Introduction

Coral Whisperers

IB: What does it mean, coral whisperers?

LK: The point of it is to diagnose problems with corals before they’re actually dead because once they’re dead, it’s not helpful. So we’re listening to the corals, this is how they talk.

IB: So the corals are whispering?

LK: Coral whisperer means I’m whispering to the corals. But the coral is whispering back.

—Author’s interview with Les Kaufman, 2017

I was not even twenty when I completed my two-year mandatory military service in Israel. In an attempt to help me return to civilian life, my father purchased a weeklong scuba diving course in Sinai for me. That week of diving alongside corals in the Red Sea was transformative. Immersed in saltwater, enchanted by the kaleidoscopic array of color and form, and utterly dependent on the air in my tank, I was reminded of the connectivity among all forms of life and of the importance of returning to my own breath. Life seemed so undisturbed in the tranquility of the sea. Whatever pettiness and cruelty happened on land, it would always be met with unfaltering equanimity underwater. Or so it seemed in 1989.

**Figure 1.** In 2014, this knobby cactus coral (*Mycetophyllia aliciae*) was rescued from Port-Miami, Florida, by Coral Morphologic, a Miami-based multimedia group, just before the Army Corps of Engineers began dredging operations in the area. In 2018, this particular specimen is still aquacultured in Coral Morphologic’s lab. Courtesy of Coral Morphologic.
Fast-forward to 2014. My explorations of wildlife management across the wild-captive divide led me to visit a couple of coral nurseries in Culebra, a small island off the shores of Puerto Rico. As a new mother and a mid-career academic in Buffalo, New York, I had forgotten all about corals and oceans. When I went underwater to observe the Caribbean reefs, I couldn’t believe my eyes. “Where are the reefs?” I asked my coral scientist guide, Edwin Hernández-Delgado, who was very proud of his restoration project and seemed slightly offended by my question. Granted, this was the Caribbean and not the Red Sea. Still, what I saw deeply saddened me: the vibrant and diverse colors of the underwater forests that I remembered from my youth had been replaced here by yellowish coral, thinly scattered over an otherwise barren-looking surface. I decided to try and understand what had happened to corals over this twenty-five-year period.

Since I am not a biologist, and because I could not easily figure out how to speak to the corals themselves, it made the most sense to speak to the people who care for and seem to know them well: coral scientists. This approach also resonated with my broader interest in science as a particular way of producing knowledge and, specifically, in biology. So, a few days after our dive, I asked Hernández-Delgado to put me in touch with other coral scientists. This minor request ultimately led to a massive research undertaking that stretched across multiple continents and disciplines. More than four years, hundreds of interview hours, and thousands of miles later, I am now clear about one thing: the relatively short period between 2014 and 2017 during which I conducted my research for this book has been transformative both for reef-building corals and for the scientists who study them. As it happened, the duration of my research coincided with what has come to be known as the third global coral bleaching event on record, a designation I was unfamiliar with until my dive in Culebra. Having started in June 2014, this bleaching event—which marked the largest and most severe coral death in human history—was declared over in May 2017, precisely as I was writing this book’s conclusion.

*Coral Whisperers* thus captures a key moment in the history of coral reef science, and of environmental conservation more broadly. It documents the physical, intellectual, and emotional plight of coral scientists and their painstaking deliberations as they struggle to understand and save corals from what many of them have come to see as the corals’ inevitable catastrophic future on a polluted and rapidly warming planet. Drawing on in-depth interviews with one hundred coral scientists and managers, the book shows how, in the face
of this great acceleration in coral decline, coral experts are becoming the vanguard of conservation in the Anthropocene.

We are in the thick of contemporary coral science here and can feel its urgency: the experts, who are witnessing massive coral death around the planet, both grieve for this death and must simultaneously narrate it. In this role, they oscillate between positions of despair and hope. The despair-hope divide, I will argue, tracks an emergent tension between traditional approaches to conservation and newer, more interventionist, perspectives. But despite their vehement disagreements about the right thing to do, coral scientists all share a deep appreciation and intimacy, some would say love, toward corals. Through their passionate narratives, corals emerge as both a sign and a measure of the imminent catastrophe facing life on earth. At the same time, corals can also show us the way out of this apocalyptic mode and beyond the hope-despair pendulum—both so characteristic of conservation in the Anthropocene—toward what may become a more relational, or “coralated,” world.

DESPAIR AND HOPE IN THE ANTHROPOCENE

The phenomenon that most struck me after interviewing coral scientists for a couple of years is that they are increasingly caught between two extreme emotional states: despair and hope. Driving one extreme are the catastrophic predictions by some scientists of a mass death of reef-building corals by mid-century, which highlight climate change and ocean acidification as the last nails in the coffin of human assaults on coral ecosystems. In this despondent narrative, reef-building corals are doomed, and nothing short of an abrupt (and many would say unlikely) shift in how we use fossil fuels will save them. As the central proponent of this worldview, Australian coral scientist Ove Hoegh-Guldberg told me in an interview: “The Titanic is sinking and all we are doing is rearranging the chairs to get a better view.”

The widely reported and minutely recorded coral bleaching event that hit the Great Barrier Reef between 2015 and 2017—wherein huge tracts of coral colonies lost their symbiotic algae and embarked on a quick and whitened path toward death—validated this pessimistic side of the pendulum, which comes replete with daunting algorithms, images, and maps. “This has changed the Great Barrier Reef forever,” one scientist lamented. The world’s largest living structure has become the world’s largest dying structure.
Driving the other extreme are the scientists’ narratives of hope for coral futures to come. “Give me the dying corals that you have given up on and I will restore them,” pleaded a coral restoration scientist to a large and visibly uncomfortable audience at an evening plenary at the International Coral Reef Symposium held in Hawai’i in June 2016. Trendy terms—like bright spots, which highlights locations where humans have been able to strengthen coral resilience and reverse the trend for coral death, and assisted evolution, the selective captive breeding of “super corals” for transplantation in order to strengthen depleted coral colonies—have been coined to represent actions that humans can take in the face of the growing threats to coral life. “From despair to repair,” as marine ecologist Jeremy Jackson put it. Under the hashtag #OceanOptimism, marine biologist Nancy Knowlton, joined by a growing number of scientists, managers, and activists, has been circulating good news about the oceans.

Knowlton and Jackson fell in love with the reefs of the Caribbean and, simultaneously, with each other, some forty years ago. For decades, they were referred to by their students and colleagues as “Doctors Doom and Gloom”—until they called for a move “Beyond the Obituaries” and toward ocean optimism. “We don’t want people going into a catatonic state of sitting in the corner and moaning because all is lost,” marine ecologist Peter Sale reflected on this turn to a more hopeful worldview. Indeed, many coral scientists and managers are shifting away from catastrophe-centered narratives to focus on collaboration and hope, highlighting that “feeling hopeful enhances our capacity to take meaningful action.”

Both stances toward the future of coral life on earth—namely, the hope and despair ends of the pendulum—are invested with considerable emotional intensity. What I found to be most striking, however, is not so much the fervor of these stances as the disconnect—the alienation even—between the coral scientists who hold them. For instance, at the International Coral Reef Symposium in Hawai’i, I witnessed cynicism and contempt, especially from the self-appointed “realists” toward the restoration people. “Restoration is crap,” one Australian coral ecologist told me. While others may not have been so blunt, the tensions surfaced clearly and produced several awkward moments at the symposium, despite the attempt by the organizers to present a united front for the sake of saving corals.

In my work studying coral scientists, I am interested in how the tensions between traditional coral conservation and newer approaches like coral resto-
ration play out, and in what they represent. In a nutshell, I would offer that such tensions go deeper than personal and professional disagreements. They signify the ongoing, and arguably intensifying, rift between those conservation scientists who still assume that it is possible to use traditional conservation tools (chiefly the removal of adverse local human impacts) to allow natural systems to restore themselves to a prior state, and others who hold that even with the deleterious impacts removed, natural systems will not return to a prior state because their environment has fundamentally altered. These latter conservation scientists are prepared to consider active interventions of one type or another. Within the interventionist approach, some go so far as to depict nature as a garden that can and must be intensely managed in order to save it. Rather than perceiving humans as “screwing it up,” as many traditional conservationists would have it, such radical interventionists see hope in human-nonhuman networks and collaborations and seek to foster such connections.

These ideological distinctions translate into different modes of environmental management: one highlights the importance of preserving and protecting existing habitats, for example through the establishment and maintenance of marine protection areas such as the Great Barrier Reef Marine Park; the other highlights possibilities of active restoration as well as the capacity of technological advances to create novel and better-adjusted organisms and species through strategies such as assisted evolution and the design of super corals. The differences between the two ideologies and their respective modes of operation are only magnified by the grave climate predictions already afoot.

Over time, I began to notice that the bifurcated approaches toward nature within the community of coral scientists often align with gender and geography. Specifically, female scientists, many of them young and with diverse backgrounds, have taken the lead in promoting narratives of hope and models for assisted evolution. This new leadership is noteworthy in a discipline traditionally dominated by older white men. As for geography, the world of coral scientists is differentiated among regions. For example, the Australians have been historically and culturally more inclined toward traditional preservation models such as securing marine protection areas, while their colleagues in the Caribbean have focused more strongly on restoration and other intensive management strategies. Currently, however, the Australians are reassessing their approach, as corals have suffered a serious death toll in their region, too. In a 2017 article published in the magazine Nature and entitled “Coral Reefs in the Anthropocene,” thirteen prominent coral scientists, many
of them based in Australia, announced that “it is no longer possible to restore coral reefs to their past configurations.” They argued that “instead of attempting to maintain or restore historical baseline assemblages, the governance and management of coral reefs will need to adapt continuously to the new conditions of the coming centuries.”

Such “new conditions of the coming centuries” have also been referred to, controversially, as the Anthropocene. The Anthropocene, or the Age of Man, is an unofficial geological term coined by Paul Crutzen in 2000 and defined as the time in which the collective activities of humans have substantially altered the earth’s surface, atmosphere, oceans, and nutrient cycles. Corals are on the front lines of this purportedly new era, and the scientists who study them have likewise found themselves on the front lines of conservation science. There is therefore much to glean from their experiences that will be relevant to conservation scientists working with many other species and ecosystems in the near future.

The existential crisis of coral scientists and their bifurcated response to this crisis is the above-water story that I tell in this book. Underwater, another, much less bifurcated, story emerges: that of the corals themselves.

CORAL BIOLOGY ON THE FLY

Coral is a generic name for more than 2,500 species of colonial invertebrates. Relatives of sea anemones and jellyfish, corals are different in that, like trees, they are fixed to one spot for the majority of their lifetime. But coral species are also different from one another. Stony and soft corals; deep, mesophotic, and shallow corals—these are just a few distinctions that divide the various forms of life organized under the broad title coral. For the most part, this book focuses on reef-building corals—corals who live in the shallow waters of tropical areas and rely intensely on a symbiotic relationship between the animal polyp, microscopic algae called Symbiodinium, and a wide range of bacteria and viruses.

Most reef-building coral species are colonial. They are comprised of multiple polyps, who typically measure only a few millimeters long and share the same genetic makeup as hundreds or even thousands of their fellow polyps who make up the coral colony. A polyp includes a stomach (gastrovascular cavity), which opens into a central mouth surrounded by a set of tentacles. Hard corals also have a skeleton, or corallite, at their base, into which the polyp
retreats during the day. Because of their morphological similarity to higher-order plants, in his fourteen-volume *Cyclopedia of Natural History* (1552), Edward Wotton named corals *zoophytes* (literally, plant-animals). Although this term was eventually abandoned, K. Brandt’s discovery in 1881 of photosynthetic algae inside the tissues of many of these tiny animals confirmed their vegetal nature. These algae, most abundant in the tentacles and oral disc of the cnidarians (a large taxonomic group of over ten thousand animal species, including corals, jellyfish, and hydra, that use specialized cells for capturing prey), are still commonly called *zooxanthellae*. However, this term is now understood to apply specifically to the genus *Symbiodinium*: organisms who convert atmospheric carbon dioxide into organic carbon compounds such as carbohydrates and produce oxygen inside the animal, who is often referred to as the “host.”

The mutual benefits of cooperation to both animal and algae are at the heart of the symbiotic relationship that characterizes reef-building corals. Reef-building corals are phototrophic organisms: the *Symbiodinium* algae live inside the polyps and provide them with nutrients derived from photosynthesis. This relationship with the algae helps “speed up the process by which corals build their stony skeleton, putting down layer after layer of calcium carbonate, a form of limestone. It is this process of calcification that physically constructs the bedrock of the coral reef.” Without their symbionts, reef-building corals would not have such high rates of growth and thus would not be able to form reefs as we know them.

Corals are both autotrophs, able to derive energy from the sun, and heterotrophs, able to absorb nutrients from the environment by ingesting microorganisms such as bacteria and zooplankton who drift through the oceans. A recent study showed that during bleaching events, certain coral species were able to maintain and restore energy reserves by increasing their feeding rates.

As for the algal symbionts, they are genetically diverse, comprising nine evolutionary lineages (“clades”) that share a common ancestor from approximately fifty million years ago. Alongside *Symbiodinium*, the coral assemblage includes a vast array of microbial symbionts such as bacteria and viruses. This entire symbiotic assemblage is referred to by coral scientists as a *holobiont*.

When the ocean water becomes too warm, the *Symbiodinium* algae living in tropical coral tissues are expelled, causing the coral to turn completely white. This process is called bleaching (figure 2). It is still unclear who initiates the expulsion, the animal or the algae, but the evidence leans toward the latter. The algae also apparently “choose” which corals to “infect” in the first place—
and I use scare quotes here because many scientists would contest this implied agency by the algae and see it as problematically anthropomorphic. “It happens once in a very early stage, just after the larva settles, and then the window of opportunity closes, nobody [else] can get in—the coral will just eat the latecomers up,” coral geneticist Mikhail Matz told me, not shying away from agency and anthropomorphism himself. “There is only one winner when you infect the coral,” he clarified. “It’s like a little bit of natural selection within that particular tiny little coral polyp.” Marine biologist Mary Alice Coffroth noted that “it can take up to four years until the final *Symbiodinium* type is established, although it probably gets in within the first three months.”

A bleached coral is not dead, yet. Corals can survive a bleaching event, but such an event puts them under increased stress and they are therefore more likely to die. Research has shown that when recovering from bleaching, coral species and even colonies cooperate with their original strain of symbionts. Since the 1980s, episodes of coral bleaching and mortality, due primarily to climate-induced ocean warming, have occurred almost annually in one or more of the world’s tropical or subtropical seas.

Alongside such local episodes of bleaching, in 1998 the U.S. National Oceanic and Atmospheric Administration (NOAA) announced a new type of event: global bleaching, defined as mass bleaching of at least one hundred square kilometers in all three ocean basins. Triggered by the El Niño of that
year, the first major global bleaching event was declared when a huge underwater heat wave killed 16 percent of the corals on reefs around the world’s oceans. The second global bleaching event was caused by the El Niño of 2010. In 2015, NOAA announced the third global bleaching event, the longest on record, which impacted reefs around the world between June 2014 and May 2017. It hit the Great Barrier Reef particularly hard, with 93 percent of the surveyed reefs bleaching between 2015 and 2017. During that time, some locations in Hawai‘i saw 75 percent of their corals bleached. As for the future, climate models predict that most of the world’s reef-building corals will face annual temperature extremes before the end of this century, with some experiencing such conditions starting as early as 2030. Scientists are currently documenting how this grim forecast unfolds from moment to moment, producing a painfully detailed testimony about the process of corals becoming extinct.

Yet many members of the public find it hard to relate to coral death on such grand scales. For me, the face of bleaching is the pale look of Edwin Hernández-Delgado—the scientist who introduced me to his coral nurseries during our 2015 dive in Culebra—when he noticed that the corals he had transplanted were turning white. The correlation between the coral’s whitening polyps and the scientist’s whitened face is, poignantly, yet another sign of our “coralated” materialities.

**CORAL ECOSYSTEMS UNDER THREAT**

Humans have only recently come to recognize that coral reefs are living beings, not simply rocks, and that their existence is under threat by our capitalist modes of consumption. In “From Threatening to Threatened: How Coral Reefs Became Fragile,” historian Alistair Sponsel observes how human perceptions of corals have changed through time—from seeing them as hazardous impediments to navigation to seeing them as fragile living organisms who are threatened by humans and who should thus be protected and saved. In biopolitical terms, corals have transformed from killable to grievable creatures.

Today, tropical coral reefs are considered among the most diverse marine ecosystems on earth, providing shelter to myriad species, including four thousand species of fish and another one to eight million still undiscovered species of organisms living in and around reefs. Coral scientists like to emphasize that although reefs represent less than 0.1 percent of the world’s
ocean floor, they help support approximately 25 percent of all marine species, which is why they are commonly referred to as the rainforests of the ocean. As a result of their precarious state, the livelihoods of five hundred million people and an income worth over $30 billion are at risk. Coral reefs also provide buffers that protect shorelines against waves, storms, and floods. The absence of these natural barriers will increase the damage to coastal communities from wave action and violent storms.

Coral scientists warn that at present, corals are facing multiple stresses caused by pollution, overfishing, and, increasingly, global warming and ocean acidification. The scientists further contend that corals act as an early warning system, their alarming status reflecting the deteriorating health of the oceans. Coral reefs are thus referred to as canaries in the coal mine. If they radically decrease or even disappear, this analogy implies, other marine life will soon follow, and human life will be severely affected.

Reef-building corals have disappeared several times before. The most recent event happened at the end of the Cretaceous era, approximately sixty-five million years ago. After each of these catastrophes, it has taken roughly ten million years for reef building to recommence. Although in the 1970s most reefs showed slightly positive growth rates, this trend reversed course shortly after, and coral populations have been declining ever since. What we have seen over the past few decades, and can expect to see in the foreseeable future, is an exceptionally rapid and global death of reef-building corals. The coral thus emerges as the less-like-us cousin of the polar bear—the new “poster child” of climate change.

But while being in the spotlight can be a good thing for coral protection, it may also carry a price. For under climate change’s all-consuming shadow, it is easy to lose sight of other conservation threats and potential courses of action—and, indeed, to overlook the corals themselves as diverse and complex creatures. In this sense, embracing the reality of climate change has, ironically, hindered coral conservation. In the words of Jeremy Jackson: “The fascinating thing about climate change is that it’s an excuse for doing nothing.” Alongside documenting the recent shift of conservation science toward a focus on global warming, this book also records the attempts by many coral scientists to mitigate its effects through targeted local action and by crafting alternative balancing schemes. Historian Dipesh Chakrabarty reminds us, accordingly, that “the climate change problem is not a problem to be studied in isolation from the general complex of ecological problems that humans now
face on various scales—from the local to the planetary—creating new conflicts and exacerbating old ones between and inside nations.”

THINKING WITH CORALS

Corals are “good to think with.” The symbiotic algae-animal relationships at the core of their precarious existence reveal that, more than a single unified entity, corals are, in fact, “coralations”—bundles of constantly changing assemblages that shape and reshape their ways of being in the world. Beyond the symbiotic underpinnings of their microscalar existence, coralations also occur at the level of the coral colony and ecosystem as well as at the intersections of culture, science, and law.

Corals confuse and destabilize our categories: they are a cross between animal, plant, rock, microbe, and ecosystem; we sentimentalize them because of their beauty, despite the fact that they don’t have a face or a clear sex and so we can’t easily anthropomorphize them; and while they live in the ocean, which constitutes the majority of the earth but which we know so little about, they also constitute some of our terrestrial mountains and buildings. Reef-building corals are animals, yet they photosynthesize; they make massive stony structures that can be seen from space, but they are tiny and, some claim, fragile creatures; they are sessile, yet travel long distances in their larval stage; and each has a mysterious symbiotic relationship with a particular strain of algae—who, under certain conditions, disembark from the coral cells, leaving them bleached and depleted. Individual coral polyps in a colony may differ in morphology and genetics, and some may be fusions of two or more genotypes. For the most part, however, polyps who belong to one colony have the same genetic composition—what scientists refer to as “ramets.” Coral colonies are interconnected by living tissue. Finally, unlike most animals known to science, they don’t really age: given the right conditions, corals can live forever.

Throughout history, corals have inspired indigenous cultures, poetry, and art. The Kumulipo (“Beginning-in-deep-darkness”) is the sacred creation chant of a family of Hawaiian ruling chiefs. Composed and transmitted entirely in the oral tradition, its two thousand lines provide an extended genealogy detailing the family’s divine origin and tracing its history from the beginning of the world. The Kumulipo opens with the coral as the first organism in the Hawaiian universe. Corals are the beginning of life, the most ancient ancestors of all living things.
Corals have also fascinated great intellectuals such as Karl Marx, who mentions them as prime examples of the relationship between the individual and the community. Charles Darwin’s first monograph in 1842 was entitled *The Structure and Distribution of Coral Reefs, Being the first part of the geology of the voyage of the Beagle, under the command of Capt. Fitzroy, R. N. during the years 1832 to 1836.* More recently, the coral made a prominent appearance in revered evolutionary biologist and historian of science Stephen Jay Gould’s last book, *The Structure of Evolutionary Theory.* There, Gould used an image of a coral to represent the basic ideas of Darwinian theory.

Ironically, many scientists who have studied corals have come to challenge the traditional Darwinian principles of evolution, highlighting the centrality of the symbiotic relationship and the importance of understanding the coral as a holobiont (again, a composite of coral animal and a diverse set of microbes, including algae). These coral-spawned realizations have brought about a substantial paradigm shift in the field of biology, which was until recently dominated by neo-Darwinian theories of origin and natural selection. It is thus not very surprising that scientists who study corals also promote a rhizomatic outlook on the world. The “rhizome” is a concept developed by French philosophers Gilles Deleuze and Felix Guattari in the 1970s to highlight ways of thinking that are multiple and nonhierarchical, as opposed to “arborescent” (tree-like and hierarchic) knowledge that works with dualistic categories and binary choices. As Darwin himself acknowledged in his notebook, “The tree of life should perhaps be called the coral of life,” implying that his own view was much less “Darwinian” than it was later interpreted to be.

This is just a sliver of what happens when one starts thinking with reef-building, tropical corals, commonly referred to as stony corals or scleractinians. Add to this the existence of soft corals (gorgonians, or octocorals), who have very different skeleton composition and symbiotic relationships, and who possess eight tentacles (hence octo-) instead of the multiple sixes of the scleractinians, and you get a mind-blowing diversity that raises a set of important questions (see figure 3). For example, scientists have observed that soft corals don’t bleach as much as their stony relatives. They are now asking what this means for rapidly transforming coral ecosystems in polluted, overfished, and warming oceans. Who are these corals of the Anthropocene, and what can we learn from them about the corals of the future?

And here’s another coralated question to consider: only in the past few decades have marine scientists discovered that at least half of all coral species
in fact live in the dark and cold abyss of the deep ocean. Unlike the corals near the ocean’s surface, deep-sea corals do not photosynthesize or bleach. But in addition to warming oceans and pollution, myriad other threats assail these unique ecosystems, such as bottom trawling, deep-sea mining, and ocean acidification—the ongoing decrease in the pH of the oceans caused by the absorption of carbon dioxide from the atmosphere. Because of the invisibility of deep-sea corals to human eyes and the relative paucity and unenforceability of international legal regimes that pertain to their habitats in the high seas, these corals are underprotected by law and marginalized within the field of
coral science when compared to their shallower kin. Indeed, deep-sea scientists often complain that cold-water coral ecosystems are more alien to humans and less explored than the landscapes of Mars. In this sense, immersing ourselves in the multiplicity of coral life allows us to step back and recognize the many assumptions, including legal ones, that underlie our understandings and our regulation of life and death—both in our environment and, eventually, in ourselves.

But perhaps I am overstating the importance of thinking with corals. The emotional layers in the work of coral scientists are arguably just as meaningful as their analysis, if not more so.

**Scientists on the Brink: A Note on Method and Emotions**

The account in this book is both eclectic and entangled. It was almost as if the corals themselves—with their fragmented, reticulate, and unwilling-to-be-classified nature—whispered their resistance to me and left me spellbound. Inspired by Anna Tsing’s patchy ponderings about mushrooms and by Paul Rabinow’s direct presentation of scientific narratives, this book focuses on coral scientists attempting to understand their world both individually and as a community. It is organized around their oscillation between hope and despair, with climate change playing an intensifying role for both sides of the pendulum.

Such swings from hope to despair and back again are certainly not the sole province of contemporary coral scientists, although they are quite acute in this context. Myriad recent books about conservation in general, and about climate change in particular, embrace one emotional extreme or the other. Despair titles include philosopher Dale Jamieson’s *Reason in a Dark Time: Why the Struggle against Climate Change Failed—and What It Means for Our Future* (2014), historian Joshua Howe’s *Behind the Curve: Science and the Politics of Global Warming* (2014), climatologist James Hansen’s *Storms of My Grandchildren: The Truth about the Coming Climate Catastrophe and Our Last Chance to Save Humanity* (2010), political scientist Stephen Meyer’s *The End of the Wild* (2006), journalist Elizabeth Kolbert’s *The Sixth Extinction: An Unnatural History* (2014), and environmentalist Bill McKibben’s early iteration of this mood, *The End of Nature* (1989).

Hope, on the other hand, is the central theme in countless other titles, including psychologist Mary Pipher’s *The Green Boat: Reviving Ourselves in*
Our Capsized Culture (2013),
philosopher Jonathan Lear’s Radical Hope: Ethics in the Face of Cultural Devastation (2006),
literary scholar Teresa Shewry’s Hope at Sea: Possible Ecologies in Oceanic Literature (2015),
environmental activist Joanna Macy and psychologist Chris Johnstone’s Active Hope: How to Face the Mess We’re in without Going Crazy, conservation scientist Andrew Balmford’s Wild Hope: On the Front Lines of Conservation Success (2012), and Climate of Hope: How Cities, Businesses and Citizens Can Save the Planet (2017) by former New York City mayor Michael Bloomberg and former executive director of the Sierra Club Carl Pope.

Increasingly, scholars are highlighting the need to balance between the despair-hope extremes. “How might it be possible to move environmentalism beyond the stereotypical narrative of the decline of nature without turning it into progress boosterism?” asks cultural scholar Ursula Heise. Donna Haraway argues, similarly, that “there is a fine line between acknowledging the extent and seriousness of the troubles and succumbing to abstract futurism and its affects of sublime despair and its politics of sublime indifference.” Finally, Teresa Shewry calls for an understanding of hope beyond hope: “Hope is not well understood simply as the loss of awareness of reality . . . or as entirely distinct from sorrow, despair, and other experiences,” she writes. Instead, “hope is offered through attunements to present world struggles to enliven environmental relationships that have been lost or damaged. As such, it is never alone; it always exists intimately with experiences such as sorrow.” Although on the surface each is experienced as exclusive of the other, when examined more deeply one can begin to see the ways in which the hope-despair narratives by the coral scientists in this book are interconnected and even contemporaneous. This recognition will emerge within the chapters and will surface again in the book’s conclusion.

My decision to write a book about coral scientists and their oscillation between despair and hope was far from obvious, and not without its perils. I am keenly aware that “the primary and sometimes exclusive focus on science . . . is what drives the failure of climate change advocacy,” as Joshua Howe put it. His critique is twofold, as he highlights science’s fundamental inability to state anything with 100 percent certainty as well as its problematic conviction that the solution to uncertainty is yet more scientific research. Another problem with focusing on scientists emerges at the emotional level. Dale Jamieson warns in this context that “ignorance of science can give rise to excessive respect, which can quickly turn to disillusionment when science does not deliver the goods or
when scientists turn out to be as petty and selfish as the rest of us.”

Relatedly, geographer Jessica Barnes and social ecologist Michael Dove write about the “unexpected and resolute mistrust of this science in many segments of the public, especially in the United States.”

Yet rather than seeking to move beyond the perspective of scientists, this book fully embraces it. Indeed, Coral Whisperers is an attempt to see corals as coral scientists see them, to understand the world as they understand it. The phrase “on the brink” intends to capture the sense of urgency and crisis that has prevailed throughout my discussions with these scientists as they attempt to save the corals from imminent death and themselves from imminent obsolescence. Mary Pipher argues that “there is an enormous gap between what scientists know and what most people know.” This is especially true with regard to oceans, which many of us don’t experience regularly and don’t know much about.

But instead of focusing only on what scientists know, argue, and do in their professional life, Coral Whisperers depicts coral scientists as people and situates them within a dynamic community. I have therefore not shied away from relaying the fierce debates that split this community, nor from pointing to the care and anguish that unites them. Rather than turning to narratives of non-scientists, as Howe calls for, and while being careful not to glorify the scientific enterprise, this book works to dispel the myth of a homogeneous and objective science, at the same time granting scientists a voice by accounting for their real-world experiences and deliberations.

In dealing with the volume of interviews and observations I’ve gathered over the course of several years, my intuition has been to let the scientists speak in a less mediated way. This means that the book contains quite a bit of science—and some rather long quotes. Coral scientists from around the world emerge here not only as harbingers of doom and messengers of hope, but, perhaps more importantly, as humans facing an existential crisis. Their task is tough: they must both witness their beloved corals dying out and at the same time narrate this death to the world. They must be careful not to sound too gloomy, lest their warnings be labeled alarmist, nor too hopeful, lest they be dismissed as Pollyannaish or even as denialists. Finally, all this is happening in the face of what many coral scientists experience as disinterest in coral death and its causes on the part of the general public and certain prominent politicians.

In this dramatically changing world, under the looming shadow of climate change, the role of the coral scientist is also undergoing dramatic transforma-
In the not-so-distant past, scientists focused on nuanced studies of their subject species; now they must become spokespersons for their corals if they are to save them. Although many of my interviewees felt uneasy speaking about their emotional bond with their coral subjects and were also quite wary of taking any sort of political stance—and they are not different in this regard from scientists in other disciplines—I also encountered a growing cohort of scientists who were prepared to do so, and boldly (see, e.g., figure 4). I soon noticed that many of the latter scientists were women, and have come to see...
these individuals as the “Jane Goodalls” of coral science. Although an outsider to this community, I, too, have been struck by the tragedy of coral demise and humbled by the persistence, dedication, and love for corals that I have witnessed on the part of so many of the scientists I interviewed.

I’d like to share just one example of this dedication from my fieldwork in Hawai’i. When we came to the surface during a work dive on the Big Island, local Ph.D. student Katia Chika-Suye spontaneously expressed her appreciation for the blue rice coral (*Montipora flabellata*), which is endemic to these islands. “Isn’t it so beautiful?” she asked me, not awaiting my answer as she dove right back down, with me lagging behind. I had joined Chika-Suye and her colleague Jenna Budke for a morning dive at the Wai’opae tide pools in 2016. We were there to ensure that the temperature-monitoring equipment was still operative and to collect samples of a few coral species (figure 5). By breaking several of these corals off from their colony with a chisel and hammer and observing them under a microscope, Chika-Suye and Budke would find out
whether the corals were getting ready to spawn, in which case they would collect their eggs. Just when I thought I would lose my fingers and toes from being submerged in the cold water for what seemed like forever, my belly grumbling from an overdose of saltwater inhaled in the high and rough tide, we finally gathered all of the instruments and samples and headed back to shore.

I was grateful for the sun’s warmth and for not having to struggle for every breath. Under the microscope, the samples we had collected provided an intricately beautiful scene: what had looked no different than dead rock revealed itself as very lively and exquisite tentacles connected to a body containing tiny and perfectly shaped eggs. When we finished studying these creatures, Budke headed straight back to the water. I was too exhausted to join her, but when I asked about it later, she explained that she had returned the coral fragments back to the ocean, with the hope that they would reattach and survive.88

Many months later, I met with a different group of coral scientists, this time at the Boston University marine lab. In that instance, while the younger female graduate students shied away from making statements about intimacy with their coral subjects, the lab’s senior male professors strongly emphasized the depth of this relationship. One of them, Les Kaufman, stressed that to be the person who knows a coral species better than anyone else in the entire world carries with it an immense responsibility to serve as the spokesperson for this coral, who cannot speak for herself.89 “Now this is intimacy!” Kaufman exclaimed.90 Everyone in the room was in complete agreement.

When I reflect on the many hours that coral scientists have taken from their work in order to speak to me, I realize that this is precisely what they were doing: serving as spokespersons for their corals and hoping that the message of urgency, love, and grief would travel through me to a larger public. “Maybe, in your book, you can make people understand what an extraordinary animal the coral is and how horrible a world without them would be,” one scientist confided in me after our formal interview was over.91 The term coral whisperer thus takes on an additional meaning, now including the whisper’s intended audience. The whisper of the scientists, the whisper of the corals, must both be magnified so that they may be heard by this audience. My book undertakes an atypical journey into the world of those who whisper to corals and to whom corals may whisper back. It is my hope that it will serve to amplify these whispers into the piercing cry that they deserve.
THE STRUCTURE OF CORAL WHISPERERS

Broadly stated, this book is a chronological documentation of how scientists have come to gradually realize and respond to the magnitude of threat to their beloved coral species and ecosystems—from their initial insistence to hold on to traditional conservation methods and to projects of monitoring (chapter 2), to their growing reliance on restoration (chapter 3), through their collaborations with legal actors and regulatory projects (chapter 4), and, finally, to their recent turn to coral genomics and assisted evolution (chapter 5).

Beyond this chronological account, however, Coral Whisperers is structured as a pendulum swinging between hope and despair. Chapter 1 explains the workings of this pendulum and the stakes involved. Relying considerably on my observations at the International Coral Reef Symposium in Hawai‘i in June 2016, this chapter relates the intellectual and emotional debates among scientists about how best to manage the impending catastrophe facing coral reefs. This chapter is, in many ways, a snapshot of the entire book, depicting the oscillation between hope and despair and telling the stories of particular scientists who have experienced this oscillation firsthand.

Next, chapter 2 documents the despair side of the pendulum as it contemplates the existing modes and technologies for recording coral bleaching and death. Here, the trajectory typically tends toward devastation and gloom, as the numbers are depressing at best. Much of the chapter focuses on the third global bleaching event at the Great Barrier Reef, documenting how scientists have both recorded and narrated this event to themselves and to the general public. I examine the role of monitoring in particular, considering whether enhancing scientific knowledge about corals by monitoring them is an act of hope, in that it supports conservation action, or one of despair, in that it stifles such action and masks the resulting inaction with more and more monitoring. Finally, the chapter shows that even in the world of numbers and maps, “bright spots” and optimistic indexes still rear their more hopeful heads.

In chapter 3, the pendulum swings again, this time to document acts of hope by coral restoration scientists. Drawing on my visits to five coral nurseries—Culebra in the Caribbean, southern Israel, Honolulu and Coconut Island in Hawai‘i, and the Florida Aquarium—this chapter explores the scientific, cultural, and emotional challenges facing restoration efforts and the criticisms directed toward these efforts from within the coral science community. A marginalized field only a few years ago, coral restoration is becoming increasingly
important to a growing number of scientists and managers, who see it as a way to resist death by engaging in coral propagation. The coral nursery assumes center stage in this process and emerges as part of the broader attempts by restoration scientists to establish coral restoration as a science that is aligned with silviculture and restoration ecology. The coral nursery is finally compared to the coral farm, where corals are propagated for the mariculture industry. Throughout, the chapter discusses the often fraught relationship between biologists, aquarists, and hobbyists, pointing to the importance of enhancing collaborations between these groups for coral survival.

In chapter 4, the pendulum swings back to despair. The chapter documents the focus of contemporary legal regimes, and the U.S. Endangered Species Act in particular, on threat and endangerment, exposing how ill-suited existing law is for dealing with the weirdness of corals and with the sheer scale of their "super wicked problem": climate change. Here, federal administrators provide insight into the processes through which listing and delisting decisions are made, their deliberations about coral classification engendering a fresh perspective on the coralations between law and science. While the relationship between scientists and lawyers is often fraught, and both express frustrations with existing legal regimes, some also see hope on the legal horizon. Two such hopeful instances are the emerging international regulation of climate change and the signals of possible receptiveness by U.S. courts to the assertion of constitutional rights to a healthy environment.

Finally, chapter 5 explores the hope encapsulated within the corporeality of coral life. Holobionts, hologenomes, chimeras, and reticulate evolution are just a few of the concepts deployed by coral scientists to shed light on the microscopic and macroscopic complexity of corals, highlighting the emergence of a genomic turn in coral science. The chapter delves into coral symbiosis, exploring how it challenges our definitions and understanding of the individual—in corals and beyond. It also points to debates among coral scientists about the resilience of hybrids and about the efficacy and appropriateness of novel experiments in assisted evolution. These novel designs focus on tweaking present-day corals for the sake of corals of the future, creating what some scientists have called “super corals.” Coral tissues may also serve as living gene banks—repositories of DNA that freeze cellular life in time until they can be thawed in the future. Finally, forensic readings of the rings of coral skeletons provide a window into past climates, especially in tropical oceans where reading ice cores and tree rings is often not possible.
Throughout the chapter, tensions emerge between field scientists and geneticists about the right way to save corals; nonetheless, it ends on a hopeful note—with an invitation for cooperation.

In between the chapters, six extended interview segments provide a first-person perspective from the following conservation experts on their work with corals: Peter Sale, Ove Hoegh-Guldberg, Jeremy Jackson, Ken Nedimyer, Murray Roberts, and Ruth Gates. These interludes allow the coral experts, most of them scientists, to speak for themselves more directly. They also shed light on the unique bond between the scientists and these imperiled animals, who are otherwise rather alien to most humans and so the scientists’ relationship to them is not as obvious as it would be toward, say, a rhino or a polar bear. A majority of the book’s photographs were chosen and introduced by the scientists interviewed, providing another powerful medium through which they may may relay their relationship to particular corals and environments.

Throughout this book, a sense of urgency prevails. Coral reefs are experiencing, with growing frequency and severity, mass bleaching, disease, and mortality, as carbon dioxide and temperatures increase, water quality deteriorates, and marine fishery stocks are overexploited. As when trying to save a dying loved one, coral scientists can’t afford to waste time or words. It is now or never—they must get it right as they embark on what, for them, is the ultimate “emotional race against time.”