Preface

Like many of my scientific colleagues, I am often overwhelmed. Climate change, ocean acidification, species extinctions: we contemplate these difficult issues constantly. I know well what it is like to just want to give up.

It seems so easy: losing faith in humans. It promises relief from struggle and responsibility. Yet, whenever I have gone there, I have also felt empty. Claustrophobic. Horribly hollow.

And, apparently, I am too chicken to stomach those feelings. Whenever I have allowed myself to sink into cynicism, I have—invariably—jolted myself out of my catatonic state before hitting bottom and resumed swimming towards shore.

As an ecologist working on marine conservation with modern Indigenous peoples of the Northeast Pacific Ocean, I live at the crossroads of different world views and ways of knowing that, I believe, capture some of the best that humans have to offer to ourselves and to our non-human kin. We already have set in motion such rapid and ineluctable changes to our planet that both the traditional knowledge of Indigenous peoples and science will have to remain fluid and adaptive in order to not become obsolete. Both knowledge systems are designed to do exactly that. When combined synergistically, they can provide us with the tools we need to keep learning as change continues and accelerates—helping us connect with fundamental pieces of reality in ways that might allow us to remain our essential selves.

This book is my personal journey through the interface of science and traditional Indigenous knowledge. It is the story of why, despite the apparent evidence trying to talk me into doing otherwise, I believe in us.

Different cultures—collective ways of perceiving, knowing, creating, and behaving in the world—are combining today in ways that our ancestors would have welcomed. That is the challenging gift that accompanies the ongoing transformation of our planet into something that, in many ways, would be unrecognizable to those who lived before us, even in the near past.

I do not deny the losses that accompany that transformation. A planet in which wild salmon and ancient rainforests are being diminished is something to mourn. Yet I also like to think that, if they could catch a glimpse of our modern world, departed ancestors from Indigenous cultures of the northeast Pacific Ocean would recognize the continuity of many of their fundamental legacies, such as adaptability to change and the responsibilities of knowing how to give and how to receive a gift. And, above all, kinship.

These legacies, and more, are held within the works that artist Michael Nicoll Yahgulanaas gifted to this book. Michael described this gift as a symbol of the unprecedented solidarity that exists today among many Indigenous peoples and of the alliances that are being formed between First Nations and settlers who came from away. Michael is Haida. His people and the Central Coast First Nations I feature in this book were once dangerous enemies but are now fierce friends. And despite the past and ongoing crimes perpetrated by some settlers and their governments against the original inhabitants of the land, today millions of people from different Indigenous Nations and from settler groups are working together, globally, to fulfil our common obligations of respect, gratitude, and reciprocity towards all living things.

When Michael offered the gift of his art for this book, it reaffirmed for me that we live in fortunate times.

1

Gravity Suspended

A swift transition between worlds. That is how I experience the start of a research dive into the ocean—when I roll backwards from the gunwale of a small boat and, for a second, my vision traces an arc across the sky that culminates inside a burst of white bubbles. And then: the transparency, or murkiness, of the underwater world. The air trapped within my dry suit bobs me up to the surface, but only briefly. As I press the air release valve, my buoyancy steals away. And I sink…

That is the instant when all heaviness vanishes: the weight of my tank and other gear, of my body itself, and perhaps my mind too. I am now free to plummet, float in place, spin, rise—to act as if the very existence of gravity has been suspended.

And maybe just before I plunged into the water, the wind or boat engines were loud. Maybe wolf howls from the nearby forest pierced the air. Whatever the sounds were above the surface, they are now gone, replaced by the rhythm of my own breathing.

I always pause to acknowledge this transformation, this shift in perspective that allows me to access a unique freedom of the body and the mind. I soak it in so that it may stay with me throughout the busyness I am about to face when surveying rockfish—a genus of long-lived, marine fish that are easy to overexploit and culturally significant to Indigenous peoples who live along the coast of the northeast Pacific Ocean.

The surveys are part of the long-term and collaborative research I conduct with four First Nations along the Central Coast of what is now known as British Columbia, in western Canada. The ancestral territories of these Indigenous groups are made up of lush temperate rainforests and vertical granite walls that rise from a rich ocean to become corrugated mountains, where you can stand on a glaciated peak and look, almost straight down, into estuaries and rivers where the white-coated spirit bear (which is found nowhere else in the world) and other predators—grizzly bears, wolves, and wolverine—feed seasonally on large numbers of spawning salmon. These animals scatter fish carcasses among tall Sitka spruces that are nurtured by the decomposing flesh, linking the high seas that fed the salmon with forests that sustain myriad species of birds, insects, plants, lichens, and fungi. And, if standing on that peak, you raise your gaze slightly and the day happens to be clear, you will see fjords give way to islands large and small, some mountainous and heavily forested, some flat and strewn with bogs and ponds that resemble the subarctic, some little more than windswept rocks where seabirds nest and sea lions haul themselves out to rest. The islands extend far out to sea, sparkling in the sun amidst the breaking waves of the northeast Pacific.

I am the ecologist and science coordinator for the Central Coast Indigenous Resource Alliance, which the Wuikinuxv, Heiltsuk, Nuxalk, and Kitasoo/Xai'xais First Nations have created to join forces in the proactive management of resources within their territories. Our studies of rockfish and other marine organisms—including Pacific herring and Dungeness crabs—are part of an effort to support conservation and fishery management by cultures that are both grounded in ancient traditions and very much part of the modern world. While contemporary life has brought opportunities to these coastal cultures, it has also brought challenges. These include rapid climate changes that reassemble biological communities into unprecedented configurations of species; industrial fisheries that carry off vast amounts of fish very quickly; and logging, which has

destroyed parts of the rainforest and clogged some nearshore ecosystems with wooden debris that smother marine life and deplete life-sustaining oxygen dissolved in seawater. Yet the notion of managing people's behavior in the face of the human potential to destroy ecosystems is not new to my Indigenous friends and colleagues. Their tradition has always recognized our destructive capacity and—more importantly—our power to preempt it.

It is through my time with First Nations—in the field, in communities, and in the city boardrooms of Vancouver—that I have come to understand that the seemingly wild coast of British Columbia has been home to very large populations of technologically sophisticated cultures for thousands of years. In the process, I've come to appreciate that, despite having had the capacity to deplete rockfish and other species, they did not.

These facts tell me something profound about humans. Something that many of us have failed to recognize, and that may be essential for global society to avert the worst of our current, and very pressing, climate change and biodiversity crises.

Rockfish are a mirror for how we use—or don't use—some of our best human qualities.

The genus *Sebastes* (as rockfishes are scientifically called) stands out for its many species in which individuals can live to be centenarians, occasionally twice over. Chief among them are rougheye rockfish: solitary shrimp- and fish-eaters known to reach the astounding age of 205 years. Rougheyes can grow to half the size of a tall person. They prefer the relative darkness of greater depths—200 to 400 meters beneath the surface—which means that I will never dive among them.

The long-lived species that I know best are yelloweye and quillback rockfish. Yelloweyes are a beautiful orange color punctuated by one or two white stripes. They have been aged to 121 years and can grow almost as large as rougheyes. Quillbacks can live nearly a

century and grow to about half the length of yelloweyes. They look like miniature interstellar events—bright yellows merge into deep blacks, and white quills shoot straight up from their backs. During our dive surveys, we commonly see young and middle-aged individuals of these species. Yet the oldest and largest fishes are found much deeper than my colleagues and I can dive, so we study them through fishery catches and video from remotely operated cameras.

Quillbacks and yelloweyes have occupied much of my attention because their cultural and biological contexts converge in important ways. Both species are highly prized in the traditional diets of Coastal First Nations. They also have—like other species in which individuals live a century or more—a very slow life history that makes them very vulnerable to overfishing: long-lived individuals also grow slowly and take a long time to start reproducing, one to two decades in the case of many rockfishes. Having a slow life history also means that, once sexually mature, females reproduce annually throughout their very long lives. Critically, larger and older mothers are disproportionately more fecund than smaller, younger mothers. A 50-centimeter-long quillback rockfish will birth 800,000 larvae; that is seven times more offspring than a quillback mother that is only one third smaller. The greater fecundity of larger mothers is critical, because larvae have a tough life that is often short. Immediately upon birth, these baby fish—which are smaller than my pinky nail, have huge orange eyes and a translucent skin that makes the spine and innards visible to an observer—are thrust into the predator-laden ocean to fend for themselves. Most get eaten or starve within a few months. Odds are that very few or no larvae from a cohort will survive into reproductive adulthood. In some rockfish species, older mothers are important not only because of their hyper-fecundity but also because they give birth earlier in the year than younger females. This variation between different-aged mothers extends the length of the reproductive season and increases the chances that larvae will be born when their main food—tiny invertebrates known as zooplankton—are most abundant. The more

zooplankton they can access shortly after birth, the faster the larvae will grow and be able to avoid predators, including larger rockfishes.

These life history characteristics are both fascinating and worrisome. Given their higher reproductive capacity, big, old mothers are essential for the persistence of most rockfish species, yet modern fisheries target the biggest and oldest fish, effectively shrinking the average size and age of fish populations. The consequences can be misleading: when examining the impact of a fishery we may find that lots of fish are still around, and perhaps even pat ourselves on the back for not depleting the stock. But if we take a more nuanced view and realize that those remaining fish are all young and small, we will recognize a tenuous situation called longevity overfishing—the loss of big old fish that can be a precursor to a stock collapse, or a barrier to rebuilding and maintaining a sustainable fishery.

Yet not all rockfish species are characterized by extremely long life spans, which is important for fishery sustainability. Yellowtail, widow, and black rockfishes, for instance, have maximum ages of only 50 to 60 years, which means that their life history is just plain slow (as opposed to *very* slow), and therefore these species are less vulnerable to overfishing than longer-lived species.

The diversity of rockfish life spans correlates with a diversity of lifestyles that can make the busyness of our research dives hard-hitting and immediate. My colleagues and I often have the cosmic experience of descending midwater through mixed-species schools that include many hundreds of yellowtail, widow, or black rockfishes, plus a few individuals from similar species, like dusky and deacon rockfish. These schools create a moving mass of yellow and black bodies, with a smattering of whitish, greenish, and blue tones thrown in, hovering far off the bottom in crystal clear water, sometimes preying on herring and other small fishes. Upon reaching the reef we encounter a very different set of species—including quillback and yelloweye—among boulders or inside bedrock crevices, often solitary. After settling on a reef, adults of these longer-lived species

will stay near the bottom and move distances of only a few hundred meters for the rest of their lives. In other words, longer-lived rockfishes are archetypal "sitting ducks" for depletion by anybody with a boat, basic fishing gear, time, and disregard for the stewardship of resources that the ocean offers us. In a world where humans have derived much of their food from the ocean, longevity overfishing in general, and the status of rockfish populations in particular, are litmus tests for the human capacity to destroy—or choose to conserve.

Given their vulnerability to human exploitation, why are long-lived rockfishes still here if First Nations have had plenty of time and capacity to overfish them? Indigenous people have been harvesting rockfishes in British Columbia for at least 9,100 years, perhaps longer, given that humans have occupied the region for at least 14,000 years. And rockfish fisheries have always been geographically widespread. Archaeologists studying middens—sites within former villages or camps where shells, bones, and similar food remains accumulated over time—have found rockfish bones at nearly two thirds of the sites examined throughout British Columbia and adjacent areas of Oregon, Washington, and Southeast Alaska. Importantly, rockfishes were not a rare treat. Of 17 types of fish remains in middens, rockfish bones are the sixth most abundant throughout the region, and the fifth most abundant in British Columbia's Central Coast. This means that rockfishes were a predictable, year-round staple food, fished for millennia by large and dense human populations.

The middens of Barkley Sound, in southern British Columbia, are well-studied and particularly illustrative of the sustainability of Indigenous fisheries for rockfish. The sound covers 800 square kilometers, most of which is water, and its pre-colonial population is estimated to have been about 8,500 people: twice the current population in the area. By analyzing DNA from fish bones in middens, archaeologists recently identified continuous consumption of at

least 12 rockfish species over the course of 2,500 years. I find this remarkable, given that many rockfishes have a slow life history and are vulnerable to overfishing.

Even more notably, prior to colonization, Indigenous fishers were not technologically limited in their fishing capacity. Granted, their potential to overexploit was lower than that of modern, fossil-fuel-powered industrial fleets, but it was high enough to inflict serious damage. Dozens of paddlers propelled massive canoes far offshore, hunting whales, Pacific bluefin tuna, and other species. Sticking closer to shore and home, where many rockfish species can be fished, would have been easy, especially because people had very strong longlines made from cured bull kelp, hooks designed to target specific types of fish, and basket traps. That technology, coupled with a large human population, could have wiped the reefs clean of all their rockfish. Yet that sort of depletion did not happen.

The ancient DNA data for Barkley Sound suggests that people associated with the middens rarely consumed the slower-growing, longer-lived species (such as yelloweye and quillback rockfish) that are easier to deplete. Instead, they ate mostly species with shorter life-spans—such as yellowtail, widow, and black rockfishes—which grow faster, begin reproducing earlier in life, and withstand fishing pressure better than longer-lived species. These findings are rather puzzling to me. In our modern times, Coastal First Nations cherish the taste of quillback and yelloweye, and formal interviews with elders from their communities reinforce the cultural and nutritional role that these species have had over their lifetimes. So why do we not see a higher proportion of longer-lived species in the ancient DNA data set?

The archaeological data from Barkley Sound suggest that fishers kept their gear above the bottom and instead fished midwater, particularly near kelp beds, where smaller fish provide ample prey for yellowtail, black, and similar rockfish species. In other words, fishers appear to have made the deliberate choice of exploiting shorter-lived rockfishes at higher rates than longer-lived rockfishes, actively miti-

gating potential impacts on the most vulnerable species and allowing for sustainability over the course of millennia.

True, evidence from middens cannot distinguish whether conservation of long-lived rockfish that live along the bottom was active or passive. After all, fishing for mid-water species at shallower depths requires less effort and a lower risk of snagging and damaging gear, which may have influenced the fishers' behavior. But the fact is that other species that live in deeper water and along the bottom were targeted. For instance, the remains of Pacific halibut—a delicious flatfish that can grow to two and a half meters long and weigh one third of a ton—occur in one fifth of the middens in British Columbia and vicinity. Pacific halibut are targeted along sandy or muddy bottoms, where rockfish are less likely to be caught but which still have isolated boulders that may snag and damage fishing gear. Along the coast, Pacific halibut are most often found between 30 and 270 meters—a depth range that overlaps with that of long-lived rockfish. In combination, these facts suggest that pre-contact fishers actively fished deep bottom habitats where Pacific halibut could be targeted and the bycatch of long-lived rockfish reduced. Given that Pacific halibut live to only 55 years—and, consequently, are less vulnerable to fisheries than yelloweye and other rockfish that live twice as long—these practices are consistent with active conservation.

Although archaeologists have yet to use DNA to examine the selectivity of ancient rockfish fisheries elsewhere in the northeast Pacific, long-lived rockfishes remained abundant throughout the region into the 20th century. Indigenous people likely employed strategies for the sustainability of rockfish fisheries throughout the entire coast for millennia, even if such strategies differed from those in Barkley Sound.

But not all that starts well stays well. Rockfish overexploitation in British Columbia became rampant between the 1970s and 1990s—a period representing less than 1% of the documented history of Indigenous fisheries for rockfish—when industrial fisheries expanded and removed 90% or more of the biomass of many rockfish species in

British Columbia. Indigenous people and scientists (Indigenous and non, myself included), with valuable input from commercial fishers, are now working together to clean up that mess via a combination of protected areas and more conservative fishery management.

But this history is about much more than rockfishes. It is about a fundamental question that has occupied my mind for many years.

Are humans inherently destructive? If your knee-jerk response is "yes," then chances are that you have been paying attention to trends in our climate, species extinctions, and the loss or degradation of ecosystems that sustain our individual bodies, collective economies, and more intangible values such as inspiration, peace, and our sense of connection and belonging. And we humans are the ones who are causing these losses. So while we are at it, we may as well rephrase the question as Are humans inherently *self*-destructive?

If your answer is still "yes," then you are in the same camp as many environmental scholars. And at first glance, who can argue?

There is no doubt that humans have changed the world irrevocably. The severity of such change is encapsulated in fossils of trilobites—ancient sea creatures related to and reminiscent of today's horseshoe crabs—that had lain buried for the past 507 million years under the rocky bottom of a former sea in what now is the desert in modern-day Utah. Recently, geologists studied these trilobites, searching for clues into their ancient environments and lifestyles by studying biomarkers: substances that are environmental in origin but that infiltrate the living cells, dead remains, or fossils of organisms. But only a fraction of the geologists' findings qualified as ancient. The chemical composition of the half-billion-year-old trilobite specimens is now largely comprised of artificial chemicals that we, humans, began synthesizing in corporate labs less than 100 years ago: plasticizers, flame retardants, petroleum by-products, and insect repellent. Less than half of the biomarkers—41% on average—held traces of microorganisms and plants from a world that preceded the recent explosion of synthetic chemistry. In the blink of an eye,

our modern compounds have largely diminished the chemical storytellers of primordial Earth.

The power of the trilobite study is more than symbolic. What we do to the geologic record, we do to our insides. In the words of Sally Walker, a coauthor of the study, "Plastics, pesticides, and other petroleum byproducts are the worst. They affect our endocrine and reproductive systems.… I am sure that my entire body is outlined by plastic from all the plasticized paper I've touched and all the water I've imbibed."

When put that way, then maybe we should cling to the story that humans are inherently destructive and are particularly good at being self-destructive. Tempting. Very tempting. And a total cop-out.

It is true that we, humans, have excelled in our capacity to be a geologic force. In doing so, we have catapulted ourselves out of the Holocene, the 11,700-year-long geological period that began at the end of the last Ice Age and allowed civilization to develop under a stable climate. Those days are now replaced by the Anthropocene: the new geological epoch in which the atmosphere, ecosystems, and geologic materials that comprise Earth reflect the collective actions of dominant human cultures.

Yet it is even more essential to recognize that the human potential for causing further change—positive or negative, constructive or destructive—is still latent. The next many millennia on Earth will reflect the stories that *Homo sapiens*, the tool user, decides to ditch or to accept into our collective identity during the second and third decades of the 21st century. At this pivotal moment in history, the most important story we can be telling ourselves is that humans are *not* self-destructive. This reinterpretation of ourselves is not mere fancy mired in nostalgia for a golden age that never was. Rather, it is consistent with the world views and actions of Indigenous cultures that took shape millennia ago and that are still very much alive, integrating the traditional and the modern, teaching others and learning from others.

As the environmental scholar Jennifer Jacquet reminds us, "Not all humans are a geologic force—and a geologic force is not what humanity must be. That humans have become the main driver of environmental change is largely the result of specific cultures mixing with specific economic systems and mixing with specific technologies."

These ideas ask us all to work. They demand that we let go of the comfort and ease of riding along with the story that humans are hard-wired to destroy. Letting go of that story is difficult. Otherwise, the need to reinterpret ourselves would not be as real and urgent as it is today.