water's surface during the high tide. The rockweed's bags are used for more than just flotation devices. They also ooze a brew of sperm and eggs, creating a gamete slush that swirls around with the water. External fertilization is a messy form of procreation.[62] Rockweed is not the only species that practices broadcast fertilization. In the late summer months, thousands upon thousands of pink salmon eggs, or roe, join the clutter. The soft roe deliver a bright pop of orange coloring in a zone of greens and browns. Cables entered this marine environment without a clear role to play in the spring bloom: delivering not death, not life, and not nutrients. Marine life would decide, however, that cables make for sufficient reefs.

---

[60] Morgan Benowitz-Fredericks, A. S. Kitaysky, Alan M. Springer "Seabirds," in *Long-Term Ecological Change,* 95.

[61] Abby Barber, "Puffins on the Pacific," NWF Blog, updated April 20, 2016, https://blog.nwf.org/2016/04/puffins-on-the-pacific/; "Analysis of Remediation Alternatives for the Pacific Crossing-1 North and East Submarine Fiber Optic Cables in the Olympic Coast National Marine Sanctuary," U.S. Department of Commerce, National Oceanic and Atmospheric Administration (November 2005), https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/library/pdfs/remediationofaltforpacxesubocnms_ea_2005.pdf, 11.

[62] Stanley D. Rice, Jeffrey W. Short, Mark G. Carls, Adam Moles, and Robert B. Spies "The *Exxon Valdez* Oil Spill," in *Long-Term Ecological Change,* 465-466.

Enemies of the Cable

For cable-layers, the seabed represented two contradictory environments: a flat plane on which they could safely install undersea cables, and equally, a mysterious environment inhospitable to human technologies. Cable-layers often evoked this double image of the seafloor, interpreting the ocean bottom as both savior and attacker. Anthropologist Stefan Helmreich calls this duality of trust and discomfort “alien ocean.”[63] A contradiction, for sure, but one that made sense in the early 1900s. One the one hand, the cable’s time out of the water was precarious: it could fault or snap during the delicate process of transportation and installation. Once it arrived on the seafloor, however, the cable crew could breathe a sigh of relief—it was out of their control and in the care of the ocean’s. But the ocean floor wasn’t particularly safe, either. The seafloor’s dangers included ship’s anchors and fishing nets, which risked snagging a cable in the shallower water. Cable owners also feared that a marine creature would attack and infiltrate the line.

The Pacific does contain some fearsome characters, to be sure. Biggest among them is the man-sized halibut, which nestles into the sand and mud of the seafloor.[64] Like many other types of groundfish, the halibut appears to have been placed between two

---

[63] Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Berkeley: University of California Press, 2009), 9.

[64] Lauri L. Sadorus, Nathan J, Mantua, Timothy Essington, Barbara Hickey, and Steven Hare, “Distribution Patters of Pacific Halibut (*Hippoglussus stenolpis*) in Relation to Environmental Variables along the Continental Shelf Waters of the U.S. West Coast and Southern British Columbia,” *Fisheries Oceanography* 23, no. 3 (2014), 229.

heavy books, squished flat, and returned to the floor of the ocean. The halibut has an undeniable top and bottom side, the top hosting both eyeballs to provide a two-eyed view up into the water column. It's an odd look, but dead useful. Watchful, too, is the slimy Arrowtooth flounder, another flat fish that frequently haunts the seabed.[65] Where the mud is soft and the sand loose, these flatfish are joined by the tanner crab, which nuzzles beneath the sediments to hide from predators.[66] Once it feels safe, the crab moves about and employs its pink pinchers to snack on the random assortment of marine body parts that litter the shelf's seafloor. Bigger and stronger, the red king crab prefers its section of the seabed rockier and cluttered with rough features. One of the king's favorite snacks is the stalked tunicate, a reddish, fleshy tube that grows up from the bottom. Tunicates have a strange appearance. Humans have assigned it nicknames that range from "sea squirt" and "sea onion" to "sea tulip." For the red king crab, however, it matters little if the tunicate is more onion, squirt, or tulip. Tunicates are tasty creatures but so are clams, worms, snails, barnacles, sea stars, urchins, and other red king crabs.[67] With hunger, anything goes.

---

[65] Stephani G. Zador, Sarah K. Gaichas, Stephen Kasperski, Colette L. Ward, Rachael E. Blake, Natalie C. Ban, Amber Himes-Cornell, and J. Zachary Koehn, "Linking Ecosystem Processes to Communities of Practice Through Commercially Fished Species in the Gulf of Alaska," *ICES Journal of Marine Science* 74, no. 7, (2017): 2026; "Arrowtooth Flounder," FishWatch.gov, accessed July 12, 2021, https://www.fishwatch.gov/profiles/arrowtooth-flounder.

[66] Gordon H. Kruse "Crabs and Shrimps," in *Long-Term Ecological Change*, 136.

[67] Kruse "Crabs and Shrimps," 137.

Figure 4.3. Tubeworms, sea spiders, scale worms, limpets, and gastropods colonize and use a deep-sea cable. Early cable designers feared that marine life would infiltrate a cable's exterior. Image courtesy of Ocean Networks Canada/CSSF-ROPOS.

Cable-owners worried that the seabed's predators would turn their hungry intentions towards the cable's precious materials. Sourced from a global supply of ingredients, telegraph cables had three distinct layers: the inner core of copper, which conducted the signal; a middle layer that insulated the conductor, usually a rubbery material called gutta percha or India rubber; and the outermost section of the cable, made of metal, which protected the inner core from seawater, sea monsters, rocks, and anchors.[68] The copper center of a telegraph cable was its most precious component and

[68] The U.S. Army Signal Corps selected the Safety Insulated Wire and Cable Company to manufacture the 1,330 nautical miles (2,463km) of submarine cable. English companies manufactured the majority of the globe's submarine cables, however. See "Alaska Central," *Alaska Prospector*, July 16, 1903; "Effort Will Be Made to Extend Cable," *Daily Alaskan*, November 13, 1903; "Signal Corps May Lay New Ocean Cable," *Cordova Daily Times*, May 10, 1922; Bright, *Submarine Telegraphs*, 214; "A Cable to Hawaii," *San Francisco Call* 73, no. 116 (March 26, 1893); on the close association between sea monsters and cables, see Hayley Brazier, "Of Cables and Serpents," *Smithsonian Voices*, March 21, 2023, https://www.smithsonianmag.com/blogs/smithsonian-institution-office-fellowships-and-int/2023/03/21/of-cables-and-serpents/.

typically comprised of the purest copper on earth.[69] Also rare was the gutta percha, derived from a tree that grows in Southeast Asia.[70] Not just anyone could harvest the gutta percha tree, either. It was primarily the Indigenous men of Sarawak who had enough knowledge of the forest to successfully locate, fell, and process the sap from the gutta percha. Collectors drained each tree of its milky sap, then boiled, kneaded, and sold it through a lucrative global supply chain. From there, it arrived in European and American cable factories, where machines laid it across the cable's copper core. By the late 1800s, gutta percha trees perished by the tens of millions every year—all in service of the growing submarine telegraph industry.[71] The least expensive component was the outer metal sheathing, the cable's first line of defense. If constructed properly, the cable could survive the Pacific's alkaline seawater, its crumpling pressure, the rub of invertebrates and vertebrates, the tickle of insects, and the crush of rocks and currents for decades.

Protected by many layers of materials, to say that the Pacific's first telegraph cables were heavy would be an understatement. The typical undersea telegraph weighed between 1.5 to seven tons *per mile*—the equivalent heft of one adult-sized elephant every 1,760 yards.[72] Cables became even heavier near the shore, where they required more

---

[69] The onshore telegraph cable industry struggled for decades to source copper in pure-enough form to transmit a strong signal, and the undersea branch of the telegraph industry confronted the same dilemma. See Gloria Calhoun, "Why Wire Mattered," 156.

[70] Gutta percha trees grow in Malaysia and India rubber trees in India. Bright, *Submarine Telegraphs,* 254, 257, 258, 350; "Skagway-Juneau Cable," *Hillsboro Argus,* March 21, 1901.

[71] Helen Godfrey, *Submarine Telegraphy and the Hunt for Gutta Percha* (Leiden: Brill 2018), 161.

[72] Bright, *Submarine Telegraphs,* 12. One earlier telegraph cable in the Pacific that linked Vancouver Island and mainland Canada was 35,000 feet in length and weighed in at a whopping 30,000 pounds, meaning each foot of cable weighed nearly a pound. See "Pacific Submarine Telegraph Cables," *New York Times*, November 13, 1872.

armoring to protect them from ship anchors. Engineer Charles Bright estimated that shore-end cables weighed closer to twenty-eight tons per nautical mile.[73] Due to their sheer weight, cable-layers were forced to install cables in shorter sections before returning shoreside to load up more cable. If there was a choice between thinning the telegraph line or lightening the load of cable ship, the cable's security won every time. After all, there was enemy animals down there.

Cable-designers viewed the cable as a delicate machine vulnerable to the ocean's attacks. They did not question *if* that attack would come, but instead how and when.[74] One leading cable engineer, Charles Bright, warned against such marine creatures, or what he called "Enemies of the Cable."[75] From his perspective, the swordfish stood first in line. These troublesome "marine monsters" treated the cable as a personal buffet, he attested. Knowing that barnacles, anemones, tunicates, and fish typically lived along the cable, Bright reckoned that the swordfish would scour the cable for its critters, leaving the sensitive technology scratched or pierced by the swordfish's sharp bill.[76] Worrisome, too, were sharks. The shark, he lamented, would "bite the line savagely, leaving a few

---

[73] Bright, *Submarine Telegraphs,* 197. Crews usually filled cabled storage tanks less than full, particularly if the cable was armored. The tanks were typically filled with water, which added to the ship's weight. If it was too heavy, the ship could risk an imbalance or sink. See Wilkinson, *Submarine Cable Laying and Repairing,* 117-119.

[74] Cable designers' fears that the ocean was an aggressor, and the cable the victim, were part of a larger historical trend when Euro-Americans romanticized their fears of the ocean. See Alain Corbin, *The Lure of the Sea: The Discovery of the Seaside in the Western World 1750-1840*, translated by Jocelyn Phelps (London: Penguin Books,1995); John R. Gillis, *The Human Shore: Seacoasts in History* (Chicago: University of Chicago Press, 2012; John Mack, *The Sea: A Cultural History* (London: Reaktion Books, 2011).

[75] Bright, *Submarine Telegraphs,* 90.

[76] Ibid., 164.

teeth…as a moment of the encounter."[77] Although not a common occurrence, sharks have been known to pierce cables, so Bright's suspicions were not totally misplaced.[78]

While swordfish and sharks aimed a frontal approach, the more insidious predators were the "marine ravaging insects." The bug-like crustacean, liminoria, could nibble its way into the cables for a free meal or, simply, "idle curiosity."[79] And all feared the teredo worm. Though technically a type of clam, sailors and maritime experts often referred to them as "shipworms" because they used their long, wormy bodies and sharp shells to eat holes into wooden structures, like the hull of a ship. In the early twentieth century, experts reported that cables laying at depths around of eighteen-hundred to twenty-four hundred feet (244-732 m) were "liable to the depredations" of the teredo worms.[80] Damage from boring insects turned out to be rare, but it did occur occasionally. In 1867, for instance, an inspection of the cable between Dover and Calais revealed that "a small white insect, not unlike a maggot, with many legs and prominent black eyes, had

---

[77] Bright, *Submarine Telegraphs,* 13, 164.

[78] Luana Albert, Fraançois Deschamps, Aurélie Jolivet, Frédéric Olivier, Laurent Chauvand, Sylvain Chauvaud, "A Current Synthesis on the Effects of Electric and Magnetic Fields Emitted by Submarine Power Cables on Invertebrates," *Marine Environmental Research* 159 (2020), 1-2; Bruce K. Heezen, "Whales Entangled in Deep Sea Cables," *Deep Sea Research* 4 (1957): 114; Louis J. Marra, "Sharkbite on the SL Submarine Lightwave Cable System: History, Causes, and Resolution," *IEEE Journal of Oceanic Engineering* 14, no. 3 (July 1989): 230, 232, 236.

[79] Bright, *Submarine Telegraphs,* 381; 382; Maureen Ann McEnroe, "'The Crimson Thread of Kinship': The Pacific Submarine Cable, 1877-1902, a Study in British Imperial Communications," PhD diss., (University of California Santa Barbara, 1999), 169.

[80] Henry D. Wilkinson, *Submarine Cable Laying and Repairing* (London: "The Electrician" Printing and Publishing Company, 1908), 72; Carson, *The Edge of the Sea*, 185; Bright, *Submarine Telegraphs,* 164; "Cable Survey Completed," *San Diego Union and Daily Bee* (February 16, 1900); Stephenson, "Mother Earth"; "Bonds Beneath the Sea: The Cables," *The Mentor*, File No. 37, Box No. 1, Collection No. 638, William K. Applebaugh Papers, National Museum of American History, Smithsonian Institution, Washington, D.C.

bored through the serving and the gutta percha in several places down to the copper."[81] In Bamfield, British Columbia, cable-operators reported that "Sometimes a marine animalculae [minute organisms] may bore through the insulation of the cable and expose the core to salt water, causing an interruption."[82] The industry's fear of marine ravaging insects, then, was also based in some truth.

Just as the Pacific's animals threatened to sabotage cables, so too could its fluids and sediments. Cable-designers feared that seawater would decay the machine's exterior. Bright wrote that the iron sheathing around cables "tends to be prejudicially attacked—i.e., corroded—by the carbonic acid dissolved in sea-water."[83] They likewise worried that the seafloor's sediments contained increased levels of iodine from decaying remains of plant and animal life, which would further corrode the metal sheathing.[84] Coral, too, was a problem, because it could grow around a cable, embedding it in the seabed and leading to a "destructive" outcome for the technology.[85] Unbound by factual data, and led by imagination, cable engineers cast cables as vulnerable targets and marine animals as constant aggressors.

---

[81] Willoughby Smith, *The Rise and Extension of Submarine Telegraphy* (London: J. S. Virtue, 1891), 206. For another reference to cable designers fearing boring insects, see Wilkinson, *Submarine Cable Laying and Repairing*, 72, 90.

[82] R. Bruce Scott, "Bamfied Cable Station: The Weakest Link," *Daily Colonist* (June 2, 1968), D-D01.24, Bamfield Historical Society, Bamfield, Canada.

[83] Bright, *Submarine Telegraphs,* 504.

[84] United States Commission of Fish and Fisheries, *Results of the Survey for the Purpose of Determining the Practicability of Laying a Telegraphic Cable Between the United States and the Hawaiian Islands* (Washington, DC: Government Printing Office, 1892), 28; Bright, *Submarine Telegraphs*, 164, 406.

[85] Wilkinson, *Submarine Cable Laying and Repairing*, 110.

The extent to which swordfish, teredo worms, sharks, or seawater have historically harmed cables is negligible when compared to the greater risks of ship anchors and undersea avalanches, which since the nineteenth century have broken more cables than any other factors.[86] But cable-layers could only speculate about the threats the cable faced in an environment about which they understood very little, let alone visited. After the 1858 failure of a transatlantic line, for example, an American newspaper admitted, “Experience shows that, after all that has been said and printed about the bottom of the ocean, little or nothing is really known on the subject.” The article concluded, “It is all guess work and blind experiment.”[87] The newspaper’s reporter provided a rare moment of critique towards an industry that typically moved full-steam ahead with cable installations.

Cable-layers and engineers overestimated the likelihood of animals attacking submarine cables, but they were right about one thing: marine life is drawn to submarine cables, not for the materials the machine contains on the inside, but for the habitable surfaces they provide.

Creatures of the Shelf

[86] Nicole Starosielski, *The Undersea Network* (Durham: Duke University Press, 2015), 77.

[87] Newspaper Clipping [no title], October 23, 1858, collection no. 638, box no. 1, William K. Applebaugh Papers, National Museum of American History, SI.

Within hours of first entering the seawater, microorganisms began to build an invisible slime layer over the Alaska cable. This slime is an important prerequisite for the next visitors, larvae and algae, which select a substrate based on the nutrient characteristics of the slime. In no time, adult sea anemones, urchins, algae, sea cucumbers, mussels, and sea stars anchor down on the cable for a fruitful sojourn. In turn, more mobile creatures join the scene. Shrimp and lobster and crabs make an appearance, then even bigger fish drop by for a visit to the invertebrate's cable party.[88] In a matter of months and then years, what was once a drab metal cable transforms into a substrate that can support its own microenvironment, a tiny oasis on the vast plains of the continental shelf.[89] Like the tideland drilling piers and debris on Southern California's shoreline, cables joined the list of suitable hard substrate in an environment where substrate is sometimes scarce. Particularly in those muddy areas of the seabed, the uncolonized surfaces of these machines offer the equivalent of a new high-rise apartment in a competitive real estate market. Functioning as both machine and habitat, the cable transformed into part machine, part ocean.

As early as the 1850s, scientists and cable-layers had evidence that marine creatures colonized cables, no matter the cable's location in the world ocean—Pacific, Atlantic, Indian. For those scientists keeping a close eye on the submarine telegraph field,

---

[88] "Alternative Methods for Environmentally Friendly Fouling Control," *EUROFISH Magazine* (June 2019); Diego Meseguer Yebra, Søren Kiil, Kim Dam-Johansen, "Antifouling Technology—Past, Present and Future Steps Towards Efficient and Environmentally Friendly Antifouling Coatings," *Progress in Organic Coatings* 50 (2004): 79.

[89] Irina Kogan, Charles K. Paull, Linda A. Kuhnz, Erica J. Burton, Susan Von Thun, H. Gary Greene, James P. Barry, "ATOC/Pioneer Seamount Cable After 8 Years on the Seafloor: Observations, Environmental Impact," *Continental Shelf Research* 26 (2006): 785; Taormina, "Potential Impacts of Submarine Power Cables," 385-386.

such discoveries of animal-covered-cables informed scientists of something significant: the depth at which certain creatures could survive.[90] In the nineteenth century, for example, a cable-repair ship pulled up a cable from the depths of the Mediterranean Sea, finding various thin worms and gooey gastropods suckered to the cable—and further proving to the larger scientific community that lifeforms could, indeed, survive at such depths.[91] British scientist Sir Wyville Thomson noted that marine life "moulded [sic] upon its outer surface or cemented to it by calcareous or honry [sic] excretions." Some organisms, such as the corals, "must have become attached to it as minute germs, and have grown to maturity in the position in which they were found." Despite being stuck hard to the cable, these organisms did not seem to harm the machine.[92]

Marine life on submarine cables often proved a source of curiosity and scientific inquiry for those on the cable ship. In 1910, the *Burnside* pulled up a portion of the cable from the Gulf of Alaska, six years after its original installation. Surprised and jostled, the cable's fauna underwent an unexpected ascent many of hundreds of feet to the ocean's surface.[93] One newspaper reported the cable was "covered with a coating of plant and animal life two feet deep." The crew recognized the seaweeds, urchins, and sponges that stuck to the cable—those were familiar enough. But the cable also hosted some unknown creatures, their colors and shapes defying human recognition. Bamboozled, the onlookers grasped for terrestrial analogs. One of the creatures appeared to be a crab, except it had

[90] C. Wyville Thomson, *The Depths of the Sea*, second edition (London: MacMillan, 1874), 27-28.

[91] Sydney John Hickson, *The Fauna of the Deep Sea* (London: Kegan Paul, Trench, Trübner, 1893), 7-8.

[92] Thomson, *Depths of the Sea*, 26, 27, 30.

[93] "Deep Sea Gives Up Queer Folk," *Medford Mail Tribune*, July 10, 1910.

"Balls of red hair, looking like tousled human heads." Another creature, shaped like an hourglass, reminded the crew of a juggler's "diabolo spool." A third creature, fleshy and disc-like, looked like the "chunks of meat" served at evening mess onboard the night before. The crew handed the weirdest of the creatures over to scientists in Seattle who dropped them into alcohol-filled jars and sent them onward to the Smithsonian.[94]

It wasn't just the *Burnside*'s crew that marveled at marine life on the cables. Others in the cable industry reported on it, too. "While picking up the cable, especially if it has been somewhat buried, and not touched for a number of years," wrote cable expert Henry Wilkinson in 1908, "it comes up covered in many places with beautiful deep-sea growths, the roots having got a very firm all-around grip of the cable." For Wilkinson and other cable crewmen, an older cable covered in marine life was a "beautiful" spectacle worth beholding, providing them a glimpse of life on the ocean floor.[95] Having spent a few years on the seabed, marine life transformed the cable into something that looked more marine than machine. These cable colonies, reported Thomson in 1874, did not appear to negatively affect or corrode the telegraph cable—a perspective in stark contrast with Charles Bright's fear, expressed later in the 1890s, that marine life would infiltrate the line.[96] Where cable met seafloor, marine fauna migrated toward the technology and made the foreign object familiar.

What or *who* were these creatures living on the cable? Pink hearted hydroids, first and foremost, get around. Hydroids not only clung to California's drilling wharves, but

---

[94] "Cable Ship Finds Deep Sea Things," *Oregon Daily Journal*, July 9, 1910.

[95] Wilkinson, *Submarine Cable Laying and Repairing*, 72.

[96] Thomson, *Depths of the Sea*, 26-27; Bright, *Submarine Telegraphs*, 90.

they also find habitat on a cable and feed on the plankton floating in the water. Rachel Carson specifically noted this fluffy colonizer growing on multiple objects. “I have seen [hydroid Tubularia] coating wharf pilings, floats, and submerged ropes and cables so thickly that not a trace of the substratum could be seen,” she reflected.[97] Compare the hydroid to the blue mussel, sea pen, or anemone, all of which have also been recorded growing on cables.[98] Strangest of all is the brittle star, the alien cousin of the sea star. Brittle stars use their spider-like arms to prowl across the seafloor. These echinoderms have colors ranging from orange and pink to tan and brown. They are always at risk of losing an arm, but it’s no bother. By allowing the brittle star to regrow another, evolution has provided a solution in the event of such a loss.[99] These lifeforms are joined by algae, drift kelp, sea hash, corals, sponges, and crinoids, which cling to the cable and turn its drab grey color into a rainbow of life.[100] In a matter of months, the Alaska cable would have looked different from the technology that first entered the water, related in function but not in form.

Nowadays, scientists call these colonizers “Engineer species.”[101] In some locations, cables have been shown to not only increase the number of individual animals

[97] Rachel Carson, *The Edge of the Sea* (Boston: Houghton Mifflin, 1955), 106.

[98] Marty et al., “Experimental Study of Hard Marine Growth,” 4; “Submarine Cables and BBNJ,” International Cable Protection Committee (ICPC Ltd. August 1, 2016): 5, https://www.un.org/depts/los/biodiversity/prepcom_files/ICC_Submarine_Cables_&_BBNJ_August_2016.pdf.

[99] “Analysis of Remediation Alternatives for the Pacific Crossing-1,” 11, 30, 31.

[100] Taormina, “Potential Impacts of Submarine Power Cables,” 385; Carson, *The Edge of the Sea*, 106; See Kogan et al., “ATOC/Pioneer Seamount Cable,” 771-787; “The Ocean’s Floor,” *Seattle Post-Intelligencer*, October 31, 1888, WDN.

[101] Taormina, “Potential Impacts of Submarine Power Cables,” 386.

nearby, but also the diversity of species.[102] That's an important point, so let me repeat it: more individuals are found around cables than nearby areas that don't have a cable. That doesn't necessarily indicate that cables are spurring more marine production, but instead that marine life from the region are drawn to the cable's surface and build up from there.[103] Scientists now also understand that organisms don't just randomly arrive on a cable; instead, they *select* the surface.[104] "Before settling," observed one group of researchers, "oyster pediveliger and barnacle cyprid larvae investigate surfaces using an exploratory array of sensory cells."[105] These larvae are in search of even smaller species on the cable, not visible but present, which will provide a good source of food for the long term.

That increased diversity around the cable is not uniform across the seafloor, however. The PC-1 fiber optic cables that skirt Cape Flattery into the Juan de Fuca Ridge, for example, do not appear to support higher diversity or a greater number of species around the cable.[106] Why marine life may heavily colonize one section of cable and not another has to do with various factors including the seabed's depth, the ocean-

---

[102] Olivia Langhamer, "Artificial Reef Effect in Relation to Offshore Renewable Energy Conversation: State of the Art," *Scientific World Journal* (2012): 1

[103] L. Antrim, L. Balthis, C. Cooksey, *Submarine Cables in Olympic Coast National Marine Sanctuary: History, Impact, and Management Lessons,* Marine Sanctuaries Conservation Series ONMS-18-01, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries (Silver Spring, MD, 2018), 24.

[104] For a study on animal choices and emotions, see Carl Safina, *Beyond Words: What Animals Think and Feel* (New York: Henry Holt, 2015).

[105] Neeraj V. Gohad, Nihar M. Shah, Andrew T. Metters, Andrew S. Mount, "Noradrenaline Deters Marine Invertebrate Biofouling When Covalently Bound in Polymeric Coatings," *Journal of Experimental Marine Biology and Ecology* 394 (2010): 64.

[106] Antrim et al., *Submarine Cables in Olympic Coast*, 43.

bottom currents, and the type of sediment below the cable. In certain locations, cables provide habitat; in other places, marine life is not particularly drawn to cables and congregate elsewhere. The marine ecosystem has no single reaction to a cable's presence on the seafloor.

Certain sessile species have benefitted from the cable's surface, while other species have not. Whales have been the primary victims of an improperly installed cables. Death by cable was not a common occurrence, but not unheard of, either. Within the Alaska Cable system alone, cable ships reported at least three whale entanglements between the 1900s and the 1920s.[107] In the story of the whale that opened this chapter, the cetacean was likely swimming along the seafloor, its mouth open to collect food, when it hooked the slackened cable around its jaw—clotheslined, in effect. Twisting and turning in a panic, the whale further wrapped the cable around its large head, exhausting itself in the struggle.[108] Unable to reach the water's surface, but unable to breathe, the entangled whales would have suffocated slowly. Perhaps friend and foe heard the whale's calls of distress from miles away. Who could guess the number of minutes whales suffered before their thrashing slowed, their screaming ceased, and finally, their heart stopped.[109]

Whale entanglements are not unique to the northeast Pacific Ocean, either. Renowned marine scientist Bruce Heezen studied cable company records to calculate

---

[107] The U.S. Army Corps found entangled whales in 1905, 1909, and 1927. See "Fish Story," *Morning Astorian*, January 25, 1905; "Whale Strangled Self," *Athena Press*; "Whale Chews 80 Feet of Cable to Alaska," *Beaverton Review*, June 10, 1927; "Whale Breaks Alaska Cable," *Daily Alaskan Empire*, April 9, 1927. Matthew Peter Wood and Lionel Carter, "Whale Entanglements With Submarine Telecommunications Cables," *IEEE Journal of Oceanic Engineering* 33, no. 4 (October 2008): 447.

[108] "Whale Strangled Self," *Athena Press*.

[109] Bruce Hecker, "How Do Whales and Dolphins Sleep without Drowning?" *Scientific American*, February 2, 1998, https://www.scientificamerican.com/article/how-do-whales-and-dolphin/.

global records of whale entanglements. Between the mid-nineteenth and mid-twentieth centuries, submarine telegraph cables killed about a dozen to two dozen whales worldwide, although the number is likely much higher.[110] He concluded in 1957, "Many more such reports will undoubtedly turn up as more cables are studied."[111] Despite Heezen's claim, we will never know the exact number of whale deaths. For starters, if a cable continued to transmit messages normally—despite the presence of an entangled whale—there was no reason for the cable owner to pull up the line and discover the carcass. Second, cable owners were not legally required or even inclined to report whale entanglements, likely causing some incidents to go unrecorded.

While some people viewed whale entanglements as an "amusing" piece of entertainment, others considered cetaceans a serious threat. Charles Bright, fearful as always about enemies of the cable, described the situation as "warfare between a whale and a cable," during which the cetaceans, or "monsters" as he called them, were not at all deterred by the cable's thick metal casing.[112] In 1884 off the western coast of South America, for example, a whale had "voluntarily attacked the cable," resulting in a deep slash to the whale's torso that led to its disembowelment and death. The whale's entanglement caused the telegraph cable to stop working briefly, but not permanently. The cable managers reported that it was "satisfactory to know that the cable did not give way naturally," and that the "sheathing, yard and core were found to be in an almost perfect state of preservation, in fact, looked as good as on the day the cable was first

---

[110] Most cables in other parts of the globe entangled sperm whales, particularly at the deeper depths where the sperm whale swims the seafloor in search of food. Heezen, "Whales Entangled," 108.

[111] Heezen, "Whales Entangled," 107.

[112] Bright, *Submarine Telegraphs,* 90, 381; Giberne, *The Romance of the Mighty Deep,* 282.

laid."[113] After undergoing repairs, the cable reentered the ocean and continued to function, although the whale did not.

In Southern California, where the public responded with swift protests to the increased presence of drilling wharves, reports of cables entangling whales received no such comparable outrage. Instead, newspapers framed these events as curiosities during which the whale purposefully victimized the cable, not the other way around. "The fish proved himself his own hangman," wrote the *Athena Press* after the *Burnside* discovered the whale carcass in 1909. "The cable was twisted tighter about the head of the whale than any mortal could have twisted it with the most powerful machinery," the *Press* pointed out.[114] "Whales Breaks Alaska Cable," added the *Alaskan Daily Empire*. Other reports adopted similar perspectives. The *Beaverton Review* accused one whale of "chewing" on the cable.[115] The *Alaskan Daily Empire* reasoned a whale likely bit the cable out of "Curiously or hunger."[116] When All America Cables, a private cable company, reported finding a dead whale entangled in its line off the coast of Chile in 1906, the entanglement was "an amusing example of the unforeseen obstacles" that cables faced in the ocean.[117] In late nineteenth and early twentieth centuries, the public's thoughts, prayers, and sympathies resided with the cable, not the marine environment.

---

[113] Heezen, "Whales Entangled," 111.

[114] "Whale Strangled Self," *Athena Press*.

[115] Ibid.

[116] "Whale Breaks Alaska Cable," *Daily Alaskan Empire*, April 9, 1927.

[117] All America Cables, *A Half Century of Cable Service*, 27.

Cables and the American Mind

On August 31, 1904, hundreds of celebrators gathered to greet the *Burnside* as it rounded the corner into Seattle's Elliott Bay.[118] The *Burnside*'s crew was surrounded by the "tooting of steamboat whistles" and the "crash of bands," each playing the Star Spangled Banner to their own cadence. Hundreds of onlookers joined the celebration, cheering and whooping, trying to catch a glance of the famed cable and see its final "splice," when the shore-end of the cable would be joined with the ocean-end. Even Seattle's "preeminent citizens" stooped and tiptoed for a view of the line.[119] Once spliced, the *Burnside*'s crew dropped the conjoined line into the sea where it "struck the water with a mighty splash."[120] The crowds cheered again. The celebrators couldn't really see the technology they were applauding, but that mattered little. Instead, it was enough to *imagine* the Alaska cable and its temporal powers.

Before submarine telegraph cables arrived in the nineteenth century, communications across the oceans moved only as fast as humans could travel—which is to say, not fast at all. In the late 1800s, letters between the Alaskan territory and Seattle required anywhere from many weeks to many months.[121] By compressing weeks into

[118] "Cable to Alaska," *Corvallis Gazette*, September 2, 1904, reported the distance between Sitka and Seattle as 800 miles (1,287 km).

[119] "Alaska Cable To Be Completed," *Oregon Sunday Journal*, May 22, 1904; "Cable to Alaska," *Corvallis Gazette*, September 2, 1904.

[120] "Cable to Alaska," *Corvallis Gazette*, September 2, 1904.

[121] Before the 1904 undersea system, the U.S. Army Signal Corps also relied on Canada's overland telegraph lines to more quickly communicate with outposts in Alaska, which made the military vulnerable

minutes, undersea telegraph communications changed everything. “The defining feature of high-speed communications,” wrote historian Robert W. D. Boyce, “is that information is no longer constrained to travel at the same speed as physical goods or people.” That change was mind boggling for North Americans whose lives were governed by similar time constraints to those of the Greeks.[122] The cable’s speed of communication, combined with its location in the foreign depths of the sea, was mindboggling. Never mind the fact that most Americans were not wealthy enough to send an overseas telegram—they still incorporated its technological accomplishments into their perception of the time, travel, and distance.[123] Submarine telegraph projects were popular everywhere in the world, and the Army Signal Corps’ Alaska system proved just as exciting.

A new cable was universally appreciated: children and adults, families and businessmen, politicians and policemen all equally reveled in the accomplishment. One historian has argued, “Telegraphy was a marvelous and mysterious phenomenon, far beyond the comprehension of the average citizen.”[124] Yet the great fanfare in support of the Alaska cable indicates that the public did indeed comprehend the magnitude of submarine telecommunications. Besides, this type of public spectacle wasn’t unique for the era. Two years before, a crowd gathered on the beach near San Francisco to cheer on the Commercial Pacific Cable Company as it installed the country’s first transpacific

---

to foreign sabotage. See “ACS to Celebrate 58th Anniversary on May 26th,” *Nome Nugget*, May 23, 1958, ADNP.

[122] Arthur C. Clarke, *Voices across the Sea* (New York: Harper and Row, 1974), 13.

[123] Müller, “From Cabling the Atlantic to Wiring the World,” 514.

[124] McEnroe, “’The Crimson Thread of Kinship,’” 6.

cable.[125] From coast to coast, bells chimed, newspapers ran front-page stories, and communities rejoiced at the arrival of a new cable.[126]

The Seattleites who applauded both crew and cable had followed the *Burnside*'s installation progress in the newspapers for multiple years—it's triumphs and failures, its location and projected completion date. Through the newspapers, the public traced the cable ship as it connected the cable to Seward, Valdez, Cordova, Skagway, Haines, Juneau, Sitka, and finally, its final stop on the multi-year installation project, Elliot Bay.[127] Average folks—schoolteachers, insurance salesmen, housewives—sat at their morning breakfast tables, sipping coffee and crunching on toast, and opened their newspapers to read about the development of telecommunications on the seafloor. This project proved worth the read. By anyone's standards, the Alaska Cable was a spectacular feat of engineering. When completed, the entire Alaska system included 2,524 miles (4,062 km) of undersea telegraph cable and over one thousand four hundred miles (2,253 km) of telegraph lines that traveled over land.[128]

---

[125] Landing of the first transpacific telegraph cable at Ocean Beach, San Francisco, Calif, BANC PIC 2007.024—A; BANC PIC 2007.024—A, Bancroft Library, University of California, Berkeley.

[126] Isabella Field Judson, ed., *Cyrus W. Field: His Life and Work, 1819-1892*, (New York: Harper and Brothers, 1896), Box 2, Collection No. 1386, Box 2, Cyrus W. Field Papers, National Museum of American History, Smithsonian Institution, Washington, D.C.

[127] "Alaskan Cable," *San Juan Islander* 13, no. 6, March 12, 1903; "Alaska Cable Finished," *Daily Capital Journal*, August 29, 1904; "Cable to Alaska," [Portland] *Morning Oregonian*, August 29, 1904. The cable link to Seattle was finished August 31, 1904.

[128] Jones, "The Washington-Alaska Military Cable and Telegraph System"; "The Alaska Cable Service," *Daily Alaskan*; Jessup, "Connecting Alaska," 407; "Cable to Alaska," *Corvallis Gazette*, September 2, 1904.

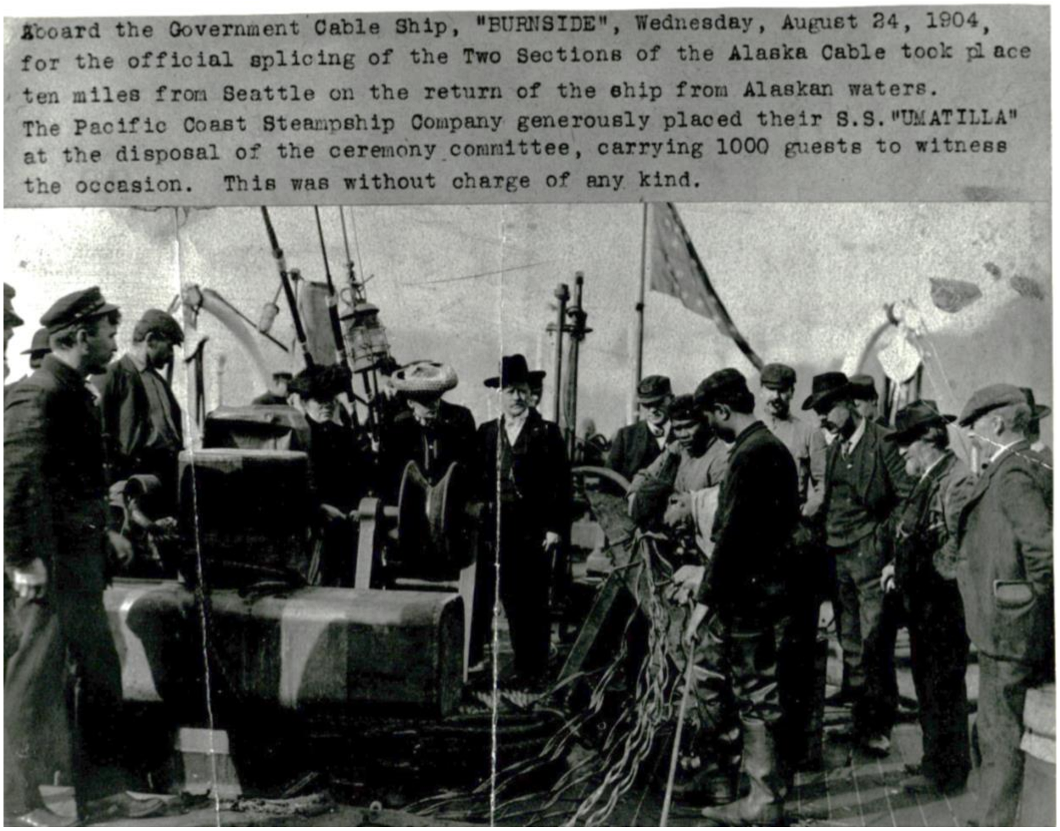


Figure 4.4. Crew of the CS *Burnside* splices the Alaska cable's shore end to the ocean end, 1904. Hundreds of onlookers cheered the completion of the telegraph system. MS 11-1-A2, Alaska Communications Systems Manuscript Collection, Alaska State Library.

Submarine cables acted as a bridge between the public's curiosity and the ocean's depths. Entreating readers to imagine cables in a seafloor environment, author Agnes Giberne wrote in 1905, "Deep down under the sea, on the sloping ocean-floor, amid dead vegetable and animal remains, lie strange snake-like forms. Not natural creations but made by man and placed there for his own benefit."[129] Traveling to a place where no human had ventured before, submarine cables were a marvel of technological innovation and national pride, their triumph not unlike the connection of the transcontinental railroad at Promontory Summit or the Wright brothers' pioneering flying machines. Undersea

[129] Agnes Giberne, *The Romance of the Mighty Deep* (Philadelphia: J. B. Lippincott, 1905), 276.

telegraph cables "were the moonshots of their day," writes scientist Jeffrey Marlow. It mattered little that the public may never set eyes on a submarine cable, let alone send a telegraph. The seafloor environment was not physically accessible to readers, but stories about this industrializing world were enough to ignite their imaginations.[130]

The public's response to submarine cables was the exact opposite of their response to tideland oil drilling. Americans detested oil and gas infrastructure, even as they consumed the resources the machines procured. Tall and erect in the exposed intertidal zone, drilling machinery stood as an eyesore that disrupted the beauty of the beach. An almost opposite perception buoyed the submarine cable industry. Tucked away, flat against the seafloor, and buried underneath the beach, cables easily hid from the public's view. Submarine cables produced no spills or bad smells and did not require the hustle and bustle of men and trains and barrels of crude along the shoreline. Where the tideland oil industry represented a nuisance, the cable industry represented adventure; where the oil derricks were an eyesore, the cable was sleek and modern; where the oil industry darkened the shore with spills and putrid smells, the cable silently and seamlessly escaped into a mysterious world. That coastal dwellers in Washington, British Columbia, and Alaska were unbothered by the cable passing near their shores meant they could throw their support behind the project.

Technological marvels though they were, submarine telegraphers were not laid for the thrill of the accomplishment. Whether operated by the government or a private entity, the cable needed to make money for its investors, who wanted to see a monetary

---

[130] Jeffrey Marlow, "Undersea Internet Cables Can Detect Earthquakes—and May Soon Warn of Tsunamis," *New Yorker*, July 26, 2022, https://www.newyorker.com/science/elements/undersea-internet-cables-can-detect-earthquakes-and-may-soon-warn-of-tsunamis; see also Roderick Nash, *Wilderness in the American Mind* (New Haven, CT: Yale University Press, 1967).

return.[131] The plan for making a profit on the cables was simple: individuals or organizations that wanted to send a telegraph needed to pay in cash for each word. Any individual could send a telegraph through the Alaska cable system, but it was pricey.[132] Because it was the only method to communicate quickly with the Lower Forty-Eight, the Army Signal Corps cornered the market and soon made a profit on undersea telecommunications. In 1925, the Corps reported that the system was speeding sixty words a minute across the line and bringing in $300,000 a year.[133] The majority of telegram-senders included private companies, governmental bodies, and to a smaller degree, private citizens. And despite the occasional break, the Alaska cable worked efficiently, much better than the notoriously slow transpacific cable that operated between California and Japan.[134] In that sense, the Alaska cable was not only an exciting feat of engineering, it also became a critical form of communications for the military, businesses, and private individuals alike.

The 1904 celebration in Elliott Bay marked not only the completion of the Alaska Cable, but also the start of a new telecommunications era for the northeast Pacific Ocean. Alaska and the Lower Forty-Eight were finally connected. From that moment forward, this stretch of seafloor would never be without at least one telecommunications cable. In the decades following the original 1904 installation, Army Signal Corps continued to fix

[131] *All Red Line*, 50.

[132] *All Red Line*, 50-51; Headrick et al., “Submarine Telegraph Cables,” 552.

[133] “Tallest Man in Northland is in Seattle,” *Alaska Daily Empire*, May 25, 1925.

[134] By comparison, the American submarine telegraph cable connecting California to Japan was notoriously slow with delayed messages. See Misc. Legislation, 227-18, Box 227, Wesley L. Jones Papers, 1896-1932, Special Collections, University of Washington, Seattle.

breaks, address problems, and add new cables. In 1924, the Corps laid a new telegraph cable with five times the capacity of the original cable, which, after two decades on the seafloor, was becoming battered and slow.[135] In 1936, the Army Signal Corps officially changed the system's name from Washington-Alaska Military Cable and Telegraph System (WAMCATS) to the Alaska Communications System (ACS). And in 1956, ACS partnered with American Telephone and Telegraph (AT&T) to lay a twin telephone cable system that connected Alaska to Washington state.[136] By the mid-twentieth century, telephone cable designers were installing repeaters, previously called joints, every forty or so miles (sixty-four km) along the line. Repeaters sit within the cable, making it appear wider in sections—not unlike a snake that has swallowed a big meal. The repeaters boosted the electrical signal as it scooted along the interior copper wire, which made a system that was already working well function even better.[137] At its peak, one oceanographer estimated that the Alaska system had eighty-six telegraph cables running between the Puget Sound and the Gulf of Alaska, although that number likely included both private and governmental cables.[138] The Army Signal Corps continued to own and operate its system until 1962, when it was passed over to the U.S. Air Force. In 1970,

---

[135] "ACS to Celebrate 58th Anniversary," *Nome Nugget*; "New Cable is Needed," *Cordova Daily Times*; the Army Signal Corps also replaced the aging *CS Burnside* for a new ship, the *CS Dellwood*. See Raines, *Getting the Message Through,* 226. There is no evidence to show that they pulled up the old cable, although the Signal Corps' CS *Dellwood* was equipped with a machine that had the capacity to remove a cable. See "Amateurs Barred from Radio Cable," *Oregon Statesman*, July 12, 1923.

[136] Jones, "The Washington-Alaska Military Cable"; "The Alaska Cable Service," *Daily Alaskan*; Raines, *Getting the Message Through,* 236.

[137] Clarke, *Voices across the Sea*, 151; Marlow, "Undersea Internet Cables Can Detect Earthquakes."

[138] Bruce C. Heezen and G. Leonard Johnson, "Alaskan Submarine Cables: A Struggle with a Harsh Environment," *Arctic* 22, no. 4 (December 1969): 413.

Radio Corporation of America purchased ACS, marking the end of the system's federal ownership and operation.[139]

Conclusion

When radio and then satellites arrived on the scene during the early and mid-twentieth century, some technophiles rang the death knell of submarine cables. Despite the arrival of other technologies that threatened to make undersea cables obsolete, the submarine cable systems persisted, not only in the northeast Pacific Ocean, but around the world. Instead of making cables obsolete, radio's cheaper costs and faster transmission times forced the submarine cable industry to adapt, grow, and improve the capacity of its undersea lines. Historian Jonathan Reed Walker notes that cables endured because of their capacity, despite the huge expenses required for laying and maintaining them.[140] Ultimately, radio and satellites proved to be compatible and supplemental to cables. Used together, the three continue to provide a reliable telecommunications systems.[141]

As the Alaska system shifted between owners and new types of cables entered the ocean, it's not totally clear what became of the old lines. There's no record that I have found stating that the main cable ever came out of the water, meaning it still rests in the Pacific's depths today, its exact location known only to marine life. In all of their

---

[139] "Submarine Phone-Cable System Ordered for Southeast Alaska," *Seattle Times*, June 12, 1969, Box: MS 11-5 ACS News Items and Clippings Jan.-June 1969, Alaska State Library Historical Collections, Juneau; Jessup, "Connecting Alaska," 407.

[140] Walker, "Bridging the Gap," 42.

[141] Bernard Finn and Daqing Yang, "Introduction," and Jonathan Reed Walker, "Bridging the Gap: The Cable and Its Challengers, 1918-1988," in *Communications Under the Seas,* 6, 25, 33.

planning to install the cable—sounding the seafloor, armoring the cable, testing it for faults—there was never a plan to remove it. As Chapter V investigates, there are many hundreds of broken and abandoned cables that still sit on the seabed, undergoing a biotic afterlife as substrate for marine life. From an environmental perspective, should those cables ever come back up? Should new fiber optic cables entering the ocean in the twenty-first century remain in the seabed indefinitely? It's been nearly one-hundred and twenty years since the first transoceanic cables touched down Northeast Pacific Ocean bottom, and the same question—to remove or not to remove the aging machines—still persists.

Figure 4.5. Two workers splice a cable at Sokolof Island in southeastern Alaska, ca. 1940s. MS 11-11-7-5, Alaska Communications System Manuscript Collection, Alaska State Library, Juneau.

CHAPTER V

ABANDONING THE LINE

In 1999, a candy-yellow machine descended towards the seafloor near the Strait of Juan de Fuca. Weighing 30,000 pounds—the equivalent of a city bus crammed with passengers—it landed on the soft sediments with a muffled thud. Called a sea plow, this big machine is towed behind a cable ship. Its job is twofold: cut a trench into the seafloor while simultaneously depositing a length of fiber optic cable into the trench. Sea plows must be hefty enough to slice through the seafloor's compacted rocks, muds, clays, and sands. That weight, however, means the machine can equally squash marine creatures unlucky enough to find themselves under its skids, to say nothing of the creatures in the path of the trench cutter.[1]

This stretch of ocean bottom is no stranger to technologies like the sea plow. Nearly a century before, it was the same region where the CS *Burnside* installed the Alaska cable on its way to Seattle. And a century before that, it was the sole territorial waters and fishing grounds of the Makah and the Klallam Tribes—including the Lower

[1] Installation of PC-1 cables through the Olympic Coast National Marine Sanctuary occurred in 1999 and 2000. Reinstallation to bury the cables deeper occurred in 2006. See Ken Weiner and Seth Davis, "Olympic Re-Lay: Innovative Techniques in Cable Projects with Regulatory and Environmental Dimensions," in *K&L Gates-Nera Global Telecom Review*, eds. Christian M. Dippon and Martin L. Stern (Seattle: Kirkpatrick and Lockhart Preston Gates Ellis LLP, Nera Economic Consulting, 2008), 81-82; L. Antrim, L. Balthis, C. Cooksey, *Submarine Cables in Olympic Coast National Marine Sanctuary: History, Impact, and Management Lessons*, Marine Sanctuaries Conservation Series ONMS-18-01, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries (Silver Spring, MD, 2018), 1-2, 8.

Elwha Klallam, Jamestown S'Klallam, and Port Gamble S'Klallam nations.[2] Now, during the turn into the twenty-first century, the seafloor belonged to the Olympic Coast National Marine Sanctuary (OCNMS), a federally protected reserve regulated by the National Oceanic and Atmospheric Administration. The big yellow sea plow was installing a dual fiber optic cable system, called PC-1, that would connect the United States to Japan with new undersea lines. OCNMS's job was to balance the seafloor's many users: historic Indigenous fishing and treaty rights, commercial fishing fleets, federal and state agencies, cable companies, and the many thousands of marine organisms that call this environment home. The seafloor was busier than ever.

Engineers assign cables a twenty-five year lifespan. Originally installed in 1999-2000, the PC-1 fiber optics are now nearing the end of their projected usefulness.[3] Will the cables come back up, or stay on the seafloor indefinitely? An earlier agreement between the seafloor's stakeholders, including the NOAA, the Makah Tribe, and the cable owner, punted the answer to that question down the road, leaving it to be decided at a future date. "A cable inspection survey will be conducted 1-2 years before final expiration," the agreement recorded, "to assist NOAA in its evaluation of whether to

[2] The Makahs hold fishing and territorial rights to the region, protected by the 1855 Treaty of Neah Bay. For a longer history on Treaty of Neah Bay, see Joshua L. Reid, *The Sea is My Country: The Maritime World of the Makahs* (New Haven, CT: Yale University Press, 2015), chapter four. The Lower Elwha Klallam Tribe, Jamestown S'Klallam Tribe, and Port Gamble S'Klallam have fishing rights protected under the Point No Point Treaty, 1855. See Lower Elwha Klallam Tribe "Point No Point Treaty, 1855," elwha.org, accessed March 11, 2023, https://www.elwha.org/culture-history/point-no-point-treaty/; Jamestown Tribe, "Treaty with the S'Klallam, 1855," accessed March 11, 2023, https://jamestowntribe.org/history-and-culture/treaty-with-the-sklallam-1855/; Ron Charles, "History and Culture," pgst.nsn.us, accessed March 11, 2023, https://pgst.nsn.us/history-culture/; "Analysis of Remediation Alternatives for the Pacific Crossing-1," NOAA, 12; Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 47.

[3] Neal Stephenson, "Mother Earth Mother Board," *Wired*, December 1, 1996; Weiner et al., "Olympic Re-Lay," 79; Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 3, 7. The PC-1 cables were re-buried deeper into the seabed within the sanctuaries parameters in 2006.

have the cable removed after it is taken out of service or to allow it to be left in place in the Sanctuary."[4] But between the installation of the cables and the expected end of their lifespan in 2024, the PC-1 cable owner filed for bankruptcy, making it somewhat unclear which organization would foot the bill for the cables' future removal. The other alternative is purposeful abandonment, which would mean leaving the cables on the seafloor indefinitely. That may be a surprising choice, possibly, but in the history of the undersea telecommunications industry, more common than not.

For the past century, cable-owners have routinely abandoned their lines on northeast Pacific Ocean's seabed. For telegraph, telephone, and now fiber optic cable owners, the decision to desert obsolete cables in the ocean is standard practice. Historically, the industry has been frank about leaving lines in the ocean. Cable engineer Charles Bright wrote in 1898 that "attempts are seldom seriously made to pick up an entire cable in a greater depth than about 1,000 fathoms [1,829 m]."[5] Even the *Morning Oregonian* told its readers in 1900, "It is cheaper to make new ones than to recover them."[6] This tradition of abandoning aging machines in the ocean is similar to that of California's tideland oil and gas industry, where companies left their drilling piers, derricks, pipelines, and barrels to rust and rot in the shoreline. Californians witnessed this abandonment with anger and outrage, and when prompted with the decision to remove or

---

[4] "PC-1 Settlement Agreement," U.S. Department of Commerce, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers, U.S. Department of Justice, Makah Indian Tribe, Pacific Crossing Ltd., Tyco Telecommunications, November 4, 2005, https://www.gc.noaa.gov/documents/2017/pc-1%20settlement%20agt%20final%2011-04-05.pdf, 7-8.

[5] Charles Bright, *Submarine Telegraphs: Their History, Construction, and Working* (London: C. Lockwood and Son, 1898), 410, HT.

[6] "To Manila via Dutch Harbor," [Portland] *Morning Oregonian*, January 24, 1900.

not to remove the derelict materials in later decades, they provided a clear answer: remove. Yet submarine cables have a different history. Prompted with the question of removal, one-hundred and twenty years of cable history provides us another clear, yet opposite answer: do not remove. For the fiber optic cable owners, removal of a dead or obsolete cable is expensive and not usually mandated by regulatory bodies.[7] Inert but not biodegradable, most dead cables will sit in the ocean indefinitely, hidden from the public who is usually none the wiser.

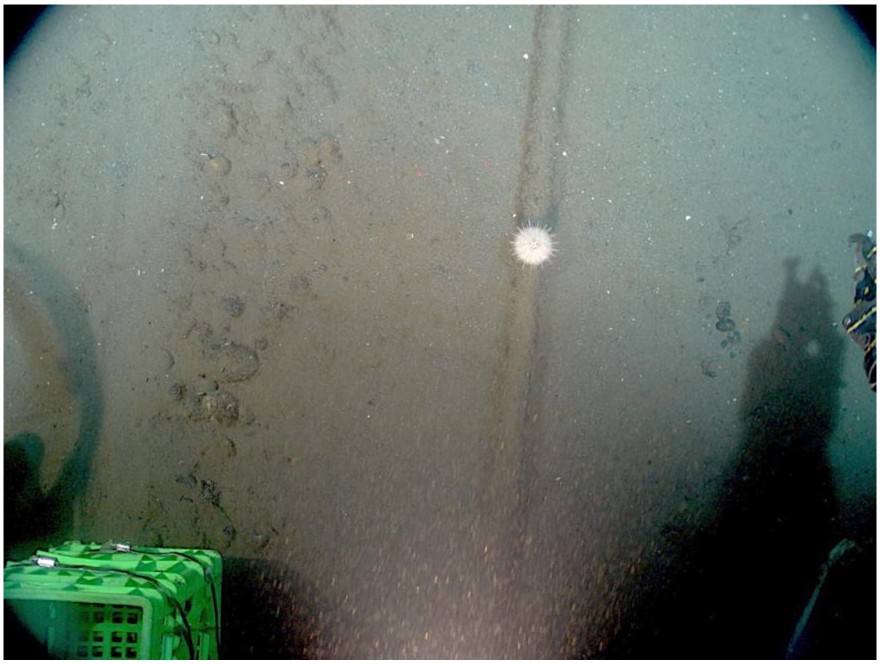


Figure 5.1. A fiber optic cable, part of the PC-1 system, is captured on camera from a remotely operated vehicle (ROV) within the Olympic Coast National Marine Sanctuary. The cable is covered in sediment, marine growth, and a sea urchin. Photo courtesy of Olympic Coast National Marine Sanctuary, National Oceanographic and Atmospheric Association, Port Angeles, Washington.

Like most stretches of the global ocean, the northeast Pacific Ocean hosts a graveyard of cables—old and abandoned, broken and forgotten, relics of the nineteenth

[7] Benoît Pirenne, interview with the author, February 22, 2023.

and twentieth centuries.[8] One cable ship captain referred to the number of abandoned cables in the deeper stretches as the "Wild West" of undersea telecommunications—unregulated and unpoliced.[9] Forgotten on the seafloor by everyone except marine life, it's often unclear where exactly these old cables are located.[10] The *Guardian* reported that ninety-four percent of cables "are abandoned on the seabed."[11] Thanks to a lack of public cable records and a long list of now-defunct cable companies, that statistic is hard to verify. And yet it does prove a point: most abandoned cables never return to the surface. I, for one, rarely find historical records that report on the *removal* of old cables. Instead, all attention is paid to their installation. Just imagine the thousands of miles of cables cluttering the seabed. Their original owners are long gone, and all that remain are the algae, mollusks, and bivalves that use them for habitat and the fishermen who sometimes snag them.

When cables languish on the seabed for decades—now creeping into centuries—do they pose an environmental problem? If I answered that question based on the environmental histories of *other* industrialized landscapes or waterscapes, the answer would almost always be yes. Open-pit mining, toxic effluents from factories, plutonium

---

[8] Irina Kogan, Charles K. Paull, Linda A. Kuhnz, Erica J. Burton, Susan Von Thun, H. Gary Greene, James P. Barry, "ATOC/Pioneer Seamount Cable After 8 Years on the Seafloor: Observations, Environmental Impact," *Continental Shelf Research* 26 (2006): 778.

[9] Senay Boztas, "Buried at Sea: The Companies Cashing in on Abandoned Cables," *The Guardian*, December 14, 2016, https://www.theguardian.com/sustainable-business/2016/dec/14/ocean-pollution-cable-waste-technology-reuse-recycling-circular-economy-crs-holland.

[10] Christopher R. Barnes, "Quantum Leap in Platforms of Opportunity: Smart Telecommunications Cables," in *Challenges and Innovations in Ocean in Situ Sensors: Measuring Inner Ocean Processes and Health in the Digital Age*, eds. Eric Delory and Jay Pearlman (Amsterdam: Elsevier, 2019), 209; Heezen, "Whales Entangled," 105.

[11] Boztas, "Buried at Sea."

production, offshore oil and gas drilling, dams and flood control infrastructure, mechanized agriculture, power plants, and industrialized fish production all include physical remnants, and lingering debris, that require removal before environmental restoration can occur.[12] But submarine cables don't offer a parallel history of environmental decline. A century of Pacific cable history demonstrates that this technology is not particularly destructive for benthic organisms: cables don't leak toxic liquids, and despite some possible interference with the seafloor's electronic field, they don't appear to seriously bother most marine species. Instead, cables often attract organisms and provide a source of substrate in an environment where substrate is sometimes scarce.[13] Therefore, in a departure from other industrial histories, this tale is not one of environmental declensionism.

I'll show my cards right up front: I don't believe that old, abandoned cables should not be pulled from the seabed, particularly when they pose no acute environmental

[12] See Timothy J. LeCain, *Mass Destruction: The Men and Giant Mines That Wired America and Scarred the Planet* (New Brunswick, NJ: Rutgers University Press, 2009); Nichelle Frank, "Sanitizing History: Environmental Cleanup and History Preservation in U.S. West Mining Communities" (PhD diss., University of Oregon, 2020); Brett L. Walker, *Toxic Archipelago: A History of Industrial Disease in Japan* (Seattle: University of Washington Press, 2010); Kate Brown, *Plutopia: Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium Disasters* (New York: University of Oxford Press, 2013); Andrew Needham, *Power Lines: Phoenix and the Making of the Modern Southwest*. (New Jersey: Princeton University Press, 2014); Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1996); Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, 1979); Timothy Mitchell, *Rule of Experts Egypt, Techno-Politics, Modernity* (University of California Press, 2002); Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1962); Mark Carey, *In the Shadow of Melting Glaciers: Climate Change and Andean Society* (New York: Oxford University Press, 2010); Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980* (Cambridge University Press, 1990); Teresa Sabol Spezio, *Slick Policy: Environmental and Science Policy in the Aftermath of the Santa Barbara Oil Spill* (University of Pittsburgh Press, 2018); Jack Davis, *The Gulf: The Making of an American Sea* (New York: Liveright, 2017).

[13] Bastien Taormina, Juan Bald, Andrew Want, Gérard Thouzeau, Morgane Lejart, Nicolas Desroy, Antoine Carlier, "A Review of Potential Impacts of Submarine Power Cables on the Marine Environment: Knowledge Gaps, Recommendations and Future Directions," *Renewable and Sustainable Energy Review* 96 (2018), 385; Christoph Kraus and Lionel Carter, "Seabed Recovery Following Protective Burial of Undersea Cables – Observations from the Continental Margin," *Ocean Engineering* 157 (2018): 251, 259.

threats. I argue the same for oil and gas drilling debris. It's during this long afterlife on the seabed—their biotic afterlife—that these machines often serve as habitat for marine creatures. By removing such items, we risk disturbing the seabed even further. Having spent significantly more time on the seafloor than on land, they have transformed into objects that should, more often than not, stay in the ocean.

And yet, no rule is hard and fast. Caveats abound. There are instances when old cables should come out of the water. Removal is ideal for cables that persistently sway in the water column, which pose a threat to passing marine life, such as whales, who may become entangled in the lines.[14] Likewise, unburied cables endanger fishing vessels, which likewise become entangled in floating cable lines. For fishermen, that's a deadly scenario, particularly in bad weather.[15] And finally, some regions of the seafloor are culturally sensitive sites, such as the PC-1 cables operating in Makah tribal and fishing territory; if that nation should choose to remove the lines, the cable's owners would need to respond accordingly. As one science writer noted, "pragmatic choices must be made, weighing the costs and benefits of leaving debris in place."[16] It's a case-by-case kind of solution. Luckily, most old cables don't sway in the water column, they don't severely interfere with fishing, and they don't impede on culturally sensitive areas. Most old cables are forgotten, lost, and settled into the muds and sands and clays. Painted with algae, anemones, and the odd tunicate or sea star, the only beings that know of the machine's presence on the seafloor are the marine organisms already living on it.

---

[14] Audun Rikardsen, "One Great Shot: High Stakes Humpback Rescue," *Hakai Magazine*, November 18, 2022, https://hakaimagazine.com/videos-visuals/one-great-shot-high-stakes-humpback-rescue/.

[15] Scott McMullen, interview with the author, November 7, 2019.

[16] Bradley van Paridon, "When Litter Becomes Habitat," *Hakai Magazine*, March 9, 2020, https://hakaimagazine.com/news/when-litter-becomes-habitat/.

In the twenty-first century, there are two types of cables active on the seafloor: power cables and communication cables (sometimes referred to as C-cables and P-Cables). Power cables transmit energy between land and an offshore structure, such as a wind turbine or oil and gas platform. Fiber optic cables, by comparison, facilitate Internet and phone communications. Sometimes, the two functions are combined into one cable. Often compared to a garden hose, twenty-first century cables are surprisingly thin and appear almost delicate. But what those cables lack in girth they make up in capacity. Despite innovations in radio and satellite technologies during the twentieth century, undersea cables have only proven more valuable in each passing year. In 2022, fiber optic cables provided over 98 percent of the world's Internet services and international phone calls.[17] The International Cable Protection Committee reports that satellites could only support 7 percent of U.S. Internet traffic if all of its undersea fiber optics were cut.[18] Without those fiber optic lines, every aspect of global connection crashes: banking, trade, travel, geopolitics, communications. It's the work of cables sitting on the seafloor, not satellites, that connect our global population.[19] Ignore momentarily the talk about

---

[17] Jeffrey Marlow, "Undersea Internet Cables Can Detect Earthquakes—and May Soon Warn of Tsunamis," *New Yorker*, July 26, 2022, https://www.newyorker.com/science/elements/undersea-internet-cables-can-detect-earthquakes-and-may-soon-warn-of-tsunamis; Barnes, "Quantum Leap in Platforms," 209; "Submarine Cables and BBNJ," International Cable Protection Committee (ICPC Ltd. August 1, 2016): 5, https://www.un.org/depts/los/biodiversity/prepcom_files/ICC_Submarine_Cables_&_BBNJ_August_2016.pdf.

[18] "Submarine Cables and BBNJ," 5.

[19] Barnes, "Quantum Leap in Platforms," 209. On high voltage power cables, see Bastien Taormina, Juan Bald, Andrew Want, Gérard Thouzeau, Morgane Lejart, Nicolas Desroy, and Antoine Carlier, "A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions," *Renewable and Sustainable Energy Reviews* 96 (2018): 380-391, "Submarine Cables and BBNJ," 1.

satellites, Elon Musk, and the International Space Station. It's cables that make global telecommunications go round. Think ocean, not space.

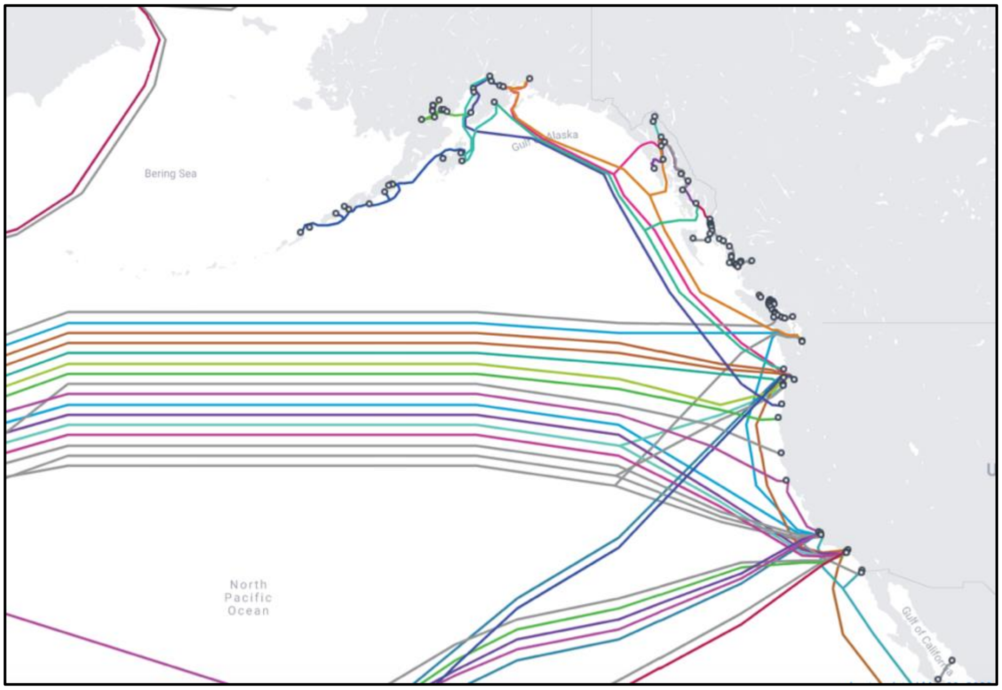


Figure 5.2. A map depicting major submarine fiber optic cables in the northeast Pacific Ocean, 2023. Image courtesy of TeleGeography.com

The cable industry's footprint is expanding, however, even as the cables become thinner and thinner. In the early 1900s, the seafloor already hosted around two hundred thousand miles (321,869 km) of telegraph cables.[20] By the 1950s, that number reached almost five hundred thousand miles (804,672 km) of telephone and telegraph cables. Now, in the twenty-first century, there are over seven hundred and forty-five thousand miles (1.2 million km) of fiber optic cables in operation around the world—that's enough cable to wrap around the earth's equator more than twenty-seven times.[21] That statistic

[20] Giberne, *The Romance of the Mighty Deep*, 281; "Submarine Cables and BBNJ," 1.

[21] Marlow, "Undersea Internet Cables."

doesn't include the five thousand miles (8,047 km) of submarine electricity cables on the seabed, as well, which if stretched in one line out would reach from the United States to Austria.[22] If we look towards the future and envision a seafloor that is cluttered with even more cables, the ecological impacts begin to matter even more. While I'm in support of leaving old, abandoned cables in the ocean, I don't support an unregulated increase of new fiber optic cables going into the sea. Albeit localized, there are environmental consequences for every fiber optic or power cable that is installed, fixed, moved, or removed. Consider the grapnel hooks that scrape the cable from the seabed, the sea plows that cut trenches into the sediment during installation, and the power cables that interfere with the seabed's electromagnetic field.[23] It's about scale, and that scale is ever-increasing.

In this chapter, we will return to the northeast Pacific Ocean's shelf to learn about the many marine elements that can kill a cable, causing them to languish on the sea bottom: currents, rockslides, earthquakes, anchors, and fishing nets. For cable owners, these problems are timeless, posing a persistent threat since cables first entered the Pacific over a century ago. In the twenty-first century, cable companies do everything in their power to prevent a cable from breaking, even if that prevention includes environmentally invasive methods of installation.

---

[22] Taormina et al., "A Review of Potential Impacts," 380. Douglas Burnett, Tara Davenport, and Robert Beckman, "Introduction: Why Submarine Cables?," in *Submarine Cables: The Handbook of Law and Policy*, eds. Douglas Burnett, Tara Davenport, and Robert Beckman (Leiden: Martinus Nijhoff Publishers, 2014), 3; Luana Albert, Fraançois Deschamps, Aurélie Jolivet, Frédéric Olivier, Laurent Chauvand, Sylvain Chauvaud, "A Current Synthesis on the Effects of Electric and Magnetic Fields Emitted by Submarine Power Cables on Invertebrates," *Marine Environmental Research* 159 (2020): 1-2.

[23] Boztas, "Buried at Sea."

Surviving the Seabed

Everything ages in the ocean. Kelp shrivels and releases from the rocks, fish weaken and slow, and the saltwater—seemingly timeless—maintains an ancient record of the ocean's chemical fluctuations. While the Pacific's ecosystem changes by the hour and the day, undersea cables are designed to take no part in that quick temporal change. In stark contrast to all other features of the sea, cables are designed to not age—at least for a few decades, after which they are expected to die just like everything else. Twenty-five years, that's the typical lifespan industry experts have assigned to undersea cables.[24] That is just an estimate, though. Some cables survive much longer while others function for just a few years before experiencing a catastrophic break. Just as the Pacific dismantled tideland drilling piers in California's shoreline, the ocean also collects a toll on the shelf's cables. What kills a cable? In the northeast Pacific Ocean, underwater currents, rockslides, ice, and earthquakes are just a few of the elements that make this stretch of seafloor a dangerous place. Since 1904, cables within the Gulf of Alaska broke at least twenty times.[25] Those were just the sudden breaks and do not include the regular wear

---

[24] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 1.

[25] At least one or more breaks occurred in 1900, 1901, 1903, 1908, 1909, 1911, 1913, 1915, 1919, 1925, 1927, 1937, 1957, 1958, 1960, 1965, 2014, 2016, 2020, and 2021. See Bruce K. Heezen, "Whales Entangled in Deep Sea Cables," *Deep Sea Research* 4 (1957): 106-107; "Fish Story," *Morning Astorian*, January 25, 1905; "Seattle Marine News," *Sunday Oregonian*, April 5, 1908; "Vancouver Barracks Notes," [Portland] *Morning Oregonian*, February 18, 1908; "Earthquake in Alaska Did Little Damage," *Daily Capital Journal*, January 13, 1909; "Earth Trembles on Puget Sound," [Portland] *Morning Oregonian*, January 12, 1909; "Quake Not Responsible," [Portland] *Morning Oregonian*, January 16, 1909; "Whale Strangled Self," *Athena Press*, November 5, 1909; "Will Repair Cable," *Morning Astorian*, January 13, 1909; "Cable to Alaska Breaks," [Portland] *Morning Oregonian*, March 11, 1919; "Summer Means News Supplies for Signal Corps," *Oregon Statesman*, June 26, 1927; "Severe Earthquake Rocks S.E. Alaska; Cables Break," *Oregon*

and tear on the cables that require repairs. This region's number of cable breaks drew the attention of Bruce Heezen, the venerated American oceanographer, and his co-author, G. Leonard Johnson. They wrote in 1969, "The marine environment in Alaskan waters treated the cables harshly, and the history of their repair and maintenance reveals much concerning the geological agents at work on the sea floor."[26] As cable-layers have figured out over the previous one-hundred and twenty years, the key to preventing a cable break in the Pacific begins long before the cable enters the water. First, you have the find the right seafloor.

In the late nineteenth and early twentieth centuries, cable-layers were always on the lookout for "good" seafloor—often a perception more than a scientific determination. Key to determining a seafloor's suitability was its depth, which cable-layers fretted over more than any other feature of the ocean bottom. Without the availability of remote

---

Statesman, October 25, 1927; "Landslide Under Sea Snaps Cable," [Portland] *Morning Oregonian*, October 13, 1911; "Submarine Slides May Have Disabled Cable," *Alaska Daily Empire*, July 14, 1913; "Dragging Anchor Puts Alaska Cable Off the Job," *Daily Rogue River Courier*, November 18, 1915; "Dellwood Enroute North to Repair Broken Cables," *Alaska Daily Empire*, February 26, 1925; "Whale Breaks Alaska Cable," *Daily Alaskan Empire*, April 9, 1927; "No Money to Repair Broken Alaska Cable," *Nome Nugget*, May 10, 1937; "Repairs Completed On Cable Break in ACS Line," *Nome Nugget*, September 4, 1957; "ACS Rushes Repairs To Submarine Cable After Earthquake," *Nome Nugget*, July 11, 1958; "Alaska Submarine Telephone Cable Repaired," *Nome Nugget*, October 12, 1960; "Cable Break Laid to Red Trawlers," *Seattle Post-Intelligencer*, October 28, 1965, MS 11-2 ACS News Items 1962-1965, Alaska State Library, Historical Collections, Juneau, Alaska; David Eric Jessup, "Connecting Alaska: The Washington-Alaska Military Cable and Telegraph System," *Journal of the Gilded Age and Progressive Era* 6, no. 4 (Oct. 2007): 392-393; Laurel Andrews, "Damaged Undersea Cable Disrupts Sitka's Internet, TV service," *Anchorage Daily News*, September 28, 2016, https://www.adn.com/business/article/damaged-undersea-fiber-optic-cable-interrupts-sitka-s-internet-cable-service/2016/02/17/; Pat Forgey, "5.9 Earthquake Causes Telecom Outage in Southeast Alaska," *Anchorage Daily News*, September 28, 2016, https://www.adn.com/alaska-news/article/59-earthquake-causes-telecom-outage-southeast-alaska/2014/07/26/; Mike Ross, "GCI to Repair Broken Underwater Fiber Optic Cable," *Alaska News Source*, January 31, 2020; Michael S. Lockett, "Damage to Undersea Cable Leads to Widespread Communication Outages." *Juneau Empire*. April 30, 2021. https://www.juneauempire.com/news/damage-to-undersea-cable-leads-to-widespread-communication-outages/; *The All Red Line: The Annal and Aims of the Pacific Cable Project*, ed. George Johnson (Ottawa: James Hope and Sons, 1903), 189.

[26] Heezen et al., "Alaskan Submarine Cables," 415.

scanning or ROVs common by the late twentieth century, mariners, naturalists, and scientists routinely used sounding devices to gauge the seabed's depth. Sounding device were, in their simplest form, a long line with a weight at the end. Those were simple and useful tools, but not without their problems. For example, ocean currents could pull the ship or the sounding line to the side, causing the seafloor to measure deeper than it actually was. Sailors would perform many hundreds or even thousands of soundings during a single expedition. Unfortunately for them, sounding was a tedious task: drop and wait, record the line's length, pull it back in, wax it, rinse and repeat. Piano wire—sturdy, available, inexpensive—was the line of choice in the Thomson Deep Sea Sounding Machine, a common technology on U.S. Naval ships. Soldered together every 1,200 or 2,400 feet (366-732 m), the line could measure even the deepest bottoms. To avoid rust, crews would rub the piano wire with sperm oil, an oozy liquid drained from the heads of dead sperm whales.[27] An odd task, surely, but worth the effort if it meant a safer installation for the cable.

Naval ships, naturalists, and cable developers across the globe shared their sounding records with each other to "ascertain the true ocean bed."[28] When combined onto charts, these thousands of individual soundings began to provide a rough sense of

---

[27] Charles Bright references Thomson first using the machine in 1872. See Bright, *Submarine Telegraphs*, 29; "The Ocean Depths," *New York Times*, March 29, 1874; George E. Belknap, *Deep-Sea Soundings in the North Pacific Ocean* (Washington: Government Printing Offices, 1874), 5, 13; Jason W. Smith's recent work, *To Master the Boundless Sea*, recounts the cartographic turn within the U.S. Navy during the 19th century, the country's effort to establish an empire by means of charting, recording, and measuring the oceans. See Smith, *To Master the Boundless Sea: The U.S. Navy, the Marine Environment, and the Cartography of Empire* (Chapel Hill: University of North Carolina Press, 2018), 126.

[28] "Washington. The Brooklyn Post Office—Pacific Survey for a Cable to China," *New York Times*, September 9, 1873.

the Pacific's seafloor, or "character," as the Victorians might describe it.[29] During the early twentieth century, the shelf framing the northeast Pacific Ocean near the Gulf of Alaska had the popular reputation of being flat, meaning it was a good seabed for a cable. The flatter, the better. In 1899, while describing sixty-three million square miles of some of the most diverse ecosystems on earth, the British Cable Committee offered this statement, "It is generally admitted that the bottom of the Pacific is soft, and of a kind favourable to the life of a cable."[30] The *New York Times* agreed and reported that the northeast Pacific seabed was so delightfully flat that industrialists could run a railroad line across it—a claim the reporter made based on conjecture, not the Pacific's actual bathymetry.[31] The *Oregon Sunday Journal* reported that the seabed near Alaska boasted a "great continental shelf," free of the coral reefs that threatened to scrape the cable's exterior. And the *Morning Oregonian* favorably noted that the Gulf of Alaska's waters were also "free from ice at all seasons," making the environment safe for cables and cable ships.[32]

Industrialists and scientists, eager to install their instruments on the seabed, "metamorphosed [the ocean floor] into a flat, quiescent environment safe for submarine cables," writes historian Helen Rozwadowski.[33] It was a type of boosterism for the

---

[29] Helen Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea* (Cambridge, MA: Belknap Press of Harvard University Press, 2005), 60.

[30] "The Report of the Pacific Cable Committee," *The Electrical Review* (1899): 17.

[31] "The Ocean Depths," *New York Times*, March 29, 1874; "The Cable Will Come," *Seattle Post-Intelligencer*, March 17, 1900.

[32] "Pacific Trade Is Gaining Headway Despite Handicap," *Oregon Sunday Journal*, June 1, 1919; "Trade Handicapped By Cable Service," [Portland] *Morning Oregonian*, January 26, 1922.

[33] Cyrus W. Field relied on information from Matthew F. Maury that a flat "telegraph plateau" ran between Newfoundland and Ireland, an ideal host for the first transatlantic cable. Rozwadowski, *Fathoming the Ocean*, 86.

seabed behind which cable promoters, newspapers, and government officials could rally.[34] But as time and technology would reveal, many of these beliefs about the Pacific Ocean proved untrue. For instance, cold-water corals flourish along the deeper stretches of the Gulf of Alaska, and ice scrapes along the seafloor near the coastline.[35] Likewise, earthquakes commonly jostle the seabed. Hindsight also tells us that the Pacific seafloor has a great number of terrains. In addition to being soft and flat, it also contains rough corals, mushy clays, hot volcanic discharge, scalding steam vents, and coarse sands. Despite these inconsistencies, the work of sounding and mapping the Pacific seabed helped industrialists and cable-layers recast the Pacific seafloor from an alien environment into a legible one, as historian Jacob Darwin Hamblin has noted.[36] Whether their beliefs proved true or not, the search for good seafloor provided owners the reassurance they needed to install cables in a foreign environment.

The northeast Pacific's "great continental shelf"—popularly known to be flat, soft, and ideal for hosting a submarine cable—turned out to be a tectonic powerhouse that's plagued by earthquakes both big and small.[37] Around the northern Pacific Ocean,

---

[34] For other histories that discuss environmental boosterism, see Henry Knight Lozano, "Water in Paradise: California, Florida, and Environmental Rivalry in the Gilded Age," *Environmental History* 20, no. 4 (October 2015): 619-44; Kristine C. Harper, *Make it Rain: State Control of the Atmosphere in Twentieth-Century America* (University of Chicago Press, 2017); Adrian Howkins, "The Significance of the Frontier in Antarctic History: How the US West has Shaped the Geopolitics of the Far South," *The Polar Journal* 3, no. 1 (2013): 9-30.

[35] W. J. Tudor, *Structures in the Deep Ocean: Engineering Manual for Underwater Construction* (Port Hueneme, California: U.S. Naval Civil Engineering Laboratory, 1964), 2-38.

[36] Jacob Darwin Hamblin, "Seeing the Oceans in the Shadow of Bergen Values," *Isis* 105 (June 2014): 357; Smith, *To Master the Boundless Sea,* 38. The military's interest in sounding the shelves was part of a larger mission they hoped would benefit both the nation and the submarine cable industry. See Smith, *To Master the Boundless Sea,* 7, 128; Michael Reidy, *Tides of History: Ocean Science and Her Majesty's Navy* (University of Chicago Press, 2008), 89.

[37] Bruce C. Heezen and G. Leonard Johnson, "Alaskan Submarine Cables: A Struggle with a Harsh Environment," *Arctic* 22, no. 4 (December 1969): 416; Jeff Wheelwright, *Degrees of Disaster: Prince William Sound: How Nature Reels and Rebounds* (New Haven, CT: Yale University Press, 1994), 17;

multiple tectonic plates jockey for space, their edges bumping and grinding against each other. As one tectonic plate forces the other underneath it, mammoth earthquakes can shake the entire region on land and at sea. Often referred to as the Ring of Fire, these active plates cause ninety percent of the world's earthquakes.[38] Even in the nineteenth century, those who studied the ocean understood that earthquakes could originate from the seafloor, or what the well-known naturalist Ernest Ingersoll described as "a shock at the bottom." He continued, "Whenever a subterranean convulsion occurs beneath or at the edge of the sea, the water will be agitated in proportion to its force."[39] Ingersoll also noted that wherever volcanic mountains erupted on land, the nearby seafloor tended to respond with an earthquake, as though the "ocean retorts with terrible vengeance when it is struck by the land."[40] Not yet knowledgeable of plate tectonics—a scientific theory that would not be introduced until the mid-twentieth century—Ingersoll nevertheless discerned a connection between active coastal volcanoes and an active seafloor. Other deep-sea enthusiasts did have some knowledge of undersea earthquakes, as well. "Sometimes, deep down," reported author Agnus Giberne in 1905, "a big 'landslip' takes place, and a vast mass of débris slides to a lower level. If such a mass happens to descend upon a cable, the breakage of the latter is no unlikely event."[41] What scientists and

---

"Pacific Trade Is Gaining Headway Despite Handicap," *Oregon Sunday Journal*, June 1, 1919; "Alaska Cable To Be Completed," *Oregon Sunday Journal*, May 22, 1904.

[38] Scales, *Brilliant Abyss*, 6; David Igler, "The Northeastern Pacific Basin: An Environmental Approach to Seascapes and Littoral Places," in *A Companion to American Environmental History*, ed. Douglas Cazaux Sackman (Hoboken, NJ: John Wiley and Sons, 2010): 579.

[39] Ernest Ingersoll, *Book of the Ocean* (New York: Century, 1898), 202-203, HT.

[40] Ibid., 203.

[41] Giberne, *Romance of the Mighty Deep*, 282-283.

Pacific cable-promoters did not always appear to do, however, was speak to each other. Each camp had a different understanding of the seafloor's safety.

Notwithstanding their ignorance about the Pacific Ocean's tectonic activity, cable-layers had more awareness about the dangers of its currents. Just as the surface water is always in motion, so too is the seafloor. In this region, scores of rivers and streams deliver freshwater into the ocean. Wherever strong sources of freshwater dive into the sea, resulting currents can shuffle rocks, sands, and animals. Cable-layers tried to avoid currents by steering clear of regions of the seabed with a rocky bottom, which indicated that strong currents had pulled away the softer muds and sands. Conversely, a soft bottom indicated an area free of currents.[42] They were right to worry about currents and moving rocks. In the mid-twentieth century, oceanographer Bruce Heezen reported that the seafloor along the Gulf of Alaska's continental shelf "chafed" portions of the undersea cable system twenty-six times over the course of four decades. Chafing, in this context, occurred when the ocean bottom's currents, rocks, and sands rubbed against the cable to the point of wearing down its protective exterior and exposing its copper center. The number of chafing incidents only increased nearer the shoreline, where the "sand-blasting by the current" frayed the cable within a couple of years. He also noted that rockslides risked "bruising" the cable.[43] Considering the Alaska cable network included many hundreds of miles of undersea cables that branched across the northeast Pacific

---

[42] Bright, *Submarine Telegraphs,* 410.

[43] Ibid., 415-416, 419.

region like tree limbs, Heezen and his co-author did not consider twenty-six to be so egregious a number.[44]

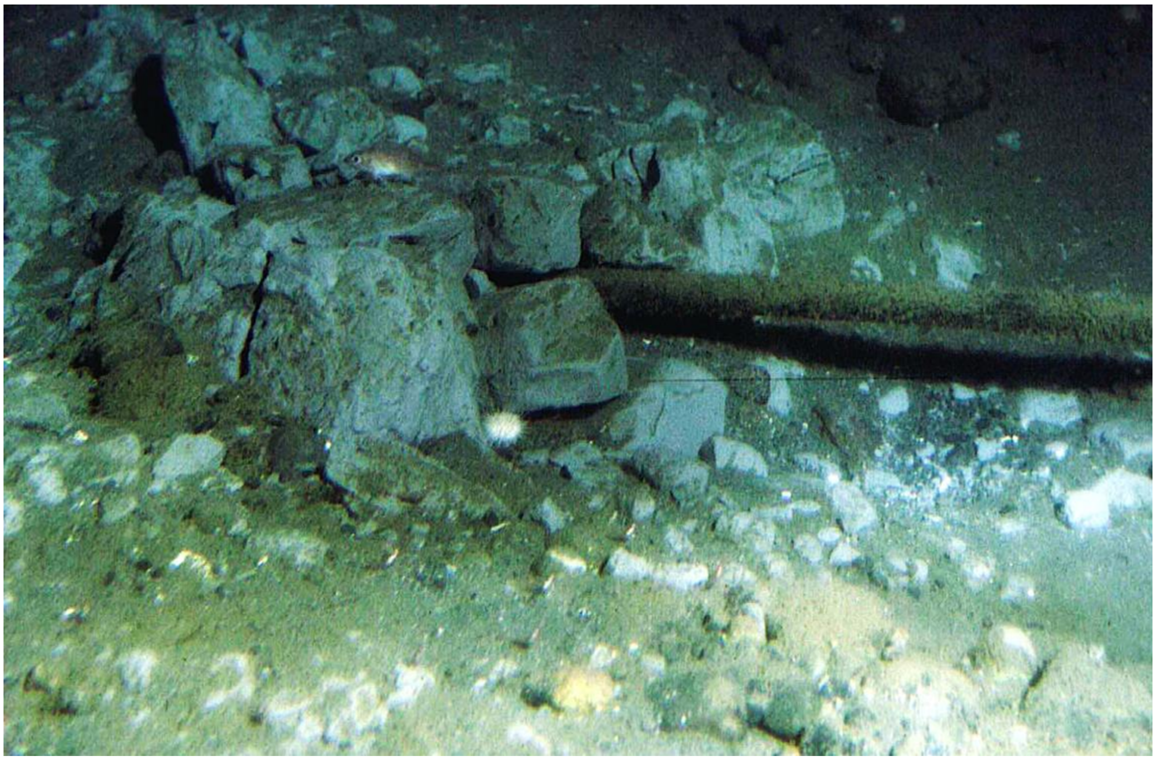


Figure 5.3. A section of the PC-1 cable is buried under rocks and suspended above the seafloor. Suspensions are dangerous for fishing nets and passing marine life. Image courtesy of Olympic Coast National Marine Sanctuary, National Oceanographic and Atmospheric Association, Port Angeles, Washington.

Earthquakes, turbidity currents, and chafing aren't the only marine elements that have threatened cables in the region. Ice also collects around the margins of the Alaskan terrestrial borders, from the salty sea ice to the less-frequent icebergs that calve from nearby glaciers. Weighed down by their mass, glaciers plunge from the surface of the water towards the shallow ocean bottom and scrape along the seafloor. U.S. naval officers, who spent not a small portion of their careers sailing the ocean and avoiding that

[44] Heezen et al., "Alaskan Submarine Cables," 415.

very ice, warned in the early 1900s that a cable may not survive the northeast Pacific Ocean's annual marine freeze.[45] The strong force of icebergs as they move in the water or the all-consuming pack ice was apt to clamp onto the small cable and tear it like a knife to a ligament. Unless cable-layers could identify areas of seafloor that provided protection from scraping ice, such as natural depression in the seabed or the mouth of a river, the northeast Pacific seafloor would never be a totally safe place for such a technology.[46]

Despite the ferocity of the ocean's currents, rocks, and ice, however, they have never proven to be the primary killers of cables. That ranking goes to humans. Ship anchors and bottom-trawl fishing gear have snapped, snagged, and dragged more cables than any other natural element. That reality holds true in the northeast Pacific Ocean and around the global ocean.[47] The conflict between fishermen and cables stretches back to 1850, when one of the first telegraph cables ever laid underwater—this one crossing the English Channel—was struck by a fisherman's net hours after installation.[48] Snags by fishing gear have occurred every year since then, making the animosity between trawl fishermen and cable companies severe and litigious. Between 1959 and 2006, trawling nets accounted for more than forty-four percent of cable breaks, while anchors caused

---

[45] "Alaska Telegraph Line," [Portland] *Morning Oregonian*, November 12, 1900; "Alaska Cable to be Completed," *Oregon Sunday Journal*, May 22, 1904.

[46] "Alaska Telegraph Line," [Portland] *Morning Oregonian*, November 12, 1900; *Annual Report of the Chief Signal Officer 1902* (Washington: Government Printing Office, 1902), 48.

[47] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary*, 5.

[48] Ibid., 65; Giberne, *Romance of the Mighty Deep*, 277.

fourteen.[49] At the heart of this conflict is not necessarily two industries that oppose each other. Indeed, cable companies and fishing boats don't compete for buyers, customers, or capital. But they do compete for space on the seafloor. Most often, fishing vessels are unaware of a cable's location, and when they snag one, they don't always inform the cable company.[50] Entanglements and lawsuits are the results of both industries being unaware of how and where the other is using the seabed. The other most common cause for cable breaks, accounting for over twenty percent of dead cables, is "Unknown."[51] When a cable breaks, its owners aren't always privy to why, which is a common problem, even in the twenty-first century.

In April 2021, just after lunchtime, an ominous rumble disturbed the tranquility of the seafloor just off Alaska's coastline. Possibly a tumble of heavy rocks or the drag of a ship's anchor—we humans will never know for sure—caused a commotion across a small section of the ocean bottom. Excitement on the seabed arrives in bursts: currents rush overhead, rocks tumble, ice scrapes the seabed, and the ground sometimes shakes. But the disturbances are often temporary. Adept with what scientists call an avoidance mechanism, most marine life would have fled the scene with a *whoosh! swirl!* and *rush!* Just a temporary upheaval, however, for once the storm of sediments drifted away, and

[49] L. Carter, D. Burnett, S. Drew, G. Marle, L Hagadorn, D. Bartlett-McNeil, and N. Irvine, *Submarine Cables and the Oceans – Connecting the World*, UNEP-WCMC, Biodiversity Series No. 31. ICPC/UNEP/UNEP-WCMC (2009), 45, 48.

[50] Bright, *Submarine Telegraphs,* 90; Scott McMullen, Oregon Fishermen's Cable Committee, conversation with the author, Astoria, Oregon, November 7, 2019; Carter et al., *Submarine Cables and the Oceans,* 45, 48.

[51] Carter et al., *Submarine Cables and the Oceans,* 45.

the Pacific's benthic organisms returned to the muds and rocks of the seafloor, life quieted down again. Quiet is the wrong term, however, for this shelf is never really silent. The seafloor's creatures make noise, lots of noise. It's a constant symphony of shrimp *click-clack click-clacking*, of fish humming, and whales singing. A distant beep, an eerie whistle, and the ceaseless grumble are reminders of the many species harmonizing nearby—always there, but rarely visible.[52] The ocean plays its song and life returns to normal.

But miles away, in a wholly different world, life was not returning to normal. At the very moment that the seafloor's creatures fled to safety, thousands of humans living in Southeast Alaska lost their phone and Internet connections. No ability to reach 9-1-1 operators, and no Internet connection. A region of people, already isolated by a global pandemic, became instantly disconnected.[53] Alaska Communications, a private company that operates under a similar name of the Army Signal Corps' earlier system, realized their undersea fiber optic cable wasn't working and quickly released a statement: "It's uncommon for cables to have problems, but it does happen from time to time," explained a company representative.[54] But knowing your cable is broken is a totally different beast than finding and fixing it. Despite the company's access to a state-of-the-art cable ship, locating and grabbing a broken cable still required nothing less than a maritime triumph. "It takes a tremendous effort to locate the cable break," the company reported to its angry customers. After two weeks of round-the-clock work, Alaska Communications finally

[52] Sabrina Imbler, "Could Listening to the Deep Help Save It?" *New York Times*, November 11, 2020.

[53] Quoted in Michael S. Lockett, "Damage to Undersea Cable Leads to Widespread Communication Outages," *Juneau Empire*, April 30, 2021.

[54] Lockett, "Damage to Undersea Cable."

located and fixed the fault. Even after assessing the cable's damaged components, the company still couldn't determine the cause of the break—either a rockslide or an anchor. As a representative of the company told me, "We know it was one or the other, but it was never clear which one."[55] When it comes to the seafloor environment, there's always an element of surprise, and the humans never have full control over the fate of their technologies. The seafloor still keeps its secrets.

Fiber Optic Cables

Today's global undersea cable system is a paradox. One the one hand, it is sprawling, with hundreds of thousands of miles of lines crossing every type of basin, depth, and sediment. On the other hand, the system is surprisingly lean. Modern fiber optic cables are often compared to a garden hose: slim, unobtrusive, with one section easily lifted by a human hand.[56] Minimal, really, when we consider that only about three hundred individual cables serve billions of Internet users around the globe.[57] Thanks to the system's leanness, the cable industry has maintained that undersea cables do not negatively impact the marine environment. One biologist from the National

---

[55] Quoted in Lockett, "Damage to Undersea Cable"; Alaska Communications representative, Twitter message to the author, July 29, 2021.

[56] Tyler Cooper, "Google Owns 63,605 Miles and 8.5% of Submarine Cables Worldwide," *BroadbandNow*, September 12, 2018, https://broadbandnow.com/report/google-content-providers-submarine-cable-ownership.

[57] Marlow, "Undersea Internet Cables."

Oceanography Centre stated that submarine cables, "have a tiny to zero impact," on the marine environment. The authoritative *Handbook on Submarine Cables* concluded, "its impacts on the marine environment are benign."[58] The International Cable Protection Committee (ICPC), an international institution representing cable owners and contractors, even went as far to suggest that cables have "nil environmental impact" and make a "contribution to sustainability."[59] The ICPC points to other marine industries it considers to be more destructive, including "shipping, fishing and mining."[60] From the industry's standpoint, then, there are decades of environmental neutrality—a selling point that sets undersea telecommunications apart from other seafloor industries.

There's truth in these comments. For starters, undersea communication and power cables are physically inert and compact. They do not leak noxious chemicals, even when they break. And as the previous chapter established, cables often provide artificial habitat for epifauna.[61] Likewise, the industry's historic practice of abandoning cables *in situ* generally avoids the ecological disruptions that come with removing machines encrusted with organisms and sediment. Despite cables' apparent environmental neutrality, however, the industry's installation techniques are growing more invasive, while its reach is ever-expanding. As this section discusses, the act of installing, moving, fixing, or removing a line causes some disruption to benthic habitats and marine life.[62] In the

[58] Douglas R. Burnett, Robert C. Beckman, and Tara M. Davenport, *Submarine Cables: The Handbook of Law and Policy* (Martinus Nijhoff, 2013), 8.

[59] "Submarine Cables and BBNJ," 2; see also Boztas, "Buried at Sea."

[60] Ibid.; Burnett et al., *Submarine Cables,* 8.

[61] "Submarine Cables and BBNJ," 5; Carter et al., *Submarine Cables and the Oceans,* 30.

[62] Kraus et al., "Seabed Recovery," 259.

twenty-first century, with over seven hundred and forty-five thousand miles (1.2 million km) of submarine cables in the ocean and counting, the industry's growth *will* affect the marine environment. What's up for debate, however, is the scale and degree. With cables increasingly ubiquitous across our global ocean, the seafloor's response to the industry matters more than ever.

Since the 1980s, it has become standard practice for cable-layers to bury their cables into the seabed. As fishing boats trawl deeper and deeper into the abyss, cable-layers must bury their cables to a water depth of approximately 6,500 feet (1,981 m).[63] That's a big shift from earlier decades. When the U.S. Army Signal Corps first installed the Alaska cable in 1904, for instance, they left the system's thousands of miles of line unburied. Historically, it was only when a cable crossed a beach that cable-layers would bury the line.[64] But the introduction of remotely operated vehicles (ROVs) and sea plow machines in the late twentieth century have made burial not only doable, but expected. Nowadays, cable burial has become so standard that certain cables, such as light wired armored cables, are designed with the expectation that the cable ship will bury them during installation. The cost of laying a new transoceanic fiber optic cable is thus extremely expensive—sometimes more than a billion dollars—so cable companies take route selection, installation, and burial seriously.[65] Though expensive, a well-buried cable helps all stakeholders sleep easier at night.

---

[63] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 1; "Analysis of Remediation Alternatives for the Pacific Crossing-1," NOAA, ii; Kraus et al., "Seabed Recovery," 251-252. Offshore hydrocarbon exploration is now reaching over 9800 feet of water depth. See Carter et al., *Submarine Cables and the Oceans,* 10.

[64] Weiner et al., "Olympic Re-Lay," 80; See Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 6.

[65] Starosielski, *Undersea Network,* 11

The cable industry has developed a few methods to bury a cable. The most common is plowing, whereby a remotely operated vehicle cuts a ditch into the seafloor and inserts the cable into the trough while continually creeping forward. These colossal sea plows are now “bigger, stronger and heavier” than ever before, some weighing up to thirty tons—or the equivalent of four adult male African elephants. With that weight comes power, meaning the plow can cut multiple meters into the seafloor on a single pass.[66] An even harsher method, jetting, uses high-pressures fluids to “liquefy sediments” on the seafloor, including rockier areas, easily slicing a clean line into the seabed in which the cable can nestle. Companies also use directional drilling to bore diagonally into the seabed from the shore. Cable-layers typically bury the cable to at least three feet (one meter), but depending on the region’s level of maritime activity, cable may be buried about sixteen feet (5 m) into the seafloor.[67] Any creature living within the trench path could be squished or displaced, including organisms like worms, shrimp, crabs, sea stars, urchins, sea cucumbers, brittle stars, snails, limpets, mussels, squat lobster, anemones, corals, sponges, and sea hares.[68] The sea plow’s skids press down on the sediments, too. The Sea Plow VII, which installed the PC-1 cables mentioned at the beginning of this chapter, can “crush epibenthic organisms” at a range of nineteen feet (6 m) in width.

---

[66] Douglas R. Burnett, Robert C. Beckman, and Tara M. Davenport, *Submarine Cables: The Handbook of Law and Policy* (Martinus Nijhoff, 2013), 32; John Horne and Raynald Leconte, “Marine and Maintenance (From Inception to End of Life),” in José Chesnoy, ed., *Undersea Fiber Communication Systems* (London: Elsevier, 2016), 614.

[67] “Analysis of Remediation Alternatives for the Pacific Crossing-1,” NOAA, 33-34; Kraus et al., “Seabed Recovery,” 251; Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 1.

[68] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 8, 18.

It isn't just the marine life living on or below the seabed that are disturbed. Cable burial also sends plumes of sediment up into the water column and across the seafloor. If those plumes are thick enough, they can darken and clog the surrounding seawater and choke out oxygen-loving organisms. These plumes don't just travel up, they also span out. Jetting, in particular, can send debris over a mile's distance from the original installation site.[69] Sometimes, installation does not go to plan, and entire sections of the cable are left unburied, even in busy coastal areas. Two industry experts admitted that cable burial "is not an exact science."[70] The telecommunications industry, in other words, is still making educated guesses. Consider, then, a future in which hundreds of thousands of miles of new cable enter the seafloor—each section of trenching, jetting, or sediment displacement could accumulate from a localized disturbance into a regional one.

Some rocky regions of the seabed make it impossible to bury a cable. In those locations, cable-layers may place the cable inside a pipe, cover the line in a concrete mattress, or even cover it in a piles of rocks. In cases where the seafloor dips low and causes the cable to hang in the water column, cable-layers might instead build up the height of the seafloor to meet the suspended cable.[71] Marine life colonizes these protective structures, just as they would colonize an exposed cable. In the southwest Pacific Ocean, for instance, scientists found one protective pipe "encrusted by an epifauna" after four years of its arrival on the seabed.[72] The cable industry often reworks

---

[69] Kraus et al., "Seabed Recovery," 252, 259; "Analysis of Remediation Alternatives for the Pacific Crossing-1," NOAA, 34, 37.

[70] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 8.

[71] Taormina et al., "A Review of Potential Impacts," 382.

[72] Kraus et al., "Seabed Recovery," 254; Taormina et al., "A Review of Potential Impacts," 385.

the configuration of the seafloor to meet the needs of the cable, in turn disorganizing and sometimes killing benthic life in the immediate region around the cable.

How the seabed responds to cable burial depends on its proximity to the coastline. Put simply, the closer to shore, the faster the recovery. Think of the inner continental shelf, or the seabed nearest the coastline, as a young person: vibrant and bustling, constantly transforming with fresh deliveries of sediment, nutrients, and strong currents delivered from land. When this nearshore seafloor receives an injury—such as a deep trench—it heals quickly thanks to the constant influx of new sediments. Being further from shore, the inner and outer continental shelves don't receive the same amount of nutrients, sediments, or swift currents. These regions respond to cable burials like an older adult responds to an injury: still capable of healing, but unable to bounce back as quickly. The vibrant inner shelf may take months or a year to heal from such an injury; the middle and outer shelves need multiple years. Overall, scientists are finding that the seabed will restore itself, but recovery times vary.[73]

Cable-layers adopt a motherly, hands-on approach during installation, but once the cable is operational, they will leave it alone on the seabed and monitor breaks remotely. But alone is not quite the right term, for the cable is never really on its own down there. The species that we et in the previous chapters—the algae, mussels, and anemones—will begin to colonize and frequent sections of unburied cable.[74] Consider the millions of Pacific vertebrates and invertebrates that have colonized one technological

---

[73] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* iv.

[74] Taormina et al., "A Review of Potential Impacts," 386; Olivia Langhamer, "Artificial Reef Effect In Relation To Offshore Renewable Energy Conversation: State of the Art," *Scientific World Journal* (2012): 1.

iteration of undersea cables after another over the last one-hundred and twenty years—telegraph, telephone, electrical, and fiber optic cables.[75] After decades on the seabed, most cables are unrecognizable, covered in such thick layers of marine flora and fauna that they appear to totally blend with the ocean bottom. Nowadays, scientists call the process of marine life covering the cable the "reef effect," wherein the marine technology creates an artificial reef that supports marine species.

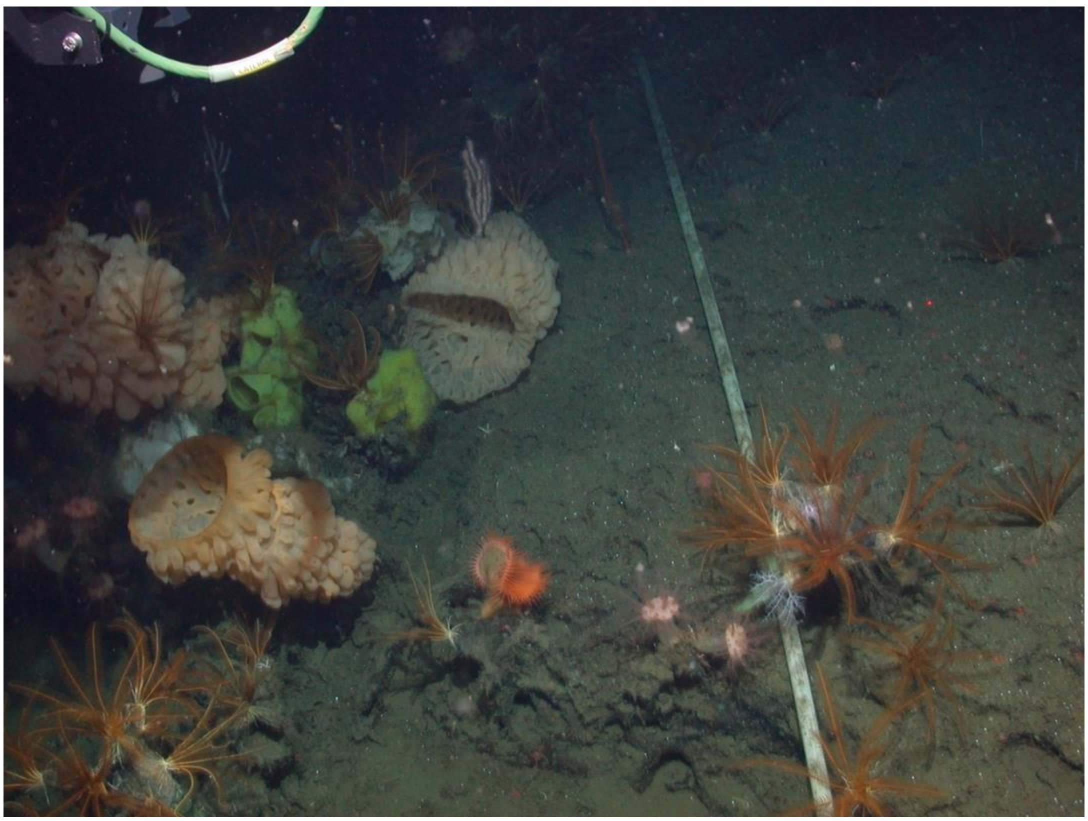


Figure 5.4. Marine life flourishes across the seafloor's depths. The installation, maintenance, and removal of undersea cables can affect these benthic communities. Pictured here is a segment of the ATOC cable at Pioneer Seamount, off the coast of Half Moon Bay, captured by a remotely operated vehicle (ROV) at a depth of approximately 1,050 meters. © 2003 Monterey Bay Aquarium Research Institute.

[75] Taormina et al., "A Review of Potential Impacts," 385.

Many species often benefit from the new substrate that cables provide, but there are drawbacks for others. The power running through cables may disorient species dependent on the seafloor's natural electromagnetic field, including sharks, sea turtles, lobsters, crabs, and others. With huge amounts of electricity passing through them, the "magnetic emissions" from power cables and fiber optic cables can variously repel, attract, and confuse certain species.[76] Sharks are a perfect case in point. In 1985, AT&T laid the first deep-sea fiber optic cable system between the Canary Islands. In the immediate months after installation, the company discovered evidence of four different instances of sharks biting the line.[77] AT&T wasn't the first company to deal with shark bites. There are both historical and modern instances of sharks and other fish chomping down onto a cable, leaving behind teeth or teeth marks.[78] In 2014, a camera caught a shark biting one of Google's undersea cables. Echoing the industry's century-old belief that cables are vulnerable to the whims of marine monsters—"Enemies of the Cable" as one nineteenth century engineer called them—many industry experts and news outlets have chalked these incidents up to a shark's aggression.[79] Sharks aren't alone in their

---

[76] See Taormina et al., "A Review of Potential Impacts," 385; Luana Albert, Fraançois Deschamps, Aurélie Jolivet, Frédéric Olivier, Laurent Chauvand, Sylvain Chauvaud, "A Current Synthesis on the Effects of Electric and Magnetic Fields Emitted by Submarine Power Cables on Invertebrates," *Marine Environmental Research* 159 (2020), 1-2; Bruce K. Heezen, "Whales Entangled in Deep Sea Cables," *Deep Sea Research* 4 (1957): 114; Louis J. Marra, "Sharkbite on the SL Submarine Lightwave Cable System: History, Causes, and Resolution," *IEEE Journal of Oceanic Engineering* 14, no. 3 (July 1989): 230, 232, 236.

[77] Marra, "Sharkbite on the SL," 230.

[78] Heezen, "Whales Entangled," 114.

[79] Marra, "Sharkbite on the SL," 233, 236; Taormina et al., "A Review of Potential Impacts," 381, 386-387; Albert et al., "A Current Synthesis," 2-3, 6,7; Samuel Gibbs, "Google Reinforces Undersea Cables After Shark Bites," *The Guardian*, August 14, 2014; Milton S. Love, Mary M. Nishimoto, Scott Clark, Merit McCrea, Ann Scarborough Bull, "Assessing Potential Impacts of Energized Submarine Power Cables on Crab Harvests," *Continental Shelf Research* 151 (2017): 23.

disorientation around cables. One study found that glass sponges experienced one-hundred percent mortality near three high voltage power cables.[80] With environmental impacts such as these, it's difficult to square the "nil environmental impact" language that the International Cable Protection Committee espouses.[81]

Other studies, however, report that power cables aren't such a big deal for certain animals. Consider crabs. Crawling every which way, they cluster together into a mounded mass of writhing exoskeletons. Fishermen worry that crabs may choose to avoid areas with a cable, thereby impeding their fishing grounds. A recent scientific study showed that Dungeness crabs appeared unbothered by changes to the electromagnetic field, however, and behaved normally around a power cable.[82] But with hundreds of thousands of species living in the ocean—many identified, but some not—it's impossible to know the extent to which power cables interfere with marine life's reliance on the earth's natural electromagnetic field, particularly in the abyssal regions. Like most things involving the ocean's depths, the extent of humans' impacts still remains something of a mystery.

In an environment where fish beep, whales sing, and shrimp clack, power cables are one of the shelf's quieter features. Still, the cable's pulse of electricity contributes some noise to the soundscape, even if it's heard only by those creatures attuned to high-frequency noises, such as crustaceans and cetaceans. Is a cable's sound pollution enough

---

[80] Kraus et al., "Seabed Recovery," 259.

[81] "Submarine Cables and BBNJ," 2.

[82] In the twenty-first century, undersea power cables do not appear to deter Dungeness crabs from moving over the cables. See Love et al., "Assessing Potential Impacts," 23; Stuart H. Munsch, Jeffrey R. Cordell, Jason D. Toft, "Effects of Shoreline Engineering on Shallow Subtidal Fish and Crab Communities in an Urban Estuary: A Comparison of Armored Shorelines and Nourished Beaches," *Ecological Engineering* 81 (2015): 313.

to bother marine species? It's hard to know. "Compared with other anthropogenic sources of noise, such as sonar, piling or explosions," concludes one groups of scientists, "underwater noise linked to undersea cables remain low."[83] Potentially problematic, too, is the fact that high voltage power cables emit some heat, warming the sediments immediately around them. It's not yet clear, however, if this heat causes much harm to the many microscopic creatures that live in the muds and sands.[84] When considered cumulatively, these small sources of sound, heat, and electromagnetic pollution could amount to a larger environmental problems as the industry expands.

To Remove, or Not to Remove?

When it comes to cable projects, cable-layers place a lot of emphasis on installation: route planning, financing, and legal barriers are front-loaded during the cable's arrival and first few years on the seabed. But decades after its original installation, when the revelers have gone home, the original owners may have shut their doors or filed for bankruptcy. Or what is more often the case, a shinier new cable model comes along, and the aging cables easily slip from memory. After twenty-five years or so on the seabed, even functional cables have typically outlived their usefulness—at least for human society.[85] While new cables appear in the historical record, the abandonment of

[83] Albert et al., "A Current Synthesis," 2-3, 6; Taormina et al., "A Review of Potential Impacts," 385.

[84] Ibid., 387.

[85] Antrim et al., *Submarine Cables in Olympic Coast National Marine Sanctuary,* 1.

old or broken cables is much rarer. When abandonment is mentioned, it's typically noted in ship logs. In 1927, for instance, when sediment buried a cable near the mouth of the Stikine River in British Columbia, the cable-repair ship reported in its logbook: "Cable deeply buried, 250 nauts [of the cable] abandoned." In 1940, within the cold waters off the coast of Alaska, a crew member on a different cable ship reported, "Unable to find old cable so new one laid." Just a few years later, in 1947, a cable crew in Alaskan waters reported, "Repairs impractical due to heavy silt on top of cable making it impossible to bring it to the surface without breaking it."[86] Without fear of public or governmental retribution, abandoning cables or their broken parts has been standard practice.

Once abandoned, the knowledge of an undersea cable's exact whereabouts often dies with the company that originally owned it. Sometimes, an old cable will surprise scientists or cable-layers who are poking around the seabed for a different project. The 1903 transpacific cable linking the United States to Asia, for instance, still haunts the ocean bottom. Its exact location was forgotten until scientists studying the much-newer ATOC/Pioneer cable off California's coastline glimpsed the 1903 line—latent, overgrown, covered by sea creatures and mud and debris.[87] In the twenty-first century, cable owners keep better track of their dead or aging fiber optic cables, but only to a degree. Even now, there's little international or federal oversight, a continuation since the nineteenth century. As one journalist noted, "While current operators have licenses, nobody is apparently responsible…for defunct telegraph cables from long-gone

[86] Logbook quoted in Heezen et al., "Alaskan Submarine Cables," 419.

[87] Kogan et al., "ATOC/Pioneer Seamount Cable," 778, 780.

companies."[88] Without a national or international regulatory body keeping track, cables have disappeared into the ocean at the rate of human forgetfulness.

From an economic perspective, it's often more cost effective for cable-owners to repair a broken cable than to replace it—but maintenance comes with environmental effects, too.[89] The best tool for cable repair crews it the grapnel, a type of large hook kept on cable ships since the nineteenth century. Grapnel hooks range in size from a bowling ball to a small car. Typically, cable repair ships keep many sizes of grapnels on board.[90] To retrieve a cable, the repair ship lowers the grapnel down to the seafloor and moves it left and right, cutting into the sediments as it goes. On the first successful pass, it cuts the cable at the spot where the cable has faulted. On the second pass, the grapnel grabs one end of the cable and brings it to the surface. On the third pass, the grapnel grabs the other end. Each pass along the seafloor—whether successful or unsuccessful—cuts many feet down into the seafloor's sediments and collides with any corals, animals, or seaweeds unable to move out of the way.[91] In turn, the seafloor's muddy sediments *swirl*, *poof* into the water column, where they can remain for days before settling back down. All sorts of species dislike this swirl of sediments: the eggs on the bottom now buried in mud, the predators now unable to see their prey, and the hungry fish unable to feed on the bits of

---

[88] Boztas, "Buried at Sea."

[89] Increasingly, cable owners can update a cable's capacity by replacing the two shore rather than laying a whole new line; Benoît Pirenne, Ocean Networks Canada, conversation with the author, University of Victoria, Canada, February 22, 2023.

[90] Horne et al., "Marine and Maintenance," 611.

[91] "Analysis of Remediation Alternatives for the Pacific Crossing-1," NOAA, 33; Taormina et al., "A Review of Potential Impacts," 386.

poop, body parts, and other detritus that falls from the sea's surface.[92] The grapnel also unearths the microbes living in the deeper sediments. Exposed worms squirm back into the mud, and the unsuspecting animals that had made their life on the cable—sea stars, tubularian, anemones—face the wrath of the hook or, even more shocking, begin a journey to the ocean's surface while still attached.

At every stage of the cable's journey—installation, maintenance, and possible removal, the disturbed sediments may linger in heaps and mounds around the cable repair site for many years—like wagon-wheel impressions marking the existence of old trails.[93] For these reasons, the ICPC contends that, in certain cases, the environmentally friendly choice is to leave old or irreparable cables on the seabed if removal risks harming sensitive benthic habitats, particularly in coastal areas. Put simply, from an ecological perspective, removing a cable can do more harm than good. I agree with the ICPC: most abandoned cables should stay in the ocean to avoid upsetting benthic communities. But I'm also opposed to any headlong rush to add more cables down there. States like Oregon often fast-track cable companies without much forethought as to how or if those cables will one day be removed, the same being true for the PC-1 cables in the Olympic Coast National Marine Sanctuary. The industry, and regulatory bodies, need to contend with the environmental and ethical choices of continuously installing new cables, not just the impacts of removing the old ones.

In the last few years, the public seems to be paying closer attention to the environmental effects of cable installation. Take, for example, a recent controversy

---

[92] Taormina et al., "A Review of Potential Impacts," 383-384.

[93] "Analysis of Remediation Alternatives for the Pacific Crossing-1," NOAA, 33-34; Bright, *Submarine Telegraphs*, 162-163, 166.

involving Edge Cable Holdings, a company Facebook hired to install a new fiber optic cable in Oregon's coastline. When finished, the cable would connect to Facebook's extensive network of onshore telecommunications infrastructure. The contractor used a type of "bore gel" inserted into the seafloor through a drill pipe to create a trench for the cable. But when the boring went awry, Edge Cable Holdings deserted the pipe, the boring gel, and related materials on the seafloor. What made this incident so controversial was not the fact that a company was burying a cable along Oregon's coastal seabed—that's common enough.[94] Instead, the real rub was the company's decision to abandon its drilling equipment. The materials, and particularly the thousands of gallons of boring gel, could pose a risk to the surrounding seafloor biota.[95]

When Oregon's Department of State Lands learned of the pollution, they ordered Edge Cable Holdings to clean up the remaining mess. But the damage was done. Most of the installation materials will remain lodged in the seafloor forever.[96] While the cable industry is no stranger to abandoning its technologies on the seafloor, this controversy shed light on the invasive techniques cable-layers use to install and bury a cable. For an industry that has been overlooked by environmental-advocacy groups, the Facebook

---

[94] "Analysis of Remediation Alternatives for the Pacific Crossing-1," NOAA, p. ii.

[95] Maddie Stone, "Facebook Abandoned Drilling Equipment beneath the Ocean Floor," *Vice*, August 14, 2020, https://www.vice.com/en/article/4ay5mj/facebook-abandoned-drilling-equipment-beneath-the-ocean-floor.

[96] Stone, "Facebook Abandoned."; Nigel Jaquiss, "Mark Zuckerberg Is Despoiling a Tiny Coastal Village and Oregon's Natural Treasures. The State Invited Him," *Willamette Weekly*, August 19, 2020, https://www.wweek.com/news/2020/08/19/mark-zuckerberg-is-despoiling-a-tiny-coastal-village-and-oregons-natural-treasures-the-state-invited-him/; Kale Williams, "Facebook Abandons Broken Drilling Equipment under Oregon Coast Seafloor," *OregonLive*, August 13, 2020.

cable debacle, and the anger it engendered from the public, marks a shift. The Pacific Ocean once seemed safe in the undersea cable industry's hands; now, not so much.

Conclusion

In the future, the northeast Pacific seafloor will host a greater number of cables. It's a booming industry that isn't going anywhere. New undersea fiber optic cables will connect growing populations with mounting Internet needs, power cables will transfer energy between shore and offshore energy production sites, and cables will transport data to a growing network of undersea scientific instruments. Offshore wind energy, in particular, is receiving lots of media attention for the cleaner, greener energy it can provide. Although the United States does not have any large offshore windfarms along the Pacific coastline, the industry is turning in that direction. In 2022, the federal government held its first auction for floating offshore wind sites near California's coastline.[97] Whether the turbines are floating or anchored to the seabed, the industry will still rely on cables to transmit energy between the turbine and the shore. In each instance, the wind farm's cables will come in contact with epifauna, sediments, and other mobile species. How will the offshore wind industry deal with biofouling? Will they bury the cables or remove them once they are obsolete? Like most marine industries, offshore

---

[97] Elizabeth Weise, "First Offshore Wind Power Sites Auctioned Off California's Coast," *USA Today*, December 7, 2022, updated December 10, 2022. https://www.usatoday.com/story/news/2022/12/07/first-ever-pacific-offshore-wind-auction-nets-757-million/10847186002/#:~:text=First%20offshore%20wind%20power%20sites,could%20power%201.5M%20homes.&text=The%20first%2Dever%20federal%20auction,could%20power%201.5%20million%20homes.

wind development is focusing on progress, installation, and growth. But the dilemma of what to do with the aging machines doesn't always make the headlines or the planning documents. By kicking the can down the road, marine technology owners can avoid deciding if decommissioned turbines will leave the water, or not.[98] From that perspective, seafloor industries continue to repeat the same pattern throughout this seafloor history: the majority of their energy and focus is geared towards installation, rather than planning for the machine's long, biotic afterlife in the ocean.

Just as the number of cables will increase, regulations may too. Regulations could take the form of marine spatial planning, a management approach that takes into account the needs and claims of many marine users.[99] Already, there are more rules now in the twenty-first century than the twentieth, meaning cables are "installed in a different regulatory climate than for earlier cables," according to two industry experts. They refer to "multiparty on-board decision-making," or the many groups that need to be at the table before a cable is installed, including state and federal governments, the cable owners, Indigenous tribes, and environmental representatives who protect ecologically sensitive areas.[100] Likewise, the cable recovery industry—finding old cables and scrapping them

---

[98] Katie Smyth, Nikki Christie, Daryl Burdon, Jonathan P. Atkins, Richard Barnes, Michael Elliott, "Renewables-To-Reefs? Decommissioning Options for the Offshore Wind Power Industry," *Marine Pollution Bulletin* 90 (2015): 247-248.

[99] The growing field of marine spatial planning is attempting to reduce conflicts between seafloor users. See Rebecca Retzlaff and Charlene LeBleu, "Marine Spatial Planning: Exploring the Role of Planning Practice and Research," *Journal of Planning Literature* 33, no. 4 (2018): 466-491; Luke Fairbanks, Noëlle Boucquey, Lisa M. Campbell, and Sarah Wise, "Remaking Oceans Governance: Critical Perspectives on Marine Spatial Planning," *Environment and Society: Advances in Research* 10 (2019): 122-140; A.D. Guerry, M.H. Ruckelshaus, J.R. Bernhardt, G. Guannel, C.K. Kim, M. Marsik, J.E. Toft, D.A. Sutherland, "Modeling Benefits from Nature: Using Ecosystem Services to Inform Coastal and Marine Spatial Planning," *International Journal of Biodiversity Science, Ecosystems Services and Management* 8 (2012): 107-121.

[100] Weiner et al., "Olympic Re-Lay," 79.

for parts—may grow as demand for precious materials increases.[101] A global run on abandoned cables might prompt intergovernmental organizations like the International Seabed Authority (ISA) within the United Nations to levy stricter regulations. But as the ISA dedicates a majority of its resources to facilitating deep-sea mining, any regulation on the retrieval of abandoned cables seems unlikely—at least not anytime soon.[102]

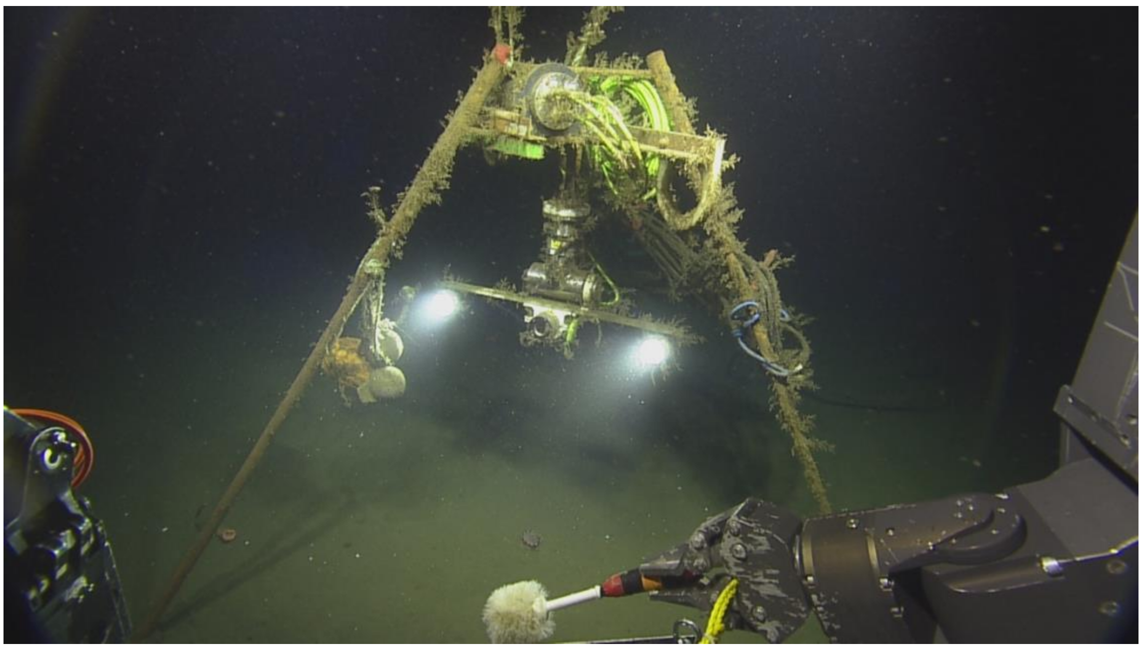


Figure 5.5. A deep-sea camera covered in marine growth, NEPTUNE Observatory, Northeast Pacific Ocean. Image courtesy of Ocean Exploration Trust/Ocean Networks Canada/UVic.

In the next chapter, we journey down from the continental shelf into the abyss. Here, darkness reigns and marine life—dispersed but diverse—plumbs the depths for food. Those deep-sea creatures are increasingly joined by a new type of seafloor technology. Called the cabled observatory, this approach to marine science embraces the

[101] Boztas, "Buried at Sea."

[102] Elizabeth Kolbert, "The Deep Sea Is Filled with Treasure, But It Comes At A Price," *New Yorker*, June 21, 2021.

permanent installation of machines on the seabed to continually collect data, images, and video footage in real-time. While scientists first developed iterations of cabled instruments in the twentieth century, in the twenty-first century, they are becoming standard methodological approach for the field of oceanography. Just as offshore drilling and the undersea telecommunications industries have left their aging machines and debris in the Pacific, scientific instruments in the abyss are likely to leave behind their mark on the seabed, too.

CHAPTER VI

MACHINES IN THE ABYSS

In 2013, a fourteen-year-old Ukrainian boy named Kirill Dudko was staying up past his bedtime. He couldn't tear himself away from an online channel, which played a live video feed from a cabled observatory sitting on the Pacific Ocean's seafloor—like reality T.V., but for the abyss. Dudko tuned in frequently, but this night was proving to be special. A slimy hagfish was slowly wiggling along the seabed below the camera, its purple coloring illuminated by the camera's light. The hagfish's presence on the feed was excitement enough for an environment often still and slow, but what happened next sent Dudko into a frenzy of excitement. Some animal darted into the camera's view, sucked up the hagfish, and then zipped from view. He knew it had to be a mammal because of its nose and the presence of a "mustache." Dudko emailed Ocean Networks Canada (ONC), the University of Victoria-based organization that owns and operates the camera, to report what he saw. "You know, it was like a horror film!" he later exclaimed. The mustached-predator turned out to be a northern elephant seal. Among scientists who study northern elephant seals, there had been no prior confirmation on how deep they could dive. The seal's appearance on the seafloor camera, and Dudko's witness to it, not only proved that seals could not only hunt at 2,933 feet (894 m), but also their previously unknown appetite for hagfish.[1]

Dudko's finding was important moment in community science, but it also represented something bigger, beyond the elephant seal and hagfish. For all of human history, the abyss was totally inaccessible to our species. But now, in the twenty-first century, a fourteen-year-old boy could sit in his room, exploring the Pacific seafloor and making discoveries about its depths. For anyone with an Internet connection, and an interest, the Pacific's abyss is wide open and available—marking a significant turn in humans' interactions with the ocean. And it's the long history of machines on the ocean bottom that is making this shift in marine science possible.

In their simplest form, cabled observatories are a cluster of scientific instruments installed on the seafloor. These instruments send data collected about the ocean back to computers on land via a long fiber optic cable—hence the term "cabled observatory." Depending on their set up, scientists label these seafloor observatories by a few different names: seafloor observatories, autonomous monitoring systems, undersea laboratories, cabled networks, *in situ* platforms, fixed point multidisciplinary cabled observatories, and integrated infrastructure programs.[2] Despite the variety of descriptors, their function is fundamentally similar: they rest permanently or semi-permanently on the seabed, are

[1] Christopher Barnes, interview with the author, February 21, 2023; Andy Heil, "The Sea Monster of Donetsk," *Atlantic*, February 1, 2013, https://www.theatlantic.com/international/archive/2013/02/the-sea-monster-of-donetsk/272725/; "Teen Spots Hagfish-Slurping Elephant Seal," Ocean Networks Canada, January 23, 2013, https://www-static01.oceannetworks.ca/teen-spots-hagfish-slurping-elephant-seal.html.

[2] The National Research Council defined seafloor observatories as a "system of instruments, sensors, and command nodules connected either acoustically or *via* a seafloor junction box to a surface buoy or a fiber optic cable to land." See Marjolaine Matabos, Thibaut Barreyre, S. Kim Juniper, Mathilde Cannat, Deborah Kelley, Joan M. Alfaro-Lucas, Valérie Chavagnac, Ana Colaço, Javier Escartin et al., "Integrating Multidisciplinary Observations in Vent Environments (IMOVE): Decadal Progress in Deep-Sea Observatories at Hydrothermal Vents," *Frontiers in Marine Science* 9 (May 2022): 2.

autonomous, and collect environmental information on the surrounding ocean, which is their laboratory.

The camera that caught the seal eating the hagfish belongs to NEPTUNE (North East Pacific Time-series Undersea Networked Experiments), which is the biggest cabled observatory in the world. NEPTUNE is located off the west coast of Vancouver Island and operated by an academic non-profit called Ocean Networks Canada (ONC), an organization based at the University of Victoria.[3] NEPTUNE launched in 2009, although ONC has been adding instruments and updating the observatory every year since.[4] NEPTUNE is a colossal system with thousands of components: instruments, cables, electrical connectors, electrical penetrators, junction boxes, repeaters. It includes five-hundred and seventy miles (917 km) of submarine fiber optic and power cables, plus five "nodes," each of which includes many dozens of individual instruments—and there's room for more. NEPTUNE's nodes are installed at various depths that range from the shallow coastline down to 8,727 feet in the abyss (2,660 m). NEPTUNE's size reflects the global reach of its science. Experts from around the world plug into NEPTUNE, including scientists in Germany, Japan, China, America, Ireland, Italy, and Spain, among others.[5] To put it another way, NEPTUNE is the godfather of cabled observatories. All eyes are on this system and its findings.

---

[3] Arthur B. Baggeroer, Bruce M. Howe, Peter N. Mikhalevsky, John Orcutt, and Henrik Schmidt, "Ocean Observatories: An Engineering Challenge," *The Bridge* (Fall 2018): 22; S. Martin Taylor, "Supporting the Operations of the NEPTUNE Canada and VENUS Cabled Ocean Observatories." OCEANS 08 KOBE (2018): 1-8.

[4] Ocean Network Canada was established in 2007.

[5] ONC is working to add a sixth node to NEPTUNE, but the system can host up to ten. Christopher Barnes, "NEPTUNE Canada: Overview," PowerPoint presentation, June 2, 2011, personal papers shared with the author; Benoît Pirenne, interview with the author, February 22, 2023.

Although NEPTUNE is the biggest and first of its kind, it's by no means the only seafloor observatory in the Pacific. ONC runs a sister observatory, the Victoria Experimental Network Under the Sea (VENUS) which sits on the other side of Vancouver Island. ONC also operates smaller community observatories and instruments in the Arctic and the Atlantic. NEPTUNE's southern neighbor on the Juan de Fuca plate, the Ocean Observatories Initiative (OOI), an American-run observatory that collects data similar to that of NEPTUNE. Further south, the Monterey Bay Aquarium operates the Monterey Accelerated Research System (MARS) and the Deep Echo-Integrating Marine Observatory System (DEIMOS).[6] On the other side of the Pacific, the Hawaii Ocean Time-Series (HOT) monitors physical, chemical geological, and biological features in the water column.[7] But the Pacific is not alone in hosting a growing number of seafloor observatories. From the Atlantic to the Artic, the global ocean now hosts 193 observatories. Thirty-four of those observatories rely on fiber optic cables to link the observatory to a shore station on land.[8]

[6] Christoph Kraus and Lionel Carter, "Seabed Recovery Following Protective Burial of Subsea Cables – Observations from the Continental Margin," *Ocean Engineering* 157 (2018): 157; Stephanie Steinhardt, "The Instrumented Ocean: How Sensors, Satellites, and Seafloor-Walking Robots Changed What It Means to Study the Sea" (PhD diss., Cornell University, 2018), 50; Sandra Hines, "DEIMOS joins MARS and its Satellite of Instruments on Seafloor," *UW News*, March 18, 2009, https://www.washington.edu/news/2009/03/18/deimos-joins-mars-and-its-satellite-of-instruments-on-seafloor/.

[7] Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Berkeley: University of California Press, 2009), 131.

[8] "Submarine Cables and BBNJ," International Cable Protection Committee (ICPC Ltd. August 1, 2016): 6-7, https://www.un.org/depts/los/biodiversity/prepcom_files/ICC_Submarine_Cables_&_BBNJ_August_2016.pdf.

Figure 6.1. A map of the NEPTUNE and VENUS cabled observatories. Image courtesy of Ocean Networks Canada.

ONC and its observatories embody big science and big data. The organization's underwater systems, including NEPTUNE, collect 1.2 petabytes of data every year. ONC uploads this data to their website for anyone to access—what they describe as a "revolutionary data policy."[9] And that data are collected not just at one depth but at many depths, across many locations, and over many years. That amount of information is staggering. As Benoît Pirenne, Ocean Networks Canada's director of user engagement told me, ONC's product is not the instruments they install in the ocean, but instead the

[9] M. M. R. Best, C. R. Barnes, B. D. Bornhold, and S. K. Juniper, "Integrating Continuous Observatory Data from the Coast to the Abyss: Assembling a Multidisciplinary View of the Ocean in Four Dimensions," in *Seafloor Observatories*, ed. P. Favali (Berlin: Springs Praxis Books, 2015), 15; See Nicole Starosielski, *The Undersea Network* (Durham: Duke University Press, 2015), 213-216; Helmreich, *Alien Ocean*, 241; Antony Adler, *Neptune's Laboratory: Fantasy, Fear, and Science at Sea* (Harvard University Press, 2019), 158-159; Ocean Networks Canada (@ocean_networks), "ONC has over 14,000 underwater sensors collecting more than 1.2 petabytes of ocean data," Instagram photo, February 15, 2023, https://www.instagram.com/p/CosT3QZPmIn/.

data they collect and share.[10] As radical as ONC's data policy is, they aren't the only organization freely sharing information. OOI, the American observatory on the Juan de Fuca plate, also publishes its data online as a "open community resource." With OOI, researchers can not only access the observatory's data free on their website, but they can also submit proposals to add a new instrument to the seafloor array.[11] This open-source approach to marine science is a far cry from the competitive, private, and secretive companies that occupy other types of seafloor industries, such as telecommunications cables and offshore oil and gas drilling.[12]

Thanks to its physical size, interdisciplinarity, and global connections, NEPTUNE is touted as the revolutionary future of marine science. "This project is destined to transform the ocean sciences," wrote one group of NEPTUNE's founding scientists and experts.[13] Renowned University of Washington oceanographer John Delaney promised cabled observatories to be the "dawning of a new age of how humans can explore the oceans."[14] Cabled observatories are making a profound impact in not only the knowledge they are collecting about the deep-sea environment, but also the openness with which that

---

[10] Pirenne, interview with the author; Barnes, interview with the author; Best et al., "Integrating Continuous Observatory," 17; Christopher R. Barnes, Mairi M. R. Best, Fern R. Johnson, and Benoît Pirenne, "Large Subsea Observatory for Earth-Ocean Science: Challenges of Multidisciplinary Integration Across Hardware, Software, and People Networks," personal papers shared with the author, n.d.

[11] "The Vision," Ocean Observatories Initiative, accessed April 18, 2023, https://oceanobservatories.org/the-vision/; Adler, *Neptune's Laboratory*, 158-159.

[12] Meghan Paulson, "Wiring the Abyss: ONC's Fall Expedition Season," Virtual Presentation, November 18, 2020, https://www.youtube.com/watch?v=yzpkgQZWbIA.

[13] Chris Barnes, Mairi Best, Fern Johnson, Peter Phibbs, and Benoît Pirenne, "NEPTUNE Canada: Building the World's First Regional Cabled Observatory," *Journal of Ocean Technology* 3, no. 3 (2008): 17.

[14] Quoted in Robert F. Service "Oceanography's Third Wave," *Science* 318, no. 5853 (November 16, 2007): 1056-1058.

information is shared. Although research cruises continue to be important for the study of marine systems, both excitement and funding are flowing towards large infrastructure projects like NEPTUNE. Seen from this perspective, observatories are democratizing marine science and increasing global access to the deep seafloor.[15]

Unprecedented access to the seafloor comes with its own set of drawbacks, however. Whatever scientists discover and share about the deep sea may increase the likelihood of other anthropogenic activity in those environments. Both scientific and mining industries, for instance, share a fascination for hydrothermal vents.[16] At cooled vent sites, miners may be able to pluck zinc, copper, and nickel from the chimneys surrounding the vents, or what are called polymetallic sulphide deposits. Pharmaceutical companies are also interested in the bacteria clinging to active vent sites—each of which could hold value for developing new drugs.[17] Some scholars have estimated these bacterial vents could become an industry worth three-billion dollars a year.[18] But that's not all the abyss has to offer, money-wise. Cobalt has been found around seamounts, another precious material of interest to mining companies.[19] Last but not least are polymetallic nodules, also called manganese nodules, which are potato-sized rocks that sit on the vast expanse of abyssal plains and contain nickel, copper, and cobalt.[20] As

---

[15] Helmreich, *Alien Ocean,* 242.

[16] Ibid. 244-245.

[17] Matabos et al., "Integrating Multidisciplinary Observatories," 3.

[18] Helmreich, *Alien Ocean,* 244; Taylor, "Supporting the Operations," 6.

[19] "About Deep-Sea Mining," Deepsea Conservation Coalition, accessed February 1, 2023, https://savethehighseas.org/deep-sea-mining/.

[20] Eric Lipton, "Secret Data, Tiny Islands and a Quest for Treasure on the Ocean Floor," *New York Times,* August 30, 2022, https://www.nytimes.com/2022/08/29/world/deep-sea-mining.html; Eric Lipton, "Battle

companies begin to mine these nodules, the United Nation's International Seabed Authority (ISA) is not imposing strict regulatory measures, a point of frustration for many deep-sea scientists.[21] Those experts hope that cabled observatories will protect ecosystems by regulating companies that perform abyssal mining.[22] Other scientists, by comparison, seem more open to partnerships and funding between for-profit companies and deep-sea oceanography. Some leading experts expect that deep-sea scientific organizations will partner with corporations like Microsoft, Intel, and ExxonMobil in discovering and profiting from the deep.[23]

Are cabled observatories democratizing access to the ocean or participating in the global charge to discover and industrialize it? The reality seems to reside somewhere in between. The twenty-first century is not the first time that the field of marine science has been caught between multiple industries. Historically, scientists have been situated between academic science and for-profit initiatives.[24] For example, in Michael Reidy in *Tides of History*, tracks the development of tidal science, which served to aid and protect British ships in the empire's global expansion.[25] Likewise, Jacob Hamblin argues that

---

Over Deep-Sea Mining Takes on New Urgency as Trial Run Winds Down," *New York Times*, November 3, 2022, https://www.nytimes.com/2022/11/03/world/deep-sea-mining.html.

[21] Certain organizations are fighting to protect the deep-sea from increased mining. See, for instance, the Deep-Ocean Stewardship Initiative (DOSI), www.dosi-project.org.

[22] Tunnicliffe, interview with the author; Matabos et al., "Integrating Multidisciplinary Observatories," 1-2, 4.

[23] Following the end of the Cold War, the military tightened its purse strings, leading marine scientists to look for funding from biotechnology companies. Nowadays, both state and private money is going towards genomic bioscience and biotechnology. Helmreich, *Alien Ocean*, 4, 113, 241.

[24] See Naomi Oreskes, *Science on a Mission: How Military Funding Shaped What We Do and Don't Know About the Ocean* (University of Chicago Press, 2021).

[25] Michael Reidy, *Tides of History: Ocean Science and Her Majesty's Navy* (University of Chicago Press, 2008), 8.

oceanographers courted the U.S. Navy following World War II for sources of funding, power, and global research. Hamblin calls it the “paradoxes of oceanography,” meaning oceanographers have historically served multiple sovereigns.[26] And sociologist Chandra Mukerji points to the “odd mixture of autonomy and dependence for scientists”—on the one hand empowered to study and publish science while, simultaneously, dependent on big funds from outside organizations, particularly the government but also private entities.[27] Whether they welcome it or not, it’s clear that deep-sea scientists will have for-profit companies joining them in their exploration of the ocean bottom.

Despite the historical connections between science, industries, and government, in the twenty-first century, ocean observatories have mostly dropped the nationalistic drumbeat that characterized the field during the previous two-hundred years. Arguably, cabled observatories and their open-access data policies reflect the field’s intention to broaden global access to the ocean.

Cabled observatories like NEPTUNE are what scholar Stephanie Steinhardt calls “transformative infrastructure.”[28] While it’s true that observatories are transformative, they are also products of earlier scientific machines and other seafloor industries developed in the nineteenth and twentieth centuries.[29] NEPTUNE would not be possible

---

[26] Jacob Darwin Hamblin, *Oceanographers and the Cold War: Disciples of Marine Science* (Seattle: University of Washington, 2005), xviii.

[27] Chandra Mukerji, *A Fragile Power: Scientists and the State* (Princeton: Princeton University Press, 1989), 12; Adler, *Neptune’s Laboratory*, 101.

[28] Stephanie Steinhardt, “The Instrumented Ocean: How Sensors, Satellites, and Seafloor-Walking Robots Changed What It Means to Study the Sea” (PhD diss., Cornell University, 2018), iii.

[29] Taylor, “Supporting the Operations,” 1; See also Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd edition (University of Chicago Press, 1970).

without the earlier development of fiber optic cables in the telecommunications industry or remotely-operated vehicles (ROVs) in the offshore oil and gas industry, to name just two examples. Cabled observatories did not develop in a vacuum—they share ideas, knowledge of the oceans, and technologies with other seafloor industries. By centering the history of scientific instruments on the seafloor, this chapter highlights the myriad of ways that society has learned to use and benefit from the abyssal ocean bottom.[30] This research also moves beyond the "great ship narrative" that has characterized many histories of marine science.[31] Ships remain an important tool for marine scientists in the twenty-first century, but expeditionary research is decreasing as the role of autonomous instruments is growing.

Welcome to the abyssal seafloor, where science, industry, and fantasy collide.

The Abyss from a Ship

Traces of sunlight can travel thousands of feet down into the ocean, but by about six-hundred feet (183 m), it's no longer noticeable to the human eye. Descending the slope beyond the blue of the continental shelf and descending the slope one enters the

[30] For a growing body of scholarship on the ocean's depths, see Ryan Jones, "Running into Whales: The History of the North Pacific from Below the Waves," *American Historical Review* 118 (April 2013): 349-377; Philip Steinberg and Kimberley Peters, "Wet Ontologies, Fluid Spaces: Giving Depth to Volume through Oceanic Thinking," *Environment and Planning D: Society and Space* 33 (2015): 247-264; Naomi Oreskes, "Scaling up Our Vision," *Isis* 105, no. 2 (June 2014): 379-391; Philip E. Steinberg, *The Social Construction of the Ocean* (Cambridge University Press, 2001); Helen Rozwadowski, *Vast Expanses: A History of the Oceans* (London: Reaktion Books, 2018); Helen Rozwadowski, "Ocean's Depths." *Environmental History* 15, no. 3 (July 2010): 520-525.

[31] Adler, *Neptune's Laboratory,* 3-5; Ryan Tucker Jones, "Running into Whales: The History of the North Pacific from Below the Waves," *American Historical Review* 118 (April 2013): 350; See also Helen Rozwadowski, "Scientists Writing and Knowing the Ocean," in *The Sea and Nineteenth-Century Anglophone Literary Culture*, eds. Steve Mentz and Martha Elena Rojas (London: Routledge, 2016), 28-46.

"inky void that is the abyss," as Rachel Carson described it.[32] By 3,300 feet below (1,006 m), there's no sunlight remaining at all.[33] Scientists call this zone the edge of darkness: the sun leaves you after that.[34] The journey down is by no means lonely, though. Whales, the ocean's most preeminent noise makers, call loud and hard on the descent. The sperm whale sounds like a "crackle of a roll of adhesive tape being unwound," while the humpback has a "lyrical, haunting song."[35] And despite their wafer-like appearance, mollusks, echinoderms, and arthropods make their presence known, as well. Shrimp are loud in all regions of the ocean and no less so in the deep. They are joined on the seafloor by gurgling vents and the ambient whoosh of the moving seawater.[36]

The abyss is a section of the ocean that lays beyond the continental shelf and slope. The word abyss comes to us from the Greek *byssos*, meaning "bottom," and *a,* meaning "without." A bottomless place.[37] Indeed, leading up to the nineteenth century, some naturalists argued that the ocean had no bottom. As it turns out, the abyss does have a bottom, it just happens to be quite far down. When first brought into popular use in the mid-nineteenth century, "abyss" referred to the area of the ocean six-hundred feet or

---

[32] Rachel Carson, "Undersea," in *Lost Woods: The Discovered Writing of Rachel Carson*, ed. Linda Lear (Boston: Beacon Press, 1999), 8

[33] Robert Kunzig, *Mapping the Deep: The Extraordinary Story of Ocean Science* (New York: W. W. Norton, 2000), 8; Helen Scales, *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat that Imperils It* (New York: Atlantic Monthly Press, 2021), 3.

[34] Edith Widder, "Creatures of the Deep," *Saturday Evening Post*, April 19, 2022. https://www.saturdayeveningpost.com/2022/04/creatures-of-the-deep/.

[35] Scales, *Brilliant Abyss*, 30.

[36] W. J. Tudor, *Structures in the Deep Ocean: Engineering Manual for Underwater Construction* (Port Hueneme, California: U.S. Naval Civil Engineering Laboratory, 1964), 2-30; Mukerji, *Fragile Power,* 44.

[37] William J. Broad, *The Universe Below: Discovering the Secrets of the Deep Sea* (New York: Simon and Schuster, 1997), 21-22.

deeper (183 m).[38] Scientists made this decision before knowing that the ocean extends thirty-six thousand feet (10,973 m) below at its deepest point in the Pacific. On average, though, the abyssal seafloor across all ocean basins is fifteen-thousand to twenty-thousand feet deep (4,572– 6,706 m).[39] Considering its depth and width, it's difficult to overestimate the size of the abyssal seafloor. The deep ocean occupies 65 percent of globe's surface.[40] The scale is enough to blow your mind.

Whereas coastal environments vary greatly—some marshy, some rocky, some with salmon, some with alligators—the deep sea across all the ocean basins are surprisingly similar. Drop down into any abyss, and it will share features with another abyss on the other side of the world: the temperature is cold but steady; marine life is diverse but isolated; food is scarce; the pressure is enormous; and the topography is typically muddy and flat. On the last point, however, there is definite variation: the abyss can be flat, hilly, cavernous, and mountainous depending on its distance from colliding or spreading tectonic plates.[41] But across the majority of the abyss, muddy flats reign supreme. Most elements of the abyss are familiar enough to us humans: we've all experienced darkness, cold, and some mud. But what we absolutely cannot fathom is the abyss's extreme pressure.[42] If a human body is dropped into the abyss, the ocean's pressure would crush it into a tiny, compact mass in the blink of an eye. That pressure,

---

[38] Scales, *Brilliant Abyss,* 16.

[39] Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography,* 12th edition (Boston: Pearson, 2017), 92.

[40] Broad, *The Universe Below,* 19-20; Scales, *Brilliant Abyss,* 10.

[41] Tudor, *Structures in the Deep Ocean,* 2-3.

[42] Sydney John Hickson, *The Fauna of the Deep Sea* (London: Kegan Paul, Trench, Trübner, 1893), 19.

calculated Ernest Ingersoll in 1898, "is about twenty-five time greater than the pressure that will drive a railway train."[43] Pressure is a unique feature of the deep that separates it from all other environments on Earth.

The abyss's extreme pressure and darkness has led to evolutionary similarities across deep-sea species. As one oceanographer concluded in 1960, deep-sea fish are "cosmopolitan, owing to the world-wide uniformity of this environment."[44] Deep-sea creatures usually live longer than their coastal neighbors. Eat deliberately, grow gradually, and live slow—that's the rhythm of life in the deep. One science journalist called these species "studies in slowness."[45] Nobody knows if it's the cold temperatures, pressure, or lack of food that dictates their duration.[46] Another commonality among deep-sea creatures is their bioluminescence, a chemical reaction in their bodies that causes them to light up in the darkness. A good many deep-sea creatures are bioluminescent—over 50 percent, by current estimates.[47] One scientist exclaimed, "Drag a net behind a ship almost anywhere in the ocean below the edge of darkness, and most of the animals you bring up in that net will make light."[48] These bioluminescent creatures range from squid and sharks to single-celled bacteria.[49] The green bomber, for instance, is a bantam

[43] Ernest Ingersoll, *The Book of the Ocean* (New York: Century, 1898); Hickson, *Fauna of the Deep Sea*, 19.

[44] Kenneth Orris Emery, *The Sea off Southern California; A Modern Habitat of Petroleum* (New York: Wiley, 1960), 161.

[45] Broad, *Universe Below*, 286.

[46] C. Wyville Thomson, *The Depths of the Sea* (London: MacMillan, 1874), 31; Hickson, *Fauna of the Deep Sea* 18; Scales, *Brilliant Abyss,* 98.

[47] Scales, *Brilliant Abyss*, 60.

[48] Widder, "Creatures of the Deep."

[49] Ibid.

worm that glows. It lives in depths nearly nine-thousand feet below (2,743 m). When distressed, it squirts a fluid into the water, lime green and glowing.[50] There tends to be higher numbers of bioluminescent creatures in areas of the abyss that are closer to the continents. In dark zones much further from shore, there's fewer animals and therefore less bioluminescent activity.[51]

Today, we may take this knowledge of the deep sea for granted. But for almost all of human history, the abyss maintained its anonymity. Even into the nineteenth century, in regions outside of harbors and busy coastal areas or along key shipping routes, the Pacific's depths often represented a void, save for a small but growing record of samples and measurements. Not only was there a lack of tools to interrogate the abyss, but there was also a lack of interest. Sailors in the U.S. Navy referred to the depths below the open sea as "blue water"—the kind of place one would never journey, at least not on purpose.[52] "Before the nineteenth century," writes historian Helen Rozwadowski, "the deep sea made hardly any impression on most people, even citizens of maritime nations."[53] But by the mid-1800s, revelations in science and technology were beginning to thaw this historical disinterest in the deep. In the same time period that Charles Darwin argued for the theory of evolution, new railroad lines crisscrossed entire continents, and an increasingly global market interlinked nations; naturalists from globalizing and

[50] "Bomber Warm," Monetary Bay Aquarium Research Institute, accessed March 12, 2021, https://www.mbari.org/animal/bomber-worm/.

[51] Tunnicliffe, interview with the author.

[52] Matthew Fontaine Maury, *The Physical Geography of the Sea* (New York: Harper and Brothers, 1855), 200.

[53] Rozwadowski, *Fathoming the Ocean*, 4.

industrializing countries were also turned their attention to the exploration of the ocean's depths.

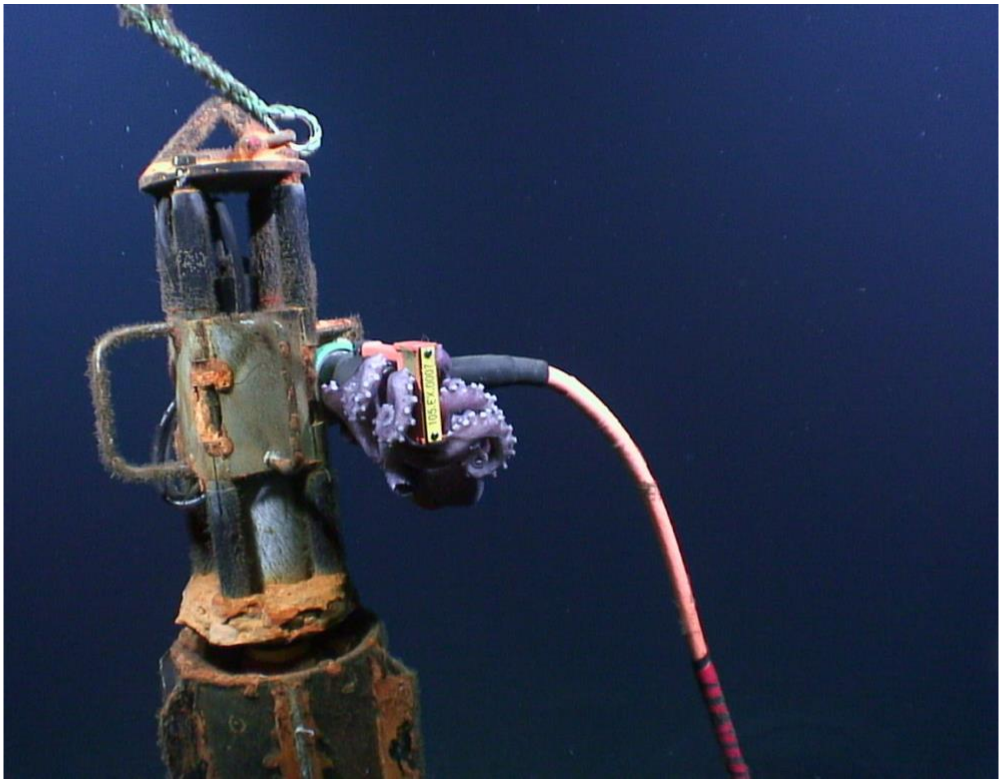


Figure 6.2. An octopus holds onto a connector on the NEPTUNE cabled observatory, northeast Pacific Ocean. Image courtesy of Ocean Networks Canada/CSSF-ROPOS.

There were, however, some technological constraints. For centuries, the average span of a man's outstretched arms—six feet (1.8 m)—was the standard distance for measuring a water's depth. In the Pacific Ocean basin, where the average depth is nearly 2,200 fathoms—and nearly 6,000 fathoms at its deepest point—the concept of measuring the ocean using a man's arm span seems almost comical. But so it went, thousands of outstretched arms here, a few hundred arm spans there. In this way, the Pacific's depths were measured by the same physical parts that were a key feature of the human experience, a meeting of the familiar and foreign. A fathom, measured in arms, helped to make the Pacific fathomable.[54]

Anyone who wanted to explore the deep ocean had three main tools at their disposal in addition to their arms: sounding lines, dredges, and nets.[55] Most useful were the sounding devices which, in their simplest form, were long lines with a weight at the end. The dredge, by comparison, scooped up sediments and marine life from the seafloor. Fishermen originally designed the dredge to scrape creatures like clams from the ocean bottom, and deep-sea explorers co-opted it for their study of sediments and marine life. Once dropped to the bottom, the dredge did not discriminate—any animal unlucky enough to be in its path made an unwanted journey to the ocean's surface.[56] Nets, too, were critical tools for naturalists, which they dragged through the water in search of specimens. But these tools by themselves were worthless in the absence of one other critical technology. They were going to need some big ships.

For centuries, all deep-sea discoveries depended on the use of a seagoing vessel. Naturalists had to be on board, bobbing on the surface of the ocean alongside the captain and sailors, to glean anything about the hidden world below.[57] A series of expeditionary trips in the mid-nineteenth century set the tone for marine science in the century follow. The U.S. Navy chartered the North Pacific Exploring Expedition in 1853 to study the

---

[54] For a history of nineteenth-century deep-sea discoveries, see Rozwadowski, *Fathoming the Ocean*.

[55] Thomson, *Depths of the Sea*, 29; Maury, *Physical Geography*, 200, 202; Charles Haskins Townsend, "The Life of the Deep Sea," *Everybody's Magazine* 6, no. 2 (February, 1902): 116-117.

[56] Adler, *Neptune's Laboratory*, 21-23.

[57] Baggeroer et. al, "Ocean Observatories," 17.

ocean's depths.[58] The USS *Tuscarora* sounded the Pacific's abyss in 1874, followed by the British HMS *Challenger* expedition in 1875. Each one of these expeditions performed thousands of soundings and hundreds of dredgings. The crew of USS *Albatross*, for instance, performed over six-thousand soundings during its scientific expedition in the South Pacific between 1899-1900.[59] In 1874, the crew of the *USS Tuscarora* collected a depth sounding at 26,136 feet (7,966 m) and scraped up a sample of the seafloor, a task that from start to finish took two and a half hours. At this rate, the *Tuscarora* could complete about five soundings a day, a number that would increase or decrease depending on a few factors. The deeper the seafloor, the longer it took to drop the sounding line and pull it back up. Finding the seafloor was an especially slow-going business on the windy days, as the ever-turbulent Pacific tossed the big ship to and fro, making it impossible to gather an accurate measurement.[60] Dredging, sounding, and sharing data about the Pacific was akin to analyzing the earth with a microscope one slide at a time, providing just a small glimpse of life below the surface.[61]

Limited by their technologies, debates raged among naturalists about whether life, in any form, could survive on the deep seafloor.[62] Beginning in the 1840s, for instance, Edward Forbes's Azoic Theory held that no marine life could exist below eighteen-

---

[58] Rozwadowski, *Fathoming the Ocean*, 51.

[59] Townsend, "Life of the Deep Sea," 118; Murray, *Report on the Scientific Results*, 9-10.

[60] George E. Belknap, *Deep-Sea Soundings in the North Pacific Ocean* (Washington, D.C.: Government Printing Office, 1874), 18, 31; "Exploration of the North Pacific—A Submarine Mountain," *New York Times*, January 14, 1859; Robert Kunzig, *Mapping the Deep: The Extraordinary Story of Ocean Science* (New York: W. W. Norton, 2000), 29-32, 90-92, 96-97.

[61] Adler, *Neptune's Laboratory*, 150.

[62] See Tony Koslow, *The Silent Deep: The Discovery, Ecology and Conservation of the Deep Sea* (University of Chicago Press, 2007); Kunzig, *Mapping the Deep;* Rozwadowski, *Fathoming the Ocean*.

hundred feet (549 m) due to the deep ocean's extreme conditions of pressure, darkness, and cold. To believe that some heretofore undiscovered species lived in an environment where all other known species could never survive required naturalists to undergo a paradigm shift. It was a shift many refused to make. "'How can animal life be conceived to exist under such conditions of light, temperature, pressure, and aëration as must obtain at these vast depths?'" questioned Thomas Henry Huxley.[63] Fair enough. Without more evidence, for a naturalist to believe in a living, squirming abyssal seafloor was a leap of scientific faith.

One belief possibly more extreme than the Azoic Theory was that of the ocean's "false bottom." This theory held that water became denser the deeper it went, so anything that fell to the bottom of the ocean—whale carcasses, drowned sailors, gold—would remain suspended mid-water at whatever point seawater became denser than the object.[64] But by the late nineteenth century, scientists doubted that theory. "It is often said," wrote the writer and naturalist Ernest Ingersoll in 1898, "that ships and other things would not sink far, but would float, suspended by dense water or some miraculous influence, only a few hundred or a few thousand feet below the surface, for no one knows how long." But he acknowledged, "this eerie notice has no foundation in fact." Instead, he offered that ships and unfortunate humans must sink "into the oceanic ooze" of the seafloor, which "forms the grave of thousands of men."[65] Whether trapped mid-water column, or sunk into the ooze, the deep ocean was a place no human could return from.

[63] Thomas Henry Huxley quoted in Thomson, *The Depths of the Sea*, 24.

[64] See Thomson, *Depths of the Sea*, 31-32; Hickson, *Fauna of the Deep Sea*, 1-2.

[65] Ingersoll, *Book of the Ocean*, 13; Hayley Brazier, "An Ode to Ooze," *Items*, Social Science Research Council, March 2021, https://items.ssrc.org/ways-of-water/an-ode-to-ooze/.

Those two theories wouldn't survive long, however, for the dredges, sounding lines, and other seafloor machines were beginning to provide some illuminating information. In 1860, both the Azoic and false bottom theories flopped when a repair ship in the Mediterranean retrieved a submarine telegraph cable encrusted with lifeforms. Having rested on the seafloor at a depth of six-thousand feet (1,829 m), that crust was proof enough to show that life existed in the deep sea.[66] The dredges were also revealing some interesting lifeforms. By terrestrial standards—and even by marine standards—naturalists discovered that creatures of the abyss are plumb odd. At points, they caught creatures so weird they were at a loss for words. In one instance, in the 1870s, scientist Wyville Thomson groped for likenesses to describe a set of deep-sea sponges, which ranged in appearance from a "knitting needle" to "Queen Elizabeth's ruff" and "a thin circular cake."[67] Rachel Carson got it right when she wrote, "creatures of the sea's bottom may be fantastic rather than beautiful."[68]

The blackfin poacher is one of those creatures that is more fantastic than beautiful. All head and razor-thin tail, its body looks like a knife with the head of a fish.[69] In the deep, it slinks between sediments and gas hydrates.[70] Other creatures prove a little

[66] Thomson, *Depths of the Sea*, 27-28; Rozwadowski, *Fathoming the Ocean*, 15; Hickson, *Fauna of the Deep Sea*, 13-14. It was Forbes who brought "abyss" into popular use to describe the area of the ocean where the sun does not go. See Scales, *Brilliant Abyss*, 16.

[67] Thomson, *Depths of the Sea*, 73.

[68] Carson, "Undersea," 7.

[69] Carrie C. Wall, Rodney A. Rountree, Corinne Pomerleau, Francis Juanes, "An Exploration for Deep-Sea Fish Sounds off Vancouver Island from the NEPTUNE Canada Ocean Observing System," *Deep-Sea Research I* 83 (2014): 61.

[70] "Barkley Canyon," Ocean Networks Canada, accessed December 1, 2020, https://www-static01.oceannetworks.ca/observatories/pacific/barkley-canyon.html.

more familiar. The rex sole, like the halibut of the continental shelf, lives with both eyes on one side of its head. In the soft sands and muds, the rex sole nestles into the seabed to fertilize its eggs. In most parts of the ocean they stay in relatively shallow waters, but for whatever reason, they go deeper in the northeast Pacific. Of the lankier variety is the cusk-eel. Cusk-eels look like two animals smushed into one: a fish in the front and an eel in the back. Unphased by the abyss's darkness or lack of food, cusk-eels swim deeper than most other fish. But scariest in appearance is the giant sea spider. With its spindly legs, it swims through the water in search of a meal. Usually, that meal is an anemone resting on the seabed. Centering itself on top of the anemone, the spider inserts its tongue-like tube, called a proboscis, into the anemone and "sucks out its insides like a smoothie."[71] Yum.

Compare those deep-sea predators to the abyss's incessant housekeepers, which feed on the detritus that falls to the bottom. Marine snow, as it's called, is made of dead phytoplankton, zooplankton, and an assortment of other organic debris.[72] Of all the thousands of edible items that fall from the ocean's surface—plankton, poop, crab legs, fish tissue, shells, appendages, rotting wood, kelp bits—only 2 percent of that loot arrives on the deep seabed.[73] Even then, such a large amount of this marine snow descends to the depths that as much as one-third of a million tons reaches the seafloor every year.[74]

---

[71] "Sea Spider," Monterey Bay Aquarium, accessed January 4, 2023, https://www.montereybayaquarium.org/animals/animals-a-to-z/sea-spider.

[72] Scales, *Brilliant Abyss*, 19. Scientists assumed in the nineteenth century that most deep-sea animals depended on falling carcasses for their main source of food. See Hickson, *Fauna of the Deep Sea,* 27-28.

[73] Scales, *Brilliant Abyss*, 20.

[74] Emery, *Sea off Southern California,* 178; see also Townsend, "The Life of the Deep Sea," 126.

Marine snow is joined by marine dust, which drifts to the abyssal seafloor from the shallower reaches. Marine dust includes particles from land and space that collect on everything, “the same way dust accumulates in all parts of your home,” according to two oceanographers.[75] This organic carbon and phytodetritus falls in pulses, descending at a rate of between thirteen to twenty feet (4-6 m) per hour.[76] Depending on the time of day or season, these pulses of marine snow and dust come and go, just as food supplies on land may wax and wane during the seasons. Nothing goes to waste on the seafloor for food is hard to come by.

Dead animals that fall onto the seafloor are gone in the amount of time it takes scavengers to find and eat them. For a large carcass, such as a whale, the devouring process may take years. For smaller species, like humans, just hours. Animals are ravenously hungry here, a characteristic they share with marine life elsewhere in the ocean. Take the small sea pig, which ambles along the bed like a pink, bulbous gummy bear. These little pigs are common across the abyss. They vacuum the mud in search of anything edible: mucus, poop, tiny body parts, fish flakes, algae.[77] Anything goes. Sea pigs are joined by organisms of the spikier variety, including urchins. Urchins of the deep are adorned in pops of pink, purple, and yellow. They trail slowly along the seabed, eating any detritus the sea pigs fail to discover.

---

[75] Trujillo et al., *Essentials of Oceanography*, 129.

[76] Kenneth L. Smith Jr., Henry A. Ruhl, Mati Kahru, Christine L. Huffard, and Alana D. Sherman, “Deep Ocean Communities Impacted by Changing Climate Over 24 Y in the Abyssal Northeast Pacific Ocean,” *PNAS* 110, no. 49 (December 3, 2013): 19838-39.

[77] “Sea Pig,” Monterey Bay Aquarium, accessed December 23, 2022, https://www.montereybayaquarium.org/animals/animals-a-to-z/sea-pig,

Speaking of dead animals, scientists created their fair share in the study of the abyss. Death arrived for any worm, fish, mollusk, or other creature unlucky enough to be scooped up by a dredge. Once caught, the journey from the seafloor to the surface proved too severe for survival. Scientist Wyville Williams recorded that all animals dredged from the deep-sea arrived on deck "either dead, or dying."[78] Scientists debated what part of the journey up the water column killed them—was it the speed of ascent, the change in pressure, or the exposure to air at the surface?[79] A majority of naturalists suspected that the swift change in pressure is what did them in.[80] One thing was clear: wherever scientific tools met ocean, creatures routinely died. Death and deep-sea science went hand-in-hand. Technologies were the primary tool for making those breakthroughs; dead marine life was worth of the price of discovery.[81]

Once on board, marine carcasses were not in good shape: they appeared crumpled, deflated, dried out, and lackluster. "The [hemp] tangles certainly make a sad mess of the specimens," recorded Wyville Thomson, feeling some regret for killing the very species he sought to study. "The first feeling is one of woe, as we undertake the almost hopeless task of clipping out with a pair of short nail-scissors the mangled remains of sea-pens, the legs of rare crabs, and the dismembered disks and separated arms of delicate crinoids and ophiurids."[82] So deformed were the organisms that scientists had a

---

[78] J. Francon Williams, *The Geography of the Oceans* (London: George Philip and Son, 1881), 66.

[79] Townsend, "The Life of the Deep Sea," 125.

[80] Williams, *Geography of the Oceans*, 66-67.

[81] On the ocean as a frontier in the twentieth century, see Gary Kroll, *America's Ocean Wilderness: A Cultural History of Twentieth-Century Exploration* (Lawrence: University Press of Kansas, 2008), 84-85; Rozwadowski, "Arthur C. Clarke," 578-579.

[82] Thomson, *Depths of the Sea*, 258.

difficult task imagining how these sorry lifeforms ever survived in an environment so rough. The dismembered creatures were not good candidates for specimen jars. Thomson wrote that a sample proves to be of "infinitely greater scientific value if it be preserved entire with its soft parts."[83] Even Ernst Haeckel, the naturalist known for his colorful illustrations of deep-sea life, had to visualize his subjects uncrumpled and whole. Haeckel drew his creatures alive and fresh, more a product of his imagination than any specimen sitting in front of him. "Not until the second half of the nineteenth century did individual, living animals begin to come back into view, when researchers put themselves in the water to witness life well below the surface," writes scientist Helen Scales.[84] Before then, calculated fantasy comprised no small portion of deep-sea science.

Despite the crumpled corpses, there was one fact scientists could piece together early on: the abyss is dark, but its inhabitants are not. In 1893, zoologist Sydney John Hickson noted that deep-sea creatures dredged from the abyss still glowed, just a little, once they reached the ship's deck. By then, they were dead, but that faint glow led scientists to argue for the presence of bioluminescence, a result of a chemical reaction in the organism's body. "We can readily imagine," Hickson wrote, "that some regions of the sea may be as brightly illuminated as a European street is at night."[85] Another scientist referred to deep-sea bioluminescent animals as "living lamps."[86] Not one of these scientists had ever set eyes on the deep sea, but they could dream of its light show.

---

[83] Thomson, *Depths of the Sea*, 261; see also Hickson, *Fauna of the Deep Sea*, 21, 103-104.

[84] Scales, *Brilliant Abyss,* 53.

[85] Hickson, *The Fauna of the Deep Sea,* 24-25.

[86] Townsend, "The Life of the Deep Sea," 123.

As scientists pulled creatures from the ocean, each stranger than the one before, writers took up their pens to describe this foreign environment to their readers. With a dash of fiction and a sense for drama, deep-sea stories exploded onto the global scene in the late nineteenth and early-twentieth centuries.[87] One universal inspiration was Jules Verne's *20,000 Leagues Under the Sea*, originally published in English in 1872. The book motivated a whole host of writers to develop a fascination with the ocean, including newspapers.[88] "In the blackness of everlasting night," reported the *Oregon Daily Journal* in 1902, "weird forms crawl and glide and swim everywhere." Another newspaper reporter dreamt of technologies "far down among the uncouth monsters that wallow in the nether seas, along the wreck-paved floor, through the oozy dungeons of the rayless deep."[89] Whereas some writers associated the deep sea with ick and danger, others adopted an enthusiastic perspective. "The floor of the ocean! The mud of The Deep!" opined one author "There is a romance in ocean mud more wonderful and entrancing than fiction's wildest, happiest dreams."[90] Even now, their excitement is palpable. Back then, these accounts were downright thrilling.[91]

[87] Helen M. Rozwadowski, "Oceans in Three Paradoxes: Knowing the Blue through the Humanities," *Environment and Society Portal*, Virtual Exhibitions 2021, no. 2, https://www.environmentandsociety.org/exhibitions/oceans-three-paradoxes.

[88] Brazier, "An Ode to Ooze."

[89] "Edward Everett on the Cable," *American Phrenological Journal*, 1858, File #40, Box No. 1, Collection No. 638, William K. Applebaugh Papers, Nation Museum of American History, Smithsonian Institution, Washington, DC.

[90] Anon., *Half Hours in the Deep: The Nature and Wealth of the Sea* (London: James Nisbet, 1880), 211.

[91] Adler, *Neptune's Laboratory*, 13.

If this under-world had prompted newspaper and fiction writers to pick up their pens, it did the same for scientists.[92] In 1902, a marine scientist published an article in *Everybody's Magazine* that painted a picture of life in the deep sea. Along for an expeditionary journey, readers discovered the "gorgeous" Hoplothethus fish, the "big scarlet" king crab, the "luminous fishing-rod" of the anglerfish, and a sea urchin the size of a "breakfast plate."[93] Impossible to visit, but impossible to ignore, humans lavishly painted the abyss with their imaginations. The deep sea was strange and foreign to everyone, expert scientists and the public alike, therein providing its shared appeal. Together, through writing, scientists, authors, reporters, fiction authors, and the public could express their shared interest in the deep.

At the same historical moment that scientists were plucking creatures from the deep sea, wildcatters were erecting drilling piers in Summerland's shoreline, and the USS *Burnside* was laying the last stretch of the Alaska submarine cable. Unlike with tideland drilling and telecommunications cables, deep-sea scientist espoused little interest in making money from the seabed. Despite their different objectives when it came to profit, these seafloor industrialists shared one key characteristic: an intense drive to deploy instruments to the ocean floor. Viewed from this perspective, they were more alike than not.

---

[92] British scholar William Whewell first used the term "scientist" in 1833. Whewell established the study of tidal science. For a history of the development of marine science, see Reidy, *Tides of History.*

[93] Townsend, "The Life of the Deep Sea," 118-119.

Advancements in the Twentieth Century

It was not until the twentieth century that the first human set eyes on the deep sea. Before that, all knowledge surmised about the abyss was drawn from samples and soundings, but never a first-person experience. American naturalist and explorer William Beebe became best known as the pioneer of the bathysphere, a steel ball connected to a ship. In the 1930s, Beebe hopped into his bathysphere to make repeated descents into the Atlantic to a depth of about three-thousand feet (914 m).[94] Next came the bathyscaphe, a self-propelled submersible, which made it possible for Don Walsh and Jacques Piccard to descend to one of the deepest parts of the Pacific seafloor, the Mariana Trench, in 1960.[95] While the thirty-five thousand foot descent to the bottom took many hours, the bathyscaphe stayed on the seafloor but twenty minutes before needing to return to the surface. Using pressurized compartments, submersibles like the bathyscaphe or its more famous relative, *Alvin*, unveiled in 1964, have allowed scientists to witness the deep-sea environment firsthand. Self-Contained Underwater Breathing Apparatus (SCUBA) also aided the first-person experience with the ocean, particularly for exploration in the shallower depths.[96] Whereas nowadays deep-sea cameras and ROVs transport people into the ocean's depths, a half century ago, if you wanted to enjoy the abyss in all its glory, you would have to catch a ride on a submersible, a privilege very few scientists had

[94] Kroll, *America's Ocean Wilderness,* 84-85.

[95] The U.S. Navy purchased one of Piccard's bathyscape, *Trieste*, in 1958. See Tudor, *Structures in the Deep Ocean,* 7-8; Broad, *Universe Below*, 59.

[96] Helen M. Rozwadowski, "Arthur C. Clarke and the Limitations of the Ocean as a Frontier," *Environmental History* 17 (2012): 581; Adler, *Neptune's Laboratory*, 104.

access to, and most certainly not accessible to a fourteen-year-old sitting at home in Ukraine.

Sound became indispensable to oceanography, as well, in the twentieth century. The process of using sound to determine the sea's depth stretched back to 1838, when Charles Bonnycastle first measured the distance of a sound's echo in water, or what came to be called the echosounder. The time it took between sending a ping into the seawater and the return of its echo measured the seabed's distance from the surface. In comparison to the hours required to unravel and re-ravel a sounding line, the echosounder provided a faster means of discovering and mapping the seafloor.[97] Building off the echosounder, in the years following World War II the U.S. Navy further developed sonar, or sound navigation and ranging. Sonar, the next step up from echo sounding, also relied on the same principles of bouncing sound waves around to determine the seafloor's depth, topography, and foreign objects that may be in the water.[98] Nowadays, it is common to find sonar on every commercial, personal, and military vessel. Single-beam sonar, multi-beam sonar, side-scan sonar, fathometers, and swath mapping enable scientists to quickly collect data about the undersea world, gleaning a much bigger sense of a region's seafloor in comparison to tools like sounding devices.[99]

In the twentieth century, sonar helped to crack the code on the seafloor's mysterious geology. Scientists discovered that the abyssal seafloor is young, geologically speaking. In a process called plate tectonics, the seafloor is constantly being created and

[97] Kunzig, *Mapping the Deep,* 40.

[98] Ibid., 64; Adler, *Neptune's Laboratory*, 97, 101.

[99] Broad, *Universe Below*, 62; Tudor, *Structures in the Deep Ocean*, 2-1.

absorbed, created and absorbed.[100] Picture the abyssal seafloor as a massive pot of boiling water, as one writer describes it. New magna boils up from mid-ocean ridges in the middle of the pot. That magma cools and becomes seafloor. The fresh seafloor slowly moves toward the edges of the pot, or the continental shelves.[101] Continually, the cooled seafloor bumps against the rock of the continental shelves and subducts back into the mantle, where the process begins again: new seafloors oozes out of the middle ridges, and older seafloor sublimates at the edges. This rolling boil moves at the speed of millions of years, which is pretty quick in geological time. The age of the seafloor crust in the northeast Pacific ranges from a few million years old to sixty-six million years, young in comparison to, say, the Appalachian Mountains, which are nearly four-hundred and eight million years old.[102] The discovery of plate tectonics was nothing less than revolutionary. Not only was the seafloor active, it was one of the most energetic geological regions on Earth.[103] The study of plates and their movements took center stage for oceanographers in the second half of the twentieth century, a focus that continues to be critical for NEPTUNE's instruments in the twenty-first century.

---

[100] Trujillo, Essential of Oceanography, 43; Kunzig, *Mapping the Deep,* 47-55.

[101] Broad, *Universe Below*, 104.

[102] Trujillo et al., *Essentials of Oceanography*, 50; "Seafloor Age," Google Earth, earth.google.com, accessed December 17, 2022. In the late 1800s, scientists were aware of valleys near coastlines, but did not yet understand that tectonic plates subducted below the continents at those sites. In the early twentieth century, Alfred Wegener proposed the theory of continental drift, which was controversial and not broadly received among the scientific community. But by the 1950s and 1960s, theories that built on continental drift including seafloor spreading, followed by plate tectonics, were not only revolutionary findings but also broadly accepted. See Ruliff S. Holway, *Cold Water Belt along the West Coast of the United States* (Berkeley: University of California Press, 1905), 282; Kunzig, *Mapping the Deep,* 46-48, 49-52.

[103] Bright, *Universe Below*, 105; For a study of scientific revolutions, see Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd edition (University of Chicago Press, 1970).

Despite the advancements in sonar, research vessels continued to be a core tool for oceanographic research in the twentieth century, just as they were in the nineteenth. For example, the U.S. Navy proudly estimated that by the 1970s, the branch's oceanographic research fleet would include one-hundred ships—a number that would be astronomically expensive for cabled observatory operators today.[104] In another example, the Scripps Institute of Oceanography, a university-operated oceanographic research organization, maintained a fleet of ten research vessels during the 1960s. Scripps reported that its fleet plied the global ocean a cumulative 1,708 days in 1966.[105] That much time on the ocean in the twenty-first century would result in significant costs and would produce less than some scientists would prefer.

The problem that plagued oceanographic study in the nineteenth century continued to be a problem throughout the twentieth: research expeditions were temporary, short, and expensive to conduct.[106] Quick visits to the deep sea with a sounding line, remotely operated vehicle, or submersible provided valuable information, but it could not provide significant amounts of data comparable to that of satellites or *in situ* systems. One scientist proclaimed, "Our community became painfully aware of the fact that for a hundred years we had catastrophically undersampled the oceans!"[107]

---

[104] Tudor, *Structures in the Deep Ocean,* 7-6.

[105] Scripps Institution of Oceanography, *Annual Report* (La Jolla: University of California, San Diego, 1967), 16-17.

[106] Scripps *Annual Report*, 13.

[107] Walter Munk, "The Evolution of Physical Oceanography in the Last Hundred Years," *Oceanography* 15, no. 1 (2002): 136.

Aware of this fragmentary data collection, in the early twentieth century scientists began to dabble with *in situ* technologies that would later develop into seafloor observatories. In 1938, the *San Bernardino Sun* reported that a scientist at Lehigh University was experimenting with attaching bombs and other devices to a seafloor cable. "Just work out a way of using the machines several miles below the surface," the newspaper joked, "Easy—well, not quite."[108] *In situ* technologies were difficult to install and maintain, but increasingly a good idea. In 1949, the United States Coast Guard installed a device called Ocean Station Papa that sat buoyed in the Pacific collecting meteorological data.[109] And during the Cold War, the U.S. Navy went even further and invented a Sound Surveillance System (SOSUS), which were a series of microphones that sat directly on the seabed—an early iteration of *in situ* instruments to come. The microphones helped the Americans listen for Russian submarines that might be travelling near the Pacific coastline.[110] Bigger machines came into the fold, too. For instance, the Scripps Institute of Oceanography developed a Floating Instruments Platform (FLIP) in 1962, a 355-foot instrument that could be towed by a ship to various study locations. Once in place, FLIP would flip ninety degrees to study the sea from different angles.[111] In 1963, the *New York Times* reported that "Altogether, there have been some 20 to 30 experiments in which instruments to measure earth tremors have been lowered to the ocean bottom."[112]

---

[108] Ronald L. Ives, "Mapping a Country No Man Ever Saw," *San Bernardino Sun*, February 1938.

[109] Baggeroer et. al, "Ocean Observatories," 26.

[110] Broad, *Universe Below,* 52.

[111] Scripps *Annual Report*, 15, 17; Stefan Helmreich, "Flipping the Field," *ISIS* 113, no. 1 (March 2022): 152-151; Tudor, *Structures in the Deep Ocean,* 8-1, 8-3, 8-4; Adler, *Neptune's Laboratory*, 109-111.

[112] "Sea-Floor Cable to Gauge Shocks," *New York Times,* October 28, 1963.

During the twentieth century, the concept of using stationary machines to study the ocean was expanding. These fixed instruments were early versions of NEPTUNE and functioned on the same premise: if a large instrumented system lived permanently in the ocean, it could collect more data. Although not all oceanographers have thrown their support behind big marine infrastructure projects and continue in the twenty-first century to depend on ship-based research for the study of oceanic processes, it's clear that a majority of funding is flowing one direction: towards big seafloor infrastructure projects.[113]

Small Plate, Big Data

In the early 1990s, an international group of scientists began to meet at workshops to discuss the feasibility of developing a large undersea observatory.[114] Their goal was huge: engineer a data collection system that could stretch across an entire tectonic plate. By doing so, the observatory would glean a panoramic understanding of the plate's hydrothermal circulation and vent communities, fluid flows, spreading and subduction, and deep-sea ecosystems. The observatory would not provide just a single snapshot of that system—a serious drawback of earlier oceanographic instruments. Instead, it would record data over many decades, which would allow scientists to see long-term patterns

[113] Committee on Guidance for NSF on National Oceanic Science Research Priorities: Decadal Survey of Ocean Sciences, Ocean Studies Board, Division on Earth a Life Studies, and National Research Council, *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences* (Washington, D.C.: National Academies Press, 2015), 39.

[114] Initially, scientists in the United States, including John Delaney at the University of Washington, spearheaded NEPTUNE's development. See Steinhardt, "Instrumented Ocean," 30.

and changes in the ocean. Small plate, big data. But there was problem. Despite the development of smaller *in situ* observatories in the twentieth century, not a single university, military agency, or company had ever come close to pursuing such a grand idea.[115]

Technical and funding challenges aside, the convening scientists had already picked out their plate. The Juan de Fuca plate off the west coast of North America fit the role: it's small enough that an observatory could feasibly cover most of it, and it's close to the North American coastline to make installation and repairs more accessible and less expensive. Small is a relative measurement, however, since the Juan de Fuca plate spans an area the size of California. Still, when compared to other tectonic plates in the ocean, it's a little one.[116] But the Juan de Fuca plate's biggest appeal derived not from its size or nearness to the coastline, but from its bombastic activity. Thanks to the fact that it's subducting under the North American plate, this plate is one of the most hydrothermally energetic, volcanic, and seismically dangerous regions in the global ocean.[117] It's this site of subduction that will cause the region's next big earthquake and tsunami, often called "Cascadia," or simply, "The Big One." Barring that event, the Juan de Fuca plate is still getting busy on a regular basis: chimneys form and crumble, hydrothermal vent communities gurgle and jostle, earthquakes rumble and tumble, and animals turn on and

---

115 Helmreich, *Alien Ocean,* 241.

116 Robert Sanders, "Scientists Map Source of Northwest's Next Big Quake," *Berkley News,* November 2, 2015, https://vcresearch.berkeley.edu/news/scientists-map-source-northwests-next-big-quake.

117 Matabos et al., "Integrating Multidisciplinary Observatories," 4; Christopher Barnes, interview with the author, February 21, 2023.

off like lightbulbs.[118] In comparison to other areas of the ocean, this stretch of seafloor has a lot going on. And if you're a marine scientist, it's a damn good spot to install your instruments.

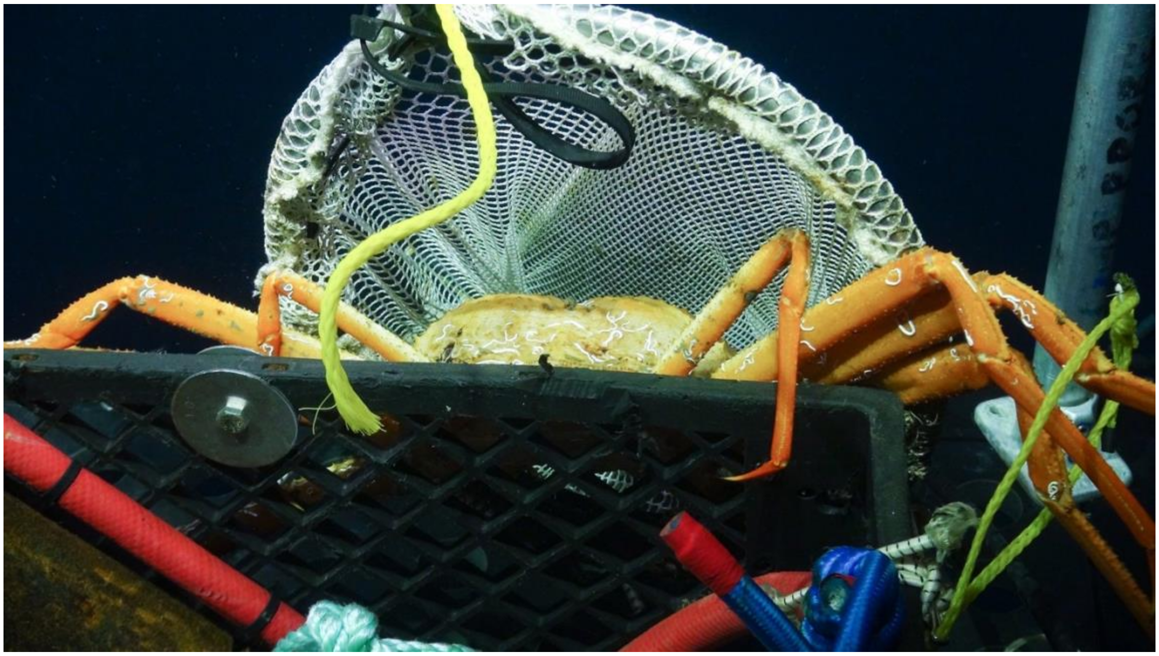


Figure 6.3. A tanner crab crawls on a remotely operated vehicle in the deep sea. Image courtesy of Ocean Networks Canada/WHOI.

Canadian scientists received funding for their observatory, named NEPTUNE, earlier than their American counterparts, so they pushed forward to design and install the observatory on the northern section of the Juan de Fuca plate.[119] The Americans' observatory on the southern portion of the plate, called Ocean Observatories Initiative

[118] The last big tsunami occurred here in 1700, which is chronicled in Indigenous oral histories. See Ruth S. Ludwin, Robert Dennis, Deborah Carver, Alan D. McMillan, Robert Losey, John Clague, Chris Jonientz-Trisler, Janine Bowechop, Jacilee Wray, and Karen James, "Dating the 1700 Cascadia Earthquake: Great Coastal Earthquakes in Native Stories," Seismological Research Letters 76, no. 2 (March/April 2005): 140-148; Cite Chris Barnes Interview; Kathryn Schulz, "The Really Big One," *New Yorker*, July 13, 2015, https://www.newyorker.com/magazine/2015/07/20/the-really-big-one.

[119] Barnes, interview with the author.

(OOI), would arrive in 2013, a few years after NEPTUNE's launch in 2009.[120] As with most large-scale seafloor projects, federal money mixed with private-sector support and services—the same held true for cable projects in the nineteenth and twentieth centuries. For NEPTUNE, Alcatel-Lucent Submarine Networks company received the contract design, build, and install NEPTUNE's main branch cable, smaller spur cables, and nodes. There's was a unique challenge, for not a single other company had ever designed or installed such a system.[121]

NEPTUNE's physical layout borrows from the learned experience of the undersea cable industry. Using a loop structure common to the telecommunications field, NEPTUNE looks like a large lasso that loops from shore to the continental shelf, down to the abyss, and back to shore.[122] This lasso is massive. Including the backbone and smaller spur cables, NEPTUNE contains over five-hundred and seventy miles (917 km) of line. If NEPTUNE's backbone cable breaks in one location, power and data can still flow in the other direction to reach the shore station.[123] The backbone cables serves as a highway between the instruments in the ocean and the shore station in Port Alberni, providing both 10kV DC of electricity and 10GB/sec of Internet connection.[124] At five locations along

---

[120] NEPTUNE received funding from the Canada Foundation for Innovation, the Natural Sciences and Engineering Research Council of Canada, University of Victoria, governmental agencies, in-kind support from private industries and partner labs, among others. It also received design support from OceanWorks International out of Vancouver, L3 MariPro out of Santa Barbara, Highland Technologies in British Columbia, CANARIE and Rocketday Arts of Victoria. Barnes, et al., "Large Subsea Observatory"; Paulson, "Wiring the Abyss"; Barnes, "NEPTUNE Canada: Overview.

[121] Barnes, interview with the author.

[122] Barnes et al., "Building the World's First," 14; Starosielski, *Undersea Network,* 49.

[123] Starosielski, *Undersea Network*, 216; Barnes, et al., "Large Subsea Observatory."

[124] Barnes, "NEPTUNE Canada: Overview."

that backbone, NEPTUNE powers instruments that collect various types of marine data. Each of these locations is called a "node," which sit at varying seafloor depths that range from the shoreline, the continental slope, and the abyss.[125] The two nodes located on the abyssal seafloor are the Cascadia Basin node at 8,727 feet (2,660 m) deep and the Endeavor node at 7,546 feet (2,300 m) deep. The nodes exist where humans cannot.

Since the twentieth century, satellites have collected important data on the ocean, but they could read only a few meters into the surface of the water, although green laser technology on satellites it mapping deeper than ever.[126] One key purpose of cabled observatories, therefore, is the observatory's ability to study the entire vertical system, from sub-seafloor to surface. Combined with instruments on the seafloor, which are measuring up while satellites are measuring down, scientists "look at the Earth as an integrated system."[127] Big picture, big data. That amount of information is staggering and the exact opposite problem that plagued marine scientists a century ago.

Considering the amount of information that NEPTUNE collects, data management is no small task for observatory owners. In fact, it's arguably ONC's biggest task and biggest product.[128] Instruments installed on the seabed collect data on microbes, the chemical makeup of upwelling waters, salinity, dissolved oxygen, nutrients, deep-sea

---

[125] Barnes, et al., "Large Subsea Observatory."

[126] Paul Voosen, "Ice-Tracking Space Laser Could Also Map Sea Floor and Monitor Health of Coral Reefs," *Science*, April 14, 2020, https://www.science.org/content/article/ice-tracking-space-laser-could-also-map-sea-floor-and-monitor-health-coral-reefs.

[127] Paolo Favali, Roland Person, Chris R. Barnes, Yoshiyuki Kaneda, John R. Delaney, Shu-Kun Hsu, "Seafloor Observatory Science," Personal papers shared with the author, n.d.; Christopher Barnes, interview with the author, February 21, 2023; Trujillo et al., "Essentials of Oceanography," 84; "Data Facilities," Ocean Networks Canada, accessed February 6, 2020, https://www.oceannetworks.ca/observatories/infrastructure/data-facilities.

[128] Pirenne, interview with the author.

sounds, currents, and temperature, to name just a few.[129] The Conductivity Temperature Depth (CTD), for instance, is a grouping of sensors that record temperature, pressure, and conductivity. Tiltmeters, by comparison, study the seafloor's geology and record movement in the seabed. Bottom Pressure Recorders (BPRs) measure seafloor pressure; BPRs are used widely and help warn scientists about potential tsunamis—an example of NEPTUNE's ability to assist and serve the broader society outside of oceanography.[130]

The most exciting sections of the Juan de Fuca plate are the hydrothermal vents, or the marine equivalent of hot springs.[131] Except that these hot springs spew iron, sulfur, hydrogen, and methane—a brew not only hundreds of degrees in temperature, but also toxic to humans. Scientists first set eyes on a hydrothermal vent in 1977 while traveling deep into the Pacific in the submersible *Alvin*.[132] Hydrothermal vents discharge fluids that attract organisms that feed near the openings. Getting as close as they can without burning to death, thousands upon thousands of lifeforms cluster and attach to the openings and on the chimneys—giant tube worms, little shrimps, snails, crabs, and anemones. In certain areas, the animals are so concentrated that the vent appears to wiggle and squirm. Unseen to the human eye are millions upon millions of microbes, which perform chemosynthesis from the compounds spewing out of the vents.[133]

---

[129] Paulson, "Wiring the Abyss."

[130] Tudor, *Structures in the Deep Ocean,* 5-18, 5-15; "Set It and Forget It: Deploying Long-Term Seismic Monitoring Instruments," Nautilus Live, August 31, 2021, https://nautiluslive.org/video/2021/08/23/set-it-and-forget-it-deploying-long-term-seismic-monitoring-instruments.

[131] Elizabeth Kolbert, "The Deep Sea Is Filled with Treasure, But It Comes at a Price," *New Yorker* (June 14, 2021), https://www.newyorker.com/magazine/2021/06/21/the-deep-sea-is-filled-with-treasure-but-it-comes-at-a-price.

[132] Trujillo et al., *Essentials of Oceanography,* 502.

[133] Scales, *Brilliant Abyss,* 70-72.

Scientists report that hydrothermal vents sound like a gurgling pot of soup, which would be appetizing if not for the vent's notorious smell.[134] Thanks to the methane, the hydrothermal vents reek like cow farts, and any scientific instruments returning from vent sites also reek like cow farts.[135] Every ocean basin has vent fields, but the northeast Pacific is particularly ripe with them. The Juan de Fuca Ridge has twenty-one vent sites alone, which burst near volcanically active undersea mountains. And the Endeavor vent field off Vancouver Island, for example, has over five hundred and seventy chimneys spewing hot gas. The chimneys stand up to ninety feet (27 m) tall. One notorious chimney in the Endeavor field, Godzilla, fell in the 1990s, but not before oceanographers had a chance to measure it. At its peak, Godzilla was fifteen-stories in height.[136] In comparison to the Godzillas of the ocean, most vents are small and periodically burp gas.[137]

Because of the pressure, temperatures, and chemicals at vent sites, scientists can't just drop down to these dangerous sites with SCUBA gear. Instead, they must use highly specialized machines. First developed in the twentieth century by the offshore oil and gas industry, remotely operated vehicles (ROVs) go where humans cannot. ONC owns an ROV whose arm can suction and collect marine life near hydrothermal vents and take them back to land for study.[138] The ROVs aren't alone in the abyss. NEPTUNE also

---

[134] Sabrina Imbler, "Could Listening to the Deep Sea Help Save It?" *New York Times*, November 11, 2020, https://nyti.ms/3kesoLV.

[135] Helmreich, *Alien Ocean,* 244; Tunnicliffe, interview with the author; Broad, *Universe Below,* 107.

[136] Scales, *Brilliant Abyss,* 57-58; Broad, *Universe Below*, 100.

[137] Helmreich, *Alien Ocean,* 244; Marlow, "Undersea Internet Cables"; Starosielski, *Undersea Network*, 216.

[138] Paulson, "Wiring the Abyss."

operates “Wally the Crawler,” which is an Internet-operated robot for the seabed. Wally and its machine sibling, Wally II, live permanently on the seafloor and move at the behest of scientists sitting in Germany.[139]

Historians have argued that tools have been humans’ primary means of understanding and interacting with the ocean, and that argument is particularly poignant when considering cabled observatories in the twenty-first century. Historian Helen Rozwadowski writes that “people can only know the sea indirectly,” resulting in the development of a field—oceanography—that uses tools to build an understanding of the ocean’s depths. “In its inaccessibility,” she states, “most of the ocean is a vast and challenging place that humans know only through the mediation of technology and knowledge systems.”[140] Oceanography, she concludes, “is in many ways technology writ large.”[141] Jacob Darwin Hamblin also argues that the deep ocean is unknowable without technology. He writes that the sea “must be made comprehensible by some intervening technology—instruments, maps, equations.”[142] A broad group of marine scholars have reached a similar conclusion: when it comes to the ocean, technology and knowledge are often synonymous.[143] As machines reach further into the depths and of the Pacific Ocean,

---

[139] Barnes, interview with the author.

[140] Helen Rozwadowski, “Oceans: Fusing the History of Science and Technology,” in Douglas Cazaux Sackman, ed., *A Companion to American Environmental History* (Oxford: Wiley-Blackwell, 2010), 443, 455. See also Reidy, *Tides of History*.

[141] Keith R. Benson, Helen M. Rozwadowski, and David K. van Keuren, “Introduction,” in Helen M. Rozwadowski and David K. van Keuren, eds. *Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment* (Canton, MA: Science History Publications, 2004), xiii.

[142] Jacob Darwin Hamblin, “Seeing the Oceans in the Shadow of Bergen Values,” *Isis* 105 (June 2014): 357.

[143] Rozwadowski, “Ocean’s Depths,” 521-522.

marine scientists depend increasingly on remote technologies rather than first-person experiences to know and study the sea—a reality since the nineteenth and twentieth centuries, but even more critical today.[144]

ONC and other cabled observatory owners still depend on big ships, but they use them infrequently, typically a couple of times per year. I've heard many ONC's current and former staff members say that "ship time is expensive." Therefore, beyond performing two maintenance cruises annually, NEPTUNE's instruments function on their own down there, freeing the scientists to study their data in the comfort of their homes. As Stefan Helmreich points out, "No need for seasickness pills, yak sites, or, indeed, fieldwork; what counts as presence in the field—presence upon which representations will be based—is transforming."[145] With cable observatories, scientists rely less on corporeal experiences and ever more on digital systems. Cabled observatories avoid the seafaring seasonality that previously defined what it meant to be a marine scientist.[146] Conceivably, with NEPTUNE's data just a few clicks away, a graduate student could complete a Ph.D. studying an aspect of the Juan de Fuca plate without ever having to visit the Pacific Ocean—a remoteness already standard for astronomers and astrophysicists.

[144] Jacob Darwin Hamblin, "Seeing the Oceans in the Shadow of Bergen Values," *Isis* 105 (June 2014): 357. Melody Jue, *Wild Blue Media: Thinking through Seawater* (Durham, NC: Duke University Press, 2020), 3; Keith R. Benson, Helen M. Rozwadowski, and David K. van Keuren, "Introduction," in Helen M. Rozwadowski and David K. van Keuren, eds. *Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment* (Canton, MA: Science History Publications, 2004), xiii.

[145] Helmreich, *Alien Ocean,* 50; See also Louie S. Echols, "A Feasibility [sic] Study for an Ocean Bottom Hydrophone Instrument to Monitor…," Box 3, Washington Sea Grant Program Records, 1967- 2000, University of Washington Special Collections, Seattle, WA; Paulson, "Wiring the Abyss."

[146] Verena Tunnicliffe, Chris R. Barnes, and Richard Dewey, "Major Advances in Cabled Ocean Observatories (VENUS and NEPTUNE Canada) in Shallow and Deep Sea Settings," personal papers shared with the author, n.d.

The accessibility of NEPTUNE's data, which they plan to store in perpetuity, sets cabled observatories apart from earlier methods of studying the ocean.

The Biotic Afterlife of Cabled Observatories

Cabled observatories provide a small fortress in a grand sea of mud. In the abyss, marine life colonizes scientific instruments, just as it does with machines in the shoreline and on the continental shelf. But colonization here tends to be slower and less crowded. There are fewer organisms in the deep in comparison to the shoreline, where the sun shines brightest.[147] When the sunlight fades, so too does the ocean's bursts of productivity and the density of marine organisms. Still, in an environment where natural substrate is difficult to find—deep-sea reefs cover less than 4 percent of the abyssal seafloor—cabled observatories like NEPTUNE provide an ideal landing spot for a variety of marine species. Octopi slink behind tiltmeters and seismometers, crabs hang onto cables, whelks fasten their eggs to metal surfaces, microscopic organisms blur camera lenses, and limpets, worms, and spiders crowd in.[148] Even at depths of 6,500 feet, hydrothermal vents cause biofouling on technologies to increase thanks to the life-giving

[147] Tunnicliffe, interview with the author. Even back as the 1960s, the U.S. Navy reported that deep-sea bacteria would "menace" submarine machines; see Tudor, *Structures in the Deep Ocean*, 2-44; Paulson, "Wiring the Abyss"; Manov et al., "Methods for Reducing," 961; Diego Meseguer Yebra, Søren Kiil, Kim Dam-Johansen, "Antifouling Technology—Past, Present and Future Steps Towards Efficient and Environmentally Friendly Antifouling Coatings," *Progress in Organic Coatings* 50 (2004), 80.

[148] Peter I. Macreadie, Ashley M. Fowler, David J. Booth, "Rigs-to-Reefs: Will the Deep Sea Benefit from Artificial Habitat?" *Frontiers in Ecology and the Environment* 9, no. 8 (2011): 458.

chemicals that spew from the vent openings.[149] Down here, just like elsewhere in the ocean, marine life transforms deep-sea instruments into part machine, part ecosystem.

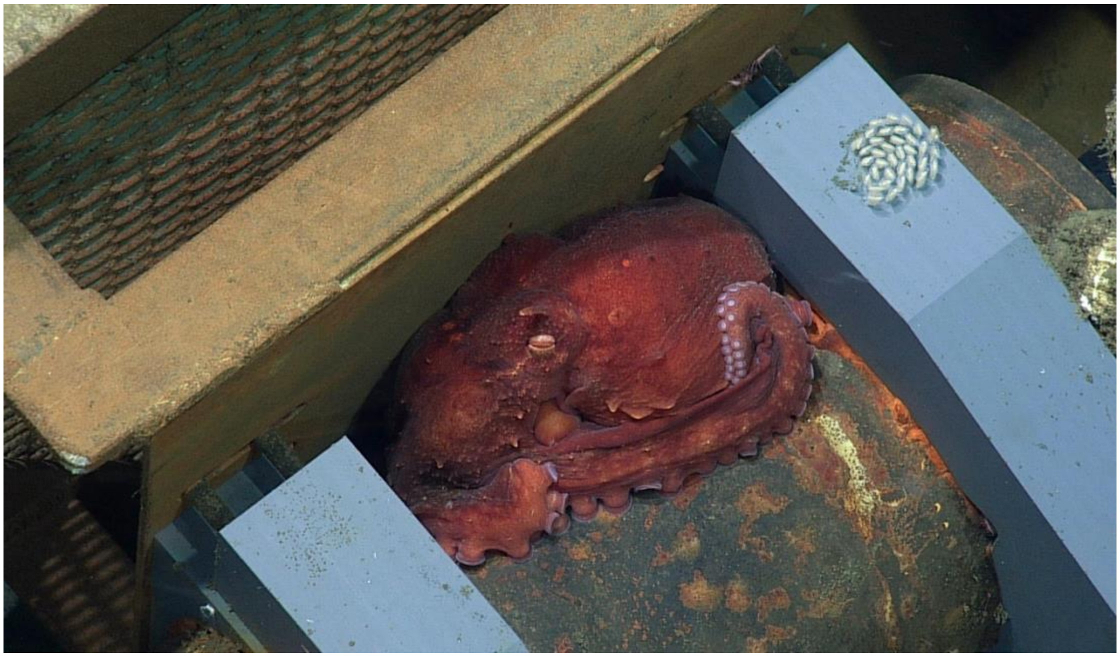


Figure 6.4. A Giant Pacific Octopus rests on a bottom pressure recorder. Whelk eggs sit to the right. Image courtesy of Ocean Networks Canada/CSSF-ROPOS.

While some animals cling to instruments, others merely visit and revisit. Among deep-sea life, curiosity is common. In the early 1900s, when scientists descended in a diving bell, they noted that many fish came toward the bell's light to investigate.[150] Marine scientists and engineers still witness this same curiosity today. Species ranging from seals to plankton are attracted to the lights of an ROV. Nothing beats seeing the Giant Pacific Octopus, however, which will lurk around NEPTUNE's instruments and is often caught on camera visiting the ROVs when they arrive to perform maintenance.

[149] Delauney, "Biofouling Protection."

[150] "On The Ocean's Floor," *Bandon Recorder*, July 20, 1905.

Inquisitive and smart, individual octopi return to scientific instruments consistently, suckering the lens of cameras and other sensors. By comparison, the decapods, such as crabs, are territorial by nature and will attack instruments invading their space.[151] Some marine life chooses to avoid deep-sea instruments altogether. The bright lights from ROVs or other instruments can startle and scare wildlife adapted to the dark. In response, some operators will use red lights to reduce the machine's brightness.[152]

Tiny as they may be marine colonizers cause other big problems across deep-sea systems. Biofouling "is the principle factor limiting the duration of deployments of submerged equipment," noted one expert.[153] Another group stated that biofouling "has been a serious concern since the inception of autonomous deployments."[154] It's expensive to deploy and clean deep-sea instruments. Just as seashore drillers and undersea cable owners dealt with the wear of seawater—bitter and corrosive and powerful—so too do observatories. Seawater chews away at the surfaces and infiltrates crannies meant to stay dry, such as the connectors.[155]

Scientists don't accept biofouling lying down, however. They fight to protect their technologies from the ocean's encroachment. Oil and gas drillers in California, you may remember, coated their wharves in a toxic chemical called creosote to deter colonizers.

[151] Tunnicliffe, interview with the author.

[152] Scales, *Brilliant Abyss*, 62.

[153] Jehan Zouak, "Foul Free at Folger Pinnacle," *AML Oceanographic*, September 17, 2017, https://amloceanographic.com/blog/post/foul-free-folger-pinnacle.

[154] Derek V. Manov, Grace C. Chang, and Tommy D. Dickey, "Methods for Reducing Biofouling of Moored Optical Sensors," *Journal of Atmospheric and Oceanic Technology* 21 (June 2004): 959; Paulson, "Wiring the Abyss."

[155] "Cables and Connectors," Ocean Networks Canada, accessed March 11, 2022, https://www-static01.oceannetworks.ca/observatories/infrastructure/cables-connectors.html.

Submarine telegraph cable planners covered their lines in heavy metal to deter sharks and swordfish from biting it. In each those instances, the owners viewed their technology as the victim, the ocean the aggressor. The same defensive instinct occurs among scientists, too. In reference to developing the right methods to ward off marine biofoulers, one scientist referred to a "'weapon'" that would act like a "silver bullet."[156] One example of a silver bullet is tributyl tin (TBT), the same toxin that mariners painted onto ship's hulls to deter biofouling. TBT dripped from the ships, poisoning the entire ocean in the process. TBT was also applied to oceanographic instruments as an antifouling chemical during the twentieth century.[157] "TBT is perhaps the most toxic chemical that has ever been deliberately placed in natural waters," reflected one group debating the chemical's utility to slow biofouling.[158] Due its toxicity, TBT is no longer allowed on ships as of 2008, although it still pops up periodically on scientific instruments.[159]

Aware they do not want to poison the very environment they seek to study, scientists are adopting new techniques to discourage biofouling without harmful chemicals. One company is trying "UV Biofouling Control" by shining UV rays on portions of deep-sea instruments. The UV rays deter marine organisms from colonizing portions of an instrument, although the marine life still finds nooks and crannies where the light doesn't bother them.[160] Another group has tried applying copper to deter

---

[156] Delauney, "Biofouling Protection."

[157] Manov et al., "Methods for Reducing," 959.

[158] Ibid., 960-961.

[159] Delauney, "Biofouling Protection"; Neeraj V. Gohad, Nihar M. Shah, Andrew T. Metters, Andrew S. Mount, "Noradrenaline Deters Marine Invertebrate Biofouling When Covalently Bound in Polymeric Coatings," *Journal of Experimental Marine Biology and Ecology* 394 (2010): 63-64.

[160] Zouak, "Foul Free at Folger Pinnacle."

colonizers, a metal that is toxic to marine organisms. Despite the antifouling efforts by other scientists, ONC does not deploy antifouling chemicals on its machines. Instead, they deal with biofouling as it occurs by cleaning the instruments and removing the lifeforms.[161] For ONC, biofouling seems to be a curiosity and an annoyance, but not a big enough problem to prohibit the collection of data.

Conclusion

Cabled observatories, like all seafloor technologies, are not meant to last forever. NEPTUNE's engineers anticipate it has a twenty-five year lifespan. The American OOI observatory is also assigned a twenty-five to thirty year lifespan.[162] Twenty-five years is the golden number for other seafloor technologies, too, including submarine cables and offshore wind turbines.[163] Sometimes, instruments join the seafloor graveyard earlier than expected when they disconnect from the observatory and float away. For example, the VENUS observatory lost an instrument in December 2019, which was dragged by a ship four-hundred meters from its original site. ONC knew it was gone because the instrument went offline. Ultimately, they found the missing technology using an ROV.[164] ONC plans to remove NEPTUNE's instruments from the ocean, but it does not plan to remove the

---

[161] Tunnicliffe, interview with the author; Barnes, interview with the author.

[162] Steinhardt, "The Instrumented Ocean," 20.

[163] Barnes, interview with the author; Pirenne, interview with the author; Barnes, "NEPTUNE Canada: Overview."

[164] Paulson, "Wiring the Abyss."

five-hundred miles (800km) of backbone cable. That technology will sit in the ocean forever. Why pull the cable out of the water, the thinking goes, only to toss it into a landfill?[165]

Figure 6.5. An octopus ascends from the Pacific Ocean while holding onto a Seismic Liquifaction In-situ Penetrometer (SLIP) instrument, which ONC was removing from the seabed. The octopus subsequently slipped back into the water. Image courtesy of Ocean Networks Canada.

From an environmental perspective, observatories toe the line: they neither deposit much waste, nor extract many resources. They collect data such as salinity, temperature, pressure, and acidity, but remove few fish, sediments, or other materials in the act of doing so. From this perspective, deep-sea scientific instruments are far less controversial than mining at the shoreline. Besides, observatories have the benefit of

[165] Portions of NEPTUNE's backbone cable are buried up to one meter into the seafloor, just like the fiber optic cables discussed in Chapter V. Despite that burial, NEPTUNE has still experienced three strikes with fishing equipment since 2009. Barnes, interview with the author.

being located at deeper depths, meaning they don't interfere with the public's use of the ocean. Instead, they help to grant access to it.

In 2022, the *New York Times* reported that 90 percent of marine species in the Pacific's abyss are still unclassified. For scientists, it's all the more reason to hurry up and study the deep.[166] In other words, they have to know what they are trying to protect before it's gone. NEPTUNE's inventors are aware of the potential for commercial firms to benefit from cabled observatories. "The development of new pharmaceuticals," writes one scientist "could be a key outcome of study deep-sea seeps." Therefore, these observatories are not necessarily purely academic tools. Industry could develop "related commercial opportunities" by gaining more information about manganese nodules, hydrothermal vents, contaminants in the water, ocean-climate regimes, fisheries, aquaculture, pollution, acidification, and algal blooms that could benefit the mining and pharmaceutical industries.[167] As earlier chapters of this dissertation have shown, however, private industry needs little connection to academic science to successfully explore and industrialize the ocean. Both with tideland drilling in Southern California and the installation of undersea cables in the Gulf of Alaska, substantial scientific knowledge about the ocean did not precede their efforts to mechanize and monetize it. Instead, mechanization of the shallower areas of the seabed has preceded thorough knowledge of those environments. The same forecast hangs like a cloud over the abyss.

---

[166] Lipton, "Secret Data."

[167] Taylor, "Supporting the Operations," 6; Helmreich, *Alien Ocean*, 244-245.

CHAPTER VII

CONCLUSION: SEAFLOOR MACHINA

In 2019, I slid off my shoes and walked down onto Summerland's beach. Sunny and warm, the shoreline looked picture perfect. Despite the fact that debris from California's tideland drilling boom still remains strewn about the coastline, I saw no visible evidence of the industry that once inhabited this area. No pipelines, no errant wooden piles, no casings peeping up from the water, no bits of steel or trash in the sand. By all appearances, Californians had been successful in their fight to save the beaches and remove tideland oil and gas drilling. The industry had finally gone. But I knew from my research into newspapers, archives, and scientific reports that the perception of a clean beach—one visibly free of industrialization and returned to its Edenic state—is an illusion. The Pacific is far dirtier in the twenty-first century than it ever was a century ago when oils piers haunted this shoreline. Nowadays, this region of the Pacific Ocean faces bigger foes than the derelict technologies that were once, and continue to be, trapped in its depths.

Despite the industrial appearance of certain seafloor machines, including offshore drilling, they aren't the primary source of pollution in the twenty-first century, just as they weren't in the twentieth. Over seventy-percent of that human-caused pollution originates from consumers and their technologies, such as cars and boats.[1] Today, humans and their technologies account for about 53 percent of the oil leaked into the

[1] Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography*, 12th edition (Boston, MA: Pearson, 2017), 354.

ocean. Oil seeps that occur naturally on the seafloor account for the other half. The oil that cakes our streets, parking lots, homes, and factories drip and dribble from land and join the ongoing flow of water and sediments that continually move down into the sea. Any oil that was once pumped from the seabed ultimately returns to the ocean, but in a more minacious form.

7.1. In the twenty-first century, Summerland's coastline is visibly free of the tideland oil industry that once cluttered this stretch of beach. However, the Pacific coastline is plagued with more pollution than ever. Image by the author.

A heavy rain—an event in Southern California that is normally greeted with appreciation—can wash a great amount of toxins from the driveways, streets, and parking lots down into the sea. But it's not only petroleum byproducts that slink from our neighborhoods. Lead, copper, and zinc also flow down to the ocean and mix with the fish, worms, and seaweeds.[2] PAHs, our toxic friend that seeped from creosote-treated wooden piles, currently enters the ocean from other sources, too, including vehicle tailpipes, oil spills, and the burning of fuels such as wood.[3] You may have also heard of PCBs, or polychlorinated byphenyls, a popular type of chemical once used in materials such as paints or coolants. As all things do, PCBs—a carcinogen that persists in the bodies of fish and other animals—have made their way down into the Pacific and settled into the seafloor's muds and sands.[4]

PCBs are not the only chemicals that sicken into the ocean's organisms. The significant amount of antibiotics ingested by both humans and livestock have spread into the oceans, as well. These antibiotics arrive in the sewage and other piped wastes that flow from bathrooms, fields, and meat-packing plants into the sea. Marine animals are repeatedly exposed to rounds of antibiotics, making them easy victims of drug-resistant bacteria. Scientists are finding these uber-resilient bacteria in all sorts of marine spaces, including the blowholes of dolphins.[5] And that's to say nothing about the warming and acidifying waters, harmful algae blooms, plastics, over-fishing, carbon sinks, marine

---

[2] Christopher Dunagan, "Fish Affected by a Legacy of Pollution," *Kitsap Sun*, April 5, 2014, https://archive.kitsapsun.com/news/environment/fish-affected-by-a-legacy-of-pollution-ep-355399370-355632001.html/.

[3] Christine Werme, Jennifer Hunt, Erin Beller, Kristin Cayce, Marcus Klatt, Aroon Melwani, Eric Polson, and Robin Grossinger, "Removal of Creosote-Treated Pilings and Structures from San Francisco Bay," California State Coastal Conservancy (December 10, 2010): 24.

[4] Dunagan, "Fish Affected."

[5] Helen Scales, *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat that Imperils It* (New York: Atlantic Monthly Press, 2021), 131-134.

diseases, coastal habitat loss, sea level rise, and species decline. It's scary, and it's getting scarier.[6]

The deeper stretches of the Pacific aren't immune to these anthropogenic changes, either. Off Vancouver Island, where NEPTUNE is located, oxygen levels are dipping. In the top 10,000 feet (3,048 m), oxygen has decreased by 15 percent in the previous 60 years, which risks suffocating marine life. The abyss could become 0.9 to 1.8 Fahrenheit degrees hotter in the coming years, which will cause a further decrease in the levels of oxygen in the water. That decreased oxygen won't break the instruments, but it does kill fish and other organisms. And as oxygen decreases, plastics increase. Between 1945 and 2009, the number of plastic pieces that arrived on the ocean floor doubled every fifteen years.[7]

The histories of seafloor technologies, including tideland oil drilling machines, undersea cables, and cabled observatories, relate to the growing effects of marine pollution, but are not synonymous with it. Not all human uses of the ocean affect the seafloor environment equally; throwing seafloor machines into the same group as chemical pollutants risks ignoring these bigger pollutive problems that come from other sources. With the exception of improperly plugged wellholes, aging machines on the seafloor are generally inert, stagnant, and forgotten. Because they integrate so closely with the marine environment, it's worth to differentiating them from more harmful sources of pollution in the ocean. Viewing all human debris in the ocean as equally toxic

---

[6] "Kelp Forests," Channel Islands National Marine Sanctuary, United States National Park Service, www.nps.gov/chis/neature/kelp-forests, accessed October 24, 2020; Lan Lin and Haitao Yu, "Offshore Wave Energy Generation Devices: Impacts on Ocean Bio-Environment," *Acta Ecologica Sinica* 32 (2012): 120.

[7] Scales, *Brilliant Abyss*, 166, 176.

and pollutive is unhelpful—it distracts away from the sources of pollution that are doing more damage.

To Remove, or Not to Remove?

What goes up must come down, the saying goes. That truism is the opposite for undersea technologies. For those machines, what goes down rarely comes back up. Their initial life above water is quite short, maybe a few months during the process of creation and installation. They spend the great majority of their existence in the ocean, usually years, but sometimes decades or centuries. It's this subsequent life—their biotic afterlife—during which they blend with the marine environment. How those objects interact with the marine environment, however, can vary. Tideland drilling machinery provided habitat for sessile species while exposing them to small doses of crude and carcinogens; undersea cables are inert and generally not destructive, but the industry's expansion and new installation methods are changing its environmental footprint; and cabled observatories are collecting vital data on the very environment that private companies seek to mine. In every case, however, marine life is attracted to the machines, even if those machines occasionally release toxins.

Should seafloor technologies be left in place as artificial reefs? In many cases, yes, but there are caveats. If the machine is free-floating, then it risks transporting invasive species, harming fishing boats or maritime vessels, and entangling wildlife.[8] In that case, removal is better. On the other hand, in instances such as decommissioned

[8] Marcelo Checoli Mantelatto, Alain Alves Póvoa, Luis Felipe Skinner, Fábio Vieira de Araujo, Joel Christopher Creed, "Marine Litter and Wood Debris as Habitat and Vector for the Range Expansion of Invasive Corals," *Marine Pollution Bulletin* 160 (2020): 1-2.

drilling rigs or cables, where multiple generations of species have created an abundant ecosystem around the structure, then proper decommissioning—and leaving it *in situ*—is preferable to full removal. Transformed into habitat, or at the very least intermixed with the marine ecology, it can be environmentally more disruptive for these technologies to come out of the ocean. In either case, companies, and the regulatory bodies that oversee them, need a detailed plan for decommissioning their structures before they ever go into the water. Unfortunately, that level of planning and foresight doesn't seem to happen, even in the twenty-first century.[9]

New seafloor industries are marching forward in the twenty-first century: part inventive, part heedless. Take, for example, wave energy generators, which harness the power of the ocean's tides. One group of scientists wrote of the blossoming technology, "Even in western countries that pioneer the development of wave energy conversion technology, environmental impacts are not properly realized and are underestimated or neglected."[10] Just like other types of seafloor technologies, wave energy generators may disrupt the electromagnetic field and kick up suffocating storms of sediment, all the while attracting unsuspecting colonizing species that transform the wave technologies into artificial reefs.[11] What will become of the offshore wave powered machines when they reach obsolescence around twenty-five years after entering the ocean? Will they be left on the seafloor as a type of artificial habitat or removed once inoperative? Even today, industries do not seem to have answers to these questions. What does seem clear,

---

[9] Katie Smyth, Nikki Christie, Daryl Burdon, Jonathan P. Atkins, Richard Barnes, Michael Elliott, "Renewables-To-Reefs? Decommissioning Options for the Offshore Wind Power Industry," *Marine Pollution Bulletin* 90 (2015): 247.

[10] Lin, "Offshore Wave Energy," 118.

[11] Ibid., 117-119.

however, is that marine life will continue to adapt, colonize, and respond to such industrial intrusions, joining machines as they transition into a biotic afterlife.

Figure 7.2. A porthole into the future. Image by the author.

REFERENCES CITED

Archival Collections:

American Petroleum Institute Photograph and Film Collection. National Museum of American History, Archives Center, Smithsonian Institution, Washington, D.C.

BANC PIC 2007.024. Bancroft Library, University of California, Berkeley, California.

Cableship Dellwood Photograph Collection, University of Washington Libraries, Collections and Archives, Seattle, Washington.

Center for the Study of Democratic Institutions Collections, Mss 18. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

Community Development and Conservation Collection ca. 1892-1995, SBHC Mss 1. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

Cyrus W. Field Papers. National Museum of American History, Archives Center, Smithsonian Institution, Washington, D.C.

D-D01.17; D-D01.46; D-D01.47; D-D04.11; P-D01.18; P-D01.188, Bamfield Historical Society, Bamfield, Canada.

George D. Eagleton Stereoview Collections, Mss 25. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

Jeffrey Wilkes Papers, 1974-2001. University of Washington Libraries, Collections and Archives, Seattle, Washington.

Miles Poindexter Papers, 1897-1940. University of Washington Libraries, Collections and Archives, Seattle, Washington.

Oil, Early Development Collection. Carpinteria Valley Museum of History, Carpinteria, California.

Photographs of Pacific Telephone and Telegraph Co. Cable Laying. University of Washington Libraries, Collections and Archives, Seattle, Washington.

Robert B. and William R. Moran Papers, Mss 282. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

Robert O. Easton Collection, SBHC Mss 6. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

Special Collections, F867 C65 1902. Santa Barbara Museum of Natural History, Santa Barbara, California.

State Land Board Records. Oregon State Archives, Salem, Oregon.

Summerland Collection. Carpinteria Valley Museum of History, Carpinteria, California.

Summerland, California Photographs, 1890s, Collection No. SC 798. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

U.S. Army Signal Corps, ca. 1889-1970. Alaska State Library – Historical Collections, Juneau, Alaska.

Walker A. Tompkins Collection 1849-1989, SBHC Mss 19. University of California Santa Barbara, Department of Special Collections, Santa Barbara, California.

Washington Sea Grant Program Records, 1967-2000. University of Washington Libraries, Collections and Archives, Seattle, Washington.

Wesley L. Jones Papers, 1896-1932. University of Washington Libraries, Collections and Archives, Seattle, Washington.

Western Union Telegraph Company Records. National Museum of American History, Archives Center, Smithsonian Institution, Washington, D.C.

William K. Applebaugh Papers. National Museum of American History, Archives Center, Smithsonian Institution, Washington, D.C.

William R. Bainbridge Collection on Submarine Cable Laying Operations. Museum of History and Industry, Seattle, Washington.

Digital Collections:

Alaska's Digital Newspaper Program, Alaska State Library, https://lam.alaska.gov/akdnp.

California Digital Newspaper Collection, Center for Bibliographic Studies and Research, University of California, https://cdnc.ucr.edu/.

HathiTrust Digital Library, https://www.hathitrust.org/.

Historic Oregon Newspapers, University of Oregon, https://oregonnews.uoregon.edu/.

ProQuest Historical Newspapers, https://about.proquest.com/en/products- services/pq-hist-news/.

TESSA Digital Collections of the Los Angeles Public Library, https://tessa.lapl.org/photocol.

United States Congressional Records, https://www.congress.gov/congressional-record.

United States Geological Survey, Denver Library Photographic Collection, https://www.sciencebase.gov/catalog/item/519ba0a3e4b0e4e151ef5dd9.

Washington Digital Newspapers, Washington State Library, https://washingtondigitalnewspapers.org/.

Interviews and Personal Correspondence:

Alaska Communications representative, Twitter message to the author, July 29, 2021.

Barnes, Christopher. Interview with the author. February 21, 2023.

_______. "NEPTUNE Canada: Overview," PowerPoint presentation. June 2, 2011. Personal papers shared with the author.

Barnes, Christopher R., Mairi M. R. Best, Fern R. Johnson, and Benoît Pirenne. "Large Subsea Observatory for Earth-Ocean Science: Challenges of Multidisciplinary Integration Across Hardware, Software, and People Networks." Personal papers shared with the author, n.d.

Favali, Paolo, Roland Person, Chris R. Barnes, Yoshiyuki Kaneda, John R. Delaney, Shu-Kun Hsu, "Seafloor Observatory Science," Personal papers shared with the author, n.d.

Love, Milton. Interview with the author, January 19, 2023.

McMullen, Scott. Interview with the author, Astoria, Oregon, November 7, 2019.

Pirenne, Benoît. Interview with the author, February 22, 2023.

Tunnicliffe, Verena. Interview with the author. February 21, 2023.

Newspapers:

Alaska Prospector
Alaska-Yukon Magazine
Athena Press
Bandon Recorder
Beaverton Review
Blade Tribune
Calexico Chronicle
Carpinteria Herald
Cordova Daily Times
Coronado Eagle and Journal
Corvallis Gazette
Daily Alaskan
Daily Alaskan Empire
Daily Capital Journal
Daily Colonist
Daily Morning Astorian
Daily Rogue River Courier
Eagle Rock Advertiser
Hanford Journal
Hillsboro Argus
Juneau Empire
Kitsap Sun
La Habra Star
Los Angeles Herald
Madera Tribune
Medford Mail Tribune
Mill Valley Record
Morning Astorian
Morning Oregonian
Morning Press
New York Times
Newberg Graphic
Nome Nugget
Oregon Statesman
Oregon Sunday Journal
Organized Labor
Palos Verdes Peninsula
Reconstructor
Sacramento Daily Union
San Bernardino Sun
San Diego Union and Daily Bee
San Francisco Call
San Juan Islander
San Pedro News Pilot

Santa Barbara Weekly Press
Santa Cruz News
Seattle Post-Intelligencer
Seattle Times
Summerland Advanced Courier
Sun
Sunday Oregonian
Tacoma Times

Published Primary Sources:

Arnold, Ralph. *Geology and Oil Resources of the Summerland District, Santa Barbara County, California*. United States Geological Survey, Department of the Interior. Washington: Government Printing Office, 1907.

Belknap, George E. *Deep-Sea Soundings in the North Pacific Ocean*. Washington: Government Printing Offices, 1874.

Bright, Charles. *Submarine Telegraphs; Their History, Construction, and Working*. London: C. Lockwood and Son, 1898.

Department of Commerce and Labor. *Report of the Commission of Corporations on the Transportation of Petroleum.* Washington, DC: Government Printing Office, 1906.

Eldridge, George Homans. *The Asphalt And Bituminous Rock Deposits of the United States*. Washington: Government Printing Office, 1901.

Emery, Kenneth Orris. *The Sea off Southern California; A Modern Habitat of Petroleum*. New York: Wiley, 1960.

Giberne, Agnes. *The Romance of the Mighty Deep*. Philadelphia: J. B. Lippincott Company, 1905.

Half Hours in the Deep: The Nature and Wealth of the Sea. London: James Nisbet, 1880.

Heezen, Bruce C., and G. Leonard Johnson. "Alaskan Submarine Cables: A Struggle with a Harsh Environment," *Arctic* 22, no. 4 (December 1969): 413-24.

Heezen, Bruce K. "Whales Entangled in Deep Sea Cables," *Deep Sea Research* 4 (1957): 105-15.

Hickson, Sydney J. *The Fauna of the Deep Sea*. London: Kegan Paul, Trench, Trübner, 1893.

Holway, Ruliff S. *Cold Water Belt along the West Coast of the United States*. Berkeley: University of California Press, 1905.

Ingersoll, Ernest. *The Book of the Ocean*. New York: Century, 1898.

Johnson, George, ed. *The All Red Line: The Annal and Aims of the Pacific Cable Project*. Ottawa: James Hope and Sons, 1903.

Lambert, May. *Growing Up with Summerland*. Carpinteria, CA: Carpinteria Valley Historical Society, 1975.

Maury, Matthew Fontaine. *The Physical Geography of the Sea*. New York: Harper and Brothers, 1855.

Murray, John. *Report on the Scientific Results of the Voyages of the HMS Challenger, 1873-1876*. Edinburgh: Neill and Company, 1891.

Nansen, Fridtjof. *The Norwegian North Polar Expedition 1893-1896*. Christiania, Denmark: A. W. Brøgger, 1904.

National Industrial Conference Board. *Oil Conservation and Fuel Oil Supply*. New York: National Industrial Conference Board, 1930.

Proceedings of the Eleventh and Twelfth Annual Meetings of the Pacific Coast Gas Association. San Francisco, CA: Althof and Bahls, July 21, 22, 23, 1903 and July 19, 20, 21, 1904.

Reid, James D. *The Telegraph in America*. New York: John Polhemus Publisher, 1886.

Schaufele, H.J. "Erosion and Corrosion on Marine Structures, Elwood, California." *Proceedings of Conference on Coastal Engineering* 1, n.d.

Scripps Institution of Oceanography. *Annual Report*. La Jolla: University of California, San Diego, 1967.

Shipek, Carl J. "Microrelief on the Sea Floor." *The Science Teacher* 28, no. 6 (October 1961): 9-10.

Smith, Willoughby. *The Rise and Extension of Submarine Telegraphy*. London: J. S. Virtue, 1891.

"The Report of the Pacific Cable Committee." *The Electrical Review* (1899): 1-45.

Thomson, C. Wyville. *The Depths of the Sea*, 2nd edition. London: MacMillan, 1874.

"Tideland Grant to the City of Huntington Beach." California Proposition 11 (1932). http://repository.uchastings.edu/ca_ballot_props/291.

Townsend, Charles Haskins. "The Life of the Deep Sea." *Everybody's Magazine* 6, no. 2 (February 1902): 115-130.

Tudor, W. J. *Structures in the Deep Ocean: Engineering Manual for Underwater Construction*. Port Hueneme, California: U.S. Naval Civil Engineering Laboratory, 1964.

U. S. Army, Corps of Engineers. "Oil and Refuse Pollution: Navigable Waters of the United States in Southern California." Los Angeles: U. S. Engineer Office, 1939.

U.S. Commission of Fish and Fisheries. *Telegraph Cable Between the United States and the Hawaiian Islands*. Washington: Government Printing Office, 1892.

U.S. Geological Survey. "Thirteenth Annual Report of the United States Geological Survey, 1891-92." Washington, DC: Government Printing Office, 1893.

U.S. War Department. *Annual Report of the Chief Signal Officer 1902*. Washington, DC: Government Printing Office, 1902.

Watts, W.L. *Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara Counties*. California State Mining Bureau, Bulletin No. 11, December, 1896.

Webb, Herbert Laws. "Proposed Cables under the Pacific." *Engineering Magazine* 6 (October 1893 - March 1894): 845-852.

Wilkinson, Henry D. *Submarine Cable Laying and Repairing*. London: "The Electrician" Printing and Publishing Company, 1908.

Williams, J. Francon. *The Geography of the Oceans*. London: George Philip and Son, 1881.

Yerkes, R. F., H. C. Wagner, and K. A. Yenne, "Petroleum Development in the Santa Barbara Channel Region," in *Geology, Petroleum Development, and Seismicity of the Santa Barbara Channel Region, California,* Geological Survey Professional Paper 679, 13-27. Washington, D.C.: United States Printing Office, 1969.

Published Secondary Sources:

Adamson, Michael R. *Oil and Urbanization on the Pacific Coast: Ralph Bramel Lloyd and the Shaping of the Urban West*. Morgantown: West Virginia University Press, 2018.

Adler, Antony. *Neptune's Laboratory: Fantasy, Fear, and Science at Sea*. Cambridge: Harvard University Press, 2019.

Albert, Luana, Fraançois Deschamps, Aurélie Jolivet, Frédéric Olivier, Laurent Chauvand, Sylvain Chauvaud. "A Current Synthesis on the Effects of Electric and Magnetic Fields Emitted by Submarine Power Cables on Invertebrates." *Marine Environmental Research* 159 (2020): 1-16.

Allen, Michael. "How Will Creatures that Can Barely Move Handle Climate Change?" *Hakai Magazine*, February 15, 2023. https://hakaimagazine.com/news/how-will-creatures-that-can-barely-move-handle-climate-change/.

Anderson, Genny. "The Splash Zone," "The High Tide Zone," and "The Mid Tide Zone." Accessed January 30, 2023. marinebio.net.

Andrews, Laurel. "Damaged Undersea Cable Disrupts Sitka's Internet, TV Service." *Anchorage Daily News*, September 28, 2016. https://www.adn.com/business/article/damaged-undersea-fiber-optic-cable-interrupts-sitka-s-internet-cable-service/2016/02/17/.

Andrews, Thomas G. *Killing for Coal: America's Deadliest Labor War*. Cambridge, MA: Harvard University Press, 2008.

Antrim, L., L. Balthis, C. Cooksey. *Submarine Cables in Olympic Coast National Marine Sanctuary: History, Impact, and Management Lessons,* Marine Sanctuaries Conservation Series ONMS-18-01, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries. Silver Spring, MD, 2018.

Atlas, Ronald M,. Donald M. Stoeckel, Seth A. Faith, Angela Minard-Smith, Jonathan R. Thorn, and Mark J. Benotti, "Oil Biodegradation and Oil-Degrading Microbial Populations in Marsh Sediments Impacted by Oil from the Deepwater Horizon Well Blowout." *Environmental Science and Technology* 49 (2015): 8356-66.

Baggeroer, Arthur B., Bruce M. Howe, Peter N. Mikhalevsky, John Orcutt, and Henrik Schmidt. "Ocean Observatories: An Engineering Challenge." *The Bridge* (Fall 2018): 17-34.

Barber, Abby. "Puffins on the Pacific," NWF Blog. Last modified April 20, 2016. https://blog.nwf.org/2016/04/puffins-on-the-pacific/.

Barnes, Chris, Mairi Best, Fern Johnson, Peter Phibbs, and Benoît Pirenne. "NEPTUNE Canada: Building the World's First Regional Cabled Observatory." *Journal of Ocean Technology* 3, no. 3 (2008): 13-18.

Barnes, Christopher R. "Quantum Leap in Platforms of Opportunity: Smart Telecommunication Cables." In *Challenges and Innovations in Ocean in Situ Sensors: Measuring Ocean Processes and Health in the Digital Age*, edited by Eric Delory and Jay Pearlman. Amsterdam: Elsevier, 2019.

Barnes, Christopher R., Mairi M. R. Best, Fern R. Johnson, and Benoît Pirenne. "Large Subsea Observatory for Earth-Ocean Science: Challenges of Multidisciplinary Integration Across Hardware, Software, and People Networks." *Institute of Electrical and Electronic Engineers* (2010).

Barnes, Christopher R., Mairi M. R. Best, Fern R. Johnson, Lucie Pautet, and Benoît Pirenne, "Challenges, Benefits, and Opportunities in Installing and Operating Cabled Ocean Observatories: Perspectives From NEPTUNE Canada," *IEEE Journal of Oceanic Engineering* 38, no. 1 (January 2013): 144-157.

Barnes, Christopher R., Mairi M. R. Best, Fern R. Johnson, Peter Phibbs, and Benoît Pirenne. "Building the World's First Regional Cabled Observatory." *Journal of Ocean Technology* 3, no. 3 (2008): 13-18.

Barnes, Christopher R., Mairi M. R. Best, Lucie Pautet, and Benoît Pirenne. "Understanding Earth–Ocean Processes using Real-time Data from NEPTUNE, Canada's Widely Distributed Sensor Networks, Northeast Pacific." *Geoscience Canada* 38, no. 1 (2011): 21-30.

Bartlett, Wendy L. "Elwood Oil Field, Santa Barbara County, California." *AAPG Pacific Section* (1998): 217-237.

Bartley, Ernest R. *The Tidelands Oil Controversy: A Legal and Historical Analysis.* Austin: University of Texas Press, 1953.

Bates, Mary. "How Do Barnacles Mate?" *Wired*. July 17, 2014. https://www.wired.com/2014/07/how-do-barnacles-mate/.

Bauer Jr., William J. *California Through Native Eyes: Reclaiming History*. Seattle: University of Washington Press, 2016.

Benton, Lauren. *A Search for Sovereignty: Law and Geography in European Empires 1400-1900*. New York: Cambridge University Press, 2010.

Best, M. M. R., C. R. Barnes, B. D. Bornhold, and S. K. Juniper. "Integrating Continuous Observatory Data from the Coast to the Abyss: Assembling a Multidisciplinary View of the Ocean in Four Dimensions. In *Seafloor Observatories*, edited by P. Favali, 5-21. Berlin: Springs Praxis Books, 2015.

Bhatia, Sonja, David Risk, Amanda Pustam, Truis Smith-Palmer, Geoff Burton, Luis Melo, Peter Wild. “Biofouling of an All-Optical Sensor for Seafloor Monitoring of Marine Carbon Capture and Storage Sites.” *Energy Procedia* 63 (2014): 3848-3852.

Biggs, David. *Quagmire: Nation-Building and Nature in the Mekong Delta.* Seattle: University of Washington Press, 2010.

Bixler, Gregory D., and Bharat Bhushan. “Biofouling: Lessons from Nature.” *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 370, no. 1967 (May 28, 2012): 2381-2417.

Blackbourn, David. *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany*. New York: W. W. Norton, 2006.

Bolster, W. Jeffrey. “Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500–1800.” *American Historical Review* 113, no. 1 (2008): 19-47.

________. *The Mortal Sea: Fishing the Atlantic in the Age of Sail*. Cambridge, MA: Belknap Press, 2012.

Booker, Matthew Morse. *Down by the Bay: San Francisco’s History Between the Tides*. Berkeley: University of California Press, 2013.

Boyce, Robert W. D. “Imperial Dreams and National Realities: Britain, Canada and the Struggle for a Pacific Telegraph Cable, 1879-1902.” *English Historical Review* 115, no. 460 (February 2000): 39-70.

________. “Submarine Cables as a Factor in Britain’s Ascendancy as a World Power, 1850–1914.” In *Kommunikationsrevolutionen: Die neuen Medien des 16. und 19. Jahrhunderts*, edited by Michael North. Köln: Böhlau, 1995.

Boztas, Senay. “Buried at Sea: The Companies Cashing In On Abandoned Cables.” *Guardian.* December 14, 2016. https://www.theguardian.com/sustainable-business/2016/dec/14/ocean-pollution-cable-waste-technology-reuse-recycling-circular-economy-crs-holland.

Brazier, Hayley and Mark Carey. “Boundaries of Place and Time at the Edge of the Polar Oceans,” in *The Cambridge History of the Polar Regions*, edited by Adrian Howkins and Peder Roberts, 724-748. Cambridge, UK: Cambridge University Press, 2023.

Brazier, Hayley. “An Ode to Ooze,” *Items*, Social Science Research Council. March 2021. https://items.ssrc.org/ways-of-water/an-ode-to-ooze/.

________. "Of Cables and Serpents." *Smithsonian Voices*, March 21, 2023. https://www.smithsonianmag.com/blogs/smithsonian-institution-office-fellowships-and-int/2023/03/21/of-cables-and-serpents/.

Broad, William J. *The Universe Below: Discovering the Secrets of the Deep Sea*. New York: Simon and Schuster, 1997.

Brown, Kate. *Plutopia: Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium Disasters*. New York: University of Oxford Press, 2013.

Bryant, Edward. *Tsunami: The Underrated Hazard*. Cambridge: Cambridge University Press, 2001.

Burnett, Douglas R., Robert C. Beckman, and Tara M. Davenport, eds. *Submarine Cables: The Handbook of Law and Policy*. Leiden: Martinus Nijhoff Publishers, 2014.

Calhoun, Gloria. "Why Wire Mattered: Building U.S. Networked Infrastructures, 1845-1910." *Technology and Culture* 62, no. 1 (2021): 156-184.

Carey, Mark. *In the Shadow of Melting Glaciers: Climate Change and Andean Society*. New York: Oxford University Press, 2010.

________. "The History of Ice: How Glaciers Became an Endangered Species." *Environmental History* 12 (July 2017): 497-527.

Carson, Rachel. *Silent Spring*. Boston: Houghton Mifflin, 1962.

________. *The Edge of the Sea*. Boston: Houghton Mifflin, 1955.

________. "Undersea." In *Lost Woods: The Discovered Writing of Rachel Carson*, edited by Linda Lear, 3-11. Boston: Beacon Press, 1999.

California Department of Fish and Wildlife. "California Mussel." Marine Species Portal. Accessed January 30, 2013. https://marinespecies.wildlife.ca.gov/california-mussel/false/.

California State Lands Commission. "Final Environmental Impact Report for the Becker Legacy Wells Abandonment and Remediation Project." July 2017. https://www.slc.ca.gov/wp-content/uploads/2017/07/FEIR.pdf.

Center for Biological Diversity. "Goleta Rally to Oppose Offshore Oil Drilling in California Sanctuary." October 18, 2016. https://www.biologicaldiversity.org/news/press_releases/2016/offshore-drilling-10-18-2016.html.

________. “Report: $550 Million Needed to Plug Abandoned California Oil, Gas Wells.” January 24, 2020. https://biologicaldiversity.org/w/news/press-releases/report-550-million-needed-plug-abandoned-california-oil-gas-wells-2020-01-24/.

Carter, Lionel, Douglas Burnett, Stephen Drew, Graham Marle, Lonnie Hagadorn, Deborah Bartlett-McNeil, Nigel Irvine. “Submarine Cables and the Oceans: Connecting the World.” *ICPC/UNEP/UNEP-WCMC Biodiversity Series*, no. 31 (2009).

Caselle, J. E., M. S. Love, C. Fusaro, and D. Schroeder, “Trash or Habitat? Fish Assemblages on Offshore Oilfield Seafloor Debris in the Santa Barbara Channel, California.” *ICES Journal of Marine Science* 59 (2002): S258–S265.

Channel Islands National Park. “Kelp Forests.” National Park Service. Accessed October, 24 2020. https://www.nps.gov/chis/learn/nature/kelp-forests.

Channel Islands National Park. “Seabirds and Shorebirds.” United States National Park Service. Accessed October 10, 2020. https://www.nps.gov/chis/learn/nature/seabirds.html.

Charles, Ron. “History and Culture.” Accessed March 11, 2023. https://pgst.nsn.us/history-culture/.

Chiang, Connie Y. *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast*. Seattle: University of Washington Press, 2008.

Christie, Donna R. and Richard G. Hildreth. *Coastal and Ocean Management Law: In a Nutshell*. Minnesota: West Academic Publishing, 2015.

Cioc, Mark. *The Rhine: An Eco-Biography, 1815-2000*. Seattle: University of Washington Press, 2002.

City of Goleta, California State Lands Commission. “Ellwood/South Ellwood Decommissioning Project.” June 27, 2019. https://www.slc.ca.gov/wp-content/uploads/2019/06/Town-Hall-Presentation-FINAL-June-2019.pdf.

Clarke, Arthur C. *Voices across the Sea*. New York: Harper and Row, 1974.

Committee on Guidance for NSF on National Oceanic Science Research Priorities: Decadal Survey of Ocean Sciences, Ocean Studies Board, Division on Earth a Life Studies, and National Research Council. *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences*. Washington, D.C.: National Academies Press, 2015.

Cooper, Tyler. “Google Owns 63,605 Miles and 8.5% of Submarine Cables Worldwide.” *BroadbandNow*. September 12, 2018. https://broadbandnow.com/report/google-content-providers-submarine-cable-ownership.

Copley, Jon. "Just How Little Do We Know about the Ocean Floor?" *The Conversation UK.* October 9, 2014. https://theconversation.com/just-how-little-do-we-know-about-the-ocean-floor-32751.

Corbin, Alain. *The Lure of the Sea: The Discovery of the Seaside in the Western World 1750-1840.* Translated by Jocelyn Phelps. London: Penguin Books, 1995.

Corfield, Richard. *The Silent Landscape: The Scientific Voyage of the HMS Challenger*. Washington, D.C.: The Joseph Henry Press, 2003.

Cronon, William. *Nature's Metropolis: Chicago and the Great West*. New York: W. W. Norton, 1992.

Cushman, Gregory T. *Guano and the Opening of the Pacific World*. New York: Cambridge University Press, 2013.

Davis, Jack. *The Gulf: The Making of an American Sea*. New York: Liveright Publishing, 2017.

Dean, Thomas A., and Stephen C. Jewett, "Habitat-Specific Recovery of Shallow Subtidal Communities Following the Exxon Valdez Oil Spill." *Ecological Applications* 11, no. 5 (October 2001): 1456-71.

Deepsea Conservation Coalition. "About Deep-Sea Mining." Accessed February 1, 2023. https://savethehighseas.org/deep-sea-mining/.

Demuth, Bathsheba. *Floating Coast: An Environmental History of the Bering Strait*. New York: W.W. Norton, 2019.

Doel, Ronald E., Tanya J. Levin and Mason K. Marker. "Extending Modern Cartography to the Ocean Depths: Military Patronage, Cold War Priorities, and the Heezen-Tharp Mapping Project, 1952-1959." *Journal of Historical Geography* 32 (2006): 605-626.

Downey, Morgan. *Oil 101.* N.p.: Wooden Table Press, 2009.

Drew, S., and Hopper, A.G. "Fishing and Submarine Cables – Working Together." International Cable Protection Committee publication, 1996. http://www.iscpc.org/publications/18.3Fishing_Booklet.pdf.

Dunagan, Christopher. "Fish Affected by a Legacy of Pollution." *Kitsap Sun*. April 5, 2014. https://archive.kitsapsun.com/news/environment/fish-affected-by-a-legacy-of-pollution-ep-355399370-355632001.html/.

Dunbar-Ortiz, Roxanne. *An Indigenous Peoples' History of the United States*. Boston: Beacon Press, 2014.

Easton, Robert. *Black Tide: The Santa Barbara Oil Spill and Its Consequences*. New York: Delacorte Press, 1972.

Edhat Santa Barbara. "Update on Ellwood Decommissioning Project." Accessed February 2, 2023. https://www.edhat.com/news/update-on-ellwood-decommissioning-project, Commenter A-1670366831.

Elias, Ann. *Coral Empire: Underwater Oceans, Colonial Tropics, Visual Modernity*. Durham: Duke University Press, 2019.

Eurofish International Organisation. "Alternative Methods for Environmentally Friendly Fouling Control." Last modified December 20, 2019. *https://eurofish.dk/alternative-methods-for-environmentally-friendly-fouling-control/.*

Fairbanks, Luke, Noëlle Boucquey, Lisa M. Campbell, and Sarah Wise. "Remaking Oceans Governance: Critical Perspectives on Marine Spatial Planning." *Environment and Society: Advances in Research* 10 (2019): 122-140.

Favali, Paolo, Roland Person, Chris R. Barnes, Yoshiyuki Kaneda, John R. Delaney, and Shu-Kun Hsu. "Seafloor Observatory Science." OceanObs'09, Community White Paper Proposal (2010).

Fenn, Elizabeth. *Pox Americana: The Great Smallpox Epidemic of 1775-82*. Hill and Wang, 2001.

Fiege, Mark. *Irrigated Eden: The Making of an Agricultural Landscape in the American West*. Seattle: University of Washington Press, 1999.

________. "Weedy West: Mobile Nature, Boundaries, and Common Space in the Montana Landscape." *Western Historical Quarterly* 36 (Spring 2005): 22-47.

Finley, Carmel. *All the Fish in the Sea: Maximum Sustainable Yield and the Failure of Fisheries Management*. Chicago: University of Chicago Press, 2011.

Finn, Bernard and Daqing Yang, eds. *Communications Under the Seas: The Evolving Cable Network and Its Implications*. Cambridge, Massachusetts: MIT Press, 2009.

Fischer, John Ryan. *Cattle Colonialism: An Environmental History of the Conquest of California and Hawai'i*. Chapel Hill: University of North Carolina Press, 2015.

FishWatch.gov. "Arrowtooth Flounder." Accessed July 12, 2021. https://www.fishwatch.gov/profiles/arrowtooth-flounder.

Forgey, Pat. “5.9 Earthquake Causes Telecom Outage in Southeast Alaska.” *Anchorage Daily News*, September 28, 2016. https://www.adn.com/alaska-news/article/59-earthquake-causes-telecom-outage-southeast-alaska/2014/07/26/.

Foster, M., M,. Neushul, R. Zingmark. “The Santa Barbara Oil Spill Part 2: Initial Effects on Intertidal and Kelp Bed Organisms.” *Environmental Pollution* 2 (1971): 115-34.

Frank, Nichelle Stephanie. “Sanitizing History: Environmental Cleanup and History Preservation in U.S. West Mining Communities.” PhD diss., University of Oregon, 2020.

Freudenburg, William R. and Robert Gramling. *Oil in Troubled Waters: Perceptions, Politics, and the Battle Over Offshore Drilling.* Albany: State University of New York Press, 1994.

Friedheim, Robert L. *Negotiating the New Ocean Regime*. Columbia: University of South Carolina Press, 1993.

Gibbs, Samuel. “Google Reinforces Undersea Cables After Shark Bites.” *The Guardian*, August 14, 2014, https://www.theguardian.com/technology/2014/aug/14/google-undersea-fibre-optic-cables-shark-attacks.

Gillis, John R. “The Blue Humanities.” *Humanities* 34 (May/June, 2013). https://www.neh.gov/humanities/2013/mayjune/feature/the-blue-humanities.

________. *The Human Shore: Seacoasts in History*. Chicago: University of Chicago Press, 2012.

Gohad, Neeraj V., Nihar M. Shah, Andrew T. Metters, Andrew S. Mount, “Noradrenaline Deters Marine Invertebrate Biofouling When Covalently Bound in Polymeric Coatings.” *Journal of Experimental Marine Biology and Ecology* 394 (2010): 63-73.

Goldsmith, Jack and Tim Wu. *Who Controls the Internet? Illusions of a Borderless World*. New York: Oxford University Press, 2006.

Glover, Bill. “CS Burnside.” Atlantic-Cable.com. Last modified June 9, 2015. https://atlantic-cable.com/Cableships/Burnside/index.htm.

Google Earth. “Seafloor Age.” Accessed December 17, 2022. earth.google.com.

Gordillo, Gastón R. *Rubble: The Afterlife of Destruction*. Durham: Duke University Press, 2014.

Grasso, Glenn M. "What Appeared Limitless Plenty: The Rise and Fall of the Nineteenth-Century Atlantic Halibut Fishery." *Environmental History* 13 (January 2008): 66–91.

Grosbard, Alan. "Treadwell Wharf in the Summerland, California, Oil Field: The First Sea Wells in Petroleum Exploration." In *Discoverers of the 20th Century: Perfecting the Search*, eds. Charles A. Sternbach, Marlan W. Downey, Gerald M. Friedman. Tulsa, Oklahoma: The American Association of Petroleum Geologists, 2005.

Grunbaum, Mara. "What Whale Barnacles Know." *Hakai Magazine*. November 9, 2021. https://hakaimagazine.com/features/what-whale-barnacles-know/.

Guerry, A.D., M.H. Ruckelshaus, J.R. Bernhardt, G. Guannel, C.K. Kim, M. Marsik, J.E. Toft, D.A. Sutherland. "Modeling Benefits from Nature: Using Ecosystem Services to Inform Coastal and Marine Spatial Planning." *International Journal of Biodiversity Science, Ecosystems Services and Management* 8 (2012): 107-121.

Gurrola, Larry D. Edward A. Keller, James H. Chen, Lewis A. Owen, and Joel Q. Spencer. "Tectonic Geomorphology of Marine Terraces: Santa Barbara Fold Belt, California." *GSA Bulletin* 126, no. 1-2 (January February 2014): 219-33.

Hamblin, Jacob Darwin. *Oceanographers and the Cold War: Disciples of Marine Science*. Seattle: University of Washington, 2005.

________. *Poison in the Well: Radioactive Waste in the Oceans at the Dawn of the Nuclear Age*. New Brunswick, NJ: Rutgers University Press, 2008.

________. "Seeing the Oceans in the Shadow of Bergen Values." *Isis* 105, no. 2 (June 2014): 352-363.

Hämäläinen, Pekka. *The Comanche Empire*. New Haven, CT: Yale University Press, 2008.

Hamilton, Jon. "How California's Worst Oil Spill Turned Beaches Black and the Nation Green." *NPR*, January 18, 2019. https://www.npr.org/2019/01/28/688219307/how-californias-worst-oil-spill-turned-beaches-black-and-the-nation-green.

Hamm, Keith. "Summerland's Becker Well Capped." *Santa Barbara Independent*, March 1, 2018, https://www.independent.com/2018/03/01/summerlands-becker-well-capped/.

Han, Lisa. "The Blue Frontier: Temporalities of Salvage and Extraction at the Seabed." *Configurations* 27 (2019): 463-481.

Hannesson, Rögnvaldur. *The Privatization of the Oceans*. Cambridge: MIT Press, 2004.

Haraway, Donna J. "A Cyborg Manifesto: Science, technology, and Socialist-Feminism in the Late Twentieth Century." In *Simians, Cyborgs, and Women: The Reinvention of Nature*, 149-181. New York: Routledge, 1991.

Harper, Kristine C. *Make it Rain: State Control of the Atmosphere in Twentieth-Century America*. University of Chicago Press, 2017.

Hau'ofa, Epeli. "Our Sea of Islands." *Contemporary Pacific* 6, no. 1 (Spring 1994): 148-161.

Haycox, Stephen. "'Fetched Up': Unlearned Lessons from the *Exxon Valdez*," *Journal of American History* 99 (June 2012): 219-228.

Haycox, Stephen. *Alaska: An American Colony*, 2nd edition. Seattle: University of Washington Press, 2020.

Headrick, Daniel R. and Pascal Griset. "Submarine Telegraph Cables: Business and Politics, 1838-1939." *Business Historical Review* 75, no. 3 (Autumn 2001): 543-578.

Headrick, Daniel R. *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century.* New York: Oxford University Press, 1981.

Hecht, Jeff. *City of Light: The Story of Fiber Optics*. New York: Oxford University Press, 2004.

Hecker, Bruce. "How do Whales and Dolphins Sleep Without Drowning?" *Scientific American*, February 2, 1998. https://www.scientificamerican.com/article/how-do-whales-and-dolphin/.

Helmreich, Stefan. *Alien Ocean: Anthropological Voyages in Microbial Seas.* Berkeley: University of California Press, 2009.

________. "Flipping the Field." *ISIS* 113, no. 1 (March 2022): 151-156.

Heil, Andy. "The Sea Monster of Donetsk," *Atlantic*, February 1, 2013. https://www.theatlantic.com/international/archive/2013/02/the-sea-monster-of-donetsk/272725/.

Henderson, Bonnie. *The Next Tsunami: Living on a Restless Coast*. Corvallis: Oregon State Press, 2014.

Holman, Tracy Lynn. *Multiple Uses of the Seabed Off the Oregon Coast: An Analysis of Recent Interactions between the Fishing Industry and the Submarine Cable Industry*. Thesis, University of Washington, 2000.

Horne, John, and Raynald Lecone. "Marine and Maintenance (From Inception to End of Life)." In *Undersea Fiber Communication Systems*. Edited by José Chesnoy, 605-49. London: Elsevier, 2016.

Houseworth, James and William Stringfellow. "A Case Study of California Offshore Petroleum Production, Well Stimulation, and Associated Environmental Impacts." In *An Independent Scientific Assessment of Well Stimulation in California Volume III: Case Studies of Hydraulic Fracturing and Acid Stimulations in Select Regions: Offshore, Monterey Formation, Los Angeles Basin*. Edited by Jane C.S. Long, Laura C. Feinstein, and Jens Birkholzer et al., 28-111. Sacramento, California: California Council on Science and Technology, 2015.

Howkins, Adrian. "The Significance of the Frontier in Antarctic History: How the US West has Shaped the Geopolitics of the Far South." *The Polar Journal* 3, no. 1 (2013): 9-30.

Igler, David. *The Great Ocean: Pacific Worlds from Captain Cook to the Gold Rush.* New York: Oxford University Press, 2013.

________. "The Northeastern Pacific Basin: An Environmental Approach to Seascapes and Littoral Places." In *A Companion to American Environmental History*, edited by Douglas Cazaux Sackman, 579-594. Hoboken, NJ: John Wiley and Sons, 2010.

Imbler, Sabrina. "Could Listening to the Deep Sea Help Save It?" *New York Times*. November 11, 2020. https://nyti.ms/3kesoLV.

International Cable Protection Committee. "Submarine Cables and BBNJ." ICPC Ltd. August 1, 2016. https://www.un.org/depts/los/biodiversity/prepcom_files/ICC_Submarine_Cables_&_BBNJ_August_2016.pdf.

International Energy Agency. "Offshore Wind Outlook 2019." November 2019. https://iea.blob.core.windows.net/assets/495ab264-4ddf-4b68-b9c0-514295ff40a7/Offshore_Wind_Outlook_2019.pdf.

Isenberg, Andrew C. *Mining California: An Ecological History*. New York: Hill and Wang, 2005.

Isenberg, Andrew C., ed. *The Oxford Handbook of Environmental History*. New York: Oxford University Press, 2014.

Jacoby, Karl. *Shadows at Dawn: A Borderlands Massacre and the Violence of History.* New York: The Penguin Press, 2008.

Jaquiss, Nigel. “Mark Zuckerberg Is Despoiling a Tiny Coastal Village and Oregon’s Natural Treasures. The State Invited Him.” *Willamette Weekly*. August 19, 2020. https://www.wweek.com/news/2020/08/19/mark-zuckerberg-is-despoiling-a-tiny-coastal-village-and-oregons-natural-treasures-the-state-invited-him/.

Jessup, David Eric. “Connecting Alaska: The Washington-Alaska Military Cable and Telegraph System.” *Journal of the Gilded Age and Progressive Era* 6, no. 4 (October 2007): 384-408.

Johnson, Walter. *River of Dark Dreams: Slavery and Empire in the Cotton Kingdom*. Cambridge: Belknap Press of Harvard University Press, 2013.

Jones, Charles S. *From the Rio Grande to the Arctic: The Story of the Richfield Oil Corporation*. Norman: University of Oklahoma Press, 1972.

Jones, Ryan Tucker. “A ‘Havok Made among Them’: Animals, Empire, and Extinction in the Russian North Pacific, 1741-1810.” *Environmental History* 16, no. 4 (October 2011): 585-609.

________. *Empire of Extinction: Russians and the North Pacific’s Strange Beasts of the Sea, 1741-1867*. New York: Oxford University Press, 2014.

________. *Red Leviathan: The Secret History of Soviet Whaling*. University of Chicago Press, 2022.

________. “Running into Whales: The History of the North Pacific from Below the Waves.” *American Historical Review* 118 (April 2013): 349-377.

Jørgensen, Dolly. “An Oasis in a Watery Desert? Discourses of an Industrial Ecosystem in the Gulf of Mexico Rigs-to-Reefs Program.” *History and Technology* 25, no. 4 (December 2009): 343-364.

________. “Environmentalists On Both Sides: Enactments in the California Rigs-To-Reefs Debate.” In *New Natures: Joining Environmental History with Science and Technology Studies*. Edited by Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard, 51-68. University of Pittsburgh Press, 2013.

Jue, Melody. *Wild Blue Media: Thinking through Seawater*. Durham, NC: Duke University Press, 2020.

Kaika, Maria. *City of Flow: Modernity, Nature, and the City*. New York: Routledge, 2005.

Kaiser, Mark. “Louisiana Artificial Reef Program.” *Marine Policy* 30 (2006): 605–23.

Keegan, Tara Aine. “Running the Redwood Empire: Indigeneity, Modernity, and a 480-Mile Footrace.” PhD diss., University of Oregon, 2021.

Kelman, Ari. *A Misplaced Massacre: Struggling over the Memory of Sand Creek*. Cambridge: Harvard University Press, 2013.

Kimmerer, Robin Wall. *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teaching of Plants*. Minneapolis: Milkweed Editions, 2013.

Kogan, Irina, Charles K. Paull, Linda A. Kuhnz, Erica J. Burton, Susan Von Thun, H. Gary Greene, James P. Barry. “ATOC/Pioneer Seamount Cable After 8 Years on the Seafloor: Observations, Environmental Impact.” *Continental Shelf Research* 26 (2006): 771-787.

Kolbert, Elizabeth. “The Deep Sea Is Filled with Treasure, But It Comes at a Price.” *New Yorker*. June 14, 2021. https://www.newyorker.com/magazine/2021/06/21/the-deep-sea-is-filled-with-treasure-but-it-comes-at-a-price.

Koslow, Tony. *The Silent Deep*: *The Discovery, Ecology, and Conservation of the Deep Sea.* Chicago: University of Chicago Press, 2007.

Kraus, Christoph and Lionel Carter. “Seabed Recovery Following Protective Burial of Undersea Cables – Observations from the Continental Margin.” *Ocean Engineering* 157 (2018): 251-261.

Kroll, Gary. *America’s Ocean Wilderness: A Cultural History of Twentieth-Century Exploration*. Lawrence: University Press of Kansas, 2008.

Kuhn, Thomas. *The Structure of Scientific Revolutions*, 3rd edition. University of Chicago Press, 1996.

Kunzig, Robert. *Mapping the Deep: The Extraordinary Story of Ocean Science*. New York: W. W. Norton, 1999.

Land, Isaac. “Tidal Waves: The New Coastal History.” *Journal of Social History* 40 (Spring 2007): 731-743.

Langhamer, Olivia. “Artificial Reef Effect in relation to Offshore Renewable Energy Conversation: State of the Art.” *Scientific World Journal* (2012): 1-8.

Langston, Nancy. *Toxic Bodies: Hormone Disruptors and the Legacy of DES*. New Haven, CT: Yale University Press, 2011.

Langston, Nancy. *Where Land and Water Meet: A Western Landscape Transformed.* Seattle: University of Washington Press, 2003.

Latour, Bruno. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press, 1987.

Lawrence, David M. *Upheaval from the Abyss: Ocean Floor Mapping and the Earth Science Revolution*. New Brunswick, NJ: Rutgers University Press. 2002.

LeCain, Timothy J. *Mass Destruction: The Men and Giant Mines That Wired America and Scarred the Planet*. New Brunswick, NJ: Rutgers University Press, 2009.

Leifer, Ira, and Ken Wilson. “The Tidal Influence on Oil and Gas Emissions from an Abandoned Oil Well: Nearshore Summerland, California.” *Marine Pollution Bulletin* 54 (2007): 1495-1506.

Leifer, Ira, Ken Wilson, Robin Lewis, Randy Imai, and John Tarpley. “Oil Emissions from Nearshore and Onshore Summerland: Final Report.” OSPR Technical Publication No. 07-001, State of California Department of Fish and Game - Office of Spill Prevention and Response. April 2007.

LeMenager, Stephanie. *Living Oil: Petroleum Culture in the American Century*. New York: Oxford University Press, 2014.

Library of Congress. “First telegraphic message—24 May 1844.” Accessed March 22, 2022. https://www.loc.gov/resource/mmorse.

Limerick, Patricia Nelson. *A Ditch in Time: The City, the West and Water*. Wheat Ridge, Colorado: Fulcrum Publishing, 2012.

Lin, Lan and Haitao Yu. “Offshore Wave Energy Generation Devices: Impacts on Ocean Bio-Environment.” *Acta Ecologica Sinica* 32 (2012): 117-122.

Lipman, Andrew. *The Saltwater Frontier: Indians and the Contest for the American Coast*. New Haven, CT: Yale University Press, 2015.

Lipton, Eric. “Battle Over Deep-Sea Mining Takes on New Urgency as Trial Run Winds Down.” *New York Times*, November 3, 2022. https://www.nytimes.com/2022/11/03/world/deep-sea-mining.html.

Lipton, Eric. “Secret Data, Tiny Islands and a Quest for Treasure on the Ocean Floor.” *New York Times*. August 30, 2022. https://www.nytimes.com/2022/08/29/world/deep-sea-mining.html.

Lockett, Michael S. “Damage to Undersea Cable Leads to Widespread Communication Outages.” *Juneau Empire*. April 30, 2021. https://www.juneauempire.com/news/damage-to-undersea-cable-leads-to-widespread-communication-outages/.

Love, Milton S. Mary M. Nishimoto, Scott Clark, Merit McCrea, Ann Scarborough Bull. "Assessing Potential Impacts of Energized Submarine Power Cables on Crab Harvests." *Continental Shelf Research* 151 (2017): 23-29.

Lowe, Christopher G., Kim M. Anthony, Erica T. Jarvis, Lyall F. Bellquist, and Milton S. Love. "Site Fidelity and Movement Patterns of Groundfish Associated with Offshore Petroleum Platforms in the Santa Barbara Channel." *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 1, no. 71-89 (2009): 71-89.

Lower Elwha Klallam Tribe. "Point No Point Treaty, 1855." elwha.org. Accessed March 11, 2023. https://www.elwha.org/culture-history/point-no-point-treaty/.

Lozano, Henry Knight. "Water in Paradise: California, Florida, and Environmental Rivalry in the Gilded Age." *Environmental History* 20, no. 4 (October 2015): 619-44.

Ludwin, Ruth S., Robert Dennis, Deborah Carver, Alan D. McMillan, Robert Losey, John Clague, Chris Jonientz-Trisler, Janine Bowechop, Jacilee Wray, and Karen James. "Dating the 1700 Cascadia Earthquake: Great Coastal Earthquakes in Native Stories." *Seismological Research Letters* 76, no. 2 (March/April 2005): 140-148.

Luther, Douglas S. "Physical Oceanography from Deep Ocean Submarine Cable Observatories." 3rd International Workshop on Scientific Use of Submarine Cables and Related Technologies. June 25-27, 2003. Tokyo, Japan.

Mack, John. *The Sea: A Cultural History*. London: Reaktion Books, 2011.

Macreadie, Peter I., Ashley M. Fowler, David J. Booth. "Rigs-to-Reefs: Will the Deep Sea Benefit from Artificial Habitat?" *Frontiers in Ecology and the Environment* 9, no. 8 (2011): 455-461.

Malarkey, Tucker. *Stronghold: One Man's Quest to Save the World's Wild Salmon*. New York: Spiegel and Grau, 2019.

Malecki, Edward J. and Hu Wei. "A Wired World: The Evolving Geography of Submarine Cables and the Shift to Asia." *Annals of the Association of American Geographers* 99, no. 2 (April 2009): 360-382.

Manov, Derek V., Grace C. Chang, and Tommy D. Dickey. "Methods for Reducing Biofouling of Moored Optical Sensors." *Journal of Atmospheric and Oceanic Technology* 21 (June 2004): 958-968.

Mantelatto, Marcelo Checoli, Alain Alves Póvoa, Luis Felipe Skinner, Fábio Vieira de Araujo, Joel Christopher Creed, “Marine Litter and Wood Debris as Habitat and Vector for the Range Expansion of Invasive Corals.” *Marine Pollution Bulletin* 160 (2020): 1-6.

Marjolaine Matabos, Thibaut Barreyre, S. Kim Juniper, Mathilde Cannat, Deborah Kelley, Joan M. Alfaro-Lucas, Valérie Chavagnac, Ana Colaço, Javier Escartin et al. “Integrating Multidisciplinary Observations in Vent Environments (IMOVE): Decadal Progress in Deep-Sea Observatories at Hydrothermal Vents.” *Frontiers in Marine Science* 9 (May 2022): 1-32.

Marlow, Jeffrey. “Exploring the Oceans by Remote Control.” *New Yorker*, May 28, 2019. https://www.newyorker.com/science/elements/how-telepresence-is-changing-exploration.

Marlow, Jeffrey. “Undersea Internet Cables Can Detect Earthquakes—and May Soon Warn of Tsunamis.” *New Yorker*. July 26, 2022. https://www.newyorker.com/science/elements/undersea-internet-cables-can-detect-earthquakes-and-may-soon-warn-of-tsunamis.

Marra, Louis J. “Sharkbite on the SL Submarine Lightwave Cable System: History, Causes, and Resolution,” *IEEE Journal of Oceanic Engineering* 14, no. 3 (July 1989): 230-7.

Marty, A., C. Berhault, G. Damblans, J.-V. Facq, B. Gaurier, G. Germain, T. Soulard, F. Schoefs. “Experimental Study of Hard Marine Growth Effect on Hydrodynamical Behavior of a Submarine Cable.” *Applied Ocean Research* 114 (2021): 1-18.

Marx, Leo. *The Machine in the Garden: Technology and the Pastoral Ideal in America*. New York: Oxford University Press, 1964.

Matsuda, Matt K. “The Pacific.” *American Historical Review* 111, no. 3 (June 2006): 758-80.

McEnroe, Maureen Ann. “’The Crimson Thread of Kinship’: The Pacific Submarine Cable, 1877-1902, A Study in British Imperial Communications.” PhD diss., University of California Santa Barbara, 1999.

McEvoy, Arthur F. *The Fisherman’s Problem: Ecology and Law in the California Fisheries, 1850-1980*. New York: Cambridge University Press, 1986.

McKinnon, Jennifer, Julie Mushynsky, and Genevieve Cabrera. “A Fluid Sea in the Mariana Islands: Community Archeology and Mapping the Seascape of Saipan.” *Journal of Maritime Archaeology* 9, no. 1 (June 2014): 59-79.

Mentz, Steve. *An Introduction to the Blue Humanities*. New York: Routledge, 2024.

Mills, Eric L. *The Fluid Envelope of Our Planet: How the Study of Ocean Currents Became a Science.* Toronto: University of Toronto Press, 2009.

Mitchell, Timothy. *Rule of Experts: Egypt, Techno-Politics, Modernity*. Berkeley: University of California Press, 2002.

Monetary Bay Aquarium Research Institute. "Bomber Warm." Accessed March 12, 2021. https://www.mbari.org/animal/bomber-worm/.

Monterey Bay Aquarium. "Deep Sea Brittle Star." Accessed January 4, 2023. https://www.montereybayaquarium.org/animals/animals-a-to-z/deep-sea-brittle-star.

Monterey Bay Aquarium. "Sea Pig." Accessed December 23, 2022. https://www.montereybayaquarium.org/animals/animals-a-to-z/sea-pig.

Monterey Bay Aquarium. "Sea Spider." Accessed January 4, 2023. https://www.montereybayaquarium.org/animals/animals-a-to-z/sea-spider.

Moskovita, George. *Living Off the Pacific Ocean Floor: Stories of a Commercial Fisherman*. Corvallis: Oregon State University Press, 2015.

Mukerji, Chandra. *A Fragile Power: Scientists and the State*. Princeton: Princeton University Press, 1989.

Müller, Simone M. "From Cabling the Atlantic to Wiring the World: A Review Essay on the 150th Anniversary of the Atlantic Telegraph Cable of 1866." *Technology and Culture* 57, no. 3 (July 2016): 507-526.

________. *Wiring the World: The Social and Cultural Creation of Global Telegraph Networks*. New York: Columbia University Press, 2016.

Munk, Walter. "The Evolution of Physical Oceanography in the Last Hundred Years." *Oceanography* 15, no. 1 (2002): 135-141.

Munns, A. and L. Haslouer. "Phase 1 Archaeological Resources Report." Santa Barbara Museum of Natural History Master Plan, Santa Barbara, California, 2013.

Munsch, Stuart H. Jeffrey R. Cordell, Jason D. Toft. "Effects of Shoreline Engineering on Shallow Subtidal Fish and Crab Communities in an Urban Estuary: A Comparison of Armored Shorelines and Nourished Beaches." *Ecological Engineering* 81 (2015): 312-20.

Myrick, David F. "Summerland: The First Decade." *Noticias* 34, no. 4 (Winter 1988): 64-103.

Nash, Linda. *Inescapable Ecologies: A History of Environment, Disease, and Knowledge*. Berkeley: University of California Press, 2007.

Nash, Roderick. *Wilderness in the American Mind*. New Haven, CT: Yale University Press, 1967.

National Geographic. "Habitat." Encyclopedic Entry. Accessed January 10, 2023. https://education.nationalgeographic.org/resource/habitat/.

National Marine Sanctuaries. "Kelp Forests." National Oceanic and Atmospheric Association. Accessed October 12, 2020. https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html.

National Oceanic and Atmosphere Administration. "Oil Spills." Accessed January 1, 2022. noaa.gov/education/resource-collections/ocean-coasts/oil-spills.

National Oceanic and Atmospheric Administration. "Analysis of Remediation Alternatives for the Pacific Crossing-1 North and East Submarine Fiber Optic Cables in the Olympic Coast National Marine Sanctuary." U.S. Department of Commerce. November 2005. https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/library/pdfs/remediationofaltforpacxesubocnms_ea_2005.pdf.

Nautilus Live. "Set It and Forget It: Deploying Long-Term Seismic Monitoring Instruments." August 31, 2021. https://nautiluslive.org/video/2021/08/23/set-it-and-forget-it-deploying-long-term-seismic-monitoring-instruments.

Near, Nicole. "Appendix B: The Cultural Importance of Kelp for Pacific Northwest Tribes." *Puget Sound Kelp Conservation and Recovery Plan*. January 2020.

Needham, Andrew. *Power Lines: Phoenix and the Making of the Modern Southwest*. New Jersey: Princeton University Press, 2014.

Nehring, Richard. *Oil and Gas Supplies for California: Past and Future*. Santa Monica: Rand, December 1975.

Noirungsee, Nuttapol, Steffen Hackbusch, Juan Viamonte, Paul Bubenheim. "Influence of Oil, Dispersant, and Pressure on Microbial Communities from the Gulf of Mexico." *Scientific Reports* 10, no. 1 (April 2020): 1-9.

Ocean Networks Canada. "Barkley Canyon." Accessed December 1, 2020. https://www-static01.oceannetworks.ca/observatories/pacific/barkley-canyon.html.

________. "Cables and Connectors." Accessed March 11, 2022. https://www-static01.oceannetworks.ca/observatories/infrastructure/cables-connectors.html.

________. “Data Facilities.” Accessed February 6, 2020. https://www.oceannetworks.ca/observatories/infrastructure/data-facilities.

________. “Tsunami Studies.” Accessed 6 July, 2019. http://www.oceannetworks.ca/science/active-research/tsunami-studies.

“PC-1 Settlement Agreement.” U.S. Department of Commerce, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers, U.S. Department of Justice, Makah Indian Tribe, Pacific Crossing Ltd., Tyco Telecommunications, November 4, 2005, https://www.gc.noaa.gov/documents/2017/pc-1%20settlement%20agt%20final%2011-04-05.pdf, 7-8.

Ocean Observatories Initiative. “The Vision.” Accessed April 18, 2023. https://oceanobservatories.org/the-vision/.

Olalde, Mark. “California Will Need $21.5 Billion to Clean up Its Oil Sites. Who’s Going to Pay for It?” *High Country News*. May 23, 2023. https://www.hcn.org/articles/energy-industry-california-will-need-215-billion-to-clean-up-its-oil-sites-whos-going-to-pay-for-it.

Oreskes, Naomi. “Scaling up Our Vision.” *Isis* 105, no. 2 (June 2014): 379-391.

Orsi, Richard J. *Sunset Limited: The Southern Pacific Railroad and the Development of the American West, 1850–1930*. Berkeley: University of California Press, 2006.

Panetta, Leon E. “Op-Ed: Create a Tribal-Led Marine Sanctuary and Stop Oil Spills on the California Coast.” *Los Angeles Times*, October 22, 2021. https://www.latimes.com/opinion/story/2021-10-22/oil-spills-marine-sanctuary-northern-chumash.

Pastore, Christopher L. *Between Land and Sea: The Atlantic Coast and the Transformation of New England.* Cambridge, MA: Harvard University Press, 2014.

Paulson, Meghan. “Wiring the Abyss: ONC’s Fall Expedition Season.” Virtual Presentation. November 18, 2020. https://www.youtube.com/watch?v=yzpkgQZWbIA.

Peckol, P., S. C. Levings, S. D. Garrity. “Kelp Response Following the *World Prodigy* Oil Spill.” *Marine Pollution Bulletin* 21, no. 10 (1990): 473-76.

Pegues, Juliana Hu. *Space-Time Colonialism: Alaska’s Indigenous and Asian Entanglements*. Chapel Hill: University of North Caroline Press, 2021.

Pinder, David. "Offshore Oil and Gas: Global Resource Knowledge and Technological Change." *Ocean and Coastal Management* 44, no. 9-10 (2001): 579-600.

Pisani, Donald J. *To Reclaim a Divided West: Water, Law, and Public Policy, 1848-1902.* University of New Mexico Press, 1992.

Priest, Tyler. *Offshore Imperative: Shell Oil's Search for Petroleum in Postwar America*. College Station: Texas A&M University Press, 2007.

Quam-Wickham, Nancy. "'Cities Sacrificed of the Altar of Oil,' Popular Opposition to Oil Development in 1920s Los Angeles." *Environmental History* 3, no. 2 (1998): 189-209.

Raines, Rebecca Robbins. *Getting the Message Through: A Branch History of the U.S. Army Signal Corps*. Washington, D.C.: Center of Military History, U.S. Army, 1996.

Reggio Jr., Villere C. *Rigs-To-Reefs: The Use of Obsolete Petroleum Structures as Artificial Reefs*. New Orleans: U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, 1987.

Reid, Joshua L. *The Sea Is My Country: The Maritime World of the Makahs*. New Haven, CT: Yale University Press, 2015.

Reidy, Michael and Helen M. Rozwadowski. "The Spaces In Between: Science, Ocean, Empire." *Isis* 105 (2014): 338-351.

Reidy, Michael. *Tides of History: Ocean Science and Her Majesty's Navy.* Chicago: University of Chicago Press, 2008.

Rens, Jean-Guy. *The Invisible Empire: A History of the Telecommunications Industry in Canada, 1846-1956*. Trans. Kathy Roth. Montreal: McGill-Queen's University Press, 2001.

Retzlaff, Rebecca and Charlene LeBleu. "Marine Spatial Planning: Exploring the Role of Planning Practice and Research." *Journal of Planning Literature* 33, no. 4 (2018): 466-491.

Rice, Stanley D. Jeffrey W. Short, Mark G. Carls, Adam Moles, Robert B. Spies. "The *Exxon Valdez* Oil Spill." In *Long-Term Ecological Change in the Northern Gulf of Alaska*, edited by Robert B. Spies. Amsterdam: Elsevier, 2007.

Ricketts, Edward F. and Jack Calvin. *Between Pacific Tides*, 4th edition. Edited by Joel W. Hedgpeth. Stanford: Stanford University Press, 1968.

Rikardsen, Audun. “One Great Shot: High Stakes Humpback Rescue.” *Hakai Magazine*. November 18, 2022. https://hakaimagazine.com/videos-visuals/one-great-shot-high-stakes-humpback-rescue/.

Ritchie, Robert. *The Lure of the Beach: A Global History*. Oakland: University of California Press, 2021.

Ritzius, D. E., Susan F. Hodgson, William F. Guerard, Jr., E. R. Wilkinson, and Don Lande. *California Oil, Gas, and Geothermal Resources: An Introduction*, 5th edition. Sacramento: California Department of Conservation Division of Oil, Gas, and Geothermal Resources, 1993.

Roscher, Mieke, André Krebber, and Brett Mizelle, eds. *Handbook of Historical Animal Studies*. München, Wien: De Gruyter Oldenbourg, 2021.

Ross, Mike. “GCI to Repair Broken Underwater Fiber Optic Cable.” *Alaska News Source*. January 31, 2020. https://www.alaskasnewssource.com/content/news/GCI-to-repair-underwater-cable-567485941.html.

Rothbach, Dan. “Rigs-to-Reefs: Refocusing the Debate in California.” *Duke Environmental Law and Policy Forum* 17 (2007): 283–95.

Rozwadowski, Helen M. and David K. van Keuren, eds. *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*. Canton, MA: Science History Publications, 2004.

Rozwadowski, Helen M. “Arthur C. Clarke and the Limitations of the Ocean as a Frontier.” *Environmental History* 17 (2012): 578-602.

________. *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*. Cambridge, MA: Belknap Press, 2005.

________. “Introduction: Reconsidering Matthew Fontaine Maury.” *The International Journey of Maritime History* 28, no. 2 (2016): 388-393.

________. “Ocean’s Depths.” *Environmental History* 15, no. 3 (July 2010): 520-525.

________. “Oceans: Fusing the History of Science and Technology with Environmental History.” In *Companion to American Environmental History*, edited by Douglas Cazaux Sackman. Oxford: Wiley-Blackwell (2010): 442-461.

________. “Oceans in Three Paradoxes: Knowing the Blue through the Humanities.” *Environment and Society Portal*, Virtual Exhibitions 2021, no. 2. https://www.environmentandsociety.org/exhibitions/oceans-three-paradoxes.

________. "Scientists Writing and Knowing the Ocean." In *The Sea and Nineteenth-Century Anglophone Literary Culture*, edited by Steve Mentz and Martha Elena Rojas, 28-46. London: Routledge, 2016.

________. *Vast Expanses: A History of the Oceans*. London: Reaktion Books, 2018.

Ruiz, Rafico. "Iceberg Economies." *TOPIA: Canadian Journal of Cultural Studies* 32 (2018): 179-199.

Sabin, Paul. *Crude Politics: The California Oil Market, 1900-1940*. Berkeley: University of California Press, 2005.

Sadorus, Lauri L., Nathan J, Mantua, Timothy Essington, Barbara Hickey, and Steven Hare, "Distribution Patters of Pacific Halibut (*Hippoglussus stenolpis*) in Relation to Environmental Variables along the Continental Shelf Waters of the US West Coast and Southern British Columbia." *Fisheries Oceanography* 23, no. 3 (2014): 225-41.

Safina, Carl. *Beyond Words: What Animals Think and Feel*. New York: Henry Holt, 2015.

Sammarco, Paul, Amy Atchison, and Gregory Boland. "Expansion of Coral Communities within the Northern Gulf of Mexico via Offshore Oil and Gas Platforms." *Marine Ecology Progress Series* 280 (2004): 129–43.

Sanders, Robert. "Scientists Map Source of Northwest's Next Big Quake." *Berkley News*. November 2, 2015. https://vcresearch.berkeley.edu/news/scientists-map-source-northwests-next-big-quake.

Santa Ynez Band of Chumash Indians. "Our History." Accessed February 1, 2023, https://www.santaynezchumash.org/chumash-history.

Scales, Helen. *The Brilliant Abyss: Exploring the Majestic Hidden Life of the Deep Ocean and the Looming Threat that Imperils It*. New York: Atlantic Monthly Press, 2021.

Schatzberg, Eric. *Technology: Critical History of a Concept*. University of Chicago Press, 2018.

Schulz, Kathryn. "The Really Big One," July 13, 2015. *New Yorker*. https://www.newyorker.com/magazine/2015/07/20/the-really-big-one.

Schulz, Marjorie, Corey Lawrence, Dan Muhs, Carol Prentice, Sam Flanagan, "Landscapes from the Waves—Marine Terraces of California." United States Geological Survey, Fact Sheet 2018-3002 (March 2018).

Schulze, Anja, Deana L. Erdner, Candace J. Grimes, Daniel M. Holstein, Maria Pia Miglietta. "Artificial Reefs in the Northern Gulf of Mexico: Community Ecology Amid the 'Ocean Sprawl.'" *Frontiers in Marine Science* 7 (2020): 1-15.

Scott, James C. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven, CT: Yale University Press, 1998.

Scott, R. Bruce. *Gentlemen on Imperial Service: A Story of the Trans-Pacific Telecommunications Cable*. Victoria, British Columbia: Sino Nis Press, 1994.

Sea Grant California. "Pacific Sanddab." Accessed November 1, 2020. https://caseagrant.ucsd.edu/seafood-profiles/pacific-sanddab.

Service, Robert F. "Oceanography's Third Wave." *Science* 318, no. 5853 (November 2007): 1056-58.

Shines, Sandra. "DEIMOS joins MARS and Its Satellite of Instruments on Seafloor." *UW News*. March 18, 2009. https://www.washington.edu/news/2009/03/18/deimos-joins-mars-and-its-satellite-of-instruments-on-seafloor/.

Smith Jr., Kenneth L., Henry A. Ruhl, Mati Kahru, Christine L. Huffard, and Alana D. Sherman. "Deep Ocean Communities Impacted by Changing Climate Over 24 Y in the Abyssal Northeast Pacific Ocean." *PNAS* 110, no. 49 (December 2013): 19838-19841.

Smith, Jason W. *To Master the Boundless Sea: The U.S. Navy, the Marine Environment, and the Cartography of Empire*. Chapel Hill: University of North Carolina Press, 2018.

Smyth, Katie, Nikki Christie, Daryl Burdon, Jonathan P. Atkins, Richard Barnes, Michael Elliott. "Renewables-To-Reefs? Decommissioning Options for the Offshore Wind Power Industry." *Marine Pollution Bulletin* 90 (2015): 247-258.

Sollen, Robert. *An Ocean of Oil: A Century of Political Struggle over Petroleum off the California Coast.* Juneau, Alaska: The Denali Press, 1998.

Spence, Mark David. *Dispossessing the Wilderness: Indian Removal and the Making of the National Parks*. New York and Oxford: Oxford University Press, 1999.

Spezio, Teresa Sabol. *Slick Policy: Environmental and Science Policy in the Aftermath of the Santa Barbara Oil Spill*. Pittsburgh: University of Pittsburgh Press, 2018.

Spies, Robert B., ed. *Long-Term Ecological Change in the Northern Gulf of Alaska*. Amsterdam: Elsevier, 2007.

Squire, Rachael and Klaus Dodds. “Introduction to the Special Issue: Subterranean Geopolitics.” *Geopolitics* (April 2019): 1-13.

Starosielski, Nicole. *The Undersea Network.* Durham: Duke University Press, 2015.

Steel, Francis. ed. *New Zealand and the Sea: Historical Perspectives*. Wellington, New Zealand: Bridget Williams Books, 2018.

Steinberg, Philip and Kimberley Peters. “Wet Ontologies, Fluid Spaces: Giving Depth to Volume through Oceanic Thinking.” *Environment and Planning D: Society and Space* 33 (2015): 247-264.

Steinberg, Philip E. *The Social Construction of the Ocean.* Cambridge, UK: Cambridge University Press, 2001.

Stephenson, Neal. “Mother Earth Mother Board.” *Wired*. December 1, 1996, https://www.wired.com/1996/12/ffglass/.

Stone, Maddie. “Facebook Abandoned Drilling Equipment beneath the Ocean Floor.” *Vice*. August 14, 2020. https://www.vice.com/en/article/4ay5mj/facebook-abandoned-drilling-equipment-beneath-the-ocean-floor.

Straughan, Dale, and Diane Hadley. “Experiments with Littorina Species to Determine the Relevancy of Oil Spill Data from Southern California to the Gulf of Alaska.” *Marine Environment Research* 1, no. 2 (October 1978): 135-63.

Sutter, Paul S. “Nature's Agents or Agents of Empire? Entomological Workers and Environmental Change during the Construction of the Panama Canal.” *Isis* 98 (2007): 724-754.

________. “The World with Us: The State of American Environmental History.” *Journal of American History* (June 2013): 94-119.

Taormina, Bastien, Juan Bald, Andrew Want, Gérard Thouzeau, Morgane Lejart, Nicolas Desroy, and Antoine Carlier. “A Review of Potential Impacts of Submarine Power Cables on the Marine Environment: Knowledge Gaps, Recommendations and Future Directions.” *Renewable and Sustainable Energy Reviews* 96 (2018): 380-391.

Taylor III, Joseph E. “Knowing the Black Box: Methodological Challenges in Marine Environmental History.” *Environmental History* 18 (January 2013): 60-75.

________. *Making Salmon: An Environmental History of the Northwest Fisheries Crisis*. Seattle: University of Washington Press, 2001.

Jamestown Tribe. "Treaty with the S'Klallam, 1855." Accessed March 11, 2023. https://jamestowntribe.org/history-and-culture/treaty-with-the-sklallam-1855/.

Taylor, S. Martin. "Supporting the Operations of the NEPTUNE Canada and VENUS Cabled Ocean Observatories." OCEANS 08 KOBE (2018): 1-8.

Teisch, Jessica B. *Engineering Nature: Water, Development, and the Global Spread of American Environmental Expertise*. Chapel Hill: North Carolina Press, 2011.

Thompson, Robert Luther. *Wiring the Continent: The History of the Telegraph Industry in the United States, 1832-1966*. Princeton, NJ: Princeton University Press, 1947.

Trujillo, Alan P. and Harold V. Thurman. *Essentials of Oceanography,* 12th Edition. Boston: Pearson, 2017.

U.S. Energy Information Administration. "Offshore Production Nearly 30% of Global Crude Oil Output in 2015." *Today In Energy*. October 25, 2016. https://www.eia.gov/todayinenergy/detail.php?id=28492.

Van Elden, Sean, Jessica J. Meeuwig, Richard J. Hobbs, and Jan M. Hemmi. "Offshore Oil and Gas Platforms as Novel Ecosystems: A Global Perspective." *Frontiers in Marine Science* 6 (September 4, 2019): 1-9.

Van Paridon, Bradley. "When Litter Becomes Habitat." *Hakai Magazine*. March 9, 2020. https://hakaimagazine.com/news/when-litter-becomes-habitat/.

Voosen, Paul. "Ice-Tracking Space Laser Could Also Map Sea Floor and Monitor Health of Coral Reefs." *Science*. April 14, 2020. https://www.science.org/content/article/ice-tracking-space-laser-could-also-map-sea-floor-and-monitor-health-coral-reefs.

Wadewitz, Lissa K. *The Nature of Borders: Salmon, Boundaries, and Bandits on the Salish Sea*. Seattle: University of Washington Press, 2012.

Walker, Brett. *Toxic Archipelago: A History of Industrial Disease in Japan*. Seattle: University of Washington Press, 2010.

Wall, Carrie C. Rodney A. Rountree, Corinne Pomerleau, Francis Juanes. "An Exploration for Deep-Sea Fish Sounds off Vancouver Island from the NEPTUNE Canada Ocean Observing System." *Deep-Sea Research I* 83 (2014): 57-64.

Weiner, Ken and Seth Davis. "Olympic Re-Lay: Innovative Techniques in Cable Projects with Regulatory and Environmental Dimensions." In *K&L Gates-Nera Global Telecom Review,* edited by Christian M. Dippon and Martin L. Stern, 79-91. Seattle: Kirkpatrick and Lockhart Preston Gates Ellis LLP, Nera Economic Consulting, 2008.

Weisiger, Marsha. *Dreaming of Sheep in Navajo Country*. Seattle: University of Washington Press, 2011.

White, Richard. “From Wilderness to Hybrid Landscapes: The Cultural Turn in Environmental History.” *Historian* 66 (Fall 2004): 557–64.

________. *Railroaded: The Transcontinentals and the Making of Modern America*. New York: W. W. Norton, 2011.

________. *The Organic Machine: The Remaking of the Columbia River*. New York: Hill and Wang, 1995.

Christine Werme, Jennifer Hunt, Erin Beller, Kristin Cayce, Marcus Klatt, Aroon Melwani, Eric Polson, and Robin Grossinger. “Removal of Creosote-Treated Pilings and Structures from San Francisco Bay.” California State Coastal Conservancy. December 10, 2010.

Weise, Elizabeth. “First Offshore Wind Power Sites Auctioned Off California’s Coast.” *USA Today*. Last updated December 10, 2022. https://www.usatoday.com/story/news/2022/12/07/first-ever-pacific-offshore-wind-auction-nets-757-million/10847186002/#:~:text=First%20offshore%20wind%20power%20sites,could%20power%201.5M%20homes.&text=The%20first%2Dever%20federal%20auction,could%20power%201.5%20million%20homes.

Wheelwright, Jeff. *Degrees of Disaster: Prince William Sound: How Nature Reels and Rebounds*. New Haven, CT: Yale University Press, 1994.

White, Damian and Chris Wilbert, “Introduction: Technonatural Time-Spaces.” *Science as Culture* 15, no. 2 (June 2006): 95-104.

Widder, Edith. “Creatures of the Deep.” *Saturday Evening Post*. April 19, 2022. https://www.saturdayeveningpost.com/2022/04/creatures-of-the-deep/.

Williams, Kale. “Facebook Abandons Broken Drilling Equipment under Oregon Coast Seafloor,” *OregonLive*. August 13, 2020. https://www.oregonlive.com/environment/2020/08/facebook-abandons-broken-drilling-equipment-under-oregon-coast-seafloor.html.

Williams, Maria Sháa Tláa, ed. *The Alaska Native Reader: History, Culture, Politics*. Durham, NC: Duke University Press, 2009.

Willon, Phil. “Failures of California’s First Plan to Stop Offshore Oil Drilling Cast Shadow over New Efforts.” *Los Angeles Times*. November 29, 2021. https://www.latimes.com/california/story/2021-11-29/failures-of-california-rigs-to-reefs-program-offshore-oil.

Woody, Todd. “California’s Critical Kelp Forests are Disappearing in a Warming World, Can They be Saved?” *National Geographic.* April 30, 2020. https://www.nationalgeographic.com/science/article/california-critical-kelp-forests-disappearing-warming-world-can-they-be-saved.

Worster, Donald. *Dust Bowl: The Southern Plains in the 1930s.* New York: Oxford University Press, 1979.

Worthington, David, ed. *The New Coastal History: Cultural and Environmental Perspectives from Scotland and Beyond*. Cham, Switzerland: Palgrave Macmillan, 2017.

Yamamura, Jean. “Say So Long to Santa Barbara’s Offshore Platforms.” *Santa Barbara Independent*. January 1, 2019. https://www.independent.com/2022/01/19/so-long-offshore-platforms/.

Yang, Daqing. *Technology of Empire: Telecommunications and Japanese Expansion in Asia, 1883-1945*. Cambridge, MA: Harvard University Press, 2010.

Yebra, Diego Meseguer, Søren Kiil, Kim Dam-Johansen. “Antifouling Technology—Past, Present and Future Steps Towards Efficient and Environmentally Friendly Antifouling Coatings.” *Progress in Organic Coatings* 50 (2004): 75-104.

Young, Oran R., Frans Berkhout, Gilberto C. Gallopin, Marco A. Janssen, Elinor Ostrom, Sander van der Leeuw. 2006. “The Globalization of Socio-Ecological Systems: An Agenda for Scientific Research.” *Global Environmental Change* 16, no. 3 (August): 304-316.

Zador, Stephani G., Sarah K. Gaichas, Stephen Kasperski, Colette L. Ward, Rachael E. Blake, Natalie C. Ban, Amber Himes-Cornell, and J. Zachary Koehn. “Linking Ecosystem Processes to Communities of Practice Through Commercially Fished Species in the Gulf of Alaska.” *ICES Journal of Marine Science* 74, no. 7 (2017): 2024-33.

Zouak, Jehan. “Foul Free at Folger Pinnacle.” AML Oceanographic. September 17, 2017. https://amloceanographic.com/blog/post/foul-free-folger-pinnacle.

Museum Exhibits and Panels

Charleston Marine Science Center. “Our New Docks.” Exhibit Panel Text, Charleston, Oregon. Visited June 11, 2022.

East Governmental Dock. “Eelgrass Grows Here.” Informational Panel, Bamfield, Canada. Visited February 18, 2023.

Royal BC Museum. “Seashores: Reproduction.” Exhibit Panel Text, Victoria, Canada. Visited February 23, 2023.

Santa Barbara Maritime Museum. “What Should We Do With Decommissioned Platforms?” Exhibit Panel Text. Visited October 22, 2018.