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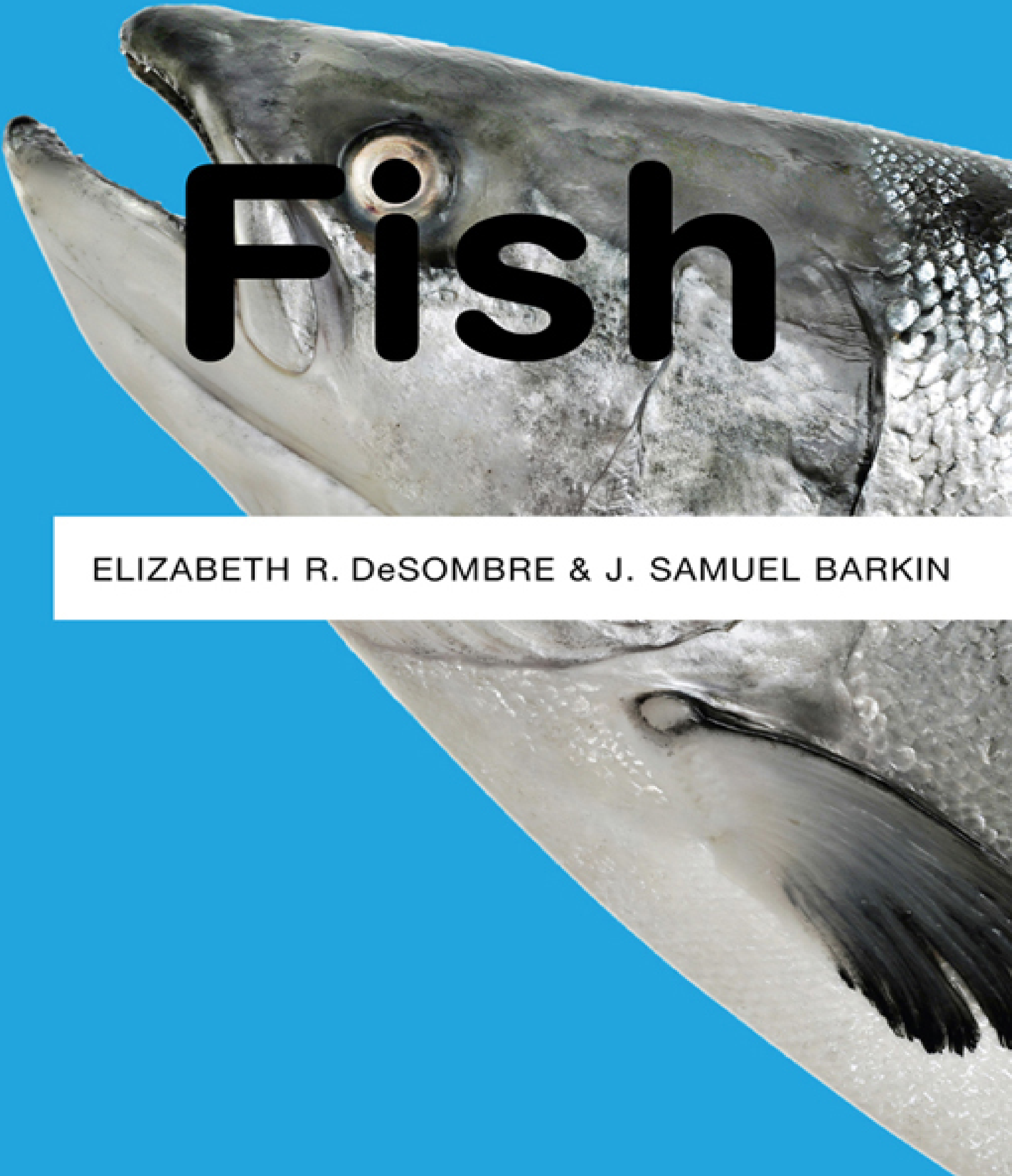
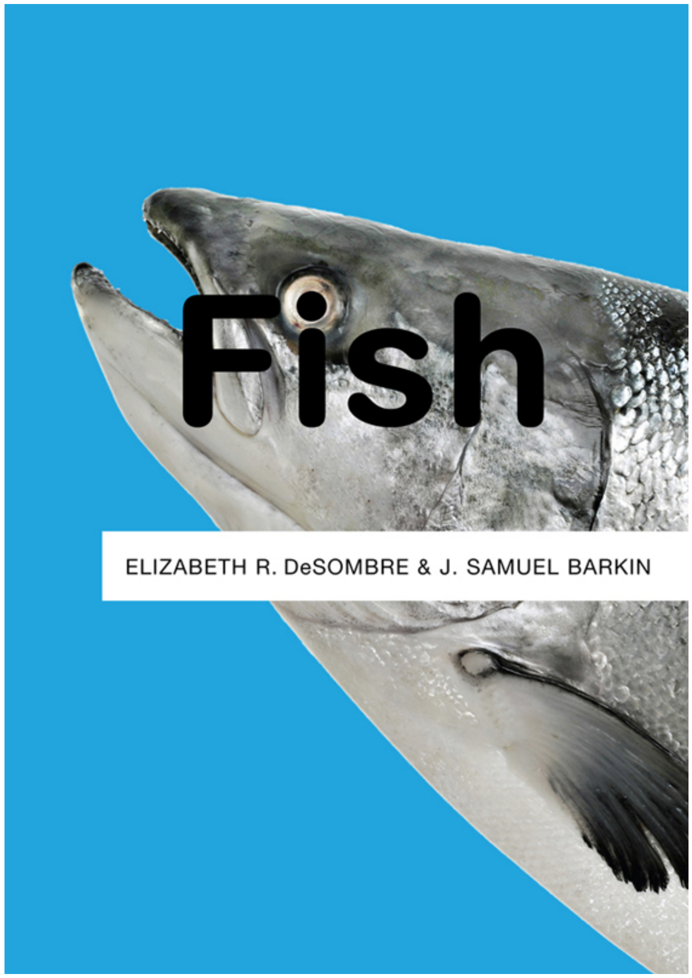
ELIZABETH R. DeSOMBRE & J. SAMUEL BARKIN

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# Contents

# Abbreviations

| | |
|---|---|
| ASEAN | Association of Southeast Asian Nations |
| CAFO | Confined Animal Feeding Operation |
| CCAMLR | Commission for the Conservation of Antarctic Marine Living Resources |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CPR | Common Pool Resource |
| CPUE | Catch Per Unit Effort |
| EEZ | Exclusive Economic Zone |
| ENSO | El Niño Southern Oscillation |
| EU | European Union |
| FAO | United Nations Food and Agriculture Organization |
| GDP | Gross Domestic Product |
| GPS | Global Positioning System |
| ICCAT | International Convention for the Conservation of Atlantic Tunas |
| IFQ | Individual Fishing Quota |
| ISA | Infectious Salmon Anemia |
| ITQ | Individual Transferable Quota |
| IUCN | World Conservation Union |
| IUU | Illegal, Unreported, and Unregulated Fishing |
| IWC | International Whaling Commission |
| MICRA | Mississippi Interstate Cooperative Resource Association |

| | |
|---|---|
| MPA | Marine Protected Area |
| MSC | Marine Stewardship Council |
| NAFO | Northwest Atlantic Fisheries Organization |
| NGO | Non-Governmental Organization |
| NOAA | National Oceanic and Atmospheric Administration |
| OECD | Organization for Economic Cooperation and Development |
| OSPAR | Convention for the Protection of the Marine Environment of the North East Atlantic |
| PCB | Polychlorinated Biphenyls |
| RFMO | Regional Fisheries Management Organization |
| TAC | Total allowable catch |
| TED | Turtle Excluder Device |
| UK | United Kingdom |
| UNCLOS | United Nations Convention on the Law of the Sea |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| USA | United States of America |
| VMS | Vessel Monitoring System |

CHAPTER ONE

# Introduction

You sit down at a restaurant, considering what fish to order, and choose a nice panko-crusted Chilean sea bass.

Long before the fish reached the restaurant menu, a set of marketing executives had decided that “Chilean sea bass” sounded more appealing than Patagonian toothfish, the fish’s true name, despite the fact that the species is in no way related to an actual sea bass (which is a type of grouper) and is only occasionally caught in Chilean waters.

It was, nevertheless, first commercially marketed internationally after Chilean President Augusto Pinochet opened up Chilean waters to foreign fishing trawlers in the 1980s. The newly exported fish quickly caught on in United States (and then Japanese and European) markets and by the 1990s was the new hot menu item in restaurants, increasing the price paid to fishers for capturing the fish, and dramatically increasing catches worldwide. Bon Apétit magazine named it the “dish of the year” in 2001. One of the other reasons for the fish’s newfound prominence on restaurant menus was the depletion of stocks of other fish, such as cod, or even white sea bass (which is an actual sea bass).

Before the fish on your restaurant plate was caught, it lived in cold waters near Antarctica. If it hadn’t been caught it might have lived to an age of 50 years and could have reached a length of 2.3 meters (7.5 feet). It grew slowly, reaching reproductive maturity at about 90 to 100 centimeters in length, at between about nine and twelve years of age, so if it was caught before then it would not yet have had a chance to reproduce. The combination of long life and slow maturation makes it difficult to tell if a species is being overfished. Because it is difficult to regulate catches before there is clear evidence of overfishing, Patagonian toothfish was a strong candidate for fast overexploitation once the species became a commercial success.

If your fish was caught by trawling, a fishing vessel dragged a net over the sea floor to take it in, damaging the sea floor ecosystem and capturing other fish and non-fish species that were probably discarded and subsequently died. This bycatch accounts for as much as one-quarter of what is caught in the world's fisheries. More likely, the fish was caught by a long-line, a set of up to hundreds or thousands of baited hooks (fewer if it was caught by a vessel following international regulations) on one line, reeled out behind fishing vessels and weighted to sink to between 500 and 2,500 meters deep. These longlines often catch seabirds (especially the endangered albatross) or non-target fish, most of which die before they can be released.

The vessel used to catch the fish was a factory fishing vessel, large and well-equipped to be able to stay at sea for months at a time. It can process catches on board, so after the toothfish are caught their heads and tails are removed, they are gutted, and flash-frozen for storage in the hold. Such vessels can hold 300 tonnes of fish before returning to port. The technological revolution allows the fishers to use GPS to find their way to and from the places they set their lines, and sonar to map the seafloor or locate schools of fish, to help the fishers identify likely areas to find the toothfish.

The fishers who caught the fish should have been following the rules set out by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), but odds are that they weren't. Even now, at least twice (and by some estimates five times) the amount of legal catch of toothfish is caught illegally. In the legal gray area are those vessel-owners who register their fishing vessels in countries that are not CCAMLR members. By international law ships are bound by the domestic and international rules their registry state has adopted, so a country that is not a CCAMLR member is not required to follow its catch rules.

Recent efforts by CCAMLR to better protect the stock from unregulated fishing, however, mean that in order to land fish in member countries (including the major toothfish markets of the United States, Japan, and the European Union) the fishers should have to demonstrate that their catches were done in a way consistent with international rules. But it also turns out to be reasonably easy to avoid even that level of regulation. When the rules were first imposed, ships reported catches in a statistically improbable distribution outside of the regulatory area, suggesting that they were perhaps not honest about where their catches took place. More recent efforts to require satellite tracking on ships to verify the locations of their catches have increased the ability of international organizations to determine whether fish were caught legally. But in some cases, the tracking systems report information only to the registry state, thereby avoiding international oversight, and some states may benefit from overlooking the illegal behavior of fishing vessels they register. This tracking process does make the fish sold in CCAMLR member states more likely to be caught within the international rules, but it is still difficult to know. And fish that were caught outside of the regulatory process are indeed able to be sold and consumed, if not in CCAMLR member states, then elsewhere.

If you had carried around your Seafood Watch pocket guide to sustainable fish consumption, from the Monterey Bay Aquarium, you would have found Chilean sea bass on the list of fish to avoid. Likewise, if you had checked with the

Environmental Defense Fund you would have discovered a health advisory for Chilean sea bass; like other fish reasonably high on the food chain, it biomagnifies the mercury contained in the smaller fish it consumes. On the other hand, if the fish came from the bottom-set longline fishery off the island of South Georgia, it would have been certified by the Marine Stewardship Council as originating from a sustainably managed fishery.

All in all, you're wondering whether it might have been simpler to order the pasta instead.

## State of the World's Fisheries

Fish are a key food source for much of the world's population, providing 15 percent of the animal protein consumed globally; nearly one-quarter of the world's people receive more than 20 percent of their animal protein from fish, and in some places in Asia and Africa (as well as in small island developing states) that number exceeds 50 percent.[1] But the ability of the resource to sustain this level of consumption is in serious doubt. Increasingly intense and environmentally degrading commercial fishing methods have called the long-term sustainability of fish stocks into question. One particularly alarmist estimate predicted that global commercial fisheries will completely collapse by 2048.[2]

Not all estimates are quite that pessimistic, but it is clear that the health of ocean fisheries is not strong. The long history of industrial fishing has had a disastrous effect on global fish stocks. The United Nations Food and Agriculture Organization (FAO) estimates that 80 percent of world fish stocks can withstand no increase and may not even be able to sustain the level of fishing currently experienced. At least one-quarter of the world's ocean fish stocks are considered overexploited or depleted, half are fully exploited (permitting no additional fishing growth), with less than one-quarter capable of sustaining any growth in catches.[3] In short, we are, on the whole, not managing the world's fisheries sustainably.

The fish stocks in greatest danger are high-seas, highly migratory fish that are top predators. These fish stocks, which include tuna and swordfish, have declined by up to 90 percent since industrial exploitation began in the 1950s.[4] Cod in the Northwest Atlantic, and salmon, pollock, and halibut in the Atlantic as a whole, are nearly commercially extinct, meaning that they cannot support a commercial fishing industry. The declines of these major predators in turn have effects throughout the ecosystem that often decrease, rather than increase, diversity and abundance of other fish species used for human consumption. Meanwhile, fishing operations move down the food chain and deplete the fish that those top predators had originally consumed.

The loss of biodiversity in the ocean that can be attributed to commercial overfishing leads to a disruption of the productivity of ocean ecosystems more generally, and therefore also disrupts opportunities for future commercial fishing. These changes also affect other ecosystem services such as water quality. Other human-caused problems, like pollution and climate change, have contributed and will increasingly contribute to the stress on fisheries.

The increasing intensity of fishing practices, and expansion and increasing technological sophistication of the fishing industry more generally, as discussed in detail in Chapter 2, have had a devastating effect on the number of fish available for capture. The broader context of who has access to fish and what has accounted for that level and type of access, provides essential background for understanding the context of increased fishing intensity and depletion of fish stocks.

## Diagnosis of the Problem

Many factors have contributed to current and projected problems in the world's fisheries. As is true with other commodities, industrialization has led to more efficient and larger-scale resource extraction and transport. At the same time, a growing world population with rising income has turned increasingly to fish to meet protein needs, as well as needs for healthy oils. Interrelated increases in supply and demand have resulted in the current crisis in ocean fisheries.

There are some ways in which fish are different from other types of resources. With many global commodities, too much control by self-interested profit-seeking actors may generate monopolies or cartels, preventing access to the commodities by those who rely on them, as is the case with industrialized food production or petroleum. The opposite is true with ocean fish. Too many people have access, and there is too little control over what any of them can do.

### *Issue Structure*

The reason for the difference between fisheries and most other natural resources is the issue structure of the resource. Two elements of this difference are key: the ownership of fisheries, and the way that fisheries resources reproduce themselves. These elements of issue structure are exacerbated by uncertainty about many aspects of fish biology and ecology, and the effects of exploitation on fish populations.

Unlike most resources, fish are generally unowned. A farm or an oil well is generally owned by a person or company (or at minimum someone has the exclusive right to farm or pump from a particular patch of land). That person or economic entity thus has an interest in using the resource in a way that maximizes its long-term potential, because if it is abused, the owner suffers most from the effects. And when ownership is not clear, bad things often happen. When people farm land to which they do not hold clear title, they are less likely to maintain the land well. When countries pump oil that is not clearly theirs, international incidents, and sometimes major wars (such as the Iraqi invasion of Kuwait) can happen.

But it is rare for a fisher to own a particular fish until it is caught. This means that fisheries work on a first-come, firstserved basis in a way that is not generally the case with other resources. The absence of clear ownership means that individual fishers do not have a clear incentive to restrain their fishing today for the sake of the health of the fishery in future years, because if they do not catch a fish, somebody else probably will. (Note that aquaculture – fish farming – does not work this way, making it a very different industry from the capture of fish in the wild, as is discussed in Chapter 5.) An area in which a resource is available on a first-come, firstserved basis is called a commons, and the resource itself is called a common pool resource (CPR). Most bodies of water are examples of commons, and the ocean is a global commons. Fisheries are a classic CPR.

Common pool resources have two key characteristics. They are subtractable (or what economists would call "rival"), meaning that use of the resource by one actor diminishes its usefulness for others. Fish taken from the ocean can no longer be caught by others, and they are no longer there to reproduce and thereby create new fish to be caught by others. And they are nonexcludable – it is difficult, both physically and, often, legally, to prevent access to them.

These structural characteristics create a set of incentives that make fishery problems particularly difficult to address. Fishery problems create tensions between collective and individual incentives, and between long-run and short-run incentives. On the one hand, because those who catch fish are, in part, harmed by their own fishing activity that decreases the abundance of fish, the very actors engaged in depleting the fishery are those who would benefit if the resource could be successfully protected. Collectively, fishers will benefit from successful management of fisheries, because it will enable them to keep fishing for the long-term.

But the temptation to free-ride on others' protection of the resource is clear. As Garrett Hardin pointed out in his important overview of the "Tragedy of the Commons,"[5] those who use a common pool resource gain all the positive utility of their action (in this case, the fish that has been caught) but only a portion of the negative utility (its absence from the ecosystem), which is shared with all other users. In the short run, therefore, the decision is often weighted toward the individual advantages to the user of the resource, who bears only a fraction of the downside of his or her resource use. The best option for a given fisher is to take a lot of fish while everyone else in the system refrains from overfishing. The one who does not exercise restraint can take advantage of the increased supply of fish. The problem, of course, is that if everyone acts that way, there is no conservation of the resource. Moreover, even if fishers can be persuaded that collective action to restrain fishing behavior is in everyone's interest, the fear that others will not go along with the action may undermine an individual's willingness to do so. In game theory the "sucker's payoff" refers to the situation in which you act for the collective good and others do not; the restraint you exhibit might have been useful if everyone else did as well, but instead you lose twice: by limiting your fishing behavior in the first place, and because the fish stock will not be saved so you will not reap the long-term benefit of your conservation action.

And because of the subtractability of the resource, efforts to limit fishing behavior to protect the resource are even more difficult. In some cooperative enterprises, free riders – those who do not contribute their fair share to the endeavor – might not undermine the cooperative outcome. The outcome in these cases is called a public good, which is different from a CPR in that it is not subtractable. A person who watches public television without contributing during the annual pledge drive will not help keep the channel on the air, but does not diminish it by her viewing activity. Unlike the provision of public goods, in which a small committed group of actors can choose to take action without the participation of all involved and thereby address a global problem, a common pool resource cannot be successfully protected by a sub-group of users. Anyone who does not join a collective fishery management agreement or consent to refrain from overfishing can actively undermine the ability of those who are cooperating to address the problem.

Many of the world’s fishery resources are entirely contained within countries, or within their exclusive economic zones (EEZs). These are areas of ocean up to 200 nautical miles from shore where countries can claim exclusive rights to manage economic activity. From the perspective of fisheries management, fish within EEZs are owned by the country whose EEZ the fish are in. Countries should have an incentive to manage these resources well, but still face the problem that, from the perspective of fishers, fish are CPRs. They are not owned by the individual fisher, and other fishers can still access that fish; once someone else has caught it, it is no longer available for you to catch. For that reason, even within an EEZ, most fishers behave as though the fishery is a common pool resource.

Other fishery resources, including some of the most valuable fish (such as Patagonian toothfish) either live in international waters, or swim between different EEZs or between EEZs and international waters. These create a CPR problem at the international level. Not only are these fish CPRs from the perspective of individual fishers, but they are CPRs from the perspective of governments as well. A fishery in international waters is first-come, first-served from the perspective of a government that wants to promote its fishing industry; if fishers from that country do not catch those fish, fishers from somewhere else will.

The time horizons of fishers and politicians add to these difficulties. Protecting fisheries requires taking costly or difficult action in the short term that will likely have benefits in the future, if everyone actually contributes. That approach is difficult to embrace. Individuals have good reasons to value the present over the future: food, or profits, now can be used for current needs or to plan for future ones. A fish left in the ocean may help create more fish for the future, but a fish caught now can be eaten or sold now. Politicians, as well, have clear time horizons: causing suffering (by restricting the ability of people to fish, for instance) that will not have paid off with beneficial results before the next election is a recipe for political defeat. It should not therefore be surprising that politicians have been reluctant to take sufficient action to require a reduction of fishing effort by their constituents.

The second key way in which the issue structure of fisheries is different from that of most other natural resources is the supply of fish. Many natural resources, such as metals or oil, are non-renewable – there is a certain amount out there, and once it is used it is not replaced. Others are renewable, but the regrowth is directly assisted by humans. Agricultural crops, for example, tend to be replanted by the same people who harvested the previous lot. Fish are renewable, but (with the exception of aquaculture, yet another reason why it is fundamentally different from capture fisheries) we count on them to renew themselves without our assistance. Fishers do not hold eggs in reserve and restock the ocean when they are done fishing.

There is thus a delicate trade-off between the economic activity of catching fish, and the need to leave enough fish behind to replace the ones caught. If too many are caught, there will be fewer next year. If far too many are caught, there may be none next year. A tricky element of the trade-off is that fish stocks often need a certain density in order to maintain themselves, in order to find mates efficiently and prevent encroachment on their ecological niche by other species. So it is not the case that one has only to leave a few fish to reproduce, even if they can often generate thousands or millions of eggs per female. The population level necessary for a stock to maintain itself may be reasonably high. Furthermore, fish populations often decline rapidly when fished beyond a sustainable level, meaning that it is easy to fish beyond this level and have the stock collapse without warning.

The irony here is that renewable resources such as fish can be easier to use up than non-renewable resources. A nonrenewable resource will gradually get scarcer, and therefore more expensive to extract. As it gets more expensive, people should start using less of it, reducing demand pressure on what remains. The market for non-renewable resources is self-correcting in this way. But as a renewable resource, the market for fish does not self-correct in the same way. The market often does not send signals to fishers to catch fewer of a species as it gets closer to the line of overexploitation, and as a result more help is needed from regulators to correct overexploitation that undermines the ability of the resource to renew itself.

All of these factors, and in particular the tradeoff between current and future benefits and the question of the renewability of the resource, are even more difficult to manage in the context of uncertainty about the state of the fish stock or the behavior of fishers or regulators.

*Uncertainty*

Uncertainty is a key reason that global fisheries are particularly difficult to manage well. There is uncertainty about almost every aspect of fisheries, about such things as population estimates, reproductive cycles, ecosystem characteristics, and human behavior. This uncertainty colors the behavior of individual fishers, of countries making regulatory and resource decisions, and of international organizations attempting to prevent overfishing.

There is, first, a lot of basic information about fish about which we are uncertain. At any given point in time no one actually knows how many fish of a given species there are in a particular area of the ocean, and it is often unclear whether those numbers are increasing or decreasing. At some points in recent history that uncertainty has been central to decisionmaking difficulties, particularly about international management of fisheries. Population estimates are difficult for any species, but much harder when the species cannot be directly observed, as is the case under water.

Population estimates in fisheries have been done in part by examining catch statistics and how the difficulty of catching fish has varied over time or season (with the understanding that as it becomes harder to catch fish, there must be fewer of them to catch). Because technology has changed over time (thereby allowing people to catch fish more efficiently) these estimates are usually calculated as Catch Per Unit Effort (CPUE). And for a variety of reasons, these estimates may not be reliable. In the first place, many fishing techniques produce extensive bycatch, the harvesting of unintended fish that may even be discarded. Gaining an accurate assessment, across all fisheries, of how much of what species is being caught is therefore extremely difficult, since fish that are bycatch in one fishing operation may be the target species in another.