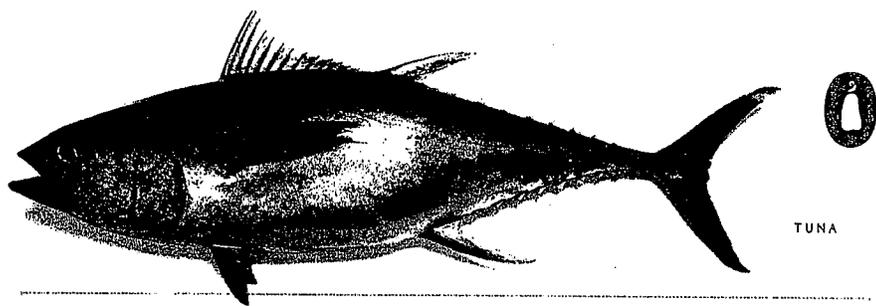


THE NEW YORK TIMES BESTSELLER

SALMON



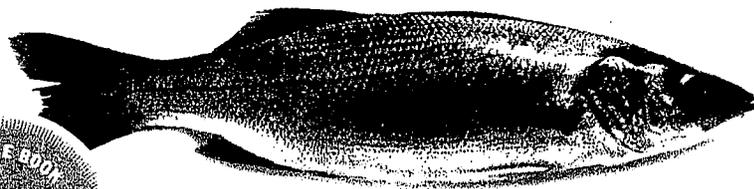
THE FUTURE OF THE LAST WILD FOOD



TUNA

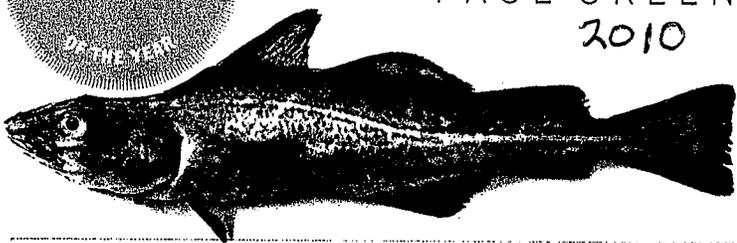
# FOUR FISH

BASS



PAUL GREENBERG  
2010

COD



"A necessary book for anyone truly interested in what we take from the sea to eat, and how, and why." —Sam Sifton, *The New York Times Book Review*

## Conclusion

Whenever I told people that I was writing a book about the future of fish, I would typically get two reactions. The first was the urbane, witty response. "Oh?" my interlocutor would say. "I didn't know fish had a future." Though it was flip and shortsighted, I didn't mind this reply. People generally don't like to look an ugly and serious problem in the eye, and the redirection implicit in this comment was, in a way, very honest and very human.

It was the second response that I found more troubling.

"Oh, you're writing a book about fish. Which fish should I eat?"

Perhaps it is a particularly American trait—the belief that the individual by his or her personal actions can somehow shift the course of history. But when it comes to choosing the "right" fish, the sentiment I first noticed in the United States has spread to other nations,

to the point where a veritable chorus rises up from any table I visit, be it in England, France, South America, or Asia, every time I mention my damn fish book.

"Which fish should I eat?"

Choosing a fish that is well managed or grown on a farm that uses sound husbandry practices is most definitely personally satisfying. One feels "good" when one eats "well." It is not for nothing that the Buddha himself included sound eating practices as part of the path to enlightenment. "Do no harm," the Buddha spoke, "practice restraint according to the fundamental precepts, be moderate in eating. . . ."

But the public's choosing of "good" fish in the marketplace has had little effect on the actual management of wild fish or the practices of growing farmed ones. The Monterey Bay Aquarium—which has distributed over a million seafood cards that label fish as "red" (avoid), "yellow" (good alternative), and "green" (best choice)—took the brave act of commissioning a survey of the programs' effects. The results were telling: fishing pressure had not been significantly reduced on any of the species or stocks consumers were advised to avoid.

In defense of the Monterey Bay Aquarium, I don't believe that the program's innovators thought seafood-advisory cards would actually change fish-consumption patterns. First and foremost, the ratings cards were conceived of as tools for public education. Prior to their introduction, relatively few people knew about the overfishing of bluefin tuna, the negative effects of farming Atlantic salmon, or even the existence of good fishing practices and bad ones. People generally saw individual species the way Mark Kurlansky's mother saw cod: "fish." A crop, harvested from the sea that magically grew itself back every year. A crop that never required planting.

The historical vocabulary around fish echoes this sentiment. Think of the word "seafood" itself. How many genera and species are described by these two opaque syllables? Equivalents in other cultures are no less vague or misleading. In German, French, Spanish, and most of the other Western European languages, seafood is "sea fruit." Slavs, meanwhile, often call the many creatures of the oceans "gifts of the sea." All these expressions imply that the ocean's denizens are vegetative, arbitrary, and free of charge. So-called vegetarians, indignant over the suffering of farmed cows and chickens, frequently include wild fish in their diets. Kosher laws that mandate the merciful slaughter of mammals and birds do not apply to fish.

Thanks to the Monterey Bay Aquarium and other organizations, we are now at a point where we know something about fish. We know that overfishing can and does happen. That, as with terrestrial animal husbandry, fish farming has problems of waste management, disease, and industrial pollutants. We are not Neolithic cave dwellers, showering this flock of passenger pigeons with arrows or driving that herd of mastadons over a cliff. We have inklings of what it is we are doing.

Nevertheless, we are still not grappling with the quandaries of fishing and fish farming in a manner commensurate with the contemporary battles of the food-reform and land-based environmental movements. We are now a bit like the jury in the 1818 *Maurice v. Judd* case. Whereas that jury sequestered itself to decide whether or not whales were fish, we are now deliberating over whether fish are wildlife—wildlife that is sensitive to our actions and merit our sound protection and propagation.

It is not that we don't have choices to make. But the choices ahead are large societal ones that require our careful attention and our active political engagement. After forty years, beginning with

the near global collapse of wild salmon, to the revival of the American striped bass, up through the closure of the cod fisheries on the Georges Bank and Grand Banks, and on into the rise of more sustainable-aquaculture alternatives like tilapia, we have seen numerous examples of oceanic disasters interspersed here and there with real improvements. Wild fish globally are declining, but the examples of science-based successes are marked, accurately documented, and clearly replicable. Pollution and dead zones have grown, but, unlike the terrestrial environment, the essential habitat of much of the world's marine life remains reclaimable. On dry land, urban sprawl consumes 2.2 million rural acres a year in the United States alone, but there is no equivalent development of the sea. If left alone, marine ecosystems have a tendency to rebuild themselves. Global warming is changing oceanic conditions, but fish have survived extreme climate change before and can again. Although ocean acidification is a real and growing threat, a rebuilt and robust wild fish population could help buffer ocean pH. Fish excretions, it turns out, are on the basic side of the pH spectrum. A radical increase in wild fish could be a bulwark against acidification.

What is needed now is a societal choice to give priority to a set of clearly achievable goals for wild fish. Those priorities should include:

1. **A profound reduction in fishing effort.** The world fishing fleet is estimated by the United Nations to be twice as large as the oceans can support. This overcapacity is being maintained primarily through government subsidies. Many billions of dollars are paid by governments to support fishing fleets that without subsidies would not turn a profit. Subsidies thus make wild fish unreasonably cheap. A move away from large, heavily extractive (and heavily subsidized)

vessels that employ very few individuals is critical. An emerging "artisanal" sector of respectful fishermen-herders that will steward the species, as well as catch them, needs to be encouraged and higher market prices will be able to support that kind of activity.

2. **The conversion of significant portions of ocean ecosystems to no-catch areas.** Up until the last decade, the default assumption with the ocean has been that any ocean habitat could and should become fishing grounds if fish are present in abundant numbers. There is, however, growing evidence suggesting that key fish breeding grounds and nursery habitat must be reserved as safe havens if overexploited fish populations are to rebuild to harvestable numbers. It is still a matter of controversy how much territory should be put aside for fish reserves, and today an average of only 1 percent of the world's ocean habitats is protected from exploitation. Surely developed nations that already protect around 10 percent of their land areas could see fit to come up with a similar amount for their ocean holdings. Rather than eating into our principal as we've done for the last thousand years, by setting up a network of fisheries reserves we will in a sense put a portion of our ocean wealth into low-interest municipal bonds, an investment that if left alone will pay a steady, compounded interest over time.

3. **The global protection of unmanageable species.** Species or stocks that straddle too many nations or that occur in unowned, international waters have been shown with very few exceptions to be unmanageable over the long term. In the face of hard science, politicians of multiparty treaties "negotiate" catch allocations that go against scientific reality. Developing nations balk at not being given their "fair share" of these depleted stocks, but if a species shows continued decline over time, as has the Atlantic bluefin tuna, the

only "fair" thing to do is to completely close the fishery. In some cases it may be advisable to consider certain species simply too valuable to hunt. If bluefin tuna were elevated and accorded the same kind of protection tigers, lions, whales, and other sensitive trans-boundary species are given, it could shift public perception of fish and give regulators a line in the sand past which a species is simply not allowed to decline.

**4. The protection of the bottom of the food chain.** With the boom of aquaculture and the rise in the use of fish as feed for pigs and chickens, small forage fish like anchovies, sardines, capelin, and herring now represent the largest portion of fish caught. All of these fish are in greater and greater numbers being ground up in reduction facilities and recast as food for fish farms and terrestrial farming operations. And yet we really do not understand the population dynamics of these smaller forage fish, and we do not really know how to manage them. With the scaling-up of so much aquaculture, we run the very real risk of what Dr. Ellen Pikitch, professor and executive director of the Institute for Ocean Conservation Science at Stony Brook University, called "pulling the rug out from underneath marine ecosystems"—that is, removing the basic food source of the ocean and causing fisheries collapses from below.

According to Pikitch, ecosystem models of forage/predator systems are increasingly showing that intact wild systems are more valuable in raw dollars than are systems converted to aquaculture. When small forage fish are left unharvested, the resulting catch of bigger commercial species that eat those forage animals is greater. There is simply more food in the water, more energy in the system, and that energy is translated into more and bigger fish.

We must therefore take a precautionary approach to the very bottom of the oceanic food chain and exploit those animals only after

models have been developed that indicate the extent of removals that the system will tolerate. We must also seek to rebuild the bottom of the food chain we have already lost by restoring the habitats where forage fish are born and reared. Estuaries and river systems are vital zones of *food* production and not simply "natural" spaces. Nearly every wild fish highlighted in this book—striped bass, European sea bass, cod, Alaska pollock, Atlantic and Pacific salmon, bluefin tuna—depends upon a supply of forage fish whose life cycles are in turn dependent upon rivers and estuaries. Herring, menhaden, smelt—all these small fish are the silver coin, the coin of the marine realm, and their hatching and rearing often occur in direct association with access to rivers that enter the sea. Restoring these areas increases the food supply for the fish we eat most. Deny the restoration and no matter how much conservation occurs at sea, abundance will inevitably be limited by a low ceiling of limited food.

Four very good, noble, and ultimately effective principles that will rebuild the seas. Goals that are more and more becoming part of a new phenomenon taking root in conservation policy, that of "ocean zoning." As more users compete for space in the ocean, some places in the world (the island of Asinara off Sardinia and the state of Massachusetts, for example) have implemented overall zoning goals, much in the same way municipalities plan a town with commercial space, green space, and residential areas. The advantage of zoning the ocean now is that it gives wild-fish advocates a chance to stake out territory *before* wildness has been relegated too far to the margins. Hand in hand with ocean zoning is the rising trend of "ecosystem management." Rather than managing individual species, ecosystem management seeks to manage entire systems, modeling patterns for fishing and restoration that work toward reestablishing the balance of the many demands of prey and predator.

But all the very good and noble goals of ocean zoning and ecosystem management become meaningless in the presence of one ominous factor: human demand.

In spite of campaigns, boycotts, publications, documentaries, and every other means of persuasion known, the global human population keeps growing and humans keep eating more fish every year, not just in aggregate but on a per capita basis. Even with so many warnings about mercury and PCBs, the world nearly doubled its per-person fish consumption in the last half century, from twenty pounds per year in the 1960s to thirty-six pounds in 2005. And because seafood is such a global, boundary-free business, whenever a restaurant, a city, or a country takes to the moral high ground and tries to reduce or improve the footprint of its seafood consumption, another, less scrupulous restaurant, city, or nation is ready to step in and continue the bad practices that the more evolved parties have abandoned.

So if we take as a given that humankind will keep eating fish, more and more of it every year, then we need to come up with a way to direct that appetite away from sensitive, unmanageable wildlife and usher it toward sustainable, productive domesticated fish. A small-scale, artisanal, wild-fish fishery would be a great thing that could inevitably lead to better protection of wild fish. But a small-scale artisanal fishery will never have the industrial capacity of the supertrawlers that decimated the Georges Bank and Grand Banks codfish stocks.

What is needed above all is a standard for boosting fish supplies in as sustainable a manner as possible. Humans should purposefully select a handful of fish species that can stand up to industrial-size husbandry with the goal of compensating for the huge gap between wild supply and growing human demand. Of course, if the global human population continues to grow unabated, no solution will

work; in such a population-growth scenario, only the stars can save us. Indeed, with terrestrial food production now reaching its limits, the ocean is, in a sense, the final option, the only remaining way for humans to convert more of the world's biomass and sun energy into more humans. The future of human growth depends largely on how we manage our ocean.

We therefore have a very clear choice. We can carefully select the fish that work well both in conjunction with human farmers *and* alongside the wild ocean food systems that still function. Or we can run roughshod over the wild ocean, install feedlots up and down the world's coasts, and continue to reap short-term calorie credits irrespective of the long-term ecological debits. If humans are at root rational creatures, then we must without question choose the former path over the latter.

It makes sense therefore to return to and expand upon postulates of an earlier era, to revisit the precepts that Francis Galton posed at the dawn of the industrialization of terrestrial animal husbandry. Galton spoke of wild animals outside the dominion of humankind as "doomed to be gradually destroyed off the face of the Earth as useless consumers of cultivated produce." But with the ocean we need both the undomesticated and the domesticated sides of fish to carry forward. It seems, then, that a new set of principles for the ocean has to be made, one *inclusive* of wild systems, systems as nourishing as they are mysterious. We cannot make up for the elimination of our wild-food calories with farmed replacements. We need both—for our nutritional as well as our emotional well-being.

For too long it has been entrepreneurs who have decided which species to domesticate and which to leave wild. Their decisions have been based on market principles and profit, and they have historically not consulted with the managers and biologists who study

wild-fish dynamics. This is senseless. If we continue along this pathway, we will only destroy one food system and replace it with another, inferior one, just as we have already done in most of the world's freshwater lakes and rivers. We therefore need a set of principles that guide us forward with domestication, one that is inclusive of impacts on wild oceans. I would propose that the next animals from the sea we domesticate should be:

**1. Efficient.** In an increasingly stretched world of food resources, we cannot afford fish that require more feed to produce a pound of edible flesh than do our most efficient terrestrial animals. Fish, by their very nature, *should* be more efficient than land animals. Fish do not have to warm their bodies, and they do not have to stand against gravity. All that energy that is wasted in mammals and birds could and should be redirected into growing fish flesh. Thus the warm-blooded bluefin tuna, whose current feed-conversion ratio can exceed twenty to one, should be abandoned as mass-scale farm animals. If a fish like a Kona Kampachi can be produced with similar flesh density at a fraction of that feed conversion, why pursue the tuna?

**2. Nondestructive to a wild system.** With salmon there is ample evidence to suggest that the culture of farmed variants in close proximity to wild strains can negatively affect wild populations over time. Indeed, if one compares the fate of Atlantic salmon with that of the American striped bass, two fish that were dangerously reduced in the wild and then domesticated, it is instructive to compare their respective fates. Wild salmon populations have generally declined in Maine, Atlantic Canada, and Europe in areas where they interact with farmed salmon. American striped bass, meanwhile, have staged a strong recovery in the wild even in the presence of an aquaculture

program that now accounts for 60 percent of all striped bass consumed. The difference? The fish called "farmed striped bass" is a sterile hybrid created by crossing a female striped bass with a male of a related freshwater species called white bass. The farmed hybrid striped bass cannot interbreed with the wild population of striped bass and thus cannot spread its genes beyond the farm. Furthermore, the hybrid striped bass is grown exclusively in freshwater ponds away from the migration lanes of wild striped bass. Wild populations are thus buffered against contracting farm-born diseases.

If the same separation of wild and farmed fish took place with salmon, the remaining populations of wild salmon might do better. Critics argue that the cost of putting salmon in a closed, recirculating system like that used for Josh Goldman's barramundi would make farmed salmon simply too expensive for the average consumer to afford. This is the logical place for subsidies. If we must subsidize fish consumption, then it certainly makes sense to subsidize those practices we know will contribute to a net gain of fish in the world, not cause the destruction of wild stocks. In certain cases—like Chile, for example—where wild salmon are not endemic and there is no obvious impact upon an existing native population, perhaps open-cage salmon farming could still be allowed. But even there the problems of sea lice and infectious salmon anemia are very clear environmental signs that fish should not be farmed too densely and without careful siting procedures. Less-dense stocking of fish farms will cause price increases, but again, this is where subsidies could help to level the playing field.

**3. Limited in number.** After the technological breakthroughs on feed, reproduction, and husbandry techniques of the 1970s and '80s, it is now theoretically possible to tame pretty much any fish in

the sea. In light of this, we have to be on guard against a certain kind of "Gee whiz, I can do it!" behavior among aquaculture researchers. Just because we *can* tame a fish doesn't mean we *should*. Every time a species is brought into culture, new diseases specific to that species or sometimes that genus can develop and spread to related wild populations. Furthermore, new hurdles present themselves with every new species, and a tremendous amount of time and energy is wasted in the early phases of domestication. Instead of constantly trying to bring new species into an imperfect culture merely because we can, we should instead choose just a handful of animals whose rearing we can perfect. Why farm cod when tilapia is already doing the job? Subtle differences in flesh texture, taste, and nutritional content are controllable through feed and rearing techniques and do not require the taming of a new species. If we want variety of species for niche markets, let that variety be provided by small-scale, sustainable wild fisheries.

**4. Adaptable.** In the debate on aquaculture, environmentalists have frequently taken the position that we should not be farming carnivorous fish, because their overall footprint is larger than that of mostly herbivorous fish like carp and tilapia. Two and sometimes more trophic levels of food consumption have to take place before a salmon gains nutrition from a sardine. Point taken. But the same argument has been made before, most notably with vegetarianism. For many decades now, environmentalists have argued that if all humans were vegetarian, humanity would have a fraction of its current footprint on the globe. I have tried vegetarianism, inspired by this irrefutable logic. And yet I have drifted back to carnivorism, as have many before me. Rather than hoping to change the world by changing consumption patterns, regulations and farm-level reforms need to be put into effect so that unsustainable food doesn't reach

the market in the first place. And where better to start this process than with the world's most commonly farmed fish, salmon? On the downside, it seems unlikely that the environmental community will succeed in dislodging the salmon industry from its dominant position in the farmed-seafood sector. On the upside, salmon do seem to have an adaptability to alternative feeds. Seaweeds and soy are increasingly forming the basis of salmon diets and could replace fish meal altogether in the not-too-distant future. As of this writing, at least one company has developed a completely algae-based feed that replaces the need for fish oil and meal in the diets of salmonids. The problem? Once again, cost. Here is another place for subsidies to play a positive role. Let governments make up for the difference in price between wild-fish meal and synthetic algal feeds until the industry has scaled up. It is an investment in the future.

**5. Functional in a polyculture.** If there is one lesson that has been learned from terrestrial agriculture, it is that monocultures of crops are susceptible to disease and can cause undue environmental degradation. Rather than starting from zero and redoing all of terrestrial agriculture's mistakes, we should start from a place of polyculture, where wastes are recycled as much as possible, where space is maximized for the growing of food, and where *systems* instead of individual species are mastered.

Five principles, then, to lead us to our selection of domesticated animals from the sea. The animals that could and should rightfully be called our "sea food."

As to what we should call wild fish in the future, I leave that to the marketers of what I hope will someday be a more informed and thoughtful fishing industry. But I would suggest that if we continue to eat wild fish, we need to find a new way of identifying them in the marketplace. A set of terms that implies an understanding of

fish as wildlife first and as food second. Wild fish did not come into this world just to be our food. They came into this world to pursue their own individual destinies. If we hunt them and eat them, we must hunt them with care and eat them with the fullness of our appreciation. We must come to understand that eating the last wild food is, above all, a privilege.

"The engrossing story of the impact of history, geography, and politics on our seafood [and] a clear-eyed manifesto for the future of fish."  
—FINANCIAL TIMES

Writer and lifelong fisherman Paul Greenberg takes us on a culinary journey, investigating the four fish that dominate our menus—salmon, sea bass, cod, and tuna. Examining the forces that get fish to our dinner tables, Greenberg reveals our damaged relationship with the ocean and its wildlife. Just three decades ago nearly everything we ate from the sea was wild. Today, rampant overfishing and an unprecedented biotech revolution have brought us to a point where wild and farmed fish occupy equal parts of a complex marketplace. *Four Fish* helps us to navigate this new landscape, offering a way for us to move toward a future where healthy and sustainable seafood is the rule rather than the exception.

"The best kind of environmental journalism: sophisticated but not dry, serious yet marinated in wit, and so well crafted it can be inhaled in one sitting from which you rise amazed to discover how much you've learned."  
—THE SEATTLE TIMES

"Finally we have learned that food is best when produced on a small scale in accordance with the rhythms of our planet. Paul Greenberg's warm and witty *Four Fish* takes this concept to the ocean. Seafood deserves the same kind of respect and political awareness as food from the land. Maybe more."  
—ALICE WATERS

Cover design: Evan Gaffney Design. Cover photographs (from top): Salmon © Dorling Kinderley/Getty Images; Tuna © P. Ginet-Drin/photocuisine/Corbis; Bass © Foodcollection/Alamy; Cod © Teubner Foodfoto/Stockfood Munich.

2010



A PENGUIN BOOK  
Food/Environment

U.S. \$16.00  
CAN. \$18.50

ISBN 978-0-14-311946-3



EAN



9 780143 119463