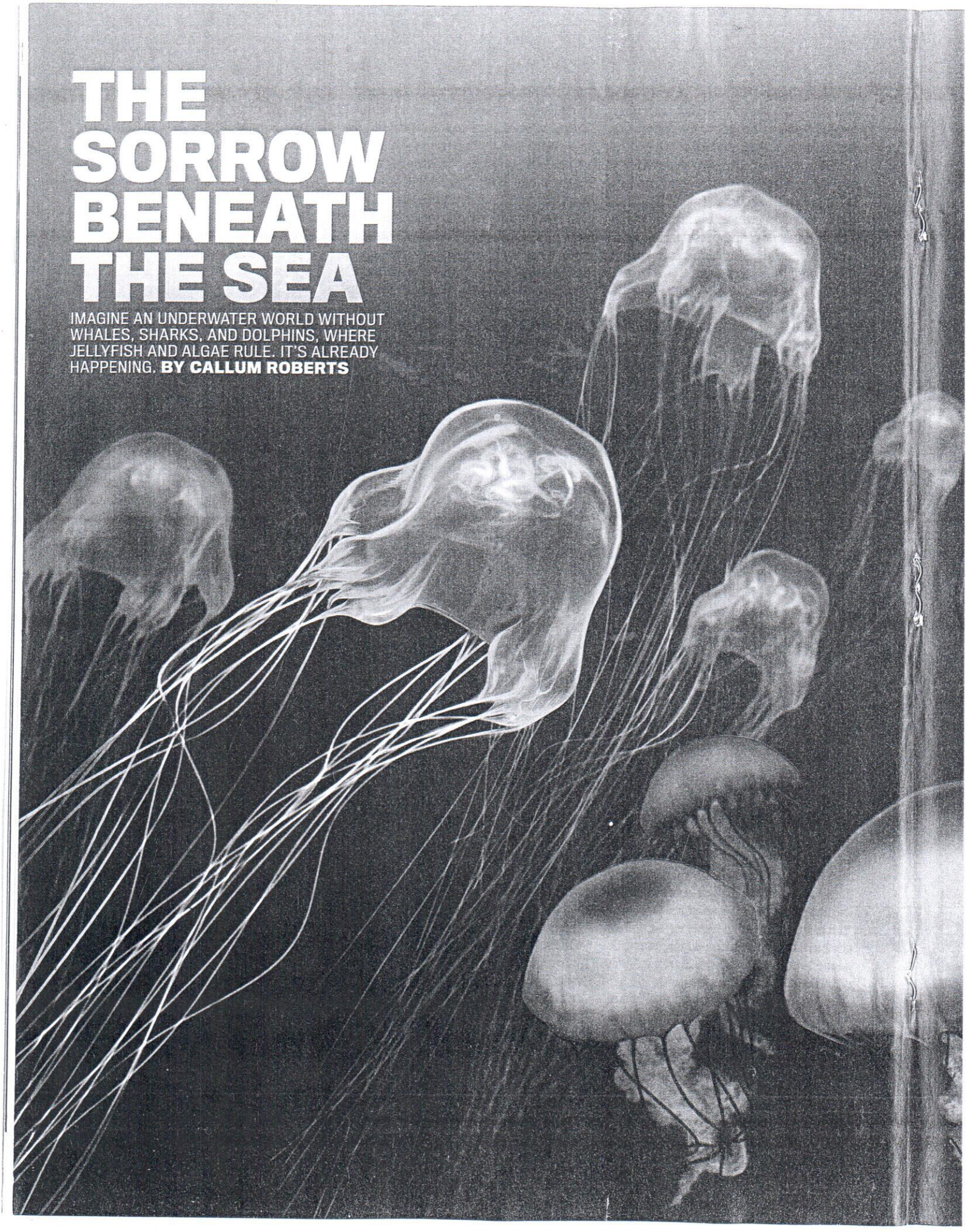
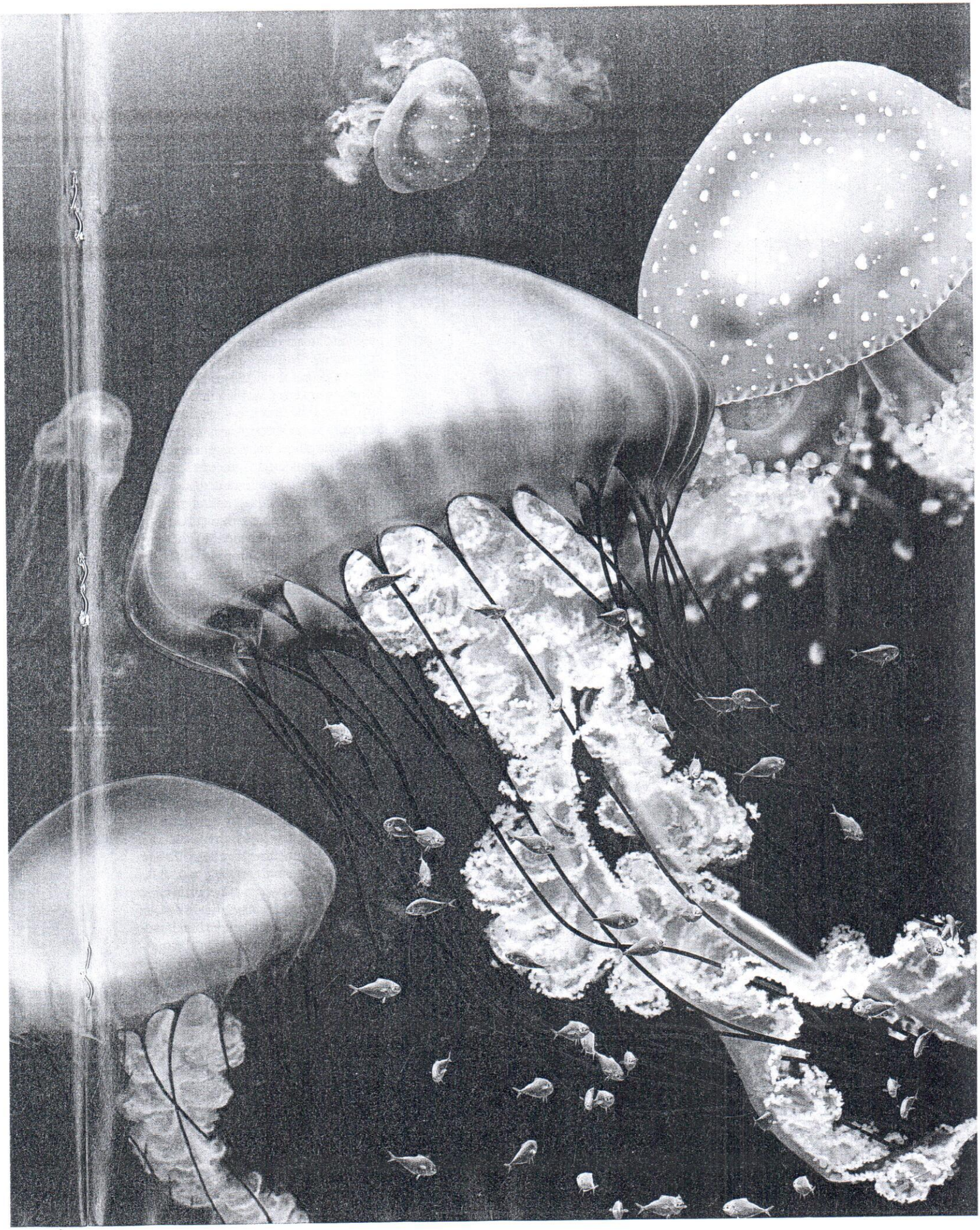
THE SORROW BENEATH THE SEA

IMAGINE AN UNDERWATER WORLD WITHOUT WHALES, SHARKS, AND DOLPHINS, WHERE JELLYFISH AND ALGAE RULE. IT'S ALREADY HAPPENING. **BY CALLUM ROBERTS**





Like children the world over, my daughters love turtles. At once incongruous and graceful, they connect us to the world of 15 million years ago, when very similar turtles swam alongside megatooth sharks, or 75 million years ago, when they rubbed shoulders with dinosaurs. Only eight species of marine turtle remain from a lineage that stretches back little changed deep into the age of dinosaurs. The largest living reptile is the leatherback turtle, a barnacle-encrusted eminence that can reach 10 feet long and weigh two tons. Today we confront the stark possibility that people will drive the leatherback turtle to extinction within the next human generation. Already there is just one leatherback left in the Pacific for every 20 in 1962, the year I was born.

Human dominion over nature has finally reached the sea.

With an ever-accelerating tide of human impact, the oceans have changed more in the last 30 years than in all of human history before. In most places, the seas have lost upwards of 75 percent of their megafauna—large animals such as whales, dolphins, sharks, rays, and turtles—as fishing and hunting spread in waves across the face of the planet. For some species, like whitetip sharks, American sawfish, or the once "common" skate, numbers are down as much as 99 percent. By the end of the 20th century, almost nowhere shallower than 3,000 feet remained untouched by commercial fishing. Some places are now fished down to 10,000 feet.

Why, in the face of widespread evidence of human impact, do so many people persist in thinking that the oceans remain wild and beyond our influence? The answer lies in part in the creeping rate of change. Younger generations are often dismissive of the tales of old-timers, rejecting their stories in favor of things they've experienced themselves. The result is a phenomenon known as "shifting baseline syndrome," as we take for granted things that would have seemed inconceivable two generations ago.

Loren McClenachan, a graduate at Scripps Institution of Oceanography, unearthed a telling example of shifting baselines in the archives of the Monroe County Library in Florida. She found a series of photographs of fish landed into Key West by one recreational fishing charter company between the 1950s and 1980s, and extended it by taking her own pictures at the same dock. In the 1950s, huge Goliath groupers and sharks dominated catches, many of them bigger and fatter than the anglers. Over the years, the fish shrink and groupers and sharks give way to smaller snappers and grunts, but the grins on the anglers' faces are just as broad today as they were in the 1950s. Modern-day tourists have no idea that anything has changed.

With the sole exception of Alaskan salmon, which have been well managed, and rockfish or striped bass, which have experienced a resurgence thanks to the careful shepherding of their fisheries, most of the species we like to eat have plummeted since their historic highs. Puget Sound's salmon runs have dwindled to a trickle. Red snapper, bluefish, and menhaden are all overfished in U.S. waters today, while grouper and capelin are far below their 19th-century numbers. In 2010, a quarter of commercial fish stocks assessed in the U.S. were considered overfished, meaning that they lie below target levels, themselves far below historic highs. But this misses the real scale of the problem. Overfishing is only one small piece in a much larger puzzle of interacting impacts.

We pump chemical and industrial pollutants into our rivers and oceans, heedless of consequences, and our unplanned experiment with greenhouse gases is gradually infiltrating the deep sea, changing ocean chemistry, impacting temperatures and oxygen levels, and shifting patterns of underwater currents with dramatic consequences. The path we are on today is pushing ocean ecosystems to the edge of their viability. Few people yet grasp the gravity of the predicament.

I began my career studying coral-reef fish. Thirty years on, fish are still at the heart of my research, but my outlook has expanded to a much wider interest in the relationship between people and the sea. Scientists are specialists and devote their lives to research within narrow fields that become further constricted as time passes. Management of pollution is segregated from that of fisheries, which in turn are rarely considered in the same place as shipping, or climate change. This means that impacts are discussed in isolation and by different people. But a view of the whole is far more alarming than the sum of its parts.

What will the future look like? It is hard to grasp the prospect of seas so compromised that they no longer sustain the ecological processes which we take for granted, and upon which our comfort, pleasure, and perhaps even our very existence depends. In the early days of European seafaring, unexplored areas of ocean were marked on charts as *"Mare Incognitum,"* or "Unknown Seas," and the truth is that we are voyaging into such seas again today.

THE 'RISE OF SLIME': OUR SEAS WILL TRANSFORM INTO JELLYFISH EMPIRES.

The oceans have absorbed around 30 percent of the carbon dioxide released by human activity since pre-industrial times, mainly from fossil-fuel burning, conversion of forests and swamp to cities and agriculture, and cement production. If carbon-dioxide emissions are not curtailed, ocean acidity is expected to rise 150 percent by 2050, the fastest rate of increase at any time in at least the last 20 million years and probably as long as 65 million years, which takes us back to the age of dinosaurs. As Carol Turley, an expert on ocean acidification from Plymouth Marine Laboratory put it, "the present increase in ocean acidity is not just unprecedented in our lifetimes, it is a rare event in the history of the planet."

The effects of acidification are hard to predict. At the very least life is likely to get much more difficult for species with carbonate shells, which includes some of the most important primary producers in the sea, the phytoplankton that sustain food webs and release life-giving oxygen. Any fall in the rate of plankton production

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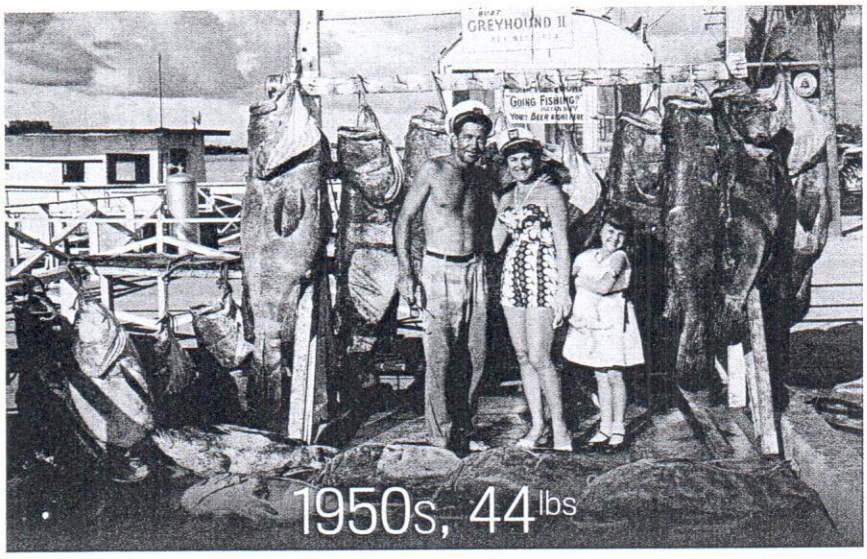
would reduce the snow of organic debris that sinks from sunlit surface layers to the deep sea. Deep-sea communities survive on meager handouts from above, and failure in supply would shrink their numbers.

Acidification is only one part of the problem. The runoff of nutrients from land, in the form of fertilizers and sewage, coupled with rising temperatures, have triggered in recent years an explosion of dead zones, low-oxygen areas where few species can survive. Dead zones are often found at the mouth of mighty rivers like the Mississippi or in populated coastal areas and inland seas. And yet despite their proliferation, future seas will not be lifeless. We are creating winners as well as losers.

Jellyfish, for example, are great opportunists, and some scientists fear that large parts of our most productive seas will transform into jellyfish empires. Jellyfish positively thrive in pollution-enriched seas. Given unlimited food, they can reach adult size fast. With their stinging tentacles, they are formidable predators. Here one of the quirks of ocean food webs comes into play to seal their dominance. Most animals that might eat jellyfish go through tiny egg, larval, or juvenile stages when the tables turn and they are themselves jellyfish prey. Such role reversals of predator and prey are rare on land. In the sea, however, they are prevalent, with surprising effects. The American oceanographer Andrew Bakun invites us to imagine a world in which zebras and antelopes are voracious predators of young of lions or cheetahs. What would the Serengeti look like if this were so?

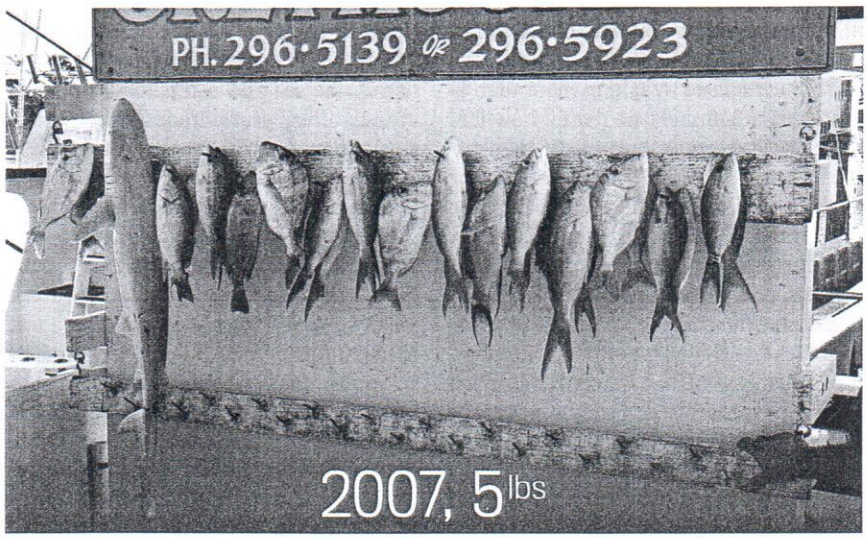
The jellyfish joyride begins when high nutrients combine with a fall in abundance of their predators. When plentiful, jellyfish suppress their predators further by eating more of their young and so pave the way for a full-blown population explosion. Mediterranean resorts have been plagued by jellyfish outbreaks in the last 20 years. The main problem species there is the mauve stinger, whose tentacles inflict slashing welts on the tender bodies of bathers. In the summer of 2004, an estimated 45,000 swimmers were treated for stings in Monaco alone. In 2007, Irish salmon farms were overwhelmed by hordes of mauve stingers which slaughtered tens of thousands of salmon in their deathly embrace. Similar mass killings have been reported in Japan, India, and Maryland.

If food runs short, jellyfish don't just die; instead they shrink and wait until



Sixty years ago, huge grouper and sharks dominated the catches in Key West.

Thirty years on, overfishing in the region had eliminated larger fish from the haul.



By 2007, the average size of Key West's fish had decreased by 88 percent.

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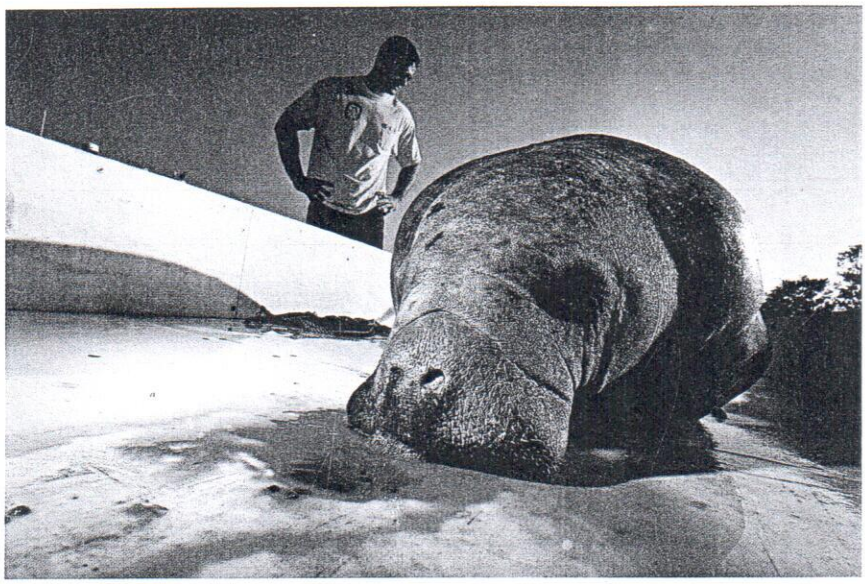


Hundreds of Florida manatees die each year from eating sea grass tainted with neurotoxins.

conditions improve (although if nutrient levels fall far enough and for long enough, jellyfish blooms can snuff out). In a future with more acidified seas, jellies won't have troublesome carbonate skeletons to handicap their chances. The altered oceans that haunt our possible future could offer jellyfish worlds of opportunity. They have been here before. Enigmatic traces in rocks from the earliest Cambrian Period, some 550 million years ago, tell of an age of jellyfish that preceded the great radiation of life that established most of the animal groups alive today. Collectively, the modern reappearance of seas dominated by gelatinous animals, microbes, and algae has been dubbed "the rise of slime." It signals a reversion toward conditions that prevailed in the earliest days of multicellular life.

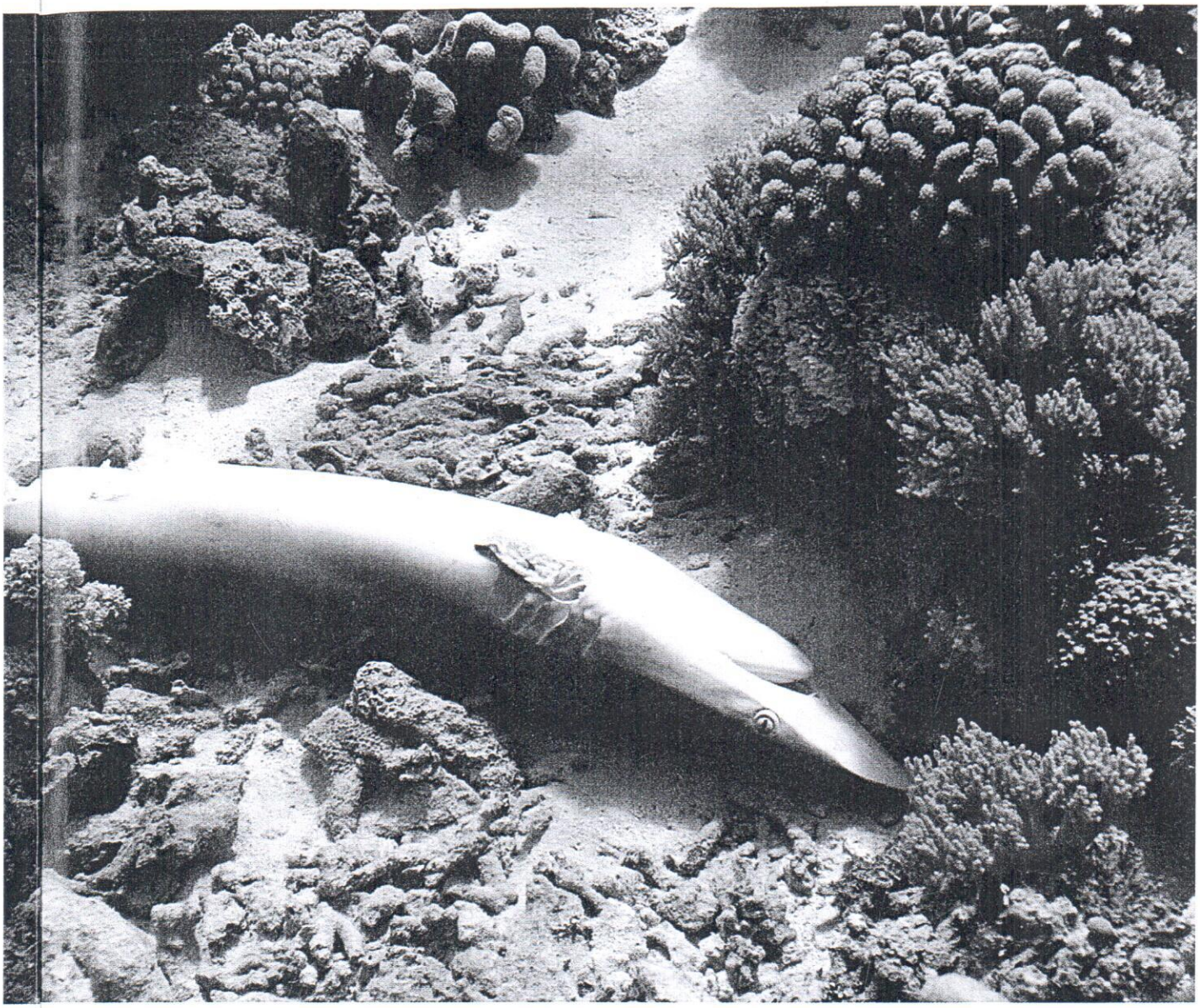
We are living on borrowed time. We can't cheat nature by taking more than is produced indefinitely, no matter how fervently politicians or captains of industry might wish it. In essence, what we have done in the last few decades is to mine fish, bringing them in at rates faster than they can replace themselves. Sharks, bluefin tuna, cod, Chilean sea bass, all have declined steeply as a result of excessive fishing. The price that must be paid for today's rapaciousness will be tomorrow's scarcity, or in some places, seas without fish. If we follow our current trajectory, that point may be only 40 or 50 years away.

Most people are unaware that some of the species that show up on the fishmonger's slab simply cannot sustain productive fisheries in the long run. They grow and reproduce too slowly. Most sharks and the bigger skates and rays fall into this category. So does almost everything caught more than 1,600 feet down—deep sea beasts like Chilean sea bass, orange roughy, or roundnose grenadier. They are caught because they are there, and when they are gone, they disappear from markets. There are good reasons why we farm animals that are highly productive and feed low in the food web, like chickens and cows, rather than bears or cougars. But it is the bears and cougars of the sea that we have grown used to eating.

I often come across people who think that we can't afford to cut back fishing when every day there are more mouths to feed. But simple math tells you that restocking our seas makes economic sense. Think of it this way: if you have a million fish in the sea and can catch 20 percent of them every year without depleting the stock, that stock would give you 200,000 fish a year. Now imagine that you nurtured your fish and gave them a chance to grow so that you had 5 million. Your 20 percent would come to 1 million a year. The interest rate on your capital is the same, but the yield is much bigger. And with fish more abundant, they would be easier to catch, so you would need fewer boats and each would cost less to run.

Wishful thinking? Not really. A World Bank report aptly titled "The Sunken Billions" highlighted the madness of overfishing when it calculated that major fish stocks of the world would produce 40 percent more if we fished them less. It sounds paradoxical—fish less to catch more—but that is the simple message.

People often ask me, "What can I do to help?" One place to start is to avoid eating fish that are overexploited in the wild or taken using methods that harm other wildlife. Try to avoid prawns or scallops and other bottom feeders fished up by dredgers and trawlers, such as plaice, cod, and hake. Eat low in the food web, so favor smaller fish like anchovies, herring, and sardines over big predators like Chilean sea bass, swordfish, and large tunas (you will be doing yourself a favor, as these predators also concentrate more toxins). If you can't give up tuna, choose pole- and



A shark stripped of its fins—which fetch high prices in China—rots in a "graveyard" in the Pacific Ocean.

NANCY BOUCHA—WWW.SCUBASYSTEMS.ORG—MARINE PHOTOBANK

RICK LOOMIS—LOS ANGELES TIMES

line-caught animals, which have virtually zero bycatch. ("Dolphin friendly" versions alone may not be very dolphin friendly, since tuna are often caught with purse seines, walls of net that surround and stress dolphins and snare sharks, turtles, and other wildlife.) Farm-raised fish and prawns often come at a high environmental cost in destroyed habitat and wild fish turned into feed. Vegetarian fish like tilapia and carp are better than predators like salmon and sea bass. Organic is better too, since your fish will have been dosed with fewer chemicals.

If we carry on with business as usual, humanity has a bleak and uncertain future. More fertilizer and sewage input into the oceans would increase the frequency of harmful algal blooms, intensify oxygen depletion, create more dead zones, and set the stage for the jellyfish ascendancy. The spread of aquaculture will eat away at natural habitats and aggravate problems of nutrient enrichment. More intense agriculture on degrading soils will flush extra mud into coastal waters, which would destroy sensitive habitats constructed by invertebrates like corals. Sea-level rises will lead to more sea walls and other defenses in a process of coastal hardening that will squeeze out productive habitats like mud flat and marsh. With the disappearance of these vital nurseries, wild fisheries will suffer, and there will be fewer feeding grounds for migratory birds. And if we remain wedded to all the comforts that modern technology can give us, and remain as wasteful as we are today, the oceans will continue to accumulate toxic contaminants.

There is an old adage, much loved of self-help books, that says "today is the first day of the rest of your life." If we change course by a few degrees now, it will take us to a very different place in 50 years' time from where we are headed now. **NW**

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